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Tensions and Paradoxes in Electronic Patient Record Research: A Systematic Literature Review Using the Meta-narrative Method

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Context: The extensive research literature on electronic patient records (EPRs) presents challenges to systematic reviewers because it covers multiple research traditions with different underlying philosophical assumptions and methodological approaches.

Methods: Using the meta-narrative method and searching beyond the Medline-indexed literature, this review used "conflicting" findings to address higher-order questions about how researchers had differently conceptualized and studied the EPR and its implementation.

Findings: Twenty-four previous systematic reviews and ninety-four further primary studies were considered. Key tensions in the literature centered on (1) the EPR ("container" or "itinerary"); (2) the EPR user ("information-processer" or "member of socio-technical network"); (3) organizational context ("the setting within which the EPR is implemented" or "the EPR-in-use"); (4) clinical work ("decision making" or "situated practice"); (5) the process of change ("the logic of determinism" or "the logic of opposition"); (6) implementation success ("objectively defined" or "socially negotiated"); and (7) complexity and scale ("the bigger the better" or "small is beautiful").

Conclusions: The findings suggest that EPR use will always require human input to recontextualize knowledge; that even though secondary work (audit, research, billing) may be made more efficient by the EPR, primary clinical work may be made less efficient; that paper may offer a unique degree of ecological flexibility; and that smaller EPR systems may sometimes be more efficient and effective than larger ones. We suggest an agenda for further research.

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Electronic patient records (EPRs) are often depicted as the cornerstone of a modernized health service. According to many policy documents and political speeches, they will make health care better, safer, cheaper, and more integrated. Lost records, duplication of effort, mistaken identity, drug administration errors, idiosyncratic clinical decisions, and inefficient billing will be a thing of the past (Department of Health 2008; Institute of Medicine 2009).

But some scholars have cast doubt on this vision of a technological utopia (Avison and Young 2007; Hanseth 2007; Kreps and Richardson 2007). "Failed" EPR programs are common, they claim, and even "successful" initiatives are typically plagued by delays, escalation of costs, scope creep, and technical glitches, including catastrophic system crashes. They suggest that by distracting staff into data entry and standardized protocols, computerized records jeopardize the human side of medicine and nursing and that distributed record systems bring unanticipated hazards, including (but not limited to) the insidious growth of the surveillance society.

When we began this review in 2007, we found more than twenty systematic reviews of EPR, incorporating hundreds of primary studies, and several more were published while we were undertaking this work (examples follow). These reviews covered a relatively narrow body of literature restricted largely to experimental studies with quantitative designs. A wider, mostly qualitative, literature on the EPR's "people and organizational aspects" was known to exist and to be heterogeneous, complex, theoretically rich, and largely uncharted (Kaplan et al. 2001). Moreover, its points of departure differed, sometimes dramatically, from the assumptions implicit in the studies covered in previous reviews.

Aim and Scope of Our Work

We decided to undertake a new systematic review in order to map, interpret, and critique a wider range of empirical evidence on the EPR in organizations. We favored sense making over cataloging; that is, we

saw our primary task as teasing out the meaning and significance of the literature rather than producing an encyclopedic inventory of every paper published on the topic. Our reasons were three: first, a comprehensive "review of reviews" on the biomedical literature on the EPR already was being undertaken (Car et al. 2008); second, we did not have enough resources for an exhaustive search of all relevant fields; and third, we considered that making sense of the literature was a worthy goal in its own right.

The term *electronic patient record* is used in different contexts to mean different things, from an isolated file of computer-held information on a single patient, with or without decision support functions, to a nationally networked database offering built-in interoperability functions with other technologies and systems and oriented toward secondary uses such as research, audit, and billing. As technologies move on, so do the scope and purpose of the EPR. Hence, rather than impose a rigid definition, we chose to track how the definition had changed across traditions and through time and how these framings of what the EPR "is" inspired different theoretical approaches, research questions, study designs, and empirical insights. Our starting point was that however defined, the EPR is socially and organizationally embedded; that is, it is used by people in particular contexts for particular social acts.

Our research questions were the following:

1 What bodies of knowledge and specific research traditions are relevant to the understanding of EPRs in organizations?
2 In each of these traditions,
   a What are the key concepts (including taken-for-granted assumptions about the nature of the problem), theories, and methodological approaches?
   b What are seen as the seminal theoretical works and high-quality empirical studies?
   c What are the main empirical findings, and what has been concluded from them?
3 When comparing across the different traditions,
   a To what extent are the assumptions, approaches, findings, and conclusions of the different traditions commensurable?
   b What higher-order insights can be gained from the study of the agreements and disagreements among them?

4 Taking account of both the policy context and the breadth and diversity of the existing literature on the EPR, what are the priorities for further research?

Method

We previously developed a *meta-narrative method* as a way of systematically making sense of complex, heterogeneous, and conflicting bodies of literature (Greenhalgh et al. 2004). We recommend that those unfamiliar with this approach read our methodological paper (Greenhalgh et al. 2005) and consult the glossary in this article. The essential technique is interpretive synthesis; that is, we read and reread primary sources and used narrative to summarize their key methods and findings. We applied Kuhn's notion of scientific paradigms to map the meta-narratives (overarching story lines) of research as they unfolded in different research traditions, thus revealing how "normal science" on the EPR has been defined differently and explored by different groups of scholars over time (Kuhn 1962).

A *meta-narrative* embraces a shared set of concepts, theories, and preferred methods (including an explicit or implied set of quality criteria against which "good research" is judged). It also includes a time dimension: researchers look back (e.g., in editorials or book chapters) to consolidate what has been achieved to date and into the future to identify unanswered questions and find new avenues to explore. The meta-narrative is sited within a particular scientific discipline. Star (2002, p. 115) defined a discipline as "a commitment to engage in disagreements." The meta-narrative should be regarded not as the unified voice of a community of scholars but as the unfolding of what they are currently disagreeing on. Researchers in any particular meta-narrative tend to know about and cite one another's work (even if they are citing it to contest it), attend the same conferences, publish in the same journals, and accept broadly similar criteria for judging validity and rigor.

With a view to unpacking these meta-narratives, we used exploratory methods (browsing, asking colleagues) followed by snowballing (searching references of references and using citation-tracking databases) to identify key sources. In a previous meta-narrative review of heterogeneous literature, we demonstrated that both hand searching and applying formal search strategies to electronic databases were significantly less

effective and efficient than snowball techniques (Greenhalgh and Peacock 2005). In this review, therefore, we did not hand-search any journals and placed less emphasis on database searches. To help manage the data, all sources were indexed on a Reference Manager database according to five criteria: how we identified them, philosophical basis, research tradition, relevance to our review (high, medium, low), and study design.

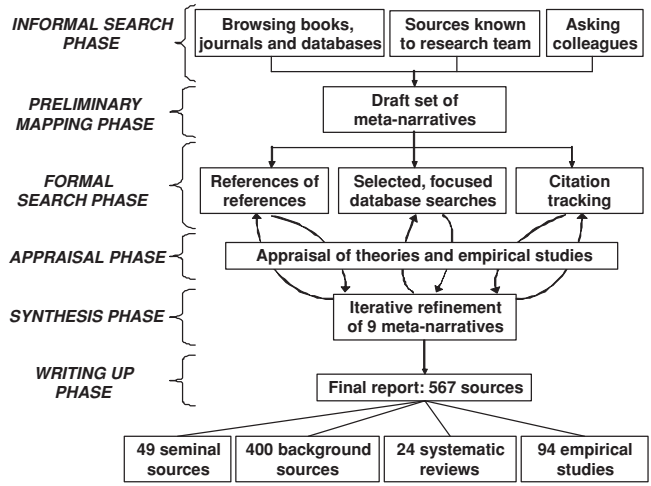
We identified seminal sources (often books) in each meta-narrative by asking what were cited as key original and scholarly contributions by other researchers in the same tradition. From these, we extracted the concepts, theories, and preferred methods that formed the criteria for rigor in each meta-narrative, and we used these to guide our appraisal of empirical studies. We gave great weight to studies that had been flagged as "high quality" by other scholars in a tradition, but because the literature included a wide range of different paradigms, perspectives, and study designs, we did not use a formal quality scoring system. In a synthesis phase, we compared and contrasted the different meta-narratives and exposed tensions and paradoxes, and we sought explanations for these in terms of how researchers had conceptualized the world and chosen to explore it.

As we had found previously, the meta-narrative method was an iterative and, at times, messy affair, with several false starts to the classification scheme and uncertainty about the quality and relevance of papers in traditions unfamiliar to us. In most but not all cases, we eventually reached a high degree of agreement as the different meta-narratives took shape. Although we initially planned to produce formal interrater agreement scores, the process turned out to be a highly constructivist one in which the ongoing dialogue among us was essential to accommodating our separate interpretations and iteratively revising both our own taxonomy and where each paper was classified within it. Figure 1 shows our study flowchart.

Main Findings

Overview and Historical Roots

We found a complex and heterogeneous literature characterized by diverse philosophical assumptions about the nature of reality (ontology), how that reality might be known (epistemology), and the preferred



Note: See glossary for definitions.

