

HOW A PAPER CHART AFFORDS COLLABORATIVE AND DISTRIBUTED SMALL DATA EXPERIMENTS FOR DECISION MAKING UNDER UNCERTAINTY

Research-in-progress paper

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Abstract

This paper presents a micro-level study of affordances of a hospital paper drug chart in the clinical context of a care of the elderly. It discusses how the chart mediates the activity of prescribing pain medication under conditions of uncertainty, in a context of distributed work among different clinical roles, each with its own rules, rights and responsibilities.

The chart is a multidisciplinary tool used over the course of time of a patient hospitalization. Its paper format is known to afford flexibility, more so than rigid computer systems and digital forms. Under uncertainty it would be reasonable to expect paper flexibility to support sensemaking. Yet, in this context it is its structure rather than its flexibility that affords reducing clinical uncertainty. The chart structures and solidifies messiness of pain management, by transforming patients' experiences into 'data points' (gathering small data) and building a record of a therapeutic trial. Thus, it simultaneously reduces and obfuscates uncertainty. This paper contributes to the literature on working with uncertainty in everyday practice, artifact's affordances and the role of small data (as opposed to big data) in decision making under uncertainty.

Keywords: Decision making, Uncertainty, Affordance, Small data, Health care practice, Drug chart

1 Introduction

Many, if not all, decisions in organizations are made in uncertainty. Uncertainty arises from inadequate understanding, incomplete information, and undifferentiated alternatives (Lipshitz and Strauss 1997). Much has been written about how people make decisions under such conditions, how such decisions might be optimized, and what coping strategies people could employ (Beckman et al. 2004; Packard et al. 2017).

Our paper, drawing on affordance theory and practice perspective (Anderson and Robey 2017; Fayard and Weeks 2014), takes a different approach. It aims to analyse how an artefact in everyday use in clinical practice – a drug chart – mediates, under conditions of uncertainty, the activity of prescribing pain medication in the clinical context of a care of the elderly ward. Our focus is on the material structure of the drug chart and its affordance in the context of distributed work among different clinical roles (mainly doctors and nurses), each with its own rules, rights and responsibilities.

In clinical practice uncertainty is ubiquitous due, amongst other factors, to a variety of symptoms of different conditions, heterogeneity of patients, different trajectories of how a condition may evolve, and existence of potential treatments available and their benefits to a particular patient (Han et al. 2011; Hillen et al. 2017; Logan and Scott 1996). Uncertainty is also inherent in the communication of

any subjective experiences, such as the experience of pain. For example, individuals have different pain threshold; pain experiences are influenced by cultural and social norms (Angelelli 2004). Communicating the nature and strength of one's pain is a challenge for any person and pain management is known to be a matter of communication, patient-clinician relationships and trust, which have also complex dynamics (Schiavenato and Craig 2010; Skipper 1965).

Pain medications have side effects detrimental to the general wellbeing of the person, including increasing mental confusion and risk of falls. If patients are able to assess and communicate their own state of being, the decision on whether to suffer the side effects but alleviate the pain, or suffer the pain but not having side effects, is shared with them. With patients with severe dementia this decision rests with the clinicians, doctors and especially nurses. Their collaborative work unfolds over time and is mediated by artefacts such as clinical records and drug charts. These charts also reflect, or embody, in their structural properties (e.g. shape, size, material) their own history, i.e. other people's activities, and the knowledge of how they are to be used.

This paper illustrates how a hospital drug chart structures and solidifies messiness and uncertainty of pain management of patients with dementia. It shows strategies the chart affords in dealing with uncertainty, such as building a record of a therapeutic trial. It highlights, however, that those strategies are not inscribed in the chart but learned through practice. In doing so, this paper contributes to the literature on the role of artifacts in everyday practice, by illuminating how an artefact mediates the conditions of uncertainty, and to our understanding of affordances. By focusing on 'small data' collected in daily trials our paper also complements the literature on the use of big data to reduce uncertainty of business decisions (Hsinchun et al. 2012; May 2014).

Furthermore, understanding of current work processes and practices is important to their digital transformation, particularly in such a complex environment as healthcare (Petракaki et al. 2016). In England, all hospitals are to turn to paperless operations, including replacing paper-based prescription charts with electronic prescribing and administration (EPMA) systems. The designs of some of these systems (e.g. MedChart) closely resemble the structure of the paper drug chart discussed in this paper. Research over implementation and adoption of EPMA systems in North America, Europe and Australia found a number of unintended consequences (Campbell et al. 2006; Mozaffar et al. 2017), some of which are associated with interface design, suggesting the need for a better understanding of the processes of medicine management that these systems are intended to support.

2 Sociotechnical View on Affordances

We adopt the concept of affordance as an underlying lens to explore how healthcare practices, and in particular pain management for people with dementia, are conditioned by a drug chart. We subscribe to the real (dispositional) *and* relational conceptualization of affordances (Fayard and Weeks 2014; Gibson 1979), i.e. we see them as possibilities for goal-oriented action that arise from an artifact's features or characteristics in relation to individuals or groups within a socio-cultural context (Markus and Silver 2008; Petракaki et al. 2016; Pozzi et al. 2014).

