INFORMATICS IN PRIMARY CARE

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Undertaking sociotechnical evaluations of health information technologies

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ABSTRACT

There is an increasing international recognition that the evaluation of health information technologies should involve assessments of both the technology and the social/organisational contexts into which it is deployed. There is, however, a lack of agreement on definitions, published guidance on how such 'sociotechnical evaluations' should be undertaken, and how they distinguish themselves from other approaches. We explain what sociotechnical evaluations are, consider the contexts in which these are most usefully undertaken, explain what they entail, reflect on the potential pitfalls associated with such research, and suggest possible ways to avoid these.

Keywords: Evaluation, health information technology, sociotechnical

INTRODUCTION

Internationally, there is a growing political drive to implement ever more complex information technologies into healthcare settings, in the hope that these will help improve the quality, safety, and efficiency of healthcare.[1] There is in parallel a growing appreciation that such interventions need to be formally evaluated, as the benefits of technologies should not simply be assumed. Complex systems such as electronic health records, and electronic prescribing and telemonitoring technologies are often very costly to procure and maintain, and so, even if effectiveness in relation to the quality of care is established, cost effectiveness needs to be examined. There is now also a growing body of work indicating that technologies may inadvertently introduce new risks, largely arising from difficulties of systems to integrate with existing work processes.[2]

The study of technological innovation into healthcare settings should therefore—particularly if the technology is likely to be disruptive—offer an opportunity to understand and evaluate the changing inter-relationships between technology and human/organisational (or socio-) factors. Whilst there is a growing theoretical and empirical evidence base on this subject, there is as yet little practical guidance explaining how such sociotechnical evaluations should be undertaken.[3–9] Although there is an increasing appreciation of the complex processes involved in using and implementing technology in social contexts to improve the safety and quality of healthcare,[3–9] current sociotechnical approaches somewhat fail to distinguish themselves from other methodologies such as usability testing and context-sensitive methods of investigation. This may be due to the lack of agreed existing definitions of what constitutes sociotechnical approaches to evaluation and the range of disciplinary backgrounds involved.

Drawing on our experience of conducting a number of recent studies of complex health information technologies,[10–16] we aim to provide a practical guide to undertaking sociotechnical evaluations: we consider the contexts in which

such approaches are most usefully employed, explain what sociotechnical evaluations involve, and reflect on the potential pitfalls associated with such work and how these might be avoided.

WHAT ARE SOCIOTECHNICAL EVALUATIONS AND WHEN SHOULD THIS APPROACH BE USED?

Sociotechnical perspectives assume that 'organisational and human (socio) factors and information technology system factors (technical) are inter-related parts of one system, each shaping the other'.[12] In line with this, sociotechnical evaluations involve researching the way technical and social dimensions change and shape each other over time.[17–19]

We summarise some typical components of a socio-technical evaluation in Box 1. This approach is potentially most appropriate when there is a complex, iterative relationship between the technology and social processes in the environment into which it is introduced. Conversely, it is less useful when there is likely to be a simple, linear cause-and-effect relationship between the technology and social processes. The dimensions explored in an evaluation may encompass investigating how technologies change social processes (e.g. the way care is delivered by, for example, introducing electronic health records), and how

technologies themselves can change over time as a result of user/organisational requirements (e.g. ongoing customi-sation to improve usability) (Figure 1).[5] Such adaptation is important as if the use of the technology results in perceived adverse consequences for the delivery of care, the technology is likely to frustrate busy clinical staff and may be abandoned altogether.[19]

A further defining component of sociotechnical evaluations is the attempt to study processes associated with the introduction of a new technology in social/organisational settings, as these mediators can offer important insights into potentially transferable lessons.[12,14,15,20] This focus on processes is important, because of the increasing number of technological functionalities and vast differences in implementation contexts. In contrast, evaluations that focus solely on investigating the impact of technology on outcomes often have limited generalisability beyond the immediate clinical setting in which the research was undertaken.

WHAT STUDY DESIGNS LEND THEMSELVES TO SOCIOTECHNICAL EVALUATIONS?

