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Exploring Control in Health Information Systems Implementation

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Abstract

Health information systems promise opportunities for improved healthcare. However, these opportunities may become challenges and obstacles to practice. This research reflects on the outcomes of implementing healthcare information systems in three English hospitals. In each case qualitative methods were used to observe and interview doctors, nurses and pharmacists as they carried out their daily healthcare routines. The changes that the implementation of health information systems brought for both the clinical encounter, as well as health care professionals' work flow, were explored. We argue that such technologies have become a central orchestrator of the clinical setting, to the extent that they often impose control on healthcare practices. Using a socio-technical approach we seek to understand how information systems technology and healthcare professionals can work together rather than apart, or around one another.

Keywords:

Information systems, Medical informatics, Medical records systems, Computerized, Hospital information systems, Electronic prescribing, Implementation, Healthcare practice, Workarounds.

Introduction

Health information systems are often implemented with anticipation for their delivering improved health care practices as part of a complex promise of reduced cost and enhanced quality, safety, and efficiency of healthcare [1,2]. However, beside these desired benefits, researchers acknowledge unexpected outcomes and changes in healthcare routines that may emerge as a result of the use of such technologies. Unintended adverse consequences are cited in studies of computerized provider order entry (CPOE) implementation [3-5]. Other literature has cited similar outcomes as 'workarounds' [6], while studies in the IS field consider issues of technology and control [7]. This research has confirmed such findings, and suggests that in addition to workarounds, health information systems impose degrees of control on clinical encounters and the professional's work practices including shifts in time and space. This control that emerges from health information systems has potentially important consequences for the way healthcare is performed and for healthcare outcomes.

This paper explores in theoretical terms these unexpected (or sometimes less expected) control-driven changes in healthcare practice. It draws on four studies we have been engaged in where the everyday work routines were to a degree controlled by a technology-in-practice [8]. The use of this technology, and the intentional and unintentional controls emergent from the technological systems in use, at times cause healthcare professionals' work practices to become obstructed, modified, or delayed. As a result and as often observed in other studies, health professionals adopt workarounds, which let them (to some extent) subvert the system's controlling features.

In the past, clinical encounters usually included a doctor or nurse and a patient. For centuries professionals have been reliant on some medical technologies too, e.g. to carry out physical examinations of the patient using a stethoscope, blood pressure monitor, or magnifying glass, alongside some technology for record keeping to make informed temporally coherent decisions (patient paper record or medical notes). The flow of the consultation was doctor-led and would be naturally dependent on the severity of the patient's condition, the completeness of his or her paper record, the time the doctor had to examine the patient, and the decisions made on how to move forward with a care plan. Today's clinical encounter continues to carry on most of these traditions, but increasingly, it is dependent on health information systems as new 'clinical leaders'. We argue that clinical encounters have changed (or are changing) significantly, from being clinician-led (by physician, nurse, or pharmacist), to technology/computer/information system-led encounters. These changes are characterised by new aspects of control. We define control here as 'the power to influence people's behaviour or the course of events' [9] through exercise of restraint, directing, auditing, or eliminating possible outcomes.

Our research stems from an interest in work practices [10]. Hence, we first present four changes in work practices: work obstruction, modification, disjunction and shifts in time and space. We present this along with examples from our field work in the results section. In the discussion, we explain two reasons for these changes; one is intentional and the other unintentional controls mediated by technologies-in-practice. We relate these findings to models of technology drawing upon ideas and constructs from sociotechnical theory. Finally, the potential implications as well as suggested areas for future research are presented in conclusions.

Methods

We follow here the tradition of information systems research that focuses on contextual, social approaches, and adopts an interpretive research methodology [11- 14]. Three healthcare institutions are considered here, drawing from our previous and

ongoing research including two London teaching hospitals and a district general hospital in England. The research we draw upon was carried out across four medical specialties; general surgery, cardiovascular surgery, elderly care, and cancer care. Qualitative methods were used to collect data [15], particularly semi-structured interviews, alongside observations. Interviews were tape recorded and subsequently transcribed, and hand-written notes were taken. Data collection was carried out during different periods in different settings, between 2005 and 2009. Further, research findings were indexed, interpreted and analysed against concepts from the sociotechnical approach [16].

