Sustained User Engagement in Health Information Technology: The Long Road from Implementation to System Optimization of Computerized Physician Order Entry and Clinical Decision Support Systems for Prescribing in Hospitals in England

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Objective. To explore and understand approaches to user engagement through investigating the range of ways in which health care workers and organizations accommodated the introduction of computerized physician order entry (CPOE) and computerized decision support (CDS) for hospital prescribing.

Study Setting. Six hospitals in England, United Kingdom.

Study Design. Qualitative case study.

Data Collection. We undertook qualitative semi-structured interviews, non-participant observations of meetings and system use, and collected organizational documents over three time periods from six hospitals. Thematic analysis was initially undertaken within individual cases, followed by cross-case comparisons.

Findings. We conducted 173 interviews, conducted 24 observations, and collected 17 documents between 2011 and 2015. We found that perceived individual and safety benefits among different user groups tended to facilitate engagement in some, while other less engaged groups developed resistance and unsanctioned workarounds if systems were perceived to be inadequate. We identified both the opportunity and need for sustained engagement across user groups around system enhancement (e.g., through customizing software) and the development of user competencies and effective use.

Conclusions. There is an urgent need to move away from an episodic view of engagement focused on the preimplementation phase, to more continuous holistic attempts to engage with and respond to end-users.

Key Words. Health information technology, engagement, implementation, adoption

Potentially transformative health information technologies (HITs), including electronic health records (EHRs), computerized physician order entry (CPOE), and clinical decision support (CDS) systems, are increasingly being implemented internationally (Blumenthal and Tavenner 2010; Morrison et al. 2011). Achieving meaningful end-user engagement is a major cause for concern among diverse stakeholders, including policy makers, vendors, and implementing organizations (Ingebrigtsen et al. 2014; Green et al. 2015; Healthcare Improvement Scotland 2015; Infoway 2015). HITs can only realize their full potential if they are used as intended (or in ways that fulfill their purpose), and there is also growing realization that HIT can introduce new risks. A recent study reviewing patient safety incidents in a large U.S. health system concluded that “EHR-related safety concerns involving both unsafe technology and unsafe use of technology persist long after ‘go-live’” (Meeks et al. 2014). A large proportion of safety incidents related to unmet information and usability needs of users, where users were presented with many unnecessary alerts, which in turn resulted in important alerts being overlooked.

To date, and perhaps partly due to the variety of technologies involved and implementation contexts, there is no agreed-upon definition of user engagement in the HIT literature. Some lessons can, however, be learned from IT products in other industries (Johnson et al. 2014). In the context of this article, we characterize the concept of engagement as a process by which different organizational groups actively become involved in and contribute to the implementation and successful adoption of HIT. The existing literature supports the view that if engagement is done well, the implementation journey is likely to be less painful, quicker, and ultimately more likely to be “successful” (Cresswell et al. 2011). Although related concepts include satisfaction, input in decision making, and associated organizational structures such as responsive systems for feedback and clear governance

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structures for responding to users' needs and ensuring smooth governance, engagement is a broader construct as it includes an array of individual (emotional, physical) and organizational (e.g., management) responses to change that may evolve over time. For instance, engagement at an individual user level can include greater satisfaction (an outcome or an indicator of effective engagement that can in turn facilitate further user engagement), while engagement strategies are organizational processes to get users involved (these may include both promoting the use of systems as intended by developers, but also incorporating user need into system design). Engagement strategies are, therefore, likely to consist of a mixture of "bottom-up" user-led approaches and "top-down" management-led approaches. Engagement is best thought of as a dynamic construct, something that many vendors and implementation teams often fail to appreciate.

Existing empirical work has mainly focused on preimplementation engagement efforts, with rather time-limited, linear views of user engagement (O'Brien and Toms 2008; Cresswell et al. 2011). Associated with this episodic view of engagement is the presumption that its benefits will roll forward in a predictable manner. The resulting dichotomous view surrounding engagement/disengagement and adopters/nonadopters is simplistic and fails to take a longer-term perspective, which takes into account evolving interactions between users and technology (Cresswell and Sheikh 2014). The paradox of engagement under this conventional (episodic) view of system development is that users' ability to anticipate implications of a system in advance are limited, but grow significantly as a system is implemented (Cressey and Williams 1990). Changing or modifying functionalities, however, tends to become difficult or impossible once certain modules of a commercial system are implemented.

The aim of this study was therefore to explore longer-term perspectives on user engagement through investigating the range of ways in which health care workers and organizations accommodate new technologies over time. This work was undertaken as part of an ongoing large-scale study of CPOE and CDS systems for prescribing in English hospitals and builds on previous work we have done on user engagement in complex HIT initiatives (Cresswell et al. 2011, 2014; Mozaffar et al. 2015).

METHODS

We conducted a series of longitudinal, qualitative case studies in hospitals implementing CPOE and CDS systems in England (Table 1) (Saldaña 2003;

Crowe et al. 2011; Sheikh et al. 2011). As user engagement emerged as one of the dominant themes in this work, we investigated the issue in more detail across our dataset.

We defined user engagement as a process having three interrelated elements: (1) the need to actively involve different types of users (clinical and nonclinical) in the selection and/or design of a technology (e.g., by giving them the opportunity to be heard); (2) the need to achieve workforce buy-in to using a new technology over extended periods of time (at least partly driven through bottom-up processes); and (3) the need to incorporate new technological features desired by users through frequent consultation and technological customization. This definition thus extends the scope of engagement beyond the initial technology acquisition, implementation, and adoption period to encompass subsequent system enhancements when users accommodate systems and system upgrades over time, and organizations customize systems. It also includes re-implementations, which are increasingly common as new systems with more functionality replace older legacy systems.

