MEDINFO 2013
C.U. Lehmann et al. (Eds.)

doi:10.3233/978-1-61499-289-9-253

User-centered Design in Clinical Handover: Exploring Post-Implementation Outcomes for Clinicians

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Abstract

This paper examines the outcomes for clinicians from their involvement in the development of an electronic clinical handover tool developed using principles of user-centered design. Conventional e-health post-implementation evaluations tend to emphasize technology-related (mostly positive) outcomes. More recently, unintended (mostly negative) consequences arising from the implementation of e-health technologies have also been reported. There remains limited focus on the post-implementation outcomes for users, particularly those directly involved in e-health design processes. This paper presents detailed analysis and insights into the outcomes experienced post-implementation by a cohort of junior clinicians involved in developing an electronic clinical handover tool in Tasmania, Australia. The qualitative methods used included observations, semi-structured interviews and analysis of clinical handover notes. Significantly, a number of unanticipated flow-on effects were identified that mitigated some of the challenges arising during the design and implementation of the tool. The paper concludes by highlighting the importance of identifying post-implementation user outcomes beyond conventional system adoption and use and also points to the need for more comprehensive evaluative frameworks to encapsulate these broader socio-technical user outcomes.

Keywords:

User-centered design, Health information technology.

Introduction

Regardless of scope or scale, effective design and implementation of health information systems involves coordination of a complex set of inter-related processes. These include ensuring that system content and functionality are relevant and can be integrated into routine clinical workflow [1]; ensuring an appropriate distribution of tasks between the user and the information technology (IT) system, including sufficient resources and training [2]; and maintaining clarity around the cognitive work that the IT system is supposed to support [3]. In this context, it is unsurprising that engaging and involving users in the design and development of health information systems has been strongly promoted as an approach for addressing these issues. Benefits from involving users reported in the literature include improved technology adoption and utilization, increased user-satisfaction, trust and usability [4]. Despite differences between approaches advocating a role for users (e.g. human factors engineering; participatory design; user-centered design, universal design, human-computer interaction), all consider users as integral to systems design and implementation processes.

Given the volume of published user-centered e-health research, it is surprising how few studies provide detailed analysis of user outcomes post-implementation. While the many problems and challenges associated with the evaluation of health information systems *per se* have been recognized [5], it would appear that involving users and evaluating their outcomes remains problematic [6].

This paper provides insights and analysis on post-implementation user outcomes based on a case study that involved clinician-users in the development of an electronic clinical handover tool as part of a clinical handover improvement initiative at the Department of General Internal Medicine, Royal Hobart Hospital. Clinical handover is vital in maintaining the quality and safety of patient care [7], and electronic tools have been promoted as a method for improving handover [7,8]. A review of existing research on the use of electronic handover tools confirms the reporting of benefits for clinical handover improvement [9], but there remains a general lack of information on how previous tools have been designed and implemented and/or the extent to which clinicians were involved at any stage of their development and implementation [10-12]. More significantly, there is also limited evaluation of post-system implementation outcomes arising from these tools, the design processes used in their development and/or other factors on end-users, their attitudes, insights and clinical practices.

Study context

This paper is based on research conducted as part of a broader handover improvement initiative conducted at the Department of General Medicine, Royal Hobart Hospital. This research conducted over more than 12 months involved three phases framed by an over-arching user-centered approach that utilized a combination of qualitative data collection and analysis techniques. Phase one was conducted to obtain an in-depth understanding of the clinical handover process and clinician insights on clinical handover improvement [13]. These insights were then used as a basis for the design and development of the electronic clinical handover tool in conjunction with the clinicians during Phase two [9,14]. This paper focuses on Phase three of the research, which was conducted to explore the post-implementation outcomes associated with involving the clinicians in the design and development of the electronic clinical handover tool.

