BETTER ELECTIVE WAITING TIMES FOR THE SURGICAL OUTPATIENT CLINIC

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ABSTRACT

Aim

This thesis seeks to optimise the delivery of health care of patients referred to the General Surgical Outpatient Clinic with rectal bleeding.

Method

Patients referred to the General Surgical Outpatient Clinic at Counties Manukau Health with the presenting complaint of rectal bleeding (also regarded as minor anorectal conditions) represented a pressure point for the Department of General Surgery. The work described in this thesis is divided into three distinct sections. The first section takes a whole system approach in determining bottlenecks in the 'system' and assessing some possible solutions. This was done, firstly by examining the trends of the current waiting list and also by performing a literature review of some of the strategies employed in other health care systems to help improve elective waiting times. This was followed by a systematic review into computer modelling systems as a means to analysing its use in the outpatient clinic setting. This provided a basis for the development of a generically constructed simulation model specific to the set-up of the outpatient clinic at CMH. The aim of the constructed simulation model was to test changes to the waiting list of outpatient clinic with hypothetical scenarios of increasing capacity through extra clinics, or through reducing unnecessary follow up appointments and of both strategies combined. The second section of the thesis investigated a patient initiated approach to follow up appointments and using General Practitioners with Specialty Interests (GPwSI). The findings

from the modelling system and the systematic reviews were used to help create a clinical pathway for patients with Per Rectal (PR) bleeding. The pathway was evaluated in a quasi-randomised controlled study to look at outcomes of PR bleeding patients referred to the outpatient clinic compared to a historical cohort. The final section of the thesis investigated the validity of the generically constructed model by comparing its predictive value to real-time data.

Results

A literature review into strategies in health care designed to improve elective waiting times in public secondary care suggested that, while there was no one-stop solution, a whole system approach was critical to any implemented strategy. The systematic review into modelling systems showed evidence of modelling system's use in improving access time via queuing theory. The prospectively constructed model analysed three hypothetical scenarios. It predicted that reducing follow up appointments would help improve waiting list at a similar rate to increasing capacity by means of an additional clinic.

A systematic review into the strategy of patient initiated follow up, showed that there is merit in such a policy. However, a systematic review looking at the role of GPwSIs showed limited evidence of efficacy and raised question marks regarding their cost-effectiveness. A prospective study, implementing the concept of Patient Initiated Follow Up (PIFU)and streamlining a pathway for PR bleeding patients showed, that follow up rates for patients were much lower in the new clinic (6% vs. 45%, $p<0.001$).

With reduced follow up appointments and the addition of a new clinic, the simulation model was tested against real data. Validity was high, for all the hypothesised scenarios, although the best match with the real data was when the model was simulated for the addition of the new clinic alone, as opposed to the combination of reduced follow up appointments and a new additional clinic.

Conclusion

Computer simulation modelling of a health system can help identify bottlenecks within a health system and this can be used to implement protocols and pathways that can not only streamline the delivery of care but also help optimise access to that care.

ACKOWLEDGEMENTS

The work presented in this thesis, is merely the tiniest piece of a puzzle that is the broad question of how, in this era of constrained resources, can we improve access to elective outpatient clinic services.

This thesis would not have been possible without the support of many. I would first and foremost, like to acknowledge my supervisor, Professor Andrew Hill. 'Prof' has not just been instrumental in his guidance and mentorship, but has constantly provided me the encouragement to think broader and bigger. His ability to always maintain a balanced perspective is a source of inspiration and not only has been of tremendous help to me in terms of navigating my way through such a broad topic but also, has helped me in my own life. My years as a Research Fellow with 'Prof' represent a fulfilling journey and some of my best years. I will always cherish his collegiality and most of all, his friendship.

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ABBREVIATIONS

A

ADHB	Auckland District Health Board
AMC	Adult Medical Clinic
ASA	American Society of Anaestheisologists

B

BC	Breast Cancer
BCC	Basal Cell Carcinoma
BCN	Breast Cancer Nurse

C

CG	Control Group
CMDHB	Counties Manukau District Health Board
CMH	Counties Manukau Health
CTc	CT colonography

D

DES	Discrete Events Simulation
DHB	District Health Board
DNA	Did Not Attend
DRES	Delivery Redesign of Elective Services

E

ERAS	Enhanced Recovery After Surgery
ES	Elective Services
ESPI	Elective Services Patient Flow Indicators
ESPWP	Elective Services Productivity & Workforce Programme

F

FOBT	Faecal Occult Blood Testing
FSA	First Specialist Appointment
FU	Follow Up
FUP	Follow Up

G

GP	General Practitioner
GPwSI	General Practitioners with Specialty Interests
GRADE	Grading of Recommendations Assessment, Development and Evaluation
GU	Genito-Urinary

H

HQSC	Health Quality and Safety Commission

I

IBD	Inflammatory Bowel Disease

ITS	Interrupted Time Series

M

MoH	Ministry of Health
NHS	National Health Service

N

NICE	National Institute of Health and Care Excellence
NZ	New Zealand

O

OR	Operations Research
ORL	Otorhinolaryngology

P

PIFU	Patient Initiated Follow Up
PR Bleeding	Rectal Bleeding
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Q

QALY	Quality Associated Life Years
QOL	Quality of Life
QT	Queuing Theory

R

RA	Rheumatoid Arthritis

RCT	Randomised Controlled Trial

S

SCC	Squamous Cell Carcinoma
SCG	Shared Care Group
SD	System Dynamics

U

UAHPEC	University of Auckland Human Participants Ethics Committee
UC	Ulcerative Colitis
UK	United Kingdom
UKFSST	The UK Flexible Sigmoidoscopy Screening Trial

V

VAS	Visual Analogue Scale

W

WDHB	Waitemata District Health Board
WL	Waiting List

CHAPTER 1 - INTRODUCTION

1.1 Background of New Zealand Elective Services

1.1.1 Basic Organisation of Elective Services in New Zealand

Elective surgical services (ES) consist of either outpatient clinics or elective surgeries and/or other procedures. The Ministry of Health of New Zealand (MoH) recognises a service as elective, if it is provided seven or more days after the decision to proceed with treatment is made (Ministry of Health website)(1). In New Zealand (NZ), referral to ES is generally made by the patient's primary care provider to the District Health Board (DHB) of the patient's domiciliary area(1). The DHBs represent secondary level care with specialists who review the referred patient and then subsequently prioritise that patient on to the elective surgical waiting list.

1.1.2 Health Policy Reforms for ES

Long waiting lists for elective services have been a common feature of the public health system in New Zealand for many years(2, 3). There have been many health policy reforms in the last two decades with the aim of treating patients in a timely manner within the availabilty and constraints of health resources(2, 4).

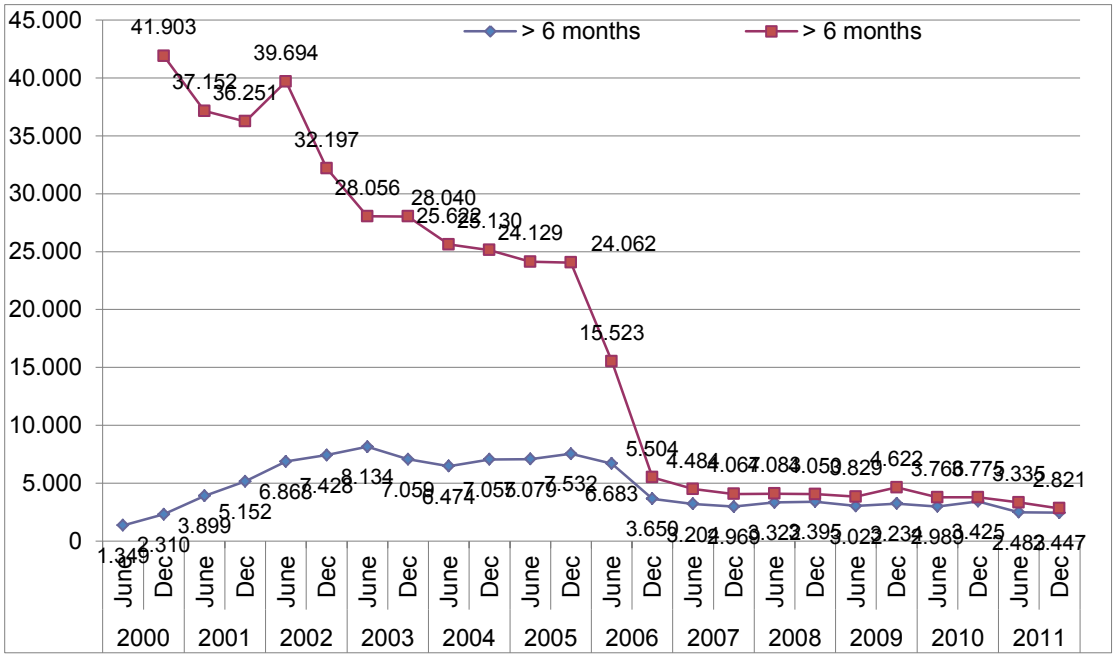
In 2000, the MoH, which funds each of the twenty DHBs in NZ responsible for delivering health care in their regions, developed strategic objectives for elective services to ensure that there would a maximum waiting time of six months for first specialist assessment (FSA) in outpatient clinics and a maxiumum waiting time of six months, once patients were given a commitment to treatment(2, 5, 6).

Since 2006, the elective services targets were applied more consistently resulting in a substantial decline in the numbers of patients not receiving their FSAs in a timely manner.

These reductions in waiting lists have been achieved in part due to increased funding for elective services and the use of financial incentives and targets. The MoH also regularly assesses each DHB's performance based on seven indicators known as the Elective Services Patient Flow Indicators (ESPIs)(7).

Figure 1.1.1 shows the number of patients waiting longer than six months for their FSA (ESPI 2) and the number of patients given a commitment to treatment but not treated within the six month period (ESPI 5) between 2000 and 2011

Figure 1.1.1 Numbers of people waiting more than six months for treatment and FSA, New Zealand, 2000 to 2011



Source: Waiting Time Policies in the Health Sector: What Works? OECD Health Policy Studies Siciliani et al 2013, page 212(8)

In addition to providing financial incentives, funding can also be withheld if DHBs fail to meet their ESPIs targets.

In 2012, the Government announced further Elective Services objectives such that patients in all DHBs would wait no longer than five months for FSA or treatment commencing June 2013 and no longer than four months for FSA or treatment commencing December 2014(1, 2, 8).

Some of the other key elements from the Elective programme objectives that were updated in 2011 included(1, 8):

- Increasing available services by improving capacity, productivity and efficiency
- Working towards everyone having equal access to elective surgery no matter where they live.
- Improving the management of patients (patient flow) to reduce waiting times.
- Supporting new and innovative ways of providing Electives, such as adopting alternative pathways and models of care.

A consequence of these new objectives was that there was a greater emphasis placed on innovation, capacity and production planning and developing novel pathways of care to allow DHBs to achieve the newer targets within the constraints of limited resources(8).

1.2 Strategies to Improve Waiting Times

A systematic review of 103 included studies, on policies to reduce elective waiting times by Kriendler et al(9), succinctly summarises the principal strategies. In broad terms, it can be considered that waitlists occur when demand outweighs supply. Hence, strategies intended to improve waiting times are either focussed on increasing supply (supply side strategies) or reducing demand (demand side strategies).

1.2.1 Supply Side Strategies

According to the systematic review by Kriendler, supply side strategies include:

- **Direct increase in supply** – This represents the most basic supply side strategy and generally requires very high resource allocation. Often temporary injections in resources to boost supply are used but this strategy may fail if the increase in resources is not sustained.
- **Buying supply externally** – this pertains to utilising the private sector with 'public' money. The main advantage of involving the private sector is that it already has an established infrastructure and maybe readily set up to provide a more flexible service. However, what is not clear is whether this strategy has any proven efficacy. A 2003 OECD report noted that while many countries (England, New Zealand, Spain, Australia, Denmark) had applied this policy, there was a lack of information about its effectiveness.
- **Alternative treatment providers** – Examples include nurse practitioners and General Practitioners with specialty interests (GPwSIs). GPwSIs have arisen from the National Health System (NHS) plan in the United Kingdom (UK) and are utilised in various other countries. Their cost effectiveness and efficacy is not clear.
- **Using capacity more efficiently** – This pertains to systems redesign and reducing inefficiencies – such as complex booking systems, unnecessary steps in the patient journey etc. However, evidence on effects of system

redesign remains patchy. The majority of evidence on system redesign comes from case studies.

1.2.2 Demand Side Strategies

Demand side strategies discussed in this review by Kriendler include:

- **Prevention of illness** – This concept relates to major public health initiatives. Its main disadvantage is that as a strategy it is difficult to quantifiably assess and implement.
- **Rationing of services** – This strategy may be effective in that it can reduce wait times for those who are prioritised higher than a set criteria. However, the difficulty lies in developing reliable and valid criteria.
- **Prioritising patients and treat high priority ones first** – Unfortunately this does not tend to reduce average wait times. Its main advantage is improved equity however.
- **Eliminating inappropriate investigations or treatments** – Whilst conceptually common sense, this strategy lacks evidence of large scale effects.

1.2.3 Maximum Waiting-Time Guarantees

A similar paper by Siciliani and Hurst, 2005(10), provides a comparative analysis of policies across 12 OECD countries including NZ. It too, discusses supply side and demand side strategies. Along with the general strategies discussed above it discusses the effect of maximum waiting-time guarantees, raising clinical

thresholds and contracting with the private sector. It also discusses the role of subsidising private insurance.

The paper noted that maximum waiting-time guarantees may be effective in reducing long waiting but are not very effective in reducing mean or median times. This view is supported by Kriendler(9). A concern however, with respect to mandatory targets such as those by the MoH, is that health care providers may undertake 'gaming' such as data manipulation or 'hidden' lists etc. This can also lead to a loss of quality. An article by Hanning(11) describes the Swedish experience in 1990's with maximum waiting-time guarantees. It identified that whilst extra-funding helped reduce waiting times initially, there was a progressive increase over the years and that it did not lead towards a more even distribution of health care resources.

1.2.4 Private Sector Utilisation for Improved Access

Contracting with the private sector appears to be a quick way to gain access to additional capacity, compared with increasing supply through public hospitals. The paper by Siciliani and Hurst(10) highlights however, that often the private units end up competing with the public units for the same resources (e.g. specialist staff) and as such, the effectiveness of such a policy is not clear. The potential risks of this policy are also highlighted in an article by Ashton(12), in which the risks include potential higher costs in the private sector, potential loss of workforce to the private sector and potential inequality in the distribution of health care.

Siciliani and Hurst also state that whilst policies such as encouraging or even subsidising private health insurance may have the intention of reducing demand for public elective services, such policies are at risk of failing unless there is spare capacity in the private sector. Otherwise, there is a risk of resources being sucked out of the public system to feed into the private system.

1.2.5 Cochrane Review on Interventions To Reducing Waiting Times for Elective Procedures

A Cochrane Review by Ballini et al (13) analysed eight studies which included three randomised controlled trials (RCTs) and five interrupted time series studies (ITS). In summary this review identified various interventions described in the studies, which are outlined below:

1. Effects of interventions aimed at rationing and/or prioritising demand (e.g. co-payment, explicit referral criteria, clinical priority scores)
2. Effects of interventions aimed at improving the organisational management of waiting lists or restructuring the intake assessment/referral process.
3. Effects of direct/open access and direct booking systems
4. Effects of distant consultancy (e.g. tele-medicine)
5. Effects of introducing generic waiting lists (pooling of patients)

Some benefit was noted with rationing or re-prioritising demand, which seemed to lead to an improvement of waiting times for those patients triaged as 'semi-

urgent', whilst patients triaged as 'urgent' or 'non-urgent' were unaffected, in the one ITS study involving urological patients. Among the seven studies that evaluated interventions aimed at restructuring the intake assessment/referral process, four showed no effect whilst three studies showed some improvement in waiting times. Distant consultancy and pooling of waitlists were noted to show no benefit in terms of waiting times. Three out of the four studies that examined the efficacy of direct access and direct booking systems showed improvement in waiting times.

Despite some evidence supporting benefit with some of the above interventions, the review found that the quality of evidence ranged from low to very low based on the GRADE (Grades of Recommendation, Assessment, Development and Evaluation)(14) tool. Furthermore, the review did not find any studies evaluating interventions to increase capacity or to ration demand that were fitted with the inclusion and exclusion criteria. Hence, given that there were only a handful of low quality studies available, no meaningful conclusions could be drawn about the effectiveness of the above interventions.

1.2.6 Factors Accounting For Variation In Different Strategic Approaches To Reducing Waiting Times

A report into achieving and sustaining reductions in waiting times for public hospitals by Appelby et al (15) to the Department of Health in the UK highlighted the difficulty in making generalisable conclusions. It identified however, four

particularly important factors that account for variations in achieving and sustaining reductions in waiting times:

1. a sustained focus on the task
2. an understanding of the nature of waiting lists and a whole system approach
3. detailed information, analysis, forecasting, monitoring and planning
4. development of appropriate capacity.

A similar point was also raised in another narrative paper by Kreindler(16). In this paper, Kreindler identifies that some of the common pitfalls in strategies to help patient flow essentially come down to an inadequate whole system approach, where patient population, capacity of the health system and process are not looked in conjunction with each other.

1.2.7 Summary of Strategies

The common theme amongst the various reviews that have looked into strategies and interventions aimed at improving waiting times is that no single policy can provide the answer on its own. Furthermore, if interventions are imposed without sufficient additional resources, they are at risk of failing. Interventions imposed without a sufficient 'whole system approach' are also at risk of failing. It must be recognised that the interventions described tend to lack generalisability. Any initiative must also be viewed from a quality and cost effectiveness viewpoint and must be consistent with the culture of the organisation. Ultimately, waiting times and waiting lists are only one aspect of

health care delivery and good quality evidence to support any one strategy over another is patchy at best.

1.3 Main Characteristics of Referral System at Counties Manukau Health

1.3.1 General Characteristics of Counties Manukau Health

Counties Manukau Health (CMH-previously Counties Manukau District Health Board-CMDHB) is one of twenty NZ DHBs. CMH is responsible for providing health and disability services to an estimated population of 520,000 people (or approximately 11% of NZ's entire population) in the combined regions of South Auckland, East Auckland and Franklin districts(17) (Figures 1.3.1.1 and 1.3.1.2).

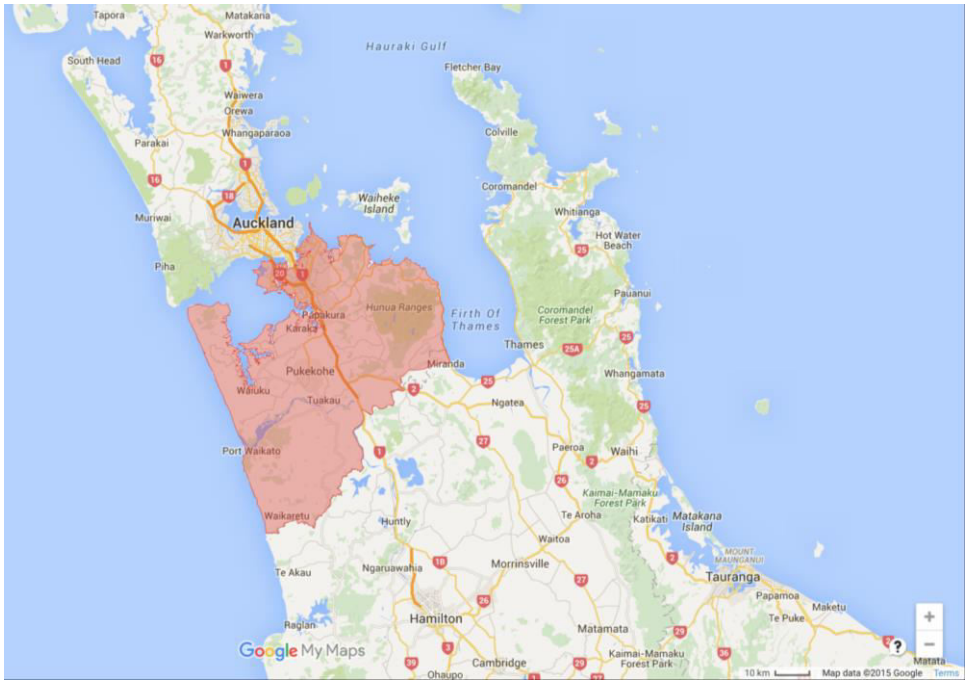
According to CMH's Quality Accounts 2013-2014 document(18), published in the Health Quality and Safety Commission (HQSC) website, CMH has the largest expected population growth both in absolute numbers and in ageing. In the last 10 years CMH population growth has averaged 2.4% per annum and future growth is forecasted at 1.5% per annum.

With new ES targets on the horizon, CMH recognized that in order to achieve a step increase in productivity to achieve the new target timelines, innovation in the management of elective workload was required.

Figure 1.3.1.1 DHBs in NZ

Source: Ministry of Health, NZ website

Figure 1.3.1.2 Boundaries for Counties Manukau Health



Source: Google Maps

1.3.2 DRES Project

In April 2013, CMH signed up to a contract with the MoH as part of their wider "Elective Services Productivity and Workforce Programme (ESPWP)" that within CMH was known as the "Delivery Redesign of Elective Services (DRES)(18)."

The DRES Programme consisted of five projects with the aim "to enhance the effectiveness and efficiency of the primary to secondary care interface across elective services, and the development and implementation of elective service delivery redesigns across the nominated patient pathways(18)." Table 1.3.2 summaries the five projects

Table 1.3.2 Project Summary DRES Programme

1. **Primary Secondary Interface Project**: for the enhancement of the effectiveness and efficiency of the primary to secondary care interface across elective services in Orthopaedics, Hands, and Otorhinolaryngology (ORL), incorporating patient referral process from Primary Care, triage, grading and scheduling for First Specialist Assessment (FSA) or alternative pathways, and discharge with effective support to their primary carers.
2. **General Surgery Pathway Redesign Project**: for the development and implementation of elective service delivery redesigns for the subspecialties of Bariatric, Varicose Veins, and Rectal Bleeding (PR bleeding) to foster clinical consistency and the implementation of best practice evidence based clinical pathways from triage to FSA, treatment, and discharge back to their primary carers.
3. **Plastic Pathway Redesign Project:** for the investigation and development of the regional delivery of Breast Reconstruction with Waitemata District Health Board (WDHB); Auckland District Health Board (ADHB); and Northland District Health Board (NDHB), in order to enhance the patient pathway through this service, through standardisation, local delivery (where appropriate) and consistency of care.
4. **Regional Urology Pathway Redesign Project:** to be carried out in conjunction with ADHB to foster equitable levels and standards of access, enhanced productivity and patient centred care delivery for the Auckland Metro DHBs (WDHB, CMH & ADHB).
5. **Sector Support Network (ERAS) Dissemination Project:** Noting the proven value of Enhanced Recovery After Surgery (ERAS) practices in colorectal and bariatric surgery (and similar initiatives in Orthopaedics), the Programme will, in consultation with the necessary external parties, expand the philosophy and practices of ERAS to as many as possible other appropriate pathways and surgical specialties, including supporting their implementation in other DHBs.

1.3.3 Background At CMH, General Surgery

The General Surgical Department at CMH is dedicated to providing a comprehensive service to its patients and its referrers. The outpatient clinics of this department review and manage patients with subset conditions such as breast surgery, bariatric surgery, endocrine surgery, upper gastro-intestinal (Upper GI) surgery and colorectal surgery. Within these subspecialties are also a group of conditions that are 'generalist' including hernias and 'lumps and bumps.' Another 'generalist' condition is PR bleeding patients. These patients come under the category of 'minor anorectal conditions'. The term 'minor anorectal conditions' is generally used to triage patients that are seen in the outpatient clinic with outlet type 'rectal bleeding' (or PR bleeding) and generally include diagnoses such as haemorrhoids (piles) and anal fissures.

The department of General Surgery at CMH has structured its outpatients to have a combination of sub-specialty clinics such as breast surgery, bariatrics etc. as well 'general' clinics. Patients with PR bleeding are seen in non-specialty general clinics, by a variety of General and Colorectal Surgeons. An important distinction to be made here is that patients who are referred with anorectal conditions but without the primary symptom of bleeding (e.g. prolapse, incontinence, fistula, masses or proctalgia etc.) are usually regarded as 'complex colorectal' and are usually triaged into specialist colorectal clinics. Patients referred with other complex symptoms (weight loss, abdominal mass, anaemia etc.) in conjunction with PR bleeding are also usually regarded as either 'complex colorectal' or have had their referrals redirected to the Department of Gastroenterology for

consideration of a direct colonoscopy. The ability to redirect referrals is usually left up to the discretion of the triaging clinician.

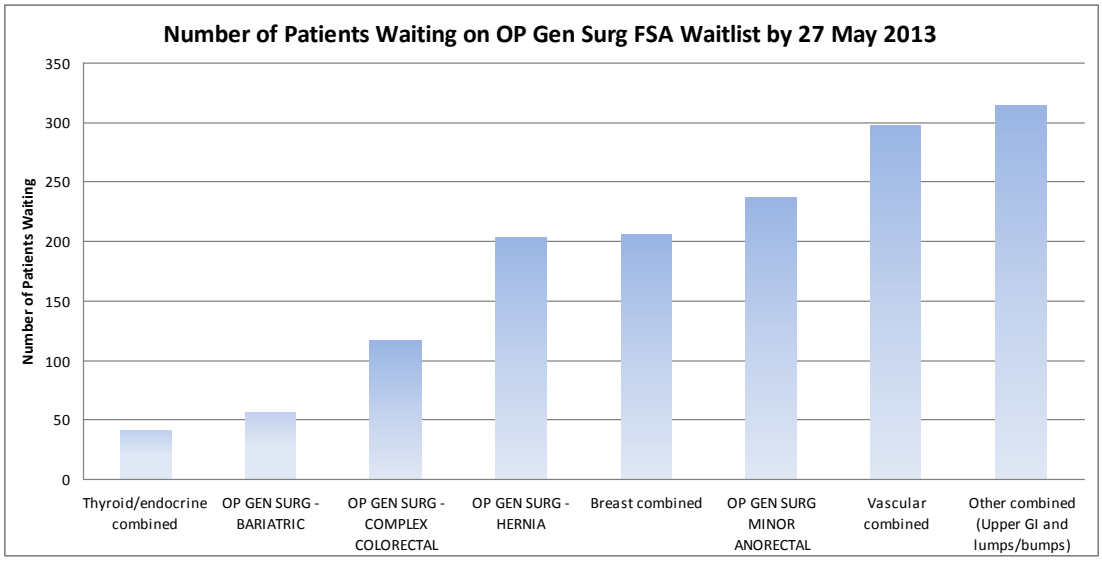
The patients coded in the outpatient department as 'minor anorectal conditions' therefore, are generally those who are referred in with PR bleeding. This is also evidenced by a review of 151 consecutive patients seen in the outpatient clinic by colorectal surgeons in 2012 under the category of minor anorectal conditions, where 136 patients (90%) were identified with PR bleeding as their primary symptom.

