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Implementing mobile devices to reduce non-rostered workload for junior doctors

Allan Plant, Suzanne Round, Joe Bourne

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Service Improvement Unit, Tauranga Public Hospital, New Zealand

Correspondence to
Allan Plant;
amplant@xtra.co.nz

ABSTRACT

There is a large body of evidence demonstrating the detrimental effect of long work hours on the performance, mood, and job satisfaction of junior doctors. By extension these effects carry over into the realm of patient safety, compromising the quality of care provision.

House officers in the general surgery department of Tauranga Hospital, New Zealand are often required to arrive at work well before their rostered start time of 7.30am to hand write the results of clinical investigations on their patient lists. Baseline measurement demonstrated that each house officer was spending an average of 28 minutes a day of non-rostered time completing this task, increasing to 33 minutes on post-acute days. This quality improvement project trialed the use of a mobile device for accessing clinical results in real-time on surgical ward rounds with the ultimate aim of reducing non-rostered workload by one hour per house officer, per week.

A sustainable reduction to a median of 15 minutes non-rostered work per day for each house officer was achieved, translating into 75 minutes less non-rostered work for each house officer every week. Importantly, this result was sustained for more than seven working weeks and spanned a changeover in house officer rotation. Furthermore, the use of the devices was associated with a perceived improvement in the accuracy and timeliness of access to clinical results with no perceived detriment to the speed or flow of the ward round.

PROBLEM

Tauranga Hospital is a secondary hospital on the east coast of New Zealand's North Island. With 349 beds, it serves a diverse population of around 220,000 people. Currently, surgical house officers at Tauranga Hospital are expected to arrive well before their start time of 7.30am to document the results of clinical testing on their patient lists. This results in house officers spending a large amount of non-rostered time at hospital and may contribute to increased stress levels, fatigue, and job dissatisfaction.The process of hand-writing the results of investigations for a large number of patients is also a likely point of human error. Combined, this may increase junior doctor burnout and contribute to poorer patient outcomes. The aim of our project was to reduce non-rostered workload for house officers in the general surgical department of Tauranga Hospital by at least one hour per week. We wanted to do this in a way that did not adversely effect the speed, flow, or quality of the information provided on the ward round. Our time frame for achieving this was six months.

BACKGROUND

The issue of junior doctor workload is one which is topical in New Zealand. As I sit writing this, on day one of the New Zealand junior doctors' strike against rostering practices in this country, the media is littered with anecdotes from junior medical staff about the the mistakes they've made, the relationships they've seen break down, and the car crashes they've survived, all of which they attribute to long working hours.

Mainstream media aside, the issue is one which is well-recognised among the academic literature; as early as the year 2000, the work-hours of junior doctors were referred to as the "Achilles heel of the profession" [1]. Indeed, going back further we find that in 1991 an article published in JAMA reported that 41% of house officers blamed fatigue for the most serious mistake they had made in their career to date, mistakes which caused death in nearly one-third (31%) of cases [2]. Locally, a 2007 study of New Zealand junior doctors showed that 66% of those surveyed reported making fatigue-related errors at some stage in their careers [3]. Importantly, it's not only the number effected but also the degree of fatigue in junior doctors which is concerning: when junior doctors undergo sleep studies - those studies reserved for investigating disorders such as obstructive sleep apnoea (OSA) or narcolepsy - we find that levels of daytime somnolence among doctors rivals or exceeds those seen in patients with these serious, debilitating conditions [4]. It is worth noting that the New Zealand Transport Authority, New Zealand's regulatory body for medical aspects of fitness to drive, recommends that patients with OSA or narcolepsy who report excessive daytime somnolence cease driving indefinitely; a point made more pertinent when you consider that 24% of New Zealand's junior doctors have reported falling asleep while driving home from work [3 5].

High workload not only makes for tired junior doctors, it also makes for unhappy ones. Studies have repeatedly demonstrated that the number of hours worked by doctors each week is a statistically significant predictor of psychiatric disease, burnout, and career dissatisfaction [6 7 8 9]. Yet it is not only the rosters which are contributing: non-rostered hours make a sizeable contribution to the overall workload of hospital staff. In a report published online at BMJ Careers, 73% of doctors and dentists assessed in the 2011 NHS staff survey reported working non-rostered hours [10]. These hours ranged from up to five extra hours (46% of respondents) to over 11 hours of overtime every week (8%) [10]. Importantly, a 2004 study into the overtime practices of registered nurses demonstrated that working overtime was found to increase the risk of nursing errors regardless of the length of time already worked (O.R = 2.06, p =.0005) [11]. Although this study looked at the rostering of nursing staff, it is hard to imagine that the results of any such study replicated in a population of junior doctors would differ greatly from those described above.