Institutional Review Board Approval and Permissions

Our work was reviewed by a National Health Service (NHS) Research Ethics Committee and classed as a service evaluation. We obtained Institutional Review Board (IRB) approval by the University of Edinburgh. Participating hospitals provided organizational approvals. All places, names, and organizations have been anonymized to ensure confidentiality. Individual participants provided informed consent for participation in the study.

Sampling and Recruitment of Organizations and Participants

Our sampling strategy was purposeful (Table 1) (Coyne 1997). We began by constructing a database of hospitals that either had already implemented or were about to implement CPOE and CDS systems for prescribing. From this list, we selected organizations that varied in terms of (1) type of system (stand-alone and integrated with EHRs) implemented; (2) implementation timelines (early-stage implementation and embedded use, that is, two or more years postimplementation); and (3) key contexts (teaching/nonteaching hospitals, size, rural/urban). This allowed us to comprehensively investigate issues surrounding user engagement (Cresswell et al. 2013, 2014). Hospitals were

Table 1: Summary of Case Studies and Data Collected

<i>Hospital Characteristics</i>	<i>System Characteristics</i>	<i>Data Collected</i>	<i>Data Collection Periods</i>	<i>Implementation Team Set-Up</i>
Site A: urban, acute care	CPOE and CDS not part of a wider hospital-wide information system Began implementation in 2010	<ul style="list-style-type: none">• Time 1 (T1): 23 interviews with users (pharmacists, nurses, doctors) and implementers• Time 2 (T2): eight inter- views with users (phar- macists, nurses, doctors) and implementers• Eight observations (12.5 hours) of strategic meetings and system use• Notes from recruitment meeting• Eight documents relating to anticipated changes (e.g, work process maps, implementation plan, business case)	T1: December 2011 to August 2012 (2 years after implementation) T2: January 2014 to February 2015 (4 years after implementation)	Regular review of systems and feedback to developers Safety group regularly reviewing incidents associated with system Implementation team consisting of clinical lead, project manager, finance representative, end-user representative, pharmacy representative, nursing representative Active role of implementation team changed over time to more “hands-off” as organization transitioned to business as usual

Continued

Table 1: *Continued*

<i>Hospital Characteristics</i>	<i>System Characteristics</i>	<i>Data Collected</i>	<i>Data Collection Periods</i>	<i>Implementation Team Set-Up</i>
Site B: urban, acute care, teaching	CPOE and CDS as part of an integrated hospital information system Began implementation in 2009	<ul style="list-style-type: none">● T1: 20 interviews with users (pharmacists, nurses, doctors) and implementers● T2: 11 interviews with users (pharmacists, nurses, doctors) and implementers● Four observations (9 hours) of strategic meetings and system use● Notes from recruitment meeting● Three documents relating to anticipated changes (e.g., work process maps, implementation plan, business case)	T1: May 2012 to June 2013 (3 years after implementation) T2: December 2014 to March 2015 (5 years after implementation)	Implementation team: senior pharmacy analysts, project nurse/clinical analyst, senior pharmacy users, clinical users, senior medical users, senior pharmacy user, training advisor clinical supplier, senior clinical user Established process for logging change requests and passing these on to developers Active role of implementation team changed over time to more “hands-off” as organization transitioned to business as usual

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Table 1: Continued

Hospital Characteristics	System Characteristics	Data Collected	Data Collection Periods	Implementation Team Set-Up
Site C: urban, acute care, teaching hospital	CPOE and CDS as a standalone application Interfaces built to enable interoperability with the wider hospital information systems	<ul style="list-style-type: none">• T1: 13 interviews with users (pharmacists, nurses, doctors) and implementation team• T2: 18 interviews with users (pharmacists, nurses, doctors) and implementation team• T3: 20 interviews with users (pharmacists, nurses, doctors) and implementation team• Nine observations (11 hours) of strategic meetings and system use	T1: May to August 2012 (prior to implementation) T2: May–July 2013 (4–6 months after implementation) T3: August to November 2014 (18 months after implementation)	Implementation team: clinical effectiveness and medicines manager, deputy medical director, clinical pharmacists, director of IT, pharmacy IT manager, director of organizational development, clinicians, clinical tutor, associate director of nursing, education and practice development, matrons, nurses, junior doctors, pharmacy technicians, medical registrars There were also work streams on reporting, training, process change and benefit realization, interfacing and development, configuration, infrastructure, and communication Safety group regularly reviewed incidents associated with system Established process for logging change requests and passing these on to developers Active role of implementation team Changed over time to more “hands-off” as organization transitioned to business as usual

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Table 1: Continued

Hospital Characteristics	System Characteristics	Data Collected	Data Collection Periods	Implementation Team Set-Up
Site D: urban, acute care, teaching	CPOE and CDS as part of an integrated hospital information system	<ul style="list-style-type: none">• T1: 15 interviews with users (pharmacists, nurses, doctors) and implementers• T2: 14 interviews with users (pharmacists, nurses, doctors) and implementers• T3: Due to start in June/ July 2015• Notes from recruitment meeting• Two documents (system implementation plans/6- month post go-live over view)	T1: July–October 2013 (prior to implementation) T2: June–July 2014 (4–6 months after implementation)	User engagement at the outset of project through meetings Users were aware of the system to be introduced from the beginning End-users reported a number of issues impacting negatively on adoption immediately after go-live Acceptability of the system appeared to improve with time as end-users became familiar with the system Users used the system demo to overcome their concerns at early stages Change requests by users were prevented by contractual barriers and led to user frustration
Site E: urban, acute care	CPOE and CDS as a standalone application	T1: 22 interviews with users (pharmacists, nurses, doctors) and implementation team	T1: July 2013 to April 2014 (prior to implementation)	Early project meetings with users for system demonstration and requirement gathering Demo system available for users to see Limited user-implementation team relationship later during the implementation Rapid change of implementation team structure and staff turnover time

