

## Insights from an iBleep trial: Understanding the implications

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### Abstract

**Purpose** Recently concern has been raised about junior doctor work load and pattern, and consideration given to how this can be improved by clinical communication systems.

**Method** North Shore Hospital (NSH) management initiated a trial of a web-to-smart mobile communication system called the iBleep, to try to improve their junior doctors' working conditions.

**Findings** Both technical aspects of iBleep function and iBleep user opinions were studied to determine whether the communication system worked in this regard. Based on results from clinician surveys and interviews, however, the majority of NSH junior doctors and nurses did not like the iBleep for technical and workflow related reasons. Clinician comments suggest the reasons for these outcomes are due to a combination of implementation and organizational factors related to North Shore Hospital, and sociotechnical factors related to communications technology usage relevant to any acute care hospital.

**Conclusion** The iBleep implementation was rolled back. Communication between nurses and doctors after hours about patient care is complex and requires further research.

## 1. Introduction

Concern has been expressed from various areas about the amount and pattern of work for junior doctors in New Zealand hospitals [1,2]. Studies focusing on out of hours work patterns have found that house surgeons can be called on average two to four times per hour [3]. Morton et al [2] also found wide variation in call frequency within different specialties, and depending on the time of night. Research in junior doctor work patterns in Australia, the UK and the USA has suggested that many of these calls concern tasks which do not necessarily need to be done by doctors or could have been addressed in daylight hours [4-6].

Ting et al [5] suggest that pager frequency could be an indirect marker of job acuity and thus junior doctor stress levels. However a review [7] of UK junior doctors' reported opinions on satisfaction with their hospital jobs and working conditions suggested that their stress levels related little to working hours or their amount of sleep. Perceived job unpleasantness was more strongly associated with particular consultant teams and hospital organizations, rather than workload. Whether pager frequency or even the quality of information accompanying pager calls could also reflect the degree of hospital organization, and thus be related to job satisfaction for junior doctors, is not known.

A pager or locator is a telecommunications device which typically displays short alphanumeric messages (via computer entry) and/ or short voice messages (via phone) from callers. The messages will give the caller's origin or a phone extension at the minimum, plus a varying amount of information about the reason for the call and the suggested recipient response (e.g. "please see now"). Pagers are assigned unique codes, so that callers can selectively send messages to a particular recipient or group of recipients. In the hospital environment, nurses or other doctors would usually call junior doctors via the latter's pagers when they need assistance with patient care. Junior doctors would then either call the phone extension given or proceed to where the call had originated. Nurses themselves do not usually carry pagers, as most only work within their home ward and are thus usually near a particular phone extension.

If for some reason a junior doctor does not reply to a pager message as above, there is no easy way of telling why, e.g. is it due to a malfunctioning pager, or is the doctor fully occupied in an emergency situation, or is the doctor not at work due to illness? This can be immensely frustrating to the caller and wastes time.

Pagers have limited facilities for indicating call urgency. Some are based on (usually) mutually understood codes, e.g. in NSH, a hospital within the northern part of Auckland, New Zealand, including "\*1" at the end of the pager text message means urgent action is required. Inclusion of words such as 'see now' in messages seems to be unusual. Nurses are free to include a patient's physiological observations in the pager message to indicate that a patient needs to be seen urgently but there is no standardized means of doing so.

Attempts have been made to define the levels of abnormal physiological observations which should initiate a call to a doctor. An example of this is the North (Shore) Early Warning Score (NEWS), which is used at NSH. Its development was based on a recognition that critically ill patients often have evidence of physiological deterioration prior to requiring intensive care unit (ICU) admission and that early intervention may improve their outcome [8,9]. NEWS is based on a patient's physiological observations, elements of which are assigned set points depending on how abnormal they are. The NEWS is the sum of these points. Guidelines on what actions to take depending on the NEWS are printed on every patient's observation chart; as a NEWS score rises, increasing the frequency of patient observation and notifying doctors to review the patient is recommended. Thus when doctors are paged to review such patients, the patient's NEWS is usually included.