Seemingly irrespective of the endpoint analysed, the literature is unanimous with regards to the detrimental effect of junior doctors' large workload and associated fatigue. Yet healthcare remains slow to regulate work hours in a manner similar to that which has occurred in other industries [12]. With that in mind, the target of this quality improvement project was to reduce the unrecognised, non-rostered workload of house officers in the surgical department of Tauranga Hospital, New Zealand. We hoped to do this by eliminating the requirement for handwriting the results of clinical investigations on patient lists.

BASELINE MEASUREMENT

For this project, three measures were considered. The first was the outcome measure of the average amount of time spent at work before the rostered start time of 7.30 am. The second was the process measure of the primary job necessitating this early arrival. The third was the balancing measure of the perceived change in the speed, flow, and quality of information provided on the ward round, as reported by the senior doctor (consultant or registrar) and team house officer.

The results of the baseline measurement demonstrated that the average amount of non-rostered time spent at work by each house officer prior to handover is 28 minutes. This increases to 33 minutes on the days of post-acute ward rounds. 72% of the time, the reason for this early arrival was to write the results of patient investigations onto patient lists, again increasing to 80% on the days of post-acute ward rounds.

The balancing measure was assessed as the perceived change in the speed, flow, and quality of information provided on the ward round following device implementation, recorded by way of a survey (see results section). As the balancing measure was recorded in terms of perceived change following device implementation, no baseline measurement for this measure was recorded.

DESIGN

When considering the requirement for surgical house officers to arrive early to prepare for the ward round, it is clear that the most time-consuming part of this is hand writing the results of investigations on the patient list. An intervention needed to target this source of non-rostered work. A QI team was formed comprising a junior doctor leading the project with consultation from our hospital's change manager and clinical director of improvement and innovation. A number of interventions were considered including developing software enabling most recent patient bloods to be printed as a part of the patient lists but this was thought to require a significant resources in the form of IT input and restructuring of hospital software.

The intervention agreed upon was the use of a mobile device capable of accessing the most up-to-date patient investigations in real-time on the ward round. This idea was thought to be sustainable because: 1) the implementation of similar measures in other hospitals [13 14] 2) its ability to tie in to further quality improvement changes such as electronic requests, 3) it would lead to a significant time saving for surgical house officers, and 4) it would enable access to the most up-to-date patient investigations, improving the accuracy of information provided.

Fortunately suitable mobile devices were already available from the IT department in the form of a portable laptop with a swivel, touch screen enabling use as both a laptop and a tablet. The tablet was trialed on a walk through the surgical wards with no significant dropout of WiFi access which may limit implementation. The implementation of a device on the ward round was discussed with the surgical consultants and the medical leader of surgical services who agreed to test the device on ward rounds.

STRATEGY

PDSA cycle 1 (17/12/15) – The aim for this cycle was to test for areas of poor WiFi connectivity which would restrict the use of mobile devices on the surgical ward round. Our hypothesis was that some areas of poor connectivity would be identified and we planned to test this by walking through the surgical wards with the device connected to the WiFi. This cycle demonstrated that although there were no areas of complete WiFi dropout, some slow connection speeds were identified which could limit practical use of mobile devices on the ward round. This cycle enabled us to inform IT services of the areas of dropout, and as a result two additional wireless access points were installed to improve wireless cover on the surgical wards.

PDSA cycle 2 (04/02/16) – The aim for this cycle was to trial the mobile devices alongside a surgical post-acute ward round to assess the feasibility of use in a 'real-life' setting. Our hypothesis was that the mobile devices would provide access to laboratory results in as timely a fashion as the current practice of hand-written results, but that access to radiology images would be no better or worse than the desktops currently used. This small test of change entailed testing the tablet on the post-acute ward round alongside the usual team house officers who continued with the current practice of hand-writing clinical results on team lists. The cycle demonstrated that it was feasible to use the devices on the round: there were no points of WiFi dropout, results were accessed in as timely a manner as using the current method, and on two occasions information was provided faster and more accurately, including one situation which directly benefited patient care (faster initiation of treatment for a patient with acute kidney injury). If anything the access to radiology was inferior to the desktop computers due to the slow rate of scrolling through CT scans. This cycle enabled us to move forward into a larger trial confident that the devices could provide accurate, real-time access to results without fear of significant detriment to patient care.

PDSA cycle 3 (11/02/16) – The aim for this cycle was for the team house officers to trial the mobile devices on the post-acute ward round to see if their use reduced non-rostered workload without adverse effect on the quality and accuracy of information provided, the speed or flow of the ward round, or on the team's knowledge of its patients. Our hypothesis was that a reduction in non-rostered workload would be achieved, but that this would adversely effect the speed and flow of the ward round as the house officers got used to the devices. We expected to see no change in the team's knowledge of its patients. The plan for this cycle was for the team house officers to trial the mobile devices in place of the current practice of hand-writing clinical results on a single post-acute ward round. This cycle demonstrated a reduction of 13 minutes from the average amount of non-rostered time spent working before handover, and an 18 minute reduction from the average for a post-acute ward round. The house officers felt that the devices improved timeliness of access and enabled access to more up to date results than when hand-written, but that slow scrolling speeds limited the access to CT scans. No perceived change in the accuracy of information provided, the quality of X-ray images, the flow and speed of the ward round, or the team's knowledge of their patients were identified. This cycle enabled us to feel confident that a longer trial of the devices was safe to proceed with.

PDSA cycle 4 (15/02/16 to 19/02/16) – This cycle was an upsizing of cycle three, trialling the devices across seven calendar days on the same surgical team. The aims were the same as those for cycle 3 assessed across a longer period of time. This cycle demonstrated a consistent reduction in non-rostered workload with similar balancing outcomes as for cycle three. Important additional information provided included the perception from the surgical registrar that the use of the mobile devices provided results more slowly than the use of hand written notes. However, additional benefits demonstrated included the ability to provide clinical past history more readily, ability to access results not likely to be written on patient lists under the previous system (e.g. most recent echocardiogram results), and the way that the mobile devices freed up desktop stations for use by other healthcare staff. This cycle enabled us to proceed to a wider roll out to the entire surgical department without need to alter the intervention.

PDSA cycle 5 (29/02/16 to 15/04/16) – The aim for this cycle was to assess the sustainability of the improvements seen in cycle 4 across the change in house officer roster and to assess the uptake of the intervention by other surgical teams. Our hypothesis was that a sustainable improvement in non-rostered workload across the change in house officer roster would be seen and that wider uptake by the rest of the surgical department would be good. We planned to test these hypotheses firstly by continuing the use of the device in the team involved in cycle 4 but crossing the change-over of the house officer roster. Outcome and balancing measures were assessed as they were in cycle 4. Assessment of wider applicability was made by rolling out the devices to all teams within the surgical department with measures of satisfaction made through the survey used in cycle 4. This cycle demonstrated a sustainable reduction of non-rostered house officer work by greater than the target of one-hour per house officer per week across the change in house officer roster. Ultimately the uptake of the devices by other surgical teams was poor, with only two of the four general surgical teams using the devices for any length of time. Further analysis of these results is available in the sections that follow (See supplementary – Detailed analysis of each PDSA cycle).

RESULTS

PDSA cycles 1 and 2 were assessments of feasibility, the purpose of which was to facilitate as seamless a transition as possible into using the mobile devices, and to give them every opportunity for success. The measures of these cycles reflect this aim - assessment of ease of connectivity and access to results. Once feasibility of use was demonstrated, we moved onto cycle 3 and commenced the collection of data relating to the primary questions of the study: could we reduce house officer non-rostered workload whilst also improving access to up-to date patient results?

PDSA cycles 3 to 5 were effectively an iterative process of upsizing the use of the mobile devices on surgical ward rounds. The use of sequential upsizing through these cycles was essential to minimise the risk associated with the implementation of a new process. These cycles directly addressed the primary questions of the project, demonstrating a sustainable reduction in non-rostered house officer workload of greater than one hour per house officer each week.

