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Epidemiology, screening and management of *Chlamydia trachomatis* infection in New Zealand

Jane Marie Morgan

*A thesis submitted in fulfilment of the requirements for the degree of Doctor of Medicine, Faculty of Medicine and Health Science, The University of Auckland, 2013*
Abstract

Control of *Chlamydia trachomatis* infection poses a substantial public health challenge internationally and in New Zealand. This thesis provides new knowledge to support improved practice in relation to chlamydia infection in the New Zealand health context. Several studies were conducted:

- Comparing laboratory and hospitalisation data from the upper North Island showed:
  - Chlamydia testing rates were 2.6 fold higher in 2008 than in 1998 (9801 vs. 3732 tests per 100000 population).
  - Chlamydia case rates were highest in women aged 15-24 years (5737 in 2008 vs. 1922 in 1998 per 100000 population).

- Examining laboratory chlamydia testing data from 2008-2010 found:
  - Using tests as the numerator, rather than individuals, over-estimated screening coverage for women aged 15-24 years (45% vs. 30.7% in 2010); less so for men (7.1% vs. 5.9%).
  - Rates of repeat testing were higher in women, in younger age groups and following a positive, rather than negative, baseline test (p<0.001).

- Chlamydia screening coverage increased from 13.9% to 16.8% between 2003-2005, in women aged 18-24 years attending GP practices targeted to provide free sexual health visits, compared with control (fee-paying) practices in the Waikato DHB.

- Evaluating chlamydia case management in 2008 against new national guidelines found there was limited patient follow-up, or documentation of partner notification, in non-sexual health clinic settings.

- There was no significant change in district-wide chlamydia testing rates after implementation of primary care chlamydia guidelines in the Waikato DHB in 2009.

Discussion

There is a large burden of chlamydial disease in young women in New Zealand, yet screening coverage among those most at risk of infection remains sub-optimal. There is
scope for improved case management and effective partner notification in the Waikato DHB. More robust surveillance systems are required and improvements can be achieved by dataset linking. Free primary care visits for under 25 year olds are associated with higher testing rates. However, further increases in screening coverage require a more fundamental shift in clinical practice and, likely, an incentive to change.
Acknowledgements

I owe huge thanks to my supervisors, Prof Ross Lawrenson and Assoc Prof Mark Thomas; their mentoring, teaching and support have been invaluable and hugely appreciated. I am also grateful to the Ministry of Health, for funding the planning and the implementation of the Waikato DHB chlamydia project, and to the Waikato Clinical School of Medicine, for funding a summer studentship for the free GP visits study and for the chlamydia trends study.

Many people have helped make this research possible. I gratefully acknowledge and thank: policy analysts, Shefali Pawar at the Waikato PHO and Regan Webb at the Waikato DHB, for help with exploring data sources and for providing data; all the laboratory staff who generously and repeatedly provided testing data; the STI team at Environmental Science & Research Ltd and Laura Neilson at the Ministry of Health for national data; Steve Holmes at the Waikato DHB for invaluable computing help that enabled mapping with the sexual health clinic database; the Waikato DHB audit support unit staff for help with disease classification and for case management data entry; Andrew Winnington and Chanukya Colonne, for data entry and coding during the aforementioned summer studentships; and the Te Ahurei youth group for project discussions and invaluable help with developing patient resources. I am indebted to the many clinical staff that participated in discussion groups, contributed case management data, and entrusted me with honest feedback and insights into their practice. I am very appreciative for the help with statistical analysis from Andre Donnell, Dr Jarrod Haar, and Dr Sarah Woodhall. Thanks also go to Peter Simpson and Dr Noreen Mir for proof reading this thesis.

Many other individuals have provided collegial support for which I am very grateful. I had the privilege of collaborating with an international network of researchers, as a result of the work in this thesis, and hugely appreciate the opportunities they provided to discuss chlamydia control in other countries. I am indebted to the staff of the Hamilton sexual health clinic, including Dr Emma Lim, and to the members of the Waikato DHB chlamydia project advisory group, for their support. Special thanks go to Dr Anita Bell, who undertook statistical analysis for several studies and, thankfully, was always happy to vigorously debate my ideas, and also to Dr Bob Hancox, for his helpful advice on various aspects of my research over the last decade and for encouraging me to embark on this journey.

Finally, and most importantly, I wish to thank my husband John for his love and support and for being the most wonderful dad to our two boys, James & Eddie.
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# Table of Contents

Abstract.................................................................................................................... ii
Acknowledgements.................................................................................................... iv
Co-Authorship Forms .................................................................................................... v
List of Figures .............................................................................................................. xvii
List of Tables ............................................................................................................... xviii
Abbreviations ........................................................................................................... xix
Research Outcomes .................................................................................................... xx

## Chapter 1: Genital *Chlamydia trachomatis* infection ........................................ 1

Overview .................................................................................................................... 1
Terminology ................................................................................................................ 1
History ........................................................................................................................ 1
Biology ....................................................................................................................... 2
  Life cycle.................................................................................................................. 2
  Taxonomy ................................................................................................................ 3
  Serovars .................................................................................................................. 4
Clinical syndromes ................................................................................................... 4
  Pelvic inflammatory disease (PID).......................................................................... 5
  Ectopic pregnancy .................................................................................................. 8
  Female infertility .................................................................................................... 10
  Adverse pregnancy outcomes .............................................................................. 11
  Epididymitis .......................................................................................................... 11
  Male infertility ...................................................................................................... 12
Diagnosis ................................................................................................................... 12
  Culture and other non-NAAT tests ..................................................................... 13
  Nucleic acid amplification tests (NAATs) ............................................................ 14
  Genital *C. trachomatis* NAAT samples .............................................................. 15
Treatment of *C. trachomatis* infections ................................................................. 16
Management of sexual partners ............................................................................. 19
Chlamydia prevalence in New Zealand ................................................................. 20
Chlamydia prevalence internationally ................................................................. 25
New Zealand’s health care system ......................................................................... 28
STI surveillance ....................................................................................................... 31
  STI surveillance in New Zealand ......................................................................... 31
  Sentinel clinic STI surveillance ........................................................................... 31
  Laboratory-based surveillance ............................................................................. 33
Reported chlamydia cases in New Zealand ........................................................ 36
Recent trends in New Zealand ............................................................................... 38
Comparison with internationally-reported chlamydia cases ............................... 40
Approaches to chlamydia control .......................................................................... 42
  Duration of *C. trachomatis* infection ................................................................. 42
  Transmissibility of *C. trachomatis* infection .................................................... 42
Risk behaviours ........................................................................................................... 43
Prevention ....................................................................................................................... 45
Screening for \textit{C. trachomatis} infection ........................................................................... 47
  Screening effectiveness ............................................................................................... 47
  Young people’s views ................................................................................................. 51
  Barriers to primary healthcare .................................................................................. 53
  Health providers’ attitudes and practice ....................................................................... 54
  Interventions to increase chlamydia screening ......................................................... 56
  International approaches to chlamydia screening ...................................................... 56
  New Zealand’s approach to chlamydia screening ....................................................... 58
Conclusions ..................................................................................................................... 59

Chapter 2: Programme of research ............................................................................... 61
  Rationale ...................................................................................................................... 61
  Aims ............................................................................................................................. 61
  Overview of the thesis ............................................................................................... 62
  My role ......................................................................................................................... 63

Chapter 3: Trends of reported chlamydia infections and related complications in New Zealand, 1998-2008 ....................................................................................... 64
  Introduction .................................................................................................................. 64
  Methods ....................................................................................................................... 64
    Chlamydia case and testing data ............................................................................. 64
    Reproductive tract morbidity data .......................................................................... 65
    Statistical analysis .................................................................................................. 65
  Results ......................................................................................................................... 66
    Testing and Detection ............................................................................................... 66
    Reproductive tract morbidity data .......................................................................... 67
  Discussion .................................................................................................................... 69

Chapter 4: Chlamydia testing across a New Zealand district; three years of laboratory data ................................................................................................................. 72
  Introduction ................................................................................................................ 72
  Methods ...................................................................................................................... 72
  Results ......................................................................................................................... 74
  Discussion .................................................................................................................... 76

Chapter 5: General practice funding to improve provision of adolescent primary sexual health care in New Zealand: results from an observational intervention ........................................................................................................... 78
  Introduction ................................................................................................................ 78
  Methods ...................................................................................................................... 78
    Setting ...................................................................................................................... 78
    Study design ........................................................................................................... 79
  Results ......................................................................................................................... 80
    Testing by intervention phase ................................................................................. 81
    Positives by intervention phase ............................................................................... 83
  Discussion .................................................................................................................... 84
Chapter 6: A multi-setting audit of the management of genital Chlamydia trachomatis infection .......................................................... 87

Introduction ......................................................................................... 87
Methods ............................................................................................... 87
Results .................................................................................................... 88
  Standard 1: Appropriate sampling should be undertaken. .................. 90
  Standard 2: The patient is aware of the implications of a positive test .... 90
  Standard 3: Treatment should be given for presumed chlamydia infection if there is a high index of suspicion (e.g. known contact of chlamydia infection, male with urethral discharge) without waiting for laboratory confirmation ......................... 90
  Standard 4: Treatment of uncomplicated chlamydia infection should be with standard treatment (drug, dose, duration). ................................................................. 91
  Standard 5: A test-of-cure is recommended if the patient is pregnant. .......... 91
  Standard 6: All patients identified with chlamydia infection should have partner notification discussed with them at the time of treatment by a trained health professional. ......................................................... 92
  Standard 7: All recent sexual contacts need to be notified that they require testing and treatment. .................................................. 92
Discussion .............................................................................................. 92

Chapter 7: Is everyone treated equally? Management of genital Chlamydia trachomatis infection in New Zealand .............................................. 96

Introduction ......................................................................................... 96
Methods ............................................................................................... 96
Results .................................................................................................... 97
  Presenting features ........................................................................... 99
  Treatment ......................................................................................... 99
  Partner management ......................................................................... 100
Discussion .............................................................................................. 101

Chapter 8: Does text-messaging test results reduce time to treatment of Chlamydia trachomatis infection? .................................................. 104

Introduction ......................................................................................... 104
Methods ............................................................................................... 104
Results .................................................................................................... 105
Discussion .............................................................................................. 106

Chapter 9: Does a clinical guideline change chlamydia testing? Report from the Waikato Chlamydia Project .................................................. 108

Introduction ......................................................................................... 108
Methods ............................................................................................... 109
Results .................................................................................................... 112
Discussion .............................................................................................. 114

Chapter 10: Discussion .......................................................................... 117
Trends of reported chlamydia cases and related complications ............. 117
Chlamydia screening coverage and repeat testing rates ....................... 123
Interventions to increase chlamydia testing rates in primary care settings ... 130
Improving case management for Chlamydia trachomatis infections ....... 137
List of Figures

Figure 1-1 Electron micrograph of *C. trachomatis* bacteria within an inclusion (white) inside a host cell (green) ................................................................. 2
Figure 1-2 Schematic representation of *Chlamydia trachomatis* life cycle [11] ...................... 3
Figure 1-3 Chlamydiaceae taxonomy [11] .............................................................................. 4
Figure 1-4 Schematic representation of *Chlamydia trachomatis* infection and sequelae in women .............................................................................................................. 5
Figure 1-5 Schematic representation of *Chlamydia trachomatis* with different targets for diagnostic tests [52] ........................................................................................................... 12
Figure 1-6 Map of New Zealand’s 20 district health boards in 2012 [152] ............................ 29
Figure 1-7 The structure of New Zealand’s health system, 2008 [151] ................................. 30
Figure 1-8 Map of New Zealand showing laboratory participation in voluntary chlamydia surveillance in 2005 and 2007 [115] ......................................................... 34
Figure 1-9 Map of New Zealand showing laboratory participation in voluntary chlamydia surveillance in 2009 and 2011 [115] ................................................................. 35
Figure 1-10 Confirmed chlamydia cases reported by sexual health clinics by age group and gender, 2011 [115] ......................................................................................... 38
Figure 1-11 Chlamydia case numbers in sexual health clinics by gender and age group, 2006-2011 [115] ................................................................. 38
Figure 1-12 Chlamydia case numbers reported from sexual health clinics by ethnicity, 2006-2011 [115] ................................................................. 39
Figure 1-13 Chlamydia case rates in selected DHBs, 1998-2011 [135] .................................... 39
Figure 1-14 Serial monogamy and concurrency [174] ............................................................ 44
Figure 1-15 Theoretical model for explaining prevention behaviour [198] ............................. 52
Figure 3-1 Laboratory chlamydia testing and percent-positivity of tests by total regional population and region, 1998-2008 ................................................................. 66
Figure 3-2 Total regional laboratory-reported cases by gender and age-band, 1998-2008 67
Figure 3-3 Rates of publicly funded hospital discharges chlamydia-related reproductive tract conditions by age-band (15–44 years), 1998-2008 ........................................... 68
Figure 4-1 Map of Waikato District Health Board [274] ..................................................... 73
Figure 4-2 Kaplan-Meier survival curves for incidence of repeat testing by gender, age group and result of baseline test, 15 to 44 year olds (February 2008 to January 2011) ..... 76
Figure 9-1 The Waikato DHB chlamydia project phases of planning, implementation and evaluation .............................................................................................................. 109
Figure 9-2 The Waikato DHB azithromycin claim volumes by month and gender, Feb 2008 to Dec 2010 ................................................................................................. 114
Figure 10-1 Trends in chlamydia diagnosis rates, testing rates and percentage of chlamydia test with a positive result, 1999 - 2008 [273] ...................................................... 119
Figure 10-2 Trends in chlamydia diagnosis rates, and rates of hospitalisation for PID, ectopic pregnancy and infertility, by country, 1999 - 2008 [273] ............................... 120
Figure 10-3 Trends in rates of hospitalisation for PID, by age-group and by ICD-10 code 56.1, for the upper North Island, New Zealand, 1998 – 2008 .......................................... 121
# List of Tables

Table 1-1 Estimates of sensitivity and specificity for diagnostic test for *Chlamydia trachomatis* in urogenital specimens \[73\] .................................................................................................................. 13
Table 1-2 New Zealand chlamydia prevalence studies .......................................................... 22
Table 1-3 General population chlamydia prevalence from published large-scale international studies ........................................................................................................................................... 27
Table 1-4 Number of test-positive chlamydia cases and chlamydia rates by DHB and gender, 2011 \[115\] .......................................................................................................................................................... 36
Table 1-5 Number of chlamydia tests per 1000 population, test positivity and number of laboratory-confirmed cases, by DHB, 2011 \[115\] ............................................................................................................................... 37
Table 1-6 Reported rates of chlamydia per 100 000 population, ranked by overall rates.... 40
Table 3-1 Annual publicly funded hospital discharges for chlamydia-related reproductive tract conditions in men and women aged 15–44 years, 1998-2008........................................ 67
Table 4-1 Chlamydia test positivity, 2008-2010, and annual population coverage of chlamydia testing, by gender, age group and ethnicity for the Waikato DHB, 2010 ........ 75
Table 5-1 Waikato PHO practice demographic and testing data ........................................ 81
Table 5-2 Total *Chlamydia trachomatis* tests by intervention phase, 2003-2005 .......... 83
Table 5-3 Total *Chlamydia trachomatis* positive tests by intervention phase, 2003-2005 ... 84
Table 6-1 Recommendations in MOH chlamydia guidelines ............................................ 88
Table 6-2 Locality of participating sites ................................................................................ 89
Table 6-3 Demographics of 415 chlamydia cases ............................................................ 89
Table 6-4 Participating sites’ treatment documentation ....................................................... 91
Table 7-1 Demographics of all the Waikato DHB cases and of study sample ................... 98
Table 7-2 Main reason for test and treatment documentation by gender ......................... 99
Table 8-1 Demographics of chlamydia cases in 2005 and 2007 ....................................... 105
Table 8-2 Time outcomes pre and post intervention......................................................... 106
Table 9-1 The Waikato DHB chlamydia tests by year, age-band, gender and ethnicity during each period, 2008-10.................................................................................................................. 113
Table 10-1 Key findings of trends of reported *Chlamydia trachomatis* infections and related complications................................................................................................................. 118
Table 10-2 Key findings of analysis of three years of laboratory chlamydia testing data in the Waikato DHB .............................................................................................................................. 125
Table 10-3 Key findings of an observational study of General Practice funding to improve provision of adolescent primary sexual health care and of a study of chlamydia testing volumes following clinical guideline implementation ........................................ 131
Table 10-4 Key findings of a multi-setting audit of the management of genital *Chlamydia trachomatis* infection and of a study to assess if text messaging results reduces time to treatment ................................................................................................................................................... 138
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>BPACnz</td>
<td>Best Practice Advocacy Centre Ltd (New Zealand)</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CME</td>
<td>continuing medical education</td>
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<tr>
<td>DFA</td>
<td>direct fluorescent antibody</td>
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<tr>
<td>DHB</td>
<td>District Health Board</td>
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<tr>
<td>DNA</td>
<td>deoxyribonucleic acid</td>
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<tr>
<td>EIA</td>
<td>enzyme immunoassay</td>
</tr>
<tr>
<td>ESR</td>
<td>Institute of Environmental Science and Research Ltd</td>
</tr>
<tr>
<td>FPC</td>
<td>family planning clinic</td>
</tr>
<tr>
<td>GP</td>
<td>general practitioner</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
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<tr>
<td>ICD</td>
<td>international classification of diseases</td>
</tr>
<tr>
<td>IVF</td>
<td><em>in-vitro</em> fertilisation</td>
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<tr>
<td>LCR</td>
<td>ligase chain reaction</td>
</tr>
<tr>
<td>LGV</td>
<td>lymphogranuloma venereum</td>
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<tr>
<td>LPS</td>
<td>lipopolysaccharide</td>
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<tr>
<td>MOH</td>
<td>Ministry of Health</td>
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<tr>
<td>MOMP</td>
<td>major outer membrane protein</td>
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<tr>
<td>NAAT</td>
<td>nucleic acid amplification technique</td>
</tr>
<tr>
<td>NHANES</td>
<td>national health and nutrition examination survey</td>
</tr>
<tr>
<td>NHI</td>
<td>national health index</td>
</tr>
<tr>
<td>nvCT</td>
<td>new variant <em>Chlamydia trachomatis</em></td>
</tr>
<tr>
<td>PCR</td>
<td>polymerase chain reaction</td>
</tr>
<tr>
<td>PHO</td>
<td>primary health organisation</td>
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<tr>
<td>PID</td>
<td>pelvic inflammatory disease</td>
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<tr>
<td>RNA</td>
<td>ribonucleic acid</td>
</tr>
<tr>
<td>SDA</td>
<td>strand displacement amplification</td>
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<tr>
<td>SHC</td>
<td>sexual health clinic</td>
</tr>
<tr>
<td>SHYC</td>
<td>student and/or youth health clinic</td>
</tr>
<tr>
<td>SMS</td>
<td>short messaging service</td>
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<tr>
<td>STI</td>
<td>sexually transmitted infection</td>
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<tr>
<td>TFI</td>
<td>tubal factor infertility</td>
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<tr>
<td>UK</td>
<td>United Kingdom</td>
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<td>US</td>
<td>United States of America</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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</table>
Research Outcomes

Included publications

7. Morgan J, Woodhall S. Repeat chlamydia testing across a New Zealand district; three years of laboratory data. Sex Transm Infect, 2013 Feb;89(1):28-31

Related publications and conference proceedings

1. Morgan J, Bell, AJ. The highs and lows of opportunistic chlamydia testing; uptake and detection in Waikato, New Zealand Sex Transm Infect. 2009;85:452-454

7. **Morgan J.** Waikato Chlamydia Project Oral abstract at New Zealand Sexual Health Society 32nd annual conference, Wellington, Sept 2010

Chapter 1: Genital *Chlamydia trachomatis* infection

**Overview**

Chapter one describes the diagnosis, clinical presentations, clinical management, epidemiology and approaches to control of genital *Chlamydia trachomatis* infection.

**Terminology**

Several species of Chlamydiae cause human disease. The focus of this thesis is *Chlamydia trachomatis* (*C. trachomatis*) infection of the urogenital tract and the terms ‘chlamydia’ or ‘chlamydial’ refer to infection or disease due to *C. trachomatis*, unless otherwise specified.

**History**

Human disease due to *Chlamydia trachomatis* has been recognised for centuries, with trachoma described in Egyptian papyri, although genital tract infections were not described until the twentieth century when it became apparent that there were non-gonococcal forms of conjunctivitis in infants and urethritis in adult males [1]. Chlamydial intracellular inclusions were first identified by Halberstaedter and von Prowazek in 1907, using Giemsa staining on conjunctival scrapings from orangutans infected with material from patients with trachoma [2]. In 1911 Lindner reported cases of inclusion-positive neonatal conjunctivitis and suggested a connection with inclusion-positive cervicitis in the mothers of affected infants [3]. However, the causative organism proved difficult to isolate.

The first successful isolation of *C. trachomatis* was reported in 1957 by Tang and colleagues using samples collected from patients with trachoma and cultured in hens’ egg yolk sacs [4]. Jones and his co-workers subsequently isolated the organism from samples from the cervix of a woman whose infant had inclusion conjunctivitis [5]. By 1964, chlamydiae had also been found in samples from the urethras of men linked to conjunctivitis cases [6,7]. However, yolk-sac isolation techniques were laborious, taking up to six weeks for isolation, and it was not until tissue culture techniques were developed in 1965 [8] that research expanded and a wide range of chlamydia-related clinical syndromes were then described.

The most significant subsequent milestone was the introduction of nucleic acid amplification tests (NAATs) in the 1990s; these more sensitive tests enable reliable diagnosis, even with self-collected non-invasive samples, facilitating population-based screening for *C. trachomatis* infections in settings other than traditional STI and medical clinics [1]. Over recent years, many countries have introduced chlamydia control efforts but substantial, continuing decreases in rates of *C. trachomatis* infection have not yet been observed. This
has led to renewed interest in reassessing what is known about the natural history of *C. trachomatis* infection and the implications for current chlamydia control strategies \[9\].

**Biology**

Chlamydiae are structurally complex and can be differentiated from viruses in that they contain both DNA and RNA and possess a cell wall that is analogous to that of Gram-negative bacteria \[1\]. They are obligate intracellular bacteria however, and require a living host cell for support, because they cannot synthesise high-energy compounds, amino acids or other factors essential for growth and replication (Figure 1-1). This also means they cannot be cultured on artificial media.

Figure 1-1 Electron micrograph of *C. trachomatis* bacteria within an inclusion (white) inside a host cell (green)

Credit: Biomedical imaging unit, Southampton General Hospital/Science Photo Library [10]

**Life cycle**

Chlamydiae have a unique biphasic life cycle (Figure 1-2) involving two specialised morphological forms; an extracellular form, known as an elementary body, and a metabolising intracellular form, known as a reticulate body \[1\]. The metabolically inactive, infectious elementary bodies have an extensively cross-linked outer membrane, which allows them to survive in the extracellular environment. An elementary body attaches to, and then penetrates a susceptible host cell, where it then transforms into rapidly dividing reticulate bodies which accumulate within host membrane bound inclusion bodies or vacuoles. The reticulate forms transform to elementary bodies, the vacuole expands and is then either extruded or ruptures. This causes the death of the host cell and releases infectious elementary bodies to begin the cycle again \[1,11\].
Figure 1-2 Schematic representation of Chlamydia trachomatis life cycle \cite{11}

Legend: RB = reticulate body, EB = elementary body

**Taxonomy**

Before 1999, Chlamydiae classification was in the class Chlamydiae, order Chlamydiales, family Chlamydiaceae and genus Chlamydia based on the unique phenotypic structure of the organism \cite{12}. In 1999, a division of the genus was proposed, to include Chlamydia genus (containing the species *C. muridarum, C. suis* and *C. trachomatis*) and the ‘chlamydia-like’ Chlamydophilia genus (containing the species *C. pneumoniae, C. pecorum, C. psittaci, C. abortus, C. felis, C. caviae*) (Figure 1-3) \cite{12,13}.

*C. trachomatis* can be differentiated from the other species within the genera on the basis that its glycogen-containing inclusions stain with iodine. The other species cannot be so easily differentiated on biochemical or other phenotypic markers and it is only the recent advent of molecular studies and genome sequencing that has enabled strain identification and improved determination of relatedness \cite{14}. However, the scientific community has not readily accepted the proposed division of the genus and it is still argued that speciation of chlamydial strains within a single genus Chlamydia would be more appropriate \cite{14}.
Serovars

*C. trachomatis* strains are divided into distinct serologically variant strains, or serovars, based on the antigenic reactivity of the major outer membrane protein with specific monoclonal antibodies \(^\text{[1,15]}\). These different serovars are associated with human disease but with distinct clinical manifestations. Serovars A, B, Ba, and C cause ocular trachoma; serovars B, Ba, D, Da, E, F, G, Ga, H, I, Ia, J and K cause ocular and genital diseases in adults and children as well as infant pneumonia; serovars L1, L2, L2a and L3 cause Lymphogranuloma venereum (LGV), a systemic sexually transmitted disease which commonly presents with fever, lymphadenopathy and anogenital symptoms, such as ulcers and proctitis \(^\text{[1]}\). *C. trachomatis* serovars D–K are most commonly associated with genital infection with E, F and D being the most prevalent serovars identified internationally \(^\text{[16-18]}\) and in New Zealand \(^\text{[19]}\). Potentially, strain variants could have differing virulence, hence impacting on prevalence and disease severity, but there is as yet no firm evidence to support this \(^\text{[18]}\). At present, serovar determination tends to be used as an epidemiological tool, for example in mapping sexual networks, and in vaccine development \(^\text{[15]}\).

Clinical syndromes

*C. trachomatis* preferentially infects columnar or transitional epithelium: of the urethra, with extension to the epididymis; the endocervix, with extension to the endometrium, salpinx and peritoneum; and the rectum \(^\text{[20]}\). Infection may produce inflammation and scarring, with a wide range of resulting clinical syndromes described. However, most infections do not cause clinically apparent symptoms, a pertinent issue for detection and early treatment \(^\text{[20]}\).

*C. trachomatis* infection is asymptomatic in approximately 80% of women \(^\text{[20,21]}\). Symptoms of lower genital tract infection in women may include dysuria, abnormal vaginal discharge, and post-coital bleeding but, as such, are non-specific for *C. trachomatis* infection \(^\text{[20]}\). Lower genital infection can ascend to the upper genital tract, leading to endometritis, salpingitis,
and pelvic inflammatory disease (PID) (Figure 1-4). Any resulting tubal pathology may increase the risk of ectopic pregnancy, tubal factor infertility (TFI) and chronic abdominal pain.

Figure 1-4 Schematic representation of *Chlamydia trachomatis* infection and sequelae in women

*C. trachomatis* genital tract infections are also asymptomatic in approximately 50% of men [20,21]. If symptoms occur, they are generally milder than noted with gonococcal infection, with mild dysuria and a mild to moderate, cloudy urethral discharge [21,22]. Urethral infection can ascend from the lower genital tract, leading to epididymitis.

*C. trachomatis* is associated with proctitis and inflammation of the rectal mucosa for both LGV (infection caused by serovars L1–L3) and non-LGV strains (infection caused by serovars D-K). Systemic illnesses such as reactive arthritis and perihepatitis (Fitz-Hugh-Curtis syndrome) may also occur [20].

Adverse pregnancy outcomes associated with *C. trachomatis* infection include miscarriage, preterm labour, premature rupture of the membranes and low birth weight [23,24]. Vertical transmission of maternal infection may result in conjunctivitis, nasopharyngitis and pneumonia among newborns [25].

**Pelvic inflammatory disease (PID)**

PID is usually a consequence of microorganisms ascending from the lower genital tract of the vagina and cervix, infecting and causing inflammation of the uterus, fallopian tubes, and ovaries [26-28]. The term PID refers to a spectrum of upper genital tract inflammation that
encompasses more specific conditions including endometritis, salpingitis, oophritis, parametritis, tubo-ovarian abscess and pelvic peritonitis. PID is associated with an increased risk of ectopic pregnancy, infertility, recurrent PID, and chronic pelvic pain because of damage to the cilia lining the fallopian tubes, fallopian tube scarring or adhesion formation among pelvic organs.

The aetiology of acute PID is polymicrobial with the most common organisms isolated from the upper genital tract in women with acute PID being *Neisseria gonorrhoeae, Chlamydia trachomatis*, genital tract mycoplasmas (particularly *Mycoplasma genitalium*), as well as the anaerobic and aerobic bacteria that are known to be endogenous vaginal flora (e.g., *Prevotella* species, black-pigmented Gram-negative anaerobic rods, *Peptostreptococci* sp., *Gardnerella vaginalis, Escherichia coli, Haemophilus influenzae*, and aerobic streptococci).

Acute PID is difficult to diagnose because of the wide variation in the symptoms and signs and considerable overlap with other conditions. Laparoscopy can help provide a more accurate diagnosis of salpingitis but is often not readily available and is an overly invasive procedure for mild to moderate cases. Consequently, a diagnosis of acute PID is often based on clinical signs and symptoms especially for mild to moderate cases, requiring a high index of clinical suspicion. The following features are suggestive of a diagnosis of acute PID:

**Symptoms**
- lower abdominal pain which is typically bilateral
- deep dyspareunia
- abnormal vaginal bleeding, including post coital, inter-menstrual bleeding and menorrhagia
- abnormal vaginal or cervical discharge which is often purulent

**Signs**
- lower abdominal tenderness which is usually bilateral
- adnexal tenderness on bimanual vaginal examination
- cervical motion tenderness on bimanual vaginal examination
- fever (>38°C)

Clinical guidelines recommend that a diagnosis of PID, and empirical antibiotic treatment, should be considered in any young sexually active woman who has recent onset, bilateral
lower abdominal pain associated with local tenderness on bimanual vaginal examination, in whom pregnancy has been excluded [29,30].

The proportion of PID caused by \textit{C. trachomatis} is still largely unknown, partly because the incidence of PID is difficult to quantify and partly because the background STI prevalence in the population being assessed is an important factor to take into consideration [26,27]. Current estimates of 25-30\% are supported by two methodologically robust studies that both used more sensitive NAAT testing to diagnose \textit{C. trachomatis} [31,32].

In a large prospective randomised treatment trial of mild to moderate acute PID recruited from emergency departments or STI clinics in the US, just over a third of the 831 study participants had \textit{C. trachomatis} or \textit{N. gonorrhoeae} infection [31]. Cervical \textit{C. trachomatis} infection was diagnosed by polymerase chain reaction (PCR) NAAT testing in 15\% of women, cervical \textit{N. gonorrhoeae} infection diagnosed by culture in 14\%, and dual coinfection in 6\%. In addition, 10\% of women had detectable \textit{C. trachomatis} infection by PCR on endometrial biopsy.

In the more recent randomised controlled Prevention Of Pelvic Infection (POPI) trial, 2529 young female students at UK university and further education colleges provided self-collected vaginal swabs at enrolment and were randomised to immediate processing of samples and treatment if \textit{C. trachomatis} positive (intervention group), or the swabs were stored and tested after one year (control group) [32]. There were 38 reported cases of probable or possible PID by one year of follow-up; 1.3\% (15/1191) in the intervention group and 1.9\% (23/1186) in the control group. Of the 23 women in the control group reporting clinically diagnosed PID by one year of follow-up, seven (30\%) were positive for \textit{C. trachomatis} on their baseline stored sample.

There have been widely varying estimates of the proportion of untreated chlamydial infections that result in PID. The highest estimate of PID incidence after untreated chlamydial infection comes from a randomised treatment trial of \textit{N. gonorrhoeae} in which a subset of 20 women co-infected with \textit{C. trachomatis} and \textit{N. gonorrhoeae} received adequate therapy for gonococcal disease but not for chlamydia and were followed for up to seven weeks [33]. Six women (30\%) were diagnosed as having PID by clinicians who were unaware of the patients’ culture results. Comparably high PID rates were found in three studies in high-risk settings in which 2-4.5\% of untreated women from STI clinics or an emergency department developed PID within a relatively short time-frame of approximately two weeks, between testing positive for \textit{C. trachomatis} and returning for their treatment [34-36].

However, studies with longer follow-up in other settings have reported lower rates of progression to PID with untreated infection, ranging from 0\%-9.5\% [32,37,38]. The lowest
estimate was noted in a 1998 case-control study in which 30 healthy adult women who screened positive for *C. trachomatis* by NAAT were compared with 186 controls: none of the asymptomatic positive women were diagnosed with PID during one year of follow-up \cite{37}. The small number of participants and reliance on self-report limit these findings, however. In the largest study, 1.1% (48/4413) of Norwegian women who tested positive for *C. trachomatis* between 1990 and 2005 were hospitalised for PID \cite{38}. This study likely underestimates chlamydia-associated PID, as testing was only offered to health-seekers and only those needing hospital care for PID were included, excluding any primary care-managed cases.

In the aforementioned POPI trial among young female students at UK university and further education colleges, seven of 74 women (9.5%) who tested positive for *C. trachomatis* by NAAT testing developed PID over 12 months of follow-up \cite{32}. However, only those who reported symptoms (17%) had any medical record review for verification of the diagnosis of PID. Nonetheless, these more recent studies in lower-risk populations suggest that the proportion of untreated chlamydial infections that progress to PID may be lower than previously believed from clinic-based studies \cite{27}.

Repeated chlamydial infection is associated with a cumulative risk of PID \cite{27}. A retrospective cohort study involving 11000 women and girls aged 10–44 years who tested positive for *C. trachomatis* in Wisconsin during 1985–1992 found a four-fold increase in PID with two infections and 6.4 fold with three or more infections \cite{39}. This may be an underestimate, as only those needing hospital care for PID were included; testing was opportunistic, not systematic; and older, less sensitive diagnostic methods were used throughout the study period.

A prospective study among 302 female sex workers in Nairobi, Kenya, of whom about half were HIV positive, similarly found that repeated *C. trachomatis* infection was associated with an almost doubled risk of clinically-determined PID over 18 months \cite{40}. This study also used older, less sensitive diagnostic methods. Although the risk of PID was similar for first and subsequent episodes of chlamydia infection among the Kenyan women, there is a lack of supporting data for this finding and it remains unclear whether the risk of PID per episode of chlamydia increases with each recurrent episode of infection \cite{27,41}.

**Ectopic pregnancy**

Ectopic pregnancy is any pregnancy that occurs outside the uterine cavity. The fallopian tube is the most common extra-uterine location for this to occur, and accounts for 98% of all ectopic pregnancies \cite{42}. About 1-2% of all pregnancies in developed countries are ectopic and can have serious consequences; haemorrhage from ectopic pregnancy remains the leading cause of pregnancy-related maternal death in the first trimester \cite{42,43}.
The diagnosis of ectopic pregnancy is based on a combination of detection of raised serum levels of human chorionic gonadotropin and the presence of typical ultrasonographic findings. These tests generally enable early diagnosis of the ectopic pregnancy before tubal rupture. The classic symptoms of ectopic pregnancy are:

- Abdominal pain
- Amenorrhoea, typically six to eight weeks after the last normal menstrual period
- Vaginal bleeding

However, these findings are nonspecific and are common in patients who miscarry. Ectopic pregnancy should be suspected in any woman of reproductive age with these symptoms and must be actively excluded in any woman with these symptoms and a positive pregnancy test.

Ectopic pregnancy usually occurs because of disruption to normal tubal anatomy, particularly if this is accompanied by impaired tubal function due to damaged ciliary activity. A range of factors may lead to tubal damage including previous ectopic pregnancy, tubal surgery, genital infections, congenital anomalies, or tumours. Current smoking also increases ectopic pregnancy risk, possibly by a direct effect on fallopian tube function. However, the mechanisms by which smoking causes tubal ectopic pregnancy are not fully understood.

There is good evidence that PID increases the risk of ectopic pregnancy. A large Swedish cohort study from the 1960s-1980s of 2501 women found that, among women with laparoscopic-confirmed salpingitis, 9.1% of first pregnancies were ectopic pregnancies, compared with 1.4% of first pregnancies among control women with normal laparoscopic findings.

*Chlamydia trachomatis* infection may lead to salpingitis and PID and hence would be expected to cause an increased risk of ectopic pregnancy. A large Norwegian retrospective case–control linkage study of 20762 women demonstrated such an increased risk, with previous chlamydial infection associated with a two-fold increased ectopic pregnancy risk among younger women, and a three-fold increased risk among those with repeat infections. A similar retrospective cohort study involving 11000 women and girls aged 10–44 years who tested positive for *C. trachomatis* in Wisconsin during 1985–1992 found that ectopic pregnancy risk doubled with two infections, and increased 4.5-fold with three or more infections. In both studies, testing was only offered to health-seekers among the study population and information about potential confounding factors was not available. There remains a lack of robust prospective data examining the risk of tubal ectopic pregnancy in women after genital *C. trachomatis* infection and of the directly attributable risk of *C.*
trachomatis infection, rather than of confounding factors such as smoking or other infections [42].

**Female infertility**

Infertility is the inability to conceive a child, usually defined as the failure to conceive following twelve months of regular sexual intercourse without contraception [46]. Global estimates of infertility suggest that about 9% of couples with women of childbearing age are affected, with higher rates associated with increasing maternal age [47].

Common identifiable female factors include ovulatory disorders, endometriosis, pelvic adhesions, tubal blockage or other tubal abnormalities and endocrine disorders [48]. Pelvic inflammatory disease (PID) is the most common cause of tubal disease, representing greater than 50% of cases [49]. Two large studies found that up to 18% of women develop infertility after symptomatic PID of any cause. A prospective cohort study of 2501 Swedish women from the 1960s-1980s found that 16% of women with laparoscopic-confirmed salpingitis developed infertility, compared with 2.7% of control women with clinically suspected PID with normal laparoscopic findings [44]. The severity of PID on laparoscopic examination affected long-term outcomes. A US study followed 831 women with mild to moderate clinically suspected PID during 1996–1999 as part of a randomised controlled trial of different treatment regimens for PID [31]. Over a mean of 35 months of follow-up, 18% of the women reported infertility, with no difference by outpatient or inpatient treatment arms of the study.

It is not clear though what proportion of tubal factor infertility is directly attributable to *C. trachomatis* infection, rather than due to confounding factors such as other infections [50]. Infertility is often diagnosed years after an infection, by which time it is not possible to differentiate tubal factor infertility caused by a previous chlamydial infection from tubal factor infertility caused by another condition, or another infection, in someone with a past but coincidental infection with *C. trachomatis* [51]. There is a lack of valid prospective data to answer this question, as a prospective study to clarify the long-term adverse events of untreated infection would be unethical [50,51]. One review estimates the risk of tubal infertility in a woman testing positive for *C. trachomatis* infection as being up to 4.6%, based on an estimate of the risk of tubal factor infertility after PID as being 10-20% [52].

In summary, the proportion of poor reproductive outcomes directly attributable to *C. trachomatis* infection is lower than historic estimates that were based on studies in higher-risk populations. Nonetheless, there is strong evidence linking *C. trachomatis* with potentially preventable tubal pathology and associated reproductive sequelae [27].
Adverse pregnancy outcomes

*C. trachomatis* infection during pregnancy is associated with a number of adverse outcomes for both mother and baby [23,53]. Pregnancy-related complications include miscarriage [54], premature rupture of membranes [55,56], preterm delivery [55,57,58], and postpartum endometritis [59]. The pathogenesis of these adverse outcomes is not yet fully understood. Chlamydia may increase the probability by infecting the fetus, by stimulating a fetal inflammatory response, or by leading to an excessive maternal–fetal immunogenic response [23].

Transmission to the neonate occurs during delivery in up to 60% of maternal infections, with resulting neonatal infection at one or more anatomical sites in exposed infants [60]. Nasopharyngitis develops in 70% of neonates born to women with untreated *C. trachomatis* infection, with conjunctivitis occurring in 30%–50% five to twelve days after birth and pneumonia in 10-20% by age one-three months [25,60,61]. Neonatal rectal and vaginal infections appear to be asymptomatic. *C. trachomatis* remains the most frequent identifiable cause of neonatal conjunctivitis in countries without routine antenatal screening for this infection during pregnancy [62,63].

Epididymitis

Acute epididymo-orchitis is a clinical syndrome consisting of pain, swelling and inflammation of the epididymis and/or testes. Epididymitis is a common cause of scrotal pain in adults in the outpatient setting [64,65], with more advanced cases presenting with epididymo-orchitis. Most cases are infective in origin, due to either ascending infection from the urethra, such as *N. gonorrhoea* or *C. trachomatis*, or urinary pathogens spreading from the bladder [64]. Epididymitis is most commonly caused by sexually transmitted infections in men aged less than 35 years, whereas in men aged over 35 years, non-sexually transmitted Gram-negative enteric organisms causing urinary tract infections are more likely, while men who have unprotected anal insertive intercourse are at risk of infection with enteric coliforms [64,65].

Diagnosis of epididymitis or epididymo-orchitis is generally made on the history and on physical examination findings. It is important however that testicular torsion is excluded as a cause of acute scrotal pain. Testicular torsion occurs when the testis twists on the spermatic cord, leading to ischaemia from reduced blood flow. The classic finding on physical examination is an asymmetrically high-riding testis on the affected side, with the testis orientated horizontally. Ultrasonography or, if not available, surgical exploration are required if there is any doubt as to the aetiology of acute scrotal pain based on history and examination alone [66].
Male infertility
Retrospective studies link epididymo-orchitis to male factor infertility in adults with epididymal obstruction and obstructive azoospermia [67]. However, male factor infertility as a result of C. trachomatis infection has not been well studied and the impact of infection in the upper male genital tract is not well known [68,69]. In-vitro studies show that co-incubation of spermatozoa with C. trachomatis causes a significant decline in numbers of motile sperm and results in premature sperm death, but in-vivo studies have provided conflicting evidence as to whether it is associated with reduced fertility in men [69,70].

The emphasis of concern around chlamydia in men tends to reflect concern about the risk of transmission to female partners leading to PID, ectopic pregnancy, or female infertility [69]. However, chlamydial infections are often asymptomatic or cause mild symptoms only for either sex, creating a major challenge for detection and prevention of possible sequelae or further onward transmission [20].

Diagnosis
C. trachomatis infection cannot be distinguished from other urogenital conditions or infections by symptoms or clinical findings alone and diagnostic testing is required. A range of diagnostic methodologies are available, including nucleic acid amplification tests (NAATs), cell culture, direct immunofluorescence, enzyme immunoassay, nucleic acid hybridisation tests and serology [71]. The non-culture based tests are designed to detect various targets, such as the major outer membrane protein (MOMP) in the outer layer of the C. trachomatis elementary body, shown schematically in Figure 1-5 [52].

Figure 1-5 Schematic representation of Chlamydia trachomatis with different targets for diagnostic tests [52]

Legend: major outer membrane protein (MOMP), lipopolysaccharide (LPS), ribonucleic acid (RNA), deoxyribonucleic acid (DNA)
Culture and other non-NAAT tests

Culture remains the only methodology that confirms the presence of viable chlamydial organisms and, until a decade ago, was considered the standard reference test or ‘gold standard’ for diagnosis of acute infection. Detection of viable *C. trachomatis* cells that have replicated in tissue culture requires a method of identifying the cultured bacterial cells. The specificity of culture-based diagnosis is very high when a specific stain for *C. trachomatis* major outer membrane protein is used for detection because of the unique appearance of stained *C. trachomatis* inclusions [71].

However, cell culture requires specialised transport to ensure a viable specimen and culture procedures are expensive, labour intensive and time consuming. In addition, although culture is believed to have high specificity (true negative probability), it has suboptimal sensitivity (true positive probability) compared to the more recently developed NAATs (Table 1-1) [71-73].

