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Student-led intervention to inNOvate hand hygiene practice in Auckland Region's medical students (the No HHARMS study)

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ABSTRACT

BACKGROUND: Hand hygiene is important in reducing healthcare-associated infections. The World Health Organization has defined 'five moments' when hand hygiene compliance is required. During 2013, New Zealand national data showed poor compliance with these moments by medical students.

AIM: To improve medical students' compliance with the five moments.

METHODS: In this prospective student-led quality improvement initiative, student investigators developed, implemented and evaluated a multi-modal intervention comprising a three-month social media campaign, a competition and an entertaining educational video. Data on individual patient-medical student interactions were collected covertly by observers at baseline and at one week, six weeks and three months after initiation of the intervention.

RESULTS: During the campaign, compliance improved in moment 2, but not significantly in moments 1, 3, 4 or 5. Statistical analysis of amalgamated data was limited by non-independent data points—a consideration apparently not always addressed in previous studies.

CONCLUSIONS: The initiative produced improvements in compliance by medical students with one hand hygiene moment. Statistical analysis of amalgamated data for all five moments should allow for the non-independence of each occasion in which clinicians interact with a patient. More work is needed to ensure excellent hand hygiene practices of future doctors.

Hand hygiene is pivotal in reducing healthcare-associated infections (HAI).^{1,2} HAI are a major problem in hospitals worldwide and create a large financial and human burden.^{3,4} Hand hygiene is considered by many to be the most important element in preventing HAI.^{1,2,5} In 2005, as part of the first global challenge of the World Health Organization (WHO) World Alliance for Patient Safety, 'Clean Care is Safer Care', the WHO developed the WHO Guidelines on Hand Hygiene in Healthcare.⁶ Over 100 experts collaborated to establish best practice, evidence-based guidelines to assist clinicians. These guidelines emphasise the use of alcohol-based

hand rubs at each of five steps in patient care (five 'moments'). In Australia and New Zealand, national programmes have adopted and adapted the WHO '5 moments for hand hygiene' as follows: (1) Before touching a patient, (2) before a procedure, (3) after a procedure or body fluid exposure risk, (4) after touching a patient and (5) after touching a patient surroundings.⁷⁻⁹

Hand Hygiene New Zealand (HHNZ) was established in 2008 by the New Zealand Ministry of Health's Quality Improvement Committee (and subsequently continued by the New Zealand Health Quality & Safety Commission (the Commission)) to reduce HAI in New Zealand hospitals.

HHNZ adopted the WHO five moments as the basis for improving the hand hygiene of New Zealand clinicians, and established a nationally standardised approach to auditing hand hygiene performance. A cadre of certified observers were trained to audit hospital staff nationwide. Medical students had the lowest compliance rates of any group audited in New Zealand hospitals in 2013, successfully completing only 52.1% of 73 observed potential moments between July and October 2013.^{10,11} If practices as a student persist throughout a practitioner's career, the benefits of improving this behaviour early could be far reaching, with the potential to reduce patient harm for many years to come. These data were discussed at a meeting of the University of Auckland's Medical Programme's Board of Studies (which includes two student representatives) on the 4th July 2013. Representatives of the Commission took part. The evidence of poor performance by medical students was considered disappointing because formal instruction in hand hygiene is an important part of the curriculum and is started early in the course, both in lectures and through practical teaching during clinical skills tutorials. At this meeting the student representatives on the Board proposed a student-led initiative to address this problem.

Various approaches have been used internationally, with variable success, to improve hand hygiene compliance, including education on appropriate hand hygiene, audits with immediate feedback, optimisation of access to sanitisers, and gaming console-based interventions.^{12–16} Importantly, effective studies have typically used a multi-modal approach. A multi-modal approach is also recommended in the WHO 'Guide to the implementation of the WHO Multimodal Hand Hygiene Improvement Strategy'. The strategy has five components addressing: (1) System Change—improving access to hand hygiene facilities, (2) Training and Education, (3) Evaluation and Feedback, (4) Reminders in the workplace and (5) Institutional safety climate.¹²

In other contexts, student-led interventions have been effective in obesity reduction, safe alcohol use and smoking cessation.^{17–19} There is contemporary interest in the importance of placing the student

at the centre of the learning process, for example through problem-based learning whereby students learn a subject through their own experience, working with peers to formulate answers to problems, or help to lead problem-based discussion sessions.^{20,21} We could find no previous research on interventions led by medical students to improve hand hygiene, but a student-led approach is consistent with the principle of 'front line ownership' that has been a cornerstone of the HHNZ programme.²²

Therefore, we aimed to improve the overall compliance of medical students in our institutions with the WHO five moments of hand hygiene by introducing a student-led, novel multi-modal intervention.