FIGURE 1. Summary of Phases in the Meta-narrative Review.

research approaches and study designs (methodology). Adapting and extending previous taxonomies (de Vaujany 2005; Orlikowski and Baroudi 1991), we identified four main philosophical positions:

- *Positivist*, which assumes an external and knowable reality that can be objectively measured, an impartial researcher, and the possibility of producing generalizable statements about the behavior of the natural and social world.
- *Interpretivist*, which assumes a socially constructed reality that is never objectively or unproblematically knowable and a researcher whose identity and values are inevitably implicated in the research process.
- *Critical*, which assumes that the social order is inherently unstable. In particular, it involves the domination of some groups by others, such as women by men, workers by capitalists, or patients by health professionals. The purpose of research is at least partly to help these dominated groups challenge their position in society.
- *Recursive* (or *integrative*), which assumes that subject and object, micro and macro, social structure and human agency, are reciprocally related and that the purpose of research is to explore the flux between these various dualities over time.

These four positions, which are described in more detail in table 1, overlap to some extent. For example, recursive approaches such as structuration theory were initially developed to build links between the polarized worlds of positivism and interpretivism (Giddens 1984). But leaving aside the philosophical small print, this pragmatic taxonomy provides a useful shorthand for describing in broad terms where the researchers in any particular tradition were coming from and how they (implicitly or explicitly) defined "rigorous" research. When we describe each meta-narrative, we will refer to its philosophical assumptions and values.

Our exploratory reading identified a number of historical roots that informed later research on the EPR (see figure 2), including

- *Human-computer interaction (HCI),* which developed in the 1970s and 1980s, sought to optimize humans' use of computers by linking behavioral science (especially cognitive psychology) with technology design (Dix et al. 2003).
- *Evidence-based medicine (EBM)* emerged in the 1990s from epidemiology. Its aim is to develop mathematical estimates of benefit and harm from population-based research and apply these to the clinical encounter (Timmermans and Kolker 2004). EBM's position is that the best research evidence on medical interventions comes from experiments (preferably randomized controlled trials, or RCTs).
- *Symbolic interactionism and ethnomethodology.* Symbolic interactionism views humans as pragmatic actors who deal with social situations by constantly interpreting the behavior of other actors (by assessing its symbolic meaning) and adjusting their own behavior accordingly (Kaplan 2001). Ethnomethodology developed from this and considers how social action emerges as a moment-by-moment sequence of talk and action, with each utterance or move taking account of the previous one (Garfinkel 1967b).
- *Workplace redesign.* This management approach was popular in the 1970s. It sought to improve productivity and well-being of workers in industrial settings by making the industrial process more efficient and user friendly (Mumford and Weir 1979).
- *Safety-critical systems research.* This interdisciplinary field links systems research, software engineering, and cognitive psychology to improve safety in high-risk environments (Perrow 1984). It

TABLE 1
Philosophical Basis of Different Approaches in EPR Research

				Recursive (Integrative)		Design	
Assumptions and Values	Positivist	Interpretivist	Critical	Technology Structuration Theory	Actor-Network Theory	Conventional (Roots in Positivism)	Participatory (Roots in Interpretivism)
Ontology (assumptions about the nature of reality).	A single reality. Knowable, probabilistic.	Multiple realities, socially constructed through symbolic interactionism, framing, and sense making.	Multiple socially constructed realities reflecting power relations and hence influenced by external forces.	Multiple realities enacted by social actors, recursively shaped and constrained by macrosocial structures of signification, legitimation, and domination and by the materiality of technologies.	Multiple realities recursively shaped and constrained by actants (people and technologies) in the sociotechnical network.	Multiple, contextually situated alternative world-states. Sociotechnically enabled.	Cocreation of socially useful artifact through negotiation and sense making.

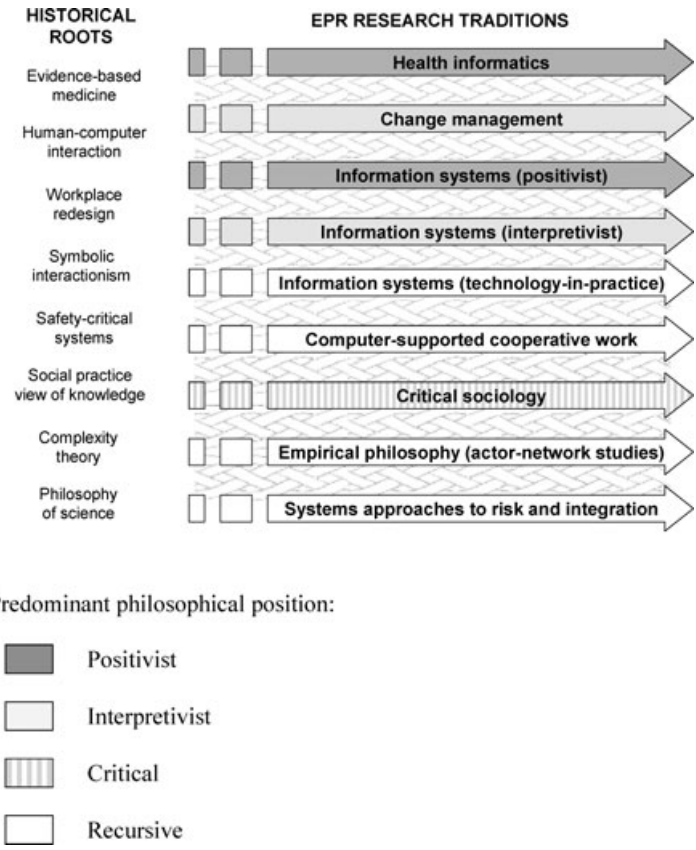
Epistemology (assumptions about the nature of knowledge).	Knowledge is objective and dispassionate and has a direct link to reality.	Knowledge is subjective, context dependent, and value laden and emerges from the researcher-participant interaction.	Knowledge is subjective, value laden, and critical; i.e., questions how and why the social situation arose as it did.	Knowledge is embodied and enacted in particular practices; social structure cannot be directly measured but can be known indirectly via actors' perceptions, understandings, and actions.	Knowledge is embodied, enacted, and generated by social actors who engage in "translation" as they seek to achieve their goals through particular practices.	Knowledge emerges through making and testing-in-reality. Design is objectively constrained construction within a context. Meaning is revealed through iterative circumspection.	Knowledge is subjective and value laden and emerges through making, which is a social process that requires shared vision and understanding.
Role and reflexivity (assumptions about the role of the researcher).	Researcher is a detached observer of truth; no reflexivity needed.	Researcher seeks valid, plausible, and reflexive understanding of the meanings ascribed by actors.	Researcher is questioner of the social order.	Researcher seeks reflexive understanding of the recursive relationship between the micro (actors' knowledgeability and practice) and macro (social structure).	Research is a reflexive performance; researcher seeks understanding of action and emergence in a sociotechnical network.	Researcher is creative, precise, technically adept, a seeker of elegance and usefulness in an artifact.	Researcher is a team member and coproducer of a useful artifact.

Continued

TABLE 1—*Continued*

Assumptions and Values	Positivist	Interpretivist	Critical	Recursive (Integrative)		Design	
				Technology Structuration Theory	Actor-Network Theory	Conventional (Roots in Positivism)	Participatory (Roots in Interpretivism)
Methodology (assumptions about what methods will generate "best evidence").	Observation: quantitative, statistical. There is a hierarchy of research design; i.e., one method is inherently "better" than others.	Qualitative, naturalistic; pluralistic (multiple methods preferred to give a rich picture of reality); data analyzed for meanings and perspectives.	Participative, qualitative, naturalistic; analyzed for hidden power relations embedded in social structures or language.	Qualitative, naturalistic; data analyzed for emergence of actors' understandings and practices and (indirectly) changes in social structures over time.	Qualitative, naturalistic, performative; data analyzed for ontologies (things brought into being through practice) and the actor-networks from which these emerge.	Developmental, with a focus on the technical. Measures artifactual impacts on the composite system.	Developmental, with a focus on the social. Measures shared vision, values, and collaborative outputs.
Axiology (what is of value).	Truth: universal and generalizable; prediction.	Understanding and description; situated and particular.	Challenge, emancipation.	Illumination of technologies-in-practice and how these shape and are shaped by social structures.	Illumination of technologies-in-practice and how these shape and are shaped by sociotechnical networks.	Control, creation, progress, improvement, understanding.	Fitness for purpose, ownership, engagement, dialogue.

Note: Design research is not a central focus of this review but is included for completeness.
Source: Partly inspired by previous work (de Vaujany 2005; March and Smith 1995; Orlikowski and Baroudi 1991).



Note: The historical roots on the left-hand side of the diagram do not link in a simple, linear way with the meta-narratives on the right-hand side. Different meta-narratives are drawn eclectically and in different ways on all these roots.

FIGURE 2. Some Historical Roots and Research Traditions in EPR Research.

assumes that such technologies cannot be studied in isolation from the humans who use them or the social contexts in which they are used.

- *The social practice view of knowledge.* This view conceptualizes knowledge in organizations not as context-free facts that people (or computers) may possess and transfer among themselves but as a set of practices that are embodied, socially shared, and learned as membership of a community (Brown and Duguid 2001; Lave

and Wenger 1991). Knowledge exists in two forms: explicit (formal, codifiable, and separable from the person who has it) and tacit (informal, uncodifiable, and tied to the person and the situation). Only the former can be stored, accessed, or analyzed as decontextualized "data."

- *Complexity theory.* In a complex system, agents are adaptive and self-organizing and make multiple and dynamic internal adjustments in response to changes in the external (and internal) environment (Plsek and Greenhalgh 2001). The behavior of such a system is never fully predictable (and the larger and more complex it is, the less predictable it is); hence, it has unintended consequences. Local, real-time feedback allows the system to be understood and actions to be planned.
- *Science and technology studies* (previously known as *philosophy of science*). Key philosophical contributions over the past twenty-five years include social construction of technology (SCOT), which rejects the idea that users are passive recipients of technology and argues instead that people actively *shape* technologies by the meanings they give to them (Bijker, Hughes, and Pinch 1987). Another, more recent contribution is actor-network theory (ANT), described in meta-narrative 8.