1.3.2.1 The Waitlist for Minor Anorectal (PR Bleeding) Conditions

In May 2013, the overall waitlist number for the Department of General Surgery and Vascular Surgery was 1421 patients. Of this waitlist, approximately 240 patients were those with minor anorectal conditions (nearly 17%). Complex colorectal patients accounted for nearly 10% of the total waitlist. If the nearly 300 Vascular Surgery patients are excluded from this waitlist, then the patients with minor anorectal conditions account for approximately 21% of the overall waitlist.

Figure 1.3.2.1 shows the distribution by numbers on waiting list of the various sub-specialties comprising 'General Surgery.'

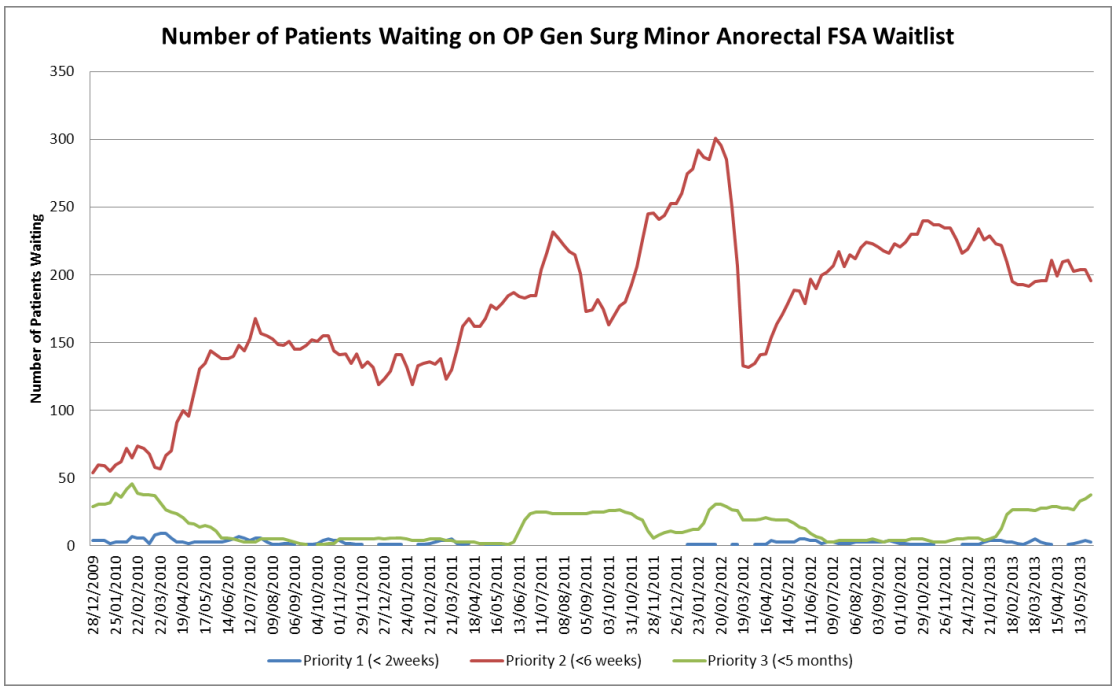
Figure 1.3.2.1 General Surgery Sub-Specialty Waitlist May 2013



Furthermore, the median waiting for patients with minor anorectal conditions as of May 2013 was approximately 16 weeks. Given the new ministerial targets, this clearly indicated that minor anorectal conditions (PR bleeding) represented a 'pressure' point for service provision in the Department of General Surgery.

A simple solution to address this problem appeared to be a direct increase in capacity for service provision. In the middle of 2012, the Department of General Surgery decided to trial introducing additional 'extra-hours' clinics to be held on Saturdays, designed to see just FSAs for PR bleeding patients. The consequence of this was a sharp dip in numbers on the waitlist. However, an unforeseen consequence of this strategy was the generation of a large volume of follow up appointments and this meant that FSA's were not able to be seen as frequently in the already established clinics. Figure 1.3.2.2 shows the gradual increase in waitlist numbers of patients with minor anorectal conditions. Note the sharp decline in waitlist numbers around April 2012 and the subsequent gradual rise towards the end of 2012.

Figure 1.3.2.2 Waiting List for Outpatient Clinic for Minor Anorectal Conditions (PR bleeding) at CMH as per clinical priority



It is clear that minor anorectal conditions/PR bleeding (mostly booked as clinical priority 2) represented a 'pressure point' for the department of General Surgery. It is also evident that simple transient injections of extra-resources failed to improve the problem of lengthy waiting times, unless the resource increase was sustained, as is seen in the case above. This notion is also highlighted in the systematic review by Kriendler(9), mentioned above.

1.4 Summary

The overall question that arises therefore is, how, in an era of constrained resources and greater expectations, can the delivery of health care of patients

referred to outpatient clinics with the specific problem of PR bleeding be optimised?

The literature review, as described above, shows that there is a paucity of evidence of strategies that have proven to work in terms of improving access to elective services in secondary care. Furthermore, initiatives have often lacked generalisability and have tended to be centre specific.

The answer to this question will therefore require a new and innovative approach. Given that there are no widely practised standardised approaches to improving efficiency this means that an in-depth understanding of what a hospital's current processes, pathways and operations are, is required. There are numerous complex interactions between multiple factors in the journey of a patient from primary care to secondary care in the outpatient clinic. Such complexities might best be understood by applied analytics and operations research.

1.5 Aims of Thesis

This thesis was developed as part of research within the DRES Programme, centred on Project 2, involving pathway redesign of elective PR bleeding patients. The broad aim of the thesis was to determine how, within an era of constrained resources is it possible to optimise the delivery of health care of patients referred to outpatient clinics with the problem of PR bleeding?

Specific objectives to answer the overall question of the thesis that will be presented in the subsequent chapters include:

1. To identify the current waitlist number, waiting times and volumes of patients referred to General Surgical Outpatients with the condition of PR bleeding. This is important to define the scope of the problem in detail and determine where in the pathway from referral from primary care to receipt of treatment in secondary care, can planned interventions make most impact.
2. To evaluate the role of simulation modelling within the field of operations research in order to improve access to outpatient clinics. This will involve a systematic review on different modelling techniques and their application with respect to outpatient clinics in secondary care.
3. To develop a 'whole system' dynamic simulation model that can map the patient journey from primary care to outpatient clinic. This will potentially allow the identification of the various 'bottle-necks' in the pathway and allow for the experimentation of hypothetical interventions or scenarios and 'test' their impact on waiting lists and waiting times.
4. To develop an evidence-based, protocolised clinical pathway with the aid of predictive estimation from a simulation modelling tool, designed to provide an efficient service for patients referred to Outpatient Clinics with PR bleeding.
5. To evaluate the role of General Practitioners with Specialty Interests (GpwSI) and consider whether a GPwSI program for PR bleeding patients would be appropriate to not only improve the primary-secondary care interface but to also improve waiting times by providing an alternative workforce capacity. The Surgical Governance Board for the DRES programme at CMH is

particularly interested in the utilisation of GpwSIs as it has been used for the treatment of skin lesions in the Plastic Surgery Department at CMH. However, there are question marks as to the efficacy of a GPwSI programme, with concerns regarding higher costs and potentially inferior quality of service.

6. To evaluate the effects of the new clinical pathway for PR bleeding patients with respect to reducing clinical variation and reducing waiting times. This will provide the main experimental study of the thesis and the aim will be to compare clinical outcomes to a historical control to determine if this translates into more efficient and more accessible care for patients referred to CMH with PR bleeding.

CHAPTER 2 - IS A MATHEMATICIAN'S PERSPECTIVE USEFUL?

2.1 Introduction

As discussed in the Chapter 1, patients with PR bleeding represent a particular 'pressure point' for the Department of General Surgery at CMH in light of newly imposed ministerial targets for outpatient clinics. Given that CMH is a wholly public health care provider, it encounters the same challenges as most public health organisations with increasing health care demands for services but limited health care resources. The drive to maintain the delivery of high quality services within such constraints has made decision makers and managers to look at tools that can help with planning, optimising and reforming the service processes.

2.1.1 Operations Research (OR)

In Chapter one it was noted that despite various strategies for improving access to public secondary level care, many studies lack generalisablity. This poses particular challenges to decision and policy makers as to what strategies to employ, knowing that what has succeeded elsewhere may lack efficacy in the current environment and set up. Furthermore, as also mentioned in Chapter 1, the report by Appleby et al 2005(15), highlighted that a 'whole system approach' is vital to ensuring that the strategies employed to help reduce waiting times are actually sustainable. A novel approach to better dealing with such issues is suggested in a perspective article by Harrison et al(19) who noted that theatre management, throughput and efficiency could improve by the use of Operations Research (OR). This is an under-utilised strategic technique in health care. OR is defined as the use of advanced analytical methods to assist with decision making

to help optimise efficiency within a given system(5). It is frequently synonymous with management science(20, 21). OR typically frames a complex problem (such as the delivery of elective health care, for example) into a mathematical structure(22). Within this structure there are three main components – objective function, variables and constraints.

2.1.2 Computer Simulation

A core feature of OR is computer simulation as it can help understand and evaluate a system's performance. It can provide an insight into the interdependence of numerous variables within a given system, such as the running of outpatient clinics, and allow alternative methods of testing or simulating hypothetical changes. This is particularly important in circumstances where actual interventions cannot be tested due to safety, economic, time or other pragmatic constraints(21).

There are numerous combinations of modelling techniques and approaches that have been used in health care research. This is well described in a systematic review of simulation modelling in surgical care by Sobolev et al(21), which broadly classifies simulation models into:

1. Stochastic or deterministic. In a deterministic simulation, all of the events and relationships among the variables are governed entirely by a set of known rules, e.g. banking interest rates and loans. Stochastic models on the other hand contain at least one probabilistic random variable to

represent the effect of factors that are unknown or unpredictable. Examples include stock market or exchange rate fluctuations or weather prediction.

2. Static or dynamic. A model is said to be dynamic if it is used to simulate an operation over a period of time. If a time component does not influence the outcome, the model is said to be static, e.g. gambling scenarios such as roulette.
3. Discrete or continuous time. Discrete event models are suitable when the variables influencing the model change at discrete times by discrete steps. A classic example of a discrete event simulation (DES) model is that of a queue, such as patients arriving at an outpatient clinic for their appointment. Continuous time models however, reflect systems where the variables can change continuously and independently. Examples of this include flight simulators, chemical process modelling, electrical circuit modelling(21).

2.1.3 Queueing Theory

One of most core and perhaps oldest areas of OR is Queueing Theory (QT). Queueing models are particularly useful in health care as they pertain to waiting times as their main outcome. In fact, it is widely recognised that the principle of QT was developed circa mid 1910's due to queues at the main telephone exchange. Queues develop because of the randomness of 'customer' arrivals, processing and exit. All these components have variable distributions and thus are difficult to map out mathematically unless aided by computer simulation.

QT has also been utilised in several areas of health care such as emergency care, transplantation services and pharmacy care(23-25)

2.2 Aims

In this chapter a systematic review is conducted to evaluate the use of computer simulation models used, specifically in the setting of outpatient clinics in secondary care.

The objectives are therefore:

To identify the different models and approaches related to outpatient clinics in secondary care and how they differ in their intended outcome measures for improving outpatient clinic efficiency in secondary care.

2.3 Methods

Appropriate methodology according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)(26) statement was followed.

2.3.1 Search Strategy

An electronic literature search was performed independently by two researchers (the author and a colleague) using the following pre-defined search terms in an abstract and keyword search:

(Simulat$ model$ AND Outpatient$ Clinic$ or outpatient$ patient$ or patient$ flow$ or wait$ time$ or schedul$)

These terms were searched from April 1990 to April 2014 over the following databases: EMBASE, Ovid MedLine, PubMed, PSYCINFO and the Cochrane Library. Each reviewer judged papers as potentially relevant based on the title and abstract and those deemed as potentially relevant were read in full and assessed for inclusion with any disagreement over inclusion and exclusion resolved by consensus.

Reference lists of all relevant articles were also screened to identify other relevant studies.

2.3.2 Study Selection

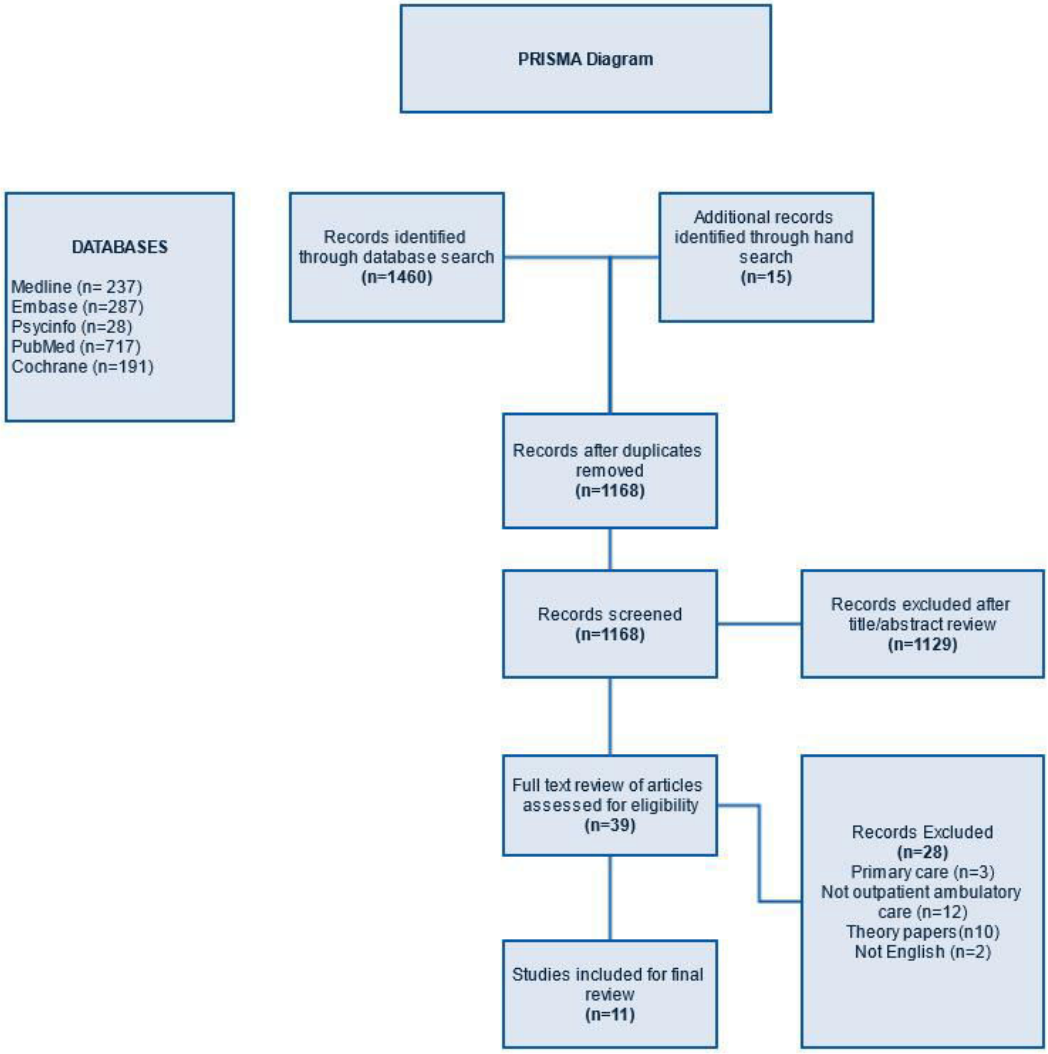
Articles were included if they specifically utilised a computer simulation model to evaluate, solely, hospital outpatient clinics with respect to patient flow, efficiency as well as waiting times. Any study that did not relate its data or application to a secondary care outpatient clinic was excluded. Procedure or treatment clinics such as endoscopy, radiotherapy or chemotherapy were excluded. Radiology appointments were excluded as were other clinics that mixed inpatient and outpatient cohorts. Simulation modelling on ancillary services was also excluded. Studies that used modelling systems to analyse any facet of waitlists for elective surgery or procedures were also excluded. Conference abstracts, editorials, commentaries, implementation protocols,

informally published reports, and non-English language articles were also excluded.

2.4 Results

A total of eleven studies(20, 27-36) were identified as suitable for inclusion in this systematic review (Figure 2.4.). Eight of these articles(27, 28, 30, 32-36) utilised discrete event simulation (DES) models across a variety of simulated outcomes ranging from determining optimal scheduling arrangements to increasing consulting times. Another model(31) looked at specifically improving access times to outpatient clinics. Two further models specifically analysed optimal staff ratios along with examination room space(20, 29).

Figure 2.4 PRISMA Flow Diagram



2.4.1 DES Modelling and Patient Queues in Outpatient Clinics

The majority of papers in this systematic review investigated patient queues within specified clinics and utilised DES modelling to simulate scenarios largely to identify ways to reduce patient waiting time within a clinic.

Aeenparast et al(27) constructed a DES model using the data of arrival time, service time and flow of 357 patients referred to an orthopaedic outpatient clinic

in a public teaching hospital in Iran. The simulation model was validated by running several replications and comparing it to actual system data. No significant differences were noted. Following this, various hypothesised scenarios were tested. The scenarios consisted of increasing resident physician numbers from two to three personnel, increasing attending physician time in the clinic from 100 to 160 minutes, or increasing resident time in clinic from 200 to 260 minutes. Various combinations were tested in the simulation model and ultimately it was noted that Scenario 9, which involved all the above mentioned changes would improve total waiting for the patient in the outpatient clinic by 73%.

Aharonson-Daniel et al(28) looked at a government hospital outpatient clinic in Hong Kong and constructed a DES model by performing a time in motion study of 4,374 patients who visited the generic outpatient department. The model constructed was then validated by using retrospective data. It was noted that patients in the outpatient department were seen on "FIFO" basis, which is first in-first out, or first in-first served. Results obtained from the model showed that the mean consultation time was about two minutes, while the mean time spent waiting for this consultation was over 50 minutes. The model identified that changing to an appointment based strategy by allowing 50 patients to arrive every 30 minutes allowed 350 patients in 7 batches. This total was similar to current workload per clinic. This strategy however, would allow clearance of list 30 minutes earlier according to the model.

The article by Parks et al(33) utilises DES modelling in an outpatient adult medical clinic (AMC) of a major tertiary level hospital in the United States. After developing a process map prospectively, the DES model was constructed by incorporating probabilities of the various components of the process map such as arrival patterns, service time, physician attendance time, patient routing probabilities etc. On average 350 patients were seen in the AMC, daily. The average time in the system for a given patient was 124.3 ±65.7 minutes. Medication administration queues and check out queues were the areas noted to have the most congestion. Interestingly they noted that increasing medication administration staff for the queue did not seem to show any benefit, whilst increasing "space" by adding another work station resulted in this queue coming down from 77.5 to 7.7 minutes. Another scenario was tested in the model by reassigning staff from the check in function to the check-out function, earlier in the day and this suggested a significant improvement in the size of the check-out queue from 36 to 7 patients without significantly negatively affecting the check in queue. No prospective validation of the suggested changes has been reported however.

Rohleder et al(34) constructed a DES model for an orthopaedic clinic at a Canadian public hospital. A process map was drawn and prospectively analysed data were used to translate the map into a model. The model was validated prospectively as well. The clinic had a monthly volume of approximately 1000 patients and ran daily from Monday to Friday. It was noted that 95% of patients required X-rays prior to consults. The model recognised that both x-ray machines needed to be operational simultaneously to avoid significant back log.

However, often one of the two technicians was on break at a given time, rendering one of the machines unavailable. The suggestion was therefore, to have an extra technician available. The model also identified that the late arrival of clinicians, 30-60 minutes after the clinic opened was another cause for significant delay for patients. The third problem identified by the model was appointment scheduling. Bookers front loaded patients - i.e. longer time was allocated to the first few patients and then subsequently less patients booked during the course of the day. The model suggested that reducing the number of patients scheduled in blocks and working with consistent intervals would lead to less waiting without creating significant surgeon idle time.

When all three suggestions were applied the model showed an improvement in waiting time of over 40 minutes and the authors proposed that each of the suggested changes contributed equally to the expected improvement in waiting time. In this study, the recommended changes were actually implemented and total waiting time improved by 22 minutes. The reason for the discrepancy was thought to be largely due to the inability to adhere exactly to the new protocols.

Two studies from Taiwan utilised DES models to determine the effects of an appointments based scheduling system(32, 35). Most clinics in Taiwan are run on a FIFO basis with no incentive for pre-registering for scheduled appointments. Su et al(35) noted that 72% of patients were walk-ins in a busy urology clinic at a large Taiwanese hospital. The simulation ran several scheduling scenarios. In the first model (Model A), the first twenty patients were reserved for scheduled appointments and after that only even numbers were

offered scheduled ones and odd numbers were left for walk ins. In the second model, the front numbers were assigned to scheduled patients successively and the later numbers were left for walk-ins. The third model (model C) assigned scheduled patients with even numbers and walk-ins with odd numbers in sequence. The DES model found that this model had significantly less throughput time vs. others (34.9 minutes vs. 55.2 minutes for model B and 56.2 minutes for model A). Model C also had less waiting time for patients (14.7 minutes vs. 34.9 vs. 35.8 minutes).

Huarng et al(32) similarly constructed a DES model in an outpatient dermatology clinic. They noted that average waiting time for patients was 32 minutes but consultation time was only 1.89 minutes. If the registration pattern was changed to an appointment system, the simulation model predicted that this would lead to time in system reduction to 17.4 minutes assuming all patients were scheduled by appointments and that there were no walk-ins. The inability to practically achieve such a system was the reason why this suggestion was not adopted. The model also analysed the effects of increasing service by adding an additional clinic. At the same time it assumed a 20% increase in demand as an estimated response to the increased capacity. It noted that despite this, the total time in system for the patient would be 19.9 minutes.

Weerawat et al(36) investigated the use of a generically created DES model for the orthopaedic outpatient clinic of a large public hospital in Thailand. The general volume of this clinic was about 2600 patients per week. A morning clinic session for example would be staffed by 11 doctors and run from 9-12 am. Total

time in the system for a patient averaged 124.9 minutes. This was largely due to waiting time as patients would often come to clinics early to avoid morning traffic. However, the model predicted that if a straddled system was used, where 4 doctors would start the clinic from 7-10 am, followed by another four from 8-11 am and then another from 9-12 am, total time in system would decline to 48.6 minutes. The DES model also identified that using electronic filing systems could save approximately 30 minutes per patient.

2.4.2 Modelling and Space and Staff Efficiency in Outpatient Clinics

There were two studies that investigated space and staff optimisation to improve efficiency for outpatient clinics(20, 29). Benninger et al(29) constructed a model in a busy ORL clinic at a suburban clinic in the USA. They found that the clinics ran at a ratio of 2 examination rooms per physician along with one support staff. However, they noted optimal ratios according to the modelling to be 3 examination rooms and 1.5 support staff per physician. By doing this the model predicted a decrease in visit length from 81 minutes to 57 minutes. Furthermore, average time from check in to examination would decrease from 47 to 16 minutes. As well as this, 3 more patients could be seen each day per physician. Interestingly, ratios of space and staff greater than this would not yield any further benefit.

Clague et al(20) analysed a Genito-urinary (GU) clinic in a large UK hospital. The model was constructed using audit data of clinic volumes and waiting times. It identified that increasing or decreasing doctor numbers led to linear changes in

waiting times in clinic for patients. The model identified however, that the gradient of these changes would be dependent on the ratios of new to follow up patients on the pre-text that follow up appointments were 3 times less in duration. It noted that the most dramatic improvement in patient waiting time occurs when doctor numbers are increased in clinics with a high ratio of new to follow up patients (1:2.5). In this setting, patient waiting times will reduce from 55 minutes to 30 minutes when doctor numbers are increased from 2 to 4. On the other end of the spectrum, the model noted that in clinics where the ratio of new to follow up patients was 1:5, waiting times would improve from 20 to 10 minutes, when doctor numbers are increased from 2 to 4. Hence this model provides capacity planning solutions. The model also showed that all new or all follow up appointment clinics had shorter waiting times overall, if the clinics were separated.

2.4.3 Modelling and Access Time

There were two models that used simulation as a means to describe improvements in access time(30, 31) which broadly relates time taken to get to clinic appointment from the point of referral. Elkhuizen et al(31) used a simple queue theory model to determine changes to capacity needed to meet the target of seeing 95% of new referrals within 2 weeks at an Amsterdam based hospital. For the Neurology service of, it was determined that to eliminate the 6 week backlog, 26 extra consultations per week were needed over two months and from there a permanent increase of 2 weekly consultations was required to keep access time within 2 weeks. For the service of Gynaecology however, it

suggested that access time was already on the way down because of decreased demand and therefore, the service could reduce outpatient capacity to 86% to achieve 2 week results. By reducing capacity, the model determined that utilisation rate would also improve from 80 to 90%.

Crane et al(30) utilised a complex DES model that took into account, costs and capacity constraints to determine alternative organisational scenarios for Glaucoma Services at a large public hospital in Adelaide, Australia. Three main aspects were tested in the validated model – follow up visit times (e.g. after medication or laser treatment), booking cycle length (from 4 monthly visits to 6 monthly visits), and alternative treatment strategies (laser treatment as first line for glaucoma as opposed to medication). The model found that increasing the booking cycle length from 4 to 6 months, increasing follow up visit times from 2 to 3 months and initiating laser as first line treatment all led to improved access and improved cost effectiveness compared to current practice. Increasing follow up periods or booking cycle lengths beyond the recommendations above could improve access but at the cost of Quality Associated Life Years (QALYs) due to the deterioration in visual fields.

2.5 Discussion

This systematic review provides a narrative review of 11 published articles that have utilised computer simulation modelling in the use of ambulatory outpatient clinics in secondary health care. The purpose of this systematic review is to

determine the different approaches of computer simulation and to determine what aspect of outpatient clinics they evaluate.