Table 1-1 Estimates of sensitivity and specificity for diagnostic test for *Chlamydia trachomatis* in urogenital specimens [73]

<table>
<thead>
<tr>
<th>Diagnostic Method</th>
<th>Sensitivity (true positive probability)</th>
<th>Specificity (true negative probability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue Culture</td>
<td>70-85%</td>
<td>100%</td>
</tr>
<tr>
<td>Direct Fluorescent Antibody</td>
<td>80-85%</td>
<td>&gt;99%</td>
</tr>
<tr>
<td>Enzyme Immunoassay</td>
<td>53-76%</td>
<td>95%</td>
</tr>
<tr>
<td>Direct Hybridisation</td>
<td>65-83%</td>
<td>99%</td>
</tr>
<tr>
<td>Polymerase Chain Reaction a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical Swabs</td>
<td>89.7%</td>
<td>99.4%</td>
</tr>
<tr>
<td>Female Urine</td>
<td>89.2%</td>
<td>99%</td>
</tr>
<tr>
<td>Male Urine</td>
<td>90.3%</td>
<td>98.4%</td>
</tr>
<tr>
<td>Strand Displacement Amplification b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical Swabs</td>
<td>92.8%</td>
<td>98.1%</td>
</tr>
<tr>
<td>Female Urine</td>
<td>80.5%</td>
<td>98.4%</td>
</tr>
<tr>
<td>Male Urine</td>
<td>94.5%</td>
<td>91.4%</td>
</tr>
<tr>
<td>Male Urethral Swabs</td>
<td>94.6%</td>
<td>94.2%</td>
</tr>
<tr>
<td>Transcriptional Mediated Amplification c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical Swabs</td>
<td>94.2%</td>
<td>97.6%</td>
</tr>
<tr>
<td>Female Urine</td>
<td>96.6-96.7%</td>
<td>97.6%</td>
</tr>
<tr>
<td>Male Urine</td>
<td>97.0%</td>
<td>99.1%</td>
</tr>
<tr>
<td>Male Urethral Swabs</td>
<td>95.2%</td>
<td>98.2%</td>
</tr>
<tr>
<td>Real Time PCR d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical Swabs</td>
<td>80.9-87.7%</td>
<td>99.4-99.7%</td>
</tr>
<tr>
<td>Vaginal Swabs</td>
<td>84.8-94.7%</td>
<td>98.8-99.1%</td>
</tr>
<tr>
<td>Female Urine</td>
<td>92.6-95.7%</td>
<td>99.2-99.55</td>
</tr>
<tr>
<td>Male Urine</td>
<td>97.3-97.8%</td>
<td>99.6-99.7%</td>
</tr>
<tr>
<td>Male Urethral Swabs</td>
<td>88.6-93.3%</td>
<td>98.3-99.1%</td>
</tr>
</tbody>
</table>

Note: Sensitivities and specificities adapted from clinical trial data, package inserts, and selected published papers.

- a. Roche Molecular, Indianapolis, IN
- b. Becton Dickinson, Sparks, MD
- c. Genprobe, Inc, San Diego, CA
- d. Abbott Molecular, Inc, Des Plaines, IL
Direct immunofluorescence and enzyme immunoassay tests use monoclonal or polyclonal antibodies to detect antigens of the Chlamydia species-specific major outer membrane protein or the genus-specific lipopolysaccharide (LPS) (Figure 1-5) in the outer layer of the organism. Handling is less specialised than culture and turnaround times for results are much quicker. Immunoassays based on LPS alone however have the potential for false-positive results caused by cross-reaction with LPS of other organisms, including other Chlamydia species, meaning that reactive tests require further confirmatory testing. These non-culture tests have now been largely superseded in routine practice, because of their lower sensitivity compared to NAATs (Table 1-1) [72,73]

As with any infection, *C. trachomatis* induces host immune responses that may promote clearance of infection as well as contributing to infection-related pathology [74]. Serum antibody tests that measure host response to *C. trachomatis* are available commercially but serology is not widely used for diagnostic testing of acute chlamydial infection because positive serology may be due to a previous infection [52]. There is also ongoing controversy over the best method for measuring specific antibodies because the organism is closely related to other Chlamydia species [75]. Use of serology tends to be limited to predicting the cause of tubal scarring in women [52,71].

**Nucleic acid amplification tests (NAATs)**

NAATs amplify *C. trachomatis*-specific DNA or RNA sequences, theoretically enabling the detection of a single strand of *C. trachomatis* nucleic acid within a sample, whereas the limit of detection for other methods is 100 to 1000 organisms [76]. There are a number of commercially available NAATs, which differ in their amplification methods, their target nucleic acid sequences and their detection methodology. Polymerase chain reaction, ligase chain reaction and strand displacement amplification assays amplify nucleotide DNA sequences of the chlamydial cryptic plasmid, which is present in multiple copies in each *C. trachomatis* elementary body. The transcription-mediated amplification reaction is directed against specific ribosomal RNA, which is also present in multiple copies [1,52].

Evaluation of the more sensitive NAATs created a challenge, however, as accepted practice is to evaluate a new test against a reference standard, a “gold standard,” yet the historic gold standard test of culture is now acknowledged as lacking sensitivity. Instead, a “composite reference standard” has been adopted [77]. Combining results from two or more test results on one sample derives a composite reference standard, to define the true positives within a population of interest. Sensitivity of a test is then the percentage of true positives (as defined by the reference standard) that are found positive by the test in question. Specificity is the percentage of true negatives that are called negative by the new test. Any positive by a new test that is not also positive by the composite reference standard is by definition a false positive and reduces specificity [77].
Despite greater sensitivity over other testing methodologies, no single NAAT provides 100% sensitivity and specificity (Table 1-1) \[^{73}\]. Factors that affect NAAT sensitivity and specificity include: sampling variability; the copy number of the amplification target in the specimen; uniqueness of the target sequence; the method of amplification; the detection methods used following amplification; processing errors; and sample cross-contamination. In addition, some specimen types, such as urine, are more likely to contain amplification inhibitors and hormonal factors that may result in false-negative results \[^{71}\]. Some commercially available tests include amplification controls to detect if inhibition has occurred and then report an inhibitory or invalid result. Indeterminate or equivocal results may occur if the signal strength of the NAAT falls at the cut-off for a positive result. Confirmatory testing, in which positive results are repeated to ensure reproducibility, is no longer considered necessary \[^{78}\]. Even so, clinicians need to be aware of the potential for false positive results, particularly when using NAATs in a low prevalence population.

In November 2006, a variant \textit{C. trachomatis} strain was first reported in Sweden \[^{79}\]. This new variant (nvCT) has a 377 base-pair deletion within its plasmid and this deleted sequence corresponded with the target sequence of some commercial NAAT assays, resulting in false negative results \[^{79,80}\]. Genome sequencing and phenotypic analysis found the biological fitness of nvCT is unaltered when compared with wild-type CT \textit{in-vitro}. Yet the nvCT spread rapidly within Sweden, likely due to the selective advantage gained from false negative test results leading to missed diagnosis in the sexually active population \[^{80}\]. Interestingly, the nvCT remains rarely reported in Europe beyond the Nordic countries \[^{81}\], with none reported from Australia or New Zealand \[^{82,83}\]. The target sequence of some commercially available assays has since been modified but not all NAAT assays are capable of detecting the nvCT. Further variants could occur and may not be detected by current commercial assays, highlighting the need for careful design of NAAT testing and ongoing quality assurance monitoring activities.

Nonetheless, NAATs are now considered the test of choice for \textit{C. trachomatis} diagnosis. In addition to greater sensitivity and high specificity, NAAT samples require less specialised transport because viable organisms are not a pre-requisite, results are available more quickly than awaiting growth by culture, and automation of newer commercial assays offers less labour-intensive testing than previous methods, such as culture or direct immunofluorescence, allowing large scale testing to become feasible. Consequently, the introduction of NAATs has revolutionised chlamydial diagnostics and these tests are now recommended as the preferred diagnostic method in clinical guidelines \[^{29,84,85}\].

**Genital \textit{C. trachomatis} NAAT samples**

Traditionally, \textit{C. trachomatis} tests have been performed on cervical swabs for females and urethral swabs for males. Due to the greater sensitivity of NAAT assays however, non-
invasive self-sampling (urine or vaginal) is as effective as more invasive provider-taken sampling (endocervical or penile urethral swab) and is more acceptable to patients [73,86].

A first catch urine specimen is the sample of choice for C. trachomatis detection for males [73]. First catch urine refers to the first 15-30 mls of urine passed at any time of the day and does not need to be the first void of the day [71]. Patients should be advised not to urinate for at least one hour before providing a first catch urine specimen, although some NAAT tests recommend at least two hours. For some NAAT assays, however, urine samples from females are slightly less sensitive than a self-taken vaginal swab or a provider-taken endocervical swab (Table 1-1) [73,87,88]. Consequently, guidelines recommend self-taken vaginal specimens are used for screening asymptomatic females, rather than self-collected urine [29,85]. On the other hand, a provider-taken cervical swab is usually recommended as the sample type for women undergoing a speculum examination, for example because of symptoms or cervical cytology sampling, but this is based on purely pragmatic reasons [29,85].

Rectal tissue sampling with a swab is recommended for those who participate in receptive anal intercourse, particularly for men who have sex with men. Traditionally, culture has been the diagnostic test of choice for rectal and oropharyngeal sites but there are now several published studies, particularly among men who have sex with men, validating the use of C. trachomatis NAATS at extra-genital sites [86].

**Treatment of C. trachomatis infections**

Treatment should be given as soon as possible for the patient’s own health and to prevent further transmission to sexual partners. The choice of treatment for chlamydia depends on the site of the infection, the age of the patient, whether the patient is pregnant and whether the infection is complicated or uncomplicated [29,84,85].

*C. trachomatis* is very susceptible to tetracyclines and macrolides. Sulphonamides, quinolones and rifampicin also show activity against Chlamydiae while aminoglycosides, nitroimidazoles and cephalosporins do not. However, there is no standardised *in-vitro* antimicrobial susceptibility assay and the relationship between results of existing *in-vitro* tests and clinical outcome after treatment is still not fully understood [89]. For example, Chlamydiae have a cell wall similar to that of other bacteria but only in the early phases of the life cycle, meaning that penicillin *in-vitro* does not show marked activity against *C. trachomatis* 16-20 hours after infection. Nonetheless, several studies have shown amoxicillin appears to be effective in treating chlamydial infection in pregnancy [1,20].

Tetracyclines and macrolides remain the treatments of choice. The current recommended treatment for uncomplicated genitourinary chlamydial infection in those who are not pregnant is 1 g azithromycin orally in a single dose or 100 mg doxycycline orally twice per
day for seven days. A 2002 meta-analysis of 12 randomised clinical trials of azithromycin versus doxycycline for the treatment of genital chlamydial infection found these treatments to be equally efficacious, with microbial cure rates of 97% and 98% respectively. Tolerability was also similar with adverse events occurring in 25% and 23% of patients treated with azithromycin and doxycycline, respectively.

However a more recent randomised treatment study of men with non-gonococcal urethritis attending STI clinics in the US found doxycycline to be much more efficacious than azithromycin for the treatment of chlamydial urethritis. Microbiological cure was reported for 94.8% (55 of 58 patients) of the doxycycline treatment group and for 77.4% (41 of 53 patients) of the azithromycin treatment group. In addition, two studies assessing repeat infections have observed azithromycin treatment failure rates of approximately 8% among women reporting no risk of re-infection following treatment. More research is needed to elucidate if this finding is due to differences in study methodology, particularly diagnostic testing; culture or EIA were used to determine microbiological cure in most of the older treatment studies, with small numbers of any persistent C. trachomatis being more likely to be detected in recent studies using NAAT testing. Alternatively, a change in antimicrobial susceptibility may have occurred over time. There are no published cases of azithromycin-resistant C. trachomatis isolates to date but it is possible this reflects that very few laboratories offer antimicrobial susceptibility assays. C. trachomatis antimicrobial assays are complex, non-standardised and difficult to interpret and, with culture no longer readily available, C. trachomatis antimicrobial susceptibility is not readily or routinely monitored.

Until more data are available, azithromycin 1 g orally continues to be recommended as a first-line treatment, particularly as it has the advantage of prolonged bioavailability enabling a one-off easily administered dose without the issues of non-adherence associated with a week of twice-daily doxycycline therapy. Gastrointestinal side effects may lead to non-absorption, however, so patients should be advised that if they vomit the dose of azithromycin within one to two hours of taking the medication, an alternative treatment is required.

Alternative treatments include erythromycin base 500 mg orally four times daily for seven days, or erythromycin ethylsuccinate 800 mg orally four times daily for seven days or ofloxacin 300 mg orally twice daily for seven days, or levofloxacin 500 mg orally twice daily for seven days. Erythromycin might be less efficacious than either azithromycin or doxycycline, mainly because of the frequent occurrence of gastrointestinal side effects that can lead to non-adherence. Levofoxacin and ofloxacin are effective treatment alternatives but are more expensive, do not offer a dosing advantage and are not available in New
Zealand. Other quinolones are either not reliably effective against *C. trachomatis in-vivo* or have not been evaluated adequately [29].

The recommended treatment for uncomplicated genitourinary chlamydial infection in pregnancy is 1 g azithromycin orally in a single dose or amoxicillin 500 mg orally three times a day for seven days [29,84,85]. Doxycycline, ofloxacin, and levofloxacin are contraindicated in pregnant women, whereas azithromycin appears to be safe and effective [29,96]. Alternative treatments include erythromycin base 500 mg orally four times daily for seven days, or erythromycin base 250 mg orally four times daily for 14 days or erythromycin ethylsuccinate 800 mg orally four times daily for seven days or erythromycin ethylsuccinate 400 mg orally four times daily for 14 days. The frequent gastrointestinal side effects associated with erythromycin can result in non-adherence.

If complications are suspected, for example PID or epididymitis, presumptive treatment should be initiated immediately before diagnostic test results are available, and should provide coverage against the most likely aetiological organisms including *C. trachomatis*.

All patients being treated for chlamydial infection should be advised to abstain from unprotected sexual intercourse for seven days after single-dose therapy or until completion of a seven-day regimen to minimise transmission to sexual partners. They should also be advised to abstain from unprotected sexual intercourse until all of their sexual partners have been treated. A repeat test, or test-of-cure, for chlamydia is not routinely recommended after completion of the antibiotic course, unless a patient has ongoing symptoms or is pregnant [29,84,85]. In addition, NAAT should not be undertaken at less than three weeks after completion of therapy, as this could yield false-positive results, because of the detection of persisting non-viable organisms.

High rates of repeat *C. trachomatis* infection following treatment have been noted in many studies and those who test positive for chlamydia are at considerably higher risk of subsequent chlamydia infection within 12 months than those who test negative [93,97-100]. Systematic reviews estimate a median re-infection rate with *C. trachomatis* of 13% among women and 11% among men across a variety of study populations and clinic settings, with re-infection more likely for those of younger age [99,100]. For example, a recent Australian prospective cohort study of 1116 women aged 16-25 years who were tested for chlamydia found 22% of those who tested positive were re-infected by 12 months, with most re-infections occurring in the first four to five months [98]. Most repeat positive chlamydia tests are believed to be repeat infections from either an untreated partner or a new infection from a different partner, rather than persistent initial infection due to treatment failure [93]. However, it is not always easy to differentiate this: it has to be established that effective treatment for the initial infection was taken; that current sexual partners were treated; that
there was no unprotected sex until all partners had been effectively treated; and whether there had been any unprotected sex with other partners in the interim. Genotyping can help identify repeat infections from persistent infection although, if a follow up infection is the same genotype as the previous infection, this does not help differentiate treatment failure, re-infection from the same partner or infection of the same genotype from another sexual partner [93].

Because repeat infections are common, and associated with a cumulative risk of PID and other complications in women, most guidelines encourage repeat chlamydia testing within 12 months following a positive diagnosis. Such repeat testing is distinct from a test-of-cure of infection and aims to detect re-infection, rather than treatment failure. However, the optimal interval for repeat testing after treatment to detect re-infection is not yet well defined. Using mathematical modelling, Heijne et al. recently estimated the optimal retesting interval to be two to five months [101]. This was based on a large cohort of women in the US who were screened for chlamydial infection from 2002 to 2006. Of those testing positive, 40% (4949) had a repeat test with 25% (3088) being re-tested within two to five months; 15% of repeat tests were chlamydia positive. For now, the suggested timing for repeat testing still varies between countries. A repeat test is recommended three to six months after treatment in New Zealand [85], three months after treatment in the US [29] and three to 12 months after treatment in Scotland and Australia [102,103]. Testing after treatment is not yet included in the English national chlamydia screening programme, although re-testing is encouraged with any change in sexual partner [104].

Management of sexual partners

Partner notification for sexually transmitted infections (STIs), also known as contact tracing, is the process of informing the sexual partners of people with STIs of their potential exposure to infection, ensuring their evaluation and/or treatment, and providing advice about preventing future infection [105]. The need for partner notification has long been recognised as an essential component of public health efforts to control STIs [106]. Treating sexual partners aims to reduce the risk of re-infection for the initial patient (the index case) and, by case finding, hopefully prevent possible morbidity and complications in partner(s) as well. Greater case finding through partner notification may also have a population level benefit of reducing the likelihood of onward transmission of infection to others.

However, partner notification for STIs is not always straightforward [20,41]. People may be reluctant to inform partners for a variety of reasons, most notably fear of reaction [107]. The partner(s) might not be a regular partner or spouse, might not be contactable, might not have been consensual, or might not want to know they might have an STI. As a result, different approaches to partner notification have evolved. These include patient referral
where the index case informs their sexual partners; provider referral where the health professional takes responsibility for confidentially notifying partners; and conditional referral where the index case agrees to notify partner(s) within a specified time period but, if partners have not been reached or advised within that time, the provider then takes responsibility for notifying the partners.

The approach chosen depends on the provider and on the STI. Provider referral and conditional referral are more likely to be used for syphilis and HIV infection than gonococcal or chlamydial infections [108,109]. In addition, there is considerable variation in the way that each approach can be carried out. Patient referral can be as basic as advising someone to tell their sexual partners to get treated but is more effective, in terms of the number of sexual partners treated, if simple additional measures such as printed material, verbal nurse-given education or counselling are provided as well [108,109].

Various resources and approaches are being assessed internationally to improve notification and treatment of sexual partners. One approach is patient-delivered partner therapy, also known as expedited partner therapy. This involves delivering medication or a prescription directly to sexual partner(s) without prior medical evaluation. A meta-analysis of five studies of patient-delivered partner therapy reported a reduced risk of recurrent infection in patients with chlamydia and gonococcal infections compared with patient referral [108], although it was also noted that this intervention was no more effective than supplementing patient referral with clear written information for partners. Patient-delivered partner therapy remains illegal in New Zealand [110]. Also, some health providers have concerns about possible adverse consequences such as missed infections or drug allergies [111].

An alternative approach of ‘accelerated partner therapy’ is being evaluated in the UK because of similar legislative obstacles. In a feasibility study of this approach, partners were provided with medication and a sampling kit after either a telephone discussion with a clinician or an evaluation from a pharmacist, and this was found to be favourable to both patients and partners [112]. Other novel approaches include the use of communication technologies such as text messaging and web-based electronic postcards to make it easier for index cases to advise their partners [113,114].

**Chlamydia prevalence in New Zealand**

*C. trachomatis* is the most commonly reported STI in New Zealand [115]. However, New Zealand lacks general population chlamydia prevalence studies and the only available prevalence estimates rely on heterogeneous studies in a range of subpopulations and settings (Table 1-2). These studies show a wide range of chlamydia prevalence depending on the population tested. In the era of NAAT testing, prevalence in young women ranged...
from 2.3% in sexually-active high school students, from predominantly socially advantaged areas in Christchurch, to 15.3% of (tested) pregnant women aged under 25 years from predominantly socially disadvantaged areas in Auckland [116,117].

Prevalence in young men ranged from 1.8% in sexually active high school students, from predominantly socially advantaged areas in Christchurch to 17% of new male inmates in an Auckland remand centre [116,123]. However, only six studies included men, with three of these reporting very small numbers [127-129], and their findings must be interpreted with caution.

An important consideration is that almost all of the 14 published prevalence studies are based on convenience sampling of selected populations. Eleven of the 14 studies recruited in health-care settings, with a preponderance among those seeking sexual or reproductive health care. These clinic-based prevalence estimates are likely to be higher than in the general population and are limited in their generalisability to other settings or populations.

Comparisons between studies are limited because of differences in study design, methodology and population studied. Rates of testing, where reported, vary considerably, and two of the included studies reported very small sample sizes. At least three of the studies tested female urine, a sample that has lower sensitivity for detection than vaginal or cervical swabs, and three older studies used non-NAAT diagnostic methods.
Table 1-2 New Zealand chlamydia prevalence studies

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study design, population, setting, time period if specified</th>
<th>Specimen type, Test method</th>
<th>Number Eligible</th>
<th>% tested</th>
<th>Number tested</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edwards et al., 1985 [118]</td>
<td>500 consecutive female patients attending a family planning clinic in Christchurch. Participants: 15-56 years, 27% less than 20 years; no ethnicity data reported</td>
<td>Endocervical swab, DFA test</td>
<td>ns</td>
<td>ns</td>
<td>500</td>
<td>15.8% overall</td>
</tr>
<tr>
<td>Wilmott et al., 1987 [119]</td>
<td>All women attending Auckland hospital STI clinic, for the first time or with a new complaint, Jan – June 1983. Participants: age 15-61 years, 64% less than 25 years; 78% European, 16% Māori, 5% Pacific</td>
<td>Endocervical swabs (or urethral swab in hysterectomised women), Culture</td>
<td>ns</td>
<td>ns</td>
<td>504</td>
<td>24% overall European: 23% Māori: 29% Pacific: 17%</td>
</tr>
<tr>
<td>Bagshaw &amp; Edwards, 1987 [120]</td>
<td>2000 consecutive female patients attending a family planning clinic in Christchurch, May 1984 - July 1985. Participants: mean age 23.7 years; no ethnicity data reported</td>
<td>Endocervical swab, DFA test</td>
<td>ns</td>
<td>ns</td>
<td>2034</td>
<td>17.5% overall</td>
</tr>
<tr>
<td>Haase et al., 1995 [121]</td>
<td>Comparison of test methodology for diagnosis of <em>C. trachomatis</em> in 819 female patients attending a family planning clinic in Christchurch, no age or ethnicity data reported</td>
<td>Endocervical swab, Amplicor PCR</td>
<td>829</td>
<td>98.8%</td>
<td>819</td>
<td>5.8% overall</td>
</tr>
<tr>
<td>Cole et al., 2001 [122]</td>
<td>Asymptomatic male army personnel in Christchurch (65) and asymptomatic male army recruits in Waiuru (135). Participants: age 17-38 years, 83% less than 25 years; no ethnicity data reported</td>
<td>First catch urine, Amplicor PCR</td>
<td>ns</td>
<td>ns</td>
<td>200</td>
<td>4.0% overall</td>
</tr>
<tr>
<td>Corwin et al., 2002 [116]</td>
<td>Students at 17 of 26 Christchurch state &amp; privately-funded high schools, year 12 &amp; year 13 (age 16 or older), June-Sept 2001. Participants: 57% attended high school in socially advantaged areas. 49% sexually active, of whom 84% provided urine. 80% European, 7% Māori, 3% Pacific. Test positivity by ethnicity not reported</td>
<td>First catch urine, Amplicor PCR</td>
<td>1583</td>
<td>72%</td>
<td>1136</td>
<td>2% of sexually active participants 1.8% of sexually active males 2.3% of sexually active females</td>
</tr>
<tr>
<td>King &amp; O’Grady, 2003 [123]</td>
<td>All new male inmates at Auckland central remand prison. Participants: 52% less than 25 years; 50% Māori, 15% Pacific, 35% non-Māori, non-Pacific. Test positivity by ethnicity not reported</td>
<td>First catch urine, Amplicor PCR</td>
<td>ns</td>
<td>ns</td>
<td>611</td>
<td>17% overall, 28.6% in &lt; 20 year olds</td>
</tr>
<tr>
<td>Lawton et al., 2004 [124]</td>
<td>All pregnant women who delivered, matched with all specimens submitted for <em>C. trachomatis</em> testing, Wellington, Sept 1999-June 2003. Participants: age 14-52 years, mean age 30.6 years, 61.7% less than 25 years; 54.9% Māori and 59% Pacific women who delivered were tested.</td>
<td>Specimen type(s) not specified, Amplicor PCR</td>
<td>6614</td>
<td>37.5%</td>
<td>2482</td>
<td>4.8% overall European: 2% Māori: 15.2% Pacific: 12.5%</td>
</tr>
<tr>
<td>Authors</td>
<td>Study design, population, setting, time period if specified</td>
<td>Specimen type, Test method</td>
<td>Number Eligible</td>
<td>% tested</td>
<td>Number tested</td>
<td>Prevalence</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------</td>
<td>-----------</td>
<td>---------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Rose et al., 2005 [125]</td>
<td>All consecutive women attending two abortion clinics in Wellington, 500 at a fee-paying clinic, 501 at a government-funded free clinic, 2003. Participants: age 14-52 years, mean age 30.6 years; 38.5% European, 17% Māori, 7% Pacific. 57% of women attending the fee-paying clinic were non-New Zealand residents.</td>
<td>Specimen type(s) not specified, Amplicor PCR</td>
<td>1001</td>
<td>100%</td>
<td>1001</td>
<td>7.7% overall 11.2% in &lt; 25 year olds European: 4.4% Māori: 12.9% Pacific: 18.6%</td>
</tr>
<tr>
<td>Baker et al., 2005 [126]</td>
<td>All sexually active 18-25 year old female university students, Wellington, March-October 2003. Participants: excluded those with C. trachomatis diagnosis in the previous 3 months or with language barriers. 82.6% European, 6.9% Māori, 2.2% Pacific.</td>
<td>First catch urine or endocervical swab, Amplicor PCR</td>
<td>1199</td>
<td>59.9%</td>
<td>718</td>
<td>2.7% overall European: 1.9% Māori: 4.1% Pacific: 13.3%</td>
</tr>
<tr>
<td>Sparrow et al., 2007 [127]</td>
<td>All family planning clinic attendees aged less than 25 years, Wellington, November 2004-May 2005. Participants: 96% female, 68% European, 17% Māori, 6% Pacific. 99% of non-participants: 99% female, 75% European, 12% Māori, 4% Pacific.</td>
<td>First catch urine, Amplicor PCR</td>
<td>4674</td>
<td>54%</td>
<td>2533</td>
<td>8% overall European: 7% Māori 14% Pacific: 16%</td>
</tr>
<tr>
<td>Lawton et al., 2010 [128]</td>
<td>All under 25 year olds attending three general practices, Wellington, 2007. Eligible participants: 65% European, 14% Māori, 3% Pacific. Ethnicity not reported for tested participants.</td>
<td>Self-taken vaginal swab or first catch urine, Taqman PCR</td>
<td>1292</td>
<td>14.5%</td>
<td>187</td>
<td>8% overall</td>
</tr>
<tr>
<td>Azariah &amp; Perkins, 2010 [129]</td>
<td>All men who have sex with men attending sexual health clinics, Auckland, May 2008 – April 2009. Participants: age 15-66 years, mean age of 34 years; 70% European, 7% Māori, 6% Pacific.</td>
<td>Specimen type not specified, NAAT test not specified</td>
<td>89</td>
<td>98%</td>
<td>87</td>
<td>9% overall</td>
</tr>
<tr>
<td>Ekeroma et al., 2012 [117]</td>
<td>All pregnant women who delivered in Middlemore Hospital matched with all STI specimens submitted for testing, Auckland, 2009. Eligible women: 35% less than 25 years; 20.3% European, 20.3% Māori, 43% Pacific. Most Māori and Pacific women were from areas of low socioeconomic advantage. Participants: 72.2% of eligible women aged less than 25 years; 49.2% European, 65.7% Māori, 70% Pacific women were tested for C. trachomatis.</td>
<td>Swabs (type not specified), urine samples excluded, NAAT test not specified</td>
<td>6795</td>
<td>58.4%*</td>
<td>3969*</td>
<td>9% overall† 15.3% in &lt; 25 year olds European 4.7% Māori 10.3% Pacific 10.7%</td>
</tr>
</tbody>
</table>

* Includes 52 women who had a urine test but excluded by the authors because female urine was deemed an inappropriate sample
† Includes 7 positive urine tests excluded by the authors because female urine was deemed an inappropriate sample
Only one setting, a family planning clinic in Christchurch, has reported repeat prevalence data, noting a significant decline in chlamydia prevalence in 1995 (5.8%) compared to a decade earlier (17.5%) \cite{120,121}. This is notable, as more sensitive NAAT testing was used in the later study. However, although the authors commented in 1995 that ‘the prevalence of chlamydia infections has declined over the past decade’ \cite{121}, this later study did not report any clinic population demographics or rates of co-infection with other STIs, meaning it is not possible to determine if the risk profile of those attending the clinic differed or if there was a true decline in chlamydia prevalence over time.

Internationally, factors known to predict higher risk of chlamydial infection include young age (less than 25 years of age), minority race and/or ethnicity and sexual behaviours such as unprotected sex, increased numbers of sex partners and recent partner change \cite{130,131}. Despite their limitations, clinic- and community-based studies in New Zealand report similar demographic findings, with higher *C. trachomatis* prevalence among those aged under-25 years of age and among those of Māori or Pacific ethnicity (Table 1-2).

Health inequalities by race and/or ethnicity are not random. Worldwide, the rich and the educated fare better in every aspect of health, with poorer health reflecting greater exposure to health hazards and lesser access to high quality health services \cite{132}. Race and/or ethnicity is a further determinant, likely because of discrimination or cultural differences in health behaviour \cite{133}, and indigenous peoples in New Zealand tend to have poorer health than expected by socioeconomic factors alone \cite{134}. Although STI research tends to focus on individual demographics and behaviours, community attributes, such as poverty, racial and/or ethnic segregation, social norms that influence sexual behaviour and condom use, and prevalence of STIs, can increase the risk associated with individual behaviours and impede the ability of individuals to adopt preventative behaviours \cite{135,136}. This in turn contributes to continuing disparities in STI prevalence.

Although most New Zealand studies have involved only relatively small numbers of Māori or Pacific women, one exception is a study of testing rates for STIs among 6795 women who delivered a baby in an Auckland hospital during 2009, which reported relatively high rates of chlamydia testing particularly for Māori and Pacific women \cite{117}. Of eligible Māori and Pacific women, approximately 50% and 80% respectively, lived in areas of high socioeconomic deprivation. Overall, 3969 (58%) women had a chlamydia test and, by ethnicity, 679 (49%) European, 907 (66%) Māori and 2046 (70%) Pacific women were screened. An important caveat is that ethnicity data were collated from the hospital patient information system and may not have been based on self-identified ethnicity. Nonetheless, in this study, Māori and Pacific women were at least twice as likely to test positive for *C. trachomatis* (10.3% and 10.7%, respectively, compared to 4.7% of European women who were tested) \cite{117}. 

24
Chlamydia prevalence internationally

New Zealand has not yet undertaken a large-scale, general population chlamydia prevalence study and comparisons of available clinic- or small-scale community-based prevalence data with similar clinic-or community-based international prevalence surveys are limited by the heterogeneity of these studies. Not surprisingly, prevalence of *C. trachomatis* infection varies depending on the subpopulation, with clinic-based sampling likely to be biased towards those who are symptomatic and/or higher risk and to those who utilise health-care. Differences in methodologies, such as study recruitment, response rates among those surveyed, diagnostic sampling and data reporting further limit comparisons of reported findings.

For example, a recent meta-analysis of the prevalence of *C. trachomatis* in Australia during 1997-2011 reviewed 76 studies, with sample sizes ranging from 44-2817 participants, and reported that pooled prevalence estimates could not be reliably calculated for women aged less than 25 years due to significant heterogeneity between studies [137]. There were a wide variety of study designs, often low participation rates, and variable diagnostic sampling that included urine NAAT testing for women. In addition, 16 of 30 studies assessing prevalence in both men and women did not report data by gender. Nonetheless, the review reported a trend towards higher chlamydia prevalence in younger populations and those attending sexual health clinics. For community or general practice settings, the estimated pooled prevalence for *C. trachomatis* for women aged less than 25 years was 5.0%, based on five studies undertaken after 2005, and for men aged less than 30 years was 3.9%, based on six studies during 1997-2011. Estimated prevalence for those aged less than 25 years attending sexual health, family planning or youth clinics in Australia was 6.2% (10 studies) for women and 10.2% (five studies) for men [137].

A meta-analysis of the prevalence of *C. trachomatis* in the UK reviewed 90 studies published before 2002, and reported similar issues of study heterogeneity and data limitations, with nearly half of the studies reviewed having little information regarding participants' age [138]. As in Australia, there was a trend towards higher chlamydia prevalence in younger populations and those attending health-care settings. By age, for studies in general practice settings, those aged less than 20 years had an estimated pooled prevalence of 8.1%, compared to 5.2% for 20–24 year olds, 2.6% for 25–29 year olds and 1.4% for those aged over 30 years. Among all women attending health-care settings, prevalence estimates were 12.7% in genitourinary medicine clinics, 8.5% in antenatal clinics and in termination of pregnancy clinics, 8.1% in family planning clinics, and 7.1% in general practice, compared to 1.6% in population based studies [138].
As a comparison between countries, recent studies in women undergoing termination of pregnancy, with almost 100% chlamydia screening rates in the era of NAAT testing, have reported chlamydia prevalence of: 11.4% in the US [139]; 9% in France [140]; 8.5% in the UK [141]; 7.7% in New Zealand [125]; 5.3% in Australia [142]; and 2.8% in Sweden [143]. However, as already discussed, such comparisons are limited by the heterogeneity of the sampled populations.

More reliable assessments of prevalence in different countries come from large-scale population prevalence surveys. Several large-scale population prevalence surveys have been conducted internationally (Table 1-3) [144-148]. These provide more robust data than clinic-based or convenience-sample community settings, although it is acknowledged that achieving truly representative population-based samples is challenging [146]. A potential bias for chlamydia general population prevalence studies is that those who have recently tested may be more likely to decline to participate, although there is conflicting opinion as to whether non-participants are more or less likely to test positive, with the potential for results to be affected in either direction [146,149]. These five large-scale population prevalence surveys demonstrate similar prevalence among young women of 3-4.7% in the UK, the Netherlands and the US, with higher rates in Peru (6.5%). Population prevalence appears higher in women (range: 1.5% to 6.5%) than in men (range: 1.1% to 4.2%), with the exception of one UK-based study. Where stratified by age, all five countries report a higher prevalence of chlamydial infection among those under 25 years of age (Table 1-3) [144-148].

The US National Health and Nutrition Examination Survey (NHANES) has been repeated every two years since 1999 and provides useful information about general population chlamydia prevalence trends over time [148]. Chlamydia prevalence has decreased approximately 40% over a 10-year time period since 1999 with prevalence among 14- to 39-year-olds estimated to be less than 2% in 2007-2008. Decreases in prevalence were most notable in men, in adolescents aged 14 to 19 years, and in non-Hispanic white people but there has been no significant change in prevalence among females aged 14 to 25 years, with prevalence of 4.1% in 1999-2000 and 3.8% in the 2007–2008 surveys. There is limited information from countries other than the USA about general population prevalence trends over time, although a repeat UK study is planned.
### Table 1-3 General population chlamydia prevalence from published large-scale international studies

<table>
<thead>
<tr>
<th>Authors</th>
<th>Country</th>
<th>Study design, population, setting, time period if specified</th>
<th>Specimen type</th>
<th>Sample size</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fenton et al., 2001</td>
<td>United Kingdom</td>
<td>16-44 year olds, national randomly selected household-based general population sexual attitudes and lifestyle survey, 1999-2001. Of those aged 18-44, half were asked to provide a <em>C. trachomatis</em> test, of which 71% agreed</td>
<td>first catch urine, ligase LCR</td>
<td>2055</td>
<td>2.2% of 18-44 year old men &lt;br&gt;1.5% of 18-44 year old women &lt;br&gt;(3% of 18-24 year old women)</td>
</tr>
<tr>
<td>Miller et al., 2004</td>
<td>USA</td>
<td>18-26 year olds, prospective cohort study, nationally representative sample of young adults, 2001-2002 66.3% of 18924 provided a urine sample</td>
<td>first catch urine, ligase LCR</td>
<td>12548</td>
<td>3.7% of 18-26 year old men &lt;br&gt;4.7% of 18-26 year old women</td>
</tr>
<tr>
<td>Van Bergen et al., 2005</td>
<td>Netherlands</td>
<td>15-29 year olds randomly selected, national general population probability sample for a <em>C. trachomatis</em> prevalence study, 2002-2003. 41% of 20495 provided a urine sample</td>
<td>first catch urine, Amplicor PCR</td>
<td>8383*</td>
<td>1.5% of 15-29 year old men &lt;br&gt;2.5% of 15-29 year old women</td>
</tr>
<tr>
<td>Cárcamo et al., 2012</td>
<td>Peru</td>
<td>18-29 year olds, national randomly selected household-based general population sexual behaviour survey, 2002. 86% of 15260 survey participants provided samples</td>
<td>male first catch urine &lt;br&gt;female self taken vaginal swab or first catch urine, Amplicor PCR</td>
<td>13099</td>
<td>4.2% of 18-29 year old men &lt;br&gt;6.5% of 18-29 year old women</td>
</tr>
<tr>
<td>Datta et al., 2012</td>
<td>USA</td>
<td>14-39 year olds, randomly selected household-based National Health and Nutrition Examination Survey, repeated 2-yearly since 1999. 92.4% of 17190 survey participants provided samples</td>
<td>first catch urine, ligase LCR 1999-2002 &lt;br&gt;Probstec BD SDA 2003-2008</td>
<td>15885</td>
<td>2007-2008 cycle: &lt;br&gt;1.1% of 14-39 year old men &lt;br&gt;2.2% of 14-39 year old women &lt;br&gt;(3.8% of 14-25 year old women)</td>
</tr>
</tbody>
</table>

*44 missing results (due to test inhibition or missing parental consent)*
International literature suggests that chlamydia prevalence varies by race and/or ethnicity, as has been noted in clinic- and community-based surveys in New Zealand. In the aforementioned Australian meta-analysis, Lewis et al. reported pooled prevalence estimates of 22.1% for indigenous Australian women aged less than 25 years and 14.6% for same-age indigenous men. However, most prevalence studies are limited by under-representation of the sampled population. Some of the most representative data come from the NHANES surveys that reported prevalence of 6.7% in non-Hispanic black persons, 2.4% in Mexican Americans and 0.3% in non-Hispanic white persons during 2007-2008 [148]. Of other larger general population prevalence surveys, a US study of a nationally representative adolescent cohort in 2002 oversampled black youth in families with relatively higher socioeconomic status, with reported chlamydia prevalence of 1.94% in young white adults, 10.41% in young Native American adults and 12.54% in young black adults [149]. Similarly, a national chlamydia prevalence study among 15-29 year olds in the Netherlands in 2003 reported prevalence of 2.2% among young women of Dutch ethnicity but 12.1% among young women of Suriname (South America) or Antillean (Caribbean) ethnicity [146].

In summary, C. trachomatis infection appears to be at least as prevalent among women in New Zealand as overseas, with comparable chlamydia prevalence rates reported for similar clinic-based settings, such as termination of pregnancy clinics. However, the heterogeneity of the studies and of the populations of interest limits robust comparison. Consistent findings across all settings are of higher prevalence among younger populations, among those attending health-care settings and of racial and/or ethnic disparities.

New Zealand’s health care system

The following section is a brief overview of New Zealand’s health care system to provide context to this thesis.

In 2012, New Zealand had an estimated population of approximately 4.4 million, of whom over three-quarters (76%) live in the North Island [150]. The majority of the population is of European descent, with the remainder comprising mainly of indigenous Māori (14.6%), Asian (9.2%) and Pacific Island peoples (6.9%). Most Māori (87%) live in the North Island.

The Social Security Act 1938 aimed to deliver a free health system universally available to all New Zealanders; however, this was never fully realised and health services evolved as a dual system of public and private health care [151]. Since 1983, the New Zealand public health sector has undergone four major structural reforms. With each change, a new set of organisations was established to fund and deliver health services: 1983-1993 Area Health Boards; 1993-1997 Regional Health Authorities and Crown Health Enterprises; 1998-2001 Health Funding Authority and Hospital and Health Services; and from 2001, District Health Boards (DHBs) (Figure 1-6) and Primary Health Organisations (PHOs) (Figure 1-7) [151].
Figure 1-6 Map of New Zealand’s 20 district health boards in 2012 [152]
DHBs are responsible for organising healthcare within their district and for meeting standards and targets set by the Ministry of Health (Figure 1-7). PHOs are not-for-profit private organisations that contract to DHBs on a per capita basis to provide primary health care services, through their member health providers who are usually GPs or practice nurses, with funding based on the demographic details of the PHO’s enrolled population. GP visits are subsidised by the government and GPs supplement these subsidies with user co-payments. Following the 2002 reforms, GPs have received extra government subsidies to offer free services for children under six and to offer a range of lower charges for other patients \[151\]. Other non-PHO-affiliated allied health professionals, including independent midwives, also provide primary care services.

A pharmaceutical management agency (Pharmac) was set up under the Health and Disability Services Act 1993 to improve the management of government expenditure and is responsible for managing and procuring pharmaceuticals in New Zealand. Only Pharmac–approved pharmaceuticals are subsidised by the government, with patients paying a small prescription co-payment (increased from $3 to $5 NZD as of January 1\[4\], 2013). Non-approved medications incur full cost to the patient. Laboratory diagnostic services are fully

Note: There are now 20 DHBs with Southland and Otago DHBs merging into Southern DHB in 2010
funded and provided by both public hospital laboratories and private, community-based laboratories.

**STI surveillance**

Surveillance is an essential part of a prevention strategy to reduce the burden of sexually transmitted infections, as it is important to:

- Assess the magnitude of the STI burden at global, country & regional levels;
- Identify vulnerable population groups;
- Provide data to advocate for resources for intervention activities;
- Monitor the impact of these intervention activities \[153\]

The core components of STI surveillance include conducting:

- Routine systematic recording and reporting of numbers of patients with STIs seen at health care facilities and of the specific diseases or syndromes diagnosed. This reporting can be done at all health care facilities or at a representative proportion of them (sentinel surveillance) and provides surrogate indicators for the monitoring of trends in disease incidence;
- Studies to collect information on proportions of individuals infected with STIs in different population groups, using appropriate laboratory techniques, to determine disease prevalence, and monitor trends in disease prevalence;
- Studies to determine the effectiveness of selected drugs for a specific STI pathogen, or monitoring the prevalence of antimicrobial resistance among specific pathogens \[153\]

**STI surveillance in New Zealand**

STIs are not notifiable in New Zealand and the monitoring of STIs is not required by laboratory service agreements. Routine surveillance in New Zealand is therefore based on voluntary reporting from sentinel clinics and participating laboratories.

**Sentinel clinic STI surveillance**

New Zealand’s publically funded sexual health clinics began recording syphilis and gonorrhoea cases from 1920, although venereal disease clinics, as they were then known, were limited to New Zealand’s four largest cities \[154\]. By the 1970s, there were 12 clinics attached to outpatient departments of major hospitals and a standardised recording format, based on UK reporting categories, had been adopted with annual reporting of clinic case data to the Department of Health. Clinics also reported the number of new or newly returning clinic patients, defined as those who had not visited a clinic in the past three
months, to allow a clinic-based incidence rate to be calculated. From 1977 to 1986, ten conditions (syphilis, gonorrhoea, non-specific urethritis, trichomoniasis, scabies, genital warts, candidiasis, genital herpes, pubic lice and molluscum contagiosum) were included in the annual Public Health report [154].

Efforts were made to ensure most STIs remained not notifiable, in line with the UK model of STI surveillance. The New Zealand Venereal Disease Regulations (1964) were revised in 1982 to facilitate treatment, contact tracing and follow-up of those with syphilis, gonorrhoea, chancroid, granuloma inguinale and lymphogranuloma venereum, but did not make the conditions notifiable [155]. Chlamydia was not included in the named venereal disease list in 1982, because diagnostic testing was not routinely available, and subsequent efforts to further amend this regulation have been unsuccessful [156].

Chlamydia clinic case reports were collated for the first time in 1986. However, the Department of Health Public Health Report ceased publication and, consequently, from 1988 until 1995, sexual health clinicians voluntarily collated and reported clinic case data under the umbrella of the New Zealand Venereological Society [154,157]. In the early 1990s, there was a major upgrade and expansion of publically funded sexual health clinics, from 14 clinics in 1989 to 24 clinics by 1993. There was considerable variability in clinics’ case reports and efforts were made to address this, by attempting to standardise case definitions and simplify forms [154,158].