The focus on investigating and exploring processes lends itself best to a naturalistic approach, but sociotechnical evaluations may also incorporate aspects of more positivist designs, particularly in the context of undertaking quasi-experimental

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Box 1 A summary of typical components of a sociotechnical evaluation

Aims

1. Identify processes, benefits, and negative impacts of the new system across a variety of dimensions (see below).
2. Extract overall potentially transferable lessons to a greater number of organisations.
3. Liaise with decision makers to inform implementation.

Methods

- Longitudinal: tracking changes over time.
- Ideally mixed methods: qualitative and quantitative work feeding into each other, focus on processes.
- Can be case study based.
- Drawing on existing theory.

Participants

Purposeful sampling of individuals within care settings (managers, implementation team members and IT staff, doctors, nurses, allied health professionals, administrative staff, patients, and carers), and also stakeholders outside the immediate care setting (e.g. policy makers and system developers).

Individual dimensions that may be studied

- **Implementation strategies and experiences** (e.g. technical, clinical, and organisational issues)—qualitative work, e.g. interviews and documentary

analysis of strategic documents such as business cases; participants: organisational decision makers.
- **Attitudes, expectations, and experiences of individuals**—qualitative work, e.g. interviews with organisational decision makers, policy makers, and users.
- **Organisational consequences** such as changes in data quality, workflows, and organisational roles and responsibilities—qualitative work, e.g. interviews with organisational decision makers and users, and observations of technology use; some quantitative measurements may be possible.
- Assessment of **implementation costs**—health economic work.
- Assessing the **impact of systems on errors, safety, and quality of care**—considering key quantifiable benefits in relation to improving quality and/or safety of care, with a focus on those outcomes that are most likely to be influenced by the technology in question.
- **Recommendations for implementation and evaluation** of similar initiatives—may contain a qualitative element interviewing policy makers and system developers, and examining policy documents.
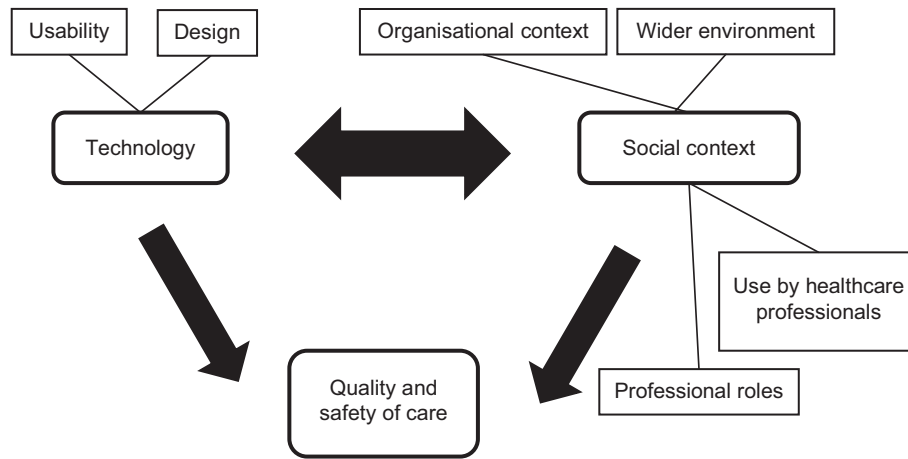

Figure 1 Dimensions commonly explored in sociotechnical evaluations of health information technologies

studies, when investigators do not have direct control over the technology that is to be implemented.[15]

Sociotechnical evaluations should ideally be undertaken using a prospective design, as this can help to map and understand the interplay between the technology and the social context, and thereby identify important insights into how the technology is received and used.[11,12,14–16,20,21]

Any appropriate design with a longitudinal dimension that allows mediating processes to be understood in detail is therefore potentially suitable for a sociotechnical evaluation. Mixed-methods sociotechnical evaluations are becoming more popular and are likely to represent an important expansion area for this research approach.[11]

WHAT DATA TO COLLECT AND HOW TO ANALYSE THESE

A range of qualitative and quantitative data may be gathered during sociotechnical evaluations (see Box 1). Qualitative data can help to shed light on social processes and perceived technical features such as individual attitudes and expectations (interviews and focus groups), planned organisational strategies and policies (documents), and use of technology in context (observations). These data may be complemented by quantitative work investigating the measurable impacts of technology on social systems. For instance, collecting health economic and cost data can provide insights into investment and maintenance costs, benefits, and returns on investment. Quantitative data collection can also help to explore the impact of systems on the safety and quality of care, e.g. by measuring reductions in errors and increased efficiencies associated with the move from paper-based to electronic systems.