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Table 1: Continued

<i>Hospital Characteristics</i>	<i>System Characteristics</i>	<i>Data Collected</i>	<i>Data Collection Periods</i>	<i>Implementation Team Set-Up</i>
Site F: urban, acute care, teaching	CPOE and CDS as part of an integrated hospital information system	<ul style="list-style-type: none">• T1: 23 interviews with users (pharmacists, nurses, doctors) and implementers• T2: 17 interviews with users (pharmacists, nurses, doctors) and implementers• Three series of observa- tions at system review and system design meetings• Notes from recruitment meetings	T1: April–July 2013 (prior to implementation) T2: November 14 to March 15 (4–6 months after implementation)	A passive approach to user engagement at the outset due to numerous delays to prevent loss of user interest Overall levels of awareness of the imminent system due to be introduced were relatively low among users High staff turnover in the project team The end-users could use the demo system to test functionalities; however, this was rarely used due to time constraints Change requests by users were prevented by contractual barriers and led to user frustration

conceptualized as individual case studies (Crowe et al. 2011), which helped investigating local implementation and adoption contexts in detail, while still permitting a common basis for comparison across sites.

We allocated designated lead researchers to case study sites (K.C., H. M., and L.L.), who coordinated local data collection activities. They initially approached relevant hospital managers, who acted as a starting point for snowball sampling individual study participants (Marshall 1996). We sought to purposefully sample stakeholders that had an interest in implementing/adopting relevant local systems, that had (or were about to) implement systems, or were in some other way affected by their introduction. We sampled for maximum variation to represent a broad range of perspectives comprising clinical users (physicians, nurses, pharmacists, and other allied health professionals), support staff (technicians), system vendors, and managers (implementation teams, information technology specialists) of varying levels of seniority.

Data Collection

The main data collection method consisted of semi-structured interviews, but we also (where possible) collected documentary and observational data (Table 1). Triangulation of these different data sources helped us to gain insights into planned activities and timelines (documents), perceptions of organizational stakeholders (interviews), and behavioral patterns (observations) (Guion, Diehl, and McDonald 2011).

Each lead researcher collected data at two case study sites at different intervals to allow investigation of changes over time (Table 1).

Topic guides had similar central components, but were tailored to individual sites, implementation timeframes, and professional backgrounds of interviewees. They explored views and expectations on system design, integration with work practices and organizational processes, implementation strategy (timelines, resources, infrastructure), and training and support provided (initial and ongoing).

Where applicable, emerging data were fed back and discussed at T2 data collection to examine changes over time. Audiorecorded interviews were transcribed verbatim by a professional transcriber and checked by the site leads, before being uploaded into NVivo10 for analysis (QSR International 2015).

We also conducted nonparticipant observations in some sites. These involved shadowing system users during their everyday system use and attending strategic meetings of local implementation teams. Our focus was on

obtaining detailed insights into everyday system impacts on users (e.g., practical issues such as workarounds and hardware issues) and implementation teams (e.g., communication with developers) that were discussed during interviews. These observations were used to provide context and nuance to interview findings.

Relevant documents were recommended by key implementation team contacts at each site. These were examined by the lead researcher in order to contextually complement any findings obtained in interviews, mainly relating to technical system and site characteristics, and locally planned strategies.

Researcher field notes were used to complement data obtained through other sources (Patton 2005).

Data Analysis

Data were thematically analyzed, initially within cases by lead researchers in order to explore local contexts and changes over time by triangulating different data sources (Denzin and Lincoln 2005). As our focus was on user engagement, we drew on our previous work in this area as a deductive coding framework, extracting excerpts from our qualitative data bearing upon engagement (see Table 2 headings). This identified important points of possible engagement, disengagement, and re-engagement (Table 2) (Cresswell et al. 2011). In addition, we also inductively identified emerging themes surrounding the notion of more sustained user engagement, which served as an analytical lens to examine our data using a deductive approach to analysis (Denzin and Lincoln 2005). Themes were developed based on frequency of occurrence across sites and salience among different stakeholder groups. Negative cases, that is, those that did not fit within the narrative, were explored in most detail.

Findings across sites were then compared in analysis meetings of the research team, with a focus on exploring extended user engagement over longer periods of time than was possible in our previous work (as the longitudinal dimension of data collection was a defining feature of our design) (Cresswell et al. 2011). This involved discussing commonalities and differences across sites, as well as exploring potential underlying explanations for differences and remaining tensions. Although we observed subtle differences between case study sites (primarily relating to varying implementation timelines and system characteristics), findings across sites were broadly comparable in relation to the key issues under consideration in this paper.

Table 2: Factors Identified and Illustrative Quotes Associated with Initial Engagement Surrounding Technology Introduction

<i>Point of Engagement</i>	<i>Illustrative Quotes</i>
Vision	<p>"You need to be out and about talking, doing lots of talking to people and getting the feedback and change things accordingly." (Site F, Manager, Implementation Team, T1)</p>
System choice	<p>"I would say the most important thing would be, which as far as I know didn't happen here, whichever system is chosen I think medics or doctors who have used the system or at least who are working in the hospital can see the different systems available and choose the one which seems best . . . for the people who are going to use it" (Site A, Consultant, System User, T1)</p>
Needs and expectations	<p>" . . . having the close involvement of the actual pharmacy team and the other clinicians about how they see it at the ground level has been very important. And having them involved from day one so they can start shaping the system is very key (. . .) it gives them ownership of the solution, it's not something that's been forced on them it's something they've helped design and build." (Site F, Manager, Implementation Team, T1)</p> <p>" . . . as a Trust we employ 5,500 people and we probably had in total maybe 100 or so involved in various different stages on different workshops . . . so that still means that there's an awful lot of people out there who we've got to get engaged in the process. . . ." (Site E, Manager, Implementation Team, T1)</p>
Trial and demonstration of systems	<p>"There are going to be things that are going to be out there to trip us up and stumble that nobody has thought of. Because you can't think of everything as the Change Lead, as the Clinical Transformation person, as the Nurse Lead . . . so therefore when it comes to testing, we will ensure that we have a robust thorough engagement as much as we possibly can with the organization." (Site D, Manager, Implementation Team, T1)</p> <p>"So the build of [name of system] was there but the user didn't use it and the strategy was that we built a dummy ward in the build with dummy patients so that when the system was live the meds team could test with dummy patients in the dummy ward, prescribe to them, over prescribe to them, under prescribe to them, late prescribe to them so that you could actually test the functionality that was built in a live environment without an impact on obviously any patients." (Site D, Manager, Implementation Team, T2)</p>