In 1995, the Ministry of Health contracted the Institute of Environmental Science and Research Ltd (ESR) to provide a national coordinating role for clinic-based surveillance [115]. Soon after, in 1998, ESR was contracted to implement an expansion of the STI surveillance system to include data from other sentinel settings with a significant sexual health caseload, such as family planning clinics (FPCs), which provide sexual and reproductive health services, and student and youth health clinics (SYHCs), which provide general and/or specialist health services for students and staff or provide drop-in services for young people. An important difference is that sexual health clinic services are free while FPCs and SYHCs may offer free, or low-cost, services to younger attendees but charge a variable user-fee to non-adolescents. FPCs and SYHCs were approached and began contributing surveillance data in 1998.

The current sentinel case definitions were also adopted in 1998 (Appendix 1). All clinics were asked to report the total number of clinic visits per month, by age, sex and ethnicity. This allowed clinic-specific incidence rates to be calculated, though visits could be for any reason, including non-sexual health consultations. This clinic-based sentinel surveillance continues to be reported quarterly by ESR to key stakeholders and complements a more detailed annual report.
Laboratory-based surveillance

The number of cases of STIs reported through the clinic-based surveillance system provides useful information but underestimates the true burden of infection in New Zealand because a substantial percentage of STIs are diagnosed in general practice. Laboratories receive specimens from all health providers and so provide a useful complementary source of surveillance data. [159,160]

In 1998, the Ministry of Health contracted ESR to implement an expansion of the STI surveillance system and laboratories were approached about providing data [115]. Voluntary laboratory-based surveillance of *N. gonorrhoeae* and *C. trachomatis* began in the Waikato and Bay of Plenty regions of New Zealand that year. The Auckland region also began providing gonococcal data in 1998 but did not provide chlamydia data until 2001. From mid-2004, further efforts were made to extend voluntary STI surveillance to all diagnostic laboratories across New Zealand (Figures 1-8 and 1-9). By 2009, most laboratories were contributing data, enabling population-based rates for these two infections to be reported for the majority of district health boards. Importantly, greater laboratory participation enabled national population-based estimates to be made for the first time.

However, there are still major limitations to this dataset. Laboratories provide anonymous data on laboratory-confirmed cases by age and sex, as well as the total number of specimens and/or patients tested. Ethnicity data are not reported. Some health-care providers use patient identifiers that are unique to their setting so, although attempts are made to de-duplicate the data to minimise the likelihood that an individual with multiple specimens is counted more than once, complete de-duplication is not possible. Reported aggregate testing volumes means that population-testing rates can be calculated but estimates of testing rates by age, gender, ethnicity or domicile are not yet possible.
Figure 1-8 Map of New Zealand showing laboratory participation in voluntary chlamydia surveillance in 2005 and 2007\textsuperscript{[115]}
Figure 1-9 Map of New Zealand showing laboratory participation in voluntary chlamydia surveillance in 2009 and 2011 [115]
Reported chlamydia cases in New Zealand

Chlamydia is the most commonly reported STI in New Zealand. In 2011, participating laboratories in New Zealand reported positive tests from 25666 patients, giving an estimated national rate of 786 per 100 000 population (95% confidence interval 753, 819). The highest rate of cases was reported for Tairawhiti DHB (1510 per 100 000, 703 cases), followed by Lakes (1265 per 100 000, 1321 cases) and Hawke’s Bay (1006 per 100 000, 1560 cases) DHBs (Table 1-4).

<table>
<thead>
<tr>
<th>District Health Board</th>
<th>Number of test-positive cases</th>
<th>Rate per 100 000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Northland</td>
<td>312</td>
<td>1075</td>
</tr>
<tr>
<td>Auckland region</td>
<td>2952</td>
<td>8103</td>
</tr>
<tr>
<td>Waikato</td>
<td>768</td>
<td>2114</td>
</tr>
<tr>
<td>Lakes</td>
<td>271</td>
<td>1048</td>
</tr>
<tr>
<td>Bay of Plenty</td>
<td>424</td>
<td>1346</td>
</tr>
<tr>
<td>Tairawhiti</td>
<td>160</td>
<td>541</td>
</tr>
<tr>
<td>Taranaki</td>
<td>210</td>
<td>471</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>369</td>
<td>1191</td>
</tr>
<tr>
<td>Whanganui</td>
<td>111</td>
<td>368</td>
</tr>
<tr>
<td>MidCentral</td>
<td>341</td>
<td>838</td>
</tr>
<tr>
<td>Wairarapa</td>
<td>47</td>
<td>178</td>
</tr>
<tr>
<td>West Coast</td>
<td>48</td>
<td>114</td>
</tr>
<tr>
<td>Southern</td>
<td>600</td>
<td>1623</td>
</tr>
<tr>
<td>Other</td>
<td>479</td>
<td>905</td>
</tr>
<tr>
<td>Total</td>
<td>6613</td>
<td>19010</td>
</tr>
</tbody>
</table>

Note: ESR’s selection criteria specify that, for a DHB to be included in the analyses, all laboratories servicing that DHB must have participated in the surveillance programme.

Nationally, 9000 chlamydia tests per 100 000 population were performed in 2011, of which 9.0% tested positive (Table 1-5). This does not exclude repeat samples from the same individual(s) during that time. The highest numbers of tests relative to population size were in Tairawhiti DHB and Lakes DHBs (10600 per 100 000 population each), with Tairawhiti DHB also having the highest rate of test positivity (14.5%).
Table 1-5 Number of chlamydia tests per 1000 population, test positivity and number of laboratory-confirmed cases, by DHB, 2011

<table>
<thead>
<tr>
<th>District Health Board</th>
<th>Total specimens</th>
<th>Tests per 1000 population</th>
<th>Specimens tested positive (%)</th>
<th>Number of laboratory-confirmed cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northland</td>
<td>11 981</td>
<td>76</td>
<td>11.6</td>
<td>1 393</td>
</tr>
<tr>
<td>Auckland region a</td>
<td>146 759</td>
<td>98</td>
<td>7.8</td>
<td>11 062</td>
</tr>
<tr>
<td>Waikato</td>
<td>29 637</td>
<td>81</td>
<td>9.8</td>
<td>2 883</td>
</tr>
<tr>
<td>Lakes</td>
<td>11 087</td>
<td>106</td>
<td>11.9</td>
<td>1 321</td>
</tr>
<tr>
<td>Bay of Plenty</td>
<td>17 664</td>
<td>83</td>
<td>10.2</td>
<td>1 777</td>
</tr>
<tr>
<td>Tairawhiti</td>
<td>4 948</td>
<td>106</td>
<td>14.5</td>
<td>703</td>
</tr>
<tr>
<td>Taranaki</td>
<td>9 908</td>
<td>90</td>
<td>8.4</td>
<td>682</td>
</tr>
<tr>
<td>Hawke's Bay</td>
<td>12 681</td>
<td>82</td>
<td>12.3</td>
<td>1 560</td>
</tr>
<tr>
<td>Whanganui</td>
<td>4 221</td>
<td>69</td>
<td>11.8</td>
<td>479</td>
</tr>
<tr>
<td>MidCentral</td>
<td>11 526</td>
<td>68</td>
<td>10.5</td>
<td>1 182</td>
</tr>
<tr>
<td>Waitara</td>
<td>2 147</td>
<td>53</td>
<td>10.9</td>
<td>225</td>
</tr>
<tr>
<td>West Coast</td>
<td>2 085</td>
<td>64</td>
<td>8.0</td>
<td>163</td>
</tr>
<tr>
<td>Southern</td>
<td>28 821</td>
<td>94</td>
<td>7.8</td>
<td>2 236</td>
</tr>
<tr>
<td>Other b</td>
<td>20 445</td>
<td>-</td>
<td>7.1</td>
<td>1 384</td>
</tr>
<tr>
<td>Total c</td>
<td>293 456</td>
<td>90</td>
<td>9.0</td>
<td>25 666</td>
</tr>
</tbody>
</table>

a Waitakere, Auckland and Counties Manukau DHBs
b Data from DHBs where selection criteria were not met
c Total includes only cases and population for DHBs meeting the selection criteria

Note: ESR’s selection criteria specify that, for a DHB to be included in the analyses, all laboratories servicing that DHB must have participated in the surveillance programme.

The national rate for females (1145 per 100 000 population, 19010 cases) was almost three-times the national rate for males (412 per 100 000 population, 6613 cases) in 2011 (Table 1-4). The mean age of test-positive cases was 22.5 years (median age 21 years, range 0 to 74 years). Seventy-one percent (18241) of positive cases were aged from 15 to 24 years. The highest national age-specific rate of test-positive cases for females was in the 15 to 19 years age group (6348 per 100 000 population, 7372 cases). For males, the highest age-specific rate of test-positive cases was in the 20 to 24 years age group (1973 per 100 000 population, 2427 cases). One hundred and five test-positive chlamydia cases were reported in the less than one-year age group.

In the same year, 9135 chlamydia cases were reported by sentinel clinics, equating to 35.6% of all laboratory-reported cases, with sexual health clinics (SHC), family planning clinics (FPC) and student and/or youth health clinics (SYHC) reporting 5343, 2827 and 965 cases respectively. More clinic cases were seen in females (67%) than males, and a large proportion were aged less than 25 years; 67.5% (3608/5343) in SHCs, 86.6% (2447/2826) in FPCs and 92.6% (885/956) in SYHCs. As in laboratory-reported cases, chlamydia case numbers were highest in the 15 to 19 years age group for females and highest in the 20 to 24 years age group for males (Figure 1-10).
By ethnicity, the highest percentage of chlamydia cases reported were of European ethnicity (SHCs 43.8%, 2305 cases; FPCs 50.9%, 1387 cases; SHYCs 50.5%, 480 cases), followed by Māori (SHCs 40.1%, 2115 cases; FPCs 35.6%, 971 cases; SHYCs 37.8%, 359 cases), Pacific Peoples (SHCs 11.0%, 580 cases; FPCs 9.9%, 271 cases, SHYCs 5.2%, 49 cases) and Other (SHCs 5.1%, 268 cases; FPCs 3.5%, 95 cases; SHYCs 6.5%, 62 cases). Using all clinic visits by ethnicity as a denominator, the clinic visit rate for chlamydia is at least three times higher among Māori and Pacific People cases compared to clinic visit rates for Europeans.

Recent trends in New Zealand

While SHCs have provided the most comprehensive source of STI data for New Zealand over many decades, changes in the definitions and the denominator used for STI surveillance in the 1980s and 1990s limit comparisons with historical data [157]. More recent trends show that confirmed chlamydia cases reported by SHCs have increased in every age group in both females and males and in all ethnic groups during 2006-2011 (Figure 1-11).
Nationally representative laboratory data have only been available for a few years, although laboratory cases from three regions comprising six DHBs (Waitemata, Auckland, Counties Manukau, Waikato, Bay of Plenty, Lakes), and nearly 50% of total New Zealand population, have been collated for a decade. Across these three regions, the annual chlamydia rate steadily increased from 491 per 100 000 in 2001 to 815 per 100 000 in 2008. Rates have been slightly higher in the Waikato and Bay of Plenty/Lakes regions than in the Auckland region (Waitemata, Auckland and Counties Manukau DHBs) over time. However, between 2009 and 2011, rates have decreased in the Waikato and Bay of Plenty/Lakes DHBs (858 to 785 per 100 000 and 1173 to 984 per 100 000 respectively), whereas the combined rate for the three Auckland DHBs has increased (689 to 736 per 100 000) (Figure 1-13).

In summary, prevalence studies in selected subpopulations and routine surveillance data suggest that chlamydia is a significant health problem among young people and Māori and Pacific peoples in New Zealand, and that reported chlamydia case rates have increased over time. However, the routine collected dataset has acknowledged limitations that hamper interpretation, particularly around testing rates.
Comparison with internationally-reported chlamydia cases

In Australia, chlamydia is a notifiable condition, meaning that legislation explicitly requires case reporting to health departments by laboratories and/or clinicians, depending on the state or territory. Since mid-2007, efforts have also been made to introduce enhanced chlamydia surveillance based on clinical and laboratory networks [161]. In 2011, the national notification rate for chlamydia infection in Australia was 357 per 100 000 population [162], about half that of the estimated New Zealand national rate (786) (Table 1-6). There were more notifications in females than in males (417 and 296 per 100 000 population, respectively). The highest national age-specific rate of test-positive chlamydia cases for females in 2011 was in the 15 to 19 years age group (2230 per 100 000 population). For males, the highest age-specific rate of test-positive chlamydia cases was in the 20 to 24 years age group (1424 per 100 000 population) [162].

National chlamydia notification rates have been steadily increasing in Australia from 54 per 100 000 population in 1994 to 357 per 100 000 in 2011 [162]. A study in New South Wales confirmed that notification rates are highly correlated to testing rates [163], with recent testing rates in Australia acknowledged as low; less than 9% of women aged 20-24 years were tested in 2004 [164]. Recent increases in notifications may therefore reflect increased testing and more widespread use of more sensitive diagnostic methods. It is also possible that chlamydia prevalence is increasing in Australia. For example, between 2003 and 2007, chlamydia test positivity increased by 12% per year, after adjusting for age, behaviour and other factors, among women tested at a large metropolitan sexual health clinic in Victoria, Australia [165].

Table 1-6 Reported rates of chlamydia per 100 000 population, ranked by overall rates

<table>
<thead>
<tr>
<th>Reported rate per 100 000 population</th>
<th>Females</th>
<th>Males</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>1145 *</td>
<td>412 *</td>
<td>786 *</td>
</tr>
<tr>
<td>Iceland</td>
<td>869 †</td>
<td>550 †</td>
<td>711 †</td>
</tr>
<tr>
<td>Denmark</td>
<td>665 †</td>
<td>414 †</td>
<td>541 †</td>
</tr>
<tr>
<td>Norway</td>
<td>586 †</td>
<td>358 †</td>
<td>474 †</td>
</tr>
<tr>
<td>USA</td>
<td>610 ‡</td>
<td>234 ‡</td>
<td>426 ‡</td>
</tr>
<tr>
<td>Sweden</td>
<td>461 †</td>
<td>355 †</td>
<td>408 †</td>
</tr>
<tr>
<td>Australia</td>
<td>417 *</td>
<td>296 *</td>
<td>357 *</td>
</tr>
<tr>
<td>UK</td>
<td>406 ‡</td>
<td>287 ‡</td>
<td>349 ‡</td>
</tr>
<tr>
<td>Finland</td>
<td>289 †</td>
<td>210 †</td>
<td>250 †</td>
</tr>
<tr>
<td>Ireland</td>
<td>102 †</td>
<td>74 †</td>
<td>90 †</td>
</tr>
</tbody>
</table>

Legend: * 2011, ‡ 2010, † 2009

Genital chlamydia is among the 49 diseases and health issues under European-wide epidemiological surveillance following a 1999 European Commission decision [166]. However, there are very disparate routine surveillance systems in the member countries, varying from mandatory or voluntary notification, comprehensive or sentinel clinic
surveillance, case-based or aggregated data, and variation as to whether clinicians or laboratories or others have reporting responsibility. European countries also vary as to whether data are nationally representative. The asymptomatic nature of chlamydia infection, the varying diagnostic methods used and varying levels of testing and reporting, mean it is likely that many diagnoses are either not made or are not reported in a number of European countries.\cite{166}

Even so, chlamydia is the most frequently reported STI in Europe.\cite{166} In 2009, 343958 cases of chlamydia were reported in 23 European Union Member States, an overall rate of 185 per 100 000 population. Data were not available in, or not reported by: Bulgaria, the Czech Republic, France, Germany, Italy, Liechtenstein and Portugal. Four countries (Denmark, Norway, Sweden and the United Kingdom) reported 88% of all cases, with the UK reporting 62% of all cases, suggesting the true incidence of chlamydia in Europe is likely to be considerably higher.

By country, in 2009, the highest rates per 100 000 population were observed in Iceland (711), Denmark (541), Norway (474), Sweden (408), the United Kingdom (348) and Finland (250) (Table 1-6). Eight countries (Cyprus, Greece, Lithuania, Luxembourg, Poland, Romania, Slovakia and Slovenia) reported rates less than 10 per 100 000 population. Reported rates in the UK increased 89% during 2006-2009, predominately due to expanded surveillance reporting, to include community-based settings in addition to sentinel STI clinics, and increased testing with the introduction of a national chlamydia screening programme.

Comparisons between countries are acknowledged as difficult because of the heterogeneity in reporting.\cite{166} Despite this, common features are apparent. In Europe, chlamydia was reported more in women than in men, with overall rates of 217 per 100 000 in women and 152 per 100 000 in men. Three quarters (75%) of all cases were reported in people between 15 and 24 years of age. Chlamydia rates from European countries have increased continuously over the last decade, thought likely to be due to improved diagnostic tools, increased case detection, and improved surveillance systems.\cite{166}

In the US, chlamydia is a notifiable disease and the Centers for Disease Control and Prevention (CDC) collate reports. Chlamydia notification in the US was 426 per 100 000 population in 2010 ranging from 186 per 100 000 population in New Hampshire to 862 per 100 000 in Alaska.\cite{167} The highest age-specific rates of reported chlamydia in 2010 among women were in those aged 15–19 years (3378 cases per 100 000 females) and 20–24 years (3408 cases per 100 000 females). The highest age-specific rates among men were in those aged 20–24 years (1187 cases per 100 000 males). Chlamydia prevalence was over two and half times higher in females than males (Table 1-6). The reported chlamydia
rates per 100 000 population by ethnicity were 1167 for black Americans, 593 for American Indians/Alaska Natives, 370 for Hispanics and 139 for white Americans [167].

Allowing for heterogeneous surveillance systems, this comparison with overseas chlamydia rates per 100 000 population suggests New Zealand’s reported chlamydia rates among men are not dissimilar to a number of other countries but reported rates are markedly higher among New Zealand women. It is not clear however if higher reported rates of chlamydia infection reflect higher chlamydia incidence in New Zealand or simply greater detection and/or greater reporting of asymptomatic infections. In addition, it is not clear from current surveillance data in New Zealand whether changes in sentinel clinic or laboratory case rates reflect changing incidence.

**Approaches to chlamydia control**

The number of new cases of a sexually transmitted infection reflects biological and behavioural variables, which are influenced in turn by demographic, social, economic and cultural determinants of the individual, their partners and the population [168]. Important biological factors to consider are the duration of infection and infectiousness, or transmissibility, to a susceptible person.

**Duration of *C. trachomatis* infection**

The natural history of chlamydial infection, including the duration of infection and factors influencing resolution of infection, is not yet completely understood, although it has been established that, if left untreated, infection can persist for years [20]. A 2010 review on the duration of untreated uncomplicated infections concluded that clearance of *C. trachomatis* increases over time, with approximately half of untreated infections spontaneously resolving within 12 months of diagnosis [169]. Most studies have either evaluated for infection resolution in the interval between diagnosis and the follow-up visit for treatment or have retrospectively assessed samples taken as part of a study protocol focused on another infection [169]. Major limitations of reported studies to date are the lack of precise data on the timing of infection acquisition, lack of strain typing to exclude re-infection and relatively short interval follow-up periods for most of the participants. However, it is ethically unacceptable to perform longitudinal studies on the natural history of untreated chlamydia. Mathematical modelling suggests asymptomatic *C. trachomatis* infection in women has a mean duration of 433 days, based on currently available data on the persistence of asymptomatic infections [170].

**Transmissibility of *C. trachomatis* infection**

Rates of transmission of *C. trachomatis* between individuals are poorly understood. Estimates have usually been based on data about the proportions of sexual partnerships in which both partners are infected (concordant) or only one partner is infected (discordant)
However, concordance within a relationship does not necessarily equate to per partnership transmission rate and estimates are likely to be affected by variation in the duration of partnerships, frequency of sexual activity, rates of condom use, rates of spontaneous clearance of infection and of health-seeking behaviour that may result in treatment. Althaus and colleagues modelled data from a study of chlamydia infection status and sexual activity in 494 heterosexual couples, and derived a per sex act transmission probability of 9.5% and a median per partnership transmission probability of 55.5%. These estimates are consistent with those from other modelling studies.

**Risk behaviours**

Although the natural history of chlamydial infection is not yet completely understood, it appears that this oft-asymptomatic infection has a long duration of infectiousness and a high per-partnership transmission probability, and both these factors facilitate the spread of *C. trachomatis* within a population. Lack of persistent immunity following infection helps maintain a pool of susceptible individuals and further facilitates spread. However, whether these biological factors lead to new cases of infection also depends on sexual behaviour and rates of partner change.

People infected with STIs generally report inconsistent condom use and more sexual partners than people who do not have STIs. Even so, some of those with STIs report relatively few sexual partners, reflecting that the choice of sexual partner also influences whether a susceptible individual is exposed to someone already infected. Social science and network theory suggest that STI epidemiology is influenced by the extent to which individuals form sexual partnerships with individuals of similar (assortative mixing) or dissimilar (disassortative mixing) risk status and also the extent to which sexual partnerships overlap (concurrency). At a population level, assortative mixing restricts the spread of infection but helps maintain high levels of infection within high-risk groups. For example, young age is a strong predictive risk factor for chlamydial infection. Sexual partnerships are strongly assortative by age albeit that heterosexual males tend to be slightly older than their female partners; consequently, assortative partnering by age is associated with higher risk of exposure to infection and contributes to the higher prevalence of chlamydia among young adults. Similarly, assortative mixing by race and/or ethnicity, or by geographical location, may help maintain differences in STI prevalence within subpopulations.

If partners are chosen to be dissimilar (disassortative mixing) or if no choice discrimination occurs (random mixing), then infection may spread from high-to-low risk individuals; at a population level, this means spread of infection within a population tends be slower but becomes more widespread over time. For example, disassortative mixing by rates of
partner change is typically present for heterosexual partnerships where social norms encourage men to have many partners.

It holds true that having multiple sexual partners typically increases the risk of a person to acquire or transmit an STI, regardless of whether those multiple partners are sequential (serial monogamy) or concurrent. The importance of concurrent partnerships however is that they greatly increase the potential for an infection to spread, more so than multiple partnerships that are sequential \[172\]. With serial monogamy, earlier partners in the sequence (person B, Figure 1-14) are not exposed to infections that the index case (person A) acquires from subsequent partners (person C). In contrast, with concurrent partnerships, all partners may be exposed to an infection acquired from any partner \[174\].

![Figure 1-14 Serial monogamy and concurrency \[174\]](image)

Young sexually active adults are more likely to have higher rates of partner change and are more likely to have concurrent partnerships than older adults \[175-177\], and thus are at greater risk of acquiring or transmitting STIs. Moreover, international evidence suggests that young people are having more sexual partners and more concurrent sexual partners than in the past \[176-178\].

A national general population survey of sexual behaviour was undertaken in New Zealand in 1991 \[175\], but has yet to be repeated, and recent information on sexual risk behaviour is only available for New Zealand adolescents \[179,180\]. In keeping with reported international trends, more New Zealand secondary school students reported any sexual activity in 2007 than in 2001 \[179\]. Of 9107 New Zealand secondary school students aged 13 to 18 years surveyed in a nationally representative sample in 2007, 36.3% of students had ever been sexually active compared with 31.3% of 9570 secondary school students surveyed in 2001. Reported condom use at last sex, by 63.7% of sexually active respondents, was unchanged from 2001 \[179\]. Rates of partner change or concurrency were not measured in either survey. The number of students reporting any sexual activity, and condom use at last sex, were...
similar to that reported for secondary school students in Australia. Of 2926 Australian year 10 (age 15 years) and year 12 (age 17 years) students surveyed in 2008, 40% of students had ever been sexually active compared with 35% in 2002 [178]. Condom use remained stable between the 2002 and 2008 health surveys, with 69% of sexually active Australian students reporting condom use the last time they had sex in 2008.

There is little other recent representative information on sexual risk behaviour in New Zealand. Some information is available from a health survey of tertiary students, aged 17-24 years, attending any of eight New Zealand universities in 2009 [181]. Of 2922 participating university students, 69% reported they had ever had sex; of these, 20% had three or more sexual partners in the last year and only 54% used a condom the last time they had sex [180]. These findings may not be representative of all 17-24 year olds in New Zealand, however, although the median age of first sex (16 years for women; 17 years for men) in 2009 was similar to that reported for New Zealand secondary school students surveyed in 2007 [179].

Sexual behaviour is very heterogeneous, however, and population behaviour studies generally identify only a small subset of the heterosexual population, typically around 5%, who engage in much riskier behaviour [175-177]. For example, among university students aged 17-24 years who participated in the aforementioned New Zealand tertiary student health survey in 2009, respondents reported a median of one sexual partner in the last 12 months, with 75% reporting two or less partners, while 3% of respondents reported six or more partners in the last 12 months. In addition, condom use at last sex paradoxically declined as the number of reported sexual partners increased; among those reporting nine or more partners in the last 12 months, only 42% reported condom use at last sex [180]. The small subset of the population who engage in riskier behaviour, often referred to as the core group, is believed to contribute disproportionately to the ongoing transmission of STIs within and across their sexual networks [172,182]. Yet the continuing fluidity of individual behaviour, and hence changing core group membership over time, makes it challenging to define core group membership for targeted interventions [183].

Prevention

The basic reproductive number $R_0$ of an infectious disease is an estimate of the average number of people, in a fully susceptible population, who would acquire infection from a single infected individual over the time course of that individual’s infection. For example, the $R_0$ of influenza is approximately 2, that of rubella approximately 6, and that of measles approximately 15 [184]. However, a variety of factors including the proportion of the population who is immune, as the result of prior infection or vaccination, the effect of antimicrobial treatment on the duration of infectiousness, and changes in patterns of
behaviour in infected and susceptible people, mean that the actual reproductive rate $R$ of most infectious diseases in most communities is much less than $R_0$ \[^{184}\].

With regard to STIs, such as $C.\ trachomatis$, $R$ is defined as the product of: the probability of transmission of infection from one person to another ($\beta$); the number of sexual partners within a period of time ($c$); and the duration of infectiousness of an infected person ($D$), i.e. $R = \beta cD$ \[^{168}\]. When $R$ is greater than one, an infection will spread within the community, whereas when $R$ is less than one, the number of new cases will decline \[^{168,184}\]. Recognition of the factors that determine the reproductive rate $R$ of an infectious disease provides a good basis for determining interventions that might help to reduce its incidence. For chlamydial infections: encouraging condom use will reduce the probability of transmission from one person to another; education may help to reduce the number of sexual partners within a period of time; and effective identification and treatment of infected persons will shorten the infectious period.

Prevention efforts that aim to modify the probability of transmission of $C.\ trachomatis$ infection from one person to another, or the number of sexual partners within a period of time, necessitate behavioural change across the total at risk population; something that is difficult to achieve. There is good evidence that consistent, correct use of condoms reduces the transmission probability and provides excellent protection against acquisition of $C.\ trachomatis$; however, both incorrect use and incomplete use of condoms remain common \[^{185}\]. Abstaining from sex and long-term mutually monogamous relationships are also protective factors against infection. Again, there is good evidence that behavioural interventions that encourage young people to adopt and maintain safer sexual behaviour are effective in increasing knowledge and self-efficacy although a recent systematic review found there is limited evidence of their impact on biological outcomes, such as increased condom use in the short-term \[^{186}\]. Nonetheless, ensuring quality sexual health education for young people is important as it increases knowledge upon which to make decisions about sexual behaviour \[^{186}\].

Sexuality education is an established component of the education curriculum in New Zealand, and compulsory until year 10 (age 14-15 years), although it is the only part of the curriculum that requires principals to consult with the school’s board of trustees and with parents regarding content, and parents can opt to have a child removed from class. In 2006, a review of 100 nationally-representative New Zealand intermediate and secondary schools found some evidence of high quality sexuality education \[^{187}\]. However, overall findings were that: schools undertook little, or no, assessment of students’ learning needs, resources were inadequate and/or inappropriate, and staff were not well prepared to teach sexuality as a subject. More than two-thirds of school-based sexuality education programmes were
evaluated as not meeting students’ learning needs, with 20% of schools reported to have substantial weaknesses in sexuality teaching practice [187].

In addition, in the last twenty years, there has been only one national social marketing campaign to raise awareness of STIs and promote condom use in New Zealand. The ‘No Rubba, No Hubba Hubba’ multimedia campaign ran for four months over the summer of 2004-2005. The campaign emphasised high reported rates of STIs in New Zealand and encouraged young people to use condoms. Condom awareness among young people was reportedly higher in the months following the campaign but there was no evaluation of behavioural change [188].

Presently available data do not suggest that the rate of condom use among young people in New Zealand is likely to increase significantly, or that the rate of partner change is likely to decline, in the near future. Consequently, behaviour change can be expected to contribute relatively little to reducing the transmission of C. trachomatis in New Zealand and chlamydia control is likely to be dependent on reducing the duration of infectiousness (D), by identifying and treating people with C. trachomatis infection.

**Screening for C. trachomatis infection**

Most chlamydial infections are asymptomatic and untreated infection can persist for years [20]. Consequently, early identification and prompt treatment of asymptomatic infections have become a focus of chlamydia prevention efforts, with the dual goals of reducing associated morbidity for the infected individual and reducing new cases of infection by shortening duration of the infection. Early detection and case finding requires that seemingly healthy individuals who may be at increased risk of infection are offered testing, i.e. screening. C. trachomatis would appear to be an ideal candidate for screening, as it is a common, curable, asymptomatic infection, readily diagnosed on non-invasive samples, with significant sequelae and morbidity from un-treated infection. However, debate continues as to the effectiveness of the chlamydia screening approaches that have been implemented to date [10].

**Screening effectiveness**

The effectiveness of screening has been estimated from four randomised controlled studies that assessed the impact of a single screening test, followed by treatment for diagnosed C. trachomatis infection, on rates of PID among populations of non-pregnant women [32,189-191].

In a landmark trial, Scholes et al. reported that, at 12 months’ follow-up, the risk of incident PID among women offered screening for C. trachomatis was about half that of the control group [189]. Non-married women, aged 18 to 34 years, who were registered with a Seattle area health maintenance organisation during 1990-1992 were randomised to screening or
usual care (control) and then sent a questionnaire to determine study eligibility based on a risk score. There were 20836 (57%) respondents from 36547 potentially eligible women: 17725 were felt to be ineligible because of perceived low risk of chlamydial infection and a further 507 declined to participate. Of the 2607 participants (7%, 2607/36547), 1009 were assigned to screening and 1598 to usual care; 64% of the intervention group underwent chlamydia screening but the proportion tested for *C. trachomatis* during usual care in the control group was not reported. PID in the ensuing year was determined by chart review, with nine cases of PID among the women in the screening group and 33 among controls, giving a relative risk of 0.44. Effort was made to reach non-respondents, but this was biased towards those randomised to the screening group because of trying to arrange screening appointments. Enrolment bias and other potential un-measured confounders, such as advice given to women found to have chlamydial infection at screening baseline compared to usual care, have led to suggestions that the results favour the intervention group.\[192,193\]

In 2000, a Danish cluster randomised trial of uptake of home self-sampling for chlamydia screening compared to conventional swab sampling performed at a doctor’s office as part of usual care reported a similar reduction in PID at 12 months.\[190\] Sexually active female and male students at 17 high schools in Arhus County were given information about the study, with 2603 intervention subjects at eight schools asked to collect urine and/or vaginal specimens at home, and 2884 control subjects told that they could be tested at a local health clinic. Nine (2.0%) women in the intervention group and 20 (4.1%) in the control group reported being treated for PID at one year of follow-up (p=0.045). However, initial participation rates were higher in those assigned to the intervention group (32% of those randomised) than in those assigned to the control group (24% of those randomised), and loss to follow-up at one year was nearly 50%, with 443 (51.1%) of 867 women in the intervention group and 487 (58.5%) of 833 women in the control group completing follow-up. Participants in the intervention group who were diagnosed with chlamydial infection were given additional information about the importance of partner notification. Again, enrolment bias and other confounders have led to suggestions that the results favour the intervention group.\[192\]

That both studies may have somewhat overestimated the effectiveness of a single chlamydia test in preventing PID over 12 months is supported by the Prevention Of Pelvic Infection (POPI) trial.\[32\] In this randomised controlled study, 2529 young female students at university and further education colleges in London, UK all provided self-collected vaginal swabs at enrolment and were then randomised either to immediate processing of samples and treatment if *C. trachomatis* infection was diagnosed (intervention group), or to storage of the swabs for one year, after which time the samples were tested (control group). All participants were advised of the risks of chlamydial infection, that their samples might not
be tested for a year, and to get tested independently of the study if they thought they had been at risk of infection.

Outcomes at 12 months were available for 2377 (94%) students and those who reported symptoms (17%) had their medical records reviewed for verification of the diagnosis of PID. There were 38 reported cases of probable or possible PID, 1.3% (15/1191) in the intervention group and 1.9% (23/1186) in the control group, giving a relative risk of 0.65 but the decrease was not statistically significant ($p = 0.19$). Among the women whose swabs collected at baseline were positive for chlamydia, 1.6% (1/63) in the screening group and 9.5% (7/74) in the control group developed PID in the ensuing 12 months ($p = 0.07$) [32]. The study was underpowered, with fewer incident cases of PID than expected and, in addition, one in five participants were screened for *C. trachomatis* independently during the study period, with higher rates of testing in the control group, which may have reduced the effect of the intervention.

Another Danish randomised trial assessed whether a single round of screening for *C. trachomatis* infection had any impact on reproductive complications [191]. A random sample of 4000 women and 5000 men aged 21-24 years in Aarhus County, Denmark were contacted by mail in 1997 and offered screening for *C. trachomatis* by self-sampling at home. The remaining 11459 young women and 9980 young men in Aarhus County, who were not contacted, received usual care and constituted the control group. A total of 1175 women and 1033 men in the intervention group were tested, with 84 (7.1%) women and 60 (5.8%) men found to have *C. trachomatis* infections at baseline. The entire study population (those who accepted the test offer, those who did not and the control group) was followed through linkage with Danish health registers during the first year after the test offer to assess the effect of screening on the rates of PID in women and epididymitis in men, and for up to nine years to assess the effects of a single-round of screening on the rates of ectopic pregnancy, infertility, *in-vitro* fertilisation (IVF) treatment, and births in women.

Among the entire population of 15459 women, 97 (0.6%) had a diagnosis of PID within the first year and among the population of 14980 men, 56 (0.4%) had a diagnosis of epididymitis within the first year; outpatient PID was defined by doxycycline prescribing. No statistically significant differences were found for any of the outcomes among women or men between the intervention group and the control group, with a calculated relative risk for PID of 0.91, ectopic pregnancy 1.02, infertility 1.1, IVF treatment 1.09, births 0.98 and epididymitis 0.85. Only a quarter of those invited participated in the intervention but there was no difference in long-term risk of reproductive complications between those who accepted the test offer and those who did not. The study was underpowered, with fewer incident cases of PID than expected and imprecise measurement of outpatient PID, which may mean the effect of the intervention was underestimated.
Methodological issues may have biased all four studies’ results, not least because ascertaining an accurate diagnosis of PID without laparoscopy is challenging. Nonetheless, the more robustly designed POPI study suggests that detecting asymptomatic chlamydial infection by a single round of screening may have less impact on population-level PID than previously expected. Importantly, however, the POPI trial also highlights the individual-level benefit of screening for \textit{C. trachomatis}\textsuperscript{[193]}. In other words, early treatment of infections detected by screening appears to reduce the risk of PID among infected women, but not to reduce the risk of PID among women who were not infected at the time of screening. Screening for and treating prevalent chlamydial infection reduced the risk of clinical PID by more than 80% (from 7/74 to 1/63) among chlamydia-infected women; albeit that the difference was not statistically significant, likely because the study was underpowered and only small numbers of PID cases occurred\textsuperscript{[193]}.

These four randomised trials assessed secondary prevention as their main outcome, i.e. whether screening and treatment for \textit{C. trachomatis} prevents existing infection from progressing to PID. Two more recent trials focussed on evaluating primary prevention as their main outcome, i.e. whether reducing transmission in the population, through screening for \textit{C. trachomatis}, reduces the rate of new chlamydial infections and hence associated sequelae.

The chlamydia screening implementation project was a cluster randomised study undertaken in three regions of the Netherlands\textsuperscript{[194]}. Using a population register, all women and men aged 16-29 years within a cluster were contacted by mail and encouraged to request a self-sampling kit to test for \textit{C. trachomatis}. This intervention was sequentially rolled out to each cluster in a randomly determined order over time so that, by the end of the three-year study period, all eligible participants in each cluster had been invited to participate at least once. From 2008 to 2011, 834971 invitations were sent to 421820 individuals aged 16-29 years in the three regions: of these, 162096 received an invitation in each of three consecutive years. A specimen was returned by 16.1% (43358/269273) after the first invitation; by 10.8% (28803/265979) after the second invitation; and by 9.5% (23899/251688) after the third invitation.

Overall chlamydia test positivity rate was 4.3% (1851/43358) among intervention participants at the first invitation, and did not change significantly with subsequent screening rounds, being 4.0% (1153/28803) at the second, and 4.1% (981/23899) at the third, nor was test positivity in participants significantly different from that in control clusters. Self-reported incidence of PID among participating women did not change over the three yearly invitations: 1.8% (19/1072) at the first invitation, 2.1% (47/2261) at the second, and 1.9% (44/2340) at the third. Notably, however, among the small number (2.8%) taking part in all
three years, chlamydia positivity declined from 6% at the first test to 3% at the third annual screen, suggesting repeated screening might be of benefit.

It is possible that sexual networks traversed cluster allocations and led to an under-estimation of the effects of the intervention but the major limitation was the low uptake of screening. For a screening programme to be effective in reducing both chlamydia prevalence and chlamydia-associated morbidity, it must achieve sufficient participation rates at frequent enough intervals to interrupt transmission of infection and in a cost effective manner. The level of participation required to have an effect on chlamydia prevalence is as yet unknown, although mathematical modelling predicts repeated annual screening of at least 30% of the sexually-active population aged less than 25 years is required [195,196]. The Netherlands study authors concluded their findings do not support a national roll out of a register-based chlamydia screening programme, given the low participation levels in the study after three years [194].

The Australian Chlamydia Control Effectiveness Pilot (ACCEPt) is another cluster randomised trial, which aims to determine whether increased and repeated rounds of opportunistic chlamydia screening among 16–29 year-old women and men attending general practices can reduce chlamydia prevalence in the surrounding population [197]. Each cluster is a geographically distinct town and all primary care clinics in each town are enrolled. Each town randomised to the intervention will receive a multifaceted package of prompts, recalls, continuing medical education modules, incentives, partner notification and regular feedback on testing rates. The primary outcome is whether the chlamydia prevalence, estimated from samples of 80–100 consecutive patients attending their GP for any reason, in each town differed significantly between the beginning and the end of the trial. The incidence of PID will be a secondary outcome. The first prevalence studies were undertaken in early 2011, with final results expected in 2015.

Young people’s views

As already mentioned, a screening programme cannot be effective in reducing disease prevalence or associated morbidity without sufficient participation. Understanding potential barriers and enablers to participation is therefore crucial. Preventative health behaviour, including uptake of screening, is influenced by many factors that can be categorised as knowledge, attitude, risk perception, health behaviour or social determinants (Figure 1-15) [198].
A systematic review of qualitative studies on women’s views on chlamydia screening found influencing factors to be consistent across the US, UK and Australia and across ethnic backgrounds [199]. Common themes as to why women would be less likely to test for *C. trachomatis* included: lack of knowledge or inaccurate information about chlamydial infection, testing and treatment procedures, and of available services; denial of risk for themselves or their partners; the moral connotations and stigma of discussing their sexual history and of a positive diagnosis; fear and anxiety about being tested, of testing positive, of future reproductive health, and about partner notification; confidentiality and privacy concerns; and, in settings without access to free healthcare, the cost of screening [199-202]. A more recent review of men’s attitudes towards chlamydia screening found similar themes although men were more likely than women to feel invulnerable to infection [203].

Conversely, factors that promote the uptake of screening for both men and women include: accurate knowledge about chlamydia; perceiving themselves or their partner to be at risk of chlamydia; being assured of confidentiality and privacy; affirming provider attributes; and favourable aspects of testing [199,203]. The latter include: being actively offered screening and being able to refuse; having multiple options and locations for testing, including home-sampling; testing that is easy, quick, convenient and free; and that incentives for testing would improve uptake [199,203]. Testing for *C. trachomatis* needs to be normalised, with women in particular feeling that the condition and testing need to be de-stigmatised.

Women want support when dealing with a positive test result, for partner notification, and for dealing with the fear of its future effect on reproductive health [199].
In a 2006 qualitative study of barriers and enablers to chlamydia testing in New Zealand, Rose et al. interviewed 28, predominantly European, 16 to 24 year old, men and women in four focus groups. Barriers, and conversely enablers, to testing were consistent with the aforementioned international findings: knowledge about chlamydial infection and of testing and treatment procedures; risk perception; perceived stigma; fear of testing or diagnosis; and costs. Participants in both of the male and both of the female focus groups also raised ‘being male’ as a factor for not being tested, with males being less likely to see a healthcare provider and more likely to deny they are at risk. In addition, men were more likely than women to favour incentives to encourage testing.

There is limited information on the views of rangatahi (that is, young, adolescent) Māori towards chlamydia screening. Waetford interviewed 16 rangatahi Māori women in Auckland about their sexual health knowledge, attitudes and behaviour. Whakamā, that is, embarrassment and shame, about needing sexual health care, of exposing their bodies to an unfamiliar person, and of dealing with the perception of others including peers, parents and health professionals, was a common obstacle to seeking help. Other factors that influenced seeking health care were cost, prioritisation with competing demands and whether providers were perceived as judgmental or prejudiced against rangatahi Māori people. Resiliency factors, such as having a strong connection with a caring adult and having positive Māori cultural identity, were associated with participants accessing sexual healthcare services despite identified barriers.

**Barriers to primary healthcare**

In New Zealand, there is inequitable access to specialist sexual health care, with publicly funded (free) sexual health clinics centralised in larger urban centres or, if available in smaller towns, only open for limited hours, and the majority of sexually transmitted infections are diagnosed and managed in primary care services. Yet New Zealand is unusual among developed countries in that the government provides only partial subsidies for primary health care services in what is otherwise a predominantly publicly-funded free healthcare system; this means that New Zealanders have traditionally paid fee-for-service user charges to visit their primary health care provider.

In response to evidence that these fees resulted in significant barriers in access to primary care, especially for those on lower income, the government began to implement a new primary health care strategy in 2001. One of the strategy’s stated aims was to improve access to primary care services by providing greater subsidies and hence reduced user fees for vulnerable populations. Implementation according to need has been challenging however, with equity and efficiency issues; about 15% of people in New Zealand still face financial barriers to primary health care, with young adults more likely than older adults to report not seeking medical care because of cost.
Cost is not the only barrier to primary health care, however. In 2001, a nationally-representative survey of 9570 secondary school students in New Zealand reported a variety of reasons as to why students had any unmet health need. Consistent with international literature, barriers other than cost included a lack of available services, lack of transport, concerns about quality, privacy and confidentiality, and not feeling comfortable with the health care provider. In a repeat secondary school survey in 2007, while 83% of surveyed students had accessed health care in the previous 12 months, only 27% reported receiving private and confidential health care, for example being seen without a family member present. Surveyed students who attended school-based clinics, family planning or sexual health services were more likely to report receiving private and confidential health care than those who attended general practice. In addition, surveyed students with concerns about privacy were more likely to report problems accessing health care for sensitive issues, such as contraception, sexual health, drug or alcohol use and emotional worries.

Despite these concerns, most young New Zealanders attend primary care each year, with 71% of 15 to 24 year olds participating in the 2011/12 New Zealand Health survey reporting they had visited a GP and/or a practice nurse in the last 12 months for any reason. Fewer young New Zealand women visit their GP in a 12-month period than in Australia (78% vs. 85.6%) however, and young men in both countries are less likely to attend than young women (65% and 64.4% vs. 78% and 85.6%).

Health providers’ attitudes and practice

Many countries have opportunistic testing recommendations for \( C. \text{trachomatis} \) in primary care, yet reported testing levels have been suboptimal. For example, 5.5% of 20–24 year-old women attending primary care in the UK were tested in 2004, before the implementation of a national chlamydia screening programme, and 8% of young sexually active 16-29 year old Australians attending primary care were tested in 2008.