Wards may also use a combination of ward based task books and dedicated ward phones where junior doctors know that they can check to see if there are any patient related tasks waiting. However these methods have their limitations, including whether ward nurses have the time to fill in such books and availability to answer such phones whenever a doctor may call. Also, these methods are impractical for addressing unpredicted, time critical clinical emergencies.

There are communication technologies now available that improve the information and response facilities with each call, compared to existing pagers. An example is the iBleep, which is a web based ward communication application that is usually loaded onto a mobile smart phone. The iBleep software enables nurses to send text messages via a web interface on the ward computer to doctors carrying iBleep-enabled mobile phones. For each message, entry of caller name, ward, patient name, and call priority (red, yellow, or green) is obligatory; patient physiological data and free text can also be entered. The iBleep program on the doctors' mobile phones shows the incoming messages, and requests an SMS acknowledgement. The iBleep also encourages (but does not oblige) notification to the caller when the junior doctor is coming to see the patient, and when the patient has been seen.

The aim of this paper was to observe clinician response to a trial iBleep implementation within a New Zealand public hospital, i.e. NSH, and give a deeper understanding about what factors may have influenced their response.

## **2. Method**

### **2.1. The context of the iBleep trial**

The iBleep system had improved internal hospital communications and had been liked by clinicians when trialled by the Auckland District Health Board (ADHB) at Auckland City Hospital (ACH) [10]. It had not been tried at the hospitals of the Waitemata District Health Board (WDHB), where the usual method of communication between junior doctors and nurses was via pagers. These messages were sent by nurses on the WDHB intraweb. Coincidentally after the iBleep trial however, WDHB management was criticised by both the New Zealand Medical Council and by the Resident Doctors Association (RDA) on the working conditions for its junior doctors. The RDA thus asked WDHB management to look at implementing the iBleep system since it had been favourably received at ACH.

## 2.2. The time period of the iBleep trial and who used it and when

WDHB management decided to trial the iBleep within medical wards at NSH for five weeks, during 12 October to 16 November 2009. NSH is an urban secondary level hospital with about 400 beds. It admits the bulk of WDHB's medical and surgical patients. A steering group was established consisting of the WDHB general medical department manager and project management personnel.

The five week iBleep deployment was timed to be in the middle of the junior doctors' run, i.e. the house surgeons' 12 week attachment to a set medical team within NSH. The junior doctors would usually work only within their set medical team during this period except when on night cover (23h00 to 08h00), when they would provide medical care to the patients of several teams. The six weeks was positioned in the middle of the run to permit the junior doctors to have three weeks to acclimatize to working in NSH prior to iBleep introduction. The iBleep was to be tested within the confines of the NSH medical wards, and only out of normal working hours, i.e. weeknights from 18h00 to 08h00 and weekends from Friday night till Monday morning. Although its use would be encouraged, the existing pagers would not be removed or disabled in any way because of potential difficulties with group emergency calls (as the other clinicians called would not be carrying iBleep enabled mobile phones).

As the iBleep system also requested physiological data entry, there was potential for confusion and unnecessary redundancy in data entry if the two systems were not aligned. In addition, if physiological observations were not entered on the iBleep system, default normal physiological values were displayed with no indication that these were potentially not representative of the patient's actual state.

There was limited facility to adjust the iBleep because of the temporary trial basis on which it was being tested at NSH, e.g. it could not be modified to be inclusive of NEWS. A fix was made that allowed a bypass for physiological observation entry which would at least not potentially mislead junior doctors. Recommendations were also made regarding the list of call reasons to enter under each colour priority group, e.g. intravenous cannulation could be red, yellow or green in priority.

Prior to the trial, the iBleep steering group consulted the six charge nurses of the medical wards in which the iBleep trial would be conducted and two ICU clinicians as the ICU had been responsible for introducing the NEWS. Members of the steering group also held a meeting to explain the iBleep system and the trial to the junior doctors who would be in it. iBleep system training for junior doctors and ward nurses took place about one week prior to the start of the trial. This included familiarisation with the HTC Touch Pro 2 mobile phones which would be used in the trial. Trainers were also present on medical wards in the first week iBleep was released. In total over 20 resident medical officers (RMOs) and 200 nurses were trained.

