Editorials

Electronic health records:

research into design and implementation

The whole point of electronic health records (EHRs) is to improve patient care and increase the efficiency of primary care practice. It has long been recognised that these goals are often not realised.[1] Not all clinicians are enthusiastic adaptors of technology in the consulting room[2] and there are differences between the US and the UK, both in utilisation and in national goals (Box 1). This reluctance may be because there are serious concerns about its impact on care.[3,4]

CONCEPTUAL FRAMEWORK TO GUIDE RESEARCH

To guide research which will be directed at improving the situation we need to be sure that the right issues and contexts are being addressed and that the best conceptual frameworks are being used. To date, EHR development and implementation been based on less helpful conceptual frameworks and assumptions.[5]

There are many potential areas of investigation where research is needed and we mention three for consideration:

- The fundamental purpose EHRs impacts on the way organisations (governments, clinics) implement the technology and incorporate it into workflow. This is particularly relevant in countries such as the US where there is the dual purpose of billing and clinical care;
- design and user interface issues (for example, the display); and
- the way that clinicians and patients actually use EHRs.

THEORETICAL MODELS

For the past 30 years the widespread adoption of EHRs was considered inevitable as predicted by the diffusion of innovation theory. The observation that uptake was patchy in different countries suggests a more complex situation where more sophisticated ideas, such as the Normalisation Process Theory (NPT) or Actor-Network Theory (ANT), need to be considered. NPT considers the ways that a material practice, for example the use of computers in clinical contexts, becomes a routine part of practice as the result of individual and group decisions and behaviours. These changes are produced by a range of social mechanisms described by the proponents of the theory as sense-making (coherence) work, engagement work (cognitive participation), the work of enacting a practice (collective action), and the work of understanding and appraising its effects(reflexive monitoring).[6]

ANT posits that the that role inanimate objects, such as computers, play in social processes is so significant that they need be considered as part of the whole system and not an external force. ANT's contributions to guiding research into EHR design, implementation, and use in primary care emphasise interconnectedness.[7]

SOCIOTECHNICAL IMPACTS

The common issue which needs to be addressed is the fact that the implementation of EHRs is a transformative sociotechnical change. This means that the EHR is not cleanly added on top of an existing work system but rather transforms work structures and processes. In turn, the transformed work system *in toto*, and not the EHR by itself, will determine how effectively, efficiently, and safely care will be delivered in an EHR-enabled workplace. Examples abound of unintended consequences arising from the failure to consider or address EHR-driven transformations, which include new workflows to access or document information, the redistribution of work among clinical and non-clinical staff, and changes to how clinicians and patients interact.[8] It should be evident from these examples that the transformations are not simply procedural, but also cognitive and social. Researchers have begun to study the procedural impact of EHRs, often discussed as 'workflow' changes, and have discovered changes in the duration and sequence of procedures, such as documentation between paper-based and EHR-based work.[9]

HUMAN COGNITION AND EHRs

Much less work has been conducted on the cognitive impact of EHRs, or the way that EHR changes the way that clinicians and patients make decisions, make sense of the situation, coordinate as a team, or become aware of, perceive, store, process, and communicate information.[10] One recent study demonstrated that although EHR improved the accuracy and speed of access to information, it also had undesirable cognitive effects.[11] Those included information overload, new cognitive demands, such as multiple clicks and screen navigations, and problems attaining situation awareness due to fragmented, over-structured, or carelessly copy-and-pasted clinical notes.

Work is underway to improve EHRs' cognitive impact by designing the EHR user interface according to usability engineering principles and by conducting cognitive task analyses, which are evaluations of the cognitive processes and cognitive needs related to using the EHR.[12]

Design for usability and cognitive task analysis are important steps forward but sometimes fail to address the team-based and social nature of clinical work. Usability tests of EHR, for example, often measure the speed with which a test user can acquire a piece of information or how well the user can see and understand an alert issued by EHR. These are measures of individual cognition. In reality, clinical work requires what is called 'team cognition',[13] which involves the cognitive processes necessary to do work in teams, including communication, distributed knowledge or 'team situation awareness,' and coordination. A more realistic usability testing scenario might therefore include

Box 1. US–UK computer utilisation and national goals

US[19]	UK[20]
• Over 50% of patients' demographic data recorded as structured data	• Already 100%
• Over 80% of patients have at least one medication entry recorded as structured data	• Near 100% for all patients who have received a prescription of any kind
• Over 40% of prescriptions are transmitted electronically using certified electronic-health-record technology	• Not standard or a planned target
• One clinical decision support rule implemented	• Not standard or a planned target
• Over 10% of patients are provided patient-specific education resources	• Not standard or a planned target

> "Social roles change when a physician must do more data entry ... than with a paper-based system; the physician takes on tasks that used to be delegated to other staff, changing the physician's role in the team."

multiple individuals such as a physician, patient, nurse, and staff who need to communicate and coordinate to complete their work with the EHR.

The notion that the EHR is used in a team setting means that EHR use occurs in a social context. As axiomatic as this statement may be, there is hardly any work explicitly aiming to understand the social phenomena surrounding EHR use or the social consequences that an EHR may have on the implementing organisation or on the wider community. Nevertheless, there is some evidence that the decision to use an EHR is greatly dependent on the social influence of colleagues and superiors,[14–16] and there is ample evidence that EHRs transform social structures and processes within organisations. For example, social roles change when a physician must do more data entry or make more decisions than with a paper-based system; the physician takes on tasks that used to be delegated to other staff, changing the physician's role in the team.[15]

COMMUNICATION AND EHRs

The introduction of EHRs can also transform sociocognitive processes such as interpersonal communication. Electronic order entry substituting for face-to-face communication is one such social change with meaningful performance consequences: whereas face-to-face communication is closed-loop (that is, the sender of information usually receives feedback when information is received), sending information electronically does not guarantee that information is received; this may result in delays or errors when the sender assumes otherwise.[17]

The dearth of research centred on EHR-related social change suggests that social change is probably acknowledged, but thought of as an inconvenient, uncontrollable side-effect. However, the less we study social change sparked by EHR, the less we will be able to predict or manage it.

We need to keep in mind that 'There is nothing more practical than a good theory'; that is, in order to advance an area of enquiry, the search for evidence would often benefit from building on existing knowledge of fundamental human processes.[18] In this case theories point to concerns about EHRs that have been ignored.

It is not EHRs that change the quality or efficiency of primary care, but rather the changes that EHRs produce in the total work system of which they are but one part.

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