Continued

Table 2: *Continued*

<i>Point of Engagement</i>	<i>Illustrative Quotes</i>
Engagement and re-engagement Champions and boundary spanners	<p>“... the project nurse who’s now the lead nurse for clinical informatics within the Trust was the project nurse for meds. She was a very experienced both nurse and in fact had been a general manager so had senior syle, knew everybody, knew how the systems worked, not obviously the IT systems but the Trust’s politics and the way you get things done and so nursing staff will turn up and do what they’re told in terms of training...” (Site D, Manager, Implementation Team, T1)</p> <p>“... we have a very strong Director of Nursing and she obviously sits on the board for the [vendor]. It’s actually, it’s what we say goes basically, it’s not about imposing the system because it’s not going to work so yeah I think it’s pretty good.” (Site D, Matron, Implementation Team, T1)</p> <p>“... we’re now using that window of opportunity to look at... getting even wider engagement than we’ve already got in terms of the wider audience. So developing a list of champions within different health care professions who will take this forward.” (Site E, Manager, Implementation Team, T1)</p> <p>“... the Trust has said ‘we’re having it and that’s the end of it’ because there’s no discussion. I’m sure they’ve spent a fortune on it; they’re not going to go back.” (Site A, Nurse, System User, T1)</p> <p>“I think that lack of communication has been the most challenging because there are key decisions that are made within each working group that are not transferred across.” (Site D, Lead Pharmacist for IT, Implementation Team, T1)</p> <p>“... we were quite strict as well about ‘there’s no get out clause here, once you’re electronic you’re electronic’. Because we’d done electronic ordering a little way in advance we kind of gave people the option ‘well if you’re not quite sure, put it on paper the labs will accept it on paper’. We didn’t do that with meds, we said ‘once you’re electronic you’re electronic, no more paper’ and they just knew that this was the way that they were going to have to work.” (Site D, Manager, Implementation Team, T1)</p> <p>“... well fortunately now the engagement has got better as everyone has come on board and I think there is much more senior level support so right from the chief exec, that support I think was missing initially.” (Site F, Pharmacist, System User, T2)</p> <p>“... this was an opportunity to develop something with our clinicians to improve their level of engagement with the process and ... having greater involvement in developing something that we would use on a daily basis. Hopefully, it will encourage a greater level of ownership of the system.” (Site E, Manager, Implementation Team, T1)</p>
Listening to users and communication across teams	
Organizational strategies, senior support, and leadership	

Continued

Table 2: *Continued*

<i>Point of Engagement</i>	<i>Illustrative Quotes</i>
Software customizability and user input in design	<p>"... our hospital bought this package and then even though we've now noticed all these things wrong with it they will now not change any of these things ... we've paid all this money for this package, I think you should be able to tailor it a bit more to your individual needs and your individual hospital ..." (Site A, Pharmacist, System User, T1)</p> <p>"... there's no sort of like open meeting people can go to [and say] 'oh I've got this issue is there any way we can solve this'. I know that there are regional meetings where the representatives go and say 'we think this is good' but then actually getting those things implemented probably takes an awful lot of time and money to sort out." (Site C, Pharmacist, System User, T3)</p> <p>"Well the first stage of the strategy was ... to run a series of workshops around different elements of the functionality of the system engaging with pharmacy staff, nursing staff, medical staff, etc. and saying ... 'what type of functionality would you want behind it', 'how does it need to work to make sure that we make the best use of our staffing resource in a safe and effective way', etc. ... Then, from all of that work the supplying company took that data away and they have done various different modifications to the software to adapt it to what we were describing as being what we felt was probably the way it would need to work." (Site E, Manager, Implementation Team, T1)</p>
Skills, training, and familiarization with the system	<p>"Because until you start to use something you don't find issues with it and you don't realize what you don't know, how to do something until you're using it, 'oh I want to do this and I can't'." (Site D, Junior Doctor, System User, T1)</p> <p>"I'd say getting used to [name of system] it was like a gradual process. From the first week of using it, we weren't too familiar with it and we made a few mistakes. After a while I think we just adapted to it, adapted the system to what we were doing." (Site D, Pharmacist, System User, T2)</p> <p>"There was training but the training is so complex and the system is so unintuitive that I don't think it's the type of training that sort of persists in the memory; you really only learn it by using it and that's always a slight risk with a complex health care system." (Site F, Consultant, System User, T2)</p>
Re-definition of professional roles Perceived usefulness	<p>"I mean there are disadvantages obviously because, you know, we do miss patient contact and things like this" (Site A, Pharmacist, System User, T1)</p> <p>"I think everyone saw the benefit of it and dealing with paper prescriptions that go missing and things like that, you know, everybody could see that there was a benefit." (Site A, Nurse, System User, T1)</p> <p>"I think it's safer, I think there's less chance of drug errors. I don't think you have to compete with dreadful handwriting of anybody, of changes of doses during the day, alternate day doses where it's not very clear ... and nurses regularly gave four or five of the nurse-related doses like paracetamol because the doctors still hadn't written it up on the paper copies. I think the system stops you doing that" (Site C, Nurse, System User, T3)</p>

RESULTS

We obtained data from a total of 173 interviews, 24 observations, and 17 documents over three different time periods in six case study sites collected between December 2011 and March 2015 (Table 1). Our findings relate specifically to CPOE/CDS functionality, but some of the themes uncovered are likely to have broader applicability to similarly complex large-scale hospital EHR implementations.