Methods

All medical registrars and medical interns working at the Department of General Internal Medicine (at the time the study was conducted) were invited to participate in the research. There was also an open invitation for senior consultants to participate in this study if they wished, but they were not the primary focus of the study as established in a previous study. This paper is based on data collected and analyzed from seven

registrars and seven interns who agreed to participate in this part of the study.

Data collection and analysis

Ten observation studies were conducted over a 5 day extended holiday period that included morning handover (8:00-8:30am), evening handover (4:30-4:00pm) and night handover (9:30-10:00pm). Observation notes were recorded during this period. Fourteen semi-structured interviews were also conducted to gather information about each clinician's understanding, expectations and experiences of clinical handover after the introduction of the electronic clinical handover tool. The research team also collected data on the clinician's perceptions and feedback on the electronic clinical handover tool. All interns and registrars who were present during the observation sessions were invited to participate in the interviews. All interviews were conducted face-to-face at a time that was convenient to the clinicians and were audio-recorded with permission from the clinicians. Interviews varied in length from 15-40 minutes and all interviews were transcribed within 48 hours in preparation for data analysis. Compilation of clinical handover notes was also conducted by a senior clinician in the research team. These notes were de-identified and summarized and used as a basis for comparison with the observation and interview data. In most circumstances, the combination of data collection methods utilized did not result in any significant discrepancies. However, in instances where discrepancies were found, the data collected from observation sessions were deemed to be the more accurate representation of the data. The data collected through observations, semi-structured interviews and clinical handover notes were analyzed using qualitative techniques, drawing on the principles of grounded theory [15]. Open, axial, selective coding, constant comparison and analytical memos were applied as a method for systematically organizing, reducing and conceptualizing the qualitative data.

Results

Analysis of the data revealed that there was a range of post-implementation outcomes arising from the use of the electronic tool, the design processes used in its development and a number of other factors impacting these clinician-users, their attitudes, and clinical practices. In addition to expected outcomes arising from tool adoption and use, a number of unanticipated and unintended benefits were identified. These outcomes are presented below.

The electronic clinical handover tool developed in collaboration with the clinicians contained all the system features and functions that had been identified, discussed and agreed upon with the clinicians during design workshops [9]. These features and functions included the ability to extract patient information from two separate information systems used more broadly within the hospital (the patient administration system and the pathology system), generation of a patient list for each medical unit including a 24hr admissions list for all admissions, the inclusion of pathology results, provision of a process structure for entering handover information in the form of issues, actions and comments, allowing for completed tasks to be ticked off, allowing for the categorization of handover tasks in order of urgency, and alerting clinicians to patients that had outstanding handover actions.

Following implementation, evidence revealed that the use of the electronic tool resulted in a more efficient clinical handover process, primarily due to improved access to up-to-date clinical handover information about a patient in a highly readable format. The tool also provided an indication of the clinician's workload for a particular shift and the urgency of handover tasks, which assisted in the planning and execution of tasks.

> *INT D: "I think it is a good thing that we have this I mean the electronic handover is quite a good idea cause when you write everything up and the other person can go back to it and tick off what he or she has done is a great thing, now you know when someone is telling you something because they can't now say you didn't tell me this or that, I mean it should be actually written down so everyone can check what was handed over and everyone can check what was done and who has done it."*

The electronic clinical handover tool allowed simultaneous, real-time access to clinical handover information at the point of care. As such, multiple team members could carry out and complete tasks required for patients in a coordinated manner. This changed the nature of face-to-face clinical handover sessions from one of information sharing to one of task division, clarification and discussion.

> *INT A: "You should cross check that the person has understood what you want to do, what they doubt, they clarify at the time of the handover."*

The electronic clinical handover tool provided a structure for issues, actions and comments that helped to streamline communication. It also helped to mitigate risks related to poor information transfer stemming from either a clinician's behavior during clinical handover, communication style or cultural background by providing a structure of issues, actions and comments.