The preceding ideas, theories, and orientations provided many of the underpinning concepts for the meta-narratives of EPR research summarized in table 2 and described in more detail later. Understanding these different roots helps explain the meta-narratives' different paths. Because the health information systems literature (meta-narrative 1) already has been extensively reviewed, we restricted our analysis of this literature to systematic reviews. Our sample of primary studies is thus skewed toward the nonbiomedical literature, so the following statistics should be interpreted accordingly.

The ninety-four primary studies (described in 129 papers) outside the health informatics literature were philosophically pluralist, with 14 percent positivist, 19 percent interpretivist, 22 percent critical, and 55 percent recursive. As table 3 shows, they also were methodologically diverse, most with different types of case studies. In all, 16 percent of the sources included in our review (excluding background references) came from searching electronic databases, 43 percent from pursuing references of references, and 16 percent from citation tracking (mostly using Google

TABLE 2
Nine Meta-narratives That Have Driven Research on the EPR in Organizations

Research Tradition	Disciplinary and Philosophical Roots	Definition and Scope	General Format of Research Question	EPR Conceptualized as	EPR User Conceptualized as	Context Conceptualized as	Key Empirical Studies or Systematic Reviews
1 Health information systems	(Evidence-based) medicine, computer science.	Study of the storage, computation, and transmission of clinical data. Until recently, focus was on benefits of EPRs and how to achieve them.	What is the impact of technology X (e.g., EPR, CDSS, CPOE) on process Y (e.g., clinician performance) and outcome Z (e.g., patient health status)?	Container for information about the patient; tool for aggregating clinical data for secondary uses.	Rational decision maker whose cognitive ability limits what can be achieved without computers.	Potential confounder that can be "controlled for" if the right study design is used.	See review of 37 previous reviews (Car et al. 2008), plus one later publication (Shekelle and Goldzweig 2009).

Continued

TABLE 2—*Continued*

Research Tradition	Disciplinary and Philosophical Roots	Definition and Scope	General Format of Research Question	EPR Conceptualized as	EPR User Conceptualized as	Context Conceptualized as	Key Empirical Studies or Systematic Reviews
2 Change management (within health services research)	(Evidence-based) medicine, social psychology, management.	Study of how to achieve organizational-level change in health care.	How can we improve the delivery of health care and sustain that improvement?	Innovation that, if implemented widely and consistently, will improve process and outcome of care.	"Resistant" agent who must be trained and given incentives to adopt new technologies and ways of working.	External milieu of interacting variables that serve as barriers or facilitators to change efforts.	See note a.
3 Information systems (positivist)	Business studies, psychology, computer science.	Study of how organizations adopt and assimilate (or why they fail to adopt and assimilate) information systems.	What factors (independent variables) account for the success or failure (dependent variable) of information system X in organization Y?	Unwelcome change that is likely to be resisted by individuals and interest groups and that may fit poorly with organizational structures and systems.	Potential adopter who may be actively engaged in the change or resist it; member of group whose power base may be enhanced or threatened.	External milieu of interacting variables that mediate or moderate the relationship between input and output variables.	Lapointe and Rivard 2005; Spil, Schuring, and Michel-Verkerke 2005; Wainwright and Waring 2007.

4 Information systems (interpretivist)	Management, sociology, social psychology, anthropology.	Study of how organizational members make sense of information systems and thereby assimilate them.	What meanings does information system X hold for the members of organization Y? How can different views be accommodated?	Sociotechnical change that holds different meanings for different individuals and groups.	Stakeholder whose "framing" of the EPR is crucial to its effective assimilation. Agent whose creativity and energy can be drawn on in this effort.	Scene and setting for an unfolding story; webs of meaning in which organizational actors are suspended.	See note b.
5 Information systems (technology-in-practice)	Organizational sociology, social psychology, philosophy.	Study of how social structures recursively shape and are shaped by human agency, and the role of technology in this process, with a focus on the meso-level of organizational life.	What is the relationship among organizational actors, technology X, and the organization, and how does this change over time?	Itinerary and organizer whose physical and technical properties structure and support collaborative clinical work.	Knowledgeable, creative agent for whom social structures both create possibilities and limit the possible.	Generated and regenerated through the interplay of action and structure. Researchers do not study "technologies" and "contexts" separately but study technologies-in-use.	See note c.

Continued

TABLE 2—*Continued*

Research Tradition	Disciplinary and Philosophical Roots	Definition and Scope	General Format of Research Question	EPR Conceptualized as	EPR User Conceptualized as	Context Conceptualized as	Key Empirical Studies or Systematic Reviews
6 Computer-supported cooperative work	Computer science, software engineering, psychology, sociology.	Study of how groups of people work collaboratively, supported by information technology.	How can technologies support the work of multiple interacting people?	Contextualized artifact.	Agent who seeks to achieve local goals in collaboration with others and creatively overcomes limitations of formal tools.	Either external milieu or an emergent property of action (constituted by, and inextricable from, an activity involving people and technologies).	See note d.

7 Critical sociology	Sociology, philosophy.	Study of the relationship between people and the social order and how this changes over time, and the role of technologies in this process.	What social structures and inherent power imbalances are embedded in technology X, and what impact does this have on social roles and relationships?	Implicated in micro- and macropower dynamics, both within the organization and more widely (because of the link between knowledge and power).	Constrained by dominant social structures or discourses; imagined user, stereotypes of which may be built into technologies by designers.	Social and material conditions into which the (inherently unequal) social order is inscribed; a more or less stable structure of macrosocial relations.	Bloomfield 1995; Bloomfield and McLean 1995; Darbyshire 2004; Doolin 2004; Goorman and Berg 2000; Harris 1990; Henwood and Hart 2003; Sharman 2007; Timmons 2003a, 2003b; Wagner 1993.

Continued

TABLE 2—*Continued*

Research Tradition	Disciplinary and Philosophical Roots	Definition and Scope	General Format of Research Question	EPR Conceptualized as	EPR User Conceptualized as	Context Conceptualized as	Key Empirical Studies or Systematic Reviews
8 Empirical philosophy (actor-network case studies)	Philosophy, sociology, linguistics.	Study of sociotechnical networks and what emerges from these. Considers how relationships and power shift within the network.	How has the network, with its various relationships, work practices, and risks, changed as a result of introducing technology X?	Actor in a network.	Actor in a network.	The EPR and its context together form the network; the one cannot be studied without the other (since the EPR becomes "the EPR" only as part of the network).	See note e.

9 Systems approaches to risk management and integration	Systems and management research, drawing on cognitive psychology, CSCW, and ANT.	The study, from a systems perspective, of how to promote safety and reduce risk in health care.	What role in both protecting against and producing error does the EPR play in a complex health care system?	Component of complex sociotechnical system whose structural features and operational properties, even when designed to protect against error, may come together in unpredictable ways to produce error.	Component of complex sociotechnical system whose structural features and operational properties, even when designed to protect against error, may come together in unpredictable ways to produce error.	Complex, changing environment that poses potential risks to patient safety.	See note f.

Notes: [a]Badger, Bosch, and Toteja 2005; Boddy et al. 2009; Doolan, Bates, and James 2003; Granlein and Simonsen 2007; Greenhalgh et al. 2008; Hendy et al. 2005, 2007; Jones 2003; Littlejohns, Wyatt, and Garvican 2003; Miller and Sim 2004; Nemeth et al. 2008; Ovretveit et al. 2007a, 2007b; Pagliari 2005; Pagliari et al. 2005; Pagliari, Gilmour, and Sullivan 2004; Sanchez, Savin, and Vasileva 2005; Scott et al. 2005; Southon, Sauer, and Dampney 1997.

[b]Brown and Jones 1998; Checkland and Holwell 1998; Chiasson and Dexter 2001; Currie and Brown 1997; Currie and Guah 2007; Davidson and Heslinga 2007; Davidson and Reardon 2005; Desjardins, Lapointe, and Pozzebon 2006; Eason 2007, 2009; Jensen and Aanestad 2007; Prasad 1993.

[c]Davidson 2000; Davidson and Chiasson 2005; Mogard, Bunch, and Moen 2006; Østerlund 2002, 2003, 2004a, 2004b, 2006; Rodriguez and Pozzebon 2006; Sicotte, Denis, and Lehoux 1998; Sicotte et al.1998.

[d]Bardram and Bossen 2005; Clarke et al. 2001, 2003; Engestrom, Engestrom, and Saarelma 1988; Greatbatch et al. 1995; Hartswood and Procter 2000; Hartswood et al. 2002; Hartswood, Procter, Rouncefield, and Slack 2003; Hartswood, Procter, Rouncefield, Slack, and Voss 2003; Heath, Knoblauch, and Luff 2000; Heath and Luff 1996, 2000; Heath, Luff, and Svensson 2003; Kuhn 1962; Luff, Heath, and Greatbatch 1992; Reddy, Dourish, and Pratt 2001; Schneider and Wagner 1993; Symon, Long, and Ellis 1996; Tellioglu and Wagner 2001.

[e]Aarts and Berg 2004; Aarts, Doorewaard, and Berg 2004; Aderibigbe, Brooks, and McGrath 2007; Berg 1997, 1998, 1999; Berg et al. 1998; Berg and Bowker 1997; Bruni 2005; Constantinides and Barrett 2006; Iedema 2003; Moser and Law 2006; Pirnejad et al. 2007; Pouloudi et al. 2004; Stoop, Bal, and Berg 2006; Winthereik 2003; Winthereik and Langstrup 2009; Winthereik, van der Ploeg, and Berg 2007.