## 2.3. How the data was gathered

There is quantitative data describing the use of the iBleep during weeknights, weekends and public holidays, reported in the accompanying report in this journal edition (by Blair and Orr) . There was no recording of patterns of pager usage over the same time, i.e. to determine if there was a need or desire to use pagers despite iBleep availability.

The quantitative data obtained from iBleep UK included (and is discussed in the accompanying report)

- iBleep call frequency distribution during the weeknight hours
- iBleep call frequency during weekend hours
- iBleep system reliability and ability to collect other usage information.

Qualitative data reported in this article was obtained using

- Survey Monkey
- A comments book for junior doctors to write in (kept in the NSH telephonists' office)
- Interviews (three house surgeons, one registrar, 26 nurses)
- Notes from meetings attended by researcher (junior doctors' training session, iBleep project team discussion with charge nurses of the wards where the trial was going to be held)
- Discussion with the General Manager who was responsible for initiating the trial.

At the beginning and end of each shift, the junior doctors collected and deposited the iBleep mobiles at the telephonists' office so this made access to the comments book easy.

The clinician interviews, meetings attended by a researcher and the discussion with the manager were additional to the Survey Monkey and comments book data. The latter two are detailed in the accompanying report by Blair and Orr . The clinician interviews were done during their after hours on-duty shifts at NSH, on 6 November 2009 and 26 November 2009. Interviews were semi-structured, following each participant's responses and conducted in the wards in which the clinicians were working.

The clinician meetings, clinician feedback and interviews were analysed in accordance with the general inductive approach described by Thomas [11]. Themes were developed from studying clinician comments (from the survey, interviews, discussions, researcher's notes and telephonist's feedback book), which were then grouped into general categories. The themes from clinician interviews were consistent with those from clinician feedback via Survey Monkey and comments book.

### 3. Results

The iBleep web program succeeded in a technical capacity, in that there was no recorded downtime although there was occasional slowness transitioning between screens. It also did well in an information gathering capacity, in that it was able to record the volume of SMS calls, plus the call types, urgency and originating locations. However, in the eyes of the clinicians using it, the iBleep did not fulfill its primary purpose, which was to improve intrahospital communications at NSH and thus improve working conditions for NSH junior doctors.

Major themes identified for both the junior doctors and nurses were: comparing the iBleep system to the pagers; technical aspects of the iBleep system; call prioritization and information to include in calls to junior doctors; the iBleep in the context of North Shore Hospital versus other hospitals.

The following table is a summary of communication technologies that have been in use at NSH, together with their capabilities and limitations relevant to clinical usage.

#### 3.1. Junior doctor feedback

From Survey Monkey, half the doctors who replied felt that they preferred the existing pager system to the iBleep system. Only 20% preferred the iBleep system, with 30% not establishing a preference for either system. Of the four doctors interviewed, all preferred the existing pager system. None of the doctors had used the iBleep system prior to this trial, although at least one had heard of its usage at ACH.

Comments from all clinician data sources had many more complaints about the iBleep than favourable feedback. Positive comments were related to being able to use the phone function after being called, and receiving more patient information from the referring nurse than that possible from the pagers. However, doctors said that when they called back, sometimes the referring nurse had moved away from the phone or started another task.

**Table 1 - A comparison of the features of different communication technologies**

	Ward based task book	Ward based phone (landline)	Pager	iBleep system with smart mobile phones
Synchronous communications	N	Y	N	Y
Asynchronous communications	Y	N	Y	Y
Portability	N	N	Y	Y
Allows for lengthy/detailed communication	Y	Y	N	Y
Cost	Low	Low	Medium	High
Formatted observations	N	N	N	Y

Negative comments were related to the mobile phones on which the iBleep software was installed, the iBleep system itself and whether it was thought to be an improvement on pagers, plus the perceived motivation behind the iBleep trial. There were no comments that the iBleep decreased the number of calls that junior doctors had to respond to in person.