Overall, systems were supplied by two different vendors and were successfully adopted across sites (although some sites faced long implementation delays). Existing findings about how user engagement may contribute to successful implementation were confirmed in this work (Table 2). However, there were differences between groups in their level of engagement. We found that where a system had been designed and implemented with little involvement of particular staff groups, their interests and requirements were not well catered for—with implications for their longer-term engagement and use of the system (Table 3).

Perceived Benefits Driving Sustained Use

Although user engagement was frequently mentioned, we observed a lack of agreement on definitions. The concept was frequently used by implementation teams to describe a “problem,” where users did not use the HIT systems as intended or avoided use altogether.

Users, however, tended to relate sustained engagement to their level of satisfaction with the system. This, in turn, although influenced by usability of software and hardware, was determined by expected and observed benefits, which varied across professions and between individuals. For example, pharmacists and young doctors frequently saw the benefits of the system and were consequently relatively engaged. However, this may have been due to the fact that CPOE and CDS system implementations were commonly driven by pharmacists or that they were perceived to be pharmacy-led, resulting in better early engagement of this group; systems are therefore tailored to their needs more than to the needs of other professions.

Some other professions (e.g., nurses and technicians in some sites) tended to be less engaged as a result of limited benefits.

... the process is being driven by a pharmacist from within pharmacy so it's probably ... maybe the system ... is being tailored for the pharmacists more perhaps

Table 3: Summary of Themes and Subthemes Emerging from This Work

Perceived benefits driving sustained use

What it was to be engaged and who defined it how (the end-user/the implementation teams?)

Different levels of satisfaction with the system

Perceived benefits for patient safety drove use by some, while perceived benefits surrounding individual workloads drove use for others

Resistance and workarounds varying among professions and specialties

Involving everyone was impossible for implementation teams and initial user involvement may not have catered for later concerns of staff. Later adopting staff may not have known about the initial involvement and they may not have felt they were represented adequately (may thus not have felt ownership/obligation to use).

Continued lack of engagement of some senior staff and specialties where a system could not be (or was not) re-designed

Unsanctioned workarounds among those who could not afford avoid using the system

Potential for passive resistance further down the line

Skills and training—continued training on new functionalities

Changes of software, strategy, and competencies over time promoted sustained use

History of deployments, expectations, and experiences

Some users got used to it over time accommodating the peculiarities of the system

Others just “put up with it” as they felt like they had to

Changes in software/hardware meant that it did get easier for users over time (usability and customization)

Skills, competencies, and confidence in system adaptation and use became more widely available across the workforce and some users saw increasing benefits as more system functionalities were implemented

than it's necessarily being tailored for other staff groups ... just because that's where the sort of background lies. (Site D, Pharmacist, System User, T2)

In most sites, the involvement of consultants was very limited at the time of procurement and during system design.

I don't have any direct involvement in terms of procurement or anything like that ... I have no idea what system is coming or not coming. I don't know what stage it's at, I know we're looking into getting one but I don't know whether we're having one built, whether we're getting one off the shelf, whether we're looking at a dozen different products and choosing one, I have no idea where it's at. (Site E, Consultant, System User, T1)

Some simply felt their views were being ignored during customization meetings:

And all the meetings I go to there are very, very few clinicians there and the only reason I have kept going is because I'm so worried by what is going to be

imposed upon us and I'm under the diligence that turning up and pointing out some of the problems that I see with it may, just may get heard by the people who can influence decisions but I'm, you know, cynical would not be a strong enough word for the way I feel my concerns have been dealt with. (Site F, Consultant, System User, T1)

There was a strong awareness, however, that this perception needed to be addressed and opportunities should be given across staff groups to take part in the customization of the system prior to roll-out, even if this may in fact be used in the longer term as a way to deflect usability problems away from the implementation team or the system:

... people can't say a small group did it, which is very important because everybody has had the opportunity to participate and when someone comes and says "I don't like that," our comeback will be "you and your team had the opportunity to participate, you chose not to, we gave you ample warning you could have organized your diary but you chose not to." (Site F, Consultant, System User, T1)

We further found that motivations among different staff groups varied. Perceived benefits for patient safety drove use by some, while perceived benefits surrounding individual workloads drove use for others. Accordingly, if systems were perceived to increase workload and compromise safety, staff tended to resist use. Across sites, users were primarily expected by management to learn how to use the system, but during this process, some safety issues relating to system design emerged over time. In these cases, where systems made the occurrence of errors more likely (due to lack of usability), implementation team members worked hard to rectify these risks by liaising with system developers in order to overcome the system design shortcomings. Accordingly, users were expected to both help mitigate design issues that could lead to patient safety threats, and also more actively engage in learning how to optimize use of the system.