Methods

Between March 2014 and October 2014 we conducted a prospective study to test the hypothesis that the overall compliance with the WHO 5 moments for hand hygiene could be improved in a cohort of University of Auckland medical students by the implementation of a student-led multimodal intervention. We obtained approval from the University of Auckland Human Participants Ethics Committee before starting the study (reference 011103).

The population eligible to participate in this study included medical students in Years 4–6 of the University of Auckland's medical programme allocated for their clinical attachments to one of three teaching hospitals within the Auckland region: Auckland City Hospital, Middlemore Hospital and North Shore Hospital (with Waitakere Hospital). About a third of the students in these years of the programme are allocated to other metropolitan regions. We excluded medical students involved in the development of the intervention.

Study oversight and development

A 'No HHARMS' oversight and intervention development committee was established. This consisted of four medical students from the Auckland University Medical Students Association, and one nursing student from the Nurses of Auckland University Student Association (NASA) who assisted in the recruitment of nurse auditors. Support was provided by two senior members of the University's

academic staff, the Commission's director of Health Quality Evaluation and Clinical Lead for Infection Prevention and Control programmes and HHNZ's Clinical Lead.

Our plan for data collection and analysis was based on the approach used by HHNZ (and other national programmes). However, in consultation with HHNZ and the Commission, it was decided that, to reduce the extent of the Hawthorne effect, our audits, unlike those of HHNZ, should be covert.²³ This required that medical students were not informed that their hand hygiene compliance was being audited, and ethics approval was sought on this basis. A protocol was developed for the four student investigators to follow if they came into contact with a nurse auditor to ensure their results were not included in the analysis.

Seventeen second and third year student nurses were recruited as paid auditors in November 2013 with assistance from NASA, and participated in HHNZ's one day 'Hand Hygiene 5 Moment Gold Auditor Training Workshop' in January 2014. To qualify as Hand Hygiene Gold Auditors, students must gain 90% in a written test at the end of the workshop. All 17 nursing students met this standard. These students carried out all the audits reported in this study (ie, the same auditors were involved before and after the intervention). All audit results were recorded on a paper version of the official HHNZ 'Hand Hygiene observation—data collection form'. We note that, independently of our study, the routine thrice-yearly DHB hand hygiene audits were also occurring.

Baseline phase

The 17 student nurses carried out 135 hours of pre-intervention observation in 45 separate three-hour periods over a fortnight, distributed between a specified selection of wards within the study hospitals, each ward subserving a particular medical speciality.

The intervention

The intervention had four elements.

- A video designed to be educational, entertaining and thought provoking, involving well-known members of the Auckland medical student body. The video was based around a fictional medical student, Gavin, who has a moral crisis over whether he should

prioritise bugs or humans. It includes an outline of the five moments, and highlights the use of alcohol gel as the most appropriate substance for routine hand hygiene. It can be viewed on: <http://www.youtube.com/watch?v=cK4BGPN6zao&feature=youtu.be>

- A social media campaign on *Facebook* named '#thehandhygieneproject'; this enabled students to have a centralised source of educational resources and current results.
- Medical student champions. One medical student, nominated by peers, was located in each district health board and underwent hand hygiene education and leadership training to continue to motivate and mobilise medical students, and communicate, information about #thehandhygieneproject.
- Competition. A competition was run between each of the three DHBs, with the cohort with the best improvement receiving a prize (a lunch).

The intervention was launched on July 2nd 2014 to all medical students in Years 4 to 6 (ie not only those in the study cohort). The initiative was introduced in the first 15 minutes of a lecture on the University campus, which all students are expected to attend (and most do), the video was played and students were introduced to the student champions at each district health board; The *Facebook* page #thehandhygieneproject went online on the 2nd July 2014 and all students received an email from the faculty, using their university email addresses, introducing the campaign with links to the video on *Youtube* and the campaign *Facebook* page. During the evaluation phase, the student leaders of the study met regularly with the student champions and students were made aware of up to date results via the *Facebook* page, the student champions and in an email to all medical students.