We have studied the implementation and use of different health information systems in varied settings.

1. Electronic Prescribing Studies (completed):
    a. A pilot of a closed-loop electronic prescribing, automated dispensing, barcode patient identification and electronic medication administration record (EMAR) system introduced on one ward (general surgery) in a London teaching hospital [17]. We refer to this case as (1a).
    b. An integrated electronic prescribing, administration and records system implemented over time in English district general hospital. We refer to this case as (1b)
2. Electronic Patient Records Studies (on going):
    a. A study of a London teaching hospital's clinical information systems, which included a patient administration systems (PAS), electronic clinical letters, picture archiving and communication systems (PACs), a pathology results reporting system (OrderComms), and an electronic prescribing and discharge systems (eTTA). We refer to this case as (2a).
    b. A Study of a Clinical Data Repository, based in a large London teaching hospital which integrated many sub-systems. These included PACs, PAS (Patient Administration System including appointment scheduling and real time bed state), Clinical Letters, Proactive electronic document capture (i.e. discharge summaries), Order Communications (pathology requests and results), Nursing assessment (ePAN), Therapy activity recording, and Knowledge management tools. We refer to this case as (2b).

Results

A repeated observation made across these healthcare settings is that the clinical work flow is manipulated or orchestrated by the health information system. This characteristic of the technology-in-practice is described by us as 'control', though this word may have some over negative connotations. The control that is seen in action seems to result in four different types of outcomes (sometimes in combination). These we describe as; work obstruction, work modification, work disjunction, and work-related shifts in time and space. Each one of these themes are explored below, with examples.

Work Obstruction

We define work obstruction as a control that is a direct consequence of the technology-in-practice, and which results in the healthcare professional's work flow stopping, or being halted and she or he are not able to carry on their work as usual.

Health information systems often control when the clinical encounter begins and when it ends. Consultations would often begin and (or) end with the physician making the patient's electronic record available on the computer terminal, rather than by ensuring the availability of patient's paper record or the physical presence of the patient. An encounter could be seen to begin, for example, before the patient enters, as in an outpatient clinic where a doctor reads the electronic record for 5 minutes while the patient is waiting outside. At other times, healthcare information systems can pause or obstruct the physician from carrying out his or her chosen task as when a record is slow to download. This may be particularly the case when the technical performance of a system was poor, which meant the system would take a long time to load, would occasionally freeze, or cause the computer to restart. The physician may have the paper record at hand, but such an obstruction would still delay his or her consultation. This resulted in major frustrations, delays in the clinical start and end time, and, less often, cancelations (2a and 2b).

Pharmacists also reported their work being obstructed by slow computer terminals. Additionally, they also had difficulty finding a single available computer terminal to use for discharging their patients. Unlike the paper system which was fast and practical and always available to carry out the discharge task. This resulted in discharge from in-patient care being delayed, which ultimately made managing hospital flow of patients and bed management more complicated (2a).

Work Modification

The term work modification is used to describe a small temporary change in usual practice in order to get work done. Similarly, workarounds have been defined as "work patterns an individual or a group of individuals create to accomplish a crucial work goal within a system of dysfunctional work processes that prohibits the accomplishment of that goal or makes it difficult" [18] and do not include deviations, mistakes or shortcuts [6].

When pharmacists compiled discharge summaries, they often could not find the exact detail on the drop down menu which they used describe some drug specification. They resorted to using the closest description that the system would accept, and then finding a free text box (often the dietary information field, which was not limited in capacity) to clarify this in more detail (2a). Another example is of a hospital where there were eleven different clinical systems used by one department, and each of those systems required different sign-on details as a security measure. It was also programmed to 'time-out' every three minutes. Physicians commonly wrote the eleven different user names and passwords on a notepad on their desktop, in their personal diaries or agendas. In one instance, a surgeon had them listed on the back of one of his business cards. While this made the physicians' work flow possible, it allowed for a new

'security breach' in the confidentiality of patient information stored on all systems.

Another workaround was commonly practiced when dealing with random pop-up boxes that usually occurred when physicians were navigating PACs. Pressing 'cancel' several times was the quickest way to by-pass the 'glitch' and carry on their work. It became common practice to flag it up to junior colleagues during orientation and training (2a).