There is extensive literature on adherence to guidelines for a wide range of health conditions, although much of the literature focuses on a single aspect of the many factors at play. In 1996, Pathman et al. developed a conceptual framework when assessing whether guidelines on paediatric vaccine usage became routine practice. The four-step model suggested that, firstly, physicians must be aware of the guidelines, secondly, agree with them, then decide to follow (adopt) them for some patients, and finally consistently follow them (adhere) for all eligible patients. A proportional drop off at each step was noted with a progressive decline across the model.

A recent systematic review that included 29 guideline recommendations from 11 studies, including a study of chlamydia screening among Canadian primary care physicians, found
an average 15% drop between each step in the Pathman awareness-to-adherence model, with the heterogeneity of included studies supporting the usefulness of the model [216]. There was substantial cumulative decline across the four stages (aware, agree, adopt, adhere), suggesting that guidelines may not be adhered to about two-thirds of the time [216]. Factors that influence each of the stages can be categorised as: knowledge (awareness of and familiarity with guideline content); attitude (agreement with specific guidelines or with guidelines in general, motivation, perceived self-efficacy, outcome expectancy); and practice-related (time, resources, reimbursement, guideline characteristics such as ease of use, perceived acceptability to patients) [216,217].

Surveys to determine primary care clinicians’ knowledge, attitudes and practice with regard to chlamydia screening in the US, Australia and the UK support these findings. Clinicians with a lack of knowledge of prevalence, or of the individual-level benefits of screening for and treating C. trachomatis, are less likely to offer testing [218-220]. Other identified knowledge or skill gaps include not knowing which specimens are optimal for an accurate diagnosis, lacking the skills to discuss sexual health issues with young patients, particularly in an unrelated medical consultation, and lacking the knowledge or skills to discuss or undertake partner notification [218,219,221,222]. Time constraints are a common concern, not just the perceived time required to discuss and undertake testing for C. trachomatis as part of a wider consultation, but also the time required to discuss positive results and partner notification [221,222]. However, one of the main reasons for not offering testing is that clinicians believe the patient would be embarrassed or upset, particularly in a consultation unrelated to sexual health [219,221].

Less is known about New Zealand primary care clinicians’ attitudes and practice to chlamydia screening although a survey in 1997, with 172 (49.7%) respondents who comprised about 11% of New Zealand GPs, found GPs to be relatively knowledgeable regarding chlamydial infection, screening and specimen collection, despite the lack of national screening or treatment guidelines for chlamydia infection in New Zealand at that time [223]. Female doctors were more knowledgeable than their male counterparts, and GPs who indicated an interest in sexual health were significantly more likely to report that they would offer screening to asymptomatic sexually active 25 year old females who had two or more partners in the previous year [223].

More recently, a pilot to improve chlamydia testing rates among patients enrolled at an Auckland primary health organisation surveyed the views of participating providers, with a 94% (76/81) response rate [224]. Consistent with international literature, reported concerns included provider-patient communication (such as sexual history taking or maintaining patient confidentiality when a parent was present), being able to offer and complete testing...
within the allocated consultation time and issues related to follow-up and partner notification.

**Interventions to increase chlamydia screening**

It is plausible that addressing these suggested barriers to chlamydia screening should increase testing rates among young people. However, in 2006, Ginige et al. identified only four controlled studies that assessed the effectiveness of interventions aimed at improving chlamydia screening rates in primary health care settings [225]. These interventions included: the use of an educational video and text package to improve Belgian primary care clinicians’ communication skills and ability to take a sexual history [226]; an Internet-based continuing medical education (CME) programme in the US [227]; a health adviser employed in primary care for six months in Scotland to improve provider and patient awareness of chlamydia screening and non-invasive testing [228]; and a multifaceted clinical improvement initiative in the US that audited current practice, addressed clinic-based and provider barriers to chlamydia screening, offered testing to all adolescents on registration, and provided regular feedback on performance indicators [229]. Three of the interventions were associated with increased screening rates [226,228,229] and one was associated with attenuation of a decline in screening rates when compared to the control group [227].

**International approaches to chlamydia screening**

Although there remains a lack of robust evidence to determine either the optimal interventions to enhance screening uptake, or the impact of screening on population-level health, many countries have nonetheless implemented chlamydia testing guidelines and related control activities [230]. The most common approach has been to recommend opportunistic screening of sexually active young people under 25 years of age when they attend health-care settings. The following provides a brief summary of chlamydia screening activities in North America, Europe and Australia.

National chlamydial screening recommendations have been in place in the US for two decades. In 1993, the CDC updated their 1985 policy guidance to recommend chlamydia screening for all sexually active women less than 20 years of age and for older women with increased risk, for example, inconsistent use of barrier contraception, or a change of sexual partner during the last three months [231]. These recommendations followed on from a pilot project of opportunistic chlamydia screening among attendees at 136 family planning clinics in four states in the north-western U.S. Prevalence decreased from 10.9% in 1988 to 6.8% in the last quarter of 1990 [232]. In 2001 the U.S. Preventive Services Task Force recommended chlamydia screening for women less than 25 years of age [233], following the study by Scholes et al. which had demonstrated a reduction in the incidence of PID associated with screening higher-risk women [189]. The Task Force noted a lack of evidence on the effectiveness of screening men at that time.
Screening in the US has increased over time; data from the Healthcare Effectiveness Data and Information Set [HEDIS] measures suggest screening coverage was 45% among sexually active females in commercial health plans and 58% among Medicaid patients in 2010-2011 [234]. However, HEDIS measures only include insured women who access care [193]. An analysis using a more representative estimation of eligible women suggests that screening rates could be as low as half those estimated by HEDIS [235]. Encouragingly, recent US ecological studies report declines in PID diagnoses in the setting of increased chlamydia screening [236-238]. Yet test positivity has not declined among those being screened in recent years [238] and prevalence has not fallen among target-aged women in serial population prevalence studies [148]. In an effort to reduce chlamydia incidence and re-infection, the US CDC has also recommended behavioural education; partner treatment including expedited partner therapy; and follow up testing three months after treatment for a positive chlamydia result [167].

In 1996, the Canadian Task Force on the Periodic Health Examination recommended annual chlamydia screening of sexually active women less than 25 years of age; men or women with new or multiple sexual partners during the preceding year; and women who use non-barrier contraceptive methods [239]. In British Columbia province, chlamydia case rates were declining (1993 to 1996) but subsequently increased (1997 to 2009) [240], although the increases may be partly attributable to a 62% increase in testing volumes during that time. As in the US, PID rates in British Columbia have declined from 1992 to 2009 [240].

Although there is no coordinated national screening programme in Sweden, the country has had a long-standing screening policy dating from the early 1980s, with legislation introduced in 1988 requiring clinicians to provide free chlamydia testing, treatment and contact tracing to anyone with suspected infection, and mandatory reporting of all positive diagnoses [241]. Screening is targeted at sexually active women aged 15-29 years seeking contraception or abortion. Men are screened when found through contact tracing or if symptomatic. Chlamydia control approaches are locally organised, with intensity varying by geographic location [241]. Initially, chlamydia testing increased and chlamydia positivity decreased, by nearly 70% in women and 61% in men, and the policy was considered a success; however, from the early-1990s, chlamydia positivity increased again despite ongoing screening [242,243]. There are different theories as to why this happened. One is that the initial reduction in test positivity was due to behavioural changes following a national HIV-prevention campaign, rather than the effects of opportunistic screening [10]. Others have proposed that screening and early treatment interferes with the slowly developing natural immunity that may be induced by chlamydial infection, and thus results in more people remaining susceptible to infection, known as the arrested immunity hypothesis [244,245].
In England, a chlamydia screening pilot offered opportunistic screening to women attending general practitioners, STI clinics, family planning clinics, adolescent health clinics, and women’s health services in two areas, the Wirral and Portsmouth, in 1999 and 2000, with 50% and 39% of the target female population tested as part of the pilot [246]. A national chlamydia screening programme was introduced subsequently in England in 2003 and rolled out across that country by the end of 2007; the programme does not cover Scotland, Wales or Northern Ireland [230]. Screening tests are offered opportunistically to sexually active women and men aged less than 25 years of age attending health care and, in some places, through outreach activities. Testing coverage was low in earlier years but overall annual testing increased to 32.5% of 16-24 year olds in England (45% of 16-24 year old women and 24% of 16-24 year old men) by 2010; however coverage fell to 30% during 2011 (41% of women; 20% of men) [247,248]. Test positivity declined from 10.3 % in 2008 to 7.1% in 2011 [247]. Recent mathematical modelling suggests the increases in chlamydia screening and diagnoses that have occurred since 2000 should have led to a reduction in prevalence among 16-24 year-olds, although the model assumed ongoing annual increments in testing coverage [249].

Other northern European countries, such as Denmark and Norway, have national guidelines recommending opportunistic chlamydia testing in primary care for those under 25 years of age [230]. The Netherlands began a pilot chlamydia screening project in 2007, based on a systematic registry-based approach with invitations for testing sent by post. However, wider roll-out is unlikely given low participation rates in the pilot areas [194].

Australia’s first national STI Strategy was published in 2005, with federal funding provided for raising chlamydia awareness, improved surveillance and a pilot chlamydia testing programme targeting sexually active young people under 25 years of age [250]. National guidelines for general practitioners recommend annual screening for chlamydia for all sexually active people aged 15–25 years and those of any age reporting a recent partner change or inconsistent condom use; other clinical guidelines extend testing to the age of 29 years among those who are sexually active [213]. However, in 2007-2008, the national GP chlamydia testing rate per 100 patients aged 16–29 years was only 8.9% [213]. The Australian Chlamydia Control Effectiveness Pilot (ACCEPt) is a cluster randomised pilot study which aims to assess the feasibility, acceptability, efficacy and cost-effectiveness of increased annual opportunistic chlamydia testing among 16–29 year olds in the general practice setting in Victoria, New South Wales, and Queensland and will help determine whether a national chlamydia screening programme is rolled out in the future [197].

**New Zealand’s approach to chlamydia screening**

New Zealand introduced its first sexual and reproductive health national strategy in 1996 with the aim of improved sexual and reproductive health, with an updated revision published
in 2001, but neither included specific actions or targets \cite{156,251}. Guidance for healthcare providers was published in 2003 which included recommendations on chlamydia testing; opportunistic testing was recommended for sexually active women and men under the age of 25 years, women presenting for pregnancy testing, women attending antenatal clinics and women seeking termination of pregnancy \cite{252}.

In 2006, in response to concerns of a significant burden of STIs in New Zealand \cite{124,253}, the National Screening Unit reviewed the appropriateness of implementing a national chlamydia screening programme \cite{254}. A cost-effectiveness report was also commissioned but this was limited by a lack of knowledge about existing screening practices or the clinical pathway following diagnosis in New Zealand; specifically, rates of testing among the target population; rates of repeat testing for those testing positive; rates of treatment and rates of partner notification and treatment \cite{255}. The National Screening Unit review concluded that "implementation of a chlamydia screening programme should not be a high priority at this time", citing a lack of robust international evidence to support a screening programme, a lack of New Zealand-specific parameters to determine local cost-effectiveness and New Zealand-specific gaps in healthcare delivery and monitoring that needed to be addressed \cite{254}. The review also suggested that "important benefits and risk mitigation could be gained by improvements within existing health system structures" and recommended an expert advisory group be established to evaluate strategies for chlamydia control in New Zealand.

A Sexual Health Advisory Group to the Ministry of Health was established in 2007 and led to national chlamydia management guidelines being published in mid-2008 \cite{85}, but the group was disbanded following a change of government in late 2008.

Conclusions

The era of NAAT testing disputes much of what was previously believed about *C. trachomatis*. Unfortunately the technological advances that have dramatically improved clinicians' ability to conveniently and reliably diagnose *C. trachomatis* infection have not yet resulted in a significant change in the prevalence of infection. While more research is needed to better elucidate the proportion of poor reproductive outcomes that are directly attributable to chlamydia infection, currently available data clearly show that this common infection is not harmless and remains a potentially preventable cause of significant morbidity among sexually active young people. For this reason, many countries including New Zealand recommend opportunistic screening of sexually active young people, even though there is not yet a proven model for an efficacious screening programme.

However, participation in opportunistic screening remains low in most settings and chlamydia infections appear to be increasing in the populations at risk. The literature suggests there is a need for further research into the effectiveness of interventions to
increase uptake of testing for *C. trachomatis*. In addition, there are many unknowns in the New Zealand context. The true burden of disease is unknown and there is a lack of knowledge about: the current level of uptake of opportunistic screening, the most effective interventions to promote early diagnosis, and whether there is optimal management following diagnosis of chlamydia infection.

It would be judicious to await the results of the randomised Australian Chlamydia Control Effectiveness Pilot (ACCEPt) trial before re-assessing whether to implement a large-scale national chlamydia screening programme in New Zealand. Nonetheless, the published articles contained in this thesis provide considerable data necessary to guide the formulation of improved approaches to chlamydia control in New Zealand. Chapter three provides information on the reproductive tract sequelae of *C. trachomatis* infection in New Zealand and in particular analyses the rates of these sequelae in relation to rates of reported chlamydia infections. Chapter four provides information on the uptake of chlamydia screening among the target population in residents of the Waikato DHB. Chapter five provides information on the impact of provision of free sexual health consultations on rates of testing for *C. trachomatis* in young people in the Waikato DHB. Chapters six and seven provide information on the clinical management of those who were diagnosed with *C. trachomatis* infection as the result of this screening. Chapter eight provides information on the effect of text messaging on time to treatment for people in the Waikato DHB with *C. trachomatis* infection. Chapter nine provides information on the impact of implementing clinical chlamydia guidelines on opportunistic testing rates in young people in the Waikato DHB.

I have been the clinical lead at the Hamilton sexual health clinic in the Waikato DHB since 1997; this body of work reflects my desire to better understand and address the seemingly high rates of chlamydial infections in the young people, particularly rangatahi Māori, of our district and in New Zealand. It is my hope that the research described in this thesis will lead to significant changes in the care offered to people at risk of chlamydia in New Zealand, and that these changes will significantly reduce the burden caused by chlamydia in the coming decades.
Chapter 2: Programme of research

Rationale
As reviewed in chapter one, *C. trachomatis* is a significant public health problem internationally and in New Zealand. Available data suggest that young people, especially Māori and Pacific young people, in New Zealand are disproportionately affected, with reported rates markedly higher among young New Zealand women than has been reported in similar countries overseas. However, as elsewhere, the reported prevalence of chlamydia in New Zealand is based on routine collected surveillance dataset and may result in significant inaccuracies. Hence it is not clear if the high reported prevalence of chlamydia among young women in New Zealand reflects a higher prevalence of newly acquired infections or higher rates of testing resulting in higher rates of detection. Trends in reproductive outcomes could be expected to mirror trends in reported infection rates and hence provide more information about underlying changes in disease burden to answer this question.

The majority of reported chlamydia cases in New Zealand occur in primary health care settings. Data on chlamydia testing coverage by age are not routinely available in New Zealand but international literature suggests there are considerable barriers to opportunistic testing in primary care with scope for approaches that might increase testing rates.

Improved health outcomes by screening require more than simply testing, however. Treatment should be given as soon as possible to reduce the risk of sequelae and to prevent further transmission. Partner notification is imperative, to reduce further transmission and to prevent re-infection, particularly as repeat chlamydial infections in women are associated with a cumulative risk of PID and other complications. Yet there are no data on current case management in the New Zealand context or on interventions that might improve the treatment pathway.

Aims
The aims of the research contained in this thesis are:

1. To advance knowledge of the epidemiology of chlamydia in New Zealand
2. To investigate the effectiveness of interventions intended to increase rates of chlamydia testing in primary care settings in New Zealand.
3. To investigate the management of chlamydia in New Zealand
4. To investigate the effects of an intervention intended to improve the chlamydia treatment pathway in New Zealand
Overview of the thesis

The research presented within this thesis makes a significant contribution to current knowledge about: the epidemiology, efficacy of opportunistic screening strategies, and management of chlamydia in New Zealand.

Chapter three describes a study of the prevalence of laboratory-diagnosed chlamydia, and of hospital admission rates for chlamydia-related complications, from 1998 to 2008 in the upper North Island of New Zealand.

Chapter four describes a study of chlamydia testing rates, and rates of repeat testing, by age, gender and ethnicity from 2008 to 2010, in the population served by the Waikato DHB. Testing data from district-wide diagnostic laboratory databases were analysed and de-duplicated using the National Health Index (NHI) number, a unique code assigned to everyone eligible to use public health services in New Zealand. These data were then related to those from the 2006 census, to provide population-based estimates of testing rates in relation to age, gender and ethnicity.

Chapter five describes a study of the effects on chlamydia testing rates of providing free sexual health consultations for young people, cared for by selected GPs in areas of high need, from 2003 to 2005. Chlamydia testing rates in these young people, 12 months after the intervention was rolled out, were compared with those in young people attending other GP practices that had not received funding to provide free sexual health consultations.

Chapter six describes a study of chlamydia case management, from February - October 2008, across a range of health settings, to identify any gaps in existing care. The findings of this study were then used to inform guideline revision and implementation in the Waikato DHB. Outcomes measures for existing care were compared to recommended standards of care in new national chlamydia guidelines. Chapter seven describes further analysis of the same study to assess if there were demographic disparities in case management.

Chapter eight describes a study into the effect of texting patients with diagnosed chlamydia on the duration of delay between diagnosis and treatment for C. trachomatis. The time between diagnosis and treatment was compared for patients diagnosed before and after the introduction of the texting intervention in 2006.

Chapter nine describes a study, from 2008-2010, of the impact of introducing primary care chlamydia guidelines on chlamydia testing rates, in the population served by the Waikato DHB. The outcome was a comparison of district-wide chlamydia testing rates for three six-month periods, before, during, and 12 months after guideline implementation in 2009.
My role

I had a lead role in the following aspects of this body of work:

- Study design, methodology, implementation and management of all projects
- Writing of ethics applications
- Recruitment of, and facilitating all discussions, with participating health providers
- Development of study resources (for example, local primary care STI guidelines in 2003: implementation of text messaging service in 2006; audit questionnaire, guideline summary flow-chart, and patient leaflet in 2009), and delivery of all continuing medical education sessions
- Data collection and management, including data cleaning, coding and reporting
- Drafting, revision and submission of all peer-reviewed publications and abstracts
Chapter 3: Trends of reported chlamydia infections and related complications in New Zealand, 1998-2008

Introduction

*Chlamydia trachomatis* is a common preventable cause of female pelvic inflammatory disease (PID), ectopic pregnancy, tubal infertility and male epididymo-orchitis [20]. Reported cases are rising in many developed countries [256]. Debate continues about the effectiveness of chlamydia screening as a public health intervention and national control strategies vary [256]. New Zealand does not yet have a chlamydia screening programme. In mid-2008, the Ministry of Health drafted national guidelines for chlamydia management that promote opportunistic targeted testing and implementation began in mid-2009 [85].

In 2009, New Zealand’s estimated national chlamydia rate of 803 per 100000 population was higher than previous years, and higher than reported national rates for Australia (287 per 100000 population in 2009), the UK (202 per 100000 population in 2008), and the US (401 per 100000 population in 2008) [257]. It is not clear from New Zealand surveillance reports, however, whether year-on-year increases in reported chlamydia cases reflect a rising incidence of infections or merely reflect greater testing and thus detection of asymptomatic infections. An increasing incidence of genital *C. trachomatis* infection would be expected to lead to a rise in the incidence of chlamydial disease. Conversely, if increasing reports reflect increasing detection of undiagnosed prevalent infection through increased uptake of testing, the incidence of chlamydial disease may remain static or even fall [258].

Our aim therefore was to investigate the hypothesis that recent increases in reported chlamydia cases in New Zealand would be associated with increased chlamydia testing rates and hence that recent time-trends in hospital discharge rates of chlamydia-related diseases, namely, pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and epididymo-orchitis, would likely be unchanged.

Methods

Chlamydia case and testing data

In New Zealand, sexually transmitted infections (STIs) are not notifiable; surveillance is dependent on laboratories and sentinel clinics providing data voluntarily. In order to examine time-trends in testing and detection, we used data only from laboratories that had been participating in STI surveillance for over five years. Laboratory surveillance of chlamydia began in the Waikato and the Bay of Plenty regions in 1998 and in the Auckland
region in 2001. All laboratories within these three regions participate and report on all specimens received from all health care settings within each region. They submit anonymised data on laboratory-confirmed chlamydia cases by age and sex, but not ethnicity, to the Institute of Environmental Science and Research Ltd (ESR). The data were de-duplicated, as one patient may have multiple positive specimens on the same day. The laboratories report only aggregate annual testing volumes without any demographic information for negative specimens. Diagnostic tests differ by region but did not change during the study period; Bay of Plenty & Waikato laboratories introduced chlamydial nucleic acid amplification testing in 1998, whereas enzyme immunoassay continued to be used for the majority of testing in the Auckland region until September 2009 (personal communication, Dr Mike Brokenshire, laboratory scientist, Auckland DHB).

Reproductive tract morbidity data
We selected the international classification of diseases version 9 (ICD-9) and version 10 (ICD-10) codes for reproductive tract conditions that may be caused by Chlamydia trachomatis, including female pelvic inflammatory disease (PID), ectopic pregnancy, female infertility from any cause, and male epididymitis (Appendix 2). The Ministry of Health’s information directorate provided an extract, based on these codes, from the national minimum dataset of all diagnoses recorded on discharge for all publicly funded treatment in public and private hospitals during the years 1998-2008. This national minimum dataset excludes cases that are either managed wholly in privately funded settings, within emergency departments but not admitted, in outpatient clinics or in primary care settings. The proportion of cases managed outside public hospital settings, and whether this has changed over time, is unknown. Each record represented a unique hospital discharge within the three regions of interest, namely Auckland, Bay of Plenty and Waikato. Anonymous data on age, five-year age-band and ethnicity were provided for each record. Repeat admissions over time could not be excluded, given the anonymous nature of the data.

Statistical analysis
We used New Zealand 2006 census-based estimates of total resident population in the three regions of interest for each year from 1998-2008 as denominator data. We calculated chlamydia testing and detection rates per 100000 persons and age-specific hospital admission rates per 100000 females for PID, female infertility, ectopic pregnancy and per 100000 males for male epididymo-orchitis. We also calculated ectopic pregnancy rates by live births to account for differences in fertility rates. Time-trends were analysed using Excel regression software and p values were calculated using the Spearman rank correlation test.
Results

Testing and Detection

The total population for the three north island regions increased by 311000 from 1998 to an estimated population of 2095400 in 2008. Total laboratory chlamydia testing volumes increased steadily in all three regions, from a total of 3732 tests per 100000 population when data collection began in 1998, to 9801 tests per 100000 population in 2008 (Figure 3-1). Overall test positivity did not change significantly with time (p = 0.2). By region, however, two of three regions had a significant upward trend in percent test positivity over the study period (Auckland region p = 0.002; Bay of Plenty region p = 0.0002; Waikato region p = 0.1). Test percent positivity was lower in the Auckland region (mean 6%) compared to the other regions (Bay of Plenty mean 11%, Waikato mean 9%). Breakdown of chlamydia tests by age or gender was not available.

Over the same period, the reported age-specific detection rate of chlamydia amongst those aged over 15 years increased from 318 cases per 100000 population in 1998, to 918 cases per 100000 population in 2008. The highest rates and greatest increase over time were noted amongst women aged 15-24 years, at 1922 cases per 100000 in 1998, increasing to 5737 cases per 100000 in 2008 (Figure 3-2). In 2008, the rate of reported chlamydia infections amongst women aged 15-24 years was four times higher than amongst women aged 25-34 years and men aged 15-24 years.
Figure 3-2 Total regional laboratory-reported cases by gender and age-band, 1998-2008

Legend: blue — 15-24 years, red — 25-34 years, green — 35-44 years, M= male, F= female

Reproductive tract morbidity data

The number of publicly funded hospital discharges per year for related reproductive tract conditions amongst those aged 15-44 years is shown in Table 3-1, with volume for each ICD-code by year shown in Appendix 2.

Table 3-1 Annual publicly funded hospital discharges for chlamydia-related reproductive tract conditions in men and women aged 15-44 years, 1998-2008

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<td>622</td>
<td>560</td>
<td>555</td>
<td>600</td>
<td>624</td>
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<td>688</td>
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<td>257</td>
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<td>297</td>
<td>308</td>
<td>277</td>
<td>273</td>
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<tr>
<td>Ectopic Pregnancy</td>
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<td>541</td>
<td>562</td>
<td>563</td>
<td>525</td>
<td>600</td>
<td>577</td>
<td>601</td>
<td>554</td>
<td>591</td>
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<tr>
<td>Epididymo-orchitis</td>
<td>120</td>
<td>168</td>
<td>211</td>
<td>259</td>
<td>196</td>
<td>265</td>
<td>272</td>
<td>281</td>
<td>302</td>
<td>319</td>
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*ICD-9 codes used for years 1998 & 1999

Age-specific hospital discharge rates for PID and chlamydia-related pelvic infections among women aged 15-44 years did not change significantly over the study period (p = 0.4). By age-band, there was no significant change in trend in PID for any of the three age groups (15-24 years, p = 0.13, 25-34 years, p = 0.16, 35-44 years p = 0.83) (Figure 3-3a). The PID rate for women aged 15-24 years declined from 156 per 100000 in 1998 to 138 per 100000 in 2004 but rose again, reaching 202 per 100000 in 2008 (Figure 3-3a).
The age-specific rate for publicly funded infertility-related conditions amongst 15-44 year old women remained stable over the study period (p = 0.43). The highest rate was amongst those aged 25-34 years (Figure 3-3b). Age-specific discharge rates fell significantly amongst women aged 15-24 years (from 10 per 100000 in 1998 to 5 per 100000 in 2008, p = 0.03) and amongst women aged 25-34 years (p = 0.04), but was unchanged amongst older women.

The overall age-specific ectopic pregnancy rate remained stable (p = 0.67) with a median 129 per 100000 women, as did the overall rate of ectopic pregnancies per 10000 live births (p = 0.54) with a median of 188 per 10000 live births. Rates differed by age-band but there was no significant change in the rate trend for any age-band over the study period (15-24 years, p = 0.43, 25-34 years, p = 0.52, 3-44 years p = 0.39) (Figure 3-3c). Similarly, differences in rates per 10,000 births were noted by age but there were no significant change in rate trend by age during 1998-2008 (15-24 years, p = 0.2, 25-34 years, p = 0.45, 35-44 years p = 0.12) (Figure 3-3d).

The age-specific rate for epididymo-orchitis amongst 15-44 year old men remained stable (p = 0.26). The only significant change in trend amongst men by age-band was an increase in those aged 35-44 years (p = 0.002) (Figure 3-3e).
Discussion

Chlamydia testing volumes for three regions of New Zealand have trebled since 1998, as have reported rates of chlamydia infection, with the greatest increase in cases noted amongst women aged 15-24 years. Over the same period for the same age group, the rate of PID and chlamydia-related admissions in these regions declined during 1998 to 2004 but rose from 2005-2008, the rate of infertility-related admissions fell and the ectopic pregnancy rate was unchanged.

As others have noted, ecological findings need to be interpreted with caution [258,260,261]. There are many confounders that need to be considered. Female PID, ectopic pregnancy, tubal infertility and male epididymo-orchitis are possible complications of chlamydial infections but may have other aetiologies. The usefulness of hospital discharge PID data as an indicator is limited because the clinical diagnosis of PID lacks sensitivity and milder cases are often managed in primary care [262]. Similarly, publicly funded infertility trends are based on incomplete data, with the falling trends noted in our study likely reflecting a transfer of care to the private sector over recent years. On the other hand, the diagnosis of ectopic pregnancy is generally more robust [43], and, although medical treatment of ectopic pregnancy has increased, outpatient management is not yet commonplace in New Zealand [263]. Again, however, there are confounding factors to consider. For example, smoking is a significant risk factor for ectopic pregnancy, contributing to up to a third of cases [43]; significant declines in smoking among adolescents for a number of years [264,265] may counter any increasing trends in other attributable risk factors. There have also been changes in contraception use over the last decade but these are unlikely to be protective. Although all contraceptives protect against ectopic pregnancy, women who become pregnant when using an intrauterine device or progesterone-only methods are more likely to have an ectopic pregnancy [43]. Progesterone only formulations gained a greater market share in New Zealand following a ‘pill scare’ around third-generation combined oral contraceptives in 1999 [266], which has been maintained since then (Greg Williams, Pharmac, personal communication).

Importantly, the inclusion or exclusion of the A56 code categories significantly influences our PID trend data. A similar ecological study undertaken in New South Wales, Australia during 1992-2001 reported rising chlamydia notifications at a time when ectopic pregnancy rates did not change and hospital admission rates for PID fell [258]. Our overall findings are similar if, as in that study, the ICD-10 classification A56 category codes are excluded (data not shown). However, our data show a non-significant trend towards increasing pelvic infection rates if the chlamydia-related pelvic infection codes are included. In the Australian study, it was noted that the ICD-10 A56 categories diagnostic codes were rarely used in 2001, accounting for less than 0.5% of cases, whereas, in our study, the ICD-10 A56
categories were commonly used in all three regions' hospital data. The reason for the difference between the two countries is not clear and whether there are true differences in chlamydia prevalence is unknown. It may simply reflect differences in the implementation of revised codes, particularly since the introduction of the ICD-10 version of coding classification in 2000. Alternatively, if chlamydia testing rates of symptomatic New Zealand women were higher than in Australia, it is possible that more PID cases in New Zealand were attributed to chlamydial infection, and coded ICD-10 A56 accordingly.

Given the data's limitations, what, if anything, can we infer? Historic trends show New Zealand's ectopic pregnancy rate increased from 50 per 100000 women aged 15-44 years in 1965 (40 per 10000 live births) to 98 per 100000 in 1983 (117 per 10000 live births) and has been relatively stable since at 112 per 100000 women aged 15-44 years in 1998 and 116 per 100000 women aged 15-44 years in 2009. Our North Island regional ectopic pregnancy rate is slightly higher than the national rate but, similarly, has remained stable from 1998 to 2008 at a time when there has been a marked increase in the detection of chlamydia infection, particularly amongst women aged less than 25 years. Ectopic pregnancy is associated with tubal damage from infection or other disease. What is not clear is the timing of tubal inflammation and damage relative to acquisition of chlamydia infection, although a recent review suggests higher short-term rates of PID with the risk decreasing after the first few weeks, and lower rates of PID within a year after asymptomatic infection. Repeat chlamydia infection and host factors appear to predict worse tubal damage as well. Notably, falling rates of chlamydia infections in women aged 20 to 34 years during 1985-1995 in Uppsala, Sweden were accompanied by an immediate reduction in the risk of ectopic pregnancy; the finding was most notable for women aged 20-24 years. Hence, it is feasible that rising cases of chlamydia infection, particularly if re-infection was commonplace, might also be associated with an immediate or early increase in ectopic pregnancies, which does not appear to have occurred in our setting.

A similar finding of increased notifications with stable ectopic pregnancy rate was suggested to have been the result of a greater uptake of more sensitive chlamydia tests. In our study, chlamydia testing volumes have increased markedly across all three regions. A major limitation of our data is that trends in testing rates by age or sex are not available for the study period. From other data, chlamydia test uptake by women under 25 years of age is believed to be high, whilst that amongst men remains low. A study in the Bay of Plenty region, looking at the feasibility of improved STI surveillance data collection, reported that chlamydia testing rates in women aged 15-24 increased annually from 40% in 2003 to 50% in 2007, whilst testing rates among men of the same age increased from 8% in 2003 to 10% over the same period. An audit of chlamydia testing during 1999-2005 from another
region in New Zealand reported similar findings \cite{270}. A Waikato region study of testing rates prior to national guideline implementation found 51% of all chlamydia tests during nine months in 2008 were from 15-24 year olds, of which 82% were from women \cite{271}. Test uptake was 37% among women aged 15-24 years and 8% amongst men of the same age, compared to a testing rate of 9% amongst all 25-44 year olds. A five-fold greater testing rate amongst women aged 15-24 years would help explain a four-fold higher rate of reported infections compared to men of the same age or men of any other age-band.

Two of three regions of interest had a significant upward trend in percent test positivity over the study period. The third region, Waikato, might have shown a similar trend but for a large drop in test positivity in 2007, coinciding with increased testing. This emphasises the role that denominator sampling may play and the increases in test positivity noted in the other regions may reflect better targeted testing of those more at-risk of infection, rather than true changes in prevalence. Test positivity was higher in the two regions using only NAAT testing; it is feasible that there are regional differences in infection prevalence but the third region’s test positivity has increased recently following the introduction of more NAAT testing in late 2009 \cite{257}. Further work is needed to clarify these issues.

In summary, chlamydia testing in the upper north island of New Zealand has trebled since 1998, as have reported rates of chlamydia infection, whereas disease complication rates do not appear to have increased, This would appear to support our initial hypothesis but the nature of the data limits inferences that may be made, highlighting the challenge of monitoring disease-complications as an end-point of chlamydia control activities. Nonetheless, the more recent rise in hospital admissions for PID amongst women aged 15-24 years is a concern and ongoing monitoring of trends, despite the data’s limitations, is important. Improving New Zealand STI surveillance to capture demographic information of those being tested is imperative as well. As mentioned, national chlamydia management guidelines that promote opportunistic targeted testing were published in mid-2008 \cite{85}. Whether implementation of these will enhance chlamydia control in New Zealand remains to be seen.
Introduction

*Chlamydia trachomatis* is the most commonly reported sexually transmitted infection in New Zealand [257]. National guidelines recommend opportunistic chlamydia testing for all sexually active under-25 year old men and women, with annual testing for those with a recent sexual partner change [85]. Re-screening of positive cases at three to six months is recommended to exclude re-infection. Any doctor, midwife or nurse smear-taker may request a chlamydia test; testing is not available in other settings such as pharmacies. Sexual health clinics (SHC) are free while family planning clinics are free only for under 21 year olds. General practice visits are subject to user fees, although some districts have introduced free sexual health visits for registered adolescents [272] and free secondary school-based clinics.

Chlamydia testing rates are amongst the highest reported for a country without a screening programme, with an estimated 9800 tests per 100000 population in 2008 [273]. New Zealand’s national surveillance data have limitations, however, including an inability to report testing rates by age or to exclude repeat testing [115]. The few districts, where testing by age is known, report annual coverage of 30% or greater among women aged 15-24 years since at least 2003, with ongoing high test positivity of about 14% among these women [269-271]. We analysed three years of chlamydia test data from one New Zealand district health board (DHB), using a unique national identifier, to investigate the impact of repeat testing on population coverage by age, gender and ethnicity and to examine repeat testing patterns in a population with high reported chlamydia rates.

Methods

Two laboratories perform all chlamydia testing for the Waikato DHB (Figure 4-1), which had an estimated resident population of 357,000 in 2008, of whom approximately 21% were indigenous Māori. Tests from 15 to 44 year old men and women between February 1st 2008 and January 31st 2011 were included. All samples were tested using nucleic acid amplification methods.
Figure 4-1 Map of Waikato District Health Board
Individuals were identified using their National Health Index (NHI) number, a unique code assigned to everyone eligible to use public health services in New Zealand. Dataset linking enabled the inclusion of tests from sexual health clinic attendees with anonymous clinic-specific identifiers, because NHI numbers were retained in the sexual health clinic’s patient registration database. Tests from non-genital sites or missing age, gender or NHI were excluded. Indigenous ethnicity was a self-reported measure, where available; NHI registry ethnicity was used for all other tests. Same-day duplicate samples were excluded from all analyses.

Test positivity was calculated by dividing positive tests by the total number of positive and negative tests. Annual testing coverage for 2010 was calculated in two ways to investigate the impact of repeat testing on estimates of population coverage; firstly, by dividing the number of tests within the year by age- and ethnicity-specific resident population estimates and, secondly, by dividing the number of individuals tested within a year by the same population estimates.

Survival analysis was used to estimate the rate of repeat testing per 100 person years. Individuals contributed follow up time from their first test record (between February 1st 2008 and January 31st 2011) until the date of their first repeat test or until the 31st January 2011 for individuals who did not have a repeat test recorded. Any test less than six weeks after a previous test were excluded for analyses of repeat testing rates to allow for tests of cure. The log rank test was used to compare rates of repeat testing across subgroups. All analyses were performed using Stata version 11.2.

Results

Of 76671 tests from 15 to 44 year olds between February 2008 and January 2011, 2792 were excluded due to: missing NHI (2228); same-day duplicates (503) or missing gender (61), leaving 73879 tests (12251 male, 61628 female) from 41342 individuals (8437 men, 32905 women). A total of 9.7% of tests among women and 17.1% among men were positive (Table 4-1).

Annual population testing coverage for 2010 using the number of individuals as the numerator was 17% lower for men and 26% lower for women than when the number of tests was used as the numerator (5.9% vs. 4.9% for men and 28.7% vs. 21.2% for women). This difference declined with increasing age among women (35% difference among 15 to 19 year olds; 14% difference among 35 to 44 year olds), but did not differ markedly by age for men (Table 4-1).
Table 4-1 Chlamydia test positivity, 2008-2010, and annual population coverage of chlamydia testing, by gender, age group and ethnicity for the Waikato DHB, 2010

|                      | Males | | | | Females | | | |
|----------------------|-------|---|---|---|-------|---|---|---|---|
|                      | 15-19 | 20-24 | 25-34 | 35-44 | All ages (15-44) | 15-19 | 20-24 | 25-34 | 35-44 | All ages (15-44) |
| **Total Test Positivity (2008 to 2010)** (number positives/number of tests, %) | | | | | | | | | | |
| **All**              | 718/2828 | 796/4178 | 464/3590 | 123/1655 | 2101/12251 | 2842/15922 | 2021/18718 | 938/17178 | 186/9810 | 5987/61628 |
|                      | 25.4% | 19.1% | 12.9% | 7.4% | 17.1% | 17.8% | 10.8% | 5.5% | 1.9% | 9.7% |
| **Non- Māori**       | 321/1654 | 455/2901 | 258/2355 | 60/1106 | 1094/8016 | 1430/10261 | 1067/12349 | 471/11581 | 98/7131 | 3066/41322 |
|                      | 19.4% | 15.7% | 11.0% | 5.4% | 13.6% | 13.9% | 8.6% | 4.1% | 1.4% | 7.4% |
| **Māori**            | 318/848 | 255/832 | 158/836 | 45/339 | 776/2855 | 1193/4428 | 814/4723 | 414/4495 | 75/2100 | 2496/15746 |
|                      | 37.5% | 30.6% | 18.9% | 13.3% | 27.2% | 26.9% | 17.2% | 9.2% | 3.6% | 15.9% |
| **Annual Population Coverage, 2010** | | | | | | | | | | |
| **All**              | 904/14430 | 1446/13300 | 1303/21800 | 594/22850 | 4247/72380 | 5111/13740 | 6706/12570 | 5987/22140 | 3338/25280 | 21142/73730 |
|                      | 6.3% | 10.9% | 6.0% | 2.6% | 5.9% | 37.2% | 53.3% | 27.0% | 13.2% | 28.7% |
| **Non- Māori**       | 488/10260 | 942/9740 | 827/16870 | 402/18550 | 2659/55420 | 3137/9830 | 4379/8840 | 3960/16870 | 2367/20290 | 13843/55830 |
|                      | 4.8% | 9.7% | 4.9% | 2.2% | 4.8% | 31.9% | 49.5% | 23.5% | 11.7% | 24.8% |
| **Māori**            | 423/10260 | 765/9740 | 684/16870 | 349/18550 | 2221/55420 | 2017/9830 | 3101/8840 | 3138/16870 | 2045/20290 | 10301/55830 |
|                      | 4.1% | 7.9% | 4.1% | 1.9% | 4.0% | 20.5% | 35.1% | 18.6% | 10.1% | 18.5% |
| **Legend:** *repeat tests within calendar year excluded*
In the survival analysis, 41340 individuals contributed 51321 person-years of follow up time. The rate of repeat testing was 16.9 per 100 person-years among men (95% CI 16.2 to 17.7) and 31.6 among women (95% CI 31.1 to 32.2) aged 15 to 44 years. Rates of repeat testing were higher among females (31.6 vs. 16.9 among males), in younger age groups (44.8 among 15-19 year olds vs. 15.2 among 35-44 year olds) and following a positive rather than a negative baseline test (49.9 vs. 26.2) (p<0.001) (Figure 4-2). Rates of repeat testing (per 100 person years) following a positive test were also higher among females compared to males (66.7 vs. 24.8), those of younger age (58.1 among 15-19 year olds vs. 35.1 among 35-44 year olds) and individuals of non-Māori compared to Māori ethnicity (56.3 vs. 47.3) (all p<0.001).

Figure 4-2 Kaplan-Meier survival curves for incidence of repeat testing by gender, age group and result of baseline test, 15 to 44 year olds (February 2008 to January 2011)

Discussion
We observed relatively high rates of repeat testing in the Waikato DHB during 2008 to 2010, most notably among young women. Estimates of population coverage by test for this group therefore considerably over-estimate individual coverage. This is an important consideration given that repeat tests are not routinely accounted for within national surveillance data in New Zealand.
Rates of repeat testing among young women in this population are higher than observed in other countries. For example, in Cornwall UK, 24% of 15-25 year olds ever tested had a second test over a six year period [275]. Among under-25 year old women enrolled in US health plans, 26% had at least one chlamydia test during 2002-2006 but only 0.1% were tested in each of the five years [235]. Reasons for higher repeat testing rates are unclear; guidelines recommend repeat testing after a positive test in New Zealand, but not in the UK, and higher initial test positivity in New Zealand, compared to other settings, may have been an influencing factor. Consistent with other studies, men had markedly lower testing and repeat testing rates, even following a positive result, which may reflect factors such as gender differences in health-seeking behaviour or provider bias [276-278].

Reducing indigenous health inequalities overarches all government strategy. Encouragingly, annual individual population testing coverage was similar or higher for Māori, but test positivity for Māori was twice that of non-Māori and rates of repeat testing following a positive result were lower, suggesting more needs to be done in this regard.

A strength of our study is the completeness of district-wide tests with very few resident individuals tested outside of the Waikato DHB (Regan Webb, Waikato DHB policy analyst, personal communication). In our survival analysis of repeat testing rates, we assumed no loss to follow up. Young people in this district, particularly students, have more options for free care than those over 25 years, which may contribute to higher testing rates among younger ages.

Findings may be biased by missing NHI numbers being disproportionately from settings without computer access to the NHI registry, such as school clinics, or from SHC attendees choosing false identities, which may under-estimate results for younger ages. Results are not adjusted for sexual activity and hence under-estimate sexually active population coverage. This is relevant for younger age-groups: in 2007, 36% of 9,107 New Zealand 13-18 year old school students had ever been sexually active [179]. No behavioural or clinical information was available within the laboratory dataset, which limited further interpretation of our findings.

Population coverage estimated by test includes repeat tests and, as such, will always be higher than estimates of individual coverage. Our findings highlight that coverage estimates are considerably inflated in our setting by not taking repeat testing into account, however, and will inform discussions around improving surveillance to capture more accurate coverage rates in New Zealand.
Chapter 5: General practice funding to improve provision of adolescent primary sexual health care in New Zealand: results from an observational intervention

Introduction
Sexually transmitted infections (STIs) are associated with serious maternal and neonatal morbidity, preventable subfertility, anogenital cancers and transmission of HIV [279]. Reducing the time to effective treatment has the potential for personal and public health gain through reduced complication rates and limiting further transmission of infection [280]. User-fees may be a barrier to health-care and many countries make at least some provision for free STI testing and treatment [281,282].