A reduction in non-rostered workload from a median of 26 minutes per house officer/day to 10 minutes per house officer/day was initially achieved, with this increased to 15 minutes per house officer/day following the change over of house officerroster where new house officers joined the surgical teams. Both of these results fall below the target of 16 minutes non-rostered work per house officer/day which marks a reduction of non-rostered work by one hour a week for each house officer. However it is worth noting that an apparent system shift occurs for days 30 - 49. Day 30 reflects a post-weekend take (i.e.: 48 hours accepting acute admissions) and with both days 32 and 33 being post-take days, patient numbers at this time were the highest seen for the duration of the project, peaking on day 33. Yet while patient numbers subsequently declined again towards the end of data collection, the the run chart clearly demonstrates an ongoing shift of the data. We cannot identify a cause for this but discussion of possible contributing biases is made in the limitations section that follows. (see figure 1).

This reduction in non-rostered workload has been achieved primarily by eliminating the requirement to hand-write the results of investigations on patient lists. The percentage of non-rostered time where the primary job attended to was writing investigation results on patient lists dropped from 72% (or 80% on post-acute days) to 0%. Interestingly, following the implementation of the mobile devices on the ward rounds the primary job requiring non-rostered work became writing patient locations on patient lists (70% of the time).

The results of the balancing measures were recorded as a weighted average on a scale of 1-5. Scores below 3 indicated worse outcomes, a score of 3 indicated no change, and a score greater than 3 indicated an improvement in that parameter. These results indicated that the use of the mobile devices was perceived to improve the accuracy (weighted average 4.17) and timeliness (weighted average 3.92) of access to results, and to enable access to more up-to-date results (weighted average 4.17). These improvements were made with no perceived effect on the speed (weighted average 3.08) or flow (weighted average 3.17) of the ward round, and with no perceived impact on the team's knowledge of their patients (weighted average 3.33). Importantly, no perceived reduction in the image quality of radiology results (weighted average 2.90) was demonstrated with the use of the devices, although a reduction in the ability to scroll through CT scans (weighted average 2.44) was recorded. Overall, 83% of respondents felt that the use of the mobile devices was beneficial as a whole.

Respondents were also asked for any specific comments or suggestions regarding the use of the mobile devices. The additional benefit of providing real-time access to results that would not have been documented under the previous system was reported by a number of respondents. Specific examples included bedside access to a patient's

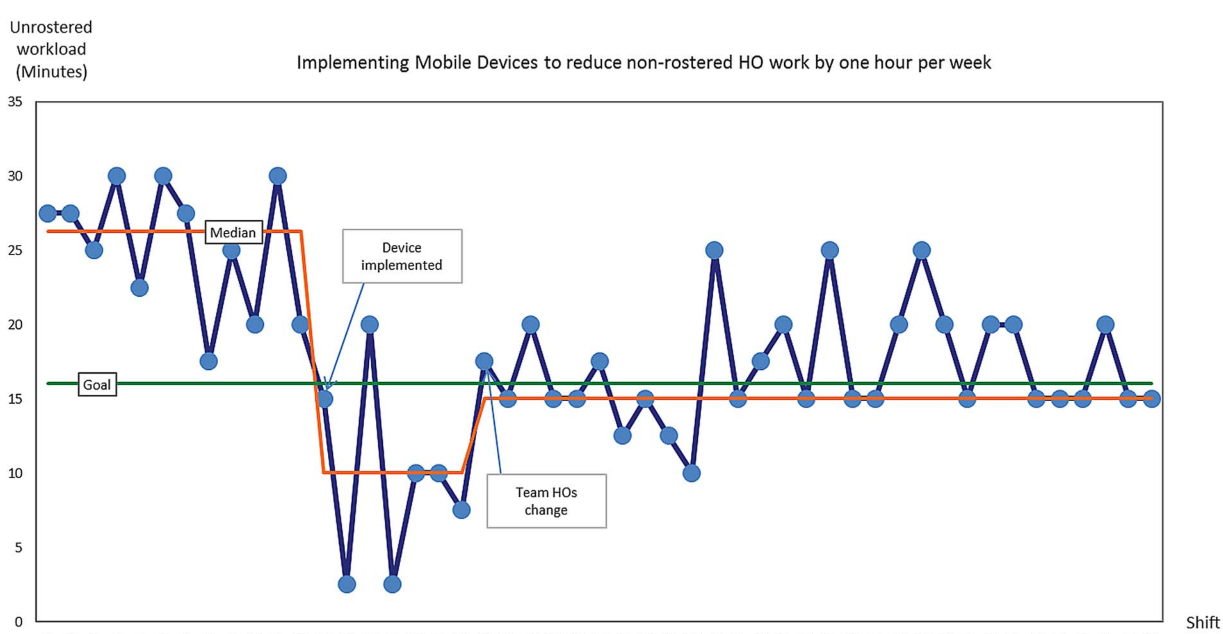

Figure 1

echocardiogram result from a previous admission. Multiple respondents also commented that the weight of the devices was restrictive to their use on the ward round, often requiring the devices be set aside whilst additional tasks were undertaken. Unfortunately access to a lighter device was not possible with current IT availability and further evaluation of the suitability of alternative devices is therefore required. Finally, multiple respondents noted a reluctance of senior staff to part ways with their hand-written patient lists. The issue of resistance to change is undoubtedly a crucial part of any quality improvement initiative and will no doubt be an ongoing barrier to the wider roll-out of the devices. Further discussion of this issue is made in the limitations section.

LESSONS AND LIMITATIONS

As with many quality improvement initiatives, one of the greatest difficulties we faced was engaging staff and breaking down resistance to change. A major learning point was the recognition that different individuals have different intrinsic capacities for adopting change and that the motivators for resistance to change can differ greatly between individuals. As such, a key step in rolling out any new initiative is to identify what those motivators or barriers are and to target them at an individual level. If we were to repeat the project, one thing we would do differently to make this process easier would be to identify "champions for change" - individuals who are readily engaged who can act on our behalf to disseminate the change to the wider group. Doing this would enable easier identification of specific barriers to change purely by having more 'numbers on the ground' and in doing so would make wider implementation of change faster, smoother, and easier. Similarly, if we were to repeat the project we would place more emphasis on engagement of senior staff. Perhaps because we initially felt that the project would live or die by the perceptions of the house surgeons using the mobile devices, we targeted our engagement at that level. However, the majority of resistance came from the registrars and consultants; those individuals who stood to least see the benefit of reduced non-rostered work hours for house surgeons. It would have been beneficial to feedback the data we were receiving to these staff members which showed positive outcomes for non-rostered work hours without detriment to ward round speed or flow.

Initially we had thought that recording data across 49 house officer shifts including a changeover in house officer staffing would provide ample demonstration of sustainability of response whilst limiting the potential for confounding. Indeed, the successful negotiation of the changeover of house officer staff provides useful information important to the real-life application of the mobile devices, and was a particular strength of the project. However, further analysis of the results suggests that collecting data for a longer period would have been beneficial; as discussed in the results section, the data shift around shift 30 cannot be wholly explained and may represent the effect of confounding variables. Indeed fluctuation in patient load resulting from things such as seasonal variation and periods of consultant leave for example are unlikely to be captured by such a short period of data collection.

There were also two specific sources of bias they may have been introduced to our project because of our method of collecting results. Firstly, the method of house officers self-reporting their start time may result in a bias towards over-representing non-rostered workload. Certainly, if we were to repeat the project, the use of an independent observer to record house officer arrival time would be beneficial. Likewise, the current practice of measuring balancing outcomes as a subjective change is subject to bias from house officers who recognise the ability of the mobile devices to reduce their non-rostered workload. Although the subjective change in ward round speed and flow is a useful balancing measure, this would be better recorded in conjunction with a more objective assessment such as recording ward round duration (controlled for patient load) pre- and post-intervention.

One of the particular strengths of the project is the type of intervention used: the trial of a mobile device is a first for our hospital and as such offers insight into the wider use of mobile technology in the hospital setting. In the first instance, our project ties in nicely with another quality improvement project at Tauranga Hospital looking to transition from paper to online referrals for all services including radiology, investigations, and patient reviews. Similarly, if our project is viewed as a small step towards the wider establishment of a mobile workforce in our hospital, it provides useful information about the desirable characteristics of the devices used. Our project taught us that the mobile devices were often found to be too heavy for comfortable daily use and that this was a factor limiting their wider uptake. This knowledge will guide not only the further roll-out of mobile technology for accessing the results of clinical testing, but also future projects looking to deliver user-friendly, practical mobile devices.