[f]Aarts, Ash, and Berg 2007; Ash et al. 2006; Ash, Sittig, Campbell, et al. 2007; Ash, Sittig, Dykstra, Campbell, et al. 2007; Ash, Sittig, Dykstra, Guappone, et al. 2007; Ash, Sittig, Poon, et al. 2007; Ash et al. 2009; Braa et al. 2006; Braa, Monteiro, and Sahay 2004; Campbell et al. 2006, 2007; Ellingsen 2003; Ellingsen and Monteiro 2003b, 2003c, 2006; Ellingsen and Munkvold 2007; Ellingsen and Obstfelder 2007; Han et al. 2005; Hanseth et al. 2006; Hanseth and Monteiro 1997, 1998; Hasan and Padman 2006; Jaeger and Monteiro 2005; Koppel et al. 2006; Obstfelder and Moen 2006; Tamuz and Harrison 2006.

TABLE 3
Breakdown of Systematic Reviews and Primary Studies

	Number of Studies/Reviews
Systematic reviews (mostly from meta-narrative 1)	
Review of reviews using Cochrane methods with some qualitative analysis[a]	1
"Cochrane" review restricted to RCTs with a statistical meta-analysis	1
"Cochrane" review restricted to RCTs but no meta-analysis	4
"Cochrane" review of other quantitative designs but no qualitative analysis	6
"Cochrane" review of quantitative designs with some form of qualitative analysis	9
Qualitative review using realist method	1
Other qualitative or narrative review	2
Total systematic reviews	24
Primary studies (excluding meta-narrative 1[a])	
Organizational case study	
Single site (i.e., main goal was understanding within the case)	18
Multisite (i.e., a key goal was comparison across two or more cases)	20
Ethnography of situated practice[b]	12
Actor-network analysis[c]	19
Participatory study	
Action research	4
Codesign[d]	2
Qualitative study (interview, focus group, or both)	5
Quantitative study	
Quantitative survey alone	2
Quantitative survey supplemented by in-depth qualitative interviews	2
Before and after study	1
Randomized controlled trial	1
Other study design	
Empirical philosophy[e]	4
Discourse analysis	2
Simulation study	2
Total primary studies	94

Notes: The unit of analysis for the empirical studies in this table is the study. Hence if one study led to three papers, only one of these was "counted" here. The only exception is one study in which the data were completely reanalyzed using a different theoretical perspective. Accordingly, this table double-counted this study.

[a]This review of reviews included all Cochrane reviews covered here, plus fourteen additional systematic reviews of specialist aspects of EPR use.

[b]Detailed ethnography of the fine-grained detail of clinical (or administrative) work, often using techniques such as video or computer screen capture, and drawing on Garfinkel's ethnomethodological approach and situated action theory.

[c]Mapping and analyzing a dynamic network in which both people and technologies are "actors."

[d]A form of action research with a stronger technical element, effectively participatory workplace redesign alongside technical (re)development (sometimes called *technomethodology*).

[e]Mainly theorizing but based on a small amount of empirical data (usually from ethnography of situated practice).

Scholar to identify which subsequent papers had cited a seminal early publication). In addition, 16 percent of sources were already known to our team; 5 percent came from our social networks (asking colleagues if they knew of relevant papers); and 5 percent were serendipitous (finding a relevant paper when looking for something else).

Meta-narrative 1: Health Information Systems (HIS)

Health (or medical) informatics is the application of computers to clinical work, and health information systems (HIS) research is the study of the systems that support such work (Chiasson et al. 2006). This predominantly positivist tradition was developed jointly by doctors with an interest in computers and computer scientists with an interest in medicine (Gardner et al. 2009). The tradition is rooted in quantitative approaches and came to be strongly influenced by the ideas and values of EBM, with an emphasis on experimental studies; the preferred design is the RCT. Much (though not all) of health informatics has assumed that the benefits of a well-designed EPR with built-in "evidence-based" decision support are intrinsic and self-evident. For example, the EPR reduces legibility errors and hence makes prescribing safer. The key challenge was seen as getting the design right, implementing the technology, and ensuring that clinicians used it. Although health informatics has a large literature on technical design, it is separate from the literature on the implementation and use of such systems in organizations. In the latter literature, at least until recently, neither the technology nor its social context was considered in depth. Empirical studies of "the EPR" (sometimes a reified concept) were grouped together by systematic reviewers in meta-analyses, as were studies of "computerized decision support."

Our own searches found twenty-four systematic reviews in this tradition covering more than 2,000 primary studies, each of which measured the impact of the EPR on some aspect of the quality, safety, or efficiency of care. Of particular note is a recent 600-page "review of reviews" embracing the EPR and other information and communications technology innovations, which covered thirty-seven previous systematic reviews (Car et al. 2008). Car and colleagues found that while some primary studies and some, but not all, systematic reviews showed positive benefits from the EPR, the nature and magnitude of benefits were not consistent

across studies, nor were there clear findings on how benefits might be maximized or what their opportunity cost might be. The preponderance of small studies with methodological flaws and positive outcomes in the early HIS literature raises the possibility of publication bias, and we were surprised that none of the reviews in this tradition included an estimate of its extent.

Kaplan argued in 2001 that the criteria that many systematic reviewers in the HIS tradition used to select their sample of "high-quality" trials led them to focus on studies in which the very features that might explain the effect of different organizational contexts had been designed out (Kaplan 2001). Perhaps partly in response to this, the HIS literature has begun to move beyond studies restricted to measuring impact ("EPR on" versus "EPR off") and to address how context mediates and moderates this impact. A recent systematic review of 183 primary studies, for example, related the impact of EPR systems to contextual variables (Shekelle and Goldzweig 2009). The data pointed to a significant difference in the likelihood of success between local "homegrown" EPR systems (developed in an ad hoc way by clinicians close to the operational detail of key work practices) and "off the shelf" systems (developed as either commercial products or public-sector systems of choice). "Homegrown" EPR systems typically emerged slowly and at the pace of local enthusiasm, energy, and need. Some impressive examples of highly efficient systems associated with improved quality and safety of care in world-leading centers of excellence were found (one notable example being the U.S. Department of Veterans Affairs, which introduced a paperless record system and afterward documented significant improvements in health outcomes) (Kupersmith et al. 2007). But the reviewers concluded that "these [homegrown] interventions are by nature not widely generalisable" (Kupersmith et al. 2007, p. 5). "Off the shelf" EPR systems, however, were often purchased or acquired as part of a strategy for rapid change (e.g., to solve a perceived pressing problem in the system). These systems typically failed to meet expectations and incurred problems of fit with the detail of work practices. Shekelle and Goldzweig (2009) concluded that an EPR system should be considered as a complex intervention with four key components—technical, human, project management, and "organisational and cultural change"—all of which must be systematically studied. This conclusion, implicitly if not explicitly, highlights the need for dialogue between the HIS tradition and some of the other meta-narratives we describe here.

Meta-narrative 2: Change Management Studies within Health Services Research

Researchers in the change management tradition are usually upbeat about the benefits of the EPR but assume that these will be realized only if the change process is properly managed (Heeks, Mundy, and Salazar 1999; Kaplan et al. 2001; Lorenzi et al. 2008). Although they sometimes argue that the "ideal" research design would be a RCT, the studies actually undertaken are generally qualitative and built on an interpretivist philosophy. We found sixteen empirical studies in this meta-narrative (for details, see table 2), most of which were single-site or multisite organizational case studies, each of which had considered the impact of a range of potential enabling or constraining factors on the fortunes of a project to implement a new EPR system. The studies consistently showed that introducing the EPR in an organization or across organizations is a complex task. It requires a well-articulated vision and strategy, strong leadership, adequate resources, good project management, an enabling organizational culture, effective communication, and attention to human resource issues. Even when these preconditions were present, success was not guaranteed, a finding that perhaps reveals the known weaknesses of contingency theories in the study of organizational change (notably that they lack precision and fail to explain much of the observed variance).

Meta-narrative 3: Information Systems (Positivist Approaches)

Information systems (IS) research is a heterogeneous tradition that emerged in business schools to consider the role of technology in business and management. It embraces a long-standing tension between positivist and nonpositivist philosophical approaches. In IS research overall, the literature is dominated by the former and is characterized by hypothesis-driven designs predicated on what are sometimes called *variance models* (DeLone and McLane 1992; Sabherwal, Jeyaraj, and Chowa 2006). But very few such studies on the EPR have been published, perhaps because of the complexity and unpredictability of health care work and the highly institutionalized nature of the health care sector (DeSanctis and Poole 1994). We found only three empirical studies in positivist IS research relevant to our research question

(listed in table 2), all of which demonstrated that model-based analyses of the determinants of EPR success left much of the observed variance unexplained.

Meta-narrative 4: Information Systems (Interpretivist Approaches)

The interpretivist perspective holds that the use, design, and study of information systems are fundamentally a hermeneutic (meaning-making) process rather than a rationalistic, decision-making process (Boland 1979). We found eleven studies in this tradition, including papers that drew on institutional theory (Currie and Guah 2007), symbolic interactionism (Prasad 1993), organizational sense making (Brown and Jones 1998; Desjardins, Lapointe, and Pozzebon 2006), and "soft systems" action research (Checkland and Holwell 1998). These different applications might justify splitting this meta-narrative further into a number of subnarratives. But the findings were highly consistent across studies: there are multiple and conflicting framings of the EPR by users (assumptions about it, expectations of it, versions of the problem to which it is seen as a solution), some of which are explained by deeply held institutional values (e.g., what counts as "professionalism" among doctors or what is seen as "good nursing care"). These contrasts partly explain the low adoption and slow spread of the EPR in many health care settings. "Successful" implementation requires accommodation among perspectives. Externally imposed deadlines and technical requirements constrain the process of mutual adaptation by which technologies and work processes become aligned.