In New Zealand, there is inequitable access to free sexual health care, with publicly funded sexual health clinics centralised in larger urban centres or, if available in smaller towns, open only limited hours [206]. Most STIs are diagnosed and managed in primary care, even though general practice (GP) is privatised with user fees [283]. However, those disproportionately affected by bacterial STIs in New Zealand, namely, adolescents, Māori and Pacific peoples, are least likely to visit a GP [284]. In an attempt to reduce cost as a barrier and improve access to primary sexual health care, free GP sexual health consultations were introduced for under-25 year olds in parts of Waikato District Health Board (DHB) in late 2003-2004. Rural and low socioeconomic areas of the region were chosen because of inequitable access to existing free urban-based sexual health services. Published evidence for the effectiveness of similar health care interventions around bacterial STIs is limited. This study aimed to determine if the introduction of free visits for registered under-25 year olds in rural and low socioeconomic areas improved provision of primary sexual health care, using testing and detection rates of Chlamydia trachomatis as a measurable outcome.

Methods
Setting
In 2003-2004, 20 general practices affiliated to the Waikato Primary Health Organisation (Waikato PHO) were selected non-randomly for access-to-care funding to enable them to offer free sexual health consultations for registered under-25 year olds. The additional funding enabled practices to claim reimbursement for providing contraceptive or STI-related health care, which included any opportunistic testing undertaken for Chlamydia trachomatis. Practice selection was based on the demographics of the practices’ registered populations, with a bias towards Māori and/or lower socio-economic populations as well as rural location.
On this basis, nearly all urban-based practices in Hamilton City (29 of 31) were excluded; these 29 urban practices continued to charge user-fees and served as controls. The access-to-care funding initiative was rolled out progressively over a 16-month period, beginning in September 2003.

All GPs affiliated to the Waikato PHO, that is, 95% GPs within the district health board, were invited to attend an education session in September 2003, regardless of whether their practice had been selected for additional sexual health funding. A variety of dates and times were offered over a two-week period, with each session run as a discussion group led by a key informant, aiming to provide a sexual health education update as well as an opportunity to discuss updated locally developed primary care STI treatment guidelines.

The two laboratories that processed Waikato DHB primary care specimens provided *Chlamydia trachomatis* testing data from January 1 2003 to December 31 2005. Since 1998, one laboratory has used a Nucleic Acid Amplification Technique (NAAT) for all *Chlamydia trachomatis* testing (PCR, Amplicor CT, Roche Diagnostics). The other laboratory introduced NAAT testing by PCR for urine samples in 1998 but, unless the requesting clinician specified PCR, this laboratory continued to process cervical and other swabs using non-NAATs for chlamydia detection until January 2005. Patterns of local GPs’ choice of laboratory provider and proportions of samples tested by different methods did not vary markedly during the study period (personal communication, Jan Parker, Southern Community Laboratories Ltd).

**Study design**

Total registered patient numbers for general practices affiliated to the Waikato PHO were obtained from the Waikato District Health Board (DHB). Registered population data for each practice was provided by DHB-determined age group bands and by gender, which was then linked to community laboratory testing data. Testing data were de-identified and same-day duplicates removed. Samples from non-Waikato PHO affiliated GPs, primary care providers without a known registered population such as community midwives, family planning clinic, and community accident and emergency centres, as well as samples from private secondary-care providers, were excluded. Hospital samples, including those from the Waikato DHB’s hospital-based sexual health clinic, were processed at a separate laboratory and were not included.

Data were analysed using SPSS for Windows (v16.0) software. Testing and positive result rates were calculated for 3 time periods: (1) pre-intervention (months 0-8); (2) during the intervention roll out (months 9-24); and (3) post-intervention (months 25-36). Rates of testing, and of positive results, for the intervention and non-intervention practices were also compared using total registered age-group patient populations as denominator data. Data
were analysed using t-tests for differences by gender, age group and intervention within the entire population and within each of the three time periods.

**Results**

Intervention practices were chosen non-randomly with a bias towards practices with higher registered Māori and/or lower socio-economic populations or more rural location, defined as more than 40 minutes’ drive by car from existing metropolitan-based, publicly-funded sexual health services.

The intervention practices’ total registered patient population data differed from non-intervention practices, with smaller registered populations (mean 2331 vs. 3819) and relatively more males (48.9% vs. 46.3%)(Table 5-1). Age-band data for intervention and non-intervention practices was similar whereas age-band data by gender differed, with intervention practices having more registered males over 25 years and non-intervention practices have relatively more older females.

The majority of all *Chlamydia trachomatis* tests undertaken during 2003-2005 were from females. By practice, intervention practices tested significantly more under-25 year olds and more males than non-intervention practices and had higher overall test positivity rates (8.7% vs. 5.9%, p<0.01). The highest positivity rates occurred in tests from under-25 year males (23.4%) at intervention practices, with no significant difference in positives noted amongst tests submitted from those aged 25 years and older.
Table 5-1 Waikato PHO practice demographic and testing data

<table>
<thead>
<tr>
<th>Patient numbers (%)</th>
<th>Patient numbers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention practices</td>
</tr>
<tr>
<td></td>
<td>N = 20</td>
</tr>
<tr>
<td>Registered patients per practice</td>
<td>range 230-9612 mean 2331.1 (SD 2259.9)</td>
</tr>
<tr>
<td>Total (% registered population)</td>
<td>63,345 (100%)</td>
</tr>
</tbody>
</table>

By gender

<table>
<thead>
<tr>
<th></th>
<th>Total females</th>
<th>Total males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered patients per practice</td>
<td>32369 (51.1%)</td>
<td>60283 (46.3%)</td>
</tr>
<tr>
<td>Total (% registered population)</td>
<td>30976 (48.9%)</td>
<td>60283 (46.3%)</td>
</tr>
</tbody>
</table>

Population (% registered population), by gender & age group

<table>
<thead>
<tr>
<th></th>
<th>Total females</th>
<th>Total males</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5 years</td>
<td>2376 (3.8%)</td>
<td>4600 (3.5%)</td>
</tr>
<tr>
<td>6-17 years</td>
<td>5043 (8.0%)</td>
<td>9944 (7.6%)</td>
</tr>
<tr>
<td>18-24 years</td>
<td>4021 (6.3%)</td>
<td>8486 (6.5%)</td>
</tr>
<tr>
<td>25+ years</td>
<td>20929 (33%)</td>
<td>45523 (35%)</td>
</tr>
</tbody>
</table>

Chlamydia trachomatis tests (% total tests), 2003-05

<table>
<thead>
<tr>
<th></th>
<th>Total tests by all GPs</th>
<th>7536</th>
<th>14033</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total male tests †</td>
<td>1321 (16.3%)</td>
<td>1809 (12.9%)</td>
<td></td>
</tr>
<tr>
<td>Total tests 0-15 years †</td>
<td>377 (5.0%)</td>
<td>388 (2.8%)</td>
<td></td>
</tr>
<tr>
<td>Total tests 16-24 years †</td>
<td>2999 (39.8%)</td>
<td>4831 (34.4%)</td>
<td></td>
</tr>
<tr>
<td>Total tests 25+ years †</td>
<td>4160 (55.2%)</td>
<td>8814 (62.8%)</td>
<td></td>
</tr>
<tr>
<td>Total % positive tests †</td>
<td>652 (8.7%)</td>
<td>825 (5.9%)</td>
<td></td>
</tr>
</tbody>
</table>

Positive Chlamydia trachomatis tests, 2003-05, by gender & age group

<table>
<thead>
<tr>
<th></th>
<th>% positive female tests †</th>
<th>473/6305 (7.5%)</th>
<th>625/12224 (5.1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15 years</td>
<td>50/332 (15.1%)</td>
<td>33/321 (10.3%)</td>
<td></td>
</tr>
<tr>
<td>16-24 years †</td>
<td>310/2469 (12.6%)</td>
<td>393/4248 (9.3%)</td>
<td></td>
</tr>
<tr>
<td>25+ years</td>
<td>113/3504 (3.2%)</td>
<td>199/7655 (2.6%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>% positive male tests †</th>
<th>179/1231 (14.5%)</th>
<th>200/1809 (11.1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15 years †</td>
<td>8/45 (17.8%)</td>
<td>2/67 (3.0%)</td>
<td></td>
</tr>
<tr>
<td>16-24 years †</td>
<td>124/530 (23.4%)</td>
<td>107/583 (18.4%)</td>
<td></td>
</tr>
<tr>
<td>25+ years</td>
<td>47/656 (7.2%)</td>
<td>91/1159 (7.9%)</td>
<td></td>
</tr>
</tbody>
</table>

Legend: † denotes significant difference of p <0.05 or lower

Testing by intervention phase

Before the funding initiative, intervention practices submitted relatively more tests from males aged 16-24 years (6.2% vs. 3.6%, t= 3.984 p<0.001) and relatively fewer tests from females aged 25 years and older (50% vs. 54%, t=-2.542, P<0.05). Otherwise, testing was similar by age and gender between the groups. During the 16 months’ rollout phase,
intervention practices tested significantly more females aged 0-15 years (4.3% vs. 1.8% p<0.001) and aged 16-24 years (33.5% vs. 31.1% p<0.001) compared to non-intervention practices and continued to do so during the 12 months beyond enrolment of the last practice into the funding intervention (Table 5-2).

Similarly, changes were noted in testing coverage of the intervention practices' registered female population by DHB-determined age-bands (Table 5-2). The annualised testing rate of registered females aged 18-24 years at intervention practices increased from 13.9% in 2003, to 15.5% during the intervention roll-out, up to 16.8% in 2005. Likewise, the annualised testing rate of registered females aged 6-17 years at intervention practices increased from 4.2% in 2003 to 6.4% in 2005 whereas, from 2003 to 2005, the annualised testing rate of registered females aged 6-17 years (2.8% vs. 2.9%) and females aged 18-24 years (13% vs. 13.2%) at non-intervention practices was unchanged. There was no increase in testing amongst those aged 25 years and older at intervention practices.
Table 5-2 Total *Chlamydia trachomatis* tests by intervention phase, 2003-2005

<table>
<thead>
<tr>
<th></th>
<th>Months 1-8</th>
<th>Months 9-24</th>
<th>Months 25-36</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention GPs</td>
<td>1527</td>
<td>3345</td>
<td>2664</td>
</tr>
<tr>
<td>Non-intervention</td>
<td>2967</td>
<td>6231</td>
<td>4835</td>
</tr>
<tr>
<td><strong>Total females tested</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention GPs</td>
<td>1282</td>
<td>2799</td>
<td>2224</td>
</tr>
<tr>
<td>Non-intervention</td>
<td>2601</td>
<td>5416</td>
<td>4207</td>
</tr>
<tr>
<td><strong>Total males tested</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention GPs</td>
<td>245</td>
<td>546</td>
<td>440</td>
</tr>
<tr>
<td>Non-intervention</td>
<td>366</td>
<td>815</td>
<td>628</td>
</tr>
</tbody>
</table>

**Number of tests (% of tests), by gender & age group**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age Group</th>
<th>Intervention GPs</th>
<th>Non-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>0-15 years</td>
<td>52 (3.4%)</td>
<td>84 (2.8%)</td>
</tr>
<tr>
<td></td>
<td>16-24 years</td>
<td>466 (30.5%)</td>
<td>914 (30.8%)</td>
</tr>
<tr>
<td></td>
<td>25+ years</td>
<td>764 (50%)</td>
<td>1603 (54%)</td>
</tr>
<tr>
<td>Males</td>
<td>0-15 years</td>
<td>8 (0.5%)</td>
<td>7 (0.3%)</td>
</tr>
<tr>
<td></td>
<td>16-24 years</td>
<td>94 (6.2%)</td>
<td>106 (3.6%)</td>
</tr>
<tr>
<td></td>
<td>25+ years</td>
<td>764 (50%)</td>
<td>1603 (54%)</td>
</tr>
</tbody>
</table>

**Annualised testing rate (coverage) of all registered females, by DHB age-band & study phase**

<table>
<thead>
<tr>
<th>DHB age-band</th>
<th>Intervention GPs</th>
<th>Non-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-17 years</td>
<td>140 (4.2%)</td>
<td>191 (2.8%)</td>
</tr>
<tr>
<td>18-24 years</td>
<td>372 (13.9%)</td>
<td>790 (13%)</td>
</tr>
<tr>
<td>25+ years</td>
<td>764 (5.5%)</td>
<td>1603 (5.5%)</td>
</tr>
</tbody>
</table>

**Annualised testing rate (coverage) of all registered males, by DHB age-band & study phase**

<table>
<thead>
<tr>
<th>DHB age-band</th>
<th>Intervention GPs</th>
<th>Non-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-17 years</td>
<td>15 (0.4%)</td>
<td>14 (0.2%)</td>
</tr>
<tr>
<td>18-24 years</td>
<td>85 (3.0%)</td>
<td>94 (1.7%)</td>
</tr>
<tr>
<td>25+ years</td>
<td>144 (1.1%)</td>
<td>252 (0.6%)</td>
</tr>
</tbody>
</table>

Legend: † significant difference of p <0.001, * significant difference of p <0.05

**Positives by intervention phase**

Intervention practices found relatively more positive tests at all stages (pre, during, post-intervention) of the study period compared to non-intervention practices (Table 5-3). An
increase in overall positivity rates at intervention practices (7.7% in 2003, 10% in 2005) related mainly to increases in positive tests amongst females aged under-25 years. Positive tests amongst males aged 25 years and older from non-intervention practice tests increased during the study period although absolute numbers of positive tests from males were small.

Table 5-3 Total *Chlamydia trachomatis* positive tests by intervention phase, 2003-2005

<table>
<thead>
<tr>
<th></th>
<th>Total positive tests (positivity) and by gender</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total positive tests</td>
<td>Total positive female tests</td>
<td>Total positive male tests</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention GPs</td>
<td>Non-intervention</td>
<td>Intervention GPs</td>
<td>Non-intervention</td>
</tr>
<tr>
<td><strong>Total tests</strong></td>
<td>117 (7.7%)</td>
<td>176 (5.9%) †</td>
<td>276 (8%)</td>
<td>358 (6%) †</td>
</tr>
<tr>
<td></td>
<td>259 (10%)</td>
<td>291 (6%) †</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total positive female tests</strong></td>
<td>79 (6.2%)</td>
<td>143 (5.5%) †</td>
<td>205 (7.3%)</td>
<td>272 (5.0%) †</td>
</tr>
<tr>
<td></td>
<td>189 (8.5%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total positive male tests</strong></td>
<td>38 (15.5%)</td>
<td>33 (9%) *</td>
<td>71 (13%)</td>
<td>86 (10.6%)</td>
</tr>
<tr>
<td></td>
<td>81 (12.9%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Positive tests by gender & age group

<table>
<thead>
<tr>
<th></th>
<th>Females</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention GPs</td>
<td>Non-intervention</td>
<td>Intervention GPs</td>
</tr>
<tr>
<td><strong>0-15 years</strong></td>
<td>5</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>16-24 years</strong></td>
<td>55</td>
<td>94</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>25+ years</strong></td>
<td>19</td>
<td>94</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>66 **</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention GPs</td>
<td>Non-intervention</td>
</tr>
<tr>
<td><strong>0-15 years</strong></td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>16-24 years</strong></td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>51</td>
</tr>
<tr>
<td><strong>25+ years</strong></td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td></td>
</tr>
</tbody>
</table>

Legend: * significant difference of p <0.05, ** significant difference of p <0.01, † significant difference of p <0.001

**Discussion**

Introducing free primary sexual health care visits for under-25 year olds was associated with an increase in testing for *Chlamydia trachomatis* in under-25 year olds from newly funded practices. The impact of funding is supported by the lack of change in testing amongst over-25 year olds at intervention practices, who were not eligible for free visits, and the lack of significant change in testing amongst urban-based general practices with user-fees. There was also an increase in detection of chlamydia cases in under-25 year olds from newly funded practices.
Although cost is acknowledged as an important barrier to New Zealand primary health care,[284] there is little reported evidence on the impact of removing fees for GP visits on STI testing and detection rates. Conversely, a publicly-funded STI clinic in the US found total clinic visits and diagnosed cases of *Chlamydia trachomatis* and *Neisseria Gonorrhoeae* dropped when a fee was introduced in 2002.[285] Similarly, introducing a fee for STI clinic services in Kenya in 1989 reduced both service use and the number of diagnoses of sexually transmitted infections.[286] Attendances by men failed to return to pre-user charge levels after the nine-month policy was revoked.

The majority of all chlamydia tests throughout the study period were from females, with more tests amongst women 25 years and older. Clinical data were not recorded for this study so we are unable to determine the appropriateness of testing for *Chlamydia trachomatis*. However, as in other countries and in local surveillance reports,[283] under-25 year olds account for over 70% of detected infections in this study, with lower positivity rates amongst older age-groups, suggesting at least some over-sampling of lower-risk older women occurred.

It is encouraging that newly funded practices tested more men; nonetheless, overall male test numbers remain small. Our results may under-estimate males accessing primary sexual health-care if, for example, treatment was given without testing. That said, GP laboratory tests in New Zealand are publicly funded and our findings are consistent with previous data that males are less likely to access primary health care in New Zealand, suggesting there are ongoing barriers other than cost. In one study, 79% of 7862 adults reported going to their GP at least once in the previous 12 months with females more likely to visit (p<0.0001), although the likelihood of visits increased with age for males.[284] Also, of those accessing primary care, females have greater numbers of visits and incur more primary medical care than males.[287] Amongst a New Zealand birth cohort at age 21, significantly more women than men (75.8% v 50.7%, p<0.05) with five or more partners in the previous year had visited their own GP over that period.[288] In addition, more sexually experienced women than men attended any setting appropriate for STI screening (93.6% v 71.6%, p<0.001). Engaging New Zealand males in preventative health-care remains a significant challenge.

An important consideration is the purposive sampling of this observational intervention, which was non-randomised to areas believed to have greater need. This introduces inherent population biases and limits the generalisability of our findings to other settings. Socio-economic and ethnicity data of those tested were not collected with laboratory testing data and could not be included in the analysis. Hence, it is not possible to determine to what extent demographic differences may have confounded the results. Further, as it is often an asymptomatic condition, chlamydia statistics are particularly vulnerable to factors
that influence testing. It is possible that other un-measured confounding factors occurred over time and influenced detection of *Chlamydia trachomatis* such as a true change in disease prevalence, increases/decreases in risk behaviours, or a changing case-mix, with more case-finding at some practices leading to greater partner management and further testing and case detection. Also, there were changes in one laboratory’s testing practices in early 2005, with greater use of a more sensitive testing methodology but the exclusion of all 2005 testing data did not alter our overall findings.

Although in development, New Zealand has not yet implemented national chlamydia clinical guidelines and past evidence has suggested that New Zealand GPs without an expressed interest in sexual health may lack relevant knowledge [223]. Therefore, prior to the funding intervention, sexual health education sessions were offered to all the Waikato PHO practices, not just newly funded practices, and the sessions were very well attended. This makes it less likely that the greater increase in testing and detection of *Chlamydia trachomatis* by newly funded practices reflect differences in practitioners' knowledge.

New Zealand’s current primary health care strategy includes aims to identify and remove health inequalities and ensure access to services so as to improve and maintain health [207]. The ongoing implementation of the strategy has led to lowering of patient user fees with additional funding available for local initiatives such as this, aimed at further improving access to primary health care for those with greater need. Our study supports that free primary sexual health care visits for under-25 year olds increases the provision of STI care in primary care as measured by a significant increase in testing and detection of *Chlamydia trachomatis* in the target age group. Ongoing free sexual health care for those most at risk is imperative.
Chapter 6: A multi-setting audit of the management of genital *Chlamydia trachomatis* infection

**Introduction**

Genital *Chlamydia trachomatis* is the most common bacterial sexually transmitted infection (STI) in New Zealand. In 2008, the Waikato district chlamydia surveillance rate of 849 cases per 100000 population was markedly higher than reported rates of 201 per 100000 in 2007 for the UK and 274 per 100000 in 2008 in Australia \[289\]. Achieving control of this infection remains elusive, in part because many chlamydia infections are asymptomatic.

In 2008, the New Zealand Ministry of Health (MOH) drafted guidelines for chlamydia management that emphasised targeted testing of those with known risk factors, along with prompt identification of cases and treatment of their sexual contacts \[85\]. When planning to implement new guidelines, it is important to first identify any gaps and potential barriers between recommended practice and current practice. Therefore, it was decided to audit current case management of uncomplicated genital chlamydia infection in a range of clinical settings in the Waikato district health board (DHB), using the new chlamydia management guidelines as the recommended standard. Information from this audit will be used to tailor implementation of the management guidelines.

**Methods**

Two Waikato laboratories perform all chlamydia testing for the district, which had an estimated resident population of 357,000 in 2008, of whom approximately 21% are Māori compared with 15% nationally. Both laboratories provided data on all tests carried out on residents from February 1st - October 31st 2008. Closure of another laboratory in January 2008 meant earlier data were unavailable. Non-genital site samples were excluded. All urogenital samples were tested using nucleic acid amplification methods (NAATs), as recommended in the MOH chlamydia guidelines.

Positive laboratory chlamydia test results by provider were used to enable case finding for audit purposes, as most primary care settings do not assign diagnostic codes for non-chronic health events such as uncomplicated chlamydia infection. Any practice or clinic setting within the Waikato DHB that diagnosed 25 or more cases of chlamydia during February 1st - October 31st 2008 was invited to participate in the audit.

The New Zealand MOH guidelines are closely aligned to UK guidelines for the management of uncomplicated genital chlamydia infection; hence, a UK validated national chlamydia management audit tool was used as a basis for our audit proforma \[290\]. The proforma was
adapted to more closely reflect the New Zealand guidelines and differences in health-care settings (Appendix 3). Each site was provided with a list of their cases and asked to complete an audit proforma for each of 20 consecutive cases seen from February 1st 2008. Recommendations in the MOH guidelines that relate to index case diagnosis, management, and partner notification were identified and used as standards for audit purposes (Table 6-1).

Table 6-1 Recommendations in MOH chlamydia guidelines

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Appropriate sampling should be undertaken</td>
</tr>
<tr>
<td>a.</td>
<td>Asymptomatic women should be sampled with a low vaginal swab or, if undergoing a speculum examination, a cervical swab</td>
</tr>
<tr>
<td>b.</td>
<td>Asymptomatic men should be sampled with a first catch urine</td>
</tr>
<tr>
<td>c.</td>
<td>Symptomatic people require examination and testing for other STIs, including gonorrhea, syphilis and HIV.</td>
</tr>
<tr>
<td>2.</td>
<td>The patient is aware of the implications of a positive test</td>
</tr>
<tr>
<td>3.</td>
<td>Treatment should be given for presumed chlamydia infection if there is a high index of suspicion (e.g. known contact of chlamydia infection, male with urethral discharge) without waiting for laboratory confirmation.</td>
</tr>
<tr>
<td>4.</td>
<td>Treatment of uncomplicated chlamydia infection should be with standard treatment (drug, dose, duration). The standard recommended treatment regimens for uncomplicated infection are azithromycin 1 g stat, or doxycycline 100 mg twice daily for seven days.</td>
</tr>
<tr>
<td>5.</td>
<td>A test-of-cure is recommended if the patient is pregnant</td>
</tr>
<tr>
<td>6.</td>
<td>All patients identified with chlamydia infection should have partner notification discussed with them at the time of treatment by a trained health professional.</td>
</tr>
<tr>
<td>7.</td>
<td>All recent sexual contacts need to be notified that they require testing and treatment.</td>
</tr>
</tbody>
</table>

The Waikato DHB audit support unit provided resources for database development, data entry and data analysis. Statistical analysis was performed using Statistica (Statsoft, Tulsa, USA). Ethical approval was given (NTY/09/25/EXP).

Results

Twenty sites across a range of clinical settings (Table 6-2) diagnosed 25 or more cases; these settings detected 70% of 2258 urogenital chlamydia cases diagnosed in the Waikato DHB during Feb-Oct 2008. All settings agreed to participate and 19 of 20 were able to provide data. The non-participating site was a correctional facility. Seven sites chose to audit more than 20 cases, giving a sample of 415 cases, or 18.4% of all the Waikato DHB genital chlamydia cases diagnosed during the nine months.
Table 6-2 Locality of participating sites

<table>
<thead>
<tr>
<th>Participating sites (number of sites)</th>
<th>Cases (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural-based general practice (9)</td>
<td>205 (49.4%)</td>
</tr>
<tr>
<td>Huntly (1)</td>
<td>25</td>
</tr>
<tr>
<td>Matamata (1)</td>
<td>19</td>
</tr>
<tr>
<td>Ngakuruwahia (1)</td>
<td>20</td>
</tr>
<tr>
<td>Thames (2)</td>
<td>44</td>
</tr>
<tr>
<td>Te Awamata (2)</td>
<td>57</td>
</tr>
<tr>
<td>Te Kuiti (1)</td>
<td>20</td>
</tr>
<tr>
<td>Tokoroa (1)</td>
<td>20</td>
</tr>
<tr>
<td>Urban-based general practice (3)</td>
<td>61 (14.7%)</td>
</tr>
<tr>
<td>Other health services (7)</td>
<td>149 (35.9%)</td>
</tr>
<tr>
<td>Sexual health/family planning clinics (2)</td>
<td>41</td>
</tr>
<tr>
<td>School clinics/university clinic (2)</td>
<td>41</td>
</tr>
<tr>
<td>24-hour A&amp;E centre (1)</td>
<td>20</td>
</tr>
<tr>
<td>Hospital departments (emergency dept., acute gynae service) (2)</td>
<td>47</td>
</tr>
<tr>
<td>All settings (19)</td>
<td>415 (100%)</td>
</tr>
</tbody>
</table>

Of the 415 cases, 316 (76%) were female and 317 (78.1%) were under-25 years (Table 6-3). By ethnicity, Europeans predominated (48.4% of those with known ethnicity) although Māori were over-represented at 169 of 394 (42.9%).

Table 6-3 Demographics of 415 chlamydia cases

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>99 (including 2 transgender)</td>
<td>316 (76%)</td>
</tr>
<tr>
<td>Pregnant</td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15 years</td>
<td>0</td>
<td>7 (2.2%)</td>
</tr>
<tr>
<td>15-19 years</td>
<td>26 (26.3%)</td>
<td>152 (48.1%)</td>
</tr>
<tr>
<td>20-24 years</td>
<td>39 (39.4%)</td>
<td>100 (31.6%)</td>
</tr>
<tr>
<td>25-34 years</td>
<td>22 (22.2%)</td>
<td>45 (14.2%)</td>
</tr>
<tr>
<td>35-44 years</td>
<td>10 (10.1%)</td>
<td>6 (1.9%)</td>
</tr>
<tr>
<td>45-54 years</td>
<td>0</td>
<td>5 (1.6%)</td>
</tr>
<tr>
<td>55+ years</td>
<td>1 (1%)</td>
<td>0</td>
</tr>
<tr>
<td>Missing</td>
<td>1 (1%)</td>
<td>1 (0.3%)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ European</td>
<td>50 (50.5%)</td>
<td>141 (44.6%)</td>
</tr>
<tr>
<td>Māori</td>
<td>29 (29.3%)</td>
<td>140 (44.3%)</td>
</tr>
<tr>
<td>Asian</td>
<td>8 (8.1%)</td>
<td>6 (1.9%)</td>
</tr>
<tr>
<td>Pacific</td>
<td>7 (7.1%)</td>
<td>12 (3.8%)</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>1 (0.3%)</td>
</tr>
<tr>
<td>Missing</td>
<td>5 (5.0%)</td>
<td>16 (5.1%)</td>
</tr>
</tbody>
</table>
Standard 1: Appropriate sampling should be undertaken.
The MOH guidelines recommend that asymptomatic women undergoing speculum examination should be sampled with a cervical swab. If speculum examination is unnecessary, asymptomatic women should be sampled with a low vaginal swab. Of 316 women, 145 (45.9%) were noted as asymptomatic, 165 as symptomatic and six did not have this information documented in their medical record. For 145 asymptomatic women, 10 cases (6.9%) were diagnosed with only low vaginal sampling, 88 (60.7%) with only cervical sampling, 11 (7.6%) on only urine sampling and 36 (24.8%) had a combination of samples e.g. cervix and urine, or vaginal and urine. Excluding those with only urine sampling meant 93% met the recommendation for asymptomatic female sampling.

The MOH guidelines recommend that asymptomatic men should be sampled with first catch urine. Of 97 men, 34 (35.0%) were noted as asymptomatic, 58 as symptomatic and five did not have this information documented in their medical record. Seven (20.6%) of 34 asymptomatic men were diagnosed by urethral swab sampling, rather than urine. Hence, nearly 80% met the recommendation for asymptomatic male sampling.

For males and females, 122 of 233 (42.4%) symptomatic cases had clear documentation of being examined and tested for other STIs such as *Neisseria gonorrhoea*, 33% had some documentation that inferred examination or additional testing occurred and 14.6% had no documentation of either examination or testing for other STIs. The remainder did not complete this question. Blood samples for tests such as syphilis, HIV or hepatitis did not take place in at least 150 (36.1%) of all 415 cases, with a lack of documentation as to whether this occurred in a further 74 (17.8%). Overall, 75% met the recommendation that symptomatic people require examination and testing for other STIs, if testing for blood-borne infections is excluded.

Standard 2: The patient is aware of the implications of a positive test
Of the 415 diagnosed cases, 259 (62.4%) had documented that verbal advice or information had been given about chlamydia and 83 (20%) had documented giving a patient information leaflet. Hence, 62% had documentation that standard two was met.

Standard 3: Treatment should be given for presumed chlamydia infection if there is a high index of suspicion (e.g. known contact of chlamydia infection, male with urethral discharge) without waiting for laboratory confirmation.
There were 42 cases where the main reason for testing was as a contact of a sexual partner diagnosed with chlamydia; 29 (69.0%) of these were treated at the time of testing but 13 (30.9%) were not treated until after their positive test result became available. Of 47 men recorded as having either urethral discharge or dysuria or scrotal pain at the time of testing, 25 (53.2%) were treated immediately, 21 were treated after their positive test result
became available and one did not receive treatment. Overall, 60% of cases met standard three.

**Standard 4: Treatment of uncomplicated chlamydia infection should be with standard treatment (drug, dose, duration).**

The MOH guidelines’ recommended first-line treatment for uncomplicated infection is azithromycin 1 g stat, or doxycycline 100 mg twice daily for seven days. Alternative regimens include erythromycin stearate, 500 mg orally, four times a day for seven days, or erythromycin ethylsuccinate, 800 mg orally, four times a day for seven days. The recommended treatment for complicated infection is ceftriaxone 250 to 500 mg IM stat plus doxycycline, 100 mg bd for 14 days, with or without metronidazole 400 mg bd, for 14 days.

Treatment drug, dose and duration were clearly documented for 373 (89.9%) cases. For a further seven, it was noted within the medical record that treatment was prescribed but there was no record of drug choice or dose. Thus, 380 cases (91.6%) had some evidence of treatment. The remaining cases were either documented as failing to attend for treatment (five, 1.2%) or there was no treatment documentation of any kind (30 cases, 7.2%). Lack of documentation around treatment outcomes was notable in cases diagnosed in hospital-based settings (Table 6-4).

<table>
<thead>
<tr>
<th>Participating sites (number of sites)</th>
<th>Incomplete or no treatment data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural-based general practice (9)</td>
<td>9/205 (4.4%)</td>
</tr>
<tr>
<td>Urban-based general practice (3)</td>
<td>4/61 (6.6%)</td>
</tr>
<tr>
<td>Emergency dept. &amp; acute gynae service (2)</td>
<td>26/47 (55.3%)</td>
</tr>
<tr>
<td>Other health-care settings (5)</td>
<td>3/102 (3.9%)</td>
</tr>
<tr>
<td>All settings (19)</td>
<td>42/415 (10.1%)</td>
</tr>
</tbody>
</table>

Of those with evidence of treatment, same-day testing and treatment occurred for 85 (22.4%), 349 (91.8%) had treatment within 14 days, and 369 (97.1%) within 28 days. Comparable proportions for all 415 cases are 20.5%, 84.1% and 88.9% respectively.

Drug, dose & duration were appropriate, when compared to first-line and second-line drug regimens in the MOH guidelines, in 364 (97.6%) of the 373 cases with clearly documented treatment. Azithromycin was documented as first-line treatment for 334 (80.5%) cases and advice about abstaining from unprotected sex was noted for 143 (34.5%). Overall, there was documentation that standard four was met in nearly 90% of cases.

**Standard 5: A test-of-cure is recommended if the patient is pregnant.**

Of the 45 cases (10.8%) were noted to be pregnant, only eight (17.8%) had any documentation that a test-of-cure was recommended.
Standard 6: All patients identified with chlamydia infection should have partner notification discussed with them at the time of treatment by a trained health professional.

The MOH guidelines define partner notification as 'a secondary prevention process through which sexual partners and other contacts exposed to an STI are identified, located, assessed, counselled, tested and treated.' There was limited documentation in most medical records around partner notification and outcomes; 246 (59.2%) had any documentation that partner notification was discussed, 127 (30.6%) had any documentation about the planned method of partner notification (e.g. by the patient or by the provider) and 73 (17.6%) had any documentation about the outcome of partner notification. It is not known if the health professionals involved in providing treatment of these audited cases had ever received education or training in undertaking partner notification. Using any documentation of any discussion relating to partner management, nearly 60% met standard six.

Standard 7: All recent sexual contacts need to be notified that they require testing and treatment.

The MOH guidelines acknowledge that partner data will be incomplete; nonetheless, there is a suggestion to monitor the percentage of partners who are contacted or advised about chlamydia and the percentage of partners who are treated and/or tested. The recommendation is that at least 50% of identified sexual partners or contacts should be treated. There was very limited documentation around the outcomes of partner notification in this audit. Of 21 cases from the sexual health clinic, where there is a designated nurse responsible for case follow-up and partner outcomes, 13/21 (61.9%) cases had documentation that all identifiable partners had been advised and 10/21 (47.6%) had health-worker verified partner treatment. For all other settings in the audit, 76/394 (19.3%) documented that all identifiable partners had been advised, 41/394 (10.4%) noted partner treatment as advised by the index patient and partner treatment was noted as verified by a healthcare worker in eight (2.0%) cases.

Discussion

This is the first New Zealand multi-setting district-wide audit against proposed national MOH guidelines for managing genital chlamydia infections. The audit has helped to identify issues in current practice in our district. Appropriate sampling for diagnosis and of recommended treatments compare well to their respective standards. Standards that were only partly met include that the patient is aware of the implications of a positive test, that treatment should be given for presumed chlamydia infection if there is a high index of suspicion without waiting for laboratory confirmation, that a test-of-cure is recommended if the patient is pregnant, and partner management.
It is important to emphasise that these findings are more a measure of documentation in the medical record, rather than of actual practice. Participants commented that the audit highlighted the sometime brevity of their documentation and also the challenges of partner management. Many noted that they had reviewed their own processes and shared their recommendations for improvements; some examples included greater use of dispensing treatment to improve adherence, thorough and complete documentation of dispensed treatments, storing written information with drug treatments to facilitate better information giving, and telephone follow-up of cases.

The most significant issue was a lack of effective partner notification. This raises concerns not only for optimal management of chlamydia but of all STIs. The MOH guidelines anticipated this finding based on overseas primary care research; their suggestions for improvements include appropriate training and support for primary care providers, DHB or PHO-employed contact tracers and exploring the use of other partner notification practices, such as patient-delivered therapy. However, the current legislative framework in New Zealand appears to limit use of the latter [110]. Interestingly, one local rural GP setting undertook a post-audit survey of newly diagnosed chlamydia index cases as to how to facilitate notifying their partners; with the majority suggesting written information would help. They have developed a practice letter and are trialling its use at present. Other audit participants suggested additional human resource and support for contact tracing would be very helpful. Finding a way forward to improve on the current situation is now imperative, both locally and nationally.

The audit found appropriate site sampling was used for diagnosis, with combinations of samples, e.g. a cervical swab and a urine sample, also noted. In the two laboratories’ original data extract, there were 22191 chlamydia tests from 21311 individuals in 9 months, that is, approximately 4% of all those tested had more than 1 chlamydia sample taken on the same-day. The MOH guidelines state that ‘In general, NAATs have a sensitivity of 90–95%, with the majority of studies indicating that as the number of sites sampled increases, the greater the detection of \textit{C. trachomatis} in any given population.’ However, multiple-site or duplicate testing of an individual greatly increases the cost of the MOH guidelines’ recommendation that molecular testing methods be used for diagnosis. That said, it might be possible to reduce molecular testing laboratory costs, for example, if samples were pooled [291].

The MOH guidelines are intended for primary care. However, a notable issue identified in our audit was management of cases diagnosed in ambulatory secondary care settings, such as the emergency department. Test results were often available only after a patient had been discharged; these were copied to a primary care provider but it was not possible to ascertain from the hospital medical record that positive results were ever acted upon, in
other words, if index cases were informed of the positive result, or if they and their partners were treated. This is a potential gap that needs to be addressed and ways to further improve local primary-secondary care communication are being considered.

A strength of the audit is that multiple settings were involved and that these reflect where chlamydia is diagnosed and managed in the Waikato DHB. Only settings that diagnosed 25 or more cases were invited to participate, as this was felt more likely to be representative of usual care and with less inherent bias related to small case numbers. It was felt important to ensure that the audit process was structured in a way that supported participation of small, busy settings and high participation rates attest that this seems to have been successful. The considerable enthusiasm and interest amongst local practitioners deserves comment. Many noted that they have made efforts to improve their documentation and that the audit was a useful learning tool. The audited cases were diagnosed in 2008 before a series of primary care sexual health articles in 2009 by Best Practice Advocacy Centre Ltd (bpac®); these articles emphasised some of the issues identified in the audit, such as optimal sampling, treatment and partner management [292,293]. Also, this is a regional rather than a national audit so the findings may not extrapolate to other areas. More detailed analysis is ongoing to assess for any disparities in case management by age, gender or ethnicity.

Following the audit, anonymous combined results were presented and discussed at local primary care multidisciplinary continuing education sessions. Learning points and suggested changes from the audit participants were included with permission. This included much greater emphasis on optimising partner management. In addition, in response to participant feedback, a local one-page summary provider resource has been developed and disseminated (Appendix 5) [294]; this is based on the new national MOH guidelines but adapted to reflect these audit findings and includes a clear statement around the need for patient follow-up so as to clarify and document treatment adherence and partner management outcomes.

The Waikato DHB testing rates for chlamydia are acknowledged as high, particularly amongst young women [271]. Recent national laboratory surveillance data suggest high chlamydia test uptake in other districts too [257]. However, testing without treatment or partner management of this common infection is effectively futile and all aspects of case management need to be considered. Our audit has helped identify potential gaps between recommended ‘best-practice’ within the new MOH guidelines and current practice, most notably around documentation of advice given as part of case management and, more importantly, around partner management. This has helped shape the development of ongoing education and training resources for all local providers. Further, it is hoped that participation in the audit may in turn contribute to improved case management in high-
caseload settings in our district. There is commitment to re-audit in another 12-24 months to evaluate this.
Chapter 7: Is everyone treated equally? Management of genital *Chlamydia trachomatis* infection in New Zealand

Introduction

*Chlamydia trachomatis* infection is a significant public health problem, as untreated infection may lead to salpingitis, tubal scarring, ectopic pregnancy and subfertility in some women [20]. New Zealand’s estimated national rate of 803 per 100 000 population in 2009 was two to four times higher than reported national rates for Australia (287 per 100000 population in 2009), the UK (202 per 100000 population in 2008), and the US (401 per 100000 population in 2008) [257]. The Waikato district health board (DHB) in the upper North island of New Zealand has a high burden of reported cases (858 per 100000 population in 2009), with nearly 80% being amongst those less than 25 years old. In addition, available data suggest disparities for Māori, with reported sentinel surveillance clinic rates of chlamydial infections amongst Māori being 2.5 times that of non-Māori [257].

Disparities in health outcomes often reflect socio-economic and other factors that impact on adequate access to appropriate health-care [134,295]. Recent local efforts have therefore focused on improving district-wide primary sexual health-care provision for young people, with free general practice visits introduced in high-need areas during 2003-4 [272]. Encouragingly, chlamydia test uptake within the Waikato DHB appears equitable by ethnicity, with high rates of testing amongst both Māori and non-Māori women under 25 years old [271], and coverage for young women reached 45% in 2009. However, if access to testing is improved without ensuring equitable access to effective treatment or partner notification, disparities in health outcomes will likely persist. Hence, our aim was to ascertain if there were any disparities in current case management of genital chlamydia infection in a range of clinical settings in the Waikato DHB.

Methods

The Waikato DHB had an estimated resident population of 357000 in 2008, of whom approximately 21% are Māori compared with 15% nationally. Nearly 54% of Māori are under 25 years of age, compared with 31% of non-Māori. Since mid-January 2008, two Waikato laboratories performed all chlamydia testing for the district. Both laboratories provided data on all tests carried out on residents from February 1st - October 31st 2008. Non-genital site samples were excluded. All urogenital samples were tested using nucleic acid amplification methods. Positive chlamydia test results were identified. Any practice or clinic setting within the Waikato DHB with 25 or more positive chlamydia test results during the nine months was invited to participate. Each site was provided with a list of their
laboratory-identified cases and asked to complete a proforma for each of 20 consecutive cases seen from February 1\textsuperscript{st} 2008. The New Zealand Ministry of Health guidelines for chlamydia management \cite{85} are closely aligned to UK guidelines for the management of uncomplicated genital chlamydia infection; hence, a UK validated national chlamydia management audit tool was used as a basis for our proforma \cite{290}. The proforma was adapted to more closely reflect the New Zealand context and differences in health-care settings (Appendix 3).

Twenty sites across a range of clinical settings were eligible. This included: nine rural general practices, three urban general practices, a family planning clinic, a sexual health clinic, a community accident and medical centre, a remand prison, a university-based student health service, high school-based student health services, a hospital-based emergency department and a hospital-based acute gynaecological service. All sites agreed to participate and 19 of 20 were able to provide data. The non-participating site was the remand prison. Combined, these sites diagnosed 70\% of 2258 urogenital chlamydia cases in the Waikato DHB during the time period. Seven sites chose to complete proformas for more than 20 cases (range 21-37), giving a sample of 415 cases (18\%) of all the Waikato DHB genital chlamydia cases diagnosed during February 1\textsuperscript{st} - October 31\textsuperscript{st} 2008.

Analysis with regard to whether recommended standards of care were met have been described previously \cite{296}. This analysis focused on differences in case management by age, gender and ethnicity. Chi-squared and Fisher exact tests were used to examine demographic and other categorical variables. Kolmogorov-Smirnov testing was used for continuous but non-normal variables, such as days to treatment. Ethical approval was given for the study (NTY/09/25/EXP).

**Results**

Of the 415 cases, 316 (76\%) were female and 317 (78\%) were under 25 years old (Table 7-1). Two transgender patients were excluded from any gender analysis.
Table 7-1 Demographics of all the Waikato DHB cases and of study sample

<table>
<thead>
<tr>
<th>Demographics</th>
<th>All Laboratory Cases (n = 2258, 100%)</th>
<th>Study Cases (n=415, 18%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Gender</td>
<td>614 (27%)</td>
<td>1644 (73%)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15 years</td>
<td>0 (0%)</td>
<td>42 (3%)</td>
</tr>
<tr>
<td>15-19 years</td>
<td>203 (33%)</td>
<td>775 (47%)</td>
</tr>
<tr>
<td>20-24 years</td>
<td>119 (19%)</td>
<td>240 (15%)</td>
</tr>
<tr>
<td>25-34 years</td>
<td>35 (6%)</td>
<td>64 (4%)</td>
</tr>
<tr>
<td>35-44 years</td>
<td>12 (3%)</td>
<td>9 (1%)</td>
</tr>
<tr>
<td>55+</td>
<td>2 (0%)</td>
<td>3 (0%)</td>
</tr>
<tr>
<td>Missing</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ European</td>
<td>247 (40%)</td>
<td>675 (41%)</td>
</tr>
<tr>
<td>Māori</td>
<td>192 (31%)</td>
<td>600 (36%)</td>
</tr>
<tr>
<td>Asian</td>
<td>9 (1%)</td>
<td>22 (1%)</td>
</tr>
<tr>
<td>Pacific</td>
<td>14 (2%)</td>
<td>42 (3%)</td>
</tr>
<tr>
<td>Other</td>
<td>16 (3%)</td>
<td>38 (2%)</td>
</tr>
<tr>
<td>Missing</td>
<td>136 (22%)</td>
<td>267 (16%)</td>
</tr>
<tr>
<td>Provider location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural general practice</td>
<td>134 (22%)</td>
<td>482 (29%)</td>
</tr>
<tr>
<td>Urban general practice</td>
<td>91 (15%)</td>
<td>283 (17%)</td>
</tr>
<tr>
<td>Other primary care:</td>
<td>83 (14%)</td>
<td>156 (9%)</td>
</tr>
<tr>
<td>community A&amp;E centre,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>high school &amp; tertiary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>education clinics,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>prisons, community</td>
<td></td>
<td></td>
</tr>
<tr>
<td>midwives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual health clinic,</td>
<td>300 (49%)</td>
<td>608 (37%)</td>
</tr>
<tr>
<td>family planning clinic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary care,</td>
<td>6 (1%)</td>
<td>115 (7%)</td>
</tr>
<tr>
<td>including emergency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dept.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: * including two transgender cases

Ethnicity data were available for fewer laboratory-identified cases than for study cases (82% vs. 95%, p<0.001). The most commonly reported ethnicity amongst study cases was European (48%), followed by Māori (43%). A range of ethnicities was noted but, because of small numbers for several of these, ethnicity was analysed as Māori and non-Māori. There were more cases from rural general practice and less from sexual and reproductive health providers, p<0.001.
**Presenting features**

The main reason for having the chlamydia test was documented for 319 of 415 cases (Table 7-2), with ‘symptoms’ being the most frequently reported reason for both sexes. Females were more likely than males to have 'offered by provider based on sexual history' as the main reason for testing, $p=0.007$, whilst males were more likely to have ‘contact of partner diagnosed with chlamydia’ as the main reason for testing, $p=0.007$. By ethnicity, Māori were more likely than non-Māori to have tests that were 'offered by provider based on sexual history’ (41 or 24% vs. 20 or 9%, $p<0.001$).

Table 7-2 Main reason for test and treatment documentation by gender

<table>
<thead>
<tr>
<th>Main Reason for Test *</th>
<th>Male (% of male cases)</th>
<th>Female (% of female cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>47 (48.5%)</td>
<td>129 (40.8%)</td>
</tr>
<tr>
<td>Asymptomatic patient requesting check-up</td>
<td>20 (20.6%)</td>
<td>91 (28.8%)</td>
</tr>
<tr>
<td>Offered by provider, based on sexual history</td>
<td>6 (6.2%)</td>
<td>57 (18.0%)</td>
</tr>
<tr>
<td>Contact of partner diagnosed with chlamydia</td>
<td>19 (19.6%)</td>
<td>23 (7.3%)</td>
</tr>
<tr>
<td>Medico-legal</td>
<td>0</td>
<td>3 (0.9%)</td>
</tr>
<tr>
<td>Reason not documented</td>
<td>5 (5.2%)</td>
<td>13 (4.1%)</td>
</tr>
<tr>
<td>*</td>
<td>97*</td>
<td>316</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment documentation*</th>
<th>Male (% of male cases)</th>
<th>Female (% of female cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment drug/dose/duration noted</td>
<td>94/97 (97%)</td>
<td>277/316 (88%)</td>
</tr>
<tr>
<td>Treatment drug/dose/duration correct</td>
<td>91/94 (97%)</td>
<td>271/277 (98%)</td>
</tr>
<tr>
<td>Azithromycin as first line</td>
<td>84/97 (87%)</td>
<td>248/316 (78%)</td>
</tr>
<tr>
<td>Immediate treatment</td>
<td>40/97 (41%)</td>
<td>45/316 (14%)</td>
</tr>
<tr>
<td>Median time-to-treatment (mean)</td>
<td>3 days (3.3 days)</td>
<td>6 days (6.6 days)</td>
</tr>
<tr>
<td>*</td>
<td>97*</td>
<td>316</td>
</tr>
</tbody>
</table>

Legend: * two transgender cases excluded

Overall, 57% of cases were symptomatic. There was no difference in symptomatic cases vs. asymptomatic cases by age-split (57% of under-25s vs. 55% of those 25 and over, $p=0.8$), by gender (65% of males vs. 54% of females, $p=0.06$) or by ethnicity (55.6% of Māori vs. 55.9% of non-Māori, $p=0.96$).

**Treatment**

Treatment drug, dose and duration were well documented for 90% (373 of 415) of cases. Treatment was noted as being prescribed for an additional seven cases but there was no record of drug choice or dose. Thus, 92% of cases had some evidence of treatment. Where treatment was documented, drug choice, dose and duration of treatment was appropriate for 98% of cases when compared to the New Zealand Ministry of Health guidelines for chlamydia management [85]. Treatment, where noted, was mostly by prescription, rather than direct dispensing (73% vs. 27%), with no difference in this by demographic variables.
Time to treatment was recorded for 90% (373 of 415) of cases. Same-day treatment occurred for 23% (85 of 373), 90% were treated within 11 days, and 95% within 17 days of being tested. The remaining 5% (18 of 373) were treated between days 19 and 90 of being tested. The only demographic difference in time-to-treatment was by gender. There was significantly less time from test to treatment for males than females (median 3 days vs. 6 days, p<0.001). Only 16% (45/278) of females with documented treatment were treated at the time of testing, compared to 42% (40/95) of males, p<0.001.

When analysed by reason for testing, known contacts had the shortest median time to treatment (1.3 days) whilst provider-offered testing had the longest median time to treatment (7.5 days). Those whose main reason for testing was ‘offered by provider’ were also less likely than those requesting a check-up to have documented treatment (78% vs. 99%, p<0.001).

No treatment was recorded for 35 cases; five cases failed to attend for treatment and the remaining 30 cases had no documented treatment or outcome, although it is possible that treatment occurred. Of cases with known ethnicity, lack of documented treatment or failure to attend for treatment was more likely for Māori than non-Māori (13.6% vs. 4.8%, p=0.036). Lack of documented treatment was also more likely for females, with 8.2% not having any treatment documented, compared with 2.1% for males, p=0.037. There was no difference by age.

Lack of documentation for treatment or outcomes was notable in cases diagnosed in two hospital-based settings, with 26 of 47 (55%) of cases having incomplete or no treatment documented. In comparison, 16 of 368 (4.3%) cases diagnosed in other settings had either incomplete or no treatment documented. Of cases with known ethnicity, more Māori were seen at these two settings than elsewhere (74% vs. 38%, p<0.001). Also, more women than men attended these two settings (43 of 47 cases, 91%, p=0.01).

**Partner management**

The results of partner notification compared to the Ministry of Health guidelines for chlamydia management have been described previously. To summarise, most cases had limited documentation in their medical record around partner notification; 59% (246 of 415) had any documentation to suggest partner notification was discussed and 31% had any documentation about the planned method of partner notification (e.g. by the patient). Most participating sites noted that discussions typically involved telling patients to tell their partners. Documentation that partner notification was discussed did not differ significantly by age-split, gender or ethnicity.

A recommended target for partner notification is at least 50% of identified sexual partners being treated. Detailed sexual history taking appeared lacking; only 47% (196 of 415) of
cases had any indication of the number of sexual partners in the preceding three months. There was also limited documentation by which to monitor the success of partner notification; 21% of all cases had any documentation that regular sexual partner(s) had been advised, 12% noted regular partner treatment as advised by the index case and 4% noted provider-verified regular partner treatment. Lack of documented partner notification outcomes was more notable for cases managed in non-sexual health clinic settings. There were no significant differences within any of the measures with respect to gender, age-split and ethnicity.

Discussion

The limited partner notification, whether by age, gender or ethnicity, noted in a wide range of clinical settings in our locale is a concern. Repeated chlamydia infections in young women are often re-infections from an untreated partner and frequent testing and treatment of women alone is not likely to reduce prevalence in high-risk populations [83]. Documentation that partner notification was discussed was similar to that reported in primary care or community settings in other countries [297,298]. However, with the exception of the local sexual health clinic, there was little patient follow-up and documented outcomes of partner notification were notably lower than reported by UK genitourinary medicine clinics [299,300], where partner notification is most often undertaken by specialist sexual health advisers [301]. In New Zealand, most sexually transmitted infections are diagnosed and managed in primary care and very few health boards employ contact tracers or health advisers for sexually transmitted infections. Improvements are feasible within existing systems, however. With training and support, practice nurses can undertake partner notification that is at least as effective as referral to a specialist health adviser [302]. A systematic review of interventions found involving index patients in shared responsibility for the management of sexual partners, and providing additional information for partners, improved outcomes, and new methods of partner management are emerging, for example, patient delivered partner therapy and home sampling for partners [108].

Of diagnosed cases in this study, men were no more likely to be symptomatic than women but more men were treated immediately. This is presumably because male urethral symptoms, particularly urethral discharge, more accurately predict sexually transmitted infections than female symptoms, such as vaginal discharge [303]. Men in the study were also more likely to be a contact of a chlamydia case. Others have reported men as being more likely to receive immediate treatment [304,305], and have suggested clinical features or the use of on-site microscopy as important influences. None of the settings involved in our study use on-site microscopy yet, encouragingly, the overall median time to treatment of five days is comparable to that previously reported from specialist genitourinary medicine clinic audits [306,307]. However, for women in our study, the median time to treatment was
double that of men and they were also more likely to have a lack of documented treatment. If treatment is not given immediately, a range of structural health-care factors, including the rapidity with which tests results are received, may influence the time to treatment \([305,308]\); having a reliable point of care test to enable more immediate treatment for women would help overcome these factors.

Analysis by reason for testing suggests those that request testing may be more likely to have documented treatment than cases where testing was provider-offered. This raises the issue of whether provider-offered testing may be associated with a lower likelihood for returning for results and/or treatment, and warrants further investigation. Also, compared to women, case finding for men appeared more related to clinical features, such as symptoms or being a contact of infection, and less related to provider-offered opportunistic testing. This raises the possibility of missed opportunities to offer chlamydia testing to young men, as was noted in a UK general practice study \([214]\). New Zealand has achieved high chlamydia test uptake amongst young women but not young men, with five times as many women aged 15-24 years being tested \([271,309]\). However, our data did not capture if men were more likely than women to receive syndromic treatment without testing for chlamydia.

New Zealand’s ethnic disparities in access to health-care are well documented \([134]\). There may also be disparities in the quality of health care \([310]\). In our study, treatment outcomes, such as time-to-treatment, appropriateness of treatment, and partner management, were similar. However, there were some differences for Māori compared to non-Māori. Reasons for testing amongst Māori was more likely because of provider-offered testing than by patient-requested testing. It may be that providers perceive Māori as being at greater risk of having chlamydia and hence be more likely to offer testing as, although local test uptake is equitable by ethnicity, Māori are twice as likely as non-Māori to test positive \([271]\).

Lack of documented treatment or failure to attend for treatment was also more likely for Māori than non-Māori; although the numbers affected were small, this occurred for more than one of every seven Māori compared to less than one in twenty non-Māori. This may be another measure of access, as Māori may be more likely to face structural barriers in returning for treatment e.g. poor transportation. However, this finding may simply reflect the bias around documentation for some settings involved in this study. As reported in the overall audit, secondary-care test results were often available only after a patient had been discharged from hospital and it was not possible to ascertain from the hospital medical record that cases and their partners were ever treated \([296]\). Those facing cost-barriers to health care may be more likely to choose to attend the local emergency department, particularly out-of-hours when there are no alternative options for free or low-cost primary care in the Waikato DHB. This study was not designed to look at these issues and further study is needed to clarify this.
Study limitations include the retrospective study design and purposive sampling of cases. Only settings that diagnosed 25 or more cases were invited to participate, so that there was less inherent bias related to small case numbers. Relatively more cases were from rurally based general practice and less from sexual and reproductive health services, meaning that these results are not generalisable to settings where sexual health care is delivered predominately at specialist clinics. Data collection was based on the clinical record where documentation may not reflect actual care. Some pertinent information was not available, for example, 73% of treatment was prescribed rather than dispensed, but there were no data regarding adherence to non-dispensed medications. Study strengths include a high participation rate and measuring clinical performance in a wide range of settings. Ethnicity data for the study were collected from the patient medical record. Historically, ethnicity data within New Zealand databases were provider-assigned and self-identified non-European ethnicities under-counted as a result [311]. However, local health-care settings have made efforts over recent years to collect self-identified ethnicity within their patient management systems. This information was felt to be more accurate than National Health Identifier (NHI) mapped ethnicity within the laboratory database, where 18% of cases had missing data.

In conclusion, our study found differences in case management by gender and ethnicity that suggest barriers to timely appropriate health-care persist. However, by far the most notable issue was the overall lack of effective partner notification and, until this improves, prevalence within local population networks is unlikely to reduce and current disparities in reported infections will likely continue. Ongoing efforts are required to ensure equitable access to timely treatment and to ensure more effective partner notification strategies are implemented.
Chapter 8: Does text-messaging test results reduce time to treatment of *Chlamydia trachomatis* infection?

Introduction

Reducing time to effective treatment for *Chlamydia trachomatis* has the potential for personal and public health gain through reduced complication rates and limiting further transmission \[^{280}\]. In 2006, the introduction of text messaging test results in a UK genitourinary medicine clinic was associated with a decrease in median time to treatment from 15 to nine days \[^{312}\]. This study aims to assess any impact of introducing text messaging in a different locality.

Methods

All sexually active patients attending the sexual health clinic in Hamilton, Waikato, are offered testing for sexually transmitted infections. Men with symptomatic urethritis and sexual contacts of confirmed cases of *Chlamydia trachomatis* are treated immediately with appropriate antibiotics. *Chlamydia* test results are available to patients by telephoning in seven days or opting to attend a follow-up appointment. Laboratory test (Roche PCR) results are received within three to five days and a designated nurse attempts to contact any patient with a positive result. Anyone not already treated is offered an appointment within 24 hours.

In 2005, initial communication by the designated nurse was by land- or mobile-phone, with letters sent if the person was un-contactable by phone. In 2006, text messaging was introduced as the preferred method of communicating the need to discuss (positive) results. Desktop software (Healthcare Communications Ltd, UK) was used to generate multiple text messages. A generic message, with no personal information or diagnoses, was sent asking recipients to contact the designated clinic nurse as soon as possible. Other means of communication were used (e.g. land-line, letter) if this was the patient’s documented preference or if software audit reports indicated text message delivery failure (e.g. due to poor mobile phone network coverage in rural areas).

Notes of those with uncomplicated *Chlamydia trachomatis* infection in the same six-month period (1 March to 31 August) in 2005 and 2007 were reviewed and their demographic and attendance data compared. The interval from testing to appropriate treatment, either in clinic or documented treatment elsewhere, was calculated.

Data were analysed using SPSS for Windows (v14.0) software. Differences between age groups and ethnicity were tested using analysis of variance (ANOVA), and t-tests were used
to determine differences by gender and service variables (treated immediately and delay to treatment).

Results

Between March-August 2005, 303 cases of uncomplicated *Chlamydia trachomatis* (293 individuals) were diagnosed. Five cases were un-contactable and remained untraceable. Of the remaining 298, 140 (47%) were treated immediately. Between March-August 2007, 293 cases (281 individuals) were diagnosed; one case was untraceable. Of the remaining 292, 139 (47.6%) were treated immediately. There was no significant difference between the groups in terms of gender, age, ethnicity, number of patients treated immediately, or time between testing and treatment (Table 8-1), (Table 8-2).

Table 8-1 Demographics of chlamydia cases in 2005 and 2007

<table>
<thead>
<tr>
<th>Case demographics</th>
<th>Number (%)</th>
<th>Mar – Aug 2005</th>
<th>Mar – Aug 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total chlamydia cases</td>
<td>303</td>
<td>293</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>172 (57%)</td>
<td>163 (56%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>131 (43%)</td>
<td>130 (44%)</td>
<td></td>
</tr>
<tr>
<td>Age-group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 to 15 years</td>
<td>11 (3.6%)</td>
<td>8 (2.7%)</td>
<td></td>
</tr>
<tr>
<td>16 to 19 years</td>
<td>89 (29.4%)</td>
<td>92 (31.4%)</td>
<td></td>
</tr>
<tr>
<td>20 to 25 years</td>
<td>144 (47.5%)</td>
<td>134 (45.7%)</td>
<td></td>
</tr>
<tr>
<td>26 to 35 years</td>
<td>50 (16.5%)</td>
<td>44 (15.1%)</td>
<td></td>
</tr>
<tr>
<td>36 years and over</td>
<td>9 (3%)</td>
<td>15 (5.1%)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ European</td>
<td>135 (44.6%)</td>
<td>142 (48.5%)</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>150 (49.5%)</td>
<td>129 (44%)</td>
<td></td>
</tr>
<tr>
<td>Pacific Islanders</td>
<td>5 (1.6%)</td>
<td>8 (2.7%)</td>
<td></td>
</tr>
<tr>
<td>Other/not given</td>
<td>13 (4.3%)</td>
<td>14 (4.8%)</td>
<td></td>
</tr>
<tr>
<td>Contact details provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landline</td>
<td>135 (45%)</td>
<td>107 (37%)</td>
<td></td>
</tr>
<tr>
<td>Mobile Phone *</td>
<td>245 (81%)</td>
<td>257 (88%)</td>
<td></td>
</tr>
</tbody>
</table>

Legend: All differences were non significant except for * t = 2.19, p<0.05
The majority of patients provided a mobile phone number in their contact details, with considerably fewer providing a landline number (in 2005, 81% mobile phone vs. 42% landline, p<0.001 and, in 2007, 88% vs. 37%, p<0.001). Significantly more patients provided a mobile phone number in 2007 than in 2005 (p<0.05). Between March-August 2007, 237 text messages were sent, with 93% successfully delivered. Excluding those treated immediately, 311 cases had treatment delay (158 from 2005, 153 from 2007). There was a trend to earlier treatment between those who had provided mobile phone details compared to those who had not (t=-1.300, P<0.1). There were no significant differences between the groups in terms of age, gender and ethnicity.

**Discussion**

We found no significant difference in median time to treatment for all patients (three days in 2005, four days in 2007) and, for delayed treatment, no change in median time to treatment (both seven days) following the introduction of text messaging. Our results contrast with Menon-Johansson who found the introduction of text messaging reduced median time to treatment for 28 patients, but from 15 to nine days suggesting the two clinical settings are not directly comparable [312].

Our outcome measures compare well to others [299,307,313], although an Australian audit reported median time to treatment of two days, with 97% treated within two weeks [308]. Rapidity of receiving laboratory results in the Australian setting appears to be the major difference to our service [308]. Although median time to treatment did not improve significantly, we treated more cases within four weeks in 2007 than in 2005 (98.6% vs. 96%), possibly because greater number of mobile phones in 2007 meant contacting people was easier than in 2005, rather than being directly attributable to the use of text-messaging.
Studies of factors affecting time to treatment have found prompt notification important, with letters being associated with greatest treatment delay.\[305,306]\.

Limitations include the retrospective study design with historical controls and a potential lack of generalisability to other clinical settings; the interval between testing and treatment is affected by many service delivery factors and these may vary considerably between settings. Common to ethnic disparities within New Zealand health statistics, Māori were over-represented in our study (44% in 2007 vs. 20% of all attendees). It is reassuring we did not find any ethnicity disadvantage associated with text messaging.

Our study adds further support that the use of this technology is at least as effective as more traditional means of communication in service delivery.
Chapter 9: Does a clinical guideline change chlamydia testing? Report from the Waikato Chlamydia Project

Introduction

*Chlamydia trachomatis* infection is a significant public health problem, and untreated infection may lead to salpingitis, tubal scarring, ectopic pregnancy and subfertility in some women [20]. It remains the most common reported bacterial sexually transmitted infection (STI) in New Zealand [314], with the rate of hospital admissions for chlamydia-related pelvic infections in women aged 15-24 years rising recently [318]. In addition, data suggest disparities for Māori, with sentinel surveillance clinic rates of chlamydia infections being 2.5 times that of non-Māori [314]. Uncertainty continues over the merits of a screening programme however, with randomised evaluations of different screening approaches ongoing in the Netherlands and in Australia [316].

In 2008, the New Zealand Ministry of Health drafted national guidelines for chlamydia management which emphasised targeted testing of those with risk factors, particularly under 25 year olds [85]. Three districts, Waikato district health board (DHB), Lakes DHB and an Auckland primary health organisation (PHO), were chosen to assess guideline implementation impact with particular interest in laboratory test volumes. Pilot selection was based on factors that included at least some free or very low-cost primary care access for under 25 year olds, laboratory engagement, and clinicians’ willingness to participate.

Effective guideline implementation might significantly increase laboratory testing as reported by other interventions in New Zealand [128,317,318]. In Northland, testing and case detection amongst under-25 year old Māori males increased in 2006-07, during an intervention that included social marketing, community health promotion, outreach screening and funding to improve access to existing health services [317]. Increased testing rates were also noted during a general practice study of opportunistic chlamydia screening in Wellington, which was based on a multi-faceted intervention shown to be effective overseas [229,319], and also included a financial incentive [128]. However, the latter study also noted that the increases were not sustained, with testing rates returning to baseline within three months [128]. Testing rates also returned to baseline, from 18.8% to 9.7% of 15-25 year old women and from 18.9% to 1.3% of 15-25 year old men, in a Dunedin-based general practice, following a three-month quality improvement initiative to increase chlamydia screening in eligible-aged patients [318].

Our primary aim, therefore, was to examine the Waikato DHB’s chlamydia test volumes a year after guideline implementation in 2009, to ascertain if any changes in testing patterns...
by age, gender or ethnicity were sustained. Secondary aims were to assess crude estimates of population test uptake and to examine any changes in treatment over time, using dispensed volumes of azithromycin as a measure.

**Methods**

The Waikato DHB had an estimated resident population of 357000 in 2008, of whom approximately 21% were Māori compared with 15% nationally, serviced by approximately 300 GPs. A multi-disciplinary project advisory group reviewed local information gathered by the project lead (JM) (Figure 9-1).

Figure 9-1 The Waikato DHB chlamydia project phases of planning, implementation and evaluation

Laboratory test data were used to determine chlamydia test uptake by age, gender and ethnicity in the Waikato DHB for the first time. Details of this analysis have been reported elsewhere [271]. In summary, baseline chlamydia test uptake for women under-25 years of age was higher than expected and with similar testing rates for Māori and non-Māori. Screening coverage from Feb 1st – 31st Oct 2008 was estimated as 37%, by testing volumes, for 15-24 year old women residing in the Waikato DHB, and 28.4% of 15-24 year old women had at least one chlamydia test during that period. Of all tests during Feb 1st – 31st Oct 2008, 14% were positive, with positivity double for Māori (24.2% vs. 12.5%).
Discussions were held with a group of 15 GPs from both rural and urban settings and with a group of five rural-based practice nurses around opportunistic testing for chlamydia. Participants reported existing awareness of chlamydia as a significant issue and that they were 'already testing' young women, supporting findings from the baseline test analysis.

Consequently, the project advisory group shifted the project’s focus from simply raising awareness of offering opportunistic testing to a greater emphasis on ensuring those likely to have higher rates of infection, namely those under 25 years of age or Māori, were offered testing and ensuring optimal case management of those identified with infection. The Ministry of Health supported this change. Likely barriers and enablers to changing clinical practice were identified by reviewing published literature and from further discussion with local providers.

Some discussants suggested additional interventions, such as computer-alerts to prompt an offer of testing, but others had negative views about these. Audit was felt to be a useful tool; some discussants felt their practice had changed after participating in a Best Practice Advocacy Centre Ltd (bpac®) audit of how often practitioners undertook chlamydia testing in early 2009 [320]. Clear guidance on testing and treatment was thought likely to be helpful, with suggested improvements to national chlamydia print resources (Appendix 4, Appendix 6). Subsequently, these national materials were adapted, following national guidance on developing health resources [321], with changes approved by the Waikato project advisory group, for use in the Waikato DHB initially. A hard copy one-page health provider summary flowchart of chlamydia testing and case management was disseminated and made available as a downloadable file on the Waikato DHB’s website (Appendix 5) [294]. Local health promoters facilitated a rangatahi Māori focus group who helped design a youth-friendly chlamydia patient information leaflet (Appendix 7). The Auckland chlamydia project in 2010-11 planned to use, and possibly further modify, the adapted materials prior to any national rollout. Raising young people’s awareness of the issue was felt to be important but the project did not include any funding for social marketing.

A district wide audit of chlamydia cases diagnosed during 2008 was undertaken in June and July 2009. Details of the audit have been reported elsewhere [296] and are summarised here. Any setting within the Waikato DHB with 25 or more positive chlamydia test results during 2008 was invited to participate. Each site was provided with a list of their laboratory-identified cases and asked to complete a proforma for each of 20 consecutive cases. Twenty sites across a range of clinical settings were eligible. This included: nine rural general practices, three urban general practices, a family planning clinic, a sexual health clinic, a community accident and medical centre, a remand prison, a university-based student health service, secondary school-based student health services, a hospital-based emergency department and a hospital-based acute gynaecological service. All sites agreed
to participate and 19 of 20 were able to provide data. The non-participating site was the remand prison. Combined, these sites detected 70% of 2258 urogenital chlamydia cases diagnosed in the Waikato DHB during February 1st - October 31st 2008. Each site self-determined who would collect case data and complete the audit proformas, with most sites opting to share the task amongst medical and nursing staff. Seven sites chose to complete proformas for more than 20 cases (range 21-37), giving a sample of 415 cases (18%) of all the Waikato DHB genital chlamydia cases diagnosed during the 2008 time period.

The indicators of interest were: reason for testing, appropriate sampling, immediate treatment given for presumed chlamydia infection where there was a high index of suspicion (e.g. known contact of chlamydia infection, male patient with urethral discharge) without waiting for laboratory confirmation; standard recommended treatment given; test-of-cure a month later recommended if the patient was pregnant; partner notification discussed at the time of treatment; all recent sexual contacts notified that they require testing and treatment. The standard recommended treatment for uncomplicated infection are azithromycin 1 g stat dose orally or doxycycline 100 mg twice daily orally for seven days.

The case audit found a high standard of documented care on some indicators, such as appropriate sampling, appropriate choice of antibiotic and timely treatment, but other aspects of care, such as partner notification, were not well documented. Importantly, non-Māori were more likely to have clear documentation of receiving any antibiotic treatment. Discussions with audit participants about actual practice highlighted the significant role of practice nurses in testing and treatment. Participants provided helpful feedback as to ways in which their clinical practice improved post-audit and this information was included in the subsequent continuing medical education (CME) sessions.

Three face-to-face CME meetings were planned within existing primary care CME networks. Session content, which included results of the baseline testing analysis and the district wide case audit, was reviewed with a local GP clinical advisor and the Waikato project team. Local PHO staff facilitated the meetings, with the same speaker (JM) on each occasion. The meetings occurred during late September to mid-November 2009, with registered attendance of 104 providers. The first CME meeting, held in the district’s main urban centre and the largest of the three sessions, was recorded and made available as a CD-ROM and as a password-protected webcast on a local PHO website.

Two laboratories perform all chlamydia testing for the Waikato DHB and provided data on all tests carried out on residents from February 1st 2008 - January 31st 2011. All samples were tested using nucleic acid amplification methods. Non-genital site samples and same-day duplicate samples for any individual were excluded. Chlamydia test volumes for three six-month periods - before (June-Nov 2008), during (June-Nov 2009) and after (June-Nov
2010) project implementation – were compared using the Kruskal–Wallis equality of populations rank test for non-parametric data, with further comparisons of test volumes by age, gender and ethnicity.

Crude population test uptake was estimated by dividing the number of chlamydia tests by age-, gender- and ethnicity-specific resident population estimates. Repeat tests for any individual were not excluded. The Waikato DHB community pharmacy monthly claims during 2008 – 2010 for the antimicrobial drug azithromycin were collated. Claims excluded hospital or bulk-funded treatments but included community prescriber supply orders, i.e. stock volumes held by prescribers for emergency use or for when prescriptions are not practicable. Age, sex and ethnicity were ascertained for pharmacy claims with a National Health Index number.

Analysis was carried out using statistical package R version 2.13.0, R Foundation for Statistical Computing, 2011. A Bonferroni-corrected p value of < 0.003 for significance was used for the multiple comparative analyses.

Results
There was no significant change in overall test volumes, p=0.23, or in tests from those aged less than 25 years, p=0.06, comparing the three six-month time periods before, during and after implementation (Table 9-1). For the same periods, there was no significant change in test volumes from Māori, p=0.14, or for non-Māori, p=0.36.

By age and ethnicity, there was no significant change in test volumes from Māori aged less than 25, p = 0.24, and, although tests for non-Māori aged under-25 years appeared to decline in June to November 2010, there was no significant difference between the three time periods, p=0.017, as the adjusted significant p value was < 0.003. Similarly, an upward trend in tests for Māori aged 25 and older was observed, but there was no significant difference between the three time periods, p=0.06.

A year following implementation, test uptake among all women aged 15-24 years in the Waikato DHB was unchanged from baseline. Uptake remained similar for Māori compared to non-Māori; 20.3% for Māori and 19.9% for non-Māori for the six-month period in 2010 (Table 9-1). The five-fold lower test uptake by same-age males also remained, at 4.1% for Māori and 3.6% for non-Māori during June to November 2010.
Table 9-1 The Waikato DHB chlamydia tests by year, age-band, gender and ethnicity during each period, 2008-10

<table>
<thead>
<tr>
<th></th>
<th>All Tests</th>
<th>Tests 15-24 years</th>
<th>Tests 25-44 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%‡</td>
<td>N</td>
</tr>
<tr>
<td>All tests*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun-Nov 08</td>
<td>2450</td>
<td>1.4%</td>
<td>11404</td>
</tr>
<tr>
<td>Jun-Nov 09</td>
<td>2621</td>
<td>1.5%</td>
<td>11676</td>
</tr>
<tr>
<td>Jun-Nov 10</td>
<td>2441</td>
<td>1.4%</td>
<td>11765</td>
</tr>
<tr>
<td>Non-Māori</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun-Nov 08</td>
<td>1568</td>
<td>1.1%</td>
<td>7662</td>
</tr>
<tr>
<td>Jun-Nov 09</td>
<td>1670</td>
<td>1.2%</td>
<td>7701</td>
</tr>
<tr>
<td>Jun-Nov 10</td>
<td>1511</td>
<td>1.1%</td>
<td>7699</td>
</tr>
<tr>
<td>Māori</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun-Nov 08</td>
<td>482</td>
<td>1.3%</td>
<td>2765</td>
</tr>
<tr>
<td>Jun-Nov 09</td>
<td>549</td>
<td>1.4%</td>
<td>2924</td>
</tr>
<tr>
<td>Jun-Nov 10</td>
<td>581</td>
<td>1.5%</td>
<td>2982</td>
</tr>
</tbody>
</table>

Legend: * All laboratory test volumes (N) for three six-month periods before (June-Nov 2008), during (June-Nov 2009) and after (June-Nov 2010) project implementation ‡ Crude test uptake, calculated by dividing the number of tests by population estimates; any repeat tests included

There was a two-fold difference in azithromycin claim volumes for females compared to males, but the large volume of claims with unknown gender limited any interpretation of changes by gender over time (Figure 9-2). The large number of claims without demographic information, likely because of community prescriber supply orders, also limited any data interpretation by age or ethnicity.
Primary care guideline implementation was not associated with a significant change in chlamydia test volumes in the Waikato DHB. Although test volumes from under 25 year olds increased during implementation, the changes were not significant and were not sustained. Project planning found baseline-testing among young women in this district was amongst the highest reported internationally, which raised the possibility that guideline implementation might not be associated with further significant increases. The Waikato DHB chlamydia project chose an approach thought to be very achievable for national rollout, although notably less intensive than one of the most effective interventions reported to date \[229\]. Although participants reported their practice had, or would change, testing was not measured at a per-provider level and the cumulative effect of any such changes was not sufficient to significantly impact on already relatively high district-wide test volumes. Test increases reported by other New Zealand settings likely reflect a greater intensity of intervention, along with raising awareness in the target audience \[127,128,317,318\].

Implementation in the Waikato DHB raised a number of issues. One was the optimal age threshold for targeting testing to those most at risk of infection. The national chlamydia guideline focuses on an age threshold of less than 25 years; local implementation noted however that, based on test positivity by age-band, baseline test analysis suggested this would disadvantage Māori aged 25-34 years. Although chlamydia test positivity is only an indicator, not an accurate measure, of disease prevalence \[323\], a continued focus on only
under-25 year olds may be inappropriate in some districts and the age-threshold in the national chlamydia guideline may need be reviewed.

Another issue was that five times fewer 15-24 year old males were tested in the Waikato DHB than same-age females. An oft-repeated comment was ‘how to reach men’. Higher test positivity amongst males in the baseline analysis suggested a focus on those with symptoms or known sexual contacts of chlamydia. Notably, there was only a two-fold gender difference in azithromycin claims, implying more males are treated without testing, and in keeping with anecdotal reports that patient-delivered partner treatment is commonly prescribed. The use of patient-delivered partner treatment is discussed in the national chlamydia guideline, with evidence supporting its use as a tool for partner management in relation to chlamydia infections, but such prescribing without patient evaluation is not legal in New Zealand \[^{110}\]. If legalisation remains unchanged, future revisions of the national guideline need to clarify this issue. Meanwhile, local implementation opted to promote other ways of improving partner management.

Partner management for bacterial STIs reduces the likelihood of the index case being re-infected and is a cost-effective case-finding strategy of those who may not otherwise be tested for STIs \[^{324}\]. This latter point is very relevant for the Waikato DHB and other districts with low STI testing rates amongst men. With training and support, practice nurses can undertake partner notification that is at least as effective as referral to a specialist contact tracer \[^{302}\]. The CME sessions conveyed that giving patients a verbal explanation, plus clear written information which includes treatment options for their partners, reduces infections and is as effective as patient-delivered partner treatment \[^{108}\]. The UK, with similar prescribing restrictions, is exploring nurse-led telephone consults and pharmacist-led consults for partners as alternative strategies \[^{112}\], and these options should be evaluated in New Zealand.

The pivotal role of the primary care nurse in delivering sexual health care warrants mention. This was evident from focus group discussants and from audit findings. It follows that it is imperative the required knowledge and skills for this role are supported through the provision of appropriate resources and training opportunities. Another relevant issue was that nurses working in non-GP primary care settings, such as schools, tertiary education institutions and prisons, may not be encompassed by traditional CME networks and efforts were made to ensure project-related CME was inclusive.

The implementation of clinical guidelines in the Waikato DHB was not associated with a sustained district wide increase in chlamydia testing volumes. However, the project did provide an opportunity to highlight successes such as high chlamydia test uptake in young women, whilst identifying areas for improvement such as reaching men and partner
management. Recent focus in New Zealand has been on opportunistic testing but it is essential that effective treatment and improved partner management follow on [325]. Three guideline projects adopted differing approaches; although the other settings have not yet publicised their findings, reports have been submitted to the Ministry of Health with a summary anticipated in late 2011. It is hoped the combined findings will inform strategies toward effective chlamydia control in New Zealand.

1 The Ministry of health has not yet published a summary report of the three projects' findings, as of 31st March 2013.
Chapter 10: Discussion

*Chlamydia trachomatis* is the most common bacterial sexually transmissible infection in New Zealand and control of this infection poses a significant public health challenge both nationally and internationally. Many countries including New Zealand recommend annual opportunistic screening of sexually active young people as a control strategy, even though there remains a lack of robust evidence to determine either the optimal interventions to enhance screening uptake, or the impact of screening on population-level health.

**Trends of reported chlamydia cases and related complications**

The recommendation to screen annually for *C. trachomatis* infection aims to reduce associated reproductive tract morbidity for the infected individual and, by reducing transmission and hence new cases of infection, for the wider population. Reliable surveillance of recent trends in the incidence of chlamydia-associated reproductive complications, such as pelvic inflammatory disease, ectopic pregnancy, and infertility, could be expected to help in evaluating the impact of the screening recommendation.

Two key findings of the research included in this thesis are firstly, that most of the increase in reported chlamydia cases from 1998 to 2008 in New Zealand can be attributed to increased testing and detection, with disease trends for PID and ectopic pregnancy (as measured by hospital discharge rates) remaining stable over the same period (Table 10-1). Secondly, rates of chlamydia test positivity also increased from 1998 to 2008, raising the possibility that some of the increase in reported chlamydia cases is because of rising chlamydia prevalence, even though disease hospitalisation rates remained stable.

Despite increased testing and detection, current control efforts in New Zealand have not yet led to fewer adverse reproductive outcomes at a population level. In contrast, the US, the UK and Australia have reported falling reproductive complications in the context of increasing chlamydia screening [236-238, 258, 326-328]. It is not yet clear whether there is a causal relationship for these findings, however. For example, in the UK and in Australia, the rate of PID diagnosed in primary care was already declining in both countries during years when the uptake of chlamydia screening uptake remained low [326, 328].
Table 10-1 Key findings of trends of reported *Chlamydia trachomatis* infections and related complications

**Key Findings:**

- Chlamydia testing increased steadily from 1998 to 2008 in the upper North Island of New Zealand, with the testing rate 2.6 fold higher in 2008 compared to 1998.
- In the same period, the proportion of chlamydia tests that were positive increased by 17% (p for trend, p< 0.002) and 83% (p for trend, p<0.0002) in two of the three upper North Island regions and by 57% (p for trend, p=0.1) in the third upper North Island region.
- The laboratory-confirmed *C. trachomatis* detection rate among adults aged over 15 years increased steadily from 1998 to 2008 in the same regions, and was 2.9 fold higher in 2008 than in 1998.
- The highest laboratory-confirmed chlamydia infection rates, and the greatest increase in rates over time, were found in women aged 15 to 24 years; the rate for this age group (5737 per 100 000) in 2008 was three-fold higher than in 1998, and was four times higher than in women aged 25 to 34 years and in men aged 15 to 24 years in 2008.
- Age-specific hospital discharge rates for all-cause PID, infertility, and ectopic pregnancy among women aged 15 to 44 years, and for epididymo-orchitis amongst 15 to 44 year old men, were unchanged over the same period of 1998 to 2008.
- Age-specific hospital discharge rates for PID and chlamydia-related pelvic infections for women aged 15 to 24 declined from 1998 to 2004 but increased during 2005 to 2008.

Bender et al. recently highlighted the difficulties in interpreting findings from such ecological studies and in making cross-national comparisons [273]. Similarly derived data from six countries (including data collected for this thesis) were used to describe trends in cross-national rates of chlamydia infection, PID, ectopic pregnancy and infertility and to compare trends in chlamydia test positivity with rates of PID and ectopic pregnancy. Australia, Denmark, the Netherlands, New Zealand, Sweden and Switzerland were selected for inclusion in the study, according to demographic, economic and social indicators, chlamydia testing practices, infection rates and availability of data.

Routine data about chlamydia diagnosis and testing and hospital diagnoses of PID, ectopic pregnancy and infertility in women aged 15-39 years from 1999 to 2008 were collated. For New Zealand, data related to six of 20 district health boards (Auckland, Bay of Plenty, Counties Manukau, Lakes, Waikato and Waitemata) comprising 48% of the total New Zealand population and were reported with 95% confidence intervals. Opportunistic
Chlamydia testing was recommended in all countries except Switzerland. Rates of chlamydia testing were highest in New Zealand (Figure 10-1)\textsuperscript{[273]}. Chlamydia test positivity was similar in all countries with available data (Denmark, New Zealand and Sweden) and increased over time.

Figure 10-1 Trends in chlamydia diagnosis rates, testing rates and percentage of chlamydia test with a positive result, 1999 - 2008\textsuperscript{[273]}

![Trends in chlamydia diagnosis rates, testing rates and percentage of chlamydia test with a positive result, 1999 - 2008.](image)

Legend: (A) Chlamydia diagnoses per 100 000 women 15-39 years, age standardised; (B) Total chlamydia tests per 100 000 population; (C) positive tests per 100 chlamydia tests performed in total population

Increasing chlamydia test positivity rates were associated with decreasing PID hospitalisation rates among women aged 15 to 39 years in Denmark and Sweden, but not New Zealand (Figure 10-2), and with decreasing ectopic pregnancy rates in Denmark, New Zealand and Sweden. Ectopic pregnancy rates appeared to increase over time in 15-19 year-olds in several countries. Trends in infertility diagnoses were very variable.
Figure 10-2 Trends in chlamydia diagnosis rates, and rates of hospitalisation for PID, ectopic pregnancy and infertility, by country, 1999 - 2008. [273]

Legend: (A) chlamydia diagnoses per 100 000 women 15-39 years, age standardised; (B) PID rate per 100 000 women aged 15-39 years, age standardised; (C) ectopic pregnancy rate per 1,000 live births in women aged 15-39 years, age standardised; (D) infertility rate per 100 000 women aged 15-39 years, age standardised

Overall, reported levels of chlamydia diagnosis and complication rates between or within countries over time were not consistently related. No single country has reported high population chlamydia screening rates, falling test positivity and falling complication rates in recent years. What is not clear is whether this is because trends in hospital admission data for all-cause PID, ectopic pregnancy and infertility were not sensitive or specific enough to reflect changes attributable to changes in rates of *C. trachomatis* infection or whether chlamydia control efforts were not yet intensive enough [273].

The rate of PID hospitalisation in New Zealand did not decline during 1998 to 2008 and remained notably higher among than in the other countries. The reasons for this are unclear and there are many unknowns. Interpretation and comparisons are hampered by the lack of a standardised diagnostic approach and the lack of a standardised way to record chlamydial-related PID episodes. The international classification of diseases (ICD) is developed by the World Health Organisation and is regularly reviewed and revised in order to keep up to date with clinical terminology and medicine, although revisions may be implemented at different times in different countries [329]. It could be expected that countries would use similar classification codes for a disease but there were differences in the predominant PID coding classifications used in countries in the aforementioned cross-national study, more so than for other reproductive sequelae such as ectopic pregnancy.
This partly reflects the lack of specificity of PID as a clinical diagnosis but also reflects inconsistent coding practice between countries: more PID cases were recorded as ICD-10 N73.9 code (unspecified female pelvic inflammatory disease) in Australia and New Zealand whereas, among the four participating European countries, more cases were recorded using ICD-10 N70 codes (salpingitis and/or oophritis).

New Zealand hospitals use a version of the clinical coding classification that was modified by the National Centre for Classification in Health, Australia, which may explain why there was less inter-country variation in PID diagnostic coding between New Zealand and Australia than between New Zealand and the four European countries. For example, the inclusion of ICD-10 A56.1 (chlamydial infection of pelviperitoneum and other genitourinary organs in women) code had a significant influence on New Zealand PID hospitalisation rates (Figure 10-3), yet Denmark reported only one ICD-10 A56.1 coded hospitalisation event in 2004. Although the predominant PID code varied between countries, however, the choice of code for PID hospitalisations seemed largely consistent over time within countries.

More reliable comparisons of PID hospitalisations are possible between New Zealand and Australia, given there is less coding variation between these countries. Two Australian studies have reported PID hospitalisation rates in New South Wales, using similar methodology and diagnostic codes as the New Zealand study included in this thesis. The first of these found that, among women aged 15–34 years, hospital admission rates for PID per 100,000 population fell from 165 in 1992 to 64 in 2001 at a time of rising chlamydia notifications. This study used the same diagnostic codes as our study, apart from ICD-10 A56.1, which was not in common usage at that time. A more recent analysis of PID hospital admissions in New South Wales from 1998 to 2008 used the same codes as our study, including the ICD-10 code A56.1, and noted the same previously reported decline by...
Chen et al. but at a much more gradual rate\textsuperscript{330}. Among 15 to 24 year old Australian women, PID hospital admissions rates decreased from 80 to 61 per 100 000 women from 1998 to 2008 and, among 25 to 34 year old Australian women, rates decreased from 99 to 65 per 100 000 women from 1998 to 2008. In contrast, our study found that, among 15 to 24 year old New Zealand women, PID hospital admissions rates were stable at 156 and 202 per 100 000 women from 1998 to 2008 (p for trend=0.13) (Figure 10-3) and, among 25 to 34 year old New Zealand women, rates were stable at 130 and 126 per 100 000 women from 1998 to 2008 (p for trend=0.16).