A third example is from nurses who printed patients' identification bar codes and stuck them on their bedside lockers or tables in order to be able to dispense medication when the patient was away from the bed. This was done as the drugs trolley only opened upon reading the bar code. This workaround subverted a safety feature intentionally included in 'computer logic'. Also, doctors used a subsidiary paper chart to prescribe certain drugs (i.e. warfarin, sliding scale insulin, variable dose heparin and intravenous fluids). This was a necessary work around. These drugs could not be safely prescribed through the system because their protocols did not fit easily into the structures embedded in the software –just regular doses of drugs at set times (1a).

Work Disjunctions

By work disjunctions we refer to situations when the information system has a direct or indirect effect on a healthcare professional's control over work flow, or by simply slowing down their ability to complete a task. For example, at one hospital notes regarding administering a drug in the future could not be made on the computer record, consequently the pharmacist would have to note it physically in other records. This meant that potentially important information might not be recorded or remain unnoticed (1b).

Work disjunctions are also caused indirectly by the increased structure that a health information system may impose. In the case of drug administration nurses had to follow the system's logic when dispensing drugs, and could not easily override it (unless in emergency). Initial evaluation showed that this feature might have lead to fewer dispensing errors but some procedures took more time, requiring additional work flows in some instances. Prescribing or administration that was not undertaken as part of regular drug rounds, e.g. when a nurse gives a "stat" (occasional or elective) dose, called for another work flow to log and administer. This involved the nurse walking to the computer and back twice to obtain the drug and then to record administration (1a).

Surgeons reported difficulties encountered when viewing heart ultrasound images, which forced them to change their physical space, and leave their consultancy suites, and in one incident, a live-surgery, in order to find a computer terminal that can load the images quickly enough (2a). Similarly, nurses using an EMAR system found that at times they had to queue to use the computer on the ward (1a).

Work Shifts in Time and Space

By shifts in time and space we refer to controls imposed by information systems that cause healthcare professionals to physically change their work location in order to carry out their work. We also refer to the flexibility that these systems bring, allowing professionals to manage their work from different locations and at different times than the usual ones.

When researching electronic prescribing systems, it was observed that doctors often prescribed away from the wards (e.g. from the doctors' mess). By accessing computer records, doctors could more easily deal with out of hours calls, sometimes avoiding going to the ward. This, as suggested by a doctor interviewed, should lead to more accurate prescriptions as compared to phone prescribing (a practice which sometimes took place at night). However, the availability of relevant data might mean that even less prescribing activities are done by doctors who actually see the patient. Thus, the potential implications of this shift are ambiguous (1a).

One related consequence was found in two healthcare institutions. There, before electronic prescribing was implemented, pharmacists would visit each patient daily and check their drug chart if available; now they could check through the computer and assess each patients' computer chart for changes and only visit those whose records indicated a pharmacy-related problem. This resulted in some (but not all) pharmacists choosing to do the majority of checking in the pharmacy and limiting their visits to the wards. When checking prescriptions, pharmacists had access to relevant data, for example test results more easily than in paper-based system and thus might be more likely referred to them. This potentially reduces errors and improves care. However, certain cues might be missed if patients are not seen in person, and less interaction was possible with other health care professionals. Computerisation of prescribing also meant that pharmacists could check prescriptions at any time with no need to have a set time or set amount of time and pharmacists were no longer tied to the ward timetable. This allowed a degree of flexibility and enabled them to prioritise work. Pharmacists reported that this has led to efficiency gains (1b).

The integrated nature of hospital information system has meant that doctors could potentially re-organise their clinics and conduct some aspects of care in different locations. For example, patients' notes could be accessed and tests ordered remotely. One senior doctor reported regularly accessing patients' notes and ordering tests remotely from home (1b).

Discussion

The view that ICTs do not have predefined 'impacts' is increasingly accepted in information systems, health informatics and medical informatics literature. Indeed, it is now widely acknowledged that ICTs have many unintended positive and negative consequences [3] and that these consequences depend on the organisational context, culture and the fit between the task, the clinical environment and the technology [19,20]. This suggests that we cannot study technology per se or unreflectively take findings from one setting and generalise them to another. Rather, we need to consider ICT as embedded in work (and social) practices and part of heterogeneous relations both potentially enabling and obstructing activities, i.e. as *technology-in-practice* [21].