Interpretivist approaches are popular in some academic circles, and the retrospective studies just cited offer novel explanations for failed EPR projects. However, there appears to be surprisingly little peer-reviewed research on how interpretivist approaches might be used proactively and explicitly to shape the effective implementation and use of EPR systems, especially in large-scale programs. This may be partly because such studies are highly applied and necessarily pragmatic (thus the criteria for "rigor" differ from those in more experimental traditions) and because the change agents who facilitate the process of soft-systems design or technological codesign sometimes present themselves as consultants rather than academics.

Meta-narrative 5: Information Systems (Technology-in-Practice Approaches)

Most studies in this tradition are linked to the work of Wanda Orlikowski and her team, who applied Giddens's structuration theory (see the glossary) to the introduction of technologies in organizations. Steve Barley's classic demonstration in 1986 that a new technology introduced into the workplace is an "occasion for structuring" offered high hopes for the study of a new generation of technologies in the health care sector (Barley 1986). His widely cited work suggests that a structurational approach to the study of the EPR could show how this technology might shape and support new roles and new ways of collaborative working, which would then become routinized, with positive impacts on patient care and clinical outcomes as well as the EPR's effective embedding in organizations. Our findings indicate that these hopes have yet to be realized. The eight empirical studies identified provide examples of abandoned EPR systems (Sicotte et al. 1998); widespread disruption of routines and mismatch of expectations (Davidson and Chiasson 2005; Mogard, Bunch, and Moen 2006); continuing dependence on paper or ad hoc, nonintegrated EPR systems (Østerlund 2002); and distortion of organizational response by the prevailing political and financial context of a nationally imposed program (Rodriguez and Pozzebon 2006). So far, then, the EPR has not been an "occasion for structuring" in any simple sense.

The largely negative findings from this handful of studies nevertheless offer some important insights. Orlikowski and her colleagues demonstrated that individuals, working collectively around common tasks in organizations, actively and explicitly shape both technologies and work routines in a mutually adaptive way (Orlikowski et al. 1995). In relation to the EPR, this adaptation does not appear to be taking place or, at least, not taking place smoothly or unproblematically. Key influences on the structuration process include the affordances (see the glossary) of the technology, the constraints of time and space, the conflicting meanings attached to the EPR by different groups, the patterns of human action and interaction associated with them, and how different "genres" of medical records are used and combined in both traditional and contemporary patterns of care. "Failed" EPR projects may be explained by adverse changes in the temporal or spatial structuring of work consequent on introducing new technology, the fact that knowledge is linked

in complex ways to identities and social practices, and limitations of the available technology. As the CSCW literature also has shown, health care work is uniquely complex and dependent on the coordinated practice of multiple actors. The research to date has barely scratched the surface of what the introduction of the EPR means, at the level of fine-grained detail, for a health care organization and the staff and patients who practice and interact in that setting—and still less so when the EPR is part of a large-scale regional or national program.

Meta-narrative 6: Computer-Supported Cooperative Work (CSCW)

CSCW developed from human-computer interaction and considers the collaborative use of computers by people in the workplace (Ackerman 2000; Grudin 1988). It draws eclectically and pragmatically on both positivist approaches such as distributed cognition (the study of how knowledge and computation is shared by various human brains and computers) and recursive ones like situated action (the study of how action is an ongoing accomplishment achieved by attention to local, situated detail). The preferred research design is the ethnography of the "situated micropractices" (i.e., the localized detail of what is done) of collaborative work, focusing on such things as the sequential ordering of utterances or actions and the indexicality of entries on the record (i.e., which other entries to which an entry implicitly refers).

We found eleven empirical studies on the EPR using this tradition, and in addition, meta-narratives 7, 8, and 9 draw on the principles of CSCW. These rich ethnographies have illustrated, often in meticulous detail, that collaborative clinical work involves the ordering and coordination of tasks, which requires the real-time processing of local information. They have shown that clinical knowledge is often tacit, context bound, and ephemeral rather than codifiable, transferable, and enduring. In "failed" EPR projects, technical designers typically missed these subtleties and produced artifacts that fitted poorly with the situated nature of knowledge and the microdetail of clinical work practices. Paper records, being flexible, portable, and tolerant of ambiguity, support the complex work of clinical practice remarkably well. CSCW studies have highlighted a telling paradox: that high-tech health care

environments such as intensive care units often extensively use paper charts, white boards, sticky notes, and oral communication.

Despite its apparently negative conclusion that the EPR is often *less* fit for the purpose than paper is, the CSCW literature on the EPR does not oppose technology, for three reasons. First, it has shown that humans can be very creative in overcoming the inherent limitations of technologies ("workarounds"). This tradition surfaces and values the "hidden work" that achieves positive outcomes despite the inflexibility of technology (Suchman 2007). Second, the EPR can provide multiple views and framings of the data and thus *can* tolerate (and perhaps overcome) the ambiguities inherent in interprofessional work and make the work of different professional groups more visible to others (Reddy, Dourish, and Pratt 2001). There is considerable scope for more flexible and technologically sophisticated forms of the EPR (e.g., mobile devices) to overcome current limitations. But for this to happen, technology (re)design must occur in intimate proximity to the work process and actively involve users and potential users of the EPR (Hartswood, Procter, Rouncefield, and Slack 2003; Oudshoorn and Pinch 2005).

Third, CSCW researchers have recognized two potentially conflicting work processes: immediate clinical care (primary uses) and tasks such as audit and research that are one step removed from the clinical encounter (secondary uses) (Heath and Luff 1996; Symon, Long, and Ellis 1996). When used as a formal tool (e.g., with structured templates and a requirement for data to be coded), the EPR often slows down and frustrates the clinical encounter, but it greatly accelerates the secondary uses of clinical data. Rather than promising that the EPR will "save time" or "make clinical care more efficient," a more honest message would be that creating accurate and complete clinical records requires the sacrifice of time and effort by frontline clinical and administrative staff but that this is (sometimes) justified by more benefits for efficient business processes (e.g., billing), governance, and research. Appropriate incentive structures are needed to ensure that those who do the work reap the appropriate rewards (Berg 2001; Pratt et al. 2004).

Meta-narrative 7: Critical Sociology

Critical sociology draws on the work on power by feminist scholars and the philosopher Michel Foucault (Schneider 2006; Willcocks 2006). In

sum, technologies reflect the interests and values of those who produce them. Accordingly, power struggles between bosses and workers, clinicians and managers, men and women, and the state and the citizen are played out partly through the design and use (or, indeed, nonuse) of technology (Zuboff 1988). The EPR may be a focal point around which disputes of professional jurisdiction are fought.

We found nine studies from a feminist perspective and three from a Foucauldian perspective. Feminist studies have demonstrated that EPR designers have sometimes failed to understand or fully incorporate the work practices of female staff with relatively low status in the organization, especially frontline nurses. They also have shown that nurses' work (which is largely unpredictable, close to the patient, and difficult to standardize or codify) maps closely to what the CSCW community views as *articulation*: the situated actions of creative human agents that can bridge the gap between the formal and the informal, the social and the technical. Thus, while some findings appear largely negative and unsurprising (that nurses may "resist" technology and see it as marginal to their work), the feminist literature also offers a more positive insight: that there is an important, subtle, and largely unexplored territory of "hidden work" by groups such as nurses, administrators, and data entry clerks that demands further research and offers the potential for systematically exploring and addressing the gap between theory and practice in health care.

The three studies from a (broadly) Foucauldian perspective link the introduction of the EPR with the rise in managerial surveillance and control of clinical work and draw on Foucault's concept of the panopticon. His concept is that there is an increasing capacity for large-scale surveillance of human activity, supported by technology but also embodied and policed by the actors concerned. The story is more complicated, however, than an inexorable growth in the oppression of clinicians by management (or patients by doctors), aided by technology, not least because Foucault's definition of power was a more fluid and generative one than this. One ethnographic study, for example, showed that not only did nurses successfully defend their professional practice in the face of a technical system that sought to "managerialize" it but also that managers accepted the nurses' account of what was legitimate and valuable and actively colluded with the latter's resistance to a poorly designed technology (hence the paper's title: "The Failed Panopticon") (Timmons 2003a).

Meta-narrative 8: Actor-Network Analyses

Actor-network theory (ANT) is built on a recursive philosophy (Latour 1992). It holds that people and technologies are linked in networks and that the focus of research should be the network's changing relationships and what emerges from them (rather than either the people or the technologies themselves). ANT has been applied in numerous ways, often in combination with other theories. It has been widely criticized, for example, for assuming that human and nonhuman "actors" can be treated as equivalent (Mutch 2002). Nevertheless, ANT has much to offer EPR research, especially since it is possible to draw on its core concepts while rejecting some of its more extreme assumptions.

An actor-network analysis is a special type of case study in which researchers define and explore a dynamic network of people and technologies as it evolves over time. As table 2 shows, we found twelve such studies of the EPR, all of which drew on CSCW as well as ANT, plus two empirically informed theoretical papers from ANT (Iedema 2003; Moser and Law 2006).