It is worrying that the annual rate of PID hospitalisations among New Zealand women aged 15-24 years was 3.3 fold higher than same-age Australian women in New South Wales in 2008. As mentioned already, the reasons for such differences are unclear and there are many unknowns. It is unknown if there were differences in determining the clinical diagnosis of PID between these two countries, or if this has changed over time. For example, it is possible that patients given diagnostic codes relating to PID in New Zealand may have been more likely to be given alternate, less-specific, diagnostic codes in Australia, such as ‘pelvic pain’, that were not captured in the studies’ datasets. It is also unknown if clinical management of PID differed in ways that might contribute to higher hospitalisation rates in New Zealand than in Australia, for example, if women were more likely to be admitted in New Zealand for symptomatic relief or for specific therapeutic measures, such as intravenous antibiotic therapy. Importantly, there are no data on primary care diagnosis or management of PID in New Zealand to help understand time-trends in the rate of PID diagnosed in primary care or if there has been a transfer of care towards secondary care, for whatever reason, and further research is required to elucidate this.

In 2008, ICD-10 A56.1-coded chlamydia-related pelvic infections contributed approximately 27% of total all-cause PID admissions among young women aged 15-24 years in New Zealand. It is likely, however, that the relative increase in cases recorded as ICD-10 56.1 from 1998-2008 in New Zealand (Figure 10-3) reflect changes in coding practice following the implementation of revised ICD codes in 2000, rather than a substantial increase in the relative contribution of chlamydial infection to PID admissions. Of concern is that current coding practice may alter again with future ICD revisions. Much better monitoring of adverse outcomes and evaluation of interventions would be possible if there was: standardisation and consistency in clinical diagnosis; a unique diagnostic code for chlamydial-related PID and for other adverse outcomes; and that diagnostic and recording standards were maintained over time.

Rates of chlamydia test positivity increased from 1998 to 2008 in New Zealand, and were remarkably consistent with increases in test positivity over time in Denmark and Sweden, with all three countries having relative high testing rates (Figure 10-1)\textsuperscript{273}. This finding is in
agreement with the finding of increasing test positivity among women attending a large sexual health clinic in Australia [165]. It has been suggested that the true prevalence of chlamydia is rising despite current control efforts [165]. However, such trends are at variance with reports of falling test positivity in the UK in the context of a screening programme and in the US [275,331], highlighting again the difficulty of attributing causality to ecological trends. Changes in chlamydia test positivity may simply reflect variations in the risk-profile of the screened population. For example, a greater emphasis on repeat testing following a diagnosis of chlamydial infection may result in a greater emphasis on testing those at risk of repeat infections and hence contribute to higher test positivity. More reliable evidence of underlying changes in prevalence necessitates serial population-based prevalence studies, which are only available for the US. The NHANES survey has been repeated every two years since 1999 in the US and provides useful information about chlamydia prevalence trends in the general population over time [148]. Although falling test positivity has been reported from clinical settings in the US [332], there has been no significant change in chlamydia prevalence among females aged 14 to 25 years participating in NHANES.

In summary, most of the increase in reported chlamydia cases from 1998 to 2008 in New Zealand can be attributed to increased testing and detection with hospital admission disease trends for PID and ectopic pregnancy remaining stable over the same period. However, rates of chlamydia test positivity also increased from 1998 to 2008, although it is not clear if this reflects changes in chlamydia prevalence or better targeting of testing towards those more likely to be infected. Worryingly, hospitalisation rates for PID remain high and are much higher than in comparable countries, such as Australia. The use of the ICD-10 A56.1 code in New Zealand suggests a substantial amount of PID hospitalisations among young women in 2008 reflected chlamydial-related pelvic infection. The rise in PID hospitalisations among women aged 15-24 years from 2005 to 2008, coincident with a substantial increase in reported chlamydia cases among the same-age group, and rising rates of chlamydia test positivity, is a concern. While there are acknowledged limitations to ecological analyses, the research presented in this thesis suggests considerably more needs to be done to improve reproductive health outcomes for young women in New Zealand.

**Chlamydia screening coverage and repeat testing rates**

Screening coverage is defined as the proportion of those eligible for screening who have been screened at a given point in time and is an efficacy measure of how well screening has been targeted to the eligible population. Guidelines recommend annual chlamydia screening of sexually active women less than 25 years of age, even though the optimal interval for regular testing is not yet well defined. The recommendation for annual testing is based largely on mathematical modelling studies; these suggest that very high annual
coverage of sexually active women under the age of 25 years, or 30-40% of same-age men and women, should lead to a decline in the prevalence of chlamydia infection, even though there will always be some uncertainty as to the validity of predictions based on mathematical models \cite{196,333,334}. Also, as reviewed in chapter one, those who test positive for chlamydia are at considerably higher risk of subsequent chlamydia infection within 12 months than those who test negative \cite{93,97-100} and most guidelines encourage repeat testing within 12 months following a positive diagnosis. The optimal interval for repeat testing after treatment to detect re-infection is not yet well defined and, as a result, the suggested timing varies between countries.

Overall population testing rates for \textit{C. trachomatis} in New Zealand in recent years are believed to be relatively high \cite{115} but annual testing coverage by age or other demographics are not collected in routine surveillance. Our analysis of three years of laboratory testing data in the Waikato DHB estimated a testing coverage of 45% among women aged 15 to 24 years in 2010, which is among the highest reported annual coverage rates internationally and in keeping with annual coverage rates reported from two other districts of New Zealand \cite{269,335}. As a comparison, the English national chlamydia screening programme reported annual coverage of 42.7% of eligible young women in 2010 \cite{248}.

However, this reported UK rate might have been lower if repeat testing within the same year had been taken into account, as it was in our New Zealand study. The importance of identifying and removing duplicate laboratory tests is highlighted by our finding that inclusion of subsequent tests, performed within 12 months of the initial test, significantly over-inflated the annual coverage estimate in the Waikato DHB (Table 10-2). Notably this finding was observed after exclusion of short interval duplicate tests, which were presumably performed to document post-treatment cure. Population coverage estimated from the number of chlamydia tests performed will, of course, always overestimate the number of people tested each year because of repeat testing. Nonetheless, levels of repeat testing have generally been believed to be low, despite guideline recommendations \cite{336}.
Key Findings:

- Population coverage estimated from the total number of chlamydia tests performed significantly inflates estimates of the number of women tested each year in the Waikato DHB, because of moderately high levels of repeat testing.
- Testing coverage among women aged 15 to 24 years within the Waikato DHB is high. Exclusion of repeat tests resulted in an estimated coverage of 30.7% during 2010; 32% lower than the estimated coverage of 45% if the total number of tests was used as the numerator.
- Young men are considerably less likely than women to be tested for *C. trachomatis* in the Waikato DHB. Testing coverage among men aged 15 to 24 years, excluding repeat tests, was 5.9% in 2010; 16% lower than the estimated testing coverage of 7.1% if the total number of tests was used as the numerator.
- Rates of repeat testing across a three year period in the Waikato DHB were higher among women, in younger age groups and following a positive rather than a negative baseline test.
- Rates of repeat testing following an initial positive test were higher among women compared to men and among those of younger age.
- Testing coverage was similar or higher for Māori across different age-bands and for men and women; however, test positivity for Māori was twice that of non-Māori and rates of repeat testing following a positive result were lower than for non-Māori.
- The risk of testing positive on repeat testing was approximately four times higher among 15 to 44 year olds who initially tested positive compared to those who initially tested negative (37.2 per 100 person years vs. 8.9 per 100 person years).
- The risk of testing positive on repeat testing was also higher among those of younger age (41.6 per 100 person years in those aged 15-19 years, 27.3 per 100 person years in those aged 20-24 years, 22.9 per 100 person years in those aged 25-34) and among Māori (40.6 per 100 person years vs. 27.2 per 100 person years for non-Māori).

Very low repeat testing rates would be unlikely to impact significantly on coverage estimates based on overall testing volumes. However, chlamydia testing volumes have increased over recent years and it could be expected that repeat testing may also have increased. The research included in this thesis show that repeat testing rates from 2008 to 2010 in the Waikato DHB were not insignificant. This is consistent with recent reports of moderate levels of repeat testing in Australian sexual health clinics and in areas of the English chlamydia screening programme, with the latter noting repeat testing increased over time in
 Cornwall from 2003 to 2009 [275,278]. This change over time means it is now imperative to be able to report screening coverage using the number of eligible individuals tested as the numerator, rather than simply the number of tests performed, in order to monitor efficacy and equity of chlamydia screening and to more accurately monitor test coverage trends over time. Our findings have important implications for routine STI surveillance in New Zealand and will inform plans to improve the current surveillance system.

Our data show that chlamydia testing in New Zealand is very inequitable with regard to gender. Young women resident in the Waikato DHB were five times more likely to be tested for *C. trachomatis* (30.7% vs. 5.9%) and women were 2.7 times more likely to have repeat testing following a positive diagnosis (Table 10-2). In 2000, ten times more chlamydia tests were received from women than from men at a community laboratory in Auckland and, between 1999 to 2005, women in the Wellington region of New Zealand were about five times more likely to be tested than men [309,335]. As a comparison, women aged 16-29 years attending general practices in Australia were 2.5 times more likely to be tested than men (12.1% vs. 4.8%) and test coverage estimates in 2010 were 1.9 times higher for women than men in the English national chlamydia screening programme (42.7% vs. 22.6%) [213,248]. Lower rates of testing but higher test positivity rates for men resident in the Waikato DHB suggests a focus on symptomatic management or on those with a higher risk profile, rather than on opportunistic screening. It is also possible that men who are known contacts of people diagnosed with chlamydial infection are given treatment without testing in primary care, which would contribute to lower rates of testing.

Should New Zealand be screening more young men? Guidance for New Zealand’s health care providers published in 2003 recommended offering opportunistic testing to all sexually active people under the age of 25 [252]. National chlamydia management guidelines, published in 2008, have been more circumspect, acknowledging there is insufficient published evidence to recommend routine testing for chlamydia among all asymptomatic sexually active young men [85]. As discussed in chapter one, the reproductive tract consequences of chlamydia are more common in women than in men. Randomised controlled studies of screening have therefore focused mainly on women and there has been much less research on the direct benefits of chlamydia screening in men. Hence, although the national chlamydia management guidelines in New Zealand advocate that opportunistic testing is discussed with all young sexually active people under the age of 25 years and that testing should be offered to all sexually active females under 25 years of age, it is recommended that testing for asymptomatic young men be targeted to those with a higher risk profile and higher probability of infection; this is defined as age under 25 years and either two or more sexual partners in the last year or a recent partner change or a co-infection with another STI [85].
However, it is possible that screening asymptomatic young men for chlamydia may make a significant contribution to preventing the adverse consequences of chlamydia in young women, by reducing the spread of the infection in the community. Mathematical modelling predicts that, when chlamydia screening coverage of women is very high, for example greater than 80%, increasing contact tracing and treatment of male partners of women with diagnosed chlamydia has a greater impact on the prevalence of *C. trachomatis* infection among women than screening males. However, if chlamydia screening coverage among young women is not high, a combination of screening of both men and women, and contact tracing and treatment of partners, is necessary to significantly reduce the prevalence of *C. trachomatis* infection among women. If the goal of chlamydia control programmes in New Zealand is to reduce the prevalence of *C. trachomatis* infection and its associated complications at a population level, then either chlamydia screening among young women (and effective treatment of their partners) needs to increase substantially, or both men and women need to be screened and treated.

Differences in health-seeking behaviour between young men and young women may result in fewer testing opportunities for young men. Fewer young men than young women visit their GP in New Zealand each year. The 2011/12 New Zealand health survey found that 65% of 15 to 24 year old male respondents, and 78% of 15 to 24 year old female respondents, reported that they had visited a GP and/or a practice nurse in the last 12 months for any reason. Similarly, a birth cohort study found, at age 21, more New Zealand women than men with five or more partners in the previous year had visited their GP over that period (75.8% v 50.7%, p<0.05). Nonetheless, considerably lower chlamydia testing rates among young men than in same-age women in the Waikato DHB suggest that visits to the GP and/or practice nurse are significantly more likely to result in testing for chlamydia in women than in men.

Chlamydia testing rates and of repeat testing across a three year period among residents in the Waikato DHB were highest in younger women but 44% of all tests were from women aged 25 years or older during that period, with rates of chlamydia test positivity declining with increasing age. Similarly, from 1999 to 2005, nearly 60% of all chlamydia testing in the Wellington region of New Zealand was among women aged over 25 years. This issue is not unique to New Zealand. In Victoria, Australia, during 2004, men and women aged over 25 years were more likely to be tested than men and women aged 15 to 24 years. Similarly, before widespread implementation of the national chlamydia screening programme in England, chlamydia testing in primary care settings disproportionately targeted women aged 25 years and older. While some of this testing may be appropriate, lower chlamydia test positivity among older age-groups suggests there are opportunities to better target chlamydia testing to those with greater risk of infection.
A concern is whether chlamydia testing coverage is equitable for Māori, given that Māori are more likely than non-Māori to report health service access issues and unmet health needs, such as being unable to get an appointment within 24 hours or being unable to attend due to cost and/or lack of transport. Overall population testing rates for *C. trachomatis* are routinely reported for most of New Zealand but testing coverage by demographics, such as ethnicity, are not collected in surveillance data and cannot be monitored routinely. Our analysis of three years of laboratory testing data in the Waikato DHB found that chlamydia testing coverage was similar or higher for Māori across different age-bands, for both men and women. Rose et al. recently reported similar findings that chlamydia testing coverage was slightly higher for Māori than for New Zealand-born Europeans in Wellington during 1999–2005, after allowing for age and socioeconomic deprivation.

This in turn raises the question as to whether chlamydia testing is preferentially offered to Māori, given known lower rates of primary healthcare access and utilisation might provide fewer testing opportunities for Māori. Differential selection in opportunistic chlamydia screening, of those of ethnic minority or low socioeconomic status, has been reported in the UK and in the US. Alternatively, Māori may preferentially access health providers who are more likely to offer opportunistic chlamydia testing. For example, an audit of chlamydia testing in the Waikato DHB in 2008, undertaken to generate baseline data for provider feedback during clinical guideline implementation, found that more GP-requested chlamydia tests were from GPs funded to provide free sexual health consultations than from GPs who charged user fees. In addition, more GP-requested chlamydia tests for Māori were from GPs funded to provide free sexual health consultations than from GPs with very low-cost access initiatives, such as iwi providers, or from GPs with standard user fees (64% vs. 21.3% and 14.6%, respectively). Arguably, differential selection in opportunistic chlamydia screening may simply reflect the purposive location of free sexual health care services in areas of perceived higher need within the Waikato DHB. However, more information, such as health care utilisation across all available chlamydia testing venues (including the family planning clinic, the sexual health clinic, high-school clinics, and tertiary education clinics as well as general practice), is needed to answer this question.

Another area for further research is to better understand our new finding that rates of repeat testing following a positive result were lower for Māori than for non-Māori. This may reflect lower healthcare utilisation and fewer opportunities for repeat testing for Māori but is at variance with equitable or higher rates of initial chlamydia testing, raising concerns as to the acceptability of the initial screening process for those involved. There is limited information on the views of those who have undergone chlamydia screening in New Zealand, particularly rangatahi Māori, as to the acceptability of being screened or of the impact of a positive diagnosis, and this is an issue that requires further attention.
Previous infection is highly predictive of enduring risk and repeat testing after a positive chlamydia diagnosis is gaining emphasis as a means to identity those at greater risk of infection and to better target chlamydia control efforts. In our analysis of three years of laboratory testing data, the risk of testing positive on repeat testing was approximately four times higher among 15 to 44 year olds in the Waikato DHB who initially tested positive compared to those who initially tested negative (37.2 per 100 person years vs. 8.9 per 100 person years), with 17% having a repeat positive test within 6 months. As a comparison, two recent studies of repeat chlamydia testing in the UK, which used similar methodology to our study, found that the risk of infection on repeat testing was approximately twice as high among those who initially tested positive compared to those negative.

There is significant bias to secondary analysis of testing datasets, however, as only those who have repeat testing are included and it is not known whether those who initially tested positive and were not re-tested have a similar risk. Also, the rates of repeat testing within a year were lower in the UK studies than in our setting, which may further bias results. Even so, our results are consistent with international findings that re-infection with chlamydia is common. High rates of repeat chlamydial infection might explain high rates of PID hospitalisations and ectopic pregnancy in New Zealand. However, it is unknown whether the rate of re-infection with *C. trachomatis* is as common, or more common, among young New Zealand women than reported overseas and this is an important area for future work.

As discussed in chapter one, international literature suggests that chlamydia prevalence varies by race and/or ethnicity. Differences have also been noted in clinic- and community-based cross-sectional surveys in New Zealand, with higher rates for Māori and Pacific peoples, although under-representation by ethnicity is a common bias in most studies. Approximately 25% of chlamydia tests (18601/73879) among 15-44 year olds in the Waikato DHB were from Māori, suggesting less bias from small sample size in our study, although it is important to note that chlamydia test positivity reflects those being tested, rather than true population prevalence, and needs to be interpreted with caution.

Nonetheless, our finding that chlamydia test positivity for Māori was twice that of non-Māori is consistent with previous findings in New Zealand.

Similar findings of higher test positivity are reported for indigenous peoples in Australia and North America, with racial and/or ethnic differences in chlamydia positivity persisting after adjustment for socioeconomic status. In addition, our analysis suggests the risk of testing positive on repeat testing was higher for Māori (40.6 per 100 person years vs. 27.2 per 100 person years for non-Māori) although it remains unknown whether the rate of re-infection with *C. trachomatis* is more common among rangatahi Māori than young non-Māori in New Zealand. Of concern also is that the rate of repeat testing following a positive result was lower for Māori in our district, which will likely mean missed opportunities for
early detection and treatment of re-infections, prevention of sequelae and prevention of ongoing transmission.

In summary, repeat testing in our district significantly inflates estimates of the number of people tested each year, when using total tests as a numerator. The proportion of women tested each year is not as high as suggested by total test numbers which, coupled with low testing rates for men, means the annual chlamydia testing coverage among those aged 15 to 24 years within the Waikato DHB in 2010 had not yet reached levels predicted to impact on either population prevalence or reproductive sequelae. This may explain our findings of stable hospitalisation rates for PID and ectopic pregnancy in the upper North Island of New Zealand during 1998–2008. In practice, opportunistic testing within the district appears inequitable and inefficient with lower rates of repeat testing among those more likely to be positive, yet ongoing high rates of testing among those less likely to be positive, such as older women.

High repeat test positivity is a concern and may indicate high rates of re-infection for young women. High rates of chlamydia re-infection could be expected to be associated with a high rate of PID, and it is notable that PID hospitalisations among 15-24 year old New Zealand women were more than three-fold that of same-age Australian women in 2008. However, there are still gaps in current knowledge, and further research is needed to determine chlamydial re-infection rates and elucidate the aetiology, diagnosis and management of PID in primary care in New Zealand.

Interventions to increase chlamydia testing rates in primary care settings

Following a landmark trial published in 1996 showing a reduction in PID amongst at-risk women screened for C. trachomatis [189], numerous clinical guidelines recommended chlamydia screening, yet testing of at-risk women remained low in most countries. However, by 2006, Ginige et al. identified only four controlled studies that assessed the effectiveness of interventions aimed at improving chlamydia screening rates in primary health care settings, as mentioned in chapter one [225]. These included the use of an educational video and text package to improve Belgian primary care clinicians’ communication skills and ability to discuss sexual history taking [226]; an Internet-based continuing medical education (CME) programme in the US [227]; a health adviser employed in primary care for six months in Scotland to improve provider and patient awareness of chlamydia screening and non-invasive testing [228], and a multifaceted clinical improvement initiative in the US that audited current practice, addressed clinic-based and provider barriers to chlamydia screening, offered testing to all adolescents on registration, and provided regular feedback on performance indicators [229]. Three of the interventions were associated with increased screening rates [226,228,229] and one was associated with a lesser decline in screening rates in the intervention group when compared to the control group [227].
The interventions in all four aforementioned studies aimed to increase the likelihood that providers would offer chlamydia testing. Most young people attend primary care each year, thus creating an opportunity to be offered screening. However, adolescents may face a number of barriers in accessing healthcare for their health concerns, and these issues need to be considered as well. Concerns include cost, lack of available services or lack of awareness of available services, lack of transport, concerns about quality, privacy and confidentiality, and not feeling comfortable with the health care provider. Cost is particularly pertinent to delivery of health care in New Zealand. Following primary health care reforms in 2002, GPs received extra government subsidies to offer free services for children under six and to offer a range of lower charges for other patients but user co-payments still exist. That cost is a barrier is supported by our finding that practices who received additional funding to provide free sexual health consultations for registered under-25 year olds tested significantly more women aged 18 to 24 years than previously (Table 10-3). Further, there was no increase in chlamydia testing amongst those aged 25 years and older at intervention practices and testing rates among those aged 18 to 24 years were unchanged at practices without free sexual health consultations.

Table 10-3 Key findings of an observational study of General Practice funding to improve provision of adolescent primary sexual health care and of a study of chlamydia testing volumes following clinical guideline implementation

<table>
<thead>
<tr>
<th>Key Findings:</th>
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<tbody>
<tr>
<td>During 2003 to 2005, the majority of all <em>C. trachomatis</em> tests undertaken by the Waikato DHB GPs were among women. Practices who received additional funding to provide free sexual health consultations for registered under-25 year olds tested more women aged 18 to 24 years during the roll-out phase of the funding initiative in 2004, with the increase sustained over time: 13.9% in 2003, 16.8% in 2005.</td>
</tr>
<tr>
<td>Chlamydia testing was much lower among registered men aged 18 to 24 years but increased with the provision of free sexual health consultations, from 3% in 2003 to 4.2% in 2005.</td>
</tr>
<tr>
<td>There was no increase in chlamydia testing amongst those aged 25 years and older at intervention practices; testing rates among young women (13%) and young men (2%) aged 18 to 24 years were also unchanged at practices without free sexual health consultations.</td>
</tr>
<tr>
<td>During 2008 to 2010, there was no significant change in district-wide chlamydia test volumes in the Waikato DHB following the introduction of primary care chlamydia management guidelines in 2009.</td>
</tr>
<tr>
<td>Focus group discussions and practice audits highlighted the pivotal role of the primary care nurse in delivering sexual health care in the Waikato DHB.</td>
</tr>
</tbody>
</table>
However, although our study ostensibly addressed cost as a barrier to healthcare by providing free consultations, access was not measured as an outcome. A notable weakness was that we were not able to demonstrate any change in primary care utilisation associated with the intervention because of a lack of baseline age-specific utilisation data from all the practices involved. Subsequent service utilisation data for the practices funded to provide free consultations reported that approximately 23% of enrolled under 25 year olds had free sexual health consultations each year, with claims relating to 4778 of 21015 (22.7%) 13 to 24 year olds in 2008-9, the same percentage uptake as during the previous three years [341]. It is likely that not all 13 to 24 year olds registered with these practices were sexually active; nonetheless, this moderate level of uptake of free sexual health consultations raises questions as to whether there is a lack of awareness of free GP consultations among young people in the Waikato DHB or whether aforementioned barriers, such as concerns over confidentiality or quality, persist. Although there were pre-implementation focus group discussions with young people in the Waikato DHB in 2004, there is no recent information either about young peoples’ awareness of free consultations or of their views as to how to increase utilisation of free primary sexual health care within the Waikato DHB.

It is possible that the additional funding did not improve access or increase utilisation but rather served as an incentive for primary health care providers to offer sexual health care, for example, to be able to offer a free consultation if a young person attending for any reason also received contraception or was screened for *C. trachomatis* during the same consultation. Although financial incentives have been used for many years to improve the quality of care in general practice, there is little published literature regarding their use and much of what is published is contradictory, possibly because impact relates to the perceived value of the financial incentive [342].

One systematic review of provider financial incentives identified only eight financial intervention studies during 1996 to 2002 and found that only one led to a significantly greater provision of preventive health services [342]. However, the review excluded studies using any multi-faceted interventions in which a financial incentive was only one component of the intervention. Observational data from the UK suggests financial incentives may be effective for increasing chlamydia screening among young women. General practices were offered a financial incentive of £10-25 per chlamydia test as part of the pilot chlamydia screening programme in two areas of England during 1999/2000, with high test uptake reported, and approximately 50% of the eligible population were screened [246]. Again, the multi-faceted nature of the chlamydia screening pilot made it difficult to ascertain any specific impact of the financial incentive component. Nonetheless, much lower testing rates following the introduction of the national chlamydia screening programme in England in 2003 were attributed to the discontinuation of the financial incentive and a lack of
remuneration for GPs\(^{[10]}\). A recent randomised controlled trial of offering Australian GPs $AUD5 per chlamydia test did not, however, increase chlamydia testing, possibly because the small financial reward did not outweigh other issues such as perceived time constraints for providers\(^{[343]}\).

Our study did not offer a direct financial incentive to the provider, but rather may have enabled the offer of an incentive to the patient by not charging a consultation co-payment. Young people have expressed opinions that a financial incentive would increase their likelihood of testing for \textit{C. trachomatis}\(^{[199,203,204]}\), although there is little published literature about its effectiveness as an intervention for chlamydia screening. Nonetheless, some areas of the national chlamydia screening programme in England have used a variety of patient incentives, including confectionary, condoms, branded underwear, £5-£10 vouchers and £50-£2000 prize draws, in an attempt to increase chlamydia testing rates\(^{[344]}\). An observational study, assessing the impact of monetary value incentives on chlamydia screening rates, found coverage increased more over time from 2007-2009 in areas that offered £5-£10 vouchers, but not in areas offering prize draws, compared to areas with no financial incentives. However, the absolute increases in screening coverage were modest, with an average 0.43% increase in screening coverage in areas with any financial incentive. The authors concluded that, in the current climate of financial austerity, patient financial incentives are unlikely to be a sustainable and cost effective intervention\(^{[344]}\). In addition, although patient financial incentives are increasingly being used in other health areas such as drug misuse, to encourage health-seeking behaviours, there are moral and ethical concerns about their use that are yet to be fully addressed\(^{[345]}\).

Two other New Zealand studies that aimed to increase opportunistic chlamydia screening among under 25 year olds attending general practice have been published since the completion of our study of additional primary care funding\(^{[128,346]}\). The interventions for both studies were based on the aforementioned multi-faceted ‘systems approach’ intervention shown to be effective overseas\(^{[229]}\) and tailored to each setting. Both interventions were associated with increased screening, although only one study assessed ongoing impact and found that testing rates returned to baseline when input from the project team stopped\(^{[128]}\).

In the first of these studies, Lawton et al. assessed opportunistic chlamydia screening among under 25 year olds attending general practice in Wellington during 2007\(^{[128]}\). Study design included an intervention at two practices that: involved the providers in design and implementation; offered self-sampling to under 25 year olds; and provided regular monitoring and feedback of screening rates over the three month intervention period. In addition, the two intervention practices received additional lump-sum payments for study participation and were also regularly reminded to claim reimbursements for sexual health
consultations. All general practices in the study region were eligible to claim for co-payment reimbursement for sexual consultations by registered under-25 year olds but only the intervention practices were reminded to do so. One of the intervention practices opted to offer screening during doctor consultations only whereas a ‘champion’ nurse identified eligible patients and encouraged all clinicians to offer screening in the other intervention practice. During the second three months of the study, there was no feedback of testing rates or any contact with the research team.

The two intervention practices screened significantly more 16–24 year olds during the three-month active phase of the intervention than before and in comparison to the single control practice (no intervention), with the nurse-led approach being more effective than the doctor-led approach. Screening at the nurse-led intervention practice increased from 5.1% to 35.1% of 16–24 year olds during the first month of the intervention but steadily fell thereafter, despite the ongoing intervention. Similarly, testing at the doctor-led intervention practice increased from 2.9% to 15% during the first month but steadily fell thereafter. There was no change in testing at the control practice. Testing rates returned to baseline within three months of the active intervention phase, with participating staff reporting that they stopped offering screening because the study had stopped [128].

In the second study, Azariah et al. reported high screening coverage during a pilot study that aimed to increase opportunistic chlamydia screening among under 25 year olds in general practice in Auckland [346]. A local primary health organisation agreed to fund free sexual health consultations for enrolled under-25 year olds in ten affiliated general practices for the four-month study period; the practices were purposively selected because of relatively high proportions of enrolled eligible age Māori and Pacific people. Study design was again based on the aforementioned multi-faceted ‘systems approach’ intervention [229] and included: involving providers in design and implementation; additional training; scripted suggestions on how to offer chlamydia testing; awareness materials in the waiting room and printed resources for patients; a standardised case management template in the patient management system; and telephone support from sexual health clinic staff. All sexually active under 25 year olds were offered chlamydia testing by a practice nurse during triage prior to a GP consultation.

The intervention ran for four-months during 2010-11. During the intervention period, 3687 patients in the target age group were triaged by the ten intervention practices and 46% (1715) were tested for chlamydia; 66% (1124) eligible age women and 34% (591) eligible age men. Of those screened, 17.5% (300) tested positive. Analysis was limited by being unable to accurately ascertain baseline testing rates for the eligible age-group, although laboratory reporting confirmed overall chlamydia test volumes from the intervention practices increased by 300%, compared to the same four-month period 12 months earlier,
and the proportion of tests from men increased from 18% to 29% of total chlamydia tests. Other limitations included the purposive selection of the intervention practices, lack of control settings and that testing rates were not reported beyond the implementation period.

It is possible that the greater screening coverage for under 25 year olds attending GPs in the Auckland study than for those attending GPs in the Wellington study reflected ensuring a universal offer of chlamydia testing to all eligible aged patients [128,346]. However, methodological issues and different study populations limit the comparisons and interpretations that can be made. Since the systematic review by Ginige et al. [225], more interventions aiming to improve chlamydia screening rates among eligible-aged young people attending primary health care have been studied internationally. A recently updated systematic review of the effectiveness of these interventions identified 16 interventions in 15 randomised or observational controlled studies among young women [347]. Of these, six interventions were associated with significant increases in screening rates: a multifaceted clinical improvement initiative in the US that audited current practice, addressed clinic-based and provider barriers to chlamydia screening, offered testing to all adolescents on registration, and provided regular feedback on performance indicators [229]; Internet-based continuing medical education in the US [227]; linking screening to routine cervical screening Pap smears in Australia [348]; computer reminder alerts for doctors in Australia [349]; education workshops for clinic staff in the UK [350]; and free sexual health consultations in New Zealand [272].

Two additional intervention studies reported increases in screening. These were: employing a health adviser in primary care for six months in Scotland to improve provider and patient awareness of chlamydia screening and non-invasive testing [228] and the introduction of a multi-faceted quality improvement programme in Australia [351], but neither study included sufficient data or statistical analysis to demonstrate whether the reported increases were significantly different from control groups. The remaining eight interventions that did not result in a significant increase in chlamydia screening among women included: clinician referral of patients to an interactive website called ‘Youth Check Your Risk’ in Australia [352]; a $AUD5 health provider incentive in Australia [343]; an educational video and text package to improve providers’ sexual history taking skills in Belgium [226]; laboratory forms modified to include information about chlamydia screening in the UK [350]; a written chart prompt in the US [353]; a multifaceted quality improvement programme in the US [353]; and screening recommendations and provider training in the US [354].

Of the six interventions targeting men, only two found significant increases in screening rates; these were the aforementioned multifaceted quality improvement programme in the US [229,319] and a routine test offer to all young men in Denmark when attending their doctor for any reason [355]. Overall, for both men and women, the greatest impact on testing rates
occurred with interventions that led to changes to practice-related systems, such that all eligible patients were routinely offered screening \[^{[347]}\]. For example, following the multifaceted quality improvement initiative in the US that included a universal offer of testing, 47% (478/1194) of eligible young women were screened at intervention practices, compared to 17% (203/1194) at control practices \[^{[229]}\]. The intervention was subsequently implemented in the control practices and all practices had sustained high chlamydia testing rates four years later \[^{[356]}\].

In light of this more recent evidence, both in New Zealand and internationally, and the acknowledged barriers to guideline adherence discussed in chapter one, it is not surprising that clinical guideline implementation during 2009 in the Waikato DHB was not associated with further significant increases in district-wide testing. Although implementation involved quality improvement aspects, including feedback of baseline testing volumes, provider-led audit of case management, and continuing education, implementation did not address system-related barriers and notably did not ensure all eligible patients would be routinely offered chlamydia screening.

However, a limitation in our analysis was that any impact of clinical guideline implementation on chlamydia testing was evaluated at a district-wide level, rather than by-provider or by-practice setting, and may have missed changes in testing at settings that were more directly involved with the quality improvement aspects of implementation. In reality, it was difficult to determine exactly who, of all the Waikato DHB health providers submitting chlamydia tests, should be considered to have had direct involvement. For example, settings varied as to how baseline testing (which was determined at a practice-level, not at a provider level) was fed back to staff and as to how they carried out the audit of chlamydia case management; some shared the provider-led case audit between several doctors and nurses, whereas, in other settings, one nurse reviewed all cases. Some GPs and practice nurses were involved in pre-implementation focus group discussions, but not in the audit process. Even so, it is more likely that our approach to guideline implementation was not sufficient to address persisting provider barriers to chlamydia screening.

In summary, past local initiatives, such as the provision and purposive location of free sexual health services and previous continuing medical education sessions, have contributed to moderately high screening coverage among young women in the Waikato DHB prior to guideline implementation in 2009. However, coverage of 30.7% in 2010 is still below the level modelled to impact on reproductive adverse outcomes, or population prevalence by screening only women, and is significantly lower than, for example, 50% testing rates among eligible young women in the UK chlamydia screening pilots.
The available evidence suggests that the more challenging tasks, to further increase and sustain screening coverage for young women, and to substantially increase screening in young men from 5.9% in 2010, will require fundamental changes to current clinical practice and clinic systems in the Waikato DHB. Greater screening coverage is unlikely, unless primary care providers prioritise a routine, universal screening offer to all under 25 year olds who attend health-care.

Since 2009, national health targets in primary care have focused on infant immunisation and non-communicable chronic disease prevention and management[^357]. Adolescents and marginalised health issues, including sexual health, are largely invisible in current New Zealand government policy. In the face of many competing demands, and with financial incentives to meet the current national health targets, it is unlikely that New Zealand district health boards or primary care providers will prioritise chlamydia screening without financial reimbursement or other incentives.

**Improving case management for *Chlamydia trachomatis* infections**

Identification of asymptomatic chlamydial infections has been the focus of chlamydia control efforts in many countries for some years, with the dual goals of reducing associated morbidity for the infected individual and reducing new cases of infection. However, screening for *C. trachomatis* without ensuring appropriate treatment or effective partner notification will not achieve these goals and all aspects of case management need to be considered.

Our study was the first New Zealand multi-setting and district-wide audit that compared observed case management with proposed national clinical guidelines for managing genital chlamydial infections, and helped identify issues to improve case management in our district. In general, appropriate sampling was used for diagnosis, clinicians prescribed recommended first line treatments and most patients had timely treatment prescribed (Table 10-4).
Key Findings:

- Health providers used appropriate sampling for diagnosis in women; most used appropriate urine sampling for men but it was notable that 20% of asymptomatic men were diagnosed by a urethral swab sample.
- Health providers prescribed recommended first line treatments and most patients had timely treatment, with documentation indicating that 84% had treatment prescribed within 14 days. However, there were avoidable delays with providers often waiting for laboratory confirmation rather than initiating early treatment among patients likely to have chlamydia infection, such as those who were known to be sexual contacts of chlamydia cases or symptomatic males with urethral discharge.
- Higher rates of positive chlamydia tests have been reported after treatment in pregnancy and, given the risk of neonatal transmission, a routine test of cure is recommended: few pregnant women (17.8%, 8/45), however, had any documentation in their medical record that they had been advised to have a test-of-cure or that this had happened.
- There was limited documentation in most medical records around partner notification and outcomes; for non-sexual health clinic cases, 76/394 (19.3%) documented that all identifiable partners had been advised, 41/394 (10.4%) noted partner treatment as advised by the index patient and partner treatment was noted as verified by a healthcare worker in 8 (2.0%) cases.
- Men were more likely to be treated immediately; the median time to treatment for women was double that of men and women were less likely to have any documented treatment for their infection.
- Lack of documented treatment or failure to attend for treatment was also more likely for Māori than non-Māori; although the numbers affected were small, this occurred for more than one of every seven Māori compared to less than one in twenty non-Māori.
- The introduction of text messaging as a means of faster communication did not improve the median time to treatment for sexual health clinic patients who were not given treatment for chlamydial infection at the time of their initial consultation (7 days in 2005, 7 days in 2007).
Although 73% of treatment was prescribed rather than dispensed, there was little documented follow-up after treatment and little documentation regarding likely adherence to prescribed medications. Notably, one local GP always dispensed medication after an audit of her own practice in 2006 confirmed high rates of failure to have prescriptions dispensed amongst high school students under her care\(^{[358]}\). Students attending three high school-based health clinics, all in rural socioeconomically deprived areas of the Waikato DHB, anecdotally reported a lack of nearby pharmacy services, a lack of transport, and/or prescription costs as barriers to treatment. All prescriptions from the three school-based clinic electronic databases were retrospectively linked with dispensing claim information provided by the Ministry of Health to estimate the proportion of prescriptions that were dispensed. Most of the prescriptions were for contraceptives and antibiotics. Overall, almost 40% of all prescriptions generated during one school year were not dispensed, ranging from 31% to 48% across the three school settings.

Although this small retrospective audit was of only one provider, the findings are in keeping with international literature that 20 to 30% of medication prescriptions are never filled\(^{[359]}\). Many factors influence medication non-adherence. Cost is one issue: almost 11% of 18-24 year old New Zealand adults participating in a recent national health survey reported that they had not filled one or more prescription items in the previous year due to the cost, with Māori being nearly three times as likely as non-Māori to report this unmet health need\(^{[210]}\).

Lack of transportation and access to available pharmacy services are consistent themes for people living in rural settings\(^{[360]}\). In addition, international literature suggests that people typically take less than half the prescribed doses of even short-course medications\(^{[361]}\). Ensuring appropriate treatment for diagnosed chlamydial infections is important and a greater emphasis on directly dispensed therapy with single-dose azithromycin may be an effective ongoing intervention to help overcome adherence difficulties faced by young people in New Zealand.

Clinical guidelines recommend prompt treatment for \textit{C. trachomatis} infections, particularly as delays in receiving appropriate therapy are known to be associated with complications such as PID for some patients\(^{[36]}\). In our audit of chlamydia case management, known contacts of chlamydia cases had the shortest median time-to-treatment (1.3 days), while asymptomatic cases diagnosed by provider-offered testing had the longest median time-to-treatment (7.5 days). However, there were avoidable delays with providers often waiting for laboratory confirmation rather than initiating immediate treatment among patients highly likely to have chlamydia infection, such as known contacts or symptomatic males with urethral discharge. Not surprisingly, those not treated immediately were also less likely to receive documented treatment for their infection. In addition, lack of documented treatment
or not returning for treatment was more likely for Māori than non-Māori, although the numbers affected were small. This occurred for more than one of every seven Māori with chlamydial infection compared to less than one in twenty non-Māori.

The challenge of ensuring timely treatment for chlamydial infections is not unique to New Zealand and there is considerable international interest among STI health professionals in having a high quality, rapid point-of-care diagnostic test for *C. trachomatis* to help address this issue [362]. However, there are concerns about the low sensitivity of currently available point-of-care nucleic acid amplification tests [363,364]. The World Health Organisation has a priority programme to develop affordable and reliable point-of-care tests for STIs prevalent in low resource countries, with particular focus on the diagnosis of syphilis, gonorrhoea and chlamydial infections, and it is hoped that more reliable, rapid, point-of-care tests will soon be available [363].

In the absence of an adequate point of care test, optimising early detection and treatment of asymptomatic *C. trachomatis* infection involves: prioritising assessment and treatment of known contacts; rapid turn-around of laboratory testing and results; and prompt notification and effective treatment for those who test positive. Studies of factors affecting time to treatment for asymptomatic chlamydial infection have found early treatment to be strongly associated with being an identified contact, reflecting that treatment was more likely to be given at initial assessment [305,306,308]. Longer time to treatment for asymptomatic chlamydial infection was found to be more likely for settings with laboratory reporting delays. The method of informing patients of a positive result was also significant in determining interval to treatment, with notification by letter being associated with the greatest treatment delay [305,306].

Rapid communication with patients has been facilitated by the growth in the use of mobile phones and the Internet over the last decade. In 2011, at least 86% of the New Zealand population had Internet access at home, up from 83% in 2009 and 79% in 2007 and 85% had a personal-use mobile phone in 2009, up from 80% in 2006 [365,366]. Short message (or messaging) service, known as SMS, is a system that enables mobile phone users to send and receive text messages and use of this particular application has grown exponentially over the last decade. Over the same period, a growing number of health care interventions have tried to take advantage of the increasing availability of these technologies. A systematic review identified 127 studies relating to the use of SMS in health care by the end of 2009, including our study of notifying test results [367]. The review concluded that, in general, SMS health care interventions are feasible, acceptable and efficacious in delivering preventative health messages and improved clinical outcomes [367]. There is also a growing body of specialty-specific literature on the use of SMS for health promotion and management of STIs, and many STI clinics now use SMS to promote prevention messages,
increase adherence to clinic appointments, facilitate test result notification, assist with partner notification following STI diagnosis and encourage repeat testing [368-371].

Introducing SMS to facilitate test result notification in the sexual health clinic in the Waikato DHB was not associated with improved time to treatment for *C. trachomatis* infections (Table 10-4). In contrast, a significant improvement was reported by the only other SMS intervention study to assess time to treatment for chlamydial infections as an outcome [312]. In a study of 49 patients diagnosed with *C. trachomatis* in an inner London genitourinary medicine clinic, median time to treatment for 28 patients was 8.5 days for those receiving a text message advising them to contact the clinic for their results compared to 15.0 days among the 21 patients receiving standard care. Standard care at that time was that patients returned in person or phoned the clinic for their results [312].

Menon-Johansson et al. found that the time taken for patients to re-attend once contacted was the same for the intervention and standard care groups in London, and that the overall improvement in time to treatment related to more rapid notification of results [312]. A limitation of our study design was not recording the time taken for each step in the process, for example time for laboratory results to become available and for patients to be notified of their results, rather than simply the date of their initial assessment and of when they received treatment. Hence it was not possible to ascertain if our results were biased by unmeasured changes in other aspects of the process. A notable difference between the two settings however was that standard care, pre-intervention, in our setting was to expedite treatment by attempting to contact anyone with a positive chlamydia test result, with a median time to treatment of seven days pre-intervention, in contrast to a more passive approach and a median time to treatment of 15 days with standard care in the London clinic.

Another design limitation of our study was using historical controls. Overall, the majority of patients provided a mobile phone number, rather than a landline, in their contact details but significantly more patients had a mobile phone in 2007 than in 2005 (88% in 2007 vs. 81% in 2005). It was not possible to ascertain if a trend to earlier treatment for those with mobile phones, compared to those who did not provide a mobile phone number, simply reflected improved communication rather than the use of SMS technology per se.

A further consideration is that we did not interview patients or clinicians to assess the acceptability of using SMS to communicate test results, although anecdotally patients and clinic staff reported a strong preference for SMS. Sending someone a text message using SMS has several advantages over a phone-call: it is cheap; convenient; fast; more discreet than a mobile phone conversation; text is automatically stored where it can be re-read; is convenient for hearing-impaired people; and, perhaps most importantly for time-pressured
clinicians, a large number of people can be sent the same message simultaneously. Consequently, SMS has been shown to reduce the amount of staff time dedicated to providing test results. Disadvantages of using SMS include that an error with number entry will result in a text being delivered to the wrong person and stored texts may lead to privacy breaches if someone else accesses the mobile phone. An important feature of SMS is that a message is only forwarded, and delivered, to the recipient when the phone is turned on or moves into cellular network range. In 2007, 7% text messages were not delivered in our setting, similar to reported delivery failure rates reported in the UK; it is important therefore to able to monitor non-delivery of text messages and have an alternative approach for affected patients.