The actual mobile phone devices used in the trial were not liked. Complaints included poor battery life, and bulkiness. Other comments were related to the mobiles being over complex for the ward call tasks and that they were slower than pagers, although it was not clear whether this was solely related to the iBleep system or all the functions available on the iBleep trial mobiles. There was no warning of imminent battery exhaustion, so that the junior doctor could be unaware that calls were continuing to be made after the battery expired. At least one doctor appreciated the mobile phones for their phone facility:

*“I MOSTLY get yellow calls, and have to call anyway, but being able to call the ward directly after a beep is a huge plus for me”*

Log in to the iBleep system was needed to see the list of patient calls but log in was thought to be slow and the system logged out unpredictably, before the doctor perceived an ending to the task of responding to a call. One house surgeon commented that

*“...when you tap “seeing” a patient [on the phone screen] their name and details disappear from the iBleep display which is very inconvenient...”*

Accessing iBleep pages was also thought to interfere with clinical actions, as in this comment::

*“when at patients bedsides / doing procedures difficult to access pages as so time consuming...”*

Call prioritization was not assisted by iBleep in the opinion of the junior doctors. This is where the red/ yellow/ green traffic light method of call prioritization (based on subjective judgment) on the iBleep appeared inadequate after using the well established NEWS ‘track and trigger’ system (based on objective observations) on the pagers, as evidenced by the comment:

*“The red, yellow, green prioritization is patronizing and unhelpful. I have had green bleeps about bowel obstruction and red bleeps about warfarin needing charting. Friends in other iBleep hospitals say that the system is invariably abused...”*

*“...The prioritization with just a colour allocation has no clinical value unless the nurse who pages have good judgment of the situation...”*

It was suggested by some junior doctors that inappropriate usage of the traffic light indicator may have been due to inadequate nurse training, or that nurses could be unable or unwilling to appreciate the junior doctors’ point of view. One doctor felt that:

*“The problem with on calls is one of bleep culture and training. Nurses need to put themselves in an on call house officer’s shoes, be ready to tell them the situation, background, and observations. Non – urgent jobs could be written down in a book on the ward. None of this is addressed by an overly complex system that lets nurses demand a doctor prescribe warfarin within 20 minutes”.*

The traffic light indicator engendered the most comments in suggestions for iBleep system improvement. Leaving aside medical and nursing disagreements in call urgency, the comments above suggested was that the dislike of this indicator may also have related to the doctors’ perception of how it did not take into account their workflow.

Making the entry of physiological observations optional in an iBleep call also emerged as problematic, as described by one doctor:

*“There is no benefit in the iBleep system if the triaging is inaccurate and essential obs[ervations] are not filled in for patient review requests...”*

There was, however, no consistent preference for physiological observation entry into the iBleep compared to NEWS entry.

There were suggestions that the iBleep system could be improved by including human agents to triage ward calls (other than the ward nurses). This happened in the Auckland City Hospital (ACH) iBleep implementation, which interposed senior nurses between the ward nurses sending messages and the house surgeons receiving them, to direct the calls

more appropriately. But that would still not make the iBleep the preferred communication system at NSH. For instance, one house surgeon said:

*“...The only reason it is remotely manageable at Auckland is because a coordinator filters the pages and prioritizes them accordingly. Still not worth the money or headache even if that were to happen...”*

Even with the call acknowledgement facility, not all doctors used this – there was one instance where a house surgeon did not answer seven calls from one ward (including two of red - high priority). When he appeared at the ward and was asked why he did not acknowledge the calls, he suggested that it was enough that he was aware of the calls, indicating that he was treating the iBleep as a pager with no capacity to acknowledge calls, as supported by this comment from another doctor:

*“The iBleep offers no advantage to us over a traditional pager. It seems just like an elaborate way for management to audit our movements”*

This comment also indicates suspicion about why the iBleep trial was being done, and other doctors also expressed concern over the potential for surveillance on medical activity by managers. There was no explanation of the reasons underlying the iBleep trial to the junior doctors either before or during it.