Many "findings" in this meta-narrative are conceptual; they invite us to think differently about the EPR, the EPR user, and the context in which the EPR is implemented. The EPR is not merely a container for information; it accumulates and transforms work (is "constitutive" of it) and is thus an actor (or "actant") in the network. The studies consistently demonstrated that the sociotechnical network in which the EPR is embedded is typically highly dynamic and inherently unstable. An actor-network can be stabilized to some extent when people, technologies, roles, routines, training, incentives, and so on are aligned. This alignment is achieved (or, at least, attempted) through what is known as "translation," which involves the four stages of problematization (defining a problem for which the EPR is a solution), interessement (getting others to accept this solution to the problem), enrollment (defining the key roles and practices in the network), and mobilization (engaging others in fulfilling the roles, undertaking the practices, and linking with others in the network) (Callon 1986).

Conceptualized from the ANT perspective, EPR projects "fail" when the elements in the network fail to align, that is, when efforts at translation fail. Codes and standards inscribed in the EPR and its infrastructure may help stabilize the network and thus shape and constrain medical and nursing work. The various actor-network analyses in this meta-narrative

describe the struggles (sometimes successful, sometimes not) of groups of actors who have sought to define and inscribe particular codes and standards into particular EPR technologies, and they show how once these have become part of the network, they are hard to reverse and both shape and constrain clinical work. Actor-network analyses of EPR technologies are highly regarded and extensively cited in the field of science and technology studies but have been either ignored or dismissed by most previous systematic reviews of the EPR. The reason for this is probably that ANT papers are often complex, based on very different assumptions and values from most of the biomedical literature (see table 1), expressed in a language with which most doctors and health care managers are unfamiliar, and lacking in clear, unambiguous messages on "what to do." However, Berg (among others) has worked hard to make this tradition accessible to health professionals and policymakers (Berg 2003; Berg, Aarts, and van der Lei 2003).

Meta-narrative 9: Systems Approaches to Risk and Integration

As described in meta-narrative 1, much of the health informatics research tradition has been oriented to designing EPR technologies that will improve patient safety by overcoming fallible human practice. Another, largely distinct, research tradition draws on safety-critical systems research and insights from other industries (notably aviation) to address the role of the EPR and the EPR user in complex, "high-tech" health care systems. Such systems are characterized by advanced technology, tight coupling (e.g., B must follow A and in a particular time sequence), and a high level of uncertainty, and—by virtue of all these—they are vulnerable to unpredictable, catastrophic failures (Roberts 1990). Accidents arise, rarely but inevitably, from the accumulation of such things as "minor" errors of judgment, flaws in technology, and small incidences of disrepair or damage (Perrow 1984). Successful high-reliability organizations are characterized by *mindfulness*. That is, staff must not rely too much on technical systems but must be constantly aware of the possibility of error and of the ongoing measures that must be taken to minimize it.

We found twenty-two primary research studies in this tradition, along with an interdisciplinary literature review that was thorough but not

explicitly systematic (Ash, Berg, and Coiera 2004). Overall, this meta-narrative provides considerable evidence that even though EPRs may contain features that protect against error, they also introduce new risks of their own, including cognitive overload, loss of overview, errors in data entry and retrieval, excessive trust in electronically held data, and the tendency to conflate data entry with communication within and among care teams (Ash et al. 2009; Weiner et al. 2007).

One body of work proved hard to categorize into a single meta-narrative because its authors explicitly sought to work across different research traditions. This work was developed by a Norwegian group who drew on CSCW, ANT, and systems theory to study large, networked EPR systems and the challenges of standardization, integration, and scalability within them (see, e.g., Ellingsen and Monteiro 2003a, 2003b; Ellingsen and Monteiro 2006; Hanseth et al. 2006; Hanseth and Monteiro 1997, 1998; Monteiro 2003). We placed this interdisciplinary work in meta-narrative 9 in table 2. An important finding from these authors' work is that networked EPR systems are not unproblematically scalable. The tension between standardization (which helps stabilize the network) and contingency (which reflects and responds to local needs and priorities) can never be resolved; rather, it must be actively and creatively managed—and this gets harder as the network gets bigger. As predicted by the principles of complexity theory, overly assiduous efforts to "standardize" or "integrate," especially on a sizable scale, are likely to create disorder (and thus generate work) elsewhere in the system (Berg and Timmermans 2000). Because of unpredictability, unintended consequences, and the loss of potential for using information in a locally meaningful and situated way, large-scale distributed EPR systems are likely to be less efficient, less cost-effective, less safe, and the information they contain less trusted than smaller, more local systems (Ellingsen and Monteiro 2003a; Hanseth et al. 2006; Hanseth and Monteiro 1997, 1998; Monteiro 2003). In a recent book, Hanseth added theoretical weight to these empirical findings (Hanseth 2007).

Synthesis

Because this heterogeneous literature is based on different philosophical assumptions and worldviews, a meaningful synthesis must not merely

summate the findings of different meta-narratives but also present the tensions and conflicts among them as higher-order data.

Next we consider seven key themes, each of which has inherent tensions. Most, but not all, the tensions are between studies that take a positivist worldview (broadly, meta-narratives 1 and 3) and those that take an interpretivist, critical, or recursive worldview (broadly, meta-narratives 2 and 4 through 9), although some traditions (notably CSCW) embrace more than one philosophical position.

The EPR

The first tension is between "the EPR as tool or container" and "the EPR as actor." Positivist traditions tend to take an essentialist, functionalist, and determinist view of the EPR (it has inherent properties that will perform certain tasks and, if implemented properly, will more or less predictably improve the process and outcome of the clinical encounter). In contrast, nonpositivist traditions view the EPR as either a social construction (something whose meaning and purpose are a matter of interpretation) or a fluid and flexible artifact that "acts" (to use the language of ANT) in particular, situated, and constantly changing contexts. If these last two views (built, respectively, on an interpretivist and a recursive philosophy) are accepted, it follows that the impact of introducing an EPR cannot be predicted from its essential properties and hence that studies seeking to "determine the (generalizable) impact of technology X on outcome Y" have limited value.

Positivist traditions hold that the patient's condition and journey comprise a single reality to be represented in the EPR and so seek a single ideal and "agreeable" form of the record. Multiple "front ends" of the record are allowable (e.g., nurses might be more interested in some data fields and doctors in others), but the underlying *reality* represented by the record is generally considered to be unitary, context free, and unproblematic. Interpretivist and recursive traditions hold that the very notion of an "agreeable" EPR (or a single reality represented by it) is problematic. As one seminal paper put it, the EPR's bodies are multiple (Berg and Bowker 1997).

Research traditions differ in their emphasis on the EPR's material properties. Positivist systematic reviews typically offer comparisons of the general format "EPR present" versus "EPR absent" or "decision

support on" versus "decision support off." Similarly, the interpretivist literature generally places more emphasis on the meaning of the EPR in the eyes of users and potential users than on what the EPR can and cannot do in particular conditions of use. In contrast, research in recursive traditions (much of CSCW, as well as technology-in-practice and ANT) regards the EPR's material properties (and indeed, the material properties of paper, desks, white boards, and so on) as central to their analysis. Critical sociology and ANT studies assume that power relationships are (at least to some extent) built into the structure and data models of the EPR. The feminist literature, for example, talks of the "gender scripts" inscribed in technology (Henwood and Hart 2003), and ANT gave us the powerful metaphor of software as "frozen organizational discourse" (Walsham 1997).

The EPR User

There is a tension in the literature between a cognitive view of the human subject (the user is seen as an information processer or decision maker) and a relational view (the user is defined primarily by his or her position within a social or sociotechnical system). The former perspective explains the nonuse of the EPR as a "knowledge gap," "skills gap," and "motivation gap" (thus as attributes of the individual actor) for which much of the solution is the provision of information, training, and incentives. The cognitive view assumes, broadly, that the outputs of a group of people using technologies will be the sum of their individual inputs. The relational view sees the EPR user as inextricably linked to (indeed, as embodying and reproducing) wider social structures, institutions, or sociotechnical relationships (and perhaps as "shaping" the EPR rather than "using" it) and thus regards the collective as more than the sum of its parts. While different language is used in different traditions ("ensemble," "situated," "embedded," "accommodated," "networked"), these terms share many meanings, and all place greater emphasis on system-level approaches than on interventions aimed at the individual.

One key difference between two traditions that otherwise have much in common—technology-in-practice (meta-narrative 5) and ANT (meta-narrative 8)—is the treatment of the human agent. Technology-in-practice draws on structuration theory and sees human identity and agency as central to the analysis; it offers a sophisticated theory about

what agents "know" (which, crucially, includes internalized social structures). ANT, in contrast, considers agency to be a *product* of the network rather than something intrinsic to the individual actor, so such things as knowledgeability and motivation are only weakly and indirectly theorized (Mutch 2002).

Organizational Context

One of the most striking differences among the research traditions covered in this review is their treatment of context. The tension might be expressed as "context as the setting within which the EPR is implemented" and "context as the EPR-in-use" (reflecting the difference in focus between "the organization as the place where work happens" and "the process of organizing, wherever it happens"). The positivist literature effectively views context as a conglomeration of confounding variables, which must be either carefully quantified and modeled or controlled for in a RCT design. This approach to context must overcome the challenge of repeating decomposition, that is, the sheer impossibility (especially in the highly complex field of health care) of incorporating anything approximating the fine-grained detail of the numerous contextual variables into the analysis (DeSanctis and Poole 1994). Critical research traditions also tend to view context as an external reality, in this case made up of economic and social structures that constrain action (and do so in an unequal and potentially oppressive way).