> *... technologies are embedded in relations of other tools, practices, groups, professionals, and patients and it is*

> *through their location in these heterogeneous networks that treatment, or any other action, is possible in health care.* [21]

Furthermore, it is through the situated practices of everyday users and in particular circumstances that consequences of technologies are manifested and felt [22]. But different studies have shown that the models of care delivery underpinning information systems are often based on what ought to happen (e.g. according to formal rules and practices which are not followed), rather than on what actually happens, and on perception of care as a linear process with a clinician at the centre rather than as a collaborative, non-linear process undertaken by a multi-disciplinary group [23].

The difference in theoretical and practical perception of medical work practices leads to 'aberrations', including workarounds created to by-pass the system, parallel communication channels or duplication of work due to lack of coordination [20, 24, 11, 25]. Workarounds may be introduced because of work flow blocks associated with technology or organisational processes not effectively integrated with technology. Workarounds tend to distract staff and take them away from patient care and can result in errors [6, 26].

Our paper complements and builds on this literature by focusing on controls emerging from the systems in use. Other studies have identified different types of controls [27]. Our categorization of controls is derived out of the four changes in work practices described above. We classify these controls as:

(a) ***Intentional controls***: These may be in the form of *work flow control*, when for example technologies are seen as 'clinical leaders', controlling the flow of clinical encounters and other activities, such as prescribing of medications (orders). Increasing dependence on these new 'clinical leaders' means that when they break down activities might be halted. We identify *adherence* controls, when systems are designed to enforce different ways of working, e.g. adherence to local or national guidelines. These often overlap with *work flow controls*.

(b) ***Unintentional controls***: Such as in *accidental controls* imposed by pop-up boxes appearing apparently randomly due to arbitrary systems errors, inadequate hardware or faulty software. These controls may be caused by 'unintentional mismatch of practice' when computer systems do not reflect work practices they are supposed to support. This may be a result of poor analysis and design, changing work practices and organisational context, or practices that are difficult to model in the technical system (e.g., warfarin prescribing and administration). We term these *disjoint controls*.

Controls inherent in technologies-in-practice result in different outcomes and workarounds, such as work obstruction, work modification, and work disjunctions. Information systems also have profound implications for shifting time and space of clinical encounters and clinical work and these in turn may have varied implications for the quality of healthcare delivered [18]. This implies that workarounds are to be expected and that they are inherent in work systems, which (like computerised information systems) tend to be highly structured. However, information systems not only constrain but also enable work and may lead to emergent changes in healthcare practices and ambiguous consequences.

Conclusion

Our findings lead us to conclude that when implementing and evaluating information systems it is important to consider implications of control and structuring of work due to 'computer logic', and of work shifts in time and space. Deceptively simple decisions, e.g. of where to place computers, have consequences for the practice of healthcare, e.g. for communication with patients and between health professionals. Computers can become 'centres' where different professionals meet or catalysts for further compartmentalisation of work and distancing of different healthcare professionals from each other and from patients.

We give examples of when computerised systems facilitated prioritisation of work and shifting times and places, as well as when systems obstructed or structured work and imposed their own work flows. When controls embedded in computer systems break the flow of work it is likely that people will find workarounds to subvert the logic. Thus, when implementing information systems the following need to be carefully considered: (a) what controls (and values, norms and guidelines) we want to embed in information systems and what (potentially reengineered) work processes we want them to support ; (b) in what circumstances should workarounds be 'designed into the computer and work systems' (e.g. how exceptional, emergency situations should be dealt with,); (c) how to limit 'undesirable' workarounds (e.g. by reflecting existing practices in computerised systems and when appropriate limiting the number of intentional work flow stops, as well as by re-organising work and physical spaces to make adherence to work flows easier; and (d) what emergent changes these technologies-in-practice might bring about.

There is a substantial literature on organisational impacts of information systems and implications for healthcare practice. But as new systems are implemented in varied settings new research opportunities open up. In particular, research "unpacking" information systems, such as that outlined in this paper, that reveals embedded controls, values, norms and policies and their implications for healthcare promises to deliver important insights relevant to both practitioners and researchers alike

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