### **3.2. Nursing feedback**

Nursing comments from both the web survey and the interviewed nurses indicated that most seemed to prefer the old pager system to the iBleep system, although they praised the iBleep for its facilitation of recipient acknowledgement of calls. None of the nurses interviewed reported having used the iBleep before.

The iBleep criticism was related to the perception that it was slower, more complicated and more cumbersome to use than the pager system. One of the nurses said:

*“I was not happy with the amount of time I needed to spend on the computer. This was difficult at times when patients needed my care and I was stuck on the computer”*

Five of the interviewed nurses indicated that the iBleep system was too complex for most of the messages that they wanted to send to the junior doctors.

Nurses differed in how much and what type of information that they thought doctors would want in their messages, as shown by the following two nurses' comments:

*“I prefer [the iBleep] system (sic), although more time consuming, it provides robust information to the OCHO [on call house surgeon], allowing them to correctly triage and prioritize work load...”*

*“obs [observation entry] part, make it only for NEWS score 3”*

One assumes the “robust information” referred to was the iBleep system's ability to include the patient's actual physiological observations (as opposed to the simplified, summarized version given by the NEWS score), or extra patient information entered via its free text box, into its messages. The pager system would not permit much more text entry than the call essentials, and does not present physiological information (if entered) in any formatted, easy to read fashion. The second nurse's comments however suggest that he/she would regulate information included with the call depending on its nature – something that the call recipient might not agree with. Both of these nursing comments contrast sharply with the junior doctors' dislike (see above) of nurse prioritization by the traffic light indicator.

There were no particular nursing comments about the traffic light prioritization indicator (or realization that it was a source of medical discontent), other than one nurse saying:

*“...several times I noticed some nurses would prioritise, inappropriately I felt, because they wanted the doctor to come soon...”*

Four of the interviewed nurses suggested that they used the pager system primarily to facilitate a phone conversation when they had complex clinical scenarios, and they wanted to discuss details about a patient's history and investigations with the junior doctor. They did not mention whether they would phone the junior doctors directly via their iBleep enabled mobiles in such cases, or consideration that some doctors might prefer that.

There were no nursing queries about why the iBleep trial was being done.

## 4. Discussion

How could a communication system which had been selected on the basis of local and international success with junior doctors, fail at NSH? Moreover, how could the very people whom the system was supposed to benefit, distrust the motives behind its introduction?

### 4.1. The iBleep trial and WDHB clinicians

The lack of consultation of NSH junior doctors prior to iBleep introduction was a missed opportunity to avoid some of the ensuing complaints about the system, and to assure the doctors that WDHB management was trying to improve their work conditions.

NSH had significantly different organizational structures and contexts compared to Auckland City Hospital. This may have influenced the outcome of the iBleep trial [12]. Auckland City Hospital is a tertiary level hospital with nearly double the number of patient beds compared to NSH. Greater clinical complexity may have favoured usage of a communications device capable of giving more information within each call.

Potential mechanisms by which the iBleep benefited junior doctors could have included the reduction in nurse ‘check’ calls to junior doctors, to ensure receipt of an original request for help. The iBleep would otherwise be unlikely to reduce the total number of calls to junior doctors unless some calls were diverted to others. In the NSH iBleep trial, junior doctors could only suggest to nurses that they do this by indicating in response to calls that they were busy. Another means of improving the work process could be by call aggregation, e.g. aggregating calls by location so that all calls from one area could potentially be addressed while a junior doctor was on the spot [5]; but the iBleep did not permit this.

There were no comparisons of other potential information and communication technologies (ICT) that could be used. No clinical champions were enrolled to promote and support the iBleep trial; WDHB management did not explain its underlying intent behind the trial to the clinicians who were most closely involved, i.e. the junior doctors. These missed opportunities cannot have assisted the iBleep trial outcome [13,14]. From the junior doctor perspective, they received few benefits from the iBleep. It was not surprising that they found it unsatisfactory, similar to Weiner’s [15] findings on satisfaction with computerized order entry (CPOE).