> *INT S: "Yeah so um we're not wasting our time and being told all this random crap about a patient, like who cares, just get to the point like you can see some guys are so tired they're just reading the sheet they've got in front of them word for word and it's like I don't care mate I don't care just give me relevant positives, relevant negatives so I can get down there."*

Alongside these reported benefits, there were a number of issues relating to when and how the electronic tool was used that directly impeded the electronic tool from optimizing the potential for benefit. These issues were related to the fact that utilization of the electronic tool was not mandatory. This decision was a direct consequence of the collaborative decisions made in consultation with the clinicians during the design workshops. The electronic tool was therefore implemented to be a support tool for clinical handover rather than a replacement of face-to-face handover meetings. As such, while clinicians acknowledged that the electronic clinical handover tool provided a good mechanism for formal documentation and communication of clinical handover information, they tended to use the electronic tool routinely only on weekends and extended holiday periods but not on weekdays, as it was time-consuming to do so. Registrars sometimes read through the clinical handover messages recorded on the electronic clinical handover tool but did not actively use the tool for clinical handover purposes.

> *INT E: "It is great for the weekends. When you know that it is two days away and you need jobs done on both days. I don't think that I have used it for the week days. Because I don't think I will have any jobs and even if I do, couple of jobs, I don't feel the need to, I don't feel the need to integrate with the electronic handover."*

The perception of senior clinicians on the tool also had a big influence on whether it was adopted consistently by their interns and registrars.

INT E: "Umm… my registrar doesn't like using those blood results, because she doesn't feel that it is accurate. Which she has experienced, I haven't. So, she may be right she may be wrong, I don't know. So, I don't use it, she wouldn't believe it and she will check them again anyway, so, there is no point."

The clinician's familiarity with information technology was also found to have an influence on the use of the electronic tool.

INT S: "I think it is pretty straightforward and the fact that I could figure out how to use it without actually being told…you know….I don't know….I guess like I grew up with computers so I am reasonably good at, reasonably familiar with it and using it wasn't too much of a problem."

Whilst every effort was made during the design workshops to produce an end product that would cater to a user that had a very basic level of experience with IT, clinicians that were anti-technology still refused to use it. One clinician indicated that she was not computer literate and that technology slowed down her work. She also complained of multiple problems as well as the potential negative impacts arising from the use of the tool.

REG G: "I'm not computer literate, I'm a bit older than the others, I didn't grow up on computers so I find computers a big problem – when I moved to XXX (a hospital with computer records), I nearly died. By the end of the time I got used to it but I tend to want to do a verbal handover anyway with the night person so I would find it very hard to change, I think you'd have to start with people that haven't been exposed to other methods and I'm not saying that I wouldn't but I find computers really hard to use if it involves anything where you have to put in graphs, I'm very slow so this is quicker for me that's the only reason."

The emphasis on safety had been a major focus throughout the development of the electronic clinical handover tool. As such, safety mechanisms had been included in the tool, based on consultations with the clinicians which have been discussed previously [14]. However, the safety mechanisms that had been incorporated were not found to have produced desirable effects when the electronic tool was implemented. The electronic tool had safety features built in allowing for completed tasks to be checked so that clinicians were aware of which tasks had been completed and which tasks were outstanding. However, this feature was not utilized appropriately by the clinicians and it was found that some clinicians did not check off their completed tasks.

INT B: "No, not generally, I mean I'll hand over tasks specifically that I think these need to be done, there's this, this and this, umm I don't usually follow-up whether they've been ticked off or not, I just actually go and, you know you tend to notice the next ward round you do whether they've been done or not, umm yeah so…"

INT S_2007: "A lot of my tasks that I put on there still haven't been checked off so I don't know if that's a sign that somebody doesn't know how to use it, somebody's just not doing it or they've read it and they just couldn't be bothered …"

The electronic tool also allowed for the prioritization of urgent tasks. However, it was found that clinicians often did not indicate the priority of the tasks and the default value was left showing. This had significant impact on the accuracy and reliability of the information in the electronic clinical handover tool.