A key distinctive feature in relation to analysis is the focus on exploring the dynamic relationship between technical and social factors over time. It is therefore important to obtain insights into technical characteristics and social processes before the introduction of the new technology into a new social context, changes to technical and social aspects once the technology is introduced, potential underlying relationships between technical and social dimensions, and the changes

that occur over time as the technology becomes more embedded within the new social context. Learning across implementations can be promoted by identifying what mechanisms underlie observations and hypothesising if/how these may be applicable to other contexts. This may be informed by a realistic evaluation perspective, assessing contexts (existing and desirable conditions for certain outcomes to be produced), mechanisms (potential causal pathways that may lead to an outcome), and outcomes (the observable effects produced).[22] The approach may help to overcome traditional boundaries associated with the separation of technical and social spheres, as all three aspects (contexts, mechanisms, and outcomes) are neither distinctively technical nor distinctively social—they emerge out of the interplay of both.

POTENTIAL PITFALLS AND HOW TO AVOID THESE

There are, however, a number of challenges associated with sociotechnical evaluations of health information technologies (summarised in Table 1). These stem from a lack of existing agreement on various components of a sociotechnical system, possible study designs, and data analysis strategies. They range from practical issues surrounding the management of the work itself and coping with shifting implementation timelines, to more conceptual challenges surrounding the extraction of a 'bottom line', and the pragmatic use of theory.

Practical challenges associated with sociotechnical evaluations

Implementations of complex health information technologies such as electronic health records and electronic prescribing systems affect many aspects of organisational functioning and therefore tend to require complex evaluations. This is compounded with increasing organisational size and/or if more than one organisation is studied. Specific expertise needed in the research team will vary depending on the research questions being studied and methods employed, but may include methodological (qualitative, statistical, epidemiological, and health economic), theoretical (organisational change, management, and human factors), managerial (applied team

Table 1 Summary of potential challenges and how to avoid these

Challenges	How to avoid these
Large datasets and multi-disciplinary teams	Integrating data and perspectives through robust project management allocating lead researchers to aspects of the work
Shifting implementation landscapes and timelines	Adapting the aims and methodologies originally envisaged, and realistic timeframes of evaluations over longer periods of time
Linking local implementation processes to their structuring conditions	Researching wider political and commercial processes in which local developments are taking place
Extracting a 'bottom line'	Judging 'success' and 'failure' is not constructive; there is a complex story to be told but transferable lessons are possible
Different research traditions vary significantly in the way technologies, processes, and stakeholders are conceptualised	The pragmatic use of theory, drawing on existing theoretical frameworks

management), healthcare professional (doctors, nurses, and allied health professions), and technical (information technology specialists and system developers) expertise. Exploitation of individual strengths whilst ensuring coordinated efforts can in our experience be greatly facilitated by assigning lead researchers to individual aspects of the work investigating different impacts/consequences (e.g. cost and changes to individual work practices), and organisations to be studied.

A further practical challenge that evaluators are likely to face is the impact of shifting implementation landscapes and timelines, potentially resulting in original methodologies having to be adapted accordingly.[12] This is a common problem in evaluations of technical and/or health policy interventions, where data collection activities depend on the planned introduction of technologies.[14] As a result of expanding timelines, originally anticipated quantitative measurement making before, during, and after assessments of technology introduction may not be possible, and evaluators may lack opportunities to investigate the systems once they are routinely used within organisations.[11–14] Longitudinal evaluative work over extended periods of time is therefore important.[16] This should be characterised by early and close collaboration between evaluators and decision makers, so that changes in strategic direction and potential consequences for evaluation activities can be planned for in advance.[15]

Conceptual challenges associated with sociotechnical evaluations

There are also a number of conceptual challenges associated with conducting sociotechnical evaluations of complex health information technologies. The first relates to the researching of context surrounding the technology. Here, it is important to explore the use of technology by individuals, but also the wider environment in which these processes are situated (e.g. professional, organisational, and political contexts), as this can impact significantly on the way technology is adopted and changed over time.[2,14,15] With this in mind, it is, for example, often insufficient to only explore healthcare professional perspectives on technology implementation and adoption; there is also a need to gain insights into managerial and organisational perspectives to get a more rounded understanding of implementation processes and reasons

underlying strategic decisions. Similarly, broader political and commercial developments may play a role in shaping user experiences and the deployment/design of technologies.[12,19]