Nurses were not suspicious in the way that junior doctors were of the iBleep trial, despite being as little informed of its purposes as the junior doctors. Perhaps this is because they did not think that the iBleep could be used to assess their work performance, or that they would not feel threatened by any such assessment.

### 4.2. Call prioritization

Nurses and doctors are known to have discrepant views of call urgency – the latter considering many nurse calls via pager not to be as urgent as labelled [5,16-18]. Patel et al [19] suggest that most calls received by on-call junior doctors at Auckland Hospital : “...did not need immediate responses and would have been better communicated via a less intrusive system such as text messaging or the keeping of a non-urgent jobs list” (p1)

There were clearly similar disagreements in the iBleep trial between doctors and nurses in this regard. There was even divergence in the nursing group, with some nurses apparently using the traffic light system inappropriately and other nurses concerned that doctors should receive sufficient information to make up their own minds. Perhaps in the first group, a significant reason is Coiera’s [20] suggestion: “...most clinicians seek to maximize their personal efficiency in serving their patient but do not seem to consider the consequences of their behaviour on the overall operational efficiency of their organizations.” (p280)

Interestingly, although the junior doctors were critical of nurse prioritization of calls via the traffic light indicator, they did not indicate within their comments that they felt nurse clinical assessment or judgment was any different to that before the trial. Nurse comments do not suggest that they particularly felt the indicator to have influenced their opinions about the iBleep. Thus the doctors’ comments about nurse prioritization with the traffic light indicator may reflect a mistaken interpretation that it demanded their response, rather than being there to assist their judgment of what to do first. They may have felt it to be a threat to their personal autonomy [21].

Although some doctors and nurses liked physiological data inclusion in iBleep calls about patients, presumably to help call prioritization, there was no evidence to suggest that all doctors felt the same way. It is not clear what degree of NEWS usage there was or whether it was seen to be equivalent to or better than the original data for prioritization purposes. Or other factors e.g. patient history may have been thought to be a more discriminating factor.

### 4.3. The mobile versus the pager and other communication systems

Leaving aside the iBleep system and the ability to either phone or text, the mobiles did not have any particular advantages to pagers in their configuration (see Table 1.) They were normal mobile phones with smart phone capabilities and not specially designed in any way for the iBleep system. There was no facilitated access on the mobiles to the NSH electronic clinical information system or web-based medical knowledge databases; adding these may have increased perceived usefulness and thus iBleep acceptance [22]. The reliability of the mobiles used in the trial was unsatisfactory, and the log in/ log out process was thought to be unwieldy and unpredictable.

Both the pager and the iBleep system required computer access and the ability to operate a web-based communications system. Presumably the preference for the pager was not related to this access. There were no complaints about inadequate training in how to use the iBleep system, even given the limited time for teaching prior to the trial. Some junior doctors preferred the synchronous communication facility of their iBleep-enabled mobile, despite the potential for interrupting their workflow. This has been noted by other investigators as well [23,24]. Possible advantages have been to facilitate mutual understandings between clinicians [25]; satisfaction in dealing with and completing a communication related task at the time [23]. A contributory factor to this preference in the iBleep trial may be that junior doctor comments suggest that the majority of mobile phone calls were of doctors ringing out, rather than nurses ringing in.

Asynchronous communication technologies such as electronic whiteboards or task lists have been successfully used to manage doctor – nurse communication about non urgent tasks [17,26]. However, mechanisms are required to differentiate and manage urgent calls. Locke et al [17] developed their communication system with considerable clinician (doctor and nurse) involvement and prototype checking/ changing by user focus groups. The difference in expected response times between “stat” situations/ tasks, “urgent” situations/ tasks and “non-urgent” situations/ tasks was clearly defined. Many of the “urgent” tasks were defined as well (e.g. “chest pain > 10 minutes”). Training in this system was mandatory for all users. Another example of prioritizing was suggested by Morton et al [2], by routing all out of hours calls to doctors via a senior nurse who would decide task allocation – the “clinical night coordinator”.