Evaluation phase

The 17 student nurses carried out a further 135 hours of observation, divided between three one-week periods, each involving 15 individual three-hour audits at approximately one week, six weeks and three months after the launch of the inter-

vention. We aimed to achieve a similar distribution of these observations between the wards (and hence medical specialities) to that in the baseline audit.

Sample size, data collection and analysis

Statistical analysis was undertaken using R (R: A Language and Environment for Statistical Computing, Vienna, Austria). To correct for non-independence of data points (see Discussion, below)²⁴ we adopted the approach of Allegranzi et al²⁵ and assumed a variance inflation factor of 2. We presented results as percentages and differences in percentages with 95% confidence limits. We used χ^2 tests to compare proportions of compliant moments before the intervention with the proportion after the intervention, designating $P < 0.05$ as significant, and presenting all P values without correction.

The sample size was pragmatic: our resources permitted a maximum of 45 periods of three hours each of observation time before and after the intervention, and we did not know before starting how many observations would be obtained within these two periods.

Results

The cohort included 492 medical students, 198 in year four, 158 in year five and 136 in year six of the six-year programme. We observed 780 potential moments for hand hygiene (our baseline data) between 20th March and 6th May 2014. The intervention was launched on 2nd July 2014, and our campaign ran until 14th October 2014. Over this period the Facebook page gained 244 likes and the educational video had over 600 viewings. We collected evaluation data

at one week (11th July to 15th July 2014), six weeks (August 15th to August 19th 2014) and three months (7th October to 14th October 2014). During this period there was one instance in which a student became aware of being audited; the study investigators were notified of this, and the auditor was asked to flag the student's results for subsequent exclusion. This left 726 moments for analysis. The distribution between specialities at baseline and evaluation phases were similar (see Table 1).

Overall, there was a modest improvement in compliance with appropriate hand hygiene practices. A statistically significant increase was seen in hand hygiene compliance for moment 2 ($p=0.01$). Increases in compliance for moments 3 ($p=0.07$) and 4 ($p=0.11$) were not statistically significant. No statistically or clinically relevant change in compliance for moments 1 or 5 (see Table 2).

Discussion

The medical students' compliance increased substantially (by 51%) and significantly ($P=0.01$) for moment 2 (before a procedure), but not moments 1, 3, 4 and 5, although there was a 31% non-significant ($P=0.07$) improvement in moment 3 (after a procedure or bodily fluid exposure). The data were collected over the three months of our campaign, and do not address the question of whether improvement was sustained beyond that period.

In the introduction of this paper we outlined the first global challenge of the World Health Organization (WHO) World Alliance for Patient Safety, 'Clean Care is Safer Care'. We are in no doubt that this initiative has had a huge positive impact

Table 1: Distribution of moments surveyed by clinical specialty at baseline and at evaluation of the intervention. Data from paediatrics and the emergency department ('Paeds/ED') were combined because numbers were small.

Specialty	Baseline survey	Evaluation survey
General surgery	111 (14.2%)	151 (20.8%)
Specialty medicine	107 (13.7%)	73 (10.1%)
General medicine	352 (45.1%)	300 (41.3%)
Paeds/ED	93 (11.9%)	106 (14.6)
Older people's health	117 (15.0%)	96 (13.2%)
TOTAL	780 (100%)	726 (100%)

Table 2: Compliance with hand hygiene moments during baseline and evaluation periods, overall and by moment: P values were calculated using χ^2 tests.

Moment	Baseline N correct/total (rate %)	Evaluation N correct/total (rate %)	Mean difference in rates % (95%CI), P
Total	374/780 (48)	397/726 (55)	n/a
1: before touching a patient	108/200 (54)	109/197 (55)	1.3 (-12.5, 15.2), $P=0.85$
2: before a procedure	3/15 (20)	17/24 (71)	50.8 (12.4, 89.3), $P=0.01$
3: after a procedure or bodily fluid exposure risk	11/27 (41)	23/32 (72)	31.1 (-3.1, 65.4), $P=0.07$
4: after touching a patient	124/191 (65)	138/183 (75)	10.5 (-2.5, 23.5), $P=0.11$
5: after touching a patient surroundings	128/347 (37)	110/290 (38)	1.0 (-9.6, 11.7), $P=0.85$