INT S: "...The whole prioritizing of patient issues, probably needs, people like need to be given a bit of a ear-bashing, like what do they actually mean by CAT 1!!"

Clinicians also faced increased workloads as a result of the implementation of the electronic tool, which was something that none of them had anticipated when they were involved in the development process. The tool ensured that clinical handover now occurred in the designated clinical handover room. Observation sessions revealed that clinicians often arrived earlier then the stipulated handover times to input the clinical information into the electronic tool. Informal discussions with clinicians found that there were insufficient computers and desk space in the wards to allow the clinicians to input the information near the patient's point of care. The clinicians often had to rely on their memory of brief notes that they took at the point of care when they input the handover information into the electronic clinical handover tool. Observation sessions revealed that some clinicians did stay back after their shift to enter the handover information into the electronic tool to ensure that the information was properly documented and available should the next shift require it. Informal discussions with the clinicians indicated that the lack of adequate IT infrastructure on the wards was the reason that they had to stay late. Clinicians also indicated that if they were seen trying to enter clinical handover information into the electronic tool, they were assumed to have some free time on their hands and asked to complete other clinical tasks by seniors.

The implementation of the tool also highlighted deficiencies in the current hospital IT infrastructure and its maintenance. Observation sessions revealed that the printer did not always work due to inadequate maintenance and that few clinicians knew who to contact when these types of issues arose. The result was that some clinicians arriving for handover would subsequently leave the handover session in search of a working printer to print out their patient lists and handover lists. This resulted in the clinicians coming in late for handover or them missing out of parts of the clinical handover – it was highly disrupted of smooth transfer of information, responsibility and accountability.

Analysis of the results also revealed a number of non-technical beneficial outcomes associated with involving clinicians in the development of the electronic clinical handover tool. Through their involvement in the electronic clinical handover tool, clinicians clearly acquired an increased understanding of clinical handover and their role in improving it.

INT A: "Handover takes place at every level, the registrars and interns at both levels so at an intern's level, we are mostly concerned about the blood tests ah….then the parameters of the patients, then handover about umm what else, handover about the basic management of the patient and if we have got any problems then we can portray this at anytime but handovers for interns are basically for management of the patient."

REG S: "Morning handover, our role in the morning handover is, I mean as a registrar is to lead the morning handover, umm and to ensure that things are done in an orderly fashion, and that everyone who has been involved in the care of the patient in the past 24 hrs has the opportunity to have their say and let the other people know what is going on."

Clinical handover guidelines and clinical handover manuals that had been developed but not adopted previously were also adopted for use at clinical handover sessions. Observation sessions revealed that most clinicians adhered to the handover guidelines and handover manual during handover sessions.

Overall, there was an increase in structure, with clinicians knowing what to expect from the sequence of events during morning handover. This led to the development of a stronger handover culture within the department. Observation sessions indicated that after the introduction of the electronic tool, morning handover sessions were well structured and well attended by most clinicians. There appeared to be either a consultant or other senior colleague available to take on the leadership role for morning handover as part of the routine expected in the department. Interns also made more of an effort to attend evening handover sessions regularly, with the on-take medical registrar taking a more active role in leading some of the evening handover sessions. Night handovers were also more organized, with interns often typing in handover messages into the tool and then sitting down with the night team to conduct a handover. The registrar also took on a leadership role for night handovers. Clinicians also developed greater expectations of the clinical handover process. The interns particularly had developed an expectation that there was to be a formal face-to-face handover with handover information entered into the electronic clinical handover tool and a printed copy of the handover notes passed on from one team to the next.

Discussion

Numerous studies identifying problems with the implementation of e-health frequently note a failure to adequately consider socio-technical factors and to engage users. However, this study highlights that actively engaging users in the development and implementation of an e-health system does not necessarily mitigate these risks.