The recursive (and, to some extent, the interpretivist) research traditions share a more inclusive, holistic, and fluid view of context. Context is seen as an emergent property of action constituted by, and therefore inextricable from, an activity involving people and technologies. Researchers in these traditions do not see themselves as studying "technologies" and "contexts" separately but as studying technologies-in-use. Indeed, this inseparability of the EPR from its context (the fact that context is constituted by the EPR-in-use) is a defining characteristic of literature that adopts a recursive philosophy.

Clinical Work and Knowledge

The tension here might be expressed as "clinical work as decision-making" versus "clinical work as situated practice," and between

"knowledge as transferable facts" versus "knowledge as information-in-context." Positivist traditions tend to view clinical work as largely reducible to a series of decisions, and it follows that decision support technologies will help clinical work so long as they are properly designed and implemented. The alternative view is that clinical work is less about decision making than about addressing the ongoing, local question, what to do next? (Garfinkel 1967a), and since health care work is personalized, filled with exceptions, and context bound, "the nature of health care work sets natural limits to the possibilities of IT to revolutionize this work" (Berg 2003, p. 337).

The conclusion reached by this alternative literature is not merely that the considerable research energy and resources that have so far been put into refining and testing decision support systems and other algorithmic components of the EPR have not substantially improved the quality or efficiency of frontline clinical work *yet*. Rather, the conclusion is that they are unlikely ever to produce dramatic gains in these areas. The alternative literature suggests that gains in the quality of care with EPR systems are likely to be relatively modest, incremental, local, and based on the study of articulations and workarounds (i.e., of the creative human work bridging the gap between technical design and clinical reality), although this view still recognizes the major potential efficiency savings that EPR systems offer for secondary uses.

Different traditions in EPR research dispute the extent to which information placed on the EPR can be extracted from its context and transferred to a different context while still retaining its meaning. The biomedical literature sometimes talks of "information superhighways" that will make clinical information instantly available in a way that transcends the context in which this information was originally collected (Detmer 2000). The idea that meaning is transmitted unproblematically along with data underpins many of the large-scale EPR programs currently under way (notably the National Programme for IT in England) (Department of Health 2008) and the plans for an extensive expansion of the IT infrastructure in the United States (Institute of Medicine 2009), but critics of this type of program claim that this is a flawed assumption (Berg 2000). The CSCW, technology-in-practice, and ANT literatures all offer evidence that clinical data must be interpreted in context and "framed" before they become meaningful. Thus, while positivist studies of collaborative clinical work view it as largely pertaining to the exchange of information among distributed decision makers (human and

technological), interpretivist and recursive models place much greater emphasis on *communication,* one aspect of which is contextualizing work (prioritizing, highlighting, comparing, contrasting, pointing out trends over time, interpreting, negotiating, and other tasks not achieved simply by placing information on an electronic platform that is accessible by multiple users) (Hartswood, Procter, Rouncefield, Slack, and Voss 2003; Symon, Long, and Ellis 1996).

The Process of Change

This tension might be expressed in terms of the "logic of determinism" versus the "logic of opposition" (Robey and Boudreau 1999). Taken to its extreme, the logic of determinism is focused on technology and is causalist (technology X will produce output Y, and Y can be measured) and fundamentally linear (it recognizes complicatedness but not complexity) (Plsek and Greenhalgh 2001). It assumes that the human interactions and organizational context in which technology is used will operate on the same formal and predictable technical principles as the technology itself. In such a model, the change process is one of "good project management" that sets clear strategic goals and ensures that all parties work systematically toward these.

The logic of opposition, in contrast, is fluid and contingent and contains inherent and unresolvable tensions. These tensions are variously expressed as "competing institutional logics" (Scott 2001), the need for "accommodation" (Checkland and Holwell 1998), "sense making" (Weick 1995), "negotiating knowledge among different communities of practice" (Lave and Wenger 1991; Østerlund and Carlile 2005), or "translation" (Latour 1992), approaches that have much conceptual common ground (Fox 1999; Weber and Glynn 2006). If this logic is adopted, it follows not merely that the change model will be neither linear nor predictable but also that there will be *conflict* involved. Even though good project management is essential, the key task is managing an effectively political process in a flexible and reflexive way as the drama unfolds.

One aspect of the process of change that is addressed very differently by positivist and interpretivist/recursive traditions is design. As table 1 shows, there are two principal opposing philosophical positions on design: the conventional approach (whose roots are in positivism and whose

focus is on engineering) and the participatory approach (whose roots are in interpretivism and whose focus is on social meaning). Hartswood, Procter, Rouncefield, Slack, and Voss (2003) offer a particularly eloquent exposition of the principles of codesign and call for the development of "shared practice" between designers and users. Berg talks of "growing" rather than building information systems and working to achieve synergy among three fundamental (re)design tasks: the technical system, the primary work process (e.g., clinical care), and the secondary work process (e.g., audit, management) (Berg 2003).

The Impact of Change—And the Definition of Success

The EPR tends to be introduced as part of a project or program, whose success is generally (though not always) measured by some sort of evaluation. The main tension here is between "success as objectively and prospectively defined" and "success as socially negotiated and context specific." Positivist traditions generally assume that "success" can be measured unproblematically in terms of metrics (e.g., Does the technology work? What are its uptake and usage rates? How satisfied are users?) (Mitchell and Sullivan 2001) and that transferable "success factors" can be deduced from empirical studies.

The interpretivist, critical, and recursive traditions problematize the very notion of success in an EPR project or program (e.g., it will be defined differently by different stakeholders) (Berg 2001; Klecun and Cornford 2005). These traditions also recognize that the most immediate and easily measurable impacts of a new EPR system (such as more time needed to enter data or frustrations stemming from the model-reality gap) may fail to capture more subtle or distant potential benefits (such as the easier and more reliable production of aggregated data or greater capacity for research). Accordingly, just as the "success" of a project may be talked up for political reasons, so "failed" projects should not be dismissed out of hand (Berg 2001). Critical traditions argue that the success of an EPR project also has an ethical dimension, asking, for example, who has the power to define what counts as success, who sponsors the evaluation and what its hidden aims are, and whose interests are (and are not) represented in the evaluation (Klecun and Cornford 2005).

Complexity and Scale

A final tension in the literature is between "the bigger the better" and "small is beautiful." The former view is frequently expounded in the HIS literature, whereas just as electronic systems are seen as inherently better than paper, so large, integrated systems are seen as having inherently greater value than small, isolated ones (a ubiquitous truism known as Metcalfe's law). Progress in this meta-narrative is identified as shifting from parochial departmental HIS strategies and goals to institutional, national, and even international ones and also as the concomitant need to explore new, transinstitutional information system architectures and standards (Haux 2006). Policy decisions in many countries have accepted this view and used it to justify increasingly large-scale EPR initiatives (Kreps and Richardson 2007).

The alternative view is that efficiency gains and economies of scale will never be realized because of the trade-off in loss of local, contextual detail (and thus the loss of *knowledge*) and the magnification of political disputes among stakeholders. This view runs across most of the CSCW, technology-in-practice, and ANT literature and is captured in the law of medical information:

> The further information has to be able to circulate (i.e. the more diverse contexts it has to be usable in), the more work is required to disentangle the information from the context of its production. The question that then becomes pertinent is; who has to do this work, and who reaps the benefits? (Berg and Goorman 1999, p. 51)

Although this rule certainly helps explain numerous unsuccessful large-scale EPR initiatives, a more nuanced version of it may now be needed to account for the uncommon examples of successful ones (see meta-narrative 1).

Discussion and Recommendations

Both this review and the recently published "review of reviews" on e-health research (Car et al. 2008) were written by British teams who were also undertaking empirical research on the National Programme for IT (NPfIT), described by some authors as the largest ever civilian IT project

(Brennan 2007; Department of Health 2008). The UK NPfIT appeared to be built on six assumptions, that the EPR (1) is primarily a container for information about the patient; (2) can be integrated seamlessly and unproblematically into clinical work; (3) will increase the effectiveness and efficiency of clinical work; (4) will drive changes in how staff interact with the patient and one another; (5) should replace most, if not all, forms of paper record, which are old-fashioned and limited; and (6) the more comprehensive and widely distributed it is, the more value it will add.

Much of the literature covered in this review suggests, conversely, that (1) the EPR may be alternatively conceptualized as an "itinerary," "organizer," or "actor"; (2) seamless integration of different EPR systems is unlikely because human work will always be needed to bridge the model-reality gap and recontextualize knowledge for different uses; (3) while secondary work (audit, research, billing) may be made more efficient by the EPR, primary clinical work is often made less efficient; (4) the EPR may support, but will not drive, changes in the social order of the workplace; (5) paper will not necessarily disappear, as it offers a unique level of ecological flexibility (although workable paperless systems have been developed in one or two centers); and (6) smaller, more local EPR systems may often (though perhaps not always) be more efficient and effective than larger ones.

Our findings suggest seven areas in which further research is likely to add significantly to the knowledge base. Some of these would benefit from secondary research, since the literature already contains valuable findings.

First and foremost, there is an agenda for *theory building*. It is striking that many of the alternative approaches to research on the EPR in organizations uncovered in this review have developed in parallel rather than in dialogue with one another. In our view, although there is no need for a new "grand theory," there certainly is scope for developing creative theoretical and methodological approaches by blending existing theories. In particular, some researchers (including our own group) have already begun to combine ANT with a more sophisticated theory of human agency (Greenhalgh and Stones 2009).