If systems were, however, seen to decrease workloads and improve safety, continued sustained engagement was more likely to be achieved, especially among staff groups that were already engaged such as pharmacists:

It's a real bonus for us in pharmacy, it means the whole process is automated, the labeling process is automated, it means somebody doesn't have to sit there and type in all the information and potentially could make a mistake so that's our main sort of motivator is the fact that we're cutting down on errors really. (Site A, Pharmacist, System User, T2)

Things that are very good from it is the fact that you have [drug file] on the system automatically so if you're trying to alter medications that you've never come across you can access it very quickly without having to leave the trolley and get an information sheet and it's really good that you can see all the information on the system. (Site C, Senior Sister, System User, T3)

Consensus in relation to the acceptability of the system arose when improvements, such as legibility of the drug chart, clarity and categorization of charts and drugs, and availability of information, had been recognized by end-users. Acceptance came over time as users compared their working practices after the introduction of the system to those before, even if new issues affecting usability emerged:

It's been accepted very well and everybody seems to like it . . . they don't have to look for a drug chart, they don't have to read what doctors have written or any health care professional has written and also all the information is at their fingertips. However, not everybody was actually willing to accept that because some people are slow at typing, are not very familiar with computers . . . but at the end because the benefits were better for them to compare with the paper and nonpaper . . . they have accepted it very well. (Site D, Manager, Implementation Team, T2)

Resistance and Workarounds Varying among Professions and Specialties

We found strong variation among different staff groups in relation to continued engagement. Senior consultants often delegated system use. They were in control, as they could afford to avoid using the system by delegating system operation to other staff over longer periods of time (e.g., junior doctors and nurses):

. . . a lot of the consultants in reality don't really use the system apart from to look at what drugs patients are on and really it's the junior doctors who are the ones who use it (Site D, Consultant, System User, T2)

I've heard some junior doctors had to go to other consultants, not in my team, to then input, basically become a glorified scribe which is not a particularly efficient use of resources. (Site D, Junior Doctor, System User, T1)

Other staff groups and specialties that could not avoid using the system showed low levels of engagement (e.g., nurses). They tended to cope with

perceived system shortcomings that were not addressed through re-design by employing workarounds (Ser, Robertson, and Sheikh 2014). These were either formalized, that is, sanctioned by management, in order to avoid risks introduced by the system, or informal, that is, employed by staff to compensate for some kind of impact of the system that was viewed to be inconvenient or create more work.

It makes it slow, the machines are on heavy trollies to push round, and when you're doing stat doses to lug a big trolley into a room just to give two paracetamol [acetaminophen] is a bit of pain in the backside. (Site A, Nurse, System User, T2)

We also observed degrees of passive resistance among less-engaged staff groups (e.g., nurses and consultants), both prior to implementation and in sites that had implemented some time ago. Prior to the deployment of the system, end-users' doubts over the organization's ability to complete the roll-out led to passivity and detachment from the project:

... I think there's a degree of passive inertia in the organization, but the silent majority is skeptical I think rather than desperate to be engaged. (Site F, Manager, Implementation Team, T2)

... it's all a question of how good the system is ... I think a system that is not obvious and intuitive is not going to be a good system. (Site E, Consultant, System User, T1)

There was a lot of fear as well because it's something new ... some of the nurses are quite apprehensive about using technology. So even though people have got phones and tablets and laptops and things they still have this kind of, "it's something that's new, it's new technology I don't know how I feel about that, I feel a wee bit scared." (Site C, Nurse, System User, T3)

In some sites, integrating clinical notes with CPOE and CDS functionality was dependent on nurses inputting information, but nurses resisted this as it was viewed to create additional work. Also, some users entered data retrospectively in batches thereby impacting adversely on real-time availability of information:

The pain team has got a heavy reliance on nursing staff and medical staff recording things which aren't just administering drugs or recording of pain scores and there's a real reluctance on the part of the nursing family if you like to take that on board, partly because they're not doing it at the moment so they feel like it's something new and they've also got concerns about the availability of hardware. (Site D, Manager, Implementation Team, T2)

Participants themselves identified potential ways to tackle these issues. An area frequently mentioned by managers in this respect included the need for continued training on new functionalities and skills development. Drawing on “super users” from clinical professions that could teach their peers was seen as a good way of achieving this. As systems were becoming more integrated over time, the sheer number of potential benefits to users was also likely to increase, but in some instances users may simply have not been aware of new system functionalities due to their lack of training:

... we don't do a continuous training we just train new users and then we kind of, if there are any changes with prescribing, we would filter that down through the various sort of medical teaching sessions or if there's a new software change ... we would probably try and filter the relevant changes, the most important changes. (Site A, Manager, Implementation Team, T2)

Changes of Software, Strategy, and Competencies over Time Promoting Sustained Use

Sustained engagement of users over time was influenced by a number of factors, including the organizational history of deployments and alignment of technology introduction with organizational priorities, expectations, and experiences. Some staff (particularly nurses and consultants) saw the implementation as “yet another IT project,” which was assumed to increase the bureaucracy surrounding health care practices. As such, the implementation was seen as far too removed from the reality of clinical practice, with poor communication between IT managers and clinicians, whereby those responsible for developing the system had a poor grasp of the rationale behind the design of existing paper drug charts:

... what they [managers] need to do is sit down with the people in each department and work out what are the processes that are critical for that department because the paper processes that have evolved in each individual section of the hospital have been honed and refined over years of people doing audits and looking at patients' responses and service evaluation and working out what works and if you just provide a generic template (there is) no way of replicating any of that. (Site F, Consultant, System User, T2)

This was to some extent attenuated if implementation teams consisted of multidisciplinary teams representing a range of health care professions and including “clinical champions.”

The responses of other staff groups were influenced by delayed implementations, leading to a loss of interest which could mean further resistance down the line.

As a result of these various factors, users exhibited a number of behavioral patterns. Some got used to the system over time, accommodating perceived peculiarities.

I think maybe we're just a bit more used to the problems and we're a bit more, you know, willing to put up with it. Only one person can get on the records at once, it caused more of a kerfuffle really on the wards and the nurses were saying "why can't we get on" and things like that, whereas now they're almost used to it and they know there's a reason, say someone is on it in pharmacy or one of the medics is on it, I think we're just a bit more used to the system. (Site A, Pharmacist, System User, T2)

For example, we found that after a number of years of using an "American system" and associated initial complaints in relation to terminology, users developed a certain "fondness" of precisely the language that initially turned them off.