Affordances "provide grounds for individual decisions, architect situations of choice, and 'suggest' the choice (action) that should be made" (Abrishami et al. 2014 p. 126). Thus, a drug chart may include an inscription of how and when an individual nurse should administer a drug. However, an affordance of an artefact may be perceived and actualized differently by various people (Anderson and Robey 2017; Majchrzak and Markus 2013; Strong et al. 2014). Perceptions of affordance of an artefact are shaped by its socio-technical environment, and meanings within a cultural context outside the immediate use of technology (Bloomfield et al. 2010; Petракaki et al. 2016). Hence nurses working in different cultural and regulatory contexts, whilst using drug charts to guide their practice, may exercise different levels of autonomy when administering drugs. However, an affordance should not be simply conceptualized as a dyadic relationship between an individual person and a single artefact. Affordances can also "frame stakeholders towards specific collective sociotechnical practices" (Abrishami et al. 2014 p.126). Thus, a drug chart may become a boundary object that helps to coordinate work performed by different peo-

ple and devices. Affordances of one artifact may depend on affordances of other artefacts (Burton-Jones and Volkoff 2017; Strong et al. 2014).

Whilst we agree that affordances are not about “technology as an object” but about “actions in the world that involve technology” (Faraj and Azad 2013 p. 255) we are also interested in technology’s (in our case a paper-based technology) features and how those may mediate actions. Hence, we adopt a sociotechnical perspective on affordances. This means that we consider artefacts as *technology-in-practice* (Timmermans and Berg 2003) embedded in work and social practices and part of heterogeneous relations both potentially enabling and obstructing activities. However, we do not go as far as taking a sociomaterial standpoint that sees work and material objects as mutually constitutive, always configuring each other in practice (Beane and Orlikowski 2015; Orlikowski and Scott 2008). We believe that, at least for analytical purposes, we can ‘praise apart’ the technological and the social, and analyse properties of artifacts to examine how those influence practice.

3 Methods and Settings

3.1 The case

The activity studied in this paper is that of prescribing pain medication for hospital elderly patients, including those with cognitive impairment associated with dementia (Manias 2012; Spinewine et al. 2005). Managing pain in patients with dementia is known to be a challenging clinical practice area; patients unable to tell about their pain are being left in pain or receiving inconsistent pain relief (CQC 2014). The reasons for these problematic outcomes are complex, involving for example, hospital routines centred around the organisation of the ward rather than patients’ needs, staffing levels, or the availability of hospital resources for alternative (non-pharmacological) management of pain (Lichtner et al. 2016). The data at the basis of this paper was collected in a hospital in England in 2013-2014, with a special focus on an elderly care medical ward. At the time of the study the ward had facilities to care for 28; most of the patients were often very elderly (above 80 years of age) and frail, several in a state of confusion or suffering from dementia. The clinical team were made of two hospital consultants, with their medical team of registrars and junior doctors, and two senior sisters, with staff nurses and healthcare assistants. Other members of the multidisciplinary team were a pharmacist dedicated to the ward and one or more physiotherapists.

3.2 Data collection and analysis

Data were collected with a mix of qualitative research methods including non-participant observations of daily ward activities, audits of patient records, semi-structured interviews with staff and carers, and analysis of hospital documents. The case study was part of a larger research project carried out across four hospitals in the UK (Closs et al. 2016). This paper is based on data from one of the four sites, including field notes from more than 160 hours of observations and transcripts of 26 interviews with staff nurses, medical consultants, doctors in training, pharmacists, healthcare assistants and patient relatives (Table 1). Data collection was carried out over 72 days in the period May 2013-March 2014. Observations took place in doctors’ office, at the nursing station, in the ward staff room, other wards and hospital areas. About one third took place at bedside (29 days, average 2h:30), with a focus on clinicians’ interaction with patients about their pain; with consent, the researcher seated in the patient’ bay taking field notes of any healthcare professionals’ visits (e.g. for drug rounds, or pain assessment). Further details on methods in Closs (2016).

Observations	Times (hours – approximate)
Observations of elderly ward work activities	120
Observations of other hospital areas (e.g. elderly patients in surgery ward)	40

Interviews (roles)	Number of participants
Medical consultants	2
Doctors (in training/registrar)	2
Nurse specialists (pain/education practitioners)	4
Ward nurses (incl. sisters/ward managers)	11
Physiotherapists	1
Pharmacists	1
Healthcare assistants	3
Carers (patient family members / friends)	2

Table 1. Data collection.

Data analysis was initially carried out inductively; data were indexed with emerging themes with NVivo. Themes covered aspects of clinicians' decision-making process as well as elements of the sociotechnical context. This initial inductive analysis identified the drug chart as an important analytical theme. For the purpose of this paper, we conducted a secondary analysis of these data with a focus on the work practices this artefact affords. We carried out a document analysis of the main drug chart used in this medical ward, in terms of its structure and content (e.g. the headings and instructions written on the front cover); we reflected on what was on the chart, and what was missing; we looked for reference to the chart in interview transcripts and analysed the language used to explain the use of the chart and the intended use. These were then compared with what was observed in practice.

3.3 Ethics

The study was granted NHS Research Ethics approval. Interviewees gave their written consent. The NHