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Supporting Learning within the Workplace: Device Training in Healthcare

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ABSTRACT
The phrase "lifelong learning" places emphasis on the fact that learning continues beyond the classroom and formal educational environments, though it is often supported by training within the workplace. Continued professional development is particularly important within the context of healthcare, where technology is constantly evolving and errors run the risk of causing serious harm to patients. This paper considers the case of infusion device training within UK hospitals. Interviews were carried out with staff involved in medical device training and management across seven National Health Service trusts. The analysis indicates the range of training provided by different institutions and highlights important issues that influence how users develop their understanding of these devices. Further, the research indicates that while there is an increasing interest in e-learning as a way to overcome some of the challenges trainers face in relation to time and resources, there are also significant concerns which need to be addressed when considering this approach.

Author Keywords
Device training; Healthcare; E-learning

ACM Classification Keywords
H.5.m. [Information interfaces and presentation] (e.g. HCI): Miscellaneous.

INTRODUCTION
Complex medical devices which were once only used in critical care units have now become common place in general wards [6]. For example, in the UK, the Medicines and Healthcare Products Regulatory Agency (MHRA) reports on the growing prevalence of infusion devices (used to deliver intravenous (IV) medication to patients) within both the home and healthcare context [9]. Between 2005 and 2010 the MHRA investigated 1,085 incidents involving infusion pumps; 21% of these were attributed to user error. While only a few of these errors led to serious patient harm, even those that did not, can result in anxiety for staff and patients, as well as reduced patient confidence in healthcare. Training on such devices is clearly vital for ensuring patient safety. However, the literature suggests that inadequate medical device training has been found to lead to mistakes occurring in practice [10; 11].

In addition, healthcare technology continues to evolve with developments such as "smart pumps" (which include software that requires additional information about the patient and medication to be entered so it can perform additional checks to detect possible errors). These developments place even greater demands on training since increasing numbers of users are required to be competent in their use of these increasingly complex devices, regardless of their clinical and technological expertise.

As part of the drive to modernize in 2001, a framework for lifelong learning in the UK National Health Service (NHS) was produced [5]. The document states that the main aims of the framework are to ensure that NHS staff are equipped with the skills they need to "support changes and improvements in patient care; take advantage of wider career opportunities; and realise their potential". While e-learning is highlighted as a vital tool for supporting these aims, the document also notes the advances in healthcare technologies that staff will need to be trained to use. Previous research has mentioned an accredited e-learning programme for infusion devices [11] but it is not clear how this was developed or whether it is still available. Instead, the research focused more on improving safety by emphasising the need to standardise equipment and by producing recommendations for the procurement of infusion devices [11].

Training has also been identified as an area for further Human Computer Interaction (HCI) research [1]. From an HCI perspective it is important to understand how users develop their conceptual models of device use. A method such as CASSM (Concept-based Analysis of Surface and Structural Misfits) [2] makes it possible to assess how some devices are better able to support users' conceptual models than others.

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There has also been a growing research interest in "lifelong learning" and how individuals and groups continue to learn outside formal educational institutions, e.g. [4][8]. In addition to the emphasis being placed on the need for continued professional development across employment areas, researchers such as Sharples and colleagues [13] note that learning is increasingly being conceptualised as lifelong and ubiquitous. Learning in this sense occurs through social participation where individuals engage in the process of "being active participants in the *practices* of social communities and constructing *identities* in relation to these communities" [14; p.4].

At present, it is unclear how current training provisions attempt to support NHS staff in becoming expert users of the devices which they need to operate. In this paper we report an exploratory study that investigates the use of infusion pumps across hospital contexts, and the training provided to users. Understanding how users are currently trained to use existing technologies is the first step towards ensuring that the training provided leads to acquisition of an appropriate conceptual model of the device. The following sections outline how the study was conducted and present the findings of a thematic analysis. The paper concludes with a discussion of implications for training and an outline of future work.

METHOD

Semi-structured interviews were carried out with an opportunity sample of 11 participants (F = 5, M = 6) based at 9 different UK hospitals (within seven different trusts). The participants were medical device managers and staff involved in training and education. Trainers sometimes had multiple roles (e.g. trainer and device manager) and were often responsible for device training across the whole of their organisation so would provide examples from additional hospitals. Out of the nine locations, two were specialist hospitals (coronary care and cancer) and the rest were general hospitals. All were located in cities and towns of various sizes though in order to protect the anonymity of the locations further information cannot be provided. R&D departments were consulted when setting up the interviews at each site. Approval was gained from the evaluation units (e.g. Clinical Effectiveness Units) where required. The study was also granted ethical approval by University College London.

Interviews lasted between 45-80 minutes and were audio-recorded and transcribed for analysis. The majority of interviews were one-on-one but two sessions involved two participants. Participants were asked about the context of infusion device use, who uses these devices, how devices are managed and about the training provided.

FINDINGS

The transcripts were coded using *Thematic Analysis* [3], where an iterative approach is adopted in order to develop themes that cut "across a data set... to find repeated patterns of meaning" (p. 86). The following subsections outline how infusion devices are used and managed within a clinical context; how people are trained to use the devices; potential problem areas and the issues that surround the provision of training and safe use of infusion devices (where themes are indicated in italics).

Infusion device users and contexts

Whilst nurses are the primary users of infusion devices, most doctors are only occasional users, with the exception of anaesthetists who use specialist pumps as part of their work. Infusion pumps are mainly used for delivering drug therapies as part of routine medical care. In addition, they are used in research contexts such as nuclear medicine. Infusion devices are used across many hospital areas though certain wards (e.g. critical care areas) typically contain more technology than others. Nurses who work within these areas are more likely to use advanced functionality such as smart pump technology.

Device management

Infusion devices are kept in a centralised medical equipment library and/or stored on individual wards. Pumps with specific configurations tend to be kept in an individual ward e.g. if intensive care pumps have smart pump technology configured but no other ward does, then these are kept in a separate store on the ward. In cases where a medical device library manages the infusion devices, pumps are either configured the same for use on all wards or profiles can be implemented in order to deal with the issue of pumps moving location. For example, when using a pump, the nurse has to select the correct profile according to patient and area, i.e. adult, pediatric, neo-natal. Profiles can differ in relation to rate, volume and pressure limits.

Forms of training

Users are usually expected to be declared competent before being allowed to use an infusion device. Competency forms are completed after undergoing induction and training, whether this is in the form of formal sessions (usually off-ward) and/or link training on the ward. Formal sessions can range from lasting all day (including a range of other medical devices and components on IV therapy) to half hour sessions on a particular device (with 5-20 participants in each session). Trainers provided by manufacturers are often used to train link trainers who are then responsible for cascading training throughout their ward areas.

Out of the nine hospitals, one relies only on formal sessions, three use only link trainers, and the remaining five use a mix of both. A certain amount of informal learning is also expected to occur whilst nurses are on the ward – e.g., where more senior staff provide advice to newly registered nurses. E-learning was also mentioned several times as a possible addition to device training packages, usually as a way to overcome the difficulty of finding time to fit training

into the standard work shift. At the time of interview, none of the trusts had included an e-learning component in their infusion device training however. A few other tools were also mentioned, including pump simulations, training videos/DVDs and interactive workbooks, though these were not major components.

Potential problem areas relating to infusion device use

In terms of safe device use, the following infusion device related concepts were mentioned across the interviews as being *potentially confusing*: use of the bolus function (which is used to rapidly administer medication over a short period of time), purging and priming (purging relates to syringe drivers and is required to reduce the mechanical slack in a syringe pump; priming is required to ensure there is no air in the line being fed through a volumetric pump) under and over-infusions, choosing the correct delivery method, carrying out drug calculations and advanced use: e.g. multiple infusions, being able to ramp up and taper infusions.

The bolus function is not available in all clinical contexts (in one hospital they had disabled this functionality entirely). During training, trainers are keen to emphasise the potential risk of over infusion from a post-occlusion bolus. Similarly, the importance of purging syringe pumps to avoid mechanical delay and thus causing under infusions was highlighted. Trainers also reported that nurses sometimes confused the terms 'purge' In addition, there was sometimes confusion about choosing the appropriate IV delivery method, i.e. when to use a volumetric or syringe pump. Another area of potential difficulty related to drug and drip rate calculations. There were concerns that pump software may make calculations too easy (where nurses are more likely to trust the device than work out the values themselves) and about different units (e.g. one brand of syringe driver used mm of travel (of the plunger) instead of ml). Finally, multiple infusions and adjusting pressure settings were examples of advanced use that occurred in specialist areas and were not normally covered within device training sessions.

The safe use of infusion devices

Participants discussed concerns that they had about safety in relation to the *complexity* of devices. Participant C (Location 2) expressed a desire to "dumb down the whole lot" of infusion devices as "you'd reduce incidents, I'm almost sure of it". In addition, menu options have become more complex, requiring further button presses: "well initially in the [new pump] roll out, there was an awful lot of resistance to the number of buttons they have to press, the fact they've got to lean over and they're hurting their back when they're pressing the button so many times, and they always overshoot" (Participant E, Location 4).

There were also concerns that users sometimes exhibited an *over-reliance* on technology which was not viewed as being safe practice. For instance, it was suggested that once nurses start an infusion they often rely on alarms to tell them if something is wrong, rather than checking the device as they would a gravity feed: "Done, start, button push, off you go. And then when it bips, but with a gravity set you have to go back and check." (Participant L, Location 9). While infusions are generally supposed to be checked twice, normally by a second nurse, this was not always the case. Participant K (Location 8) for example, explains how the device is supposed to be checked at regular intervals (within 15 minutes of starting an infusion, after an hour, after four hours depending on the length of treatment) and describes a strategy that was implemented to ensure that this occurs: "the latest development is that we've got clocks hanging on the drip stands so that we then put it to the time that they are next due to do a check."

The provision of training

With regard to training, the analysis indicated that there was an overall *emphasis on safety* (e.g. "We want to reduce risk by reducing incidents"; Participant A, Location 1). A lack of training was also seen as a cause of incidents, e.g. "a lot of the incidents that happen, if we look at it, its user error, reason? Training! Simple!" (Participant B, Location 1) though participants noted that they faced a challenge in training users who differ in terms of their relationship with technology. This relationship appeared dependent upon which *clinical area* users work in, how *confident* they are with technology and how *familiar* users are with a specific infusion device or particular brand of pump. For example, Participant H (Location 6) highlights the role of clinical area and confidence, "You find people who work in critical care areas, they are a lot more susceptible to change in devices because technology has moved on really quickly within theatres and intensive care and coronary care and things like that". Further, Participant F (Location 5) notes how familiarity with a device can influence the adoption of a new technology, "they were offered the new pumps and the charge nurse at the time refused to go with it 'cos his staff knew the pumps they had well, they were happy with them and he wouldn't budge on that".

Additionally, tensions were expressed in relation to training and *nursing practice*, the *time and resources* available, and the *type of learning* required. There were a small number of instances where there was a clash between what nurses do in practice and what they are taught. For example, Participant A (Location 1) refers to a training session where nurses said they would read values from the scale on the syringe instead of navigating through the device options: "they were reading the remainder of fluid from the syringe? <sharp intake of breath> You can't get a good accurate reading from the syringe scale really, only a guide". In addition, certain infusion device related activities were seen as being potentially risky and more difficult to carry out than others e.g., carrying out drug calculations, setting up multiple infusions and using advanced functionality e.g. being able to ramp up and taper infusions. However, these

activities were not covered as part of the basic device training delivered to all staff. They were usually referred to as being included within IV therapy training (delivered by clinical staff) or as aspects of practice that would be learnt whilst working on the ward.

Regarding time and resources, high staff turnover was given as a reason for not using dedicated link trainers on each ward. Instead, alternative solutions were sought such as relying on a larger number of formal sessions or using a team of practice educators to areas they were needed. In general, trainers faced a challenge with respect to finding time to train nurses not just on infusion devices but on all the devices they would be expected to use. This was especially true with respect to formal sessions off-the-ward. Further, in the following example, Participant J (Location 7) notes that while there may be a push from management towards e-learning as a way to overcome the issues of finding time and space for training "it's not easier to do e-learning, some people can't do the things with e-learning because they don't like e-learning packages. Access to computers in some areas is very good, in other areas they have two computers, one in the sister's office, one on the front desk and they're always in use so you can't get at those." There were also concerns about implementing meaningful online assessments so that situations can be avoided where users "just click to the end and it shows up as completed" on their training record (Participant C, Location 2). In addition, regarding the type of learning: "I think I've resisted pressure to try and make things as e-learning, because I think you and I [referring to Person F] both feel that it is a very kinetic type of learning" (Person G, Location 5). Participant J also discussed the type of learning required and when arguing that there should be "a blended look at training" that combines online modules with hands-on experience.

DISCUSSION

This research aimed to investigate how users are trained to use infusion devices and to explore the issues which surround infusion device use and training. The emphasis that the NHS places on training staff is clear though the challenges trainers face mean that in practice there are a range of different ways in which staff are trained. Further, while some organisations do provide official training in the form of formal sessions, it appears that much of nursing practice involving the use of these devices is learnt more informally whilst nurses are on the ward.

In general, the majority of infusion device tasks are relatively straightforward and do not take very long. Depending on the prescription, a nurse will have to set up the medication to be delivered to the patient and then program certain values (such as the volume and rate) into the device. Given the hands-on nature of these activities it is hardly surprising that learning occurs on the ward – this informal learning is also an important component of a community of practice. However, while people may prefer to learn in a real world context, learning in this way does not guarantee that all device functionality will be understood [12] or that users will develop comprehensive conceptual models. The issues are important to consider in relation to the drive towards incorporating e-learning into infusion device training.

Supporting training through e-learning?

Medical device trainers face a significant challenge in terms of being able to find the time and resources to carry out the training that is necessary to enable nurses from a range of clinical areas to become competent users of increasingly complex infusion devices. E-learning has been proposed by management as a potential solution to this challenge but the findings indicate there are particular issues regarding the design and implementation of e-learning components that would impact the success of this approach. Firstly, staff currently struggle to find time to attend formal training sessions and/or get in-depth training on the ward. Secondly, many hospital contexts only contain a small number of computers which are used for a range of different tasks. Thirdly, using an infusion device requires procedural (i.e. how-to-do-it) as well as conceptual (i.e. how-it-works) knowledge. Having knowledge of both is important for ensuring quick and accurate performance [7]. Finally, there is a risk that online assessments could be rather shallow. Given these issues it is far from clear when and where staff will be able to dedicate time for e-learning. Further, questions remain as to how to effectively incorporate e-learning into training and how online components should be assessed.

Possible solutions mentioned in the interviews include adopting a blended approach, where online components are combined with some form of hands-on training; and enabling bite-sized components that are easily interruptible and can be bookmarked (e.g. in case a nurse is called back to the ward). Care also needs to be taken when designing meaningful assessments so that online modules are not reduced to box ticking exercises.

Future Work

The issues raised are highlighted as areas to be considered in relation to training. Given the importance of clinical area in relation to the functionality required and user's confidence with technology, further interviews are currently being carried out with nurses from different wards in order to elicit their conceptual models. These models are important as they can form the basis for studies that compare learners who have been trained face-to-face and those who are trained online. The interviews will also establish the wider context in which infusions are delivered, in order to fully capture the practices that exist within specific communities. Further research is required in order to develop and evaluate effective online training tools. This should also include a consideration of how learning is to be assessed.

CONCLUSION

This study focused on a healthcare context but the findings indicate that while the boundaries between work and education are becoming increasingly blurred, it is important to consider the type of learning that is required to ensure continued development and the context within which it will take place. Training tools such as e-learning packages can provide more accessible learning materials and assessments but should also be used in conjunction with face-to-face components for more practical tasks (such as delivering infusion therapy). Wenger [14] describes training as developing "competence in a specific practice" but in order to fully support lifelong learning, training needs to be considered as part of a wider "transformative" education (p. 263) where individuals will be able to develop their identities and become fully fledged members of a community of practice.

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