... we've had the system now for 5-6 years, people now know what that term means and they understand what this means and they've kind of got used to it, so actually we become kind of Yankicized if you like because we're now just familiar with those terms ... I think that Anglicization worry was a little bit overstated because people adapt to things much quicker than they think they can do. (Site D, Manager, Implementation Team, T2)

Other users just "put up with it" as they were told by their managers that they "had to." A degree of coercion by managers was viewed as necessary, as systems could not always be modified to satisfy the range of different user needs, though this state of affairs contrasts with conceptions of user engagement as a learning system in which user dissatisfaction can serve as an engine to drive improvement.

User perceptions were colored by a sense of coercion and by digital age rhetoric of the inevitability of these developments. Electronic systems were seen to be the future and were therefore viewed as having to be used eventually:

... we don't particularly like it but we just get on with it because no one asked us did we want it we just got given it. I mean it's a national thing everything is going to be computerized. (Site A, Nurse, System User, T2)

The quote above also illustrates the reactive responses of less-engaged staff who had not been involved from the outset. Engaging users ahead of implementation and utilizing opportunities for user engagement on the extended postimplementation period were therefore seen as important, but also difficult to achieve:

... people are happy to moan about things in their own day to day work but very rarely will you get somebody who's actually prepared to try and think about how we might make it better for them or even if you do make it better for them to then use. (Site D, Manager, Implementation Team, T2)

In other settings, changes in software and hardware meant that system use got easier for users over time (improvement in usability). For example, although still present, hardware access improved in some settings:

We've got a system where you put your card over a scanner and then you just have to put a pass number in and it's very quick and that actually is really beneficial. (Site D, Consultant, System User, T2)

Changes in software included customizing the application, developing new reports, and writing new interfaces, with the aim of streamlining the use of systems over time:

We develop interfaces, we write the little bits of configuration around the edge of some of our systems so that they can talk to each other. We write some reporting solutions where we have to pull data in from different areas. (Site C, Manager, Implementation Team, T3)

In line with this, skills/competencies (and confidence) in system adaptation and use became more widely available across the workforce and some users saw increasing benefits as more system functionalities were implemented. This included, for instance, pharmacists' ability to strategically target high-risk patients through electronic searches:

We've started using a few more functions ... like task lists to prioritize which patients we see, so we can now run reports which tell us all the patients that need a medication history doing in the hospital and identify which patients are on high-risk medicines, it comes up with a little alert saying they're on high-risk medicine, so you can try and prioritize going to see them. (Site D, Pharmacist, System User, T2)

As users gained skills and confidence, they were also more able to explore possibilities surrounding the use of technology (Norman 2013).

DISCUSSION

This work has underscored the point that engagement should be seen as a sustained process, and it has also offered insights into different facets of what such sustained engagement efforts should entail. Systems were—eventually—successfully adopted in case study sites, due to a mixture of both a degree of system customization and learning, and acceptance among users over time. However, our work indicates that a smoother, quicker implementation and acceptance process could be facilitated through a closer focus on sustained user engagement with HIT initiatives. Usability issues should be ironed out in parallel to these efforts to ensure that systems do not interfere with user work practices.

We found different levels of satisfaction with systems across the workforce were influenced by perceptions surrounding individual and safety benefits, which determined levels of engagement and use over time. We also found that some senior professionals delegated system use and other users resisted use through, for example, workarounds if systems were perceived to be inadequate or there was a perceived organizational failure to create an inclusive user-led design culture. This resistance could persist for a long time among some user groups (nurses and consultants), while others (pharmacists and junior doctors) got used to the peculiarities of the system and/or developed more skilled use, which was potentially reinforced by increasing benefits over time as systems were optimized. These findings have implications for broader thinking about business process changes through HIT. Traditional understandings of how to achieve changes in business models may need to be re-conceptualized to incorporate a more iterative development of technology and working practices characterized by an inclusive user-led design culture that allows different groups of users to review and actively input into system design/redesign. This should also involve re-modeling business processes as technologies develop.

Our work will, we hope, help those concerned with conceptualizing an approach to achieving sustained engagement in HIT initiatives. This emphasizes that meaningful and ongoing feedback processes should be seen as essential by an organization working on implementing and improving HIT. It can be achieved through consistently referring back to the underlying needs that

the system was designed to address, from a variety of perspectives, and through re-defining/optimizing technical features to support existing processes. In addition, alignment with the organization's strategic priorities, oversight by a multidisciplinary HIT steering committee, use of physician champions and super users, and continuous user training and support can help to ensure that sustained engagement is promoted.

It would appear that in the initial implementation period, the strategic focus had been too much on system installation as opposed to focusing on engaging users and optimizing use. Our work indicates that a long-term model of user engagement is needed that foregrounds the potential concerns of different user groups and pursues different strategies to consider and, where appropriate, address these over time. This has by and large been neglected in the existing literature (O'Brien and Toms 2008; Cresswell et al. 2011; Healthcare Improvement Scotland 2015; Infoway 2015), although a few scholars have highlighted the important role of the engaged user in helping to customize systems over time (Austin and Boxerman 2003; Bernstein, McCreless, and Côté 2007). A future model needs to reflect issues surrounding longer-term system optimization and benefits realization, phases which have been largely overlooked by the episodic view of technologies. Such approaches view design as providing readymade solutions to organizational problems, but in reality systems tend to get customized over time to address perceived usability problems (Cressey and Williams 1990). This customization can be technical (changing system features) or work practice related (changing user behavior), ideally resulting in the realization of increasing benefits, which in turn motivates users. An episodic viewpoint surrounding technological change is rather pessimistic about end-user engagement due to the paradox of participation (Cressey and Williams 1990): user involvement is often limited in the in design and selection stage. After implementation, users become increasingly engaged (perhaps because they can identify problems), but by then, the system has already been chosen and the scope to modify it is greatly reduced.