A different approach to clinical communication strategies was outlined by Reddy et al [27] about the introduction of a wireless alerts pager in a surgical intensive care unit. ‘Critical’ laboratory results, medication and allergy alerts, and patient physiology alerts (based on trends or event combinations) were automatically sent to pagers carried by all the ICU doctors plus the ICU pharmacist. Clinician opinions were generally positive but issues noted were the lack of alert prioritization, the recipient only nature of the pagers, and the perceived need by ICU nurses to notify the ICU doctors of patient alerts even if the latter were receiving these by another route. Although superficially this would tend to support technology like the iBleep, alert prioritization would still probably require interposition of human judgment – most likely the ICU nurses, to assess alerts in the context of the patient’s clinical state. It would be interesting to see if this led to similar doctor and nurse disagreements as within the iBleep trial.

Whichever the approach to clinical communication systems, they are likely to require similar features to those suggested for effective clinical decision support systems [28] – namely, being fast and fitting into a user’s workflow – neither of which the iBleep system apparently did.

In summary, the iBleep system was implemented as a pilot study to establish if the technology would be acceptable in contributing to better communication between nurses in the North Shore Hospital’s wards and junior doctors who were responsible for a number of wards during after-hours shifts. The iBleep trial at NSH did not succeed in its primary aim due to lack of adaptation to local conditions, which would have been helped by comprehensive engagement and involvement of the junior doctors and the nurses who would be using the iBleep most. Technically, the mobile phones used had usability issues, e.g. battery life. At the same time, however, the trial revealed that a communication tool such as the iBleep has a mixed effect:

- While the technology works well and the iBleep has more flexibility and functionality than pagers, the iBleep mobiles and software were complex and difficult to use.
- There is disparity between what doctors and nurses consider worthy of a call, i.e. what should be prioritized
- Nurses have a strong need to know if a call has reached its destination (the junior doctor) and has been read
- The intent of the nurse sending the call is different from the experience of the doctor receiving it, i.e. nurses intend to notify doctors of tasks while doctors find the non-urgent calls intrusive. Task prioritization carries different meanings for sender and receiver.

These issues have also been seen in other hospitals and have been tackled with varying degrees of success.

#### 4.4. Limitations of this study

While the study has rendered valuable insights into the implementation of information and communications technology to facilitate nurse-doctor communications after hours in a hospital setting, there are some limitations to be considered. This was a small study, limited to one discipline, general medicine. It was a pilot study conducted over a short period of six weeks. It is possible that if the mobile phone function had been improved and/or the iBleep was trialled in different specialities (where the requirements from junior doctors may differ) that it may have been better accepted. Nurse education about call prioritization may also have helped. Parallel pager activity and its nature (e.g. use for emergencies alone, or because of dislike of the iBleep system), was not studied; neither was influence from previous iBleep users, which may have prejudiced junior doctors in the NSH trial.

#### 5. Conclusion

Further research is required to determine what design and implementation features best lead to the success of clinical communication systems. Questions not investigated in this pilot should be explored in future research. How does the NEWS track and trigger system on the pagers compare with the traffic light system in the iBleep in terms of nurse prioritization, doctor response, and completeness of physiological information about patients? Is there a correlation between 'alert fatigue' and the reported sense of intrusiveness of incoming calls for junior doctors? Does it change in the transition from pagers to iBleep? What role does the phone functionality (ability to make and receive phone calls) have on communications between nurses and junior doctors after hours in a hospital? What understanding do doctors and nurses have of the demands of each others' jobs?

In conclusion, this particular pilot resulted in the roll-back of the iBleep system and reinstatement of pager system; in other words, a return to the status quo. We have learnt that communication relating to nurses calling doctors in a hospital after hours setting is complex, yet clinicians prefer communication devices which above all are simple to use, reliable and fast. The next step is to engage clinicians, both doctors and nurses, in developing such a device.

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