Another common challenge facing sociotechnical evaluations is the extraction of a 'bottom line'. Large complex processes tend to be most accurately described with the help of large complex stories, but there is also a need to ensure that messages emerging from evaluations are heard by decision makers, and this is often only possible with a limited number of straightforward key messages. In the face of this pressure, many evaluators have resorted to making bold statements surrounding the 'success' or 'failure' of evaluations of complex technologies, but in our experience, this is neither constructive in relation to future decision making nor accurate in representing reality. Evaluators need to acknowledge the existence of different notions of success as well as different temporal dimensions associated with perceived 'failures' (e.g. something that was initially observed as a 'failure' may on reflection turn out to be a 'success'). A better way to conceptualise outputs of sociotechnical evaluations is through a summary of key lessons learned, outlining how and why these may be transferable to other settings.

The final conceptual challenge takes a more theoretical angle. It is now commonly recognised that theory can help to develop transferable lessons between settings, and there are many theories that draw on sociotechnical principles.[23] However, different existing research traditions vary significantly in the way technologies, processes, and stakeholders are conceptualised. This results in a lack of existing overall framework through which implementations can be examined, although some existing approaches are summarised in Box 2.[24] In addition, theoretical lenses are often hard to understand for non-academic audiences and lack pragmatism. This inhibits learning from experience and also widens the existing gap between academic research and frontline practice. With this in mind, it is key not to ignore the issue surrounding theory as is so often done in existing evaluations—particularly those carried out by healthcare organisations that lack the necessary expertise. More usable integrative theoretically informed evaluation frameworks are currently in development, but in the meantime, we advocate drawing on those that encompass not only social and technical

Box 2 Theoretical frameworks that encompass wider contexts in which local developments are taking place

- The Theory of the Diffusion of Innovations: This can help to explain why or why not certain innovations spread in and across organisations as well as how this spread may occur. Rogers E. Diffusion of Innovations. New York: Free Press, 1983.
- Normalisation Process Theory: Can help to explore how innovations become embedded within clinical practice over time and what inhibits and/or facilitates this process. May C. A rational model for assessing and evaluating complex interventions in healthcare. *BMC Health Serv Res* 2006;6:86.
- Social Shaping of Technology: Can help to examine how information technology is related to and shaped by historical, cultural, and economic factors. Williams R and Edge D. The social shaping of technology. *Res Pol* 1996;25:865.
- HOT-fit: Can help to explore the alignment between technology, human, and organisational factors. Yusof MM, Kuljis J, Papazafeiropoulou A and Stergioulas LK. An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). *Int J Med Inform* 2008;77:386.
- Cornford et al.'s evaluation framework: Can help to explore interrelationships between system functions, human perspectives, and organisational context. Cornford T, Doukidis G and Forster D. Experience outcome with a structure, process and framework for evaluating an information system. *Omega*, *Int J Manag Sci* 1994;22:491–504.

dimensions, but also the wider contexts in which local developments are taking place (Box 2).

CONCLUSIONS

Sociotechnical evaluations are a powerful tool to research complex technological change, particularly if the aim is to investigate non-linear relationships between technology and social processes. However, there are also challenges associated with their conduct as they involve investigating complex processes over time and within complex changing environments. The existing literature has, due to a lack of existing agreement on defining components of such work, not always fully appreciated these.

We hope that our suggested definitions, experiences, and reflections will contribute to a more integrated approach to conducting sociotechnical evaluations of technological systems in healthcare settings. Given the very considerable policy interest and substantial financial resources being expended in implementing health information technologies in an attempt to achieve the triple aims of enhancing the safety/quality of care, improving health outcomes, and maximising the efficiency of care, we believe that greater use of sociotechnical evaluations will help to understand key processes in the interrelationships between technology, people, and organisations. This understanding will help to derive important and potentially transferable lessons.

Competing interest declaration
The authors have no competing interests.

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