In contrast, an extended infrastructural view of change flags opportunities for system optimization. HIT increasingly takes the form of information infrastructures, as complex "systems of systems," not built in a single moment, but evolving over time as new extensions are added in multiple cycles of development and use (Pollock and Williams 2010). The longer-term view of technology adoption also stresses the extended learning process needed to get complex organizational technologies to be adopted in particular settings (Stewart and Williams 2005). This view opens up scope for the notions of re-engagement and sustained engagement, phases that take place long after

initial project implementation. Users initially consider the proposed/expected changes introduced with a new system. They then gather experiences over time and experience/consider system benefits and risks. If risks are more prominent than benefits, users become disengaged and resist use or develop workarounds (if use of the system is mandatory). They can then re-engage and begin the process from the beginning (back to the “point of engagement”) or disengage. If they experience benefits and/or get used to the system and/or adapt technical features, sustained longer-term user engagement is achieved. This may be viewed as finding an equilibrium between usability and adoption/resistance. In the longer term, following the sustained engagement model should lead to systems that are perceived as being more helpful by end-users, greater use as intended, greater user satisfaction, fewer workarounds, and better organizational outcomes in relation to safety and efficiency. Organizations could test how and if a sustained engagement model is followed through user satisfaction surveys, software/hardware usability assessments, investigation of workarounds, and assessments of care outcomes.

We have collected a large volume of data from different qualitative sources over extended time periods, allowing us to gain unique insights into issues surrounding engagement over time and in hospitals at different stages of system use. It has repeatedly been argued that short-term snapshot case studies can produce a misleading account, particularly in the immediate aftermath of implementation when actors are struggling to get technologies to work (Pollock and Williams 2010). This is why examining developments both immediately after implementation (in order to discover how different stakeholders re-negotiate their positions) and extended implementation periods (to gain insights into longer-term effects that tend to be only visible when systems have become to some degree embedded) is so important. Here, our experiences indicate that viewpoints can change from an initial sense of frustration and alienation in a context in which change is disrupting work routines and creating additional tasks and where system utilization and exploitation of system functionality are held back by initial lack of familiarity with these complex systems, toward an increasing appreciation of more advanced system features over time and more effective integration into work practices. The shift from an episodic to sustained understanding of user engagement in HIT systems and infrastructures raises issues about the methodologies needed to study such engagement. Further prospective work is clearly required to test our propositions, but we have provided a starting point for discussion surrounding the recurring issue of user engagement. A caveat to keep in

mind, however, is the issue of attribution. Improvements in the course of embedding may be gradual and/or taken for granted. They may also be attributed to other change initiatives (e.g., work reorganization or technical) and be influenced by the level of vendor support and customization. Conversely, people remain very aware of areas where the system has made their work harder and tend to more readily recall these experiences. Limitations of our work include questions about the representativeness of the sample of hospitals (as these were early adopters of this technology and therefore different to the wider hospital population), different timeframes surrounding individual implementation strategies (potentially resulting in more or less opportunity for user engagement to occur), and the subjective biases of the research team (who were interested in exploring usability considerations). Furthermore, this study did not allow us to quantify to what extent different user groups exhibited different behaviors, as our work was exploratory in nature. The results therefore gave rich qualitative insights into the range of reactions among users and provided an understanding of the reasons underpinning these responses.

Cost implications of sustained engagement activities and associated opportunity costs need to be considered and planned for by organizations in advance. Such activities may take the shape of putting in place continued engagement teams, which have dedicated responsibilities for tracking perceptions and behaviors of different user groups. They may also include creating structures that encourage end-users to report perceived usability issues as they arise and fostering innovation pathways that allow new ideas to be surfaced and incorporated in system design. However, this type of sustained engagement is likely to be more responsive in local “home-grown” systems where end-users have close relationships with developers and can influence system design (Ammenwerth et al. 2008). It is far more challenging with commercial products because changes are dependent on technical characteristics, and the willingness and ability of the vendors to collaborate. As a result, user engagement is often limited by those processes available from a standard software solution, as in this study, where this had the downstream consequence that service transformation was, at least to some degree, determined by technical characteristics. However, as we have shown, adoption can be facilitated by flexibility in user interfaces and a degree of customization. This is greatly influenced by the range of options available that can be accessed to allow adopter configuration within a system, rather than requiring new code to be written or customization requests to be actioned by vendors.

CONCLUSIONS

There is no cookie cutter approach of how to carry out user engagement “correctly” as it is context-dependent, but our work has helped to identify some common lessons across contexts through which user engagement can be promoted over time and across a range of user groups. The traditional, episodic view of systems inherited a focus on user engagement preimplementation rather than seeing this as the first stage in a long-term development of optimizing systems. The long-term evolutionary view of system development supported here raises the need (and opportunities) for sustained user engagement particularly around systems optimization and benefits realization. While the episodic view is often rather pessimistic about the scope for effective end-user engagement in systems design, the evolutionary view sees the development of infrastructures as an ongoing process of system optimization through multiple cycles of design, implementation, and adoption/use.

Information infrastructures are characterized by a growing array of uses and groups of users with different purposes, and levels of commitment to the system. Not all of these are always equally involved and able to influence system selection/design. Engagement strategies, therefore, need to attend carefully to the increasing range of types of user, with their different purposes and commitments, to ensure appropriate involvement. We hope that insights offered from this study will serve as an important starting point in this respect.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.