However, the downside of trialling new mobile technology is threefold. Firstly, as with any new technological development, there is the issue of trying to use it in an environment that has not yet fully adapted to its use. A project like ours is unlikely to see the whole benefit of mobile devices if house surgeons are constantly putting them down to hand-write requests. Likewise, the benefit of no longer hand-writing investigation results is offset by the need to hand-write patient locations care of software which fails to record this information. Secondly, the wider move towards a mobile workforce must also be accompanied by discussion around the security of patient information. Our project used only devices made available to hospital staff, and password-protected software only accessible by hospital staff. Yet, as a mobile interface for accessing patient information, theft of such a device could feasibly represent a threat to patient confidentiality should the stolen device be left logged in. The issue of security in an electronic health workforce is a complex one, and whilst full discussion of this is beyond the scope of this project, interested readers are directed to the work of Scott, Richards, and Adhikari, and Martínez-P©rez, De La Torre-Díez, and Löpez-Coronado [15 16]. Finally, the cost-effectiveness of using mobile devices as a tool for reducing non-rostered work is difficult to evaluate. An attempt at doing so requires a comparison of the tangible cost of the devices (roughly $1700NZD each, $6800NZD across the department) with the intangible cost of reduced house surgeon workload, improved efficiency, and freeing up of desktop stations provided. Our argument in favour of the devices would be that a one-time cost of purchasing the devices, with IT support provided by an IT service that is already in place, is balanced by an ongoing benefit of roughly 8 house-surgeon hours saved a week. Given that house surgeons in New Zealand are paid roughly $40 NZD an hour, this translates into an equivalent theoretical saving of $320 NZD / week, or $16640 NZD / year; theoretical because the hours we are talking about are non-rostered and hence unpaid. Undoubtedly the cost-effectiveness of the intervention will be one of the major talking points of our project as we continue with its wider roll-out.

Our final comment on the limitations of this project is around the generalisability of the intervention and measuring its impact on patient care. Firstly, although the use of a mobile device limits the application of this intervention to those centres with access to such devices, access to hospital-wide WiFi, and access to IT support services, the widespread digitalisation of health records means that a large number of hospitals will have access to the requisite technology and support to trial similar interventions. However, the lack of these systems and the cost of the devices may be prohibitive to their implementation in some centres. Finally, and always in the forefront of our mind, is the impact of this project on patient care. Our project didn't specifically record any patient-centred outcomes; however the work of Prgomet, Georgiou, and Westbrook reviews the evidence for mobile handheld technology in the hospital setting [17]. This review describes the use of such devices to improve outcomes such as door-to-reperfusion time for acute myocardial infarction, efficiency of inter-professional communication, medication error rates, accuracy of documentation, and accessibility of up-to-date evidence [17]. Ultimately our project may only be the first step towards a mobile health workforce at Tauranga hospital, yet the hope is that the improved outcomes described above may one day be seen as we make this transition towards mobile, real-time care.

CONCLUSION

The problem that we started with was high non-rostered workload among house officers in the general surgery department due to the requirement to hand-write the results of clinical investigations on patient lists. The implementation of a mobile device that enabled real-time access to results on the ward round achieved a reduction in non-rostered workload of greater than an hour per week for each house officer in the department. This result was shown to be sustainable across an extended period of time and spanned the changeover of house officer staffing. The implementation of the mobile devices had the added benefit of perceived improvement in the accuracy and timeliness of access to results, without adverse effect on ward round speed or flow.

A significant body of evidence has arisen over the course of the last 20-30 years documenting the detrimental effect of long work hours on the performance, mood, and job satisfaction of junior doctors. Increasing evidence also shows that these effects translate into poorer patient outcomes. Our project has demonstrated that simple interventions can reduce the non-rostered workload of house officers, thereby reducing the need for them to work additional, unpaid hours beyond those they are already rostered.

As with any quality improvement initiative, for every question answered another three seemingly arise. In our case next steps include further efforts to improve the wider uptake of the mobile devices and to test their use in other departments. A more lightweight alternative to the devices currently in use needs to be found, as does a means of accessing patient locations using our current patient information software. Finally, further progress on the electronic referrals project currently underway in our hospital needs to be made before a full transition to mobile technology can occur. And so the cycle of improvement continues. But as Atul Gawande said:

"Better is possible. It does not take genius. It takes diligence. It takes moral clarity. It takes ingenuity. And above all, it takes a willingness to try". [18]

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Declaration of interests The authors of this study have no conflicts of interest to declare.

Ethical approval According to the local policy at Bay of Plenty District Health Board, this work met criteria for operational improvement activities exempt from ethics review. We used the following criteria for determining if improvement activities require ethics review. Policy criterion: The work is intended to improve care locally at Bay of Plenty District Health Board sites. Explanation: The work reported here sought only to improve the efficiency and quality of surgical ward rounds at a single hospital site, without providing generalisable knowledge for a field of inquiry.

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