On the positive side, this study has proven that involving clinicians in the development of the electronic tool based on user- centered design and participatory design principles is beneficial. When used appropriately, the electronic tool was revealed to be capable of enhancing the efficiency of the process of clinical handover. Indeed, this study provides validation of Chan *et al*'s application of user-centered design principles to Computerized Provider Order Entry (CPOE) and confirms evaluation of the task efficiency, usability and safety [16]. Similarly, Thursky and Mahemoff's study exploring the use of user-centered design techniques for developing the requirements for an antibiotic decision support system in an intensive care unit concluded that the contextual design methodology in conjunction with participatory design was an effective method to design this antibiotic decision support tool [17]. The process facilitated physician and pharmacist ownership of the system that resulted in immediate uptake and ongoing use. This was also reflected in this study by clinicians actually stayed behind after their shift to enter information into the electronic clinical handover tool even though the use of the tool was entirely voluntary. They probably made that extra effort because they were involved in the development of the electronic tool and therefore had ownership of it and wanted it to work.

However, while these findings confirm that the adoption of a user-centered approach is valuable in enhancing the usability and adoption of the tool, a user-centered approach is not infallible. On the negative side, problems still arose when the tool was put into practice despite actively involving clinicians in the development of the electronic tool. The study found that despite conducting numerous feedback sessions to fine tune the electronic clinical handover tool pre-implementation, some of the problems highlighted when the electronic tool was put into practice were purely design issues, e.g. leaving adequate space in the printouts for jotting down notes and date/time stamping in relation to blood test results and task requests. This highlights the fact that clinicians are limited in their view of what is required from an electronic tool and in how they plan to use it, until after it is implemented in practice. Kaplan *et al* documented that participants from a workshop expressed difficulty in articulating what they did or needed in terms of the implementation of an e-health system [18]. More research should be conducted in this area to improve the success of future e-health systems.

It was also found that while clinicians acknowledged that the electronic tool was a good end-product that met their requirements on the whole, problems still arose in the way it was used that could compromise patient safety. For example, clinicians requested a check box for tasks that were handed over so that the check box could be ticked when the task was completed. However, it was found that some clinicians did not tick the box when they completed a task while other clinicians did not check whether a task had been recorded as completed (i.e. no safety check). In this context, it is recognized that there is now an emerging body of work highlighting some of the negative unintended consequences associated with the implementation of health information systems [19].

The most important and interesting finding in this study relates to how involving clinicians in the design and development of the electronic tool transformed awareness of and a change in attitude towards the practice of clinical handover itself independent of the electronic clinical handover tool. In the design workshops, clinicians were asked to reflect on how clinical handover was and should be conducted in order to derive functional requirements in the electronic clinical handover tool. Their ongoing participation in the development of the electronic tool brought to their attention the importance of clinical handover *per se* and contributed directly to the development of a good culture for clinical handover. This in turn created higher expectations and peer pressure for good handover to take place. Clinician involvement in the development of the electronic clinical handover tool also mitigated the risks of abandoning the tool as a result of increased workload. While it was found that there was increased workload associated with using the tool, clinicians often entered data into the electronic tool outside of their formal working hours. This was probably due to the fact that they have ownership of the tool. Kushniruk and Turner have proposed a user-task-context matrix for considering who users of healthcare applications are, their needs and their requirements under differing contexts of use for healthcare systems design and evaluation [6]. However, there appears to be very few, if any, evaluation frameworks that accommodate these facets post-implementation. There is therefore a need for stronger consideration of post-implementation outcomes and for the need to develop more comprehensive evaluation frameworks.

Conclusion

This paper has presented detailed analysis and insights into the outcomes experienced post-implementation by a cohort of junior clinicians involved in developing an electronic clinical handover tool. Significantly, a number of unanticipated flow-on effects were identified that mitigated some of the challenges arising during the design and implementation of the tool. This paper therefore highlights the importance of identifying post-implementation user outcomes beyond conventional system adoption and use and also points to the need for more comprehensive evaluation frameworks to encapsulate these broader socio-technical user outcomes.

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