As this systematic review shows, computer simulation has been utilised in outpatient clinics of different specialties from Glaucoma to Orthopaedics. There are a number of common elements and themes that are looked at. Broadly speaking, this review categorises modelling into three main groups. Firstly, there are modelling systems for optimising wait times within a clinic. Secondly, there are modelling systems for improving staff and space efficiency and finally, there are modelling systems for improving access times. In all cases however, modelling is utilised to hypothetically test scenarios that would otherwise require significant resource to test in real time, such as increasing staffing numbers or increasing clinic capacity. Simulation provides an alternative low cost strategy for helping to explore possible solutions for improving efficiency in outpatient clinics(36).

The DES models identified in the systematic review are fundamentally based on developing a process map in the first instance. This allows identification of underlying bottlenecks in the system and provides ideas for change. Of the 8 studies(27, 28, 30, 32-36) that used DES modelling, seven used them largely for determining ways to improve waiting times within clinics. Appointment scheduling was explored primarily in a majority of the articles. It was noted to be a feature of clinics in Taiwan(32, 35) and Hong Kong(28) in particular, that walk-ins were more common than scheduled appointments. Three articles clearly showed significant improvements that can be made by switching to an

appointment based strategy. The article by Rohleder et al(34) also showed how changes in appointment block scheduling could potentially be optimised.

DES modelling was also used in capacity determination. The articles by Aeenparast et al(27) tested changes to waiting times by changing the physician staff number, whilst Parks et al(33) used their model to show that staff increases may not necessarily translate to improved waiting time, as compared to increase in 'space' with specific reference to the medication administration queue. Rohleder et al(34) showed the importance of having simultaneous X-ray machines in order to ensure operational efficiency in an orthopaedic clinic where around 95% of patients received an X-ray and suggested increased staffing.

There were only two articles that analysed access time as opposed to waiting time within a clinic. The paper by Elkhuizen et al(31) used a simple queue theory strategy to determine capacity changes required to meet a 2 week target for referrals to be seen. However, the paper by Crane et al(30) uses a robust DES model to look at possible outcomes at each step of the clinical pathway for glaucoma patients. These possible outcomes are inter-connected and these relationships are established in the model which can determine trade-offs such as improved access vs. changes in quality of life scores. It is the only model in the systematic review to report quality of life data and perform a cost-effectiveness analysis.

Whilst some of the principles of model construction seem generic, their application seems limited to only their specific settings as the models have

largely been constructed in the first place to evaluate problems specific to their circumstances. Furthermore, it is also important to note that most of the recommendations made by the simulation models have not been prospectively validated. In the article by Rohleder et al(34), the model implied that the suggested changes would lead to an improvement in waiting times of over 40 minutes whereas when the changes were implemented, an average improvement of only 22 minutes was discovered. This discrepancy highlights the difference between the 'simulated' world and the 'real' world. Nonetheless, the suggested changes did still lead to a moderately significant improvement in waiting times.

2.6 Conclusion

In conclusion, simulation modelling can provide a means of hypothesis testing for improvements in outpatient clinic efficiency. Most of the evidence relates to appointment scheduling and patient waiting time in clinic, whilst evidence for access time is scant. There is also a significant lack of prospective validation of suggested changes as derived by simulation modelling.

CHAPTER 3 - SYSTEMS DYNAMICS AND A SIMULATION MODEL FOR PR BLEEDING OUTPATIENT CLINICS AT CMH

3.1 Introduction

In the previous chapter the evidence surrounding the use of computer simulation for outpatient clinics was explored. The review identified the various methods and techniques of modelling used. Most of the evidence however, was centred around appointment scheduling and patient waiting time within the clinic itself. There was scant evidence regarding simulation modelling with respect to access time, which is the focus of this thesis. Furthermore, of the two studies identified in the systematic review, one used a simple linear queuing theory to help reduce access time (31).

Referrals, waiting times and capacity for outpatient clinics however, often represent more complex systems that exhibit non-linear relationships among the different variables involved. In chapter one, the challenge created with simple capacity increase to see more FSAs for PR bleeding patients was identified. Whilst this initially brought the waiting list down in a simple linear fashion, the number of follow up appointments created, made this approach non sustainable in the long run and a rise in the waiting list for FSAs after a sharp fall was observed. This highlights the complexity of the system of outpatient clinics and hence the need for a more robust and holistic simulation model that is not based on simple linear analysis.

3.1.1 Systems Dynamics Modelling

Systems Dynamics (SD) modelling is a type of modelling that attempts to understand the nonlinear behaviour of complex systems over time using stocks,

flows, internal feedback loops, and time delays, whilst looking at a system as a whole(37, 38). It must be re-iterated that the strength of SD is underpinned by its underlying principles of non-linear dynamics(39). There are several examples of SD modelling in high level policy making in health care such as smoking cessation and cardiovascular disease prevention(40, 41). In the systematic review presented in Chapter 2, no such examples were found with respect to elective outpatient care.

3.2 Aims

In this chapter the development and use of an SD model is described in the setting of the General Surgery outpatients clinic for patients with PR bleeding, as a strategic planning tool for managing current and increasing demands.

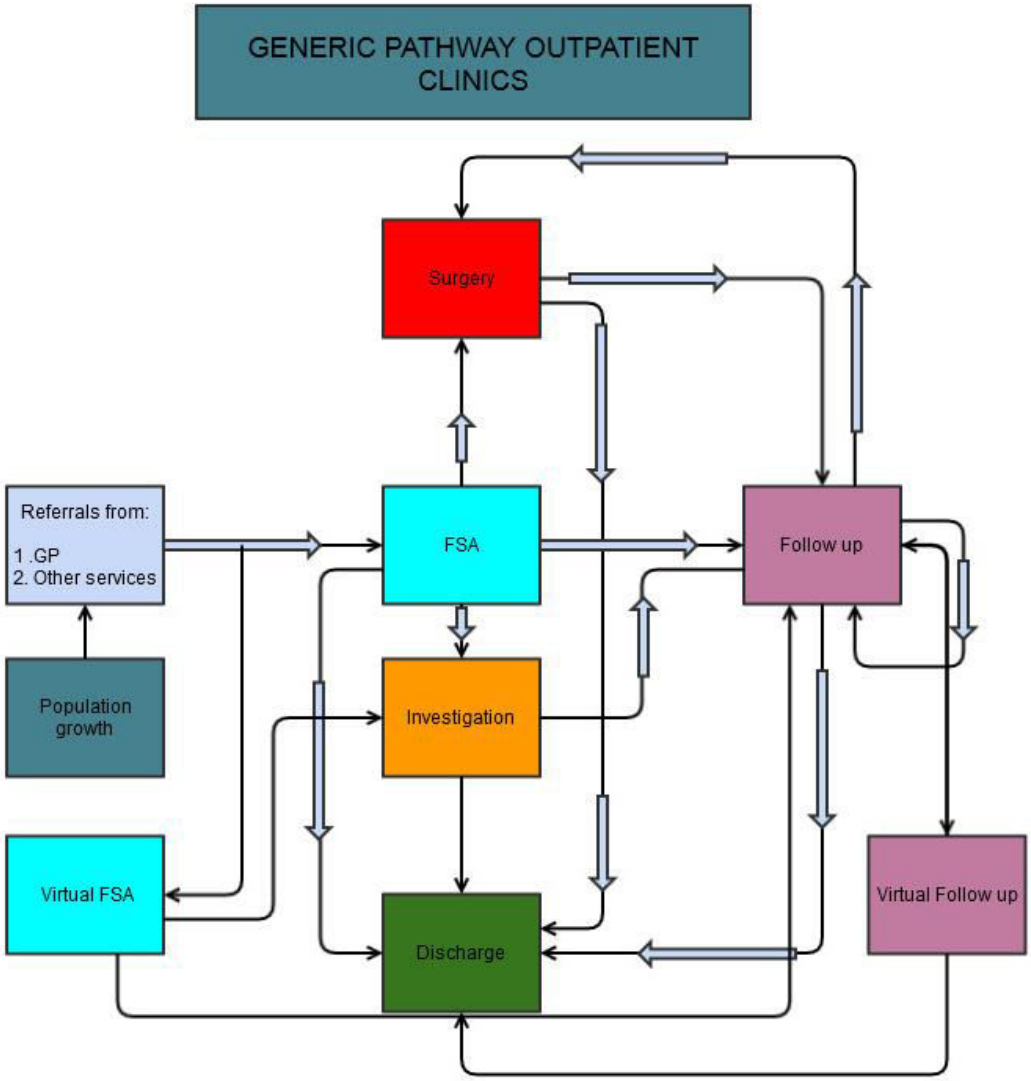
3.3 Methodology

Different techniques were used to gather information about the outpatient processes and pathways for patients with PR bleeding: interviews, brainstorm sessions, preliminary simulation model and statistical data mining methods.

3.3.1 Process Mapping

One of the first steps was to create a generic process map to map the patient journey through outpatient clinics and map out all the possible outcomes during each step (Figure 3.3.1).

Figure 3.3.1 Process map and generic pathway for outpatient clinics



In this process map it can be seen that patients are referred to clinic from GPs (and a small proportion from other services such as Emergency Department etc.). Following an FSA appointment, one of several outcomes can result. The patient may be discharged back to the primary care provider, be followed up for another appointment (FU), be booked for elective surgery or be referred for further investigations.

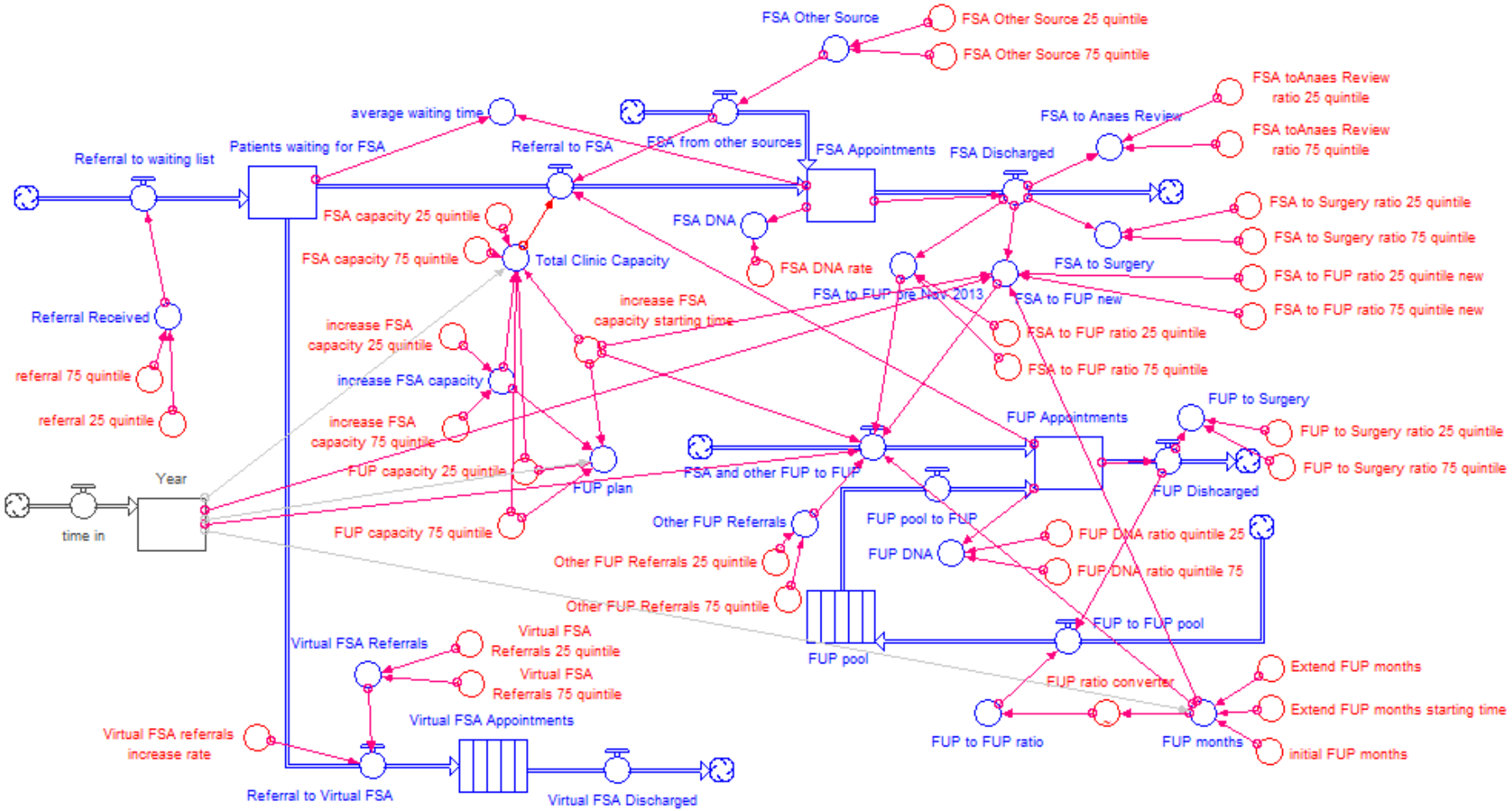
The process map in Figure 3.3.1 also shows the causal relationships of the variables. For example, an increase in discharges from FSAs will have to be compensated by either a reduction in the number of patients being listed for surgery or even more likely, the number of patients requiring follow up.

3.3.2 Computer Simulation Model for PR bleeding Patients

Using the principles of SD and the above process map, a computer simulated model for patients with PR bleeding in the Department of General Surgery at Counties Manukau Health, was developed. The software used was iThink v 20.1, ISEE Systems. This particular software was chosen because of its popularity with SD modelling(42). According to Agyapong-Kodua et al(42), the advantage of iThink software is the ability to analyse multiproduct flows and their associated product dynamics as well as the ability to reflect causal impacts of activities within the model.

Figure 3.3.2 represents the graphical model. Patient stocks are indicated as rectangles and the flows into and out of these stocks are indicated as tabs with arrows (flow directions). All other variables in the diagram directly or indirectly affect the flows, through causal relationships indicated with red arrows. The red and blue circles represent proportions and time series inputs to the model, which can be manipulated to test alternative scenarios.

Figure 3.3.2 Outpatient system dynamics model overview



3.3.2.1 Input Variables

The input variables in the model include:

- FSAs (number per month)
- FUs (number per month)
- FSAs to FU (presented as a proportion)
- FSAs to Surgery (presented as a proportion)
- FSAs to Discharge (presented as a proportion)
- FSAs to Other (e.g. investigations etc., presented as a proportion)
- FSAs to Did not attend (DNA), presented as a proportion
- FU to FU (presented as a proportion)
- FU to Surgery (presented as a proportion)
- FU to Discharge (presented as a proportion)
- FU to Other (presented as a proportion)
- FU to DNA (presented as a proportion)

3.3.2.2 Output Variables

The main output variable determined by the model is the effect on waiting list (WL) number.

3.3.2.3 Variable Determination

The values of the variables were determined as an 'average' over the preceding 14 month period from when the model was formalised in November 2013. The variables that were imputed were based on a random value between the 25th and

75th quintile of a particular variable which was then simulated 1000 times after which a mean value was taken to produce the 'best match' historical trend of the WL number. The method of generating a random value and simulating it 1000 times for each of the variables is known as the Monte Carlo method. This method simulates a probability distribution for each of the variables imputed into the model and is a used to simulate the probability of different outcomes in circumstances where an outcome cannot be reliably predicted because of the randomness of the variables(43).

3.3.3 Definition of Variables

3.3.3.1 Referral Rate

In this model, Outpatients are referred by General Practitioners or other services and are initially put onto the waiting list (WL). The 'referral received' variable is a random value generated by the model between quintile 25 and 75 based on the 14 month historical records. It relates, in simple terms, to the demand for the outpatient clinic. The 'referral increase rate' may change over time (its initial value is set at 0% per year), as affected by the population growth, so the user can change it accordingly.

3.3.3.2 Clinic Capacity

The Total Clinic Capacity is defined as a random value between quintiles 25 and 75 of the number of patients seen per month including FSAs and FUs. The model

takes into account the fact that a FU appointment is shorter than an FSA by a factor of one-third.

3.3.3.3 Referral to FSA

'Referral to FSA' is a dependent variable that refers to the ability of the clinic to see an FSA and thus remove it from the waitlist. This is in turn dependent on the availability of Total Clinic Capacity. It is calculated as follow:

Referral_to_FSA = (Total_Clinic_Capacity-FUP_Appointments*2/3) - FSA_from_other_sources

FSA from other sources includes FSA referrals from sources other than Primary Care, for example – referrals from other specialties.

The values for referral rates and total capacity are based on historical trends.

3.3.3.4 Follow up appointments

FUP appointments have two main sources. These include appointments that are derived post FSA (this includes post-FSA from other sources such as post-surgery). The other source of FUP appointments is from FUP patients who have been recalled for further FUP appointments.

3.3.4 Assumptions Of The Model

The model has three inherent and inbuilt assumptions. Firstly, as mentioned earlier, FUP appointments take up two-thirds of the time taken for an FSA consultation. This assumption was applied because FUP appointments do take a shorter time to conduct and this has implications with capacity determination because ultimately capacity is a function of time. The second assumption is that FUP appointments are given a higher priority for filling clinic spaces than FSAs. A reason for this is that FUP appointments are arranged immediately after an FSA or FUP clinic consultation at a time designated by the clinician. Any residual space typically tends to be reserved for FSAs. The third assumption in this model is that a decrease in FUP appointments will increase in the number of discharges, all other things being held equal.

3.4 Results

3.4.1 Historical Data

Table 3.4.1 shows retrospectively obtained historic data for the main input variables of the model which were determined over a period of fourteen months preceding from August 2012 to November 2013 to determine a monthly mean value.

Table 3.4.1 Descriptive statistics of key model variables (per month)

Variable	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic
FSA (number)	19	186	59.2	28.1
FU (number)	9	76	50.5	13.4
FSA to Other (%)	0.00%	33.9%	10.4%	10.2%
FSA to Surgery (%)	0.00%	37.8%	12.3%	10.5%
FSA to FU (%)	6.41%	65.3%	42.7%	15.9%
FSA to DNA (%)	0.00%	14.0%	3.53%	2.81%
FSA to Discharge (%)	16.2%	53.9%	31.2%	9.45%
FU to Other (%)	0.00%	22.2%	6.88%	6.35%
FU to Surgery (%)	0.00%	22.2%	9.08%	6.70%
FU to FU (%)	16.7%	45.2%	31.3%	7.40%
FU to DNA (%)	0.00%	8.33%	2.32%	2.39%
FU to Discharge (%)	32.4%	66.7%	50.4%	7.87%

3.4.2 Outcome Measure Of Simulation

The primary outcome of the model is to graphically forecast a future trend of the existing waiting list (WL) for FSAs with various hypothetical scenarios:

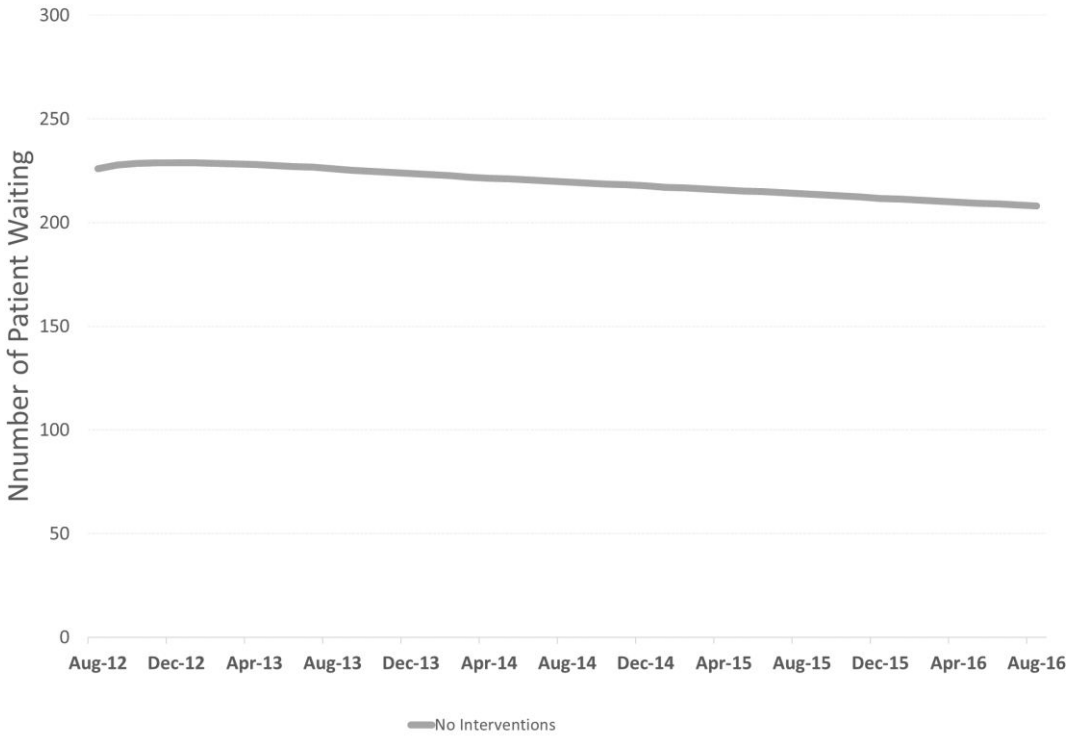
1. Status quo

2. Scenario 1: Reduction in FSA–FU proportion (without an increase in FSAs)
3. Scenario 2: Addition of a new clinic alone
4. Scenario 3: New clinic combined with a reduction in FSA-FU proportion

3.4.2.1 Forecast with status quo

Figure 3.4.2.1 shows the model's forecast of the waiting list for outpatient clinics should the status quo be held.

Figure 3.4.2.1 Forecast of waiting list without intervention

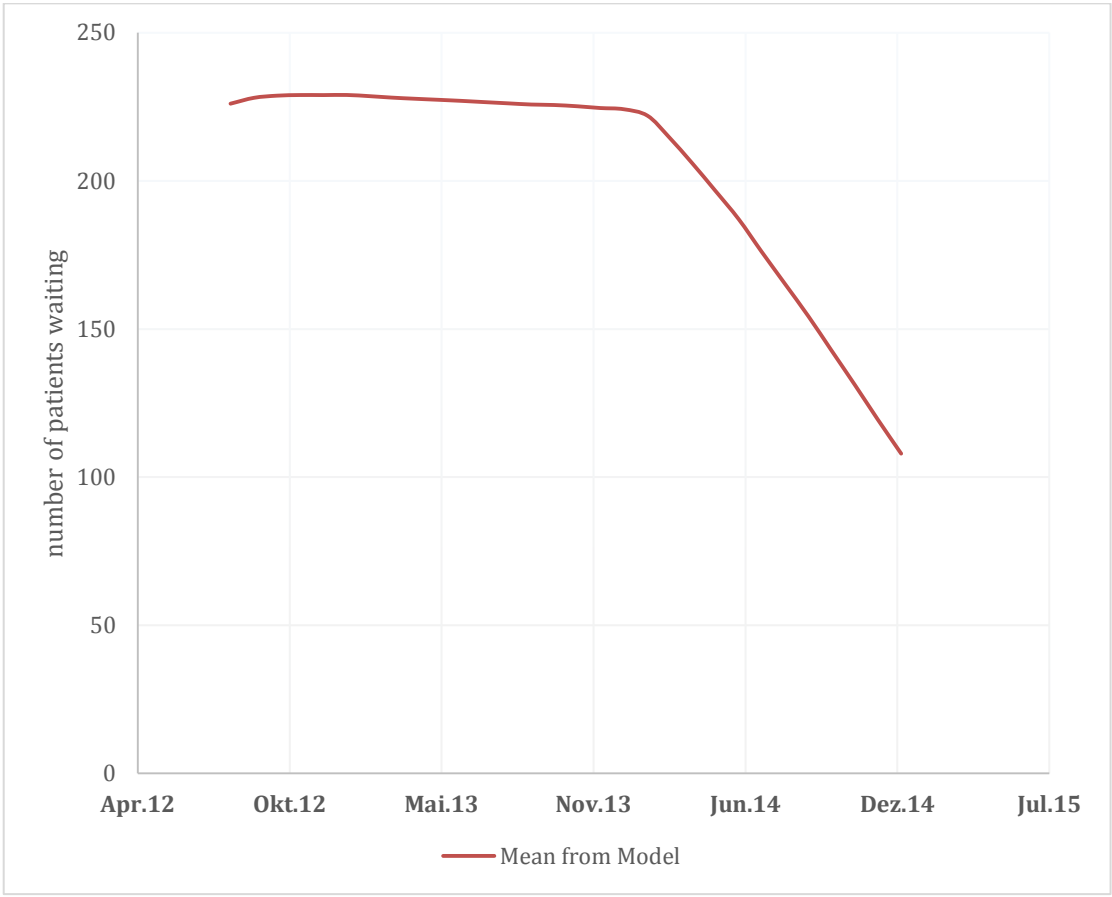


The graph shows a historical trend commencing August 2012. It shows a slowly declining waitilist extending to August 2017.

3.4.2.2 Forecast with reduction in FSA-FU proportion

Figure 3.4.2.2 shows a graph with a hypothetical scenario of reducing the FSA to FU proportion by 50%, whilst maintaining status quo with clinic capacity (i.e. no increase in FSAs). The assumption is that the changes would take place starting November 2013.