A concern is that the increasing use of technology in health care delivery will exacerbate health disparities for those who do not have access to the requisite tools, particularly Internet access. This gap between people who have access to digital technologies and those that do not is often referred to as the ‘digital divide’. It is possible that mobile phones may reduce the digital divide for Internet access, however, with recent evidence in the US suggesting ethnic minorities are twice as likely to access the Internet and e-mail on their mobile phones than white Americans. The digital divide in New Zealand has disproportionately affected Māori, although this gap appears to be closing. Nonetheless, in a national survey of 1827 New Zealanders in 2008 of whom 1044 were Māori, 78% of Māori participants reported owning a computer compared to 86% of non-Māori. In contrast, Māori were as likely to own a mobile phone (87% Māori, 86% non-Māori) and more likely to use their phone on a daily basis (82 % of Māori compared with 73% of non-Māori).

Reassuringly, we did not find any disadvantage by indigenous ethnicity associated with the introduction of text messaging in our study of time to treatment for chlamydia infection. The lack of any difference is unlikely to reflect under-representation of Māori in our sample, with 44% of chlamydia cases in 2007 being in Māori, compared to 20% of all clinic attendees being Māori during the same period. The only other study to report on the use of text-messaging as a health care intervention by indigenous ethnicity found that using text messaging to promote smoking cessation was as effective for rangatahi Māori as young non-Māori, and supports our finding that mobile phone-based health-care innovations do not exacerbate health disparities.

Treatment outcomes in the sexual health clinic in the Waikato DHB compared well to outcomes in other studies in a range of settings. Notably, however, Chen et al. reported a median time to treatment of four days for those not treated at their initial assessment at a Sydney sexual health clinic, with 97% of patients treated within two weeks. The shorter median time to treatment than reported in other settings likely reflects clinic
policy of a very proactive approach to positive results: patients were asked to provide three methods of being contacted; laboratory staff notified clinic staff daily of positive results; untreated patients were contacted urgently and prioritised for same-day clinic appointments and treatment. In comparison, standard care in our setting during 2005-2007 was to await receipt of paper-based laboratory results, typically taking three to five days.

Optimising each step in the process from diagnosis to treatment provides an opportunity to improve case management and, ultimately, health outcomes. Our case management findings demonstrate that there is room for improvement, particularly in the prioritisation and treatment of known chlamydia contacts, in our district.

**Partner notification**

Appropriate treatment is the primary goal in the management of any disease. For STIs, partner notification is an integral part of treatment. Partner notification has several objectives: to identify otherwise undiagnosed infections, to prevent onward transmission in the population, and, perhaps most importantly, to prevent re-infection of the initial (index) case. There is good evidence that more people attend for evaluation if providers undertake partner notification for STIs but, in practice, provider-led (known as provider referral) notification is labour intensive and costly and the index case is often given the responsibility for partner notification [109]. Partner notification is not always easy or even possible however and international research suggests partners are advised and treated for only about 50% of those infected with *C. trachomatis* [109,374,375].

Little is known about current approaches to partner notification for STIs in New Zealand or the efficacy of the strategies used. The incidence of chlamydia re-infection in New Zealand is also unknown although high rates of repeat positive chlamydia tests observed over a three year period in the Waikato DHB suggest re-infection is common. If so, those with chlamydial infection are not given adequate advice and support to avoid re-infection or the advice is not followed for whatever reason.

We found limited evidence of the planned approach to partner notification (such as provider referral or patient referral) for cases managed in clinical settings, other than the sexual health clinic, in the Waikato DHB (Table 10-4). Only 60% of cases managed in settings other than the sexual health clinic had any documentation that informing partners had been discussed at all. This may simply reflect inadequate documentation, as most participating providers noted that they would typically advise patients to tell their partner(s), consistent with a survey of 327 New Zealand health providers in 1997, when 97% reported always advising patients diagnosed with chlamydia to tell their partners to seek treatment [223]. Other surveys have also reported that most GPs would advise those diagnosed with chlamydia to tell partners: for example, in 2007, 95% (223) of surveyed Australian GPs felt
that it was their role to discuss partner notification. Notably, in that study, only 45% (105/232) felt sure of how best to assist their patients with this. Simply advising a patient of the need to tell partners is one of the least effective approaches to partner notification, however. While those diagnosed with STIs think that telling their partners is the right thing to do, many find it difficult to do so, and, not surprisingly, partner notification is more effective when patients are given more information and more support.

While our finding of a lack of documented follow-up and of partner notification outcomes in settings other than the sexual health clinic in the Waikato DHB does not mean that sexual partners were not evaluated or treated, unfortunately it does mean that the efficacy of current management cannot be assessed. There is limited alternative data around routine approaches to, or efficacy of, partner notification for STIs in New Zealand. A retrospective audit of 1001 consecutive patients attending two termination of pregnancy clinics in Wellington in 2003 also noted a lack of documentation, with 58% (45/77) of those with chlamydial infection having no medical record documentation regarding partner notification discussions or outcomes. Similarly, a study to increase opportunistic chlamydia screening and improved documentation of partner notification outcomes among under 25 year olds attending any of ten GP clinics in south Auckland reported that, before the study intervention, providers reported telling patients diagnosed with STIs to advise their partners but there was no documented follow-up after treatment and no documented partner notification outcomes.

Evidence suggests that follow-up after treatment improves partner notification outcomes. A randomised trial in the US of 600 patients diagnosed with either C. trachomatis or N. gonorrhoeae infection found that those who were given more information and counselling at their initial visit and were re-interviewed by telephone to identify persisting barriers to partner notification were more likely than the control group to report telling partners within a month and were less likely to be re-infected at a six month follow-up visit. However, active follow-up was only part of the overall intervention, with participants receiving more information and advice on how to achieve effective partner notification at their initial visit.

Other supporting data include a study in a UK genitourinary medicine clinic that noted a greater number of contacts were confirmed as tested or treated within four weeks when the index patient was followed-up within a month, regardless of whether this was by telephone or at a follow-up clinic appointment. Another UK study found more index cases had confirmed partner treatment (51% vs. 30%), and more partners per index case were treated (0.57 vs. 0.45 contacts per case) when patients were followed up by telephone compared to those given a follow-up appointment, because of a high appointment default rate in the latter group. Partner notification outcomes for those with gonococcal infections were better in a provincial UK genitourinary medicine clinic than in a large metropolitan clinic, with
differences attributed to more health adviser resource, more follow-up opportunities to re-interview index cases and greater use of provider referral [380].

Another reason for follow-up after treatment is to ascertain effective index case treatment. Worryingly, among under 25 year olds attending ten GP clinics in south Auckland who were diagnosed with chlamydia during 2010-11, 75 (25%) treated cases acknowledged unprotected sex in the week after treatment with a single dose of azithromycin, although it was not reported whether this was with an untreated partner [346]. In a national audit of chlamydia case management in genitourinary medicine clinics in the UK, nearly 9% (303/3795) cases successfully followed up admitted to non-abstinence during treatment, and 80% of these cases were re-treated [300]. The lack of index case follow-up demonstrated in this thesis suggests missed opportunities to ascertain treatment adherence, to assess the likelihood of early re-infection and to again offer provider help or other interventions to assist with any unsuccessful partner notification. Although New Zealand clinical guidelines encourage patient follow-up by telephone to ensure that sexual partners have been contacted, follow-up after treatment, within for example two - four weeks, is not an explicitly stated recommendation in the guidelines’ summary [85]. This should be rectified, with a clear recommendation on index case follow-up, in future iterations of New Zealand’s chlamydia management guidelines.

While it is not possible to ascertain the effectiveness of existing approaches to partner notification in primary care in New Zealand, it is likely there is considerable scope for improvement. How might partner notification improvements be achieved? There is good evidence that partner notification can be undertaken by any appropriately trained health professional. A randomised controlled trial in the UK demonstrated that partner notification for chlamydia infection was as effective when initiated by practice nurses and followed up by sexual health advisers by telephone as when patients were treated and referred to the genitourinary medicine clinic for partner notification, partly because of the high non-attendance rate among the referred group [302]. A recent analysis of partner notification in genitourinary medicine clinics in the UK also found no association between the number of partners tested for chlamydial infection and the type of health professional giving partner notification advice [374].

Encouragingly, effective partner notification outcomes have been demonstrated in non-sexual health clinic settings in New Zealand. In a study to increase chlamydia screening in New Zealand family planning clinics, testing was offered to anyone aged under 25 years attending family planning clinics in Wellington for six months during 2004-2005 [127]. All those testing positive were followed up by telephone by a trained clinic nurse to ascertain treatment outcomes and whether partner(s) had been correctly treated. Partners were successfully advised for 69% (147/212) of index cases, with partners for 47% (100/212) of
index cases known to have received treatment. Patient referral occurred for 141 index cases and provider referral for the remaining six cases. At the end of the six-months, clinicians reported that follow-up of those with positive results was sometimes time-consuming and difficult [127].

Azariah et al. recently evaluated a pilot study to increase chlamydia testing in under-25 year-olds in primary care and, subsequent to the Waikato DHB case management findings, to improve documentation of partner notification outcomes [346]. The pilot ran for four-months in ten GP practices in south Auckland during 2010-11, when all sexually active under-25-year-olds were offered chlamydia screening by a practice nurse. All those testing positive were recalled by a nurse for treatment and to discuss partner notification, with telephone follow-up one week later. Support included additional training, scripted suggestions on how to discuss partner notification, printed partner notification resources for patients, a standardised case management template in the patient management system, and telephone support from sexual health clinic staff. As already mentioned, prior to the pilot, there was no documented follow-up and no documented partner notification outcomes for any cases. During the four-month pilot, 64% of 300 index cases reported they had notified sexual contacts. Staff surveyed after pilot completion reported index case follow-up was challenging, despite the system-based improvements, resources and support provided during the pilot [224].

Neither study reported if there was a sustained effort around follow-up and documenting partner outcomes beyond the time frame of the study interventions [127,346]. However, staff in both settings reported difficulties with follow-up and partner notification, suggesting it may be challenging to sustain any improvements without ongoing provider support. In 2009, surveyed primary care providers in the Waikato DHB also rated their knowledge and skill for partner notification and partner management as being less than that for screening and treatment of chlamydia infection. Providers attending any of three continuing medical education meetings, as part of the Waikato DHB chlamydia project, were asked to complete a brief, pre-meeting survey of their self-perceived chlamydia knowledge and skill in relation to targeted screening, diagnostic sampling, and case management. Of 104 local primary care providers who attended, 82 (79%) completed the survey, using Likert 5-point items, with five indicating strong agreement. Giving advice about partner notification (mean score 3.1) and partner management of those who test positive for Chlamydia trachomatis infection (mean score 3.0) were rated lower than items relating to offering screening, testing and treatment (mean scores: 4.0, 3.7, and 3.6, respectively). These findings are consistent with international literature that GPs need and would like more guidance, resources and support with partner notification [114,376,381,382].
The challenge for New Zealand is how to provide such guidance and support. In most comparable health systems, specialist trained staff are available to assist with partner notification, either through public health services or, in the UK, by referral to health advisers in genitourinary medicine clinics. In contrast, bacterial STIs including *C. trachomatis* are not notifiable in New Zealand and, as such, are excluded from the jurisdiction of public health services that are otherwise responsible for communicable disease control. Further, few sexual health clinics employ sexual health advisers and often rely on other trained staff, such as clinic nurses, to support patients with partner notification. For any diagnosed STI, individual health providers have the responsibility for ensuring effective partner notification and there are no resources or formalised systems or processes to assist GPs or other providers with this task. Addressing this challenge, and ensuring guidance and support is available to any provider that manages those diagnosed with STIs, is an essential step to improved partner notification in New Zealand.

As stated in chapter one, various resources and approaches are being assessed internationally to improve notification and treatment of sexual partners. In a systematic review, Mathews et al. found partner notification strategies, that included provider referral, increased the rate of partners presenting for care and that patient referral was enhanced by verbal education [109]. Another approach is patient-delivered partner therapy. A meta-analysis of five studies of patient-delivered partner therapy reported a reduced risk of recurrent infection in patients with chlamydia and gonococcal infections compared with patient referral [108], although it was also noted that this intervention was no more effective than supplementing patient referral with clear written information for partners. Patient-delivered partner therapy remains illegal in New Zealand [110]. An alternative approach of ‘accelerated partner therapy’ is being evaluated in the UK because of similar legislative obstacles and is acceptable to both patients and partners [112]. Other novel approaches include the use of communication technologies such as text messaging and web-based electronic postcards to make it easier for index cases to advise their partners [113,114]. It is important that these newer approaches to partner notification, and their acceptability to patients and providers, are evaluated in New Zealand.

In summary, it is likely there is scope for improved partner notification for those with chlamydial infections in New Zealand. International evidence confirms a partner notification approach that supports the index case and offers the option of provider referral is important, and that approaches to expedite partner treatment are also effective in preventing re-infection. Partner notification can be effectively undertaken in primary care with appropriate training and support. It is important to evaluate novel approaches and to determine how to optimise partner notification in New Zealand, which in turn will require more robust monitoring and evaluation of partner outcomes.
**Strengths**

We benefited from the availability of the Waikato District Health Board's entire laboratory testing data for testing coverage estimates, although only three years of district-wide laboratory test data were available because of a change in community laboratory provider in 2008. We also benefited from the availability of a standard unique identifier, the National Health Identifier (NHI), and its increasing utilisation over recent years. We were able to ascertain valid NHI numbers for large numbers of anonymously coded chlamydia tests by linking with the sexual health clinic’s patient registration dataset, which enabled more accurate estimates of screening coverage. The linking of data via NHI also enabled analysis by ethnicity, which is not collected through laboratories.

Another strength was the remarkably high provider participation in our study of chlamydia case management, providing good representation of providers who manage the majority of diagnosed chlamydia cases in the Waikato DHB. However, as providers who managed very few cases were not invited to participate, our results may not be a true reflection and may over-estimate district-wide care.

**Weaknesses**

Nearly all the studies were undertaken only in the Waikato DHB, which may mean the findings are not valid in other areas within New Zealand. However, for some studies, such as chlamydia screening coverage by laboratory testing and documentation of follow-up and partner notification outcomes, we were able to validate our results with data from other district health boards and found our results to be similar. Our findings were, in general, in keeping with what has been reported internationally, which also supports their validity.

Laboratory forms could not be scrutinised to determine the reason why each chlamydia test was initiated, for example, for diagnostic purposes or for asymptomatic screening. Further, laboratory forms do not collect behavioural data and we were unable to retrieve this from other sources, as primary care providers did not routinely document sexual history. It was not possible to ascertain if chlamydia screening was appropriately targeted, other than by age, gender or ethnicity.

A notable limitation was that we were not able to demonstrate any change in primary care utilisation associated with the funding intervention because of a lack of baseline age-specific utilisation data from all the practices involved. Hence, we were only able to demonstrate that funding was associated with increased chlamydia screening, not increased access to care.

Methodological issues may have biased our findings. General practices were purposively selected for additional sexual health access funding, based on perceived needs’ of their
enrolled population, and the intervention practice populations differed from controls. Nonetheless, the lack of impact in non-eligible aged patients at the intervention practices supports our results.

Conclusions and future directions

*Chlamydia trachomatis* is a very common infection in New Zealand. Older evidence over-estimated the proportion of infected people who developed long-term complications. Nonetheless, chlamydial infection is not harmless and it is likely that 25-30% of PID cases in women are attributable to chlamydial infection.

Most of the increase in reported chlamydia cases from 1998 to 2008 in New Zealand can be attributed to increased testing and detection with hospital admission disease trends remaining stable over the same period. However, rates of chlamydia test positivity also increased from 1998 to 2008, although it is not clear if this reflects changes in chlamydia prevalence or better targeting of testing towards those more likely to be infected. Hospitalisation rates for PID remain high and are much higher than in comparable countries, such as Australia. The use of the ICD-10 A56.1 classification code in New Zealand suggests a substantial amount of PID hospitalisations among young women in 2008 reflected chlamydial-related pelvic infection. It is evident that, despite increased testing and detection, current control efforts in New Zealand have not yet led to fewer adverse reproductive outcomes at a population level.

Early detection and treatment of *C. trachomatis* infection improves individual-level outcomes: while chlamydia testing rates in New Zealand are relatively high, this thesis demonstrates screening rates among those most at risk of infection remain sub-optimal in the Waikato DHB. Free primary care visits for those aged under 25 years are associated with higher testing rates. Further increases in screening coverage will likely require more fundamental change in clinical practice and systems to ensure an acceptable, routine, universal screening offer is made to those most at risk of infection when they attend primary care. However, in the face of competing demands and the lack of a contemporary national strategy or national targets for sexual health, it is highly unlikely that district health boards and primary care providers will prioritise chlamydia screening without financial reimbursement or other incentives.

Chlamydial control through screening will not be achieved by merely increasing testing opportunities. This thesis demonstrates there is scope for improved case management and effective partner notification, particularly for those diagnosed with infection in settings other than the sexual health clinic in the Waikato DHB. Re-infection is a major concern. The challenge is to improve screening coverage and enhance case management to deliver more equitable, effective outcomes. In turn, more robust surveillance systems are required;
currently available data, such as overall population testing rates and all-cause PID hospitalisations, are inadequate for evaluation and monitoring purposes.

Finally, while changing behaviour at a population level is difficult, it cannot be ignored that more young New Zealanders are sexually active yet two-thirds of school-based sexuality programmes do not address their learning needs. Improved sexuality education needs to be addressed as a priority and condoms need to be promoted as a social norm.

Policy
- A national sexual health strategy, which provides nationally agreed sexual health targets for district health boards and primary care providers, should be developed and implemented.

- Consideration should be given as to whether STIs should be notifiable in New Zealand to better align with communicable disease control. The option of legislating to enable expedited partner therapy without medical assessment should also be considered.

- Systems are needed to monitor incidence of *C. trachomatis* infection and potential sequelae. Laboratory testing data collection needs to be enhanced from current aggregate volume-based reporting and must include ethnicity information; our results show this is achievable with NHI-based dataset linking. A standardised way to diagnose and record chlamydia-related PID, particularly in primary care, is required for monitoring and surveillance purposes.

- The optimal model for population-level chlamydial screening has not yet been clearly demonstrated. It would be judicious to await the results of the randomised Australian Chlamydia Control Effectiveness Pilot (ACCEPt) trial before re-assessing whether to implement a large-scale national chlamydia screening programme in New Zealand.

- Interventions that reduce sexual risk-taking behaviour of young New Zealanders need to be considered and effective sexuality education should be implemented as a priority.

Practice
- Providers should ensure that those most at risk of infection, notably young people and indigenous Māori, are aware of the importance of testing in maintaining sexual health and are aware of how to access STI screening. Funding for free sexual and reproductive primary visits for under-25 year olds should be maintained.

- Health-care providers should consider and address system-based issues that preclude an acceptable, routine offer of chlamydia testing to those aged under 25 years who attend health-care each year.
• Greater emphasis should be placed on effective management after initial screening: for example, prompt notification of test results, dispensed medications for those at high-risk of primary non-adherence, early follow-up to assess the risk of treatment failure or re-infection, and repeat testing at three months to detect re-infection.

• Partner notification approaches that support the index case and offer the option of provider referral should be implemented in all health-care settings that manage those with chlamydial infection, along with appropriate provider training and ongoing support.

Research

• Determine large-scale population-level prevalence, incidence and re-infection rate for *C. trachomatis* in New Zealand.

• Ascertaining aetiology, diagnosis, management, and referral patterns to secondary care for pelvic inflammatory disease in primary care in New Zealand.

• Evaluate novel interventions to increase chlamydia testing and repeat testing, such as home-based or community-based screening, that might better reach young people, particularly men, in New Zealand who are not regular health-care users.

• Further evaluate gaps in provider knowledge and skills to determine required education and supports for improved index case follow-up and partner notification.

• Evaluate novel approaches and determine how to optimise delivery of effective partner notification in New Zealand, which will require more robust monitoring and evaluation of partner outcomes.
## Appendices

### Appendix 1: ESR STI case definitions

**STI Surveillance Case Definitions for ESR**

<table>
<thead>
<tr>
<th>STI</th>
<th>Confirmed</th>
<th>Probable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chlamydia</strong></td>
<td>Laboratory detection of <em>Chlamydia trachomatis</em> in a clinical specimen.</td>
<td>Cases should be classified as:</td>
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<tr>
<td></td>
<td>Cases should be classified as:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. uncomplicated infection of the lower genital tract</td>
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<td></td>
<td>2. PID (pelvic inflammatory disease) or epididymitis</td>
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<td></td>
<td>3. infection of another site (e.g., eye or pharynx)</td>
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<td></td>
<td><strong>Probable</strong> Cases must be all of the following:</td>
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<tr>
<td></td>
<td>1. <strong>symptomatic, and</strong></td>
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<tr>
<td></td>
<td>2. a contact of a confirmed case, and</td>
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<tr>
<td></td>
<td>3. non-laboratory confirmed (test negative or test not done).</td>
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<tr>
<td><strong>Gonorrhoea</strong></td>
<td>Laboratory isolation of <em>Neisseria gonorrhoeae</em> from a clinical specimen.</td>
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<tr>
<td></td>
<td>Cases should be classified as:</td>
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<tr>
<td></td>
<td>1. uncomplicated infection of one or both of the following:</td>
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<tr>
<td></td>
<td>a. urethral tract</td>
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<tr>
<td></td>
<td>b. anorectal area (proctitis)</td>
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</tr>
<tr>
<td></td>
<td>2. PID (pelvic inflammatory disease) or epididymitis</td>
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<td></td>
<td>3. extra-genital infection of one or both of the following:</td>
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<tr>
<td></td>
<td>a. pharynx</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. other site not listed</td>
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<tr>
<td><strong>Anogenital Herpes</strong></td>
<td>First diagnosis for the person at your clinic, with either</td>
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<tr>
<td></td>
<td>1. laboratory detection of herpes simplex virus (HSV) from a clinical</td>
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<td></td>
<td>specimen, or</td>
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<td></td>
<td>2. a clinically compatible illness in the lower anogenital and buttock</td>
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<td></td>
<td>area (syphilis should be considered as a cause of genital ulceration)</td>
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<td><strong>Anogenital Warts</strong></td>
<td>First diagnosis for the person at your clinic, with visible* typical</td>
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<tr>
<td></td>
<td>lesions(s) on internal or external genitalia, perineum, or perianal</td>
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<tr>
<td></td>
<td>region. * Do not include persons for whom there is only demonstration of</td>
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<tr>
<td></td>
<td>human papillomavirus (HPV) on cervical cytology or other laboratory</td>
<td></td>
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<tr>
<td></td>
<td>method.</td>
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<tr>
<td><strong>Syphilis</strong></td>
<td>Infectious syphilis (primary, secondary, and early latent) as diagnosed</td>
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<tr>
<td></td>
<td>or confirmed by a venereologist, and early congenital syphilis as</td>
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<tr>
<td></td>
<td>diagnosed or confirmed by a paediatrician or venereologist.</td>
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</tr>
<tr>
<td><strong>Non-Specific Urethritis</strong></td>
<td>Urethral discharge in a sexually active male with laboratory exclusion of</td>
<td></td>
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<tr>
<td>(NSU) (males only)</td>
<td>gonorrhoea and chlamydia, who does not meet the definition of a</td>
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<tr>
<td></td>
<td>probable case of gonorrhoea or chlamydia.</td>
<td></td>
</tr>
<tr>
<td><strong>Chancroid</strong></td>
<td><strong>Confirmed</strong> Isolation of <em>Haemophilus ducreyi</em> from a clinical</td>
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<tr>
<td></td>
<td>specimen.</td>
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<tr>
<td></td>
<td><strong>Probable</strong> Typical 'shool of fish' pattern on gram stain of a</td>
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<tr>
<td></td>
<td>clinical specimen, where syphilis, granuloma inguinale (GI) and anogenital</td>
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<tr>
<td></td>
<td>herpes have been excluded, or</td>
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<tr>
<td></td>
<td>A clinically compatible illness in a patient who is a contact of a</td>
<td></td>
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<tr>
<td></td>
<td>confirmed case.</td>
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<tr>
<td><strong>Granuloma inguinale (GI)</strong></td>
<td><strong>Confirmed</strong> Demonstration of intracytoplasmic Donovan bodies on Wright</td>
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<tr>
<td></td>
<td>or Giemsa stained smears or biopsies of clinical specimens.</td>
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<tr>
<td></td>
<td><strong>Probable</strong> A clinically compatible illness in a patient who is a</td>
<td></td>
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<tr>
<td></td>
<td>contact of a confirmed case.</td>
<td></td>
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<tr>
<td><strong>Lymphogranuloma venereum</strong></td>
<td><strong>Confirmed</strong> Laboratory detection of <em>Chlamydia trachomatis</em> serotype</td>
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<tr>
<td>(LGV)</td>
<td>L1, L2 or L3 from a clinical specimen.</td>
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</tr>
<tr>
<td></td>
<td><strong>Probable</strong> A clinically compatible illness with complement fixation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>titre of &gt; 64 and other causes of alterations excluded, or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A clinically compatible illness in a person who is a contact of a</td>
<td></td>
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<tr>
<td></td>
<td>confirmed case.</td>
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</table>
Appendix 2: New Zealand ICD public hospital discharge volumes, 1998-2008

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>6140</td>
<td>N700 Acute salpingitis and oophoritis</td>
<td>5</td>
<td>13</td>
<td>9</td>
<td>15</td>
<td>19</td>
<td>9</td>
<td>18</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>6141</td>
<td>N700 Chronic salpingitis and oophoritis</td>
<td>28</td>
<td>29</td>
<td>36</td>
<td>28</td>
<td>32</td>
<td>31</td>
<td>34</td>
<td>35</td>
<td>29</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>6142</td>
<td>N309 Salpingitis and oophoritis, unspecified</td>
<td>56</td>
<td>33</td>
<td>50</td>
<td>63</td>
<td>69</td>
<td>71</td>
<td>71</td>
<td>72</td>
<td>79</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>6150</td>
<td>N710 Acute inflammatory disease of uterus</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6151</td>
<td>N711 Chronic inflammatory disease of uterus</td>
<td>11</td>
<td>9</td>
<td>3</td>
<td>8</td>
<td>11</td>
<td>14</td>
<td>13</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>6159</td>
<td>N719 Inflammatory disease of uterus, unspecified</td>
<td>20</td>
<td>33</td>
<td>43</td>
<td>61</td>
<td>31</td>
<td>17</td>
<td>35</td>
<td>31</td>
<td>37</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>6143</td>
<td>N730 Acute parametritis and pelvic cellulitis</td>
<td>23</td>
<td>26</td>
<td>24</td>
<td>32</td>
<td>19</td>
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<td>6144</td>
<td>N731 Chronic parametritis and pelvic cellulitis</td>
<td>17</td>
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<td>6145</td>
<td>N732 Unspecified parametritis and pelvic cellulitis</td>
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<td>3</td>
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<td>0</td>
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<td>N734 Female chronic pelvic peritonitis</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>1</td>
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<tr>
<td>6146</td>
<td>N736 Female pelvic peritoneal adhesions</td>
<td>11</td>
<td>72</td>
<td>68</td>
<td>61</td>
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<td>6148</td>
<td>N338 Other specified female pelvic inflammatory diseases</td>
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<td>9</td>
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<td>5</td>
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<tr>
<td>6149</td>
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<td>6148</td>
<td>N736 Female pelvic inflammatory disorders in other diseases classified elsewhere</td>
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<tr>
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<td>A540 Gonococcal infection of lower genitourinary tract with (A549) or without (A541) periurethral or accessory gland abscess (female cases)</td>
<td>6</td>
<td>0</td>
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<td>7</td>
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<td>09955</td>
<td>A560 Chlamydial infection of lower genitourinary tract (female cases)</td>
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<td>1</td>
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</tr>
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<td>A561 Chlamydial infection of pelvic/perineal &amp; other genitourinary organs (female)</td>
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<td>15</td>
<td>33</td>
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<tr>
<td>09955</td>
<td>A562 Chlamydial infection of genitourinary tract, unspecified (female cases)</td>
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<td>0</td>
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<tr>
<td>6280</td>
<td>N870 Female infertility associated with abortion</td>
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<td>8</td>
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<tr>
<td>6282</td>
<td>N911 Female infertility of tubal origin</td>
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<td>6283</td>
<td>N927 Female infertility of uterine origin</td>
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<tr>
<td>6284</td>
<td>N935 Female infertility of cervical origin</td>
<td>0</td>
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<td>6286</td>
<td>N974 Female infertility associated with male factors</td>
<td>21</td>
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<tr>
<td>6288</td>
<td>N978 Female infertility of other origin</td>
<td>22</td>
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<tr>
<td>6289</td>
<td>N978 Female infertility, unspecified</td>
<td>136</td>
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<tr>
<td>6330</td>
<td>e000 Abdominal pregnancy</td>
<td>2</td>
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<td>6332</td>
<td>e002 Molar pregnancy</td>
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<td>6333</td>
<td>e008 Other ectopic pregnancy</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6339</td>
<td>e009 Ectopic pregnancy, unspecified</td>
<td>35</td>
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</tr>
<tr>
<td>60400</td>
<td>N959 Orchitis, epididymitis and epididyério-orchitis without abscess</td>
<td>116</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>60410</td>
<td>N950 Orchitis, epididymitis and epididyério-orchitis with abscess</td>
<td>116</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

* ICD-9 data used for 1998 and 1999

Publically funded hospital discharges for Chlamydia related diseases in men and women aged 15–44 years, New Zealand, 1998-2008

153
Appendix 3: The Waikato DHB chlamydia audit data collection form 2008

A case is a person who was diagnosed with Chlamydia during 1st February – 31st October 2008. Please provide data on the first 20 consecutive cases seen during this interval. If there are less than 20 cases, please provide data on all cases seen. Please exclude cases whose positive Chlamydia test was taken by another clinic or service or department. Please note the index patient is the case being audited.

Clinic: ________________

A. INDEX PATIENT

1. **Date 1st seen** (must be between 1st Feb and 31st Oct 2008 inclusive) __________

Please note the patient’s clinic ID or NHI or date of birth (NOT name): __________

2. **Gender:** Male O Female O Transgender O Not documented O

**Tick if pregnant:** O

3. **Age group:**
   - <15 O
   - 15-19 O
   - 20-24 O
   - 25-34 O
   - 35-44 O
   - 45-54 O
   - 55 + O
   - Unknown O

4. **Ethnicity:** ________________
   - Or Ethnicity Not Given O
   - Or Ethnicity Not Documented O

5. **Ever tested for Chlamydia before:** Yes [ ] No [ ] Not documented [ ]

   If yes, please note date & result if known ________________

6. **MAIN Reason for this test** (choose one):
   - Symptoms [ ]
   - Asymptomatic patient requesting check-up [ ]
   - Offered by provider, based on sexual history [ ]
   - Contact of partner diagnosed with Chlamydia [ ]
   - Medico-legal case [ ]
   - Not documented [ ]

   **Presenting features** (tick as many as apply):
   - Asymptomatic [ ]
   - Urethral discharge [ ]
   - Dysuria [ ]
   - Post coital or intermenstrual bleeding [ ]
   - Lower abdominal pain [ ]
   - Vaginal discharge [ ]
   - Scrotal pain
   - Complications of Chlamydia [ ] specify ____________________________
   - Other [ ] specify ____________________________
   - Not documented [ ]

7. **Diagnosis:** please tick all site(s)/samples tested:
   - Urine [ ]
   - Urethral swab [ ]
   - Cervical swab [ ]
   - Vulvo-vaginal swab[ ]
   - Other [ ] specify __________
8. Other STIs and / or examination considered:

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<tr>
<th></th>
<th>Yes</th>
<th>Not documented</th>
<th>Offered but declined or window period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syphilis</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HIV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other STIs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genital examination performed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

First ‘anti-Chlamydia’ treatment given:

9.1 Either A. Uncomplicated infection: -

- Doxycycline 100mg bd for 7 days [ ] [ ]
- Azithromycin 1gm stat orally single dose [ ] [ ]
- Erythromycin 500mg bd for 14 days [ ] [ ]
- Erythromycin 500mg three times a day for 7 days [ ] [ ]
- Amoxicillin 500mg three times a day for 7 days [ ] [ ]
- No treatment documented [ ]
- Other treatments [ ] please specify drug, dose and duration: __________________________________________

9.2 OR B. Complicated infection eg treatments for pelvic infection or epididymitis:
Please specify drug(s), dose and duration: ____________________________________________________________

10. When was the index patient treated (choose one)?

- Index patient was treated at the time the Chlamydia test was taken [ ]
- Index patient was treated after the date the Chlamydia test was taken [ ]
  - How many days later? _____________
- Index patient failed to attend for treatment [ ]
- Not documented when index was treated [ ]

11. Advice given to index patient:

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<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Not documented</th>
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</thead>
<tbody>
<tr>
<td>Given advice/information about Chlamydia infection?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Given a leaflet about Chlamydia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advised to abstain from sexual intercourse until their treatment and of any partners was completed, if applicable?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. FOLLOW-UP OF INDEX PATIENT

12 Was the patient followed up (choose one)?

- Yes, face-to-face [ ]
- Yes, by telephone or text [ ]
- No, referred elsewhere for follow-up
  - If so, please note where
  - Did patient attend elsewhere Yes [ ] No [ ] Not documented [ ]
- No, recalled but unable to contact / did not attend [ ]
- No follow-up plan [ ]
13 If the patient was followed up:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Not applicable</th>
<th>Not documented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was partner notification discussed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had the patient adhered to the treatment?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had any symptoms resolved?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate management of non-adherence (e.g. re-treatment etc.)</td>
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<td></td>
</tr>
<tr>
<td>Test-of-cure recommended, if pregnant</td>
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</table>

C. PARTNER NOTIFICATION (PN)

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<th>Yes</th>
<th>Not applicable</th>
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<tbody>
<tr>
<td>Was partner notification (PN) discussed?</td>
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<td></td>
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</tr>
<tr>
<td>Was the method of PN documented?</td>
<td></td>
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<tr>
<td>Was the outcome of PN documented?</td>
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</table>

D. PARTNERS

Record the number of reported sexual partners in the 3 months preceding the index patient's presentation _____________ OR tick if not documented [ ]

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<th>As reported by index patient</th>
<th>As verified by a healthcare worker</th>
<th>Index declined to discuss</th>
<th>Not recorded</th>
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</thead>
<tbody>
<tr>
<td>Please record numbers only here</td>
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<td></td>
</tr>
<tr>
<td>Number of regular partner(s) advised about Chlamydia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of regular partner(s) tested for Chlamydia</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Regular partner(s) treated for Chlamydia</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Number of casual partners advised about Chlamydia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of casual partners tested for Chlamydia</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Number of casual partners treated for Chlamydia</td>
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</table>
Appendix 4: The New Zealand Ministry of Health recommendations for chlamydia testing (two-page summary)

Recommendations for Chlamydia Testing in New Zealand

Infection with *Chlamydia trachomatis* is usually asymptomatic. Age and sexual behaviour are the best predictors of asymptomatic infection.

### Recommendations for asymptomatic opportunistic testing

This is particularly important if the individual has not consistently used condoms.

**Females**

Testing should be offered to all sexually active females under 25 years of age if they have never been tested. The offer of testing should be repeated annually to all sexually active females under 25 years of age if they have:

- had two or more partners in the last 12 months, or
- had a recent partner change.

**Males**

Consider testing in sexually active males if they conform with the following criteria:

- aged under 25, and
- two or more sexual partners in the last year or a recent partner change, or
- co-infection with another STI.

Testing should be routinely given to:

- those with symptoms suggestive of chlamydia infection (see below for symptoms)
- sexual partners of those with suspected or confirmed chlamydia infection
- patients requesting a sexual health check
- patients with another STI
- pregnant women (test in first trimester and repeat in third trimester if there are ongoing risk factors)
- women undergoing a termination of pregnancy
- mothers of infants with chlamydial conjunctivitis or pneumonia
- pre-menopausal women undergoing uterine instrumentation
- semen and egg donors
- men who have sex with men.

### Symptoms that may be associated with chlamydia infection

<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency/dysuria syndrome</td>
<td>Dysuria</td>
</tr>
<tr>
<td>Vaginal discharge</td>
<td>Urethral discharge</td>
</tr>
<tr>
<td>Inflamed/fragile cervix on examination</td>
<td>Epididymo-orchitis</td>
</tr>
<tr>
<td>Postcoital or inter-menstrual bleeding</td>
<td>Testicular pain</td>
</tr>
<tr>
<td>Lower abdominal pain</td>
<td>Reactive arthritis</td>
</tr>
</tbody>
</table>

If people have symptoms, start treatment without waiting for laboratory confirmation.
Testing
The recommended test is a nucleic acid amplification test such as PCR or SDA.

Recommended specimens for asymptomatic testing
- **Females:** a low vaginal swab, which can either be collected by a health care worker or self-collected by the patient.
  - If the woman is undergoing a speculum examination, a cervical swab is recommended
- **Males:** the first 10–20 ml of voided urine (delay passing urine for 1–2 hours before collection).

Symptomatic people require examination and testing for other STIs, including gonorrhoea, syphilis and HIV.

Management of chlamydia infection
Counsel the individual about the prevention of STIs, use of condoms and the importance of effective partner/contact management.

Treatment of uncomplicated chlamydia
The standard treatment is:
- azithromycin, 1 g po stat, or
- doxycycline, 100 mg bd, for seven days.

In pregnancy or if breastfeeding, use:
- azithromycin, 1 g po stat*, or
- amoxicillin, 500 mg tds, for seven days, or
- erythromycin stearate, 500 mg QID for seven days, or bd for 14 days.
  - *Note: azithromycin is not licensed for use in pregnancy in New Zealand, but clinical experience and studies overseas suggest it is safe and effective.

For alternative regimens and for treating complicated chlamydia, refer to the Chlamydia Management Guidelines.

Partner notification
- All sexual contacts within the previous 60 days need to be notified that they require testing and treatment for possible chlamydia infection.
- If there have been no sexual contacts within the previous 60 days, then the most recent sexual contact should be notified, up to a maximum of six months.
- All sexual contacts within the specified timeframe should be treated for chlamydia, even if the offer of a test is declined.
- Patients should be offered the choice of:
  - patient referral, where patients themselves notify their sexual contacts to seek treatment
  - provider referral, where the health care provider agrees to undertake the task of notifying sexual contacts to seek treatment (taking care to protect index case confidentiality as much as possible).

Repeat testing
A test of cure for chlamydial infection is not required because the recommended first-line treatment regimens of azithromycin or doxycycline are more than 95% effective. Exceptions to this recommendation are:
- if a non-standard antibiotic regimen has been used, or
- if the patient is pregnant.

In these circumstances, because treatment failure is more likely, a repeat test should be done no sooner than five weeks after completion of antibiotic therapy. Because re-infection is common, it is recommended that repeat testing be offered at three to six months to people with previously treated chlamydia infections.

Note that people testing positive for chlamydia infection may have other co-existing STIs. In these circumstances, testing for other STIs including gonorrhoea, syphilis and HIV should be offered, depending on sexual behaviour.

For further information and evidence to support these recommendations, see Chlamydia Management Guidelines (www.moh.govt.nz).
Appendix 5: The Waikato DHB chlamydia guideline one-page flowchart 2009

Chlamydia Guidelines

Consider a Chlamydia test if: -
• There are signs or symptoms suggestive of Chlamydia
• There are increased risks of complications eg pre-TORP / IUD insertion
• There is greater risk / higher prevalence eg sexually active under 25 year olds or >2 partners in past year or has had an STI in last 12 months or a sexual partner has an STI

Female: MBS / PCB / pelvic pain / vaginal discharge / dysuria (urethritis)
Male: Dysuria / discharge / testicular pain (sexually active young men; STIs >> UTIs)

Think about other STIs in anyone with symptoms or if there are increased risks of complications

Testing
Verbal consent, information leaflet, getting results

Samples for NAAT tests
Female: a cervical swab if undertaking a speculum examination. If asymptomatic & no other tests / examination unnecessary, a self-taken vaginal swab or a first catch urine.
Male: first catch urine (>1 hour since last passed urine, does not have to be early morning urine)

If high index of suspicion, start treatment for patient and sexual partner(s) without waiting for lab results

Laboratory
Positive
Negative

Safety sex advice and offer condoms

Management
• Treatment takes 1 week to work
• Advice to avoid having sex, or use a condom, (or 7 days after their treatment and/or 1 week after their partner(s)” treatment even if treated at the same time

Treatment:
• Azithromycin 1g stat – not yet licensed in pregnancy but widely used
• Or Doxycycline 100mg BD 7days – not in pregnancy
• Or Erythromycin 500mg QDS 7 days

Partner/contact management:
• Be clear about language; ‘partner’ implies a relationship – all sexual contacts in the last 60 days should be advised so they can be tested & treated.
• Contacts should be treated without waiting for their test results but ideally should be tested too; if positive, then their recent contacts need to be informed as well
• Most choose to tell contacts themselves; giving written information for partners is helpful
• Notifying all contacts may not be possible eg if there is insufficient information or a threat of violence

Follow-up (phone or in person) 2-4 weeks later:
• No unprotected sex during treatment?
• Completed/tolerated medication?
• All partners treated?
• Any risk of re-infection?
• Test of cure only needed if pregnant (treatment may be less effective in pregnancy)
• NAAT tests can detect traces of dead organisms – wait at least 6 weeks
• Re-infection is very common; offer repeat Chlamydia test in 3-6 months

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<th>Author Name</th>
<th>Dept Name</th>
<th>Issue Date</th>
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<tr>
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<td>September 2009</td>
<td>September 2012</td>
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Appendix 6: The New Zealand Ministry of Health chlamydia information leaflet 2008

**CHLAMYDIA**

**INFORMATION GUIDE**

New Zealand’s most commonly diagnosed sexually transmitted infection

**What is Chlamydia?**
Chlamydia is a common infection caused by a bacteria. It is a sexually transmitted infection (STI) that can infect the genitals, rectum, eye, and throat in women and men.

**How do you get it?**
Chlamydia is passed on by having sex, including vaginal, oral, and anal sex, without using a condom or any form of barrier protection used during oral sex with someone who has the infection. Chlamydia bacteria survive in semen and vaginal secretions and can be passed from mother to baby during birth.

**Who is most at risk?**
You are most at risk of Chlamydia infection if:
- You have had sex without a condom, or sex with a condom that has ripped or come off.
- You have had more than one sexual partner in the last 12 months.
- You or your partner(s) have another STI (many other STIs also have no other symptoms).
- You are under 25.

**What are the symptoms?**
Most people have no symptoms, but symptoms can include:
- **Women**
  - Unusual vaginal discharge
  - Pain when urinating or having sex
  - Bleeding after sex or between periods
  - Lower abdominal pain
  - A discharge or discomfort in the rectum

**MEN**
- A discharge or looking at the top of the penis
- Painful peeing at the beginning of urine
- Pain when urinating
- A discharge or discomfort in the rectum.

**How is it treated?**
Treatment with antibiotics is simple and in most cases a one-off dose of antibiotics. Sometimes more antibiotics may be needed.

It’s best to avoid sex for seven days after treatment to give the antibiotics time to work and to avoid passing on the infection.

**What happens if it is left untreated?**
Chlamydia infection can lead to health problems if not treated.

- In women the bacteria may spread to the uterus (WWW) and fallopian tubes and cause pelvic inflammatory disease. Pelvic inflammatory disease may cause:
  - Scarring and blockage of fallopian tubes
  - Infertility (unable to get pregnant because of blocked fallopian tubes)
  - Miscarriage, which is when a fertilised egg starts to grow outside the uterus. This can be dangerous.

- In men, Chlamydia can travel up the penis into the testicles. Inflammation here can also cause fertility problems because sperm can not be produced efficiently.

**How do I get tested?**
If you have had sex with someone, or the condom has ripped or come off, it’s worth getting checked out.

A doctor or nurse will talk to you about whether you are at risk for STIs and ask about your health. It is important to be honest.

The usual tests are:
- Men do a urethral test
- Women have a low vaginal swab, which can be self-conducted.

In some cases you may need to have further testing. All consultations and testing results are confidential between you and the doctor/nurse.

If I have Chlamydia does my partner need to be treated? Yes, all sexual partners need to be treated even if their test results are normal.

Doctors and nurses can help you talk to your partner about Chlamydia and other STIs or give you advice if you need it.

Where can I get tested?
- Medical centres and general practices, by a doctor or nurse
- At school youth health clinics
- Sexual health clinics
- Student health services at universities or polytechnics
- Family Planning Association clinics.
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