on patient outcomes around the world, including in New Zealand through the efforts of HHNZ. Thus we substantially adopted the approach used in the HHNZ programme and several other national programmes. In line with this approach we intended to report 95% confidence limits for the difference between the *overall* total baseline (48%) and evaluation (55%) scores (1.6% to 11.8%, with a point estimate of 6.7%) and a significance level based on a χ^2 test ($P=0.009$ in the absence of a correction for variance inflation). However, on reflection, we now have serious reservations about such statistical analyses for amalgamated overall hand hygiene scores, both for our own work and in respect of many reports from national hand hygiene programmes. This point does not undermine the impressive success of HHNZ in improving rates of hand hygiene, but goes instead to the question of these successes should be reported statistically. On each 'occasion' that a particular student (or, more generally, practitioner) is observed interacting with a particular patient, there are between one and five potential moments for hand hygiene, depending on the nature of the interaction. However, these data points *are not independent*—they involve repeated observations of the same practitioner and patient in the same environment. It follows that each of these occasions should be treated, in statistical analysis, as a cluster.²⁴ We have no argument with the well-established principle of *collecting* information on each of the five moments of hand hygiene.

However, we do question the analytical approach, which seems to be widely used in national hand hygiene programmes, of treating each of these moments as a source of an individual independent data point. Doing this substantially (and incorrectly) inflates the power of statistical tests and artificially narrows estimated confidence limits in relation to amalgamated rates of compliance with all of the five moments (but not for each moment, considered separately). For this reason, some investigators (see for example Allegranzi et al, 2010²⁵ and 2013²⁶) have adjusted for the effects of clustering (there are also several secondary clustering effects, including surgical 'firm' and DHB for example). Individual practitioners (ie, students in our study) are likely to be observed in repeated interactions, which further compounds the lack of data independence. This latter issue could also affect comparisons between baseline and evaluation phases with bias introduced if 'good' or 'bad' individuals are overrepresented in either phase. Ideally, therefore, individual practitioners should be tracked (using coded identifications to preserve anonymity if required) and their identity included as a factor in statistical models comparing phases, although this would be difficult to do in the context of national hand hygiene programmes. Other factors, such as the identities of patients and auditors, or the presence of particular senior doctors for example,²⁷ might also introduce bias and, ideally, should therefore also be tracked. However, judgement is needed to strike

a balance between the demands of data collection and the extent to which different factors are likely to threaten the integrity of planned analyses in any given context, but the identity of each observed practitioner does seem to be particularly relevant.

Unfortunately, we did not collect the identities of observed students or occasions, because in adopting the approach used in the HHNZ programme, we failed to anticipate these problems. Thus, we have not been able to undertake a robust statistical analysis of the overall data and report the intended primary outcome variable—the amalgamated rate of compliance for the five moments together. Instead, we have reported results for each individual moment, with a correction for variance inflation to allow for the secondary clustering effects discussed above.

The question of correction for multiple testing (because data from each of the five moments undergoes statistical testing) also arises, but because there is some inter-dependence between the moments, such a correction need not involve standard stringent adjustment such as, for example, a Bonferroni correction.^{28,29} Thus we are reasonably confident in the finding for moment 2, although we note that the numbers of observations for moment 2 were small (as they were for moment 3).

It is perhaps worth noting that the 48% overall compliance at baseline was similar to the 52% reported by HHNZ nationally for medical students for the period 1 July to 31 October 2013.¹⁰ Their data were based on only 78 observed potential moments vs 780 in the study. More recent results from this national programme suggest that the rate for medical students has improved to 79%³⁰ (this figure was generated from 216 observations and is in line with an overall national compliance rate of 81%). Given the above discussion, it is probably best to avoid further speculation about the possible interpretation of these rates, other than to say that we find the low rates of compliance in our own data concerning. Reports from other countries suggest that low rates of compliance with hand hygiene by medical students are not unusual: medical student's knowledge of and compliance with hand hygiene is typically poor.^{31–35} This raises

questions about the way hand hygiene is taught to medical students in general, not just at Auckland, and indicates the need for new approaches in this area.^{36,37}

It may be also be worth reflecting on the fact that the five moments apply at very different frequencies and may not be clinically equivalent. A failure in hand hygiene compliance for moment 5 (after contact with the patients' environment) might often be less clinically important than a failure after contact with bodily fluid (moment 3) for example, yet, because moment 5 may be the most frequently observed, it may have an undue influence on an amalgamated overall result. Nevertheless, compliance with moments 2 and 3 (which are clearly very important) was very poor at baseline (20% and 41% respectively). These were the two moments for which compliance improved the most (to 71% and 72% respectively), but even then students failed to comply with these moments in almost 30% of cases. This would seem to raise questions about the clinical supervision of our students, but it would be helpful to know a little more about the procedures or exposures in which compliance was poor. A narrative section on the data form would add information of considerable assistance in the interpretation of the numerical data in situations of this sort.^{38,39} Such information might well make calls for further improvement more compelling than quantitative data alone.