Second, there is an extensive primary research agenda on what has been called "appreciating situated micropractices" in different clinical settings (Ellingsen and Monteiro 2006, p. 444). The research conducted to date on the microdetail of collaborative clinical work from an ethnographic perspective appears to comprise fewer than twenty studies in

total. There is much we do not yet know, for example, about what "working knowledge" *is* or how it is produced in different clinical settings and specialties (Ellingsen and Monteiro 2003b). The "hidden work" of those close to the patient (e.g., nurses and administrative staff) should be a particular focus in this program. There is much room for a detailed study of the communicative dimensions of collaborative clinical work, including how staff contextualize and prioritize knowledge for shared use.

Third, a systematic review is needed on *how information systems in health care and comparable settings might be (co)designed in the workplace* (i.e., on the proactive application of interpretivist and recursive approaches to maximize the sociotechnical fit of such systems). This literature was partially covered in this review, but we believe there is a need for a more technically oriented review by an interdisciplinary team with representation from software engineering, design, and CSCW as well as sociology and clinical disciplines. Important insights are likely to be drawn from the computing and design literatures beyond the health care setting. There also is scope for additional primary studies in this area. This review identified a number of studies on how actors made sense *retrospectively* of EPR projects, but we found very few published studies in which a sense-making or soft-systems approach was used *prospectively* in action research or comparable participatory designs. This may be partly because such studies are notoriously difficult to write up as short, focused case studies for academic journals. It may also be because funding for such studies is hard to come by. We recommend that careful thought be given to developing hybrid funding streams from research and service in this area, with a view to developing and disseminating some case examples of what has been called "engaged scholarship" (Van de Ven 2007).

Fourth, the dramatic differences in success between "off the shelf" (commercially developed) and "homegrown" EPR systems, as well as the question of whether and in what circumstances "small is beautiful" in EPR systems, all demand further critical exploration. Our review found no evidence that large-scale commercial IT systems in health care produce the benefits anticipated by their architects, and a few high-quality studies suggest that they do not. But we also found recent evidence that if EPR systems are developed organically and in-house, scale per se may not be a bar to their success. Prospective, theory-driven primary studies of large-scale EPR systems are urgently needed and should be undertaken from an interdisciplinary perspective that

includes CSCW, systems design, economics, management studies, and clinical disciplines. This program could include the question of how small-scale, homegrown, modularized systems that support effective collaborative clinical care in local settings could be interfaced with other small-scale systems so as to achieve multiple objectives (local information sharing, local research, and also secondary uses of data at the regional and national levels).

Fifth, a systematic review of the *ethics and practicalities of data sharing* is needed. We identified some important papers on this topic but put them aside because of resource and time constraints. Such a review should cover topics like the balance between technical security and accessibility; the nature of the trust relationship among the individual, the clinician, and the EPR; the desire (or not) of patients and citizens to view data concerning them; the changing dynamics of the clinical relationship as information inequality is redressed; and the involvement of patients, citizens, and civil liberties groups in influencing policy in this area.

Sixth, and perhaps as a cross-cutting theme in all the preceding areas, the realpolitik of EPR projects within and among organizations and interest groups should be more explicitly explored. ANT offers one (but not the only) theoretical perspective for addressing this. More generally, Orlikowski and Yates called for more research on the "messy, dynamic, contested, contingent, negotiated, improvised, heterogeneous, and multi-level character of ICTs in organizations" (Orlikowski and Yates 2006, p. 132). We suggest that sponsors and publishers eschew sanitized accounts of successful projects and instead invite studies of the EPR in organizations that "tell it like it is," perhaps using the critical fiction technique to ensure anonymity (Winter 1986).

Finally, given the mismatch between what is known about the EPR in organizations and what many policymakers *assume* is known, there also is room for research that addresses this mismatch. Our review covers a contemporary policy issue characterized by a vast (but, at the same time, ambiguous, conflicting, and incomplete) evidence base that both practitioners and policymakers (including those who set research policy) need some guidance to understand. The role of the systematic reviewer in this process is itself worth studying, since very little research on knowledge translation to date has explored such turbulent waters.

Our review also identified some areas where more research does *not* appear to be needed, either because definitive findings have already been produced in those areas or, for epistemological reasons, because there

never will be definitive findings (or any real hope of reducing uncertainty beyond its current level). We believe there are three such areas. The first is simplified experimental studies based on functionalist and determinist assumptions of the general format "What is the impact of technology X on outcome Y?" or variations thereof. We are not suggesting that such designs are never justified but that the circumstances in which they add value are more limited than is often assumed. Second, we believe that surveys of attitudes of patients or staff toward "the EPR" or "computerization" that are not adequately contextualized have almost no enduring value. Finally, we caution against undertheorized qualitative studies of "failed" (or, indeed, "successful") EPR projects. Although it is relatively easy to interview a range of stakeholders and ask their views, more studies showing (for example) that leadership and vision are better than no leadership and no vision are unlikely to add significantly to the evidence base. Funding for qualitative case studies of the EPR should be directed at studies that will enrich our theoretical understanding of this uniquely complex field.

Our team developed the meta-narrative method in a previous study to synthesize heterogeneous research literature on a complex topic (Greenhalgh et al. 2004, 2005). This method allowed us to tease out a number of different streams of research and show how the seminal books and papers in each tradition inspired programs of theory building and empirical research. It also allowed us to compare and contrast these traditions in a structured way, as illustrated in table 2. This review confirmed that even in the twenty-first century (when the work of researchers in other disciplines is readily accessible), most established scientists, most of the time, still operate largely within a single epistemic community and focus primarily or exclusively on the research questions being addressed by a relatively small group of colleagues.

We also found, however, that some researchers explicitly made links with other communities and used their concepts and theories. In some cases, this led to scholarly interdisciplinary research, higher-order insights, and the emergence of new paradigms (Ellingsen and Monteiro 2003b; Fox 1999; Østerlund 2004b). In other cases, discipline hopping produced a study that claimed allegiance to one research tradition but operated on the assumptions of another or that used a methodological approach that sounded appropriate but had not been applied rigorously or consistently. Some papers claiming to be seminal (and sometimes cited as such) offered little more than an incoherent list of concepts

and jargon phrases. While such confused efforts at scholarship are a fact of academic life these days, the meta-narrative approach allowed us to identify systematically the distorted concepts and flawed reasoning that they contained.

Conclusion

When we embarked on this review, we did not set out to provide an exhaustive account of all research ever undertaken on the EPR or its implementation in organizations. Instead, our goal was even more ambitious: we sought to illuminate and challenge the way that researchers think. The meta-narrative method has shown that "conflicting" findings in this large and heterogeneous literature can be fruitfully expressed as tensions and paradoxes relating to the nature of the EPR, the context in which it is implemented and used, and the way success in an EPR program is defined and pursued. Although it is tempting to present the mainstream (traditionally positivist) biomedical literature as incommensurable with, and perhaps philosophically less sophisticated than, studies written from interpretivist, critical, and recursive positions, the latest evidence suggests a less polarized picture. Studies from both inside and outside the health informatics tradition, for example, are raising questions about both the scalability and the transferability of EPR systems, especially when such systems are developed commercially rather than grown organically as part of an emergent change effort (Shekelle and Goldzweig 2009).

An interdisciplinary debate on priorities for EPR research and policy with input from academics, service users, clinicians, policymakers, technical designers, research sponsors, and the commercial IT sector is urgently needed. Accordingly, we offer this review as a preliminary contribution to that debate, not as the last word on it.

Glossary

Actor (or actant): In ANT, either a person or a technology that is part of the sociotechnical network.

Affordances: The material and technical properties of technologies that create the scope for achieving particular tasks (and that, conversely, make other tasks impossible).

ANT: Actor-network theory, a philosophical position characterized by a focus on a dynamic network of people and technologies that evolves over time.

Articulation: The local, situated actions of creative human agents that can bridge the gap between formal and informal and between social and technical.

Background sources: Books or papers that provided key contextual, theoretical, or historical detail for this review but that were not empirical studies of the EPR or seminal sources. Includes empirical studies of other technologies offering methodological insights.

CDSS: Computerized decision support system.

CPOE: Computerized provider (or physician) order entry, known in the UK as *e-prescribing*.

CSCW: Computer-supported cooperative work.

HIS: Health (care) information systems.

HSR: Health services research.

ICTs: Information and communications technologies.

IS: Information systems.

Meta-narrative: The overarching story line that drives research in a particular tradition, which embodies paradigmatic assumptions and values.

Meta-narrative review: An interpretivist approach to the systematic review of complex evidence, in which reviewers seek to define the overarching story lines that drive research in any particular tradition.

NHS: (UK) National Health Service.

Panopticon: A term introduced by Foucault to depict the increasing capacity for large-scale surveillance of human activity, supported by technology but also embodied and policed by the actors concerned.

Paradigm: A particular shared lens through which a group of researchers view the world, which contains four elements: concepts (what are considered the important objects of study and so what count as a legitimate problem to be solved by science), theories (how the objects of study are considered to relate to one another and to the world), methods (the accepted ways in which problems might be investigated), and instruments (the accepted tools and techniques to be used) (Kuhn 1962).

RCT: Randomized controlled trial.

Research tradition: A coherent body of theoretical knowledge and a linked set of primary studies in which successive studies are influenced by the findings of previous studies.

Seminal source: Theoretical or methodological publications that were cited extensively by subsequent researchers in a tradition and that shaped the focus and methods of research.

Structuration theory: A sociological theory developed by Anthony Giddens to bring together objectivist and subjectivist approaches to the study of social reality. Social structures have a real existence (i.e., they are "out there"), but they also are embodied ("in here") by human actors. As we enact social structures, we both reproduce and change them.

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