Figure 3.4.2.2 Forecast of waiting list with reduction in follow ups only



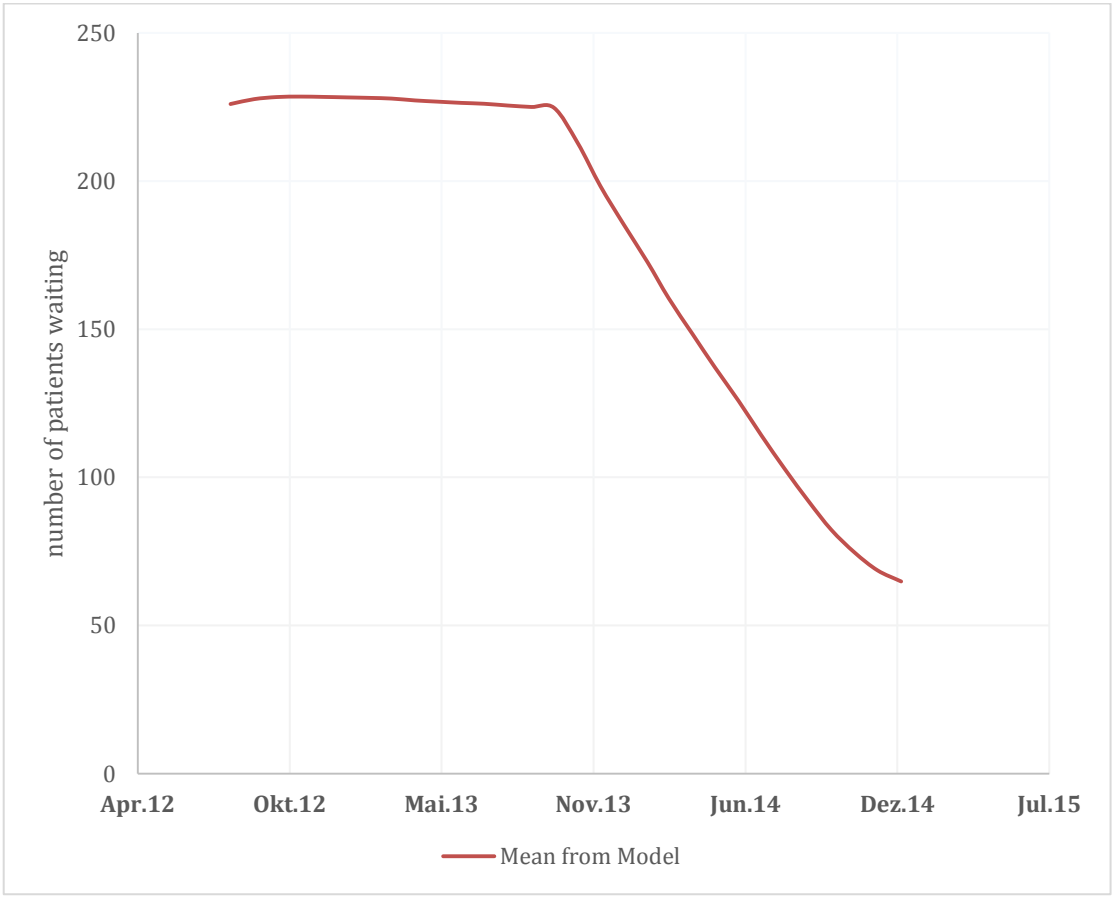
The theoretical rationale is that a reduction in FU appointments would potentially create extra capacity to see FSA appointments and hence reduce the

WL. This effect would only start to take place after a period of time, which would be equivalent to the average time to the FU appointment after an FSA. As per Figure 4, the WL starts to decline approximately March 2014, or 3 months since the start of the intervention on the model. This is roughly the time for an allocated FU appointment after the initial FSA.

3.4.2.3 Forecast with new clinic

Figure 3.4.2.3 shows a graph with a hypothetical scenario of having an extra once monthly clinic designed to see only FSAs.

Figure 3.4.2.3 Forecast of waiting list with new clinic only

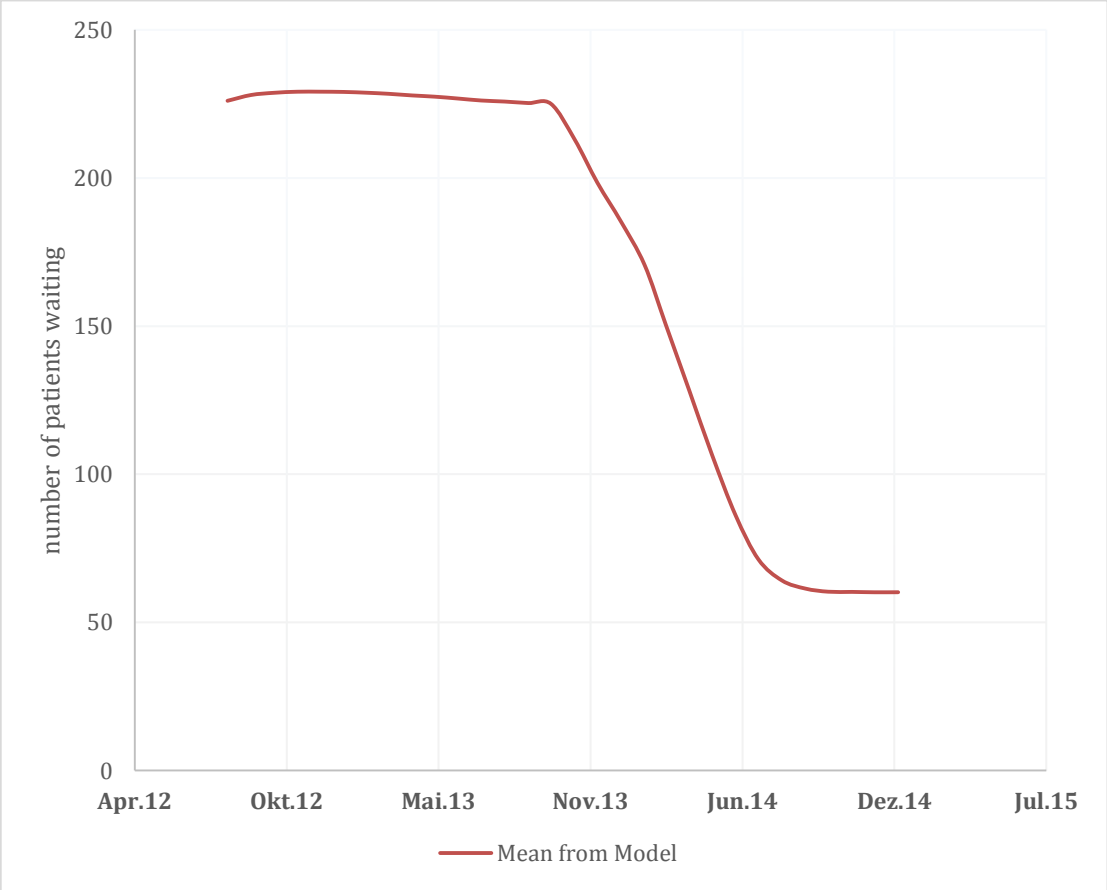


The graph shows that the reduction in the WL is immediate and rapid. The WL declines rapidly to a new steady state within 9 months.

3.4.2.4 Forecast with New Clinic and Reduction in FSA-FU proportion

Figure 3.4.2.4 shows a graph with a hypothetical scenario of a reduction in FU proportion but also increased capacity by the way of an extra once monthly clinic to see FSAs only.

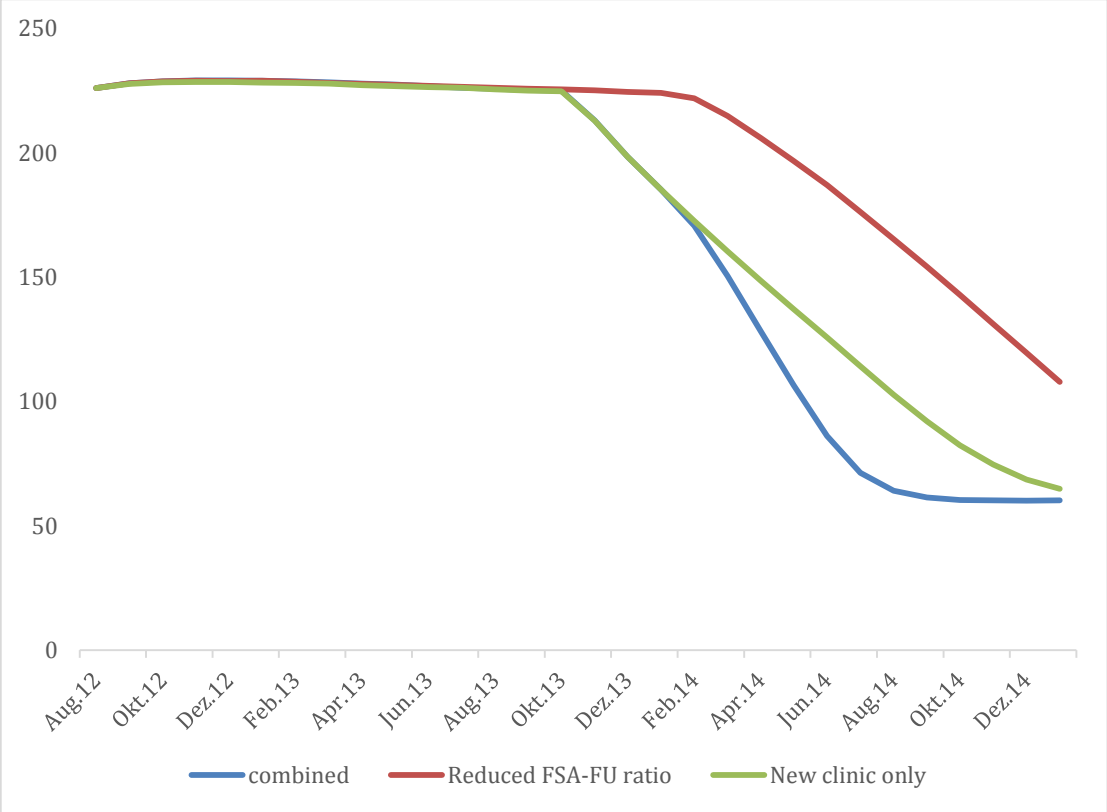
Figure 3.4.2.4 Forecast of waiting list with new clinic and reduction in follow ups



3.4.2.5 Direct Comparison of Scenarios

Figure 3.4.2.5 shows a combination of these graphs for direct comparison. As can be seen, the combination of reduced follow up proportions and new clinic would lead to the fastest reduction in the waiting list.

Figure 3.4.2.5 Graphs combined



3.5 Discussion

In this chapter a method of developing an SD simulation model to help analyse, predict and plan changes related to an outpatient clinic service in a large public hospital is described.

According to Silvester et al(44), the most important component of understanding any system, whether it be for re-design or simply for understanding the processes and the associated bottlenecks, is creating a process map. This was fundamental to the methodology used in this study. Through this, a model was able to be created that reflected the inter-dependency of the relationships with each part of the process. Based on the systematic review presented in chapter two, there are no other published articles that have utilised a similar model in the setting of outpatient clinics.

The unique feature of this model is that it has been constructed on the basis of causal relationships between outcomes that might emerge within the patient pathway in the outpatient clinic. For example, a decrease in follow up appointments will result in increased capacity see FSAs. The model is designed to allow forecasting and production planning by quantifying the effect of policy changes or changes to clinical behaviour.

In this model three main hypothetical scenarios were tested. All the scenarios that were modelled predict a significant decrease in WL for patients with PR bleeding. This has major implications on production planning. Both approaches

of reducing FU appointments or increasing clinic capacity will require innovative methods but should ultimately lead to improved WL number (and waiting times) according to the simulation model.

One of the limitations and presumptions of the model is that the main output variable measured is the WL number as opposed to waiting times. WL was chosen for pragmatic reasons during the construction of the simulation model. Given that waiting time is directly proportional to waitlist number and inversely proportional to clinic throughput, it was felt that WL number would serve as an adequate proxy for waiting times.

The accuracy of the model will require prospective evaluation, which is presented in Chapter 7.

CHAPTER 4 - REDUCING FOLLOW-UP APPOINTMENTS. THE ROLE OF A PATIENT INITIATED APPROACH

4.1 Introduction

In the previous chapter, the SD model created implied that a reduction in FU appointments could prove to be a useful way in generating extra clinic capacity and reducing the WL. A reduction of FU by 50% could substantially reduce the waitlist. This is potentially an achievable target.

4.1.1 Patient Initiated Follow Up

Outpatient care in the public secondary health system has been traditionally clinician driven, where physicians initiate clinic appointments for patients(45). There is some concern, that many clinic appointments tend to be inappropriate, particularly in the case of routine follow ups(46, 47). Whilst there is evidence to support that patients find routine follow up appointments reassuring and value the support provided by them(48-50), it is also increasingly clear that public health systems around the world are struggling to cope with capacity issues for an increasing demand(51). Hence, a greater emphasis on improving the efficiency and appropriateness of outpatient clinic appointments is emerging(52).

FU appointments can be reduced simply by clinicians choosing not to review their patients again or by shifting the responsibility back to primary care(53). The risk with such a method is that patients who continue to remain symptomatic may miss out on further treatment if required. One strategy that aims to mitigate such a risk is an initiative known as Patient Initiated Follow Up (PIFU).

PIFU is an initiative that allows patients to initiate a hospital follow-up appointment on an 'as required' basis compared to the traditional 'physician-initiated' model(54). The main principle is to reduce inappropriate regular follow-up appointments and reduce the prospect of missed appointments, which represent a costly waste of precious resources in secondary health care without compromising patient care(55).

4.2 Aims

In this chapter, a systematic review into the efficacy of PIFU across a broad range of parameters including clinical outcomes, patient satisfaction, psychological morbidity and economic evaluation is evaluated.

4.3 Methods

Appropriate methodology according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)(26) statement was followed.

4.3.1 Search Strategy

An electronic literature search was performed independently by two researchers (the author and a colleague) using the following pre-defined search terms in an abstract and keyword search:

(Patient$ initiat$ review OR *patient$ initiat$ clinic$* OR *patient$ initiat$ follow$* OR *PIFU* OR *patient$ direct$ clinic$* OR *patient$ direct$ follow$* OR *open$ access$ clinic)*

These terms were searched from July 1980 to July 2013 over the following databases: EMBASE, Ovid MedLine, PubMed, PSYCINFO and the Cochrane Library. Each reviewer judged papers as potentially relevant based on the title and abstract and those deemed as potentially relevant were read in full and assessed for inclusion with any disagreement over inclusion and exclusion resolved by consensus.

Reference lists of all relevant articles were also screened to identify other relevant studies.

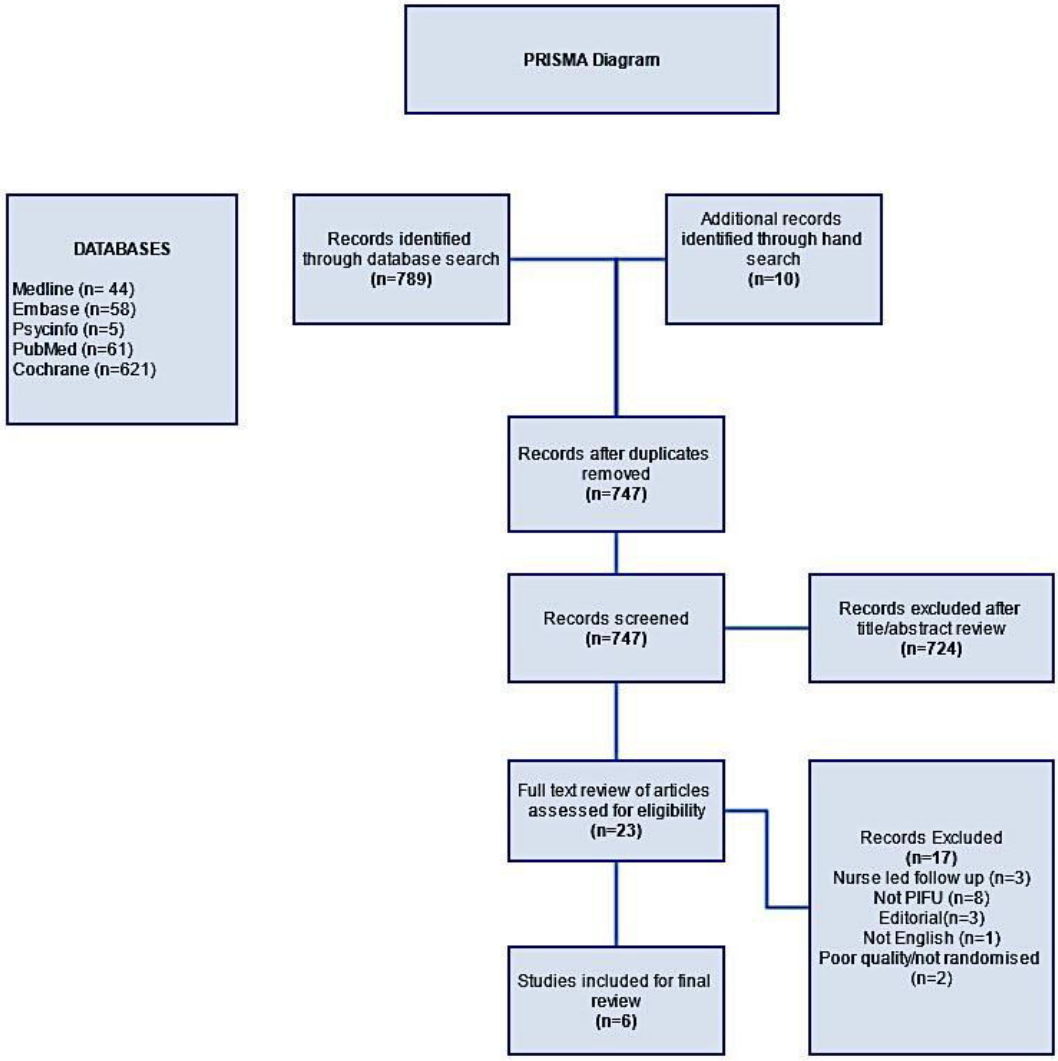
4.3.2 Study Selection

Articles were included if they specifically evaluated any aspect of patient directed or patient initiated outpatient clinic appointments specifically for a follow up visit. Articles that looked at patients outside of secondary, hospital-based care were excluded. Articles that compared conventional clinician led appointments to patient directed, but nurse led appointments were excluded. Non-randomised articles were also excluded. Conference abstracts, editorials, commentaries, implementation protocols, informally published reports, and non-English language articles were also excluded.

4.4 Results

A total of six studies(55-60) were identified as suitable for inclusion in this systematic review, as outlined in the PRISMA diagram (Figure 4.4). Three articles(57-59), which were extensions of the same randomised cohort, evaluated Patient Initiated Clinics with regards to chronic management of rheumatological disease. One randomised controlled trial, looked at PIFU in Breast Cancer follow-up(56). Two randomised trials examined patient directed follow up for inflammatory bowel disease (IBD)(55, 59).

Figure 4.4 PRISMA Flow Diagram



4.4.1 PIFU and Rheumatoid Arthritis (RA)

Hewlett et al 2000)(58) conducted a randomised trial evaluating 209 patients with RA, randomising them into a shared care with the GP group [no routine hospital review but rapid access on request; the shared care group (SCG)] or a control group (CG) where patients received routine, rheumatologist-initiated planned follow up appointments. The study was conducted in a single teaching public hospital in the United Kingdom. The initial follow up period was 2 years

but subsequent follow up at 4 and 6 years was performed and reported in separate studies(57, 60). The study evaluated clinical and psychological measures as well as patient satisfaction as its main outcomes. The overall state of RA was measured with evaluations of C-reactive protein, haemoglobin, hand X-rays, grip strength, range of movement at knee and elbow, and articular index at 0 and 24 months. As well as this, 3 monthly questionnaires were utilised to measure disease activity and pain through visual analogue scales (VAS) as well as disability, days lost from work, anxiety and depression, self-efficacy and changes in medication. Patient satisfaction and confidence in the system of care was also recorded through another VAS at 3 monthly intervals. The study also evaluated the cost of resources used in patient care by accounting for visits to health professionals, transport costs and hospital costs.

The study found that the SCG had significantly less pain at 24 months with 3.9cm on a 10cm VAS compared with 4.8cm for the CG ($P<0.05$). Also the SCG had a smaller increase in pain over 24 months (+0.4cm vs. + 1.6cm for CG, $p<0.01$). Less resources per patient were required in the SCG group (£ 208 vs. £ 313 for controls, $p<0.001$). Further, patients in the SCG group were more confident in their system of care at 6, 9,12,18,21 and 24 months of follow up ($p<0.01$ to $p<0.001$).

The study by Kirwan et al(60) was a 4 year extension of this cohort of 209 patients. Only 134 patients remained in the study at 4 years. At 4 years there were no major differences in clinical or psychological status between SCG (which was also termed direct access group in this paper) and the control group.

However, self-efficacy for function was higher in the SCG (mean score 64.0 vs. 52.0 in the control group, p=0.005). Satisfaction was also higher in the direct access group (mean score in 10cm VAS, 8.7cm in SCG vs. 7.6cm in control group , p=0.01) as was the confidence in the system (mean 8.9cm in SCG vs. 7.6cm in control group, p<0.01). This study did not examine resource utilisation.

This study was further extended to a 6 year follow up(57). Of the 209 patients in the initial study, 65% in the SCG group and 50% in the CG remained. The same outcomes as the parent study were measured. It found that there were no significant differences between the two groups with respect to clinical outcomes at six years with the exception of slightly better range of motion for elbow movement in SCG group. There were also no significant differences between the groups over any of the psychological variables measured such as anxiety, depression, helplessness, and self-efficacy. Satisfaction and confidence scores were not different at baseline between the two groups but were slightly better in the SCG group at 6 years, (p<0.005). SCG group patients had 38% fewer hospital reviews over 6 years, p<0.0001 with only 34% of SCG patients receiving more than 10 hospital reviews compared with 85% of the control patients.

On the whole, the three articles from the same study cohort represent a randomised controlled trial with follow up to 6 years. Whilst, initially the intervention group fared slightly better in terms of clinical and psychological scores, it seems that this benefit is lost over time, with both groups being comparable at 4 and then 6 years of follow up. However, scores for self-efficacy suggested that people in the direct access arm had higher rates of self-efficacy

through all the follow up periods. Furthermore, satisfaction and confidence in the system scores were also higher in the direct access group through all stages of follow up.

4.4.2 PIFU and Breast Cancer

Brown et al(56), randomised patients with stage 1 breast cancer into standard clinic follow up, where participants attended clinic as usual with the appointments being initiated by the clinician, or into PIFU, where patients were advised to contact a Breast Care Nurse Specialist (BCN) via telephone if they experienced any problems. They still received a yearly mammogram. From a potential eligible sample size of 123 patients, 31 patients were recruited in the standard clinic and 30 in the PIFU clinic. Study duration was 1 year. Only patients more than 1 year since treatment of their breast cancer were recruited. The average time since treatment, at the time of recruitment was 47 and 50 months for the standard and PIFU clinics respectively. Outcomes measured included quality of life and psychological morbidity (assessed by the European Organisation for Research and Treatment of Cancer questionnaires), as well as patient satisfaction with the type of follow up (assessed via structured interview). Details of contact with health professionals and of recurrence were also kept.

The outcomes were measured at 6 months and 1 year. The overall quality of life was not different between the groups at any stage. Psychological morbidity was also not different between the two groups at any stage. In terms of patient

satisfaction, both groups reported high rates of satisfaction with their outpatient care (23/24 patients for standard clinic and 26/28 patients for the PIFU clinic) at 6 months. Patients in the standard clinic cited reassurance as their main reason for satisfaction, whilst patients in the PIFU group cited convenience. Overall, only 3 phone calls to the BCN were made during the study, 2 from the PIFU arm with medication related queries and 1 from the standard clinic arm with local recurrence.

4.4.3 PIFU and Inflammatory Bowel Disease (IBD)

Robinson et al(55) conducted a multicentre randomised controlled trial for patients with ulcerative colitis (UC) in the Greater Manchester area in the UK. They randomised patients with UC who were undergoing routine hospital follow up to receive patient centred self-management training and follow up on request versus normal treatment and follow up (control group). The primary outcome was the time between relapse and treatment and secondary outcomes were rates of primary and secondary health care consultations (including cost analysis), quality of life (QOL) and acceptability to patients. Three hundred and thirteen patients were identified as potentially eligible of which 203 participated. Median follow up period for the study was 14 months. The self-management interventions included directions on which oral and topical therapy to use during flare ups.

Relapses were treated earlier in the intervention group (mean 14.8h vs. 49.6h, $p<0.0001$). Intervention patients also had fewer visits to hospital (mean 0.9 v s

2.9 visits per year, P<0.001) and fewer visits to primary care (mean 0.3 vs. 0.9 visits per year, P=0.0006). QOL scores were not significantly different between the groups and remained almost the same at the end of the study. In terms of economic evaluation, mean travel costs to clinic and mean time costs of doctor visits were significantly less in the intervention group. Non-attendance at clinic was also significantly improved in the intervention group (n=1 vs. n=47 in control group). Patient satisfaction in the intervention group was high with only two patients indicating they would have preferred traditional management.

Kennedy et al(59) performed a multicentre cluster randomised trial in the UK where, of 19 participating hospitals, 9 sites were randomised to the intervention group and 10 to the control group. The intervention was a guided self-management approach to chronic IBD with the patients given a contact telephone number to schedule an outpatient appointment as required. In the control arm, patients were followed up as per hospital guidelines and protocols. Each hospital centre was required to recruit the first 38 consenting patients with chronic IBD. A total of 700 patients with established IBD were recruited. Main outcome measures were recorded at one year and included QOL, health service resources use and patient satisfaction. Secondary outcomes included patient confidence to cope with the condition. The study found that patients in the intervention arm made fewer outpatient visits (difference 21.04 (95% confidence interval (CI) 21.43 to 20.65); p=0.001) without an increase in the number of primary care visits. QOL and patient satisfaction were similar. Patients in the intervention arm also reported greater confidence in being able to

cope with their condition {difference 0.90 (95% CI 0.12–1.68); p = 0.03} although this was measured straight after their initial consultation.

4.5 Discussion

This systematic review provides a narrative review of six randomised published articles that evaluate the concept of patient initiated clinics for secondary level outpatient care across a broad range of conditions. The outcomes measured from these studies were also broad. They included clinical, psychological, patient satisfaction and confidence and resource and cost analysis. Overall patient satisfaction was high without significant differences in long term clinical outcomes.

Whilst the studies around RA and PIFU suggested initial clinical benefit in the 2 year study by Hewlett et al (2000)(58), this effect was negated and clinical outcomes were essentially equivalent in follow up studies at 4 and 6 years(57, 60). There was also clinical benefit seen in the IBD study by Robinson et al(55), where time between relapse and treatment was significantly shorter in the intervention arm. The follow up period for this study was 14 months and it is possible that this benefit might be negated with a longer term follow up, as was seen in the RA studies. The remaining studies did not show any significant clinical benefit, but outcomes were not worse in any of them.

There was a trend towards increased satisfaction in some of the studies especially for RA and IBD. Satisfaction was noted to be similar in the breast

cancer group in the study by Brown et al(56). The main reason cited by patients who preferred routine follow up was for increased reassurance which highlights an important facet of follow up in patients with malignant conditions.

Patient selection is critical in determining the success of a PIFU programme and this will obviously have an impact on the results of any study. The study by Hewlett et al, (2000)(58) invited all patients with established RA to participate without any exclusion criteria. However, they noted that older patients and patients with more severe disease were more likely to not participate. Furthermore it is important to note that in the breast cancer study by Brown et al(56), one of the key elements of the inclusion criteria was to include only women with stage 1 breast cancer who had been treated for at least 1 year before recruitment. In the study by Kennedy et al(59), consultants were able to withdraw patients as well prior to consent. A selection bias is therefore inevitable for any practical and clinically justifiable PIFU system.

Two studies analysed cost-effectiveness of a PIFU system(55, 58). Hewlett et al(58) showed that less resources per patient were required in the shared care group. It is important to note that whilst it appeared that resources were less expensive in the SCG group, the cost of protected consultant availability/time (to provide for rapid access on request) was not accounted for. It was found that some consultant appointments were left unused by this ring fencing approach.

The study by Robinson et al(55) measured economic outcomes by analysing travel costs to clinic and time costs of doctor visits. Whilst it noted that there

were fewer overall clinic appointments and fewer cancellations in the intervention group there was no conversion of this number to a financial saving.

Not all of the studies reported the time taken to getting a patient initiated clinic appointment, although it was widely acknowledged that it was based around patient convenience.

There was only one study that looked at the PIFU system with reference to malignant conditions(56). This study only included patients with Stage 1 breast cancer and was limited by small numbers. It is therefore difficult to assess the value of a PIFU system in the setting of someone with malignant disease or even in the setting of someone at risk of harbouring occult malignant disease on the basis of their chronic symptoms or presentation.

The concept and success of any PIFU system is specific to the clinical condition and context and therefore is not necessarily generalisable. This study identified only three conditions in its clinical application, namely RA, IBD, BC. Furthermore, all the trials were conducted in the UK, which also has implications for its generalisability. There was also limited information in terms of the resources required to implement and run a PIFU programme.

Ultimately how this evidence translates to the use of a PIFU programme for patients with PR bleeding remains contentious. The primary objective of evaluating patients with PR bleeding is to exclude underlying malignancy. Given that patients with PR bleeding would normally undergo somewhat invasive

clinical examinations with digital rectal exam and proctoscopy, they may be further reluctant to utilise a PIFU system. Any PIFU programme for conditions where there is a risk of underlying malignancy, must have appropriate risk mitigating protocols therefore.

4.6 Conclusion

There is evidence to suggest that PIFU systems result in fewer overall outpatient appointments in secondary care led services, whilst maintaining equivalent if not better patient satisfaction, quality of life and clinical outcomes across a range of chronic conditions without compromising patient care. This may translate to financial saving to the health system although there is only limited evidence for this. The role of a PIFU system in the setting of patients with malignant disease or with the potential for malignant disease (such as rectal bleeding) is difficult to gauge given the scant evidence in literature.

CHAPTER 5 - ALTERNATIVE CAPACITY. THE ROLE OF GENERAL PRACTITIONER'S WITH SPECIALTY INTERESTS

5.1 Introduction

The SD model in Chapter 3 shows that an increase in capacity would provide a substantial improvement in waiting times. As noted in previous chapters, several studies have suggested that short transient increases in capacity run the risk of unsustained improvements in waiting times(9, 16, 61). One of the key projects in the DRES programme, as noted in Chapter 1, is improvement of the primary and secondary interface. This raises the question of whether utilising extra capacity from primary care would be of benefit.

5.1.2 General Practitioners with Specialty Interests

The past decade has noted an increase in specialisation in primary health care(62, 63). Many (GPs) have started to take lead roles for specific clinical interests(64, 65). The National Health Service (NHS) Plan(66), in the UK signalled the inception of GPs with Specialty Interests (GPwSIs) (67, 68) . This involves GPs gaining a specific set of knowledge and skills that enable them to perform the role of 'consultant' to their own colleagues with regard to specific health problems. Examples of such problems include patients requiring minor surgery and management of asthma, COPD, epilepsy, headache and diabetes, so that patients can be referred for 'expert' intervention(68-72)

The main purposes for the GPwSI programme are to improve the patient's access to specialist care from primary care and thereby improve hospital waiting-list times and referral costs(66, 68). GPwSIs function in close partnership and integrated programmes with secondary care and aim to provide care that is

equivalent in quality and outcome to secondary consultant led services, whilst not necessarily providing the same breadth of clinical care as them(73, 74).

5.2 Aims

In this chapter, a systematic review to examine the efficacy of such a programme is conducted with particular reference to GPwSIs who are involved with surgical or procedural specialties and consider whether or not such a programme would be valuable for providing a sustainable alternative to an increase in clinic capacity.

5.3 Methods

Appropriate methodology according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Statement(75) was followed.

5.3.1 Search Strategy

An electronic literature search was performed independently by two researchers (the author and a colleague) using pre-defined search terms outlined in Table 1 with the following databases searched from 1980 to April 2013: EMBASE, Ovid MedLine, PubMed, PSYCINFO and the Cochrane Library. Each reviewer judged papers as potentially relevant based on the title and abstract. Papers judged as potentially relevant were read in full and assessed for inclusion with any disagreement over inclusion and exclusion resolved by consensus.

Reference lists of all relevant articles were also screened to identify other relevant studies.

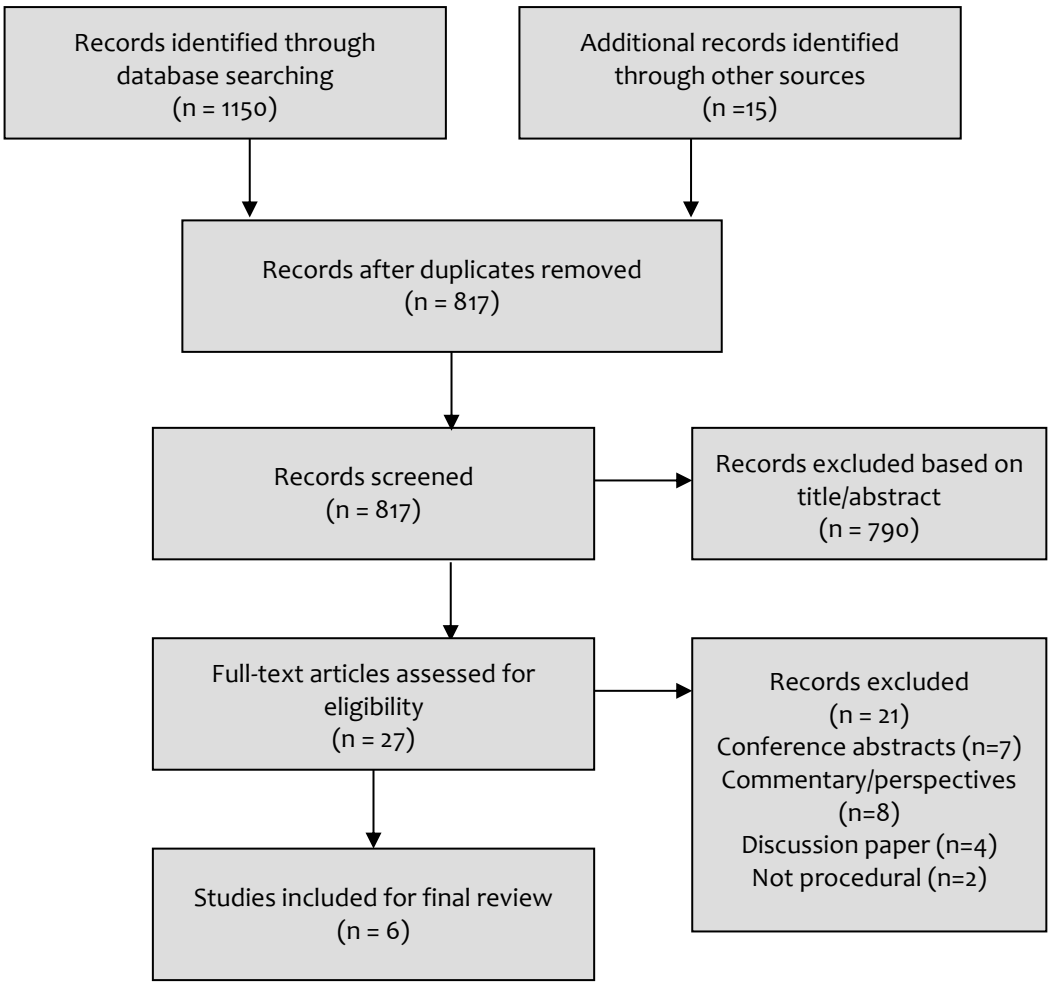
5.3.2 Study Selection

Articles were included if they specifically included GPwSIs in their study and evaluated their efficacy for surgical or procedural specialties. Studies were excluded if they did not evaluate GPwSIs specifically, contained purely non-procedural specialties or specialties outside the realm of medical doctors e.g. Dentistry. Conference abstracts, editorials, commentaries, informally published reports, and non-English language articles were excluded.

5.4 Results

A total of six (73, 74, 76-79) studies were identified as suitable for inclusion in the present review, as outlined in the PRISMA diagram (Figure 5.4). Three studies(73, 78, 79) analysed efficacy of GPwSIs with regards to surgical excision of skin lesions. One study(74) looked at the economic evaluation of a GPwSI led dermatology service in primary care and included GPwSIs carrying out skin excisions. The remaining two included studies were from the same institution and evaluated hernia repairs at a single centre GP practice.

Figure 5.4 PRISMA diagram



5.4.1 GPwSI and Skin lesions

Salmon et al (79) performed a retrospective analysis of skin pathology reports over a three month period in 2007 for all skin lesions in a provincial region of New Zealand. It primarily investigated completeness of excision of malignant skin lesions by each vocational group. These groups included dermatologists, non-specialised GPs, GPwSIs and other hospital surgical specialists. Of the 1532 lesions, the study found that GPwSIs excised 24%. Dermatologists excised significantly fewer benign lesions (7%) than other vocational groups ($p<0.001$)

with GPwSIs and other hospital specialists excising benign lesions at around 28% each. When it came to completeness of excision of skin lesions, GPwSIs (79% complete clearance) were better than non-specialised GPs (75%) and equivalent to other hospital specialists (79%). However, dermatologists had a 0% rate of incomplete excision for the 276 (18%) cases performed by them. The study also identified that head and neck lesions were much less likely to be excised completely by GPs and GPwSIs ($p<0.0001$). The rate of excision by trainees for each of the vocational groups was not determined.

Murchie et al(78) also performed a retrospective analysis of 1087 basal cell carcinoma excisions over a 1 year period, comparing non specialised GPs, GPwSIs, hospital skin specialists (dermatologists and plastic surgeons) and other hospital specialists with regards to excision of basal cell carcinomas (BCCs). The definition of GPwSIs in this study was GPs who submitted ≥ 10 lesions each. There were 6 such GPs who were classed as frequent excisers. It was found that GPs performed less well than skin specialists (dermatologists and plastic surgeons) with a complete excision rate of only 67.9% compared with 89.7% for dermatologists and 82.6% for plastic surgeons. After age, gender and biopsy site adjustments GPs were still more likely to have incomplete excisions (OR = 0.34, 95% CI 0.22-0.51) compared to skin specialists. When compared to non-skin hospital specialists however, GPs were more likely to completely excise skin lesions (OR = 1.81, 1.07-3.08). When GPwSIs were compared to non-specialised GPs, no difference was noted in excision adequacy.

This study also examined the adequacy of the clinic abstracts provided by the clinicians and the abstract diagnoses. It found that the adequacy of information provided by GPs (24% rate of comprehensive reports) was superior to skin specialists (12.8% for dermatologists and 8.8% for plastic surgeons) and other hospital specialists (18.7%). Skin specialists were superior in correctly stating the abstract diagnoses compared to GPs, who were in turn slightly better than non-skin hospital specialists. Overall, this study showed that whilst GPs compared unfavourably to hospital skin specialists in diagnosing and excising BCCs, they were superior to non-skin hospital specialists. Furthermore, GPwSIs did not appear to be better than non-specialised GPs.

Hansen et al(73) also retrospectively audited the rates of incomplete excision of non-melanoma skin cancers by Australian GPwSIs. There was no comparison group. It analysed 9417 basal cell carcinomas (BCCs) and squamous cell carcinomas (SCCs) excised by 57 GPwSIs in a single network of 15 primary care skin cancer clinics across Australia. Overall rates of incomplete excision were almost the same for BCCs and SCCs at 6.4% and 6.3% respectively. It too, identified that incomplete excisions were more likely to occur for excision of skin lesions in the head and neck – 9.8% for BCCs and 11.3% for SCCs with odds ratios of 2.30 (1.81-2.94, $p<0.001$) and 2.89 (1.52-5.51, $p<0.01$) respectively. There was significant variation in frequency of incomplete excision between clinics for BCC and SCC ranging from 3.3% to 24.7% and 0% to 17.2% respectively. It also noted that excision of skin lesions without previous biopsy was more likely to be incomplete (odds ratio 1.73, 1.36-2.20). Whilst the overall

frequency of incomplete excision by GPwSIs was low, head and neck lesions were clearly the high risk sites.

5.4.2 GPwSI economic evaluation

Coast et al(74) carried out an economic evaluation of a GpwSI programme for non-urgent skin problems, comparing them to hospital based outpatient care in Bristol, United Kingdom. This study was carried out in parallel to a randomised control trial by the same group which attempted to evaluate a GPwSI service for dermatology from a quality based perspective(80). This study identified that the overall costs incurred by the National Health Service for a GPwSI service were about 75% higher than hospital based outpatient care. Whilst direct costs to the NHS were higher for the GPwSI group (£ 207.92 vs. £ 118.14), costs to patients and their companions was slightly lower (£ 48.21 vs. £ 51.30). The higher costs were largely due to higher unit costs of each consultation. However, unit costs for excisional and incisional biopsies as well as punch biopsies were similar between hospital outpatient clinics and GPwSI clinics. Apart from direct costs it also measured two other outcomes: a change in the dermatology life quality index (scored from 0 to 30, with a lower score representing a better quality of life) and accessibility of care (scored from 0 to 100, with a higher score representing greater accessibility). There was slightly more gain in dermatology life quality index score in the GPwSI group (improved by 2.54 vs. 2.36) and more substantial gain in the access scale favouring the GPwSI group (76.13 vs. 60.47). Reduced waiting times for the GPwSI group also reflects this (72 days vs. 113 days).

5.4.3 GPwSI and hernias

Dhumale et al(76) evaluated the feasibility of hernia surgery in a general practice setting. They looked at a single general practice where a GPwSI with a special interest in General Surgery performed various surgeries including 286 groin hernias over a 9 year period, with local anaesthesia. Patient selection was based on the American Society of Anaesthesiologists (ASA) grading. ASA groups 1 and 2 were selected only. The study reported a 0% non-attendance rate. All patients were followed up at 3-4 weeks. They were also sent a questionnaire annually to monitor their progress. There were no early recurrences, no cases of haematomas and no cases of urinary retention. Abnormal sensitivity in the groin was noted in 3.9% of patients and 3.2% of patients had some bruising. Two patients had their hernia procedures abandoned and were subsequently referred to secondary care for elective hernia surgery under general anaesthetic.

Dhumale et al(77) reported a prospective analysis of 1164 patients including patients from the previous feasibility study(76) who underwent abdominal wall (including inguinal) hernia repair at a single general practice institution carried out by two GPwSIs and one retired surgeon. All procedures were performed as day cases under local anaesthesia without sedation. All patients were reviewed routinely at 6 weeks. The early recurrence rate was 0.3%. Complication rates were very low and similar to those seen in other specialist hernia units. Patient satisfaction was high.

5.4 Discussion

This systematic review provides a narrative review of six published articles with respect to GPwSIs and surgical procedures. Whilst in theory GPwSIs represent a mode of alternative treatment providers for common specialist conditions, there is a paucity of evidence addressing the issue of their efficacy, which includes their quality of care as well as cost effectiveness. Overall, it seems that their quality of care is an acceptable standard, but they appear to be no cheaper than secondary care.

Despite the increasing interests in GPwSIs, this review only identified six published articles that examined their efficacy specific to surgical related procedures. Among those included, 3 articles examined the efficacy of GPwSIs with respect to skin lesions. At least two articles(78, 79) compared GPwSIs to specialists in secondary care. It was noted that GPwSIs generally had a higher rate of incomplete excisions for skin malignancies in particular, when compared to hospital based skin specialists. However, they seemed to provide equivalent outcomes when compared to other hospital specialists also doing skin lesions such as general surgeons(78). As not all hospital units in secondary care provide the services of dermatology or plastic surgery, a GPwSI service may be useful in these settings.

There was only one study in this systematic review that examined the efficacy of GPwSIs for surgical procedures by addressing their cost-effectiveness(74). This study was linked to a randomised controlled trial involving GPwSIs in

dermatology in a specific region in the UK(80). Since this trial did not specifically evaluate skin lesion excisions or other procedural tasks within dermatology, it was excluded from the systematic review. Nevertheless the cost effectiveness study compared various costs such as consultation costs, investigation costs as well as procedural treatment costs. It found that even though GPwSIs had slightly higher number of consultations, the unit costs associated with each consultation by GPwSIs was higher than hospital care. It also analysed change in life quality index as well as an accessibility of care index. Both seemed better with GPwSIs and reduced waiting times for the GPwSI group also reflected the improved accessibilty.

The question for policy makers then comes down to whether the improved life quality index score and the improved access scale for the GPwSI group is offset by the increased costs. In summary, there is very little difference in clinical outcome with the more expensive GPwSI service and that the higher cost of GPwSIs must be offset against the benefit in improved access to health.

The study by Dhumale et al(77) showed that a high number of hernia operations could be performed in primary care with a very low complication rate. It implied that a GPwSI workforce in primary care can be obtained from the large number of adequately trained surgical trainees who do not end up becoming surgical consultants in the NHS. In essence, this study shows the feasibility of doing a higher end of surgical work in primary care. However, what needs to be determined is the level of infrastructure that needs to be in place to facilitate a GPwSI programme for higher end cases and also long term outcomes.

Apart from the cost effectiveness study,(74) all the studies were retrospective reviews. The definition of what constitutes a GPwSI was not clearly defined in many cases. Furthermore, whilst it is generally accepted that GPwSIs work in a collegial relationship or integrated programme with secondary care led services, this was not made clear in most of the studies. In the study by Murchie et al(78) a GPwSI was classed as a frequent exciser who excised 10 or more lesions per year. There was no reference to any specific integrated training programme. Likewise, Hansen et al(73) noted that whilst GPwSIs in the UK are integrated into local care networks and are provided guidance protocols, no such guidance occurred for GPwSIs in the Australian setting where they were working in skin cancer clinics in relative isolation. Many articles which did not specifically state the use of a GPwSI were excluded from this review in order to separate GPwSIs from other GP proceduralists, although there may be some overlap. Other than the hernia studies(76, 77), none of the other articles reported on complication rate as a major outcome. This is a very important component of efficacy.

5.5 Conclusion

There is generally, a paucity of evidence looking at the efficacy of GPwSIs specifically, for surgical procedures. Whilst they seem to provide an acceptable standard of specialist care in the primary care setting, they do not appear to save money. However, they provide an alternative workforce and the improved access to care that results from it may offset their higher costs. In the setting of patients with PR bleeding at CMH, the benefit of a GPwSI programme remains unclear. A GPwSI programme would require training with surgical specialists to

perform accurate anorectal examinations with procto-sigmoidoscopy as well as a protocol driven algorithm for the clinical management of such patients. Based on the findings of the systematic review, the 'buy-in' from lead clinicians for a GPwSI programme for PR bleeding patients is very low.

CHAPTER 6 - REMODELLING OF THE COLORECTAL OUTPATIENT CLINIC- A CONTROLLED CLINICAL TRIAL

6.1 Introduction

6.1.1 Clinical Pathways

In Chapter 4 it was shown, through a systematic review, that PIFU holds utility in that it can help reduce un-necessary follow up appointments. A reduction in FU can lead to a potential improvement in waiting times as demonstrated by the simulation model in Chapter 3. Patients with PR bleeding (also regarded minor anorectal conditions as per Chapter 1) represent a particular pressure point in terms of waiting time targets for the Surgical Department. The role of PIFU for conditions such as PR bleeding is untested.

Clinical pathways are tools designed to help promote organised and efficient health care(81-84). They allow for implementation of evidence based guidelines, continuous quality improvement and standardisation of processes as well as reduce clinical variation(81) and equally importantly, reduce health inequities(85). Despite the global enthusiasm for clinical care pathways, there are some potential risks. According to Vanhaecht et al clinical pathways are only effective if used for "a well defined group of patients during a well defined period"(86). The pathways that tend to be disease or process focussed rather than patient focussed may not allow for the 'holistic' provision of care especially for patients with multi-morbidity(85, 87). Furthermore, other potential disadvantages of clinical pathways may include, higher costs of implementation, reduction in job satisfaction and reduced creativity(88).

However, as per the Cochrane review of Rotter et al(83), in which seven articles were identified, there were associations with fewer complications, improved clinical documentation and greater efficiency of resource utilisation with the use of clinical pathways.

It is for these reasons that the Department of General Surgery at CMH felt that implementation of any change in practice with respect to patients with PR bleeding would best be achieved through a clinical pathway. PR bleeding patients also fall into Vanhaecht's(86) criteria of a 'well defined group'.

6.2 Aims

In this chapter therefore, a clinical pathway centred around PIFU is presented for patients referred to surgical outpatient clinics with PR bleeding at CMH. The aim is to examine the utility of PIFU and its impact on reducing follow up appointments.

6.3 Methodology

6.3.1 Main Objective of Assessment of Patients with PR bleeding

Increased demand for access to outpatient clinics for patients presenting with PR bleeding was the main driver for the development of the pathway. As mentioned in Chapter 1, the primary objective of reviewing patients with PR bleeding is to exclude the presence of a colorectal cancer. A study into patient perceptions of rectal bleeding by Kocher et al, revealed that approximately two-thirds of

patients had personal concerns about malignancy when they sought medical advice for rectal bleeding(89). Several studies have shown that other than PR bleeding or the presence of an abdominal mass, most bowel symptoms had low predictive values for the presence of colorectal cancer(90-92). A review of the 2003 NICE referral guidelines for patients suspicious for colorectal malignancy, in the UK by Eccersley et al(93) suggested that guidelines were not all encompassing and in fact most patients with identified colorectal cancer did not fit published referral criteria. Any pathway development must therefore take these facts into account.

6.3.2 Pathway Development

The purpose of the pathway was to allow standardised care by the clinicians and allow for PIFU. Two separate protocols were developed. One was for patients with 'Painful PR bleeding' (Figure 6.3.2.1) and the other was for patients with 'Painless PR bleeding' (Figure 6.3.2.2). The protocols were developed by the Colorectal Surgeons in the Department of General Surgery at CMH, taking into account local resource availability. It is important to note that access to colonoscopic investigation was restricted by high waiting times.

The key features of the new protocols included:

1. Patients with 'high risk' symptoms or signs were referred for colonoscopy. 'High risk' was defined by the presence of any one of an abdominal mass,

unexplained anaemia, relevant family history in a first degree relative and altered bowel habit

2. Any patient over the age of 45 without 'high risk' symptoms but with PR bleeding was referred for CT colonography (CTc).
3. All patients for whom investigations were requested were subjected to 'chart review' which was a review of the results of that particular investigation by the PR bleeding Nurse Specialist.
4. All patients were given a PIFU 'card' which they could use to contact the Nurse Specialist directly for any queries or to set up a follow up appointment as required. There was no time limit to the use of the PIFU card.

Figure 6.3.2.1 Painless PR Bleeding Pathway

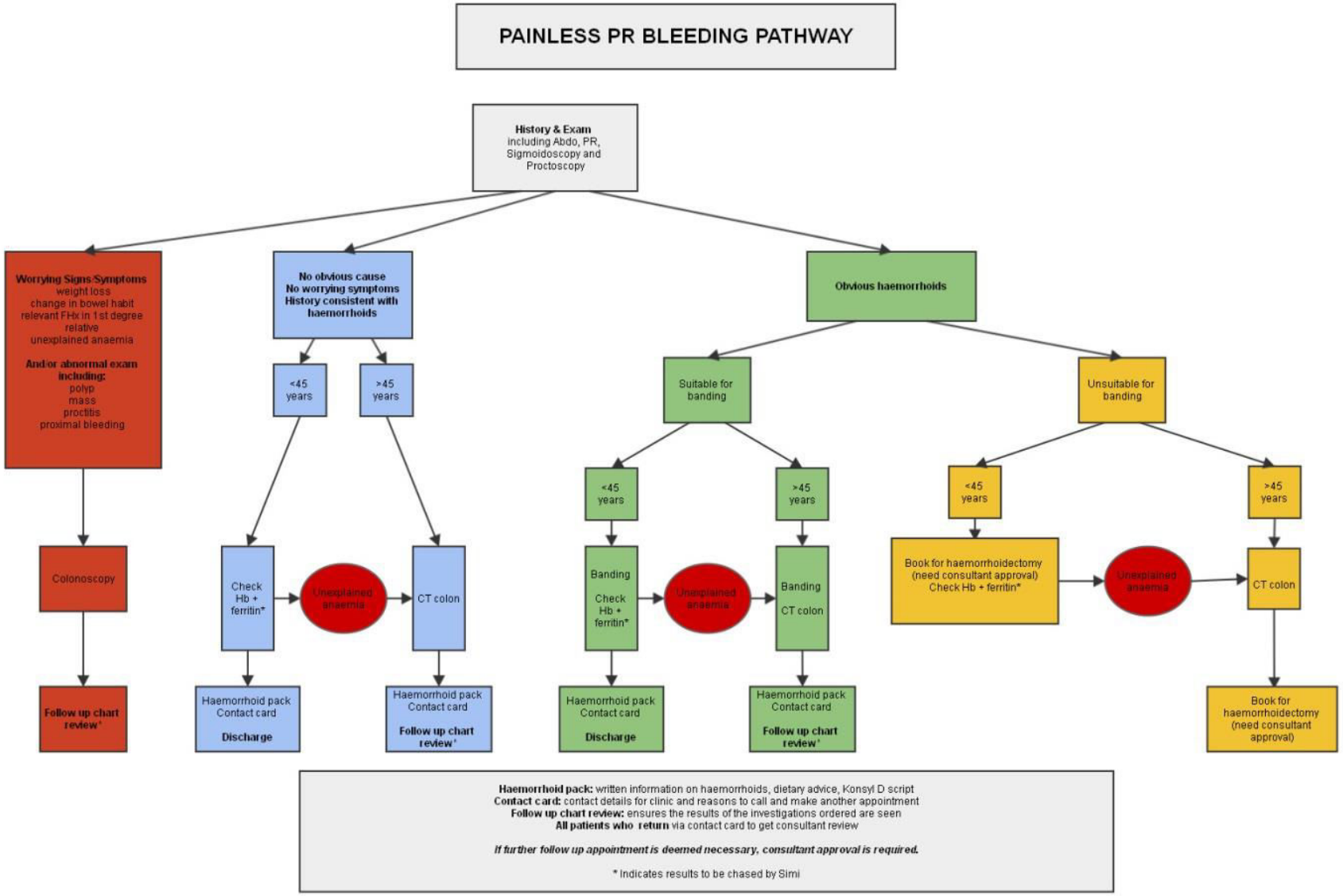
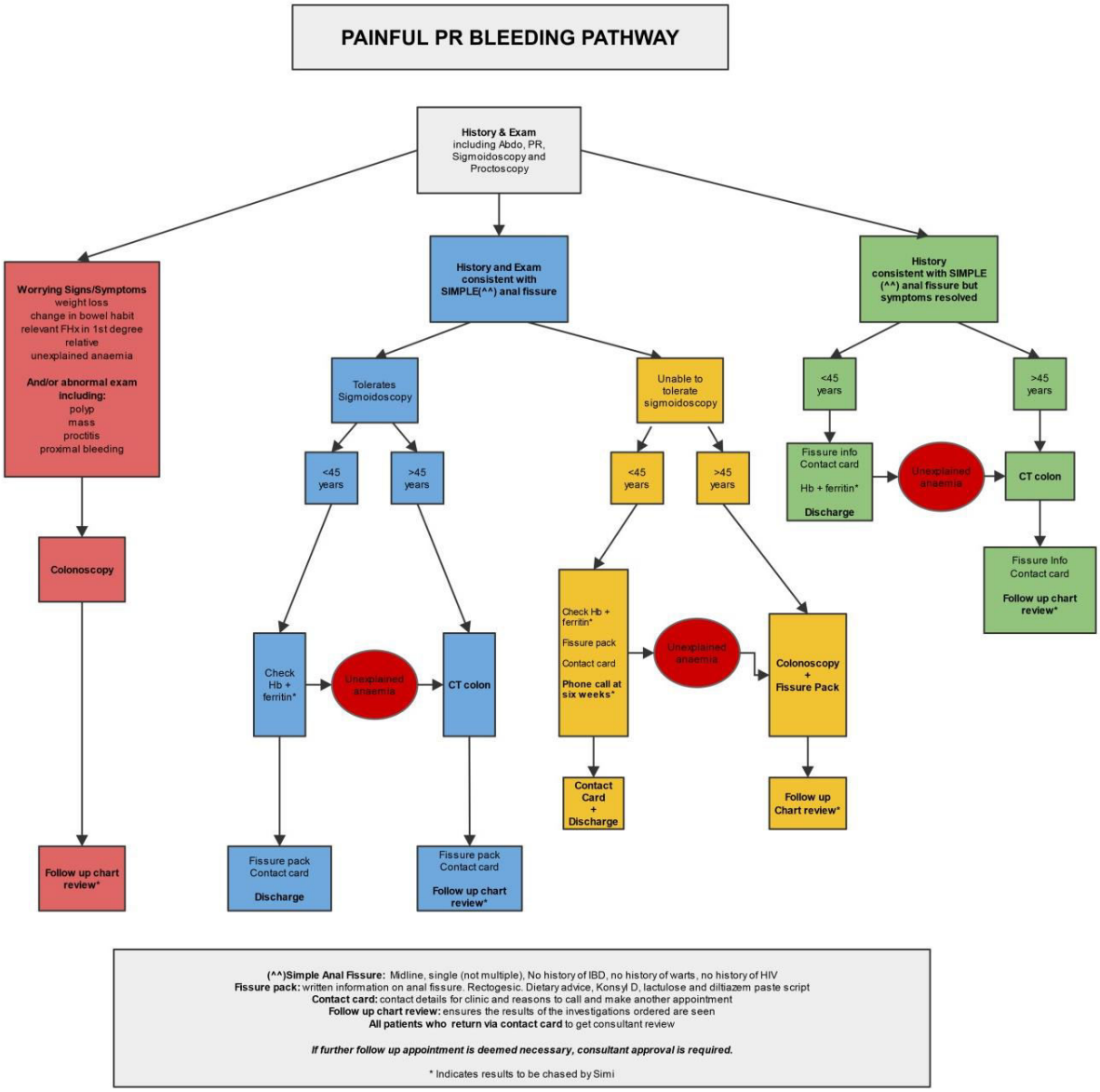


Figure 6.3.2.2 Painful PR Bleeding Pathway



6.3.3 Study Design

Prior to the implementation of this study, patients with PR bleeding were seen in mixed clinics by both Colorectal Surgeons and General Surgeons. In order to test the practicality and utility of the new pathway, a once monthly dedicated clinic was set up to see approximately fourteen new referral patients with PR bleeding only. This new clinic (NC) was an extra clinic, which ran in addition to the other

clinics. The NC was staffed by a Nurse Specialist, two Surgical Registrars and two Colorectal Surgeons (who participated in a rota of five surgeons). All clinical consultations and examinations were supervised by the two Colorectal Surgeons. Clinical examinations performed included general abdominal examination, digital rectal exam, rigid sigmoidoscopy and proctoscopy.

All patients were sent a Microlax® Enema enclosed with their clinic appointment letter and were asked to administer this themselves prior to their clinic appointment. If the quality of the anorectal examination was inadequate due to poor preparation, a repeat Microlax® Enema was administered in the clinic and the anorectal examination was repeated thirty minutes later.

The NC and the study began in November 2013. The study concluded in September 2014. Patients were non selectively allocated to the NC based on their position on the waiting list for outpatient clinic appointments. The remainder of the patients were seen in the usual clinics. Access to the newly developed protocols were available to all other surgeons in the department.

Only patients seen in the NC were recruited to the study. They were seen prior to their clinic appointment and consented for participation. Patients were excluded if they mistakenly presented to the NC as a follow up appointment or if they presented with colorectal symptoms other than PR bleeding (e.g. perianal fistula, rectal prolapse, pruritis ani, proctalgia etc.).

6.3.4 Control Group

The comparison group was a historical control of successive patients with PR bleeding, seen by the Colorectal Surgeons preceding December 2012. These patients were retrospectively identified through clinical records. The same exclusion criteria as above were applied.

It is important to note that the process of triaging referrals for outpatient appointments and the acceptance criteria was not significantly different across the two groups according to the specialists responsible. Nearly all referrals were accepted. Common reasons for declining referrals were for being out of the domiciled area and referrals sent to the wrong service. Whether a patient was accepted as 'minor anorectal' or 'complex colorectal' was left to the discretion of the triaging surgeon. As a general rule and as mentioned in Chapter 1, PR bleeding patients were regarded as 'minor anorectal'. Patients referred with other symptoms such as proctalgia, prolapse, incontinence, fistula in ano, masses etc. were generally regarded as 'complex colorectal'. Occasionally patients were also referred directly to the Gastroenterology from the triaging surgeon for consideration of colonoscopy first up, if there were significant high risk features for colorectal malignancy in the original referral. In this study, only patients with PR bleeding were included in the Control Group.

6.3.5 Outcome Measures

The primary outcome was the rate of follow up appointments. Secondary outcomes included rate of discharges, rate of elective operations and rate of

investigations. Other relevant outcomes included the number of patients utilising a PIFU appointment in the NC and the outcomes of the investigations that patients were referred for.

6.3.6 Sample Size Calculation

In chapter 3, the rate of FU after an FSA was 42%. It was felt that a new protocol would help reduce the FU rate by a factor of at least 50%. Hence assuming a power of 0.8 and a standard error rate of 0.05 the estimated sample size for each arm was calculated to be 96 patients.

6.3.7 Ethics

Ethics approval was obtained from the University of Auckland Human Participants Ethics Committee (UAHPEC) and from the local institutional organisation, (CMH).

6.3.8 Statistical Analyses

All statistical analyses were performed using SPSS (IBM SPSS V22). Categorical variables were analysed using the Fisher's Exact test for between-group comparisons. Continuous non-parametric variables were analysed using the Mann Whitney U test for between-group comparisons whilst for continuous parametric variables the student t-test was used. Continuous parametric variables were presented as means with standard deviation, whilst continuous non-parametric variables are presented as medians with inter-quartile range. Analysis was performed on an intention to treat basis.

6.4 Results

6.4.1 Baseline Data and Primary Diagnosis

Between November 2013 and September 2014, 11 new clinics were held. A total of 154 new patients presented through the NC. Of these, 14 patients were excluded from the study as their presenting complaint was not in fact PR bleeding. Another 7 patients did not provide consent for the use of their clinical information for the purposes of the study. A total of 133 patients were therefore ultimately used for prospective analysis in the NC arm of the study. In the historical control arm of the study, 135 consecutive patients with PR bleeding, seen by Colorectal surgeons preceding December 2012, were included. Table 6.4.1 shows the baseline characteristics and the diagnostic outcomes of the two groups. The mean ages are similar. A greater proportion of patients in the NC had haemorrhoids as their primary diagnosis, compared with the historical control (72% vs. 59%, p=0.001). The other diagnoses are of similar incidence. One case of rectal cancer was diagnosed in the NC on anorectal examination.

Table 6.4.1: Baseline characteristics and diagnoses of both arms

Characteristic	**New clinic (n=133)**	**Historical control (n=135)**	**p value^**
Age (mean)	48 ± 15	52 ± 15	0.001*
Gender (%)	Male 63 (47%) Female 70 (53%)	Male 52 (39%) Female 83 (61%)	0.133
Diagnosis (%)			
1. Haemorrhoids	96 (72%)	79 (59%)	0.001
2. Fissure	22 (16%)	28 (21%)	0.001
3. Anal skin tag	7 (5%)	5 (4%)	
4. Rectal polyp	5 (4%)	7 (5%)	
5. Suspicious colon cancer	0 (0%)	4 (2%)	
6. Colorectal cancer	1 (1%)	1 (1%)	
7. Normal	0 (0%)	4 (3%)	
8. Other	2 (2%)	6 (4%)	

^ Fisher's Exact Test (2 sided)
*independent samples t-test

6.4.2 Outcomes of FSA

The primary outcome of the study was the rate of follow up appointments (Table 6.4.2). There were significantly less follow ups in the NC (6% vs. 45%, $p<0.0001$). A small percentage of patients in the NC group were directly discharged (10%) whilst 70% of patients were discharged with either a PIFU card or a PIFU card along with a chart review.

Table 6.4.2 Outcomes of FSA

Outcome of FSA	**Specialised clinic (n=133)**	**Historical control (n=135)**	**p value^**
Follow up appointment (%)	8 (6%)	61 (45%)	<0.0001
Discharged (%)	0 (0%)	54 (40%)	
Discharge with PIFU (%)	66 (49%)	0 (0%)	
Discharge with chart review and PIFU (%)	41 (30%)	0 (0%)	
Booked for surgery (%)	18 (14%)	21 (16%)	0.635

^ Fisher's Exact Test (2 sided)

6.4.3 Treatment Provided

There were also significant differences between the two arms with respect to the treatment provided (Table 6.4.3). Band ligation was performed more readily in the NC group (36% vs. 15%, p=0.001). However, there were no significant differences in elective surgery rates (14% in NC vs. 16% in HC).

Table 6.4.3 Treatment Provided

Treatment	Specialised clinic (n=133)	Historical control (n=135)	p value^
Banding (%)	48 (36%)	20 (15%)	0.001
Rectogesic (%)	12 (9%)	19 (14%)	0.066
Surgery (%)	18 (14%)	21 (16%)	0.635
Phenol (%)	0 (0%)	0 (0%)	
Laxative/Diet Advice/Non-specific advice only (%)	55 (41%)	74 (55%)	0.247

^ Fisher's Exact Test (2 sided)

6.4.4 Investigations Performed

In terms of investigations performed, Table 6.4.4 shows that the rates of colonic studies overall were similar between the two groups (45% in NC vs. 40% in HC). In terms of the type of study chosen, there were significant differences with more CT colonography being performed in the NC group (24% vs. 5%, p=0.0001).

Table 6.4.4 Investigations Performed

Investigations	**Specialised clinic (n=133)**	**Historical control (n=135)**	**P Value^**
No Investigation (%)	70 (53%)	74 (55%)	<0.0001
Colonic exoneration (%)	60 (45%)	54 (40%)	
• CTC	32 (24%)	7 (5%)	0.0001
• Colonoscopy	28 (21%)	38 (28%)	0.345
• Barium Enema	1 (1%)	3 (2%)	
• Recent Colonoscopy	0 (0%)	6 (4%)	
Other[a]	3 (2%)	7 (5%)	

a-blood test only
^ Fisher's Exact Test (2 sided)

In the NC, colonoscopy was performed in 20% of cases overall. Table 6.4.4.1 demonstrates the outcome findings from colonoscopy. The most common finding was of benign colorectal polyps (41%). Normal colonoscopies or colonoscopies with only haemorrhoids were identified in 38% of cases. No malignancies were identified. The single patient in whom a rectal cancer was diagnosed in clinic had a rectal adenocarcinoma confirmed on colonoscopy.

Table 6.4.4.1 Outcomes of Colonoscopy

Colonoscopy outcome	**Number (n=28) (%)**
Did not attend (DNA)	3 (11%)
Normal	5 (19%)
Haemorrhoids	4 (15%)
Diverticulosis	2 (7%)
Polyps (benign)	11 (41%)
Cancer	1 (4%)
Other	2 (7%)

CTc was used in 24% of patients in the NC. Table 6.3.4.2 shows the outcomes from CTc.

Table 6.4.4.2 Outcomes of CTc

CTc Outcome	**Number (n=32) (%)**
Did not attend (DNA)	3 (9%)
Normal	19 (60%)
Haemorrhoids	0 (0%)
Diverticulosis	4 (13%)
Polyps (benign)	6 (19%)
Cancer	0 (0%)
Extra colonic findings • Lung lesion • Pelvic lesion • Liver lesion • Renal pathology • Biliary pathology	10 (31%) 2 3 1 2 2

Nineteen percent of patients who received a CTc went on to have a colonoscopy for polypectomy. A total of 31% were found to have extra colonic pathology but only 25% (8 patients) required further investigations. No extra-colonic malignancies were identified.

6.4.5 Utilisation of PIFU

The PIFU card was utilised by 21 patients (16%) who a made a total of 30 phone calls to the nurse specialist (Table 6.4.5). In the majority of cases, phone advice and reassurance were all that was required. Two patients presented to the hospital emergency department with acute bleeding for which they were observed and did not require surgical intervention. A total of 10 follow up appointments were made for 6 patients.

Table 6.4.5 Utilisation of PIFU

PIFU phone calls	**Number**
Total calls	30
Total patients using PIFU	21
Total presentations to Emergency department	2
Follow up appointments made	10
Reassurance and phone advice only	20

6.5 DISCUSSION

This study demonstrates the development of a clinical pathway to manage patients presenting to surgical outpatient clinics with PR bleeding and shows a reduction in overall follow up appointments through the utilisation of PIFU.

There are only a handful of examples of 'one-stop' dedicated rectal bleeding clinics in the published literature(94-97). It is interesting and worth noting that most of the cited examples of one-stop PR bleeding clinics have utilised flexible sigmoidoscopy as the main modality of investigation(94-96, 98). The UK Flexible Sigmoidoscopy Screening Trial (UKFSST) trial for colorectal cancer screening also shows efficacy of a one-off screening flexible sigmoidoscopic examination as a means of improving colorectal cancer detection and mortality(99).

In this current study however, the chief components of the two protocols for PR bleeding were the use of PIFU and the use of CTc as a one stop investigation for those patients with PR bleeding over the age of 45, whose symptoms were not deemed as 'high risk.' The role of CTc as a screening modality is evolving. Its sensitivity and specificity for detecting significant polyps (>10mm) is very high according to a meta-analysis by Sosna et al(100). Another meta-analysis by Pickhardt et al, 2011(101), suggested a near 100% sensitivity rate for the detection of colorectal cancer. Furthermore, a large multicentre randomised study in the UK, the SIGGAR trial showed that CTc had equivalence in detecting large polyps or cancer when compared to the gold-standard investigation, colonoscopy(102).

CTc is also more readily available compared to colonoscopy in the public hospital setting, especially in NZ. The capacity limitations and shortfall in access to public hospital waiting lists for colonoscopy was a significant national and political issue in NZ in 2014. An article by Johnson, in the New Zealand herald in 2014, claimed that just under a third of semi-urgent colonoscopies were being performed within the national target times, highlighting the burden on colonoscopy resources nationwide(103). There is also concern that the planned roll-out of colorectal cancer screening with fecal occult blood testing (FOBT) will further the burden on resources for colonoscopy in NZ(104).

Although access to CTc is superior compared to colonoscopy and it has a very high sensitivity for larger polyps, it does have reduced sensitivity and specificity for small to diminutive polyps (<6mm) and therefore its use for patients at 'high risk' for colorectal cancer is debatable(102, 105, 106). It is for this reason that patients who were clinically deemed as 'high risk' were referred directly for colonoscopy in both pathways.

In this study, approximately 20% of patients required colonoscopy for the identification of polyps on CTc. In all cases the polyps identified were benign. At the same time nearly 25% of patients required further investigations for extra-colonic incidental findings. These findings are consistent with ranges noted in other studies(102, 107-110)

The PIFU 'card' was given to all patients in the NC. Only 16% of patients utilised the PIFU card. In the vast majority of cases, a follow up appointment was not necessary and phone advice and reassurance was all that was required. One of the anecdotal reasons for a high follow up rate in the historical control was to re-check patient symptoms and provide reassurance to those who required it. It was also an opportunity to follow up on investigations that were requested, so that no abnormal results would be missed. The implemented pathway utilised the role of a Nurse Specialist to follow up on investigations requested by the surgical team and thereby also reducing the need for unnecessary routine follow ups.

One of the concerns with a lack of follow up is the risk of missing potential colorectal malignancy in patients who continue to be symptomatic. As mentioned in Chapter 4, since patients with PR bleeding are likely to undergo a moderately invasive clinical examination during their consultation, they may not be as forthcoming to utilise a PIFU system. This risk is therefore partly mitigated by having a slightly lower age threshold for colonic investigation of 45 years of age, when compared to other international guidelines such as in Australia and USA(111, 112). It is also conceivable that some patients may not choose a follow up appointment, given the sensitive nature of the clinical examination in these clinics. Hence, further longitudinal follow up of the patients in the NC could be considered to assess if any of the patients who did not utilise PIFU, developed malignancy in the future. It is worth noting however that the overall rates of colonic examination were similar between the two groups studied. A higher proportion of patients in the historical arm had colonoscopies compared to CTc.

Given that there were no significant differences in the mean ages of both groups, it is likely that similar indications for colonic examination were applied in the historical control group. The implication of this finding is that the new pathway at the very least does not increase the risk of missing colorectal malignancy when compared to historical practice.

Another concern with the predisposition of CTc missing small polyps is the risk of future malignancy. A longitudinal follow up in 3-5 years of these patients who received a CTc could be considered in this cohort to assess rate of malignancy. It is worth noting however, that there is some evidence that the majority of small (6–9mm) polyps will not progress to advanced neoplasia within 3 years, as presented in a study by Tutein Nolthenius, et al in 2015(113). Two other studies that looked at five year colorectal cancer outcomes in a large cohort of patients who had had negative CT colonography for screening purposes identified that the incidence of presenting colorectal adenocarcinoma is rare when re-screened at five years, implying that the malignancy transformation risk of missing small polyps is small(114, 115).

Despite several studies suggesting that other than PR bleeding or the presence of an abdominal mass, most bowel symptoms had low predictive values for the presence of colorectal cancer(90-92), only a single case of colorectal cancer was identified in the NC. The implication of this is that perhaps even rectal bleeding has a limited positive predictive value for the presence of colorectal malignancy.

This study has some significant limitations:

This study did not analyse the practice of the General Surgeons in the Department who also see outpatients with PR bleeding. In order to reduce the risk of selection bias, it was felt that study should compare the efficacy of the pathway between the same group of surgeons and hence the historical control group data was obtained for the same group of colorectal surgeons who participated in the rota for the NC.

Ultimately, what remains to be determined is the overall effect of a reduction in follow up appointments and the relative gain in extra capacity that is created by these and how that translates into waiting time improvements. A cost effectiveness analysis on the use of PIFU and the increased use of CTc would also be very valuable, particularly also because a significant proportion of patients who had a CTc, required further investigations for either due the identification of polyps or extra-colonic findings.

Another limitation in the study is the length of follow up. Further longitudinal follow up of this cohort of patients over the next 3-5 year period would be beneficial in monitoring the rate of missed malignancy or future malignancy. Furthermore, the improved access to colonic investigations might also potentially lead to increased referrals in the long term and this may also need to be monitored.

6.6 Conclusion

This clinical pathway for patients presenting to outpatient clinics for rectal bleeding demonstrates standardised protocols that can help reduce variation in clinical practice. The use of the concept of PIFU is fundamental to this pathway and a significant reduction in follow up appointments is noted which has implications for extra capacity for outpatient clinics. The study can be further enhanced by an ongoing longitudinal follow up of recruited patients to assess for future rate of colorectal malignancy. A cost effectiveness analysis on the use of PIFU and the increased use of CTc would also be beneficial.

CHAPTER 7 - VALIDATION OF THE SYSTEMS DYNAMICS SIMULATION MODEL

7.1 Introduction

In Chapter 3 an SD model was developed. Three basic hypothetical scenarios were tested for the outpatient clinic at CMH for patients with PR bleeding. The first scenario projected outcomes if there was to be a reduction in the rate of FU appointments. The second scenario projected outcomes if there was to be a direct increase in capacity by the way of a new clinic. The final scenario examined what would happen if there were both a reduction in FU and an increase in capacity.

The prospective trial presented in Chapter 6 represents both an increase in capacity and a reduction in FU. It must be reiterated however, that the new clinic ran in conjunction to 'business as usual' clinics, where patients with PR bleeding were seen along with other general surgical patients in the outpatient clinics.

7.2 Aims

In this chapter the various projected outcomes from the simulation model are prospectively assessed and compared them with the actual waiting list and determine its level of correlation and validity.

7.3 Methods

The new clinic was implemented in November 2013. Data were collected over a 4 month period from November 2013 to March 2014. Two specific variables were particularly analysed. The first was a change in clinic capacity, given that

an additional monthly clinic was being held, seeing approximately 14 FSAs. The second variable was the change in the FSA to FU proportion. The data were taken from both new clinics and 'business as usual' clinics for patients with PR bleeding. Once data over the 4 month period were accumulated, they were imputed into the model and projection over the next few months was performed.

7.3.1 Scenario Testing

Three scenarios were again hypothesized in the model:

1. Scenario 1 – Reduced follow-up appointments alone. The clinic capacity is left unaltered but the FSA to FU proprotion is adjusted as per the observational data from November 2013 to March 2014.
2. Scenario 2 – New clinic alone. The model is made to assume only an increased capacity of being able to see an extra 14 FSAs per month whilst maintaining historical follow up proportion of 0.41-0.51 (quintile 25 to 75) as noted in Chapter 3.
3. Scenario 3 – New clinic and reduced follow up appointments. The model is made to assume increased capacity of being able to see an extra 14 FSAs per month as well as an overall reduced follow up rate from FSAs based on the observational data from November 2013 to March 2014

The various data projections of the model were then tested against real time data. Statistical validation was performed by fitted linear regression to

determine correlation of real data against projected data for each of the above scenarios

7.4 Results

7.4.1 Real Data Accumulation from November 2013 to March 2014

Table 7.4.1 refers to the real time data accumulated over the 4 months period from November 2013 to March 2014 with respect to the variables required by the SD model. It is important to re-iterate that these data represent the entire outpatient clinic with respect to PR bleeding patients. It therefore comprises of both new clinic and 'business as usual clinics.'

Table 7.4.1 Descriptive statistics of key model variables (per month), November 2013-March 2014

Variable	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic
FSA	40	93	68.7	22.4
FU	21	59	42	13.6
FSA to Other	3.37%	33.9%	17.4%	14.3%
FSA to Surgery	1.79%	31.4%	16.9%	10.0%
FSA to FU	13.25%	27.5%	20.0%	6.33%
FSA to DNA	0%	3.92%	1.50%	1.50%
FSA to Discharge	37.3%	53.9%	44.1%	5.83%
FU to Other	1.89%	20.6%	7.25%	7.21%
FU to Surgery	3.77%	14.3%	9.77%	3.67%
FU to FU	17.65%	30.5%	24.5%	5.39%
FU to DNA	0%	6.78%	3.28%	2.91%
FU to Discharge	45.8%	62.5%	55.2%	6.89%

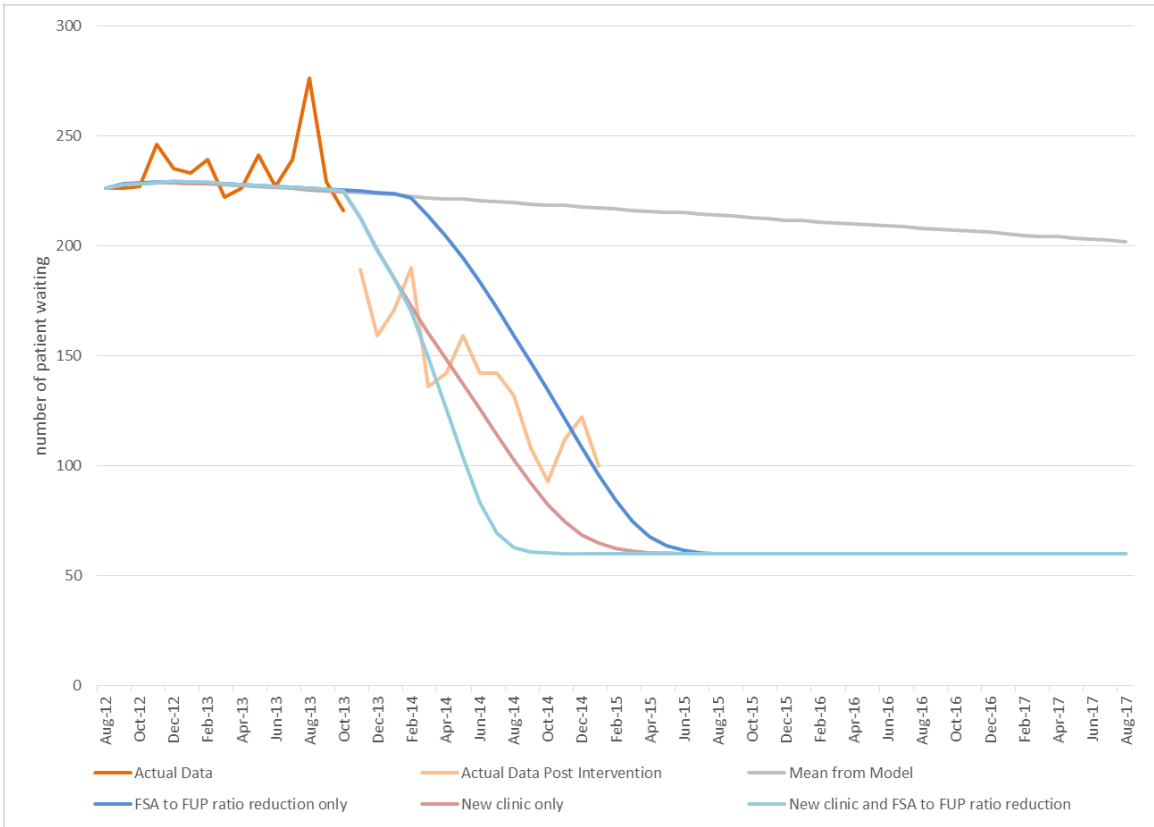
Note that the overall FSA to FU proportion across both new clinics and 'business as usual' clinics declined as a consequence of the PIFU system from from 0.41 – 0.51 (quintile 25 to 75) to 0.15 – 0.25 (quintiles 25 to 75) over a 4 month period from November 2013.

It should also be noted that the mean number of FSA patients seen increased from 59.2 patients per month in the historical group (August 2012 to November 2013, see Chapter 3) to 68.7 FSA patients per month from November 2013 to March 2014.

7.4.2 Comparison of Actual Data and Simulated Data

Figure 7.4.2 illustrates actual data vs. simulated data of the waiting list for a variety of scenarios described below. It provides the simulated results from August 2012 to October 2013 that has been validated with the actual historical records. From November 2013 onwards (i.e. from the start of the monthly new clinic) the model provides forecasting results up to August 2017. As the model takes random values from each variable, all the scenarios have been simulated 1000 times to generate a mean result (Monte Carlo method, Chapter 3).

Figure 7.4.2. Patients waiting for FSA



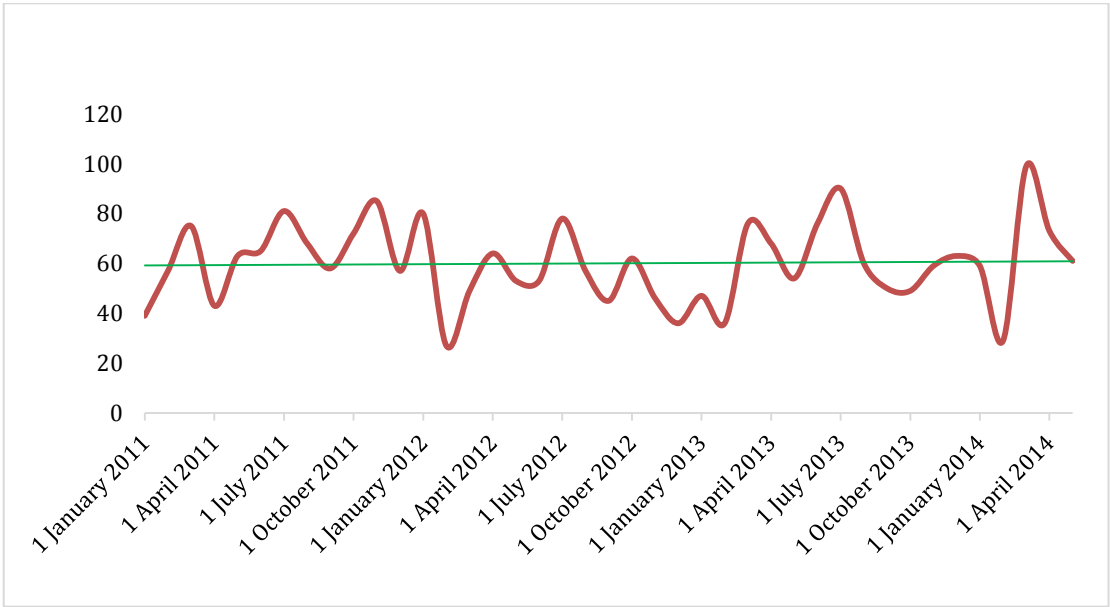
1. Baseline scenario (grey) – Assumes the clinic carrying on as usual without any interventions and that there is no change to population growth.
2. Scenario 1 – Reduction of FSA to FUP proportion only (blue). The FSA to FUP proportion in this scenario has reduced from 0.41 – 0.51 (quintile 25 to 75) to 0.15 – 0.25 (quintiles 25 to 75). The WL starts to reduce from February 2014 even if this intervention commences from November 2013. This intervention shows a clear delay effect, as the follow-up period for patient revisit clinic is about three months
3. Scenario 2 – New clinic only (red)
4. Scenario 3 – New Clinic and Reduction of FSA to FUP proportion (light green).

5. Dark Orange colour – Historical data from August 2012 to October 2013. The model almost replicates the historical data
6. Light Orange colour – Post intervention actual waiting list trend from November 2013 to January 2015.

7.4.3 Referral Rates

Figure 7.4.3 shows the trend in referrals observed leading up to April 2013. The mean referral rate was noted to be 59 referrals per month from August 2012 to November 2013. The referral rate after the new clinic had started was 66 referrals per month for the period of November 2013 to March 2014. The green line represents a line of best fit to show a very slight upwards trend in referral rates.

Figure 7.4.3 Actual Referral Rate for PR bleeding patients to Outpatient Clinic with linear regression



7.4.4 Validation of the Model

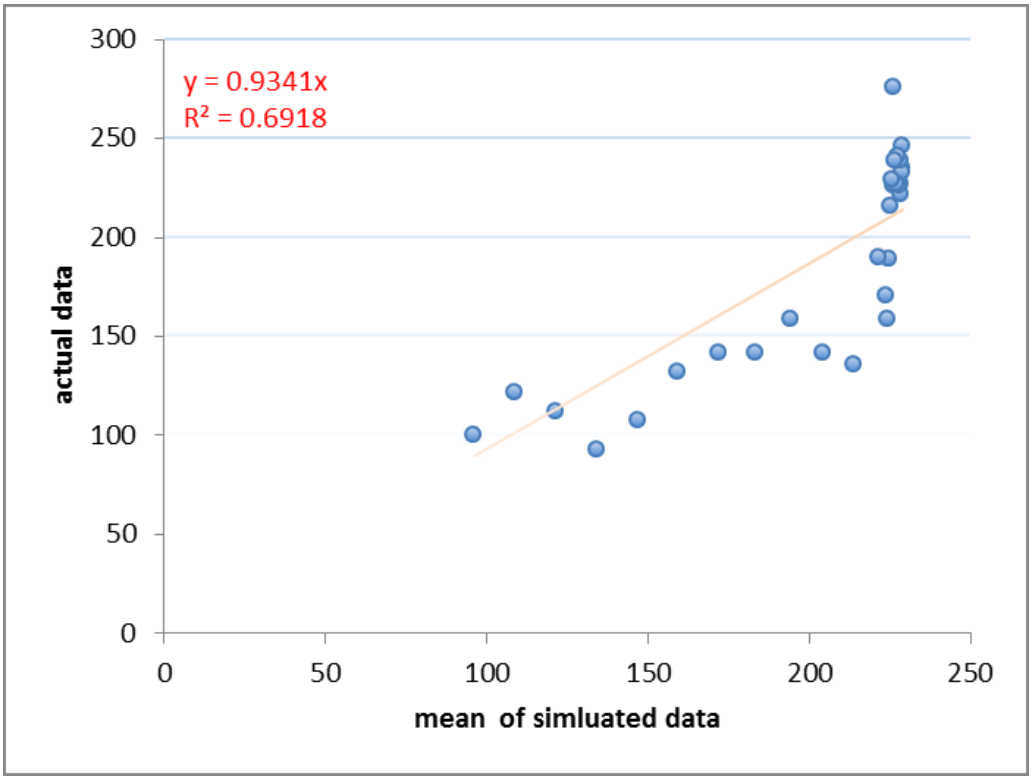
The various scenarios are tested against actual data studied prospectively. This prospective evaluation began four months after the commencement of the NC, in order to allow a 'pilot' period of evaluation to changes in the parameters for the model, such as a change in capacity, a change in FU proportion etc.

In order to validate the model, fitted linear regression was used to see how well the dynamic model fits with the observations. Both the simulated data and the observations are treated as continuous variables in linear regression. The slope of the regression provides information on the degree of correlation between the simulated data against the observed data where a gradient approaching 1 implies greater correlation. The R square provides a measure of percentage variation explained by the simulated data for the observations.

7.4.4.1 Scenario 1 – Reduction in FSA to FUP proportion only.

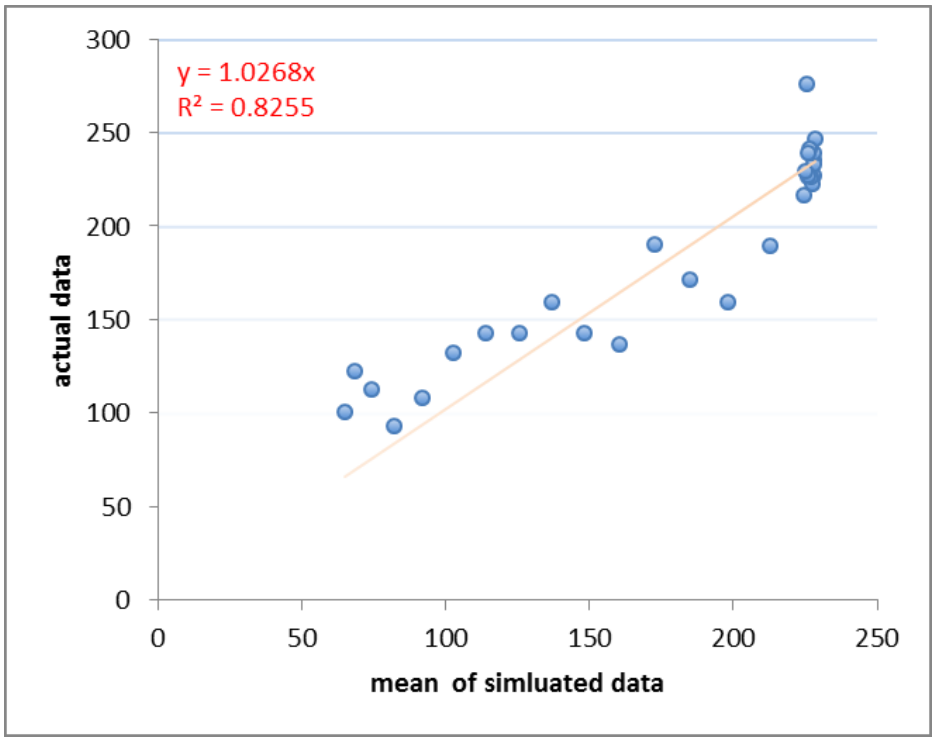
In Figure 7.4.4.1, the graph at the top demonstrates the relationship between the actual historical data (blue line) against the mean of 1000 simulations results (red line). The graph at the bottom demonstrates a fitted regression line for the mean simulated data against the actual historical data. The fitted regression has an R square of 0.69 and a slope of 0.93. The R square of 0.69 in this case, indicates that 69% of the variation is explained by the simulation. The linear slope of 0.93, which is close to 1, indicates that the simulated values have a reasonable fit to the actual data.

Figure 7.4.4.1 Validation of the Model-Reduction of FSA to FUP proportion only



7.4.4.2 Scenario 2 – New Clinic only

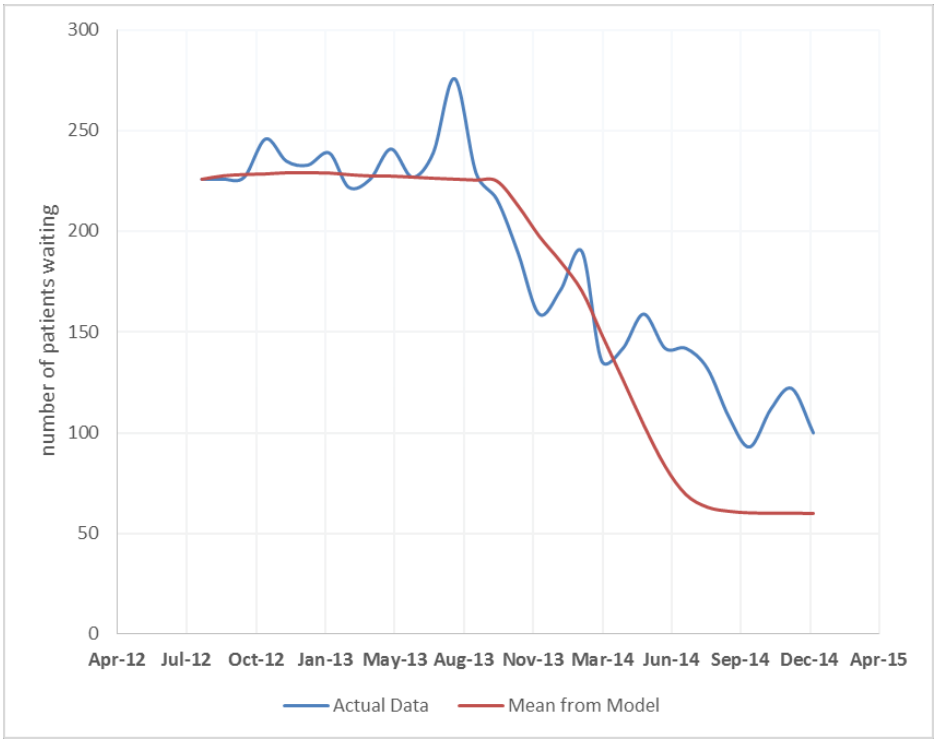
Figure 7.4.4.2 Validation of the Model-new clinic only

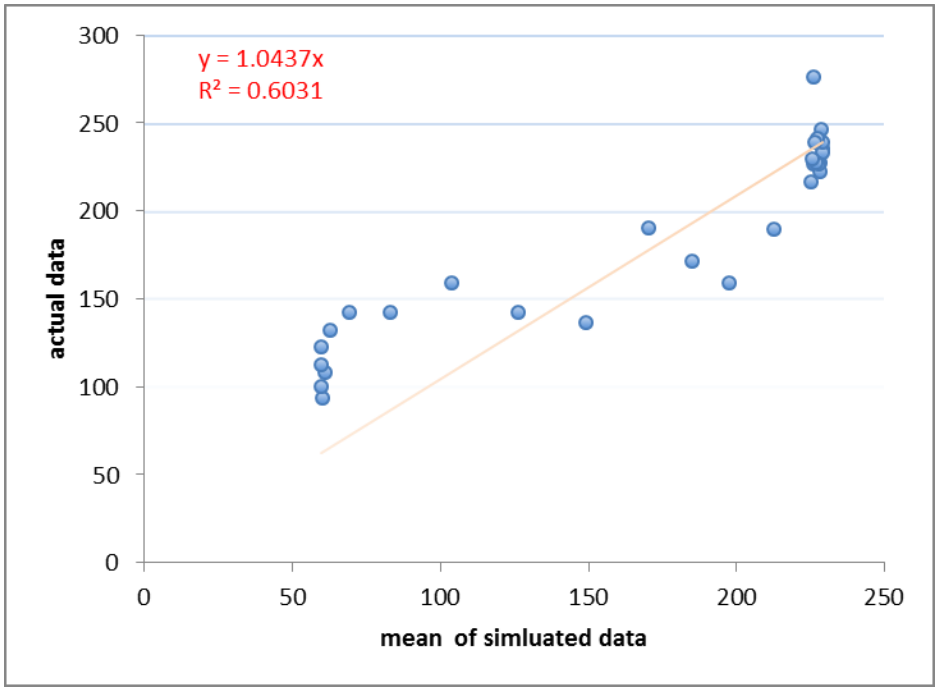


In Figure 7.4.4.2, the fitted regression has an R square of 0.83 and a linear slope of 1.03. The R square in this scenario is better than the previous scenario, which indicates that more variations in the actual data have been explained by this simulation. The smaller linear slope of 1.0268 also indicates that the simulated values have a better fit of the actual data.

7.4.4.3 Scenario 3 - New Clinic and Reduction in FSA to FUP proportion

Figure 7.4.4.3 Validation of the Model-new clinic and reduction of FSA to FUP proportion





In Figure 7.4.4.3, demonstrating Scenario 3, the fitted regression has an R square of 0.60 and a linear slope of 1.04 The linear slope of 1.0437, which is close to 1, indicates that the simulated values have a reasonable fit of the actual data but the R square of 0.60 shows that only 60% of the variations in the actual data are explained by the model. Whilst this is reasonable, this scenario does not match real data as accurately as Scenario 2.

7.5 Discussion

In this study the method of developing an SD simulation model to help analyse, predict and plan changes related to an outpatient clinic service in a large public hospital is described. Within the department of General Surgery at Counties Manukau Health, patients with PR bleeding were targeted as a subset to improve their access to the outpatient clinic.

To the best of the author's knowledge, there are no other published articles that have utilised a similar model in the setting of outpatient clinics.

The model is constructed on the basis of causal relationships between outcomes that might emerge within the patient pathway in the outpatient clinic. For example, a decrease in follow up appointments will result in increased capacity see FSAs. The model is designed to allow forecasting and production planning by quantifying the effect of policy changes or changes to clinical behaviour.

In this model several hypothetical scenarios were tested.

- Scenario 1 – Reduced follow up appointments alone
- Scenario 2 – New clinic alone
- Scenario 3 – New clinic and reduced follow up appointments.

The Department of General Surgery initiated a new once monthly extra clinic designed to see the FSAs of patients with PR bleeding in November 2013. The protocols developed for this clinic were not exclusive to the clinic and were

utilised by some surgeons in other business as usual clinics. This led to an overall decrease in follow up rates.

Scenario 2 (new clinic only) has a better fit overall (R square of 0.8255 vs. 0.6031) than the other scenarios. This is interesting because the real intervention included both an extra monthly clinic and a reduction in the FSA to FUP proportion (measured from November 2013 to April 2014). On closer inspection, the predicted trend resembles the actual trend up until April 2014, after which there is a deviation away of the actual data, with the model over estimating the reduction in the WL (Fig. 6). Various explanations can be suggested. Firstly, it is possible that the referral rate may have changed, thus increasing demand. Increased accepted referrals would mean that the rate of reduction of the wait list would decrease.

Secondly, it is also possible that the overall follow up proportion may have changed after April 2014. It is possible that clinicians were initially compliant with the new protocols resulting in fewer follow ups, but with time, there could have been a partial reversion towards previous clinical behaviour and a slightly higher follow up proportion than what was imputed in the model.

Thirdly, the model assumes that the 'business as usual' clinics are seeing patients at the same rate as they were leading up to March 2014. However, it is possible that after a period of time, as the waiting list drops and access times subsequently improve, the number of patients seen in those clinics reduces as

well as resources are directed towards other groups of General Surgical patients (e.g. hernias, skin lesions etc.)

7.6 Conclusion

The accuracy of how well the model can predict future changes will depend on how accurately the input variables reflect real practice. Nevertheless, the model has a role for production planning. As illustrated in this study it can for example, help forecast future trends when extra capacity is sought. The advantage of the model is that multiple variables can be changed at once (e.g. increased capacity, increased referral rate, decreased follow up etc.) to predict the main outcome, which is a change to the waiting list. The model's main benefit is to help drive higher level policy change for the medium to long term. It has less benefit on short-term changes simply because there can be significant short-term variation in the input variables to the model.

One of the other potential benefits of this SD model is that it is generic in its construction. The overall model can be applied to other outpatient clinics at CMH and other hospitals that have a similar process of referrals and follow ups. Linking individual models from various departments can provide a more holistic picture of the overall running of outpatient clinics and a broader idea of resource allocation and utilisation.

CHAPTER 8 - DISCUSSION

8.1 Summary of Results

This aim of this thesis was to determine how, within an era of constrained resources, the delivery of health care of patients referred to outpatient clinics with rectal bleeding at Counties Manukau Health could be optimised. PR bleeding patients (essentially regarded as minor anorectal conditions with respect to hospital clinic data) represented a 'pressure point' in terms of capacity to be seen and treated in the ambulatory care setting.

Of all the patients awaiting an outpatient specialist appointment (FSA) within the Department of General and Vascular Surgery, patients with PR bleeding accounted for nearly 17% of the total volume as of May 2013. With new waiting time targets imposed by the MoH for elective services, it was clear that the status quo of demand management and clinical management was not sustainable if the new targets were to be met. It was noted that patients with PR bleeding had a median waiting time of 16 weeks as of May 2013. The maximum waiting time as per the targets imposed by the MoH would be 16 weeks as of December 2014(1, 6).

An approach to determining and managing bottlenecks within a given system is the utilization of Operations Research (OR). OR uses a variety of analytical techniques to optimise efficiency within a given system. Computer Simulation is a core component of OR which helps with understanding and evaluating performance within a given system. Chapter 2 describes a systematic review of methods of computer simulation modelling used to help optimise outpatient

clinics in secondary care. Eleven articles were identified. The review found that most of the evidence was focused around appointment scheduling and patient waiting time in clinic. There was limited evidence however, with respect to access time and waiting lists. There were only 2 articles that investigated the use of modelling systems to improve access time to outpatients clinics. In the study by Elkhuizen et al(31), capacity determination was performed by the model to help reduce the backlog of patients on the waiting list for neurology clinics. The model predicted the extra capacity that would be required to reduce waiting times to within 2 weeks. Similarly, in the study by Crane et al(30), simulation modelling was used to determine the effect on access time by changing booking cycle length and duration between follow up visits. It found that increasing the duration between follow up visits would lead to increased capacity and reduced access time.

This review noted that in every case, computer modelling is able to provide a picture of the bottlenecks within a given system, and allow analysis of how proposed changes could affect outcome. Despite scant and varied evidence of the use of modelling systems looking specifically at outpatient clinic efficiency, the overall principle of OR has potential merit in trying to gauge the dynamic forces at play within any given system including outpatient clinics.

Therefore, in Chapter 3, a systems dynamics (SD) model was created for PR bleeding patients for outpatient clinics at CMH. A process map, mapping the patient's journey from initial consultation in primary care to being seen in the secondary care outpatient clinic and then receiving a treatment outcome, was

created initially. By determining the various probabilities of each step in the process map, hypothetical scenarios to test alternative outcomes could be developed and simulated. The scenarios tested included – increasing clinics or reducing the number of people requiring follow up appointments or both.

Interestingly, the model predicted that reducing follow up appointments would provide extra capacity and reduce waiting times at a similar rate to simply providing extra clinics. The model demonstrated that when patients are frequently brought back into the clinic for a follow up appointment, there is a reduction in the relative capacity to see FSAs. Simply increasing capacity by the way of extra clinics can compound the problem in the long term by generating further follow up appointments and thereby potentially reducing relative capacity again. The model highlights the potential merit of reducing follow up appointments to free up capacity to see FSAs. It is important to note that Ministerial targets and ESPI scores pertain to FSAs rather than follow up appointments.

Reducing follow up appointments might improve clinic efficiency but this may come at a cost of reduced quality of service and possibly poorer outcomes for patients. In Chapter 4, a systematic review investigated the value of patient initiated follow up (PIFU). PIFU is an initiative that allows patients to initiate a hospital follow up appointment on an 'as required' basis compared to the traditional 'physician-initiated' model. This potentially reduces unnecessary follow up appointments that can clog outpatient clinics. Six studies were identified in this review and they showed that PIFU led to fewer outpatient

appointments, whilst maintaining good quality of care and better patient satisfaction. There was scant evidence however, for the use of PIFU in conditions where there is a potential for underlying malignant disease, such as is the case for PR bleeding patients.

Chapter 5 reviewed the efficacy of a GPwSI programme with respect to surgical procedures. The question addressed was whether there would be any utility and applicability of such a programme with respect to PR bleeding patients. In theory, by utilizing an alternative workforce, extra capacity could potentially be generated. The review found scant evidence for the use of GPwSIs with respect to surgery and surgical clinics. Most of the evidence related to the surgical management of skin lesions. The systematic review found that whilst it appeared that GPwSIs provided a service that was acceptable in terms of quality and safety, they did not appear to save cost. However, there was a paucity of good quality evidence and it may be that the alternative workforce provided by GPwSIs might improve overall waiting times and this might offset their higher cost, especially when waiting time constraints are applied. The lack of generalizability of the studies, meant that it was not possible to determine whether a GPwSI programme was suitable for outpatient PR bleeding patients at CMH. Such a programme would be uncharted territory and hence there was reluctance to implement it. Furthermore, evidence from later chapters demonstrated that demand management by simply increasing workforce does not actually improve the waiting times for FSA in this context.

In an attempt to make the PR Bleeding clinic more efficient, a prospective controlled clinical study was performed with the intention of evaluating a newly developed clinical pathway for PR bleeding patients, utilizing the concept of PIFU to help reduce follow ups. This study is described in Chapter 6. The pathway was created and utilised an evidence and expert opinion based clinical pathway. The pathway was designed to mitigate the perceived risk of missing colorectal malignancy with the use of PIFU. In the pathway, all patients over the age of 45 were screened for colorectal cancer by way of CT colonography. Patients were non-selectively placed in a specialized new clinic that was designed to adhere to the new pathways set out. The comparison group was a historical cohort of patients with PR bleeding seen by the colorectal surgeons. The study ultimately demonstrated that follow up appointments reduced from 45% to 6% with the new protocols and the aid of PIFU. Only 16% of patients who were given a PIFU card utilised the card to book another follow up appointment themselves. Interestingly, the rate of patients requiring surgery and the rate of colonic investigations were similar in both groups. This study could benefit hugely from further longitudinal follow up, to assess the rate of future malignancy and to observe changes in referral patterns (particularly increased referrals) given the improved access to colonic investigation.

In Chapter 7, the SD simulation model that was designed for the PR bleeding patients was examined prospectively. The model was simulated to assume an additional new clinic with increased capacity to see FSAs and a reduced overall follow up proportion. When compared to actual data showing a reduced waitlist, there was a good correlation with the predicted outcome from the model. A

fitted linear regression method was used to validate the model and a linear regression of close to 1 was observed, indicating a good fit when comparing predicted data to actual data. The fitted regression had an R square of 0.60, indicating that 60% of the variations in the actual data were explained by the model. Whilst this implies acceptable correlation, it was noted that the model's second scenario of having a new clinic only without a reduction in follow up proportion had a closer fit to the actual data. Numerous explanations are possible, including a change in the referral rate of patients with PR bleeding from primary to secondary care, which was possibly not accounted for in the model. Nonetheless, the reasonable correlation of the model to actual data, shows that it is sufficient to help drive high level policy change and give a better understanding of where in the overall outpatient clinic system, targeted areas for maximum gains can be identified to help improve clinic efficiency and help improve access time.

8.2 Future Directions

This thesis has generated further questions that remain unanswered.

Whilst the systematic review on PIFU shows that it is a viable concept, there are questions as to its use in the setting of conditions where there is an inherent malignancy risk. PIFU was utilised in the new pathway for the PR bleeding patients. However, an advantage of routine follow up for such patients is that those patients who may continue to be symptomatic with PR bleeding could be referred for further investigations to investigate their colon and rectum and

exclude any malignant pathology. Thus there is the possibility of missed malignancy with PIFU. Whilst, this risk is mitigated somewhat with a lower threshold for colonic investigations, it is not eliminated. A longitudinal follow up of this cohort of patients is vital to examine if any patients present with colorectal malignancy within the next 3-5 years.

The thesis has not looked into patient satisfaction with the new clinic protocol and the use of PIFU. A survey of whether patients found PIFU to be a useful and beneficial tool or whether they would prefer routine follow up appointments would be a useful addition to future studies. Patient perception of quality of service is of importance and must be considered in driving policy for change.

The question of cost effectiveness of the new clinic protocol remains unanswered as well. Improving access times through the new clinic is obviously beneficial. However, what is unknown is whether the cost of running an extra additional once monthly clinic as in the study, as well as the cost of nursing involvement for utilizing PIFU offsets the gain in access time.

The simulation model developed in this thesis represents a high level model with the ability to provide an overall direction for production planning in the medium to long term. Further refinement and sophistication and may potentially help create an autonomous predictive model that utilizes live data measures on a daily basis to make predictions ranging from short term (days and weeks) to the longer term (months and years). This could help with production planning for decisions such as how many extra clinic sessions are required in order to meet

certain waiting time targets and decisions such as how many further surgeons may need to be employed in the coming few years to meet the demand.

Whilst the thesis shows limited evidence for GPwSIs, the lack of generalizability of the studies makes it difficult to ascertain whether or not a GPwSI programme could work with PR bleeding patients. Whilst the review suggested that the quality of service provided was acceptable when compared with secondary care, the costs tended to be higher. However, this may be offset by gains in access time.

8.3 Conclusion

From this thesis, the following conclusions can be made:

The GPwSI programme in surgical conditions, is poorly studied and reported and is largely limited to skin lesions. Whilst the service provided is not inferior in most cases to hospital level care, they may be associated with increased overall costs.

Computer systems modelling for outpatient clinics have been studied and although most of the evidence looks at improving time whilst waiting in clinic and improving staffing, there is some evidence that these approaches may be useful to develop models for driving policy to address access time issues. As demonstrated in this thesis, it can provide analytical insight into a system such

as outpatient clinics and waiting lists and test hypothetical scenarios to achieve numerical predictions rather than rely on anecdotal estimates.

PIFU is an effective method of reducing clinic follow ups without any obvious loss of clinical quality. It may in fact be associated with increased patient satisfaction and convenience as per the systematic review in Chapter 3, although this was not examined specifically in the prospective trial presented in Chapter 6. It is feasible to apply this concept to a broad range of clinical conditions.

REFERENCES

1. MOH. About the Elective Services Programme: Ministry of Health; 2013 [cited 2015 18 September 2015]. Available from: http://www.health.govt.nz/our-work/hospitals-and-specialist-care/elective-services.

2. Derrett S, Cousins K, Gauld R. A messy reality: an analysis of New Zealand's elective surgery scoring system via media sources, 2000-2006. The International Journal of Health Planning and Management. 2013;28(1):48-62.

3. Gauld R, Derrett S. Solving the surgical waiting list problem? New Zealand's 'booking system'. The International Journal of Health Planning and Management. 2000;15(4):259-72.

4. Cumming JM, McDonald J, Barr C, Martin G, Gerring Z, Daube J. New Zealand Health System Review. Health Systems in Transition. World Health Organisation, Vol 4, No 2, 2014.

5. The New Zealand Health Systems Reform. Parliamentary Library Research Paper. 2009 [cited 18 September 2015]. Available from: https://www.parliament.nz/en/pb/research-papers/document/00PLSocRP09031/new-zealand-health-system-reforms

6. Derrett S, Bevin TH, Herbison P, Paul C. Access to elective surgery in New Zealand: considering equity and the private and public mix. The International Journal of Health Planning and Management. 2009;24(2):147-60.

7. MOH. Elective Services and How DHBs are Performing 2011 [cited 2015 18 September 2015]. Available from: http://www.health.govt.nz/our-work/hospitals-and-specialist-care/elective-services/elective-services-and-how-dhbs-are-doing/about-elective-services-patient-flow-indicators-espis.

8. Siciliani L, M. Borowitz and V. Moran (eds). Waiting Time Policies in the Health Sector. What Works? OECD Health Policy Studies: OECD Publishing; 2013.

9. Kreindler SA. Policy strategies to reduce waits for elective care: a synthesis of international evidence. British Medical Bulletin. 2010;95:7-32.

10. Siciliani L, Hurst J. Tackling excessive waiting times for elective surgery: a comparative analysis of policies in 12 OECD countries. Health Policy. 2005;72(2):201-15.

11. Hanning M. Maximum waiting-time guarantee--an attempt to reduce waiting lists in Sweden. Health Policy. 1996;36(1):17-35.

12. Ashton T. The benefits and risks of DHBs contracting out elective procedures to private providers. The New Zealand Medical Journal. 2010;123(1314):84-91.

13. Ballini L, Negro A, Maltoni S, Vignatelli L, Flodgren G, Simera I, et al. Interventions to reduce waiting times for elective procedures. The Cochrane Database of Systematic Reviews. 2015;2:CD005610.

14. Schunemann HJ, Oxman AD, Brozek J, Glasziou P, Bossuyt P, Chang S, et al. GRADE: assessing the quality of evidence for diagnostic recommendations. Evidence-Based Medicine. 2008;13(6):162-3.

15. Appleby J, Boyle S, Devlin N, Harley M, Harrison A, Locock L, Thorlby R. Sustaining reductions in waiting times: identifying successful strategies. Final report to the Department of Health. London: The King's Fund, 2005.

16. Kreindler SA. Six ways not to improve patient flow: a qualitative study. BMJ Quality & Safety. 2016 Jul 27.

17. CMH. Counties Manukau Health: About Us [cited 18 September 2015]. Available from: http://www.countiesmanukau.health.nz/about-us.

18. Health CM. Quality Accounts 2013/2014 Counties Manukau Health. Counties Manukau Health, 2015.

19. Harrison S, Nugud O, Benziger H. Operating theatre management: do we lack a mathematician's perspective? ANZ Journal of Surgery. 2013;83(1-2):5-6.

20. Clague JE, Reed PG, Barlow J, Rada R, Clarke M, Edwards RH. Improving outpatient clinic efficiency using computer simulation. International Journal of Health Care Quality Assurance. 1997;10(4-5):197-201.

21. Sobolev BG, Sanchez V, Vasilakis C. Systematic review of the use of computer simulation modelling of patient flow in surgical care. Journal of Medical Systems. 2011;35(1):1-16.

22. Foster EM, Hosking MR, Ziya S. A spoonful of math helps the medicine go down: an illustration of how health care can benefit from mathematical modelling and analysis. BMC Medical Research Methodology. 2010;10:60.

23. Blake JT, Shimla S. Determining staffing requirements for blood donor clinics: the Canadian Blood Services experience. Transfusion. 2014;54(3 Pt 2):814-20.

24. Patrick J, Puterman ML. Reducing Wait Times through Operations Research: Optimising the Use of Surge Capacity. Healthcare policy / Politiques de Sante. 2008;3(3):75-88.

25. Yang M, Fry MJ, Raikhelkar J, Chin C, Anyanwu A, Brand J, et al. A model to create an efficient and equitable admission policy for patients arriving to the cardiothoracic ICU. Critical Care Medicine. 2013;41(2):414-22.

26. Moher D, Liberati A, Tetzlaff J, Altman DG. PRIMSA Group Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement. Open Medicine. 2009;3(3):e123-30.

27. Aeenparast A, Tabibi SJ, Shahanaghi K, Aryanejhad MB. Reducing outpatient waiting time: A simulation modelling approach. Iranian Red Crescent Medical Journal. 2013;15(9):865-9.

28. Aharonson-Daniel L, Paul RJ, Hedley AJ. Management of queues in out-patient departments: the use of computer simulation. Journal of Management in Medicine. 1996;10(6):50-8, 3.

29. Benninger MS, Strode SR. Model for optimal space and staff efficiency in an otolaryngology clinic. Otolaryngology-Head and Neck Surgery. 1998;119(4):394-7.

30. Crane GJ, Kymes SM, Hiller JE, Casson R, Martin A, Karnon JD. Accounting for costs, QALYs, and capacity constraints: using discrete-event simulation to evaluate alternative service delivery and organizational scenarios for hospital-based glaucoma services. Medical Decision Making. 2013;33(8):986-97.

31. Elkhuizen SG, Das SF, Bakker PJ, Hontelez JA. Using computer simulation to reduce access time for outpatient departments. Quality & Safety in Health Care. 2007;16(5):382-6.

32. Huarng F, Lee MH. Using simulation in out-patient queues: a case study. Int International Journal of Health Care Quality Assurance. 1996;9(6):21-5.

33. Parks JK, Engblom P, Hamrock E, Satjapot S, Levin S. Designed to fail: how computer simulation can detect fundamental flaws in clinic flow. Journal of Health care Management. 2011 Mar-Apr;56(2):135-44; discussion 45-6.

34. Rohleder TR, Lewkonia P, Bischak DP, Duffy P, Hendijani R. Using simulation modelling to improve patient flow at an outpatient orthopedic clinic. Health Care Management Science. 2011;14(2):135-45.

35. Su S, Shih C-L. Managing a mixed-registration-type appointment system in outpatient clinics. International Journal of Medical Informatics. 2003;70(1):31-40.

36. Weerawat W, Pichitlamken J, Subsombat P. A generic discrete-event simulation model for outpatient clinics in a large public hospital. Journal of Health care Engineering. 2013;4(2):285-305.

37. MIT System Dynamics in Education Project (SDEP) 1997 [cited 2015 18 September]. http://web.mit.edu/sysdyn/sdep.html .

38. Sobolev BG, Sanchez V, Vasilakis C. Systematic review of the use of computer simulation modelling of patient flow in surgical care. Journal of Medical Systems. 2011;35(1):1-16.

39. Homer JB, Hirsch GB. System dynamics modelling for public health: background and opportunities. American Journal of Public Health. 2006;96(3):452-8.

40. Tobias MI, Cavana RY, Bloomfield A. Application of a system dynamics model to inform investment in smoking cessation services in New Zealand. American Journal of Public Health. 2010;100(7):1274-81.

41. Loyo HK, Batcher C, Wile K, Huang P, Orenstein D, Milstein B. From model to action: using a system dynamics model of chronic disease risks to align community action. Health Promotion Practice. 2013;14(1):53-61.

42. Agyapong-Kodua K, Weston RH, Ratchev S.. The Integrated Use of Enterprise and System Dynamics Modelling Techniques in Support of Business Decisions. Advances in Decision Sciences. 2012;Volume 2012(Article ID 804324, 25 pages).

43. Kroese DP, Brereton T, Taimre T, Botev Z. Why the Monte Carlo method is so important today. WIREs Computational Statistics. 2014;6:386-92.

44. Silvester KB, S. Understanding Systems. In: Bhugra DB, S; Burns, A, editor. Management for Psychiatrists. 3rd ed: RCPsych Publications; 2007. p. 173-88.

45. Whear R, Thompson-Coon J, Rogers M, Abbott RA, Ukoumunne O, Perry M, et al. Patient-initiated appointment systems for people with chronic conditions in secondary care. Cochrane Database of Systematic Reviews. Issue 12 Art CD010763

46. Gurjar SV, Kulkarni D, Khawaja HT. Outpatient general surgical follow-up: are we using this resource effectively? International Journal of Surgery. 2009;7(1):62-5.

47. Burkey Y, Black M, Reeve H, Roland M. Long-term follow-up in outpatient clinics. 2: The view from the specialist clinic. Family Practice. 1997;14(1):29-33.

48. Cox K, Wilson E, Heath L, Collier J, Jones L, Johnston I. Preferences for follow-up after treatment for lung cancer: assessing the nurse-led option. Cancer Nursing. 2006;29(3):176-87.

49. Koinberg IL, Holmberg L, Fridlund B. Breast cancer patients' satisfaction with a spontaneous system of check-up visits to a specialist nurse. Scandinavian Journal of Caring Sciences. 2002;16(3):209-15.

50. Rozmovits L, Rose P, Ziebland S. In the absence of evidence, who chooses? A qualitative study of patients' needs after treatment for colorectal cancer. Journal of Health Services Research & Policy. 2004;9(3):159-64.

51. Niblett DJ. Pressures in outpatient clinics. Putting up with overcrowded clinics disguises need for change. BMJ (Clinical research ed). 1998;317(7157):541.

52. Donnellan F, Hussain T, Aftab AR, McGurk C. Reducing unnecessary outpatient attendances. International Journal of Health Care Quality Assurance. 2010;23(5):527-31.

53. Bamji AN. Time to act on nonsensical outpatient follow-up ratio targets. BMJ (Clinical research ed). 2012;344:d8243.

54. Rose KD, Ross JS, Horwitz LI. Advanced access scheduling outcomes: a systematic review. Archives of Internal Medicine. 2011;171(13):1150-9.

55. Robinson A, Thompson DG, Wilkin D, Roberts C, Northwest Gastrointestinal Research Group. Guided self-management and patient-directed follow-up of ulcerative colitis: a randomised trial. Lancet. 2001;358(9286):976-81.

56. Brown L, Payne S, Royle G. Patient initiated follow up of breast cancer. Psychooncology. 2002;11(4):346-55.

57. Hewlett S, Kirwan J, Pollock J, Mitchell K, Hehir M, Blair PS, et al. Patient initiated outpatient follow up in rheumatoid arthritis: six year randomised controlled trial. BMJ (Clinical research ed). 2005;330(7484):171.

58. Hewlett S, Mitchell K, Haynes J, Paine T, Korendowych E, Kirwan JR. Patient-initiated hospital follow-up for rheumatoid arthritis. Rheumatology (Oxford, England). 2000;39(9):990-7.

59. Kennedy A, Nelson E, Reeves D, Richardson G, Roberts C, Robinson A, et al. A randomised controlled trial to assess the impact of a package comprising a patient-orientated, evidence-based self-help guidebook and patient-centred consultations on disease management and satisfaction in inflammatory bowel disease. Health Technology Assessment. 2003;7(28):iii, 1-113.

60. Kirwan JR, Mitchell K, Hewlett S, Hehir M, Pollock J, Memel D, et al. Clinical and psychological outcome from a randomized controlled trial of patient-initiated direct-access hospital follow-up for rheumatoid arthritis extended to 4 years. Rheumatology (Oxford, England). 2003;42(3):422-6.

61. Silvester KL, R; Bevan, H; Steyn, R; Walley, P. Reducing waiting times in the NHS: is lack of capacity the problem? Clinician in Management 2004;12(3):p105-9.

62. Brennan ME, Spillane AJ. The breast physician: an example of specialisation in general practice. Medical Journal of Australia. 2007;187(2):111-4.

63. Nocon A, Leese B. The role of UK general practitioners with special clinical interests: implications for policy and service delivery. British Journal of General Practice. 2004;54(498):50-6.

64. Moffat MA, Sheikh A, Price D, Peel A, Williams S, Cleland J, et al. Can a GP be a generalist and a specialist? Stakeholders views on a respiratory General Practitioner with a special interest service in the UK. BMC Health Services Research. 2006;6:62.

65. Spurling G, Jackson C. GPs with special interests - benefits to patients, GPs and the community. Australian Family Physician. 2009;38(5):337-9.

66. Health Do. The NHS Plan: a plan for investment, a plan for reform. London: DH, 2000.

67. Nocon A, Leese B. The role of UK general practitioners with special clinical interests: implications for policy and service delivery. British Journal of General Practice. 2004;54(498):50-6.

68. Gervas J, Starfield B, Violan C, Minue S. GPs with special interests: unanswered questions. British Journal of General Practice. 2007;57(544):912-7.

69. Rogers G. The future of epilepsy care in general practice... a role for the GPWsi? British Journal of General Practice. 2002;52(483):872-3.

70. Gilbert R, Franks G, Watkin S. The proportion of general practitioner referrals to a hospital Respiratory Medicine clinic suitable to be seen in a GPwSI Respiratory Clinic. Primary Care Respiratory Journal. 2005;14(6):314-9.

71. Ridsdale L, Doherty J, McCrone P, Seed P, Headache, Innovation and Evaluation Group. A new GP with special interest headache service: observational study. British Journal of General Practice. 2008;58(552):478-83.

72. Zhang J, Burridge L, Baxter KA, Donald M, Foster MM, Hollingworth SA, et al. A new model of integrated primary-secondary care for complex diabetes in the community: study protocol for a randomised controlled trial. Trials. 2013;14:382.

73. Hansen C, Wilkinson D, Hansen M, Soyer HP. Factors contributing to incomplete excision of nonmelanoma skin cancer by Australian general practitioners. Archives of Dermatology. 2009;145(11):1253-60.

74. Coast J, Noble S, Noble A, Horrocks S, Asim O, Peters TJ, et al. Economic evaluation of a general practitioner with special interest led dermatology service in primary care. BMJ. 2005;331(7530):1444-9.

75. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535.

76. Dhumale R. Feasibility study of hernia surgery in a general practice setting. British Journal of General Practice. 2004;54(505):604-7.

77. Dhumale R, Tisdale J, Barwell N. Over a thousand ambulatory hernia repairs in a primary care setting. Annals of The Royal College of Surgeons of England. 2010;92(2):127-30.

78. Murchie P, Delaney EK, Thompson WD, Lee AJ. Excising basal cell carcinomas: comparing the performance of general practitioners, hospital skin specialists and other hospital specialists. Clinical and Experimental Dermatology. 2008;33(5):565-71.

79. Salmon P, Mortimer N, Rademaker M, Adams L, Stanway A, Hill S. Surgical excision of skin cancer: the importance of training. British Journal of Dermatology. 2010;162(1):117-22.

80. Salisbury C, Noble A, Horrocks S, Crosby Z, Harrison V, Coast J, et al. Evaluation of a general practitioner with special interest service for dermatology: randomised controlled trial. BMJ (Clinical research ed). 2005;331(7530):1441-6.

81. Panella M, Marchisio S, Di Stanislao F. Reducing clinical variations with clinical pathways: do pathways work? International Journal for Quality in Health Care. 2003;15(6):509-21.

82. Rotter T, Kinsman L, James E, Machotta A, Steyerberg EW. The quality of the evidence base for clinical pathway effectiveness: room for improvement in the design of evaluation trials. BMC Medical Research Methodology. 2012;12:80.

83. Rotter T, Kinsman L, James E, Machotta A, Willis J, Snow P, et al. The effects of clinical pathways on professional practice, patient outcomes, length of stay, and hospital costs: Cochrane systematic review and meta-analysis. Evaluation & the Health Professions. 2012;35(1):3-27.

84. Kitchiner D, Davidson C, Bundred P. Integrated care pathways: effective tools for continuous evaluation of clinical practice. Journal of Evaluation in Clinical Practice. 1996;2(1):65-9.

85. Beaulieu MD. Clinical pathways: unique contribution of family medicine. Canadian family physician Medecin de famille canadien. 2013;59(6):705.

86. Vanhaecht K, De Witte K, Depreitere R, Van Zelm R, De Bleser L, Proost K, et al. Development and validation of a care process self-evaluation tool. Health Services Management Research. 2007;20(3):189-202.

87. Hughes LD, McMurdo ME, Guthrie B. Guidelines for people not for diseases: the challenges of applying UK clinical guidelines to people with multimorbidity. Age and Ageing. 2013;42(1):62-9.

88. Schrijvers G, van Hoorn A, Huiskes N. The care pathway: concepts and theories: an introduction. International Journal of Integrated Care. 2012; 12(Spec Ed Integrated Care Pathways):e192.

89. Kocher HM, Saunders MP. Complacency or ignorance about rectal bleeding? Colorectal Disease. 1999;1(6):332-3.

90. Adelstein BA, Macaskill P, Chan SF, Katelaris PH, Irwig L. Most bowel cancer symptoms do not indicate colorectal cancer and polyps: a systematic review. BMC Gastroenterology. 2011;11:65.

91. Ford AC, Veldhuyzen van Zanten SJ, Rodgers CC, Talley NJ, Vakil NB, Moayyedi P. Diagnostic utility of alarm features for colorectal cancer: systematic review and meta-analysis. Gut. 2008;57(11):1545-53.

92. Astin M, Griffin T, Neal RD, Rose P, Hamilton W. The diagnostic value of symptoms for colorectal cancer in primary care: a systematic review. British Journal of General Practice. 2011;61(586):e231-43.

93. Eccersley AJ, Wilson EM, Makris A, Novell JR. Referral guidelines for colorectal cancer--do they work? Annals of The Royal College of Surgeons of England. 2003;85(2):107-10.

94. Agaba AE, Berry N, Agaba PO, Charaklias N, Wong LS. One stop rectal bleeding clinic: the coventry experience. International Surgery. 2006;91(5):288-90.

95. Lee JS, Rieger NA, Stephens JH, Hewett PJ, Rodda DJ, Lawrence MJ. Six-year prospective analysis of the rectal bleeding clinic at the Queen Elizabeth Hospital, Adelaide, South Australia. ANZ Journal of Surgery. 2007;77(7):553-6.

96. Jones LS, Nicholson RW, Evans DA. Experience with a one-stop colorectal clinic. Journal of the Royal College of Surgeons of Edinburgh. 2001;46(2):96-7.

97. Lamah M, Ahmad SM, Charalampopoulos A, Ho J, Leicester RJ. Three-year evaluation of a rapid-access coloproctology clinic. Digestive Surgery. 2000;17(2):150-3.

98. Toomey P, Asimakopoulos G, Zbar A, Kmiot W. 'One-stop' rectal bleeding clinics without routine flexible sigmoidoscopy are unsafe. Annals of The Royal College of Surgeons of England. 1998;80(2):131-3.

99. Atkin WS, Edwards R, Kralj-Hans I, Wooldrage K, Hart AR, Northover JM, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. Lancet. 2010;375(9726):1624-33.

100. Sosna J, Morrin MM, Copel L, Raptopoulos V, Kruskal JB. Computed tomography colonography (virtual colonoscopy): update on technique, applications, and future developments. Surgical Technology International. 2003;11:102-10.

101. Pickhardt PJ, Hassan C, Halligan S, Marmo R. Colorectal cancer: CT colonography and colonoscopy for detection--systematic review and meta-analysis. Radiology. 2011;259(2):393-405.

102. Atkin W, Dadswell E, Wooldrage K, Kralj-Hans I, von Wagner C, Edwards R, et al. Computed tomographic colonography versus colonoscopy for investigation of patients with symptoms suggestive of colorectal cancer (SIGGAR): a multicentre randomised trial. Lancet. 2013;381(9873):1194-202.

103. Johnson M. Bowel cancer: Govt unable to deliver on 'urgent' investigations - charity. The New Zealand Herald. 2014 Tuesday May 27, 2014.

104. Green T, Richardson A, Parry S. Colonoscopy requirements of population screening for colorectal cancer in New Zealand. The New Zealand Medical Journal. 2012;125(1356):85-95.

105. Pickhardt PJ, Choi JR, Hwang I, Schindler WR. Nonadenomatous polyps at CT colonography: prevalence, size distribution, and detection rates. Radiology. 2004;232(3):784-90.

106. Johnson CD, Chen MH, Toledano AY, Heiken JP, Dachman A, Kuo MD, et al. Accuracy of CT colonography for detection of large adenomas and cancers. The New England Journal of Medicine. 2008;359(12):1207-17.

107. Kimberly JR, Phillips KC, Santago P, Perumpillichira J, Bechtold R, Pineau B, et al. Extracolonic findings at virtual colonoscopy: an important consideration in asymptomatic colorectal cancer screening. Journal of General Internal Medicine. 2009;24(1):69-73.

108. Yun JY, Ro HJ, Park JB, Choi JB, Chung JE, Kim YJ, et al. Diagnostic performance of CT colonography for the detection of colorectal polyps. Korean Journal of Radiology. 2007;8(6):484-91.

109. Xiong T, Richardson M, Woodroffe R, Halligan S, Morton D, Lilford RJ. Incidental lesions found on CT colonography: their nature and frequency. The British Journal of Radiology. 2005;78(925):22-9.

110. Badiani S, Tomas-Hernandez S, Karandikar S, Roy-Choudhury S. Extracolonic findings (ECF) on CT colonography (CTC) in patients presenting with colorectal symptoms. Acta Radiologica. 2013;54(8):851-62.

111. Practitioners RACoG. Clinical Guidelines for Preventive Activities in General Practice. Colorectal Cancer: RACGP; [cited 23rd October 2016]. 8th edition:[Available from: https://www.racgp.org.au/your-practice/guidelines/redbook/9-early-detection-of-cancers/92-colorectal-cancer/

112. Society AC. American Cancer Society Recommendations for Colorectal Cancer Early Detection 2016 [cited 23rd April 2016]. Available from:

http://www.cancer.org/cancer/colon-rectal-cancer/detection-diagnosis-staging/acs-recommendations.html .

113. Tutein Nolthenius CJ, Boellaard TN, de Haan MC, Nio CY, Thomeer MG, Bipat S, et al. Evolution of Screen-Detected Small (6-9 mm) Polyps After a 3-Year Surveillance Interval: Assessment of Growth With CT Colonography Compared With Histopathology. The American Journal of Gastroenterology. 2015;110(12):1682-90.

114. Pickhardt PJ, Pooler BD, Mbah I, Weiss JM, Kim DH. Colorectal Findings at Repeat CT Colonography Screening after Initial CT Colonography Screening Negative for Polyps Larger than 5 mm. Radiology. 2017;282(1):139-48.

115. Kim DH, Pooler BD, Weiss JM, Pickhardt PJ. Five year colorectal cancer outcomes in a large negative CT colonography screening cohort. European Radiology. 2012;22(7):1488-94.