The study has other potential limitations. Our intervention was as substantial as we could make it, given the limitations on financial resources and on the time of the student leaders of this study, but a more substantial or prolonged intervention may have been more effective. Also, it is hard to know exactly how successful our campaign was in reaching all the students in the cohort, but the number of Facebook likes (244) and video viewings (607) suggests a reasonable level of participation. On the other hand we do not know whether all the likes came from medical students (some may have been from people outside the programme). We did not collect data to formally compare students in our pre-intervention sample with those in our post-intervention sample, but there is no obvious reason to suspect any systematic

difference between these two groups. We evaluated the impact of the intervention as a whole so we have no way of knowing which elements were important and which were not. Another potential limitation lies in possible inter-auditor variability. We attempted to lessen the effect of this by using the same 17 nursing students in both phases of the study and ensuring that all underwent HHNZ Gold Auditor training, followed by successful completion of the relevant standardised test. In fact, we believe this was one of the study's strengths. Other strengths were that we achieved reasonably similar distributions of cases across medical specialties in both phases (Table 1), and that we took steps to reduce the Hawthorne effect²³ by covert auditing. Also, the feedback given to students was in line with the WHO Guidelines on hand hygiene, which emphasise the importance not only of random audits, but also of real-time feedback to healthcare workers from these audits.⁹

The fact that the study was student-led reflects recent emphasis in the theory of medical education, which emphasises the importance of placing the student at the centre of the learning process.²¹ More generally, it is consistent with the principle of 'front line ownership' in quality improvement, which favours engaging clinicians in developing and implementing local solutions to problems over imposing ready-made directives in a top-down fashion.²²

The question arises therefore, 'What next?' New students have already replaced the cohort exposed to the intervention. Some changes have been made to strengthen the relevant parts of the curriculum at the University of Auckland, but more work is clearly needed if more substantial improvements in hand hygiene practices by students are to be achieved on a sustained basis.

In addition, we suggest that wider debate is needed about the most appropriate way to statistically analyse hand hygiene data. We do not doubt that substantial improvements have been obtained in hand hygiene practice through various initiatives based on the five moments in many parts of the world. There are many barriers to success

in efforts to improve hand hygiene, and for some of the people whose focus is, appropriately, on the central goal of achieving behavioural change in this important aspect of practice, technical statistical issues may appear to be something of a side issue. However, the importance of robust design, evaluation and reporting of practice research into patient safety has recently been emphasised by Shekelle et al, and we concur.⁴⁰ A careful review of the way in which data of the sort presented here are analysed in national programmes would seem to be warranted. Interestingly, an all-or-none approach to evaluating quality has been advocated in the context of quality improvement in general (ie, not specifically for hand hygiene) as a way of 'raising the bar' of performance⁴¹ and this would, as it happens, allow some of the statistical issues for hand hygiene to be addressed.

In conclusion, our student-led initiative produced a clear improvement in compliance by medical students in one of the WHO five moments of hand hygiene, but left considerable room for further improvement in all the moments. We have also discovered that some considerations related to the independence of data points in the statistical analysis of results of audits of the five moments may hitherto have been overlooked in at least some national hand hygiene programmes. For the future, we suggest that each discrete occasion on which clinicians interact with a patient should be recorded so that this can be used to help correct for non-independence of data points. Alternatively, reporting should be restricted to each moment separately, without amalgamation of data from all the moments (as in the present study). Consideration should also be given to including (if practical) the (anonymised) identities of observed clinicians in the statistical analysis of quantitative data on hand hygiene, and to adding narrative information to assist in the interpretation of these data. The modest improvement achieved by our initiative leaves more work to be done to ensure that sustained excellence in hand hygiene becomes embedded in the practice of our future medical practitioners.

Competing interests:

Dr Freeman was formerly Clinical Lead of the Hand Hygiene New Zealand Programme. Dr Merry reports affiliation with SaferSleep and personal fees from the Health Quality & Safety Commission New Zealand. Dr Merry is also Chair of the Board of the Health Quality & Safety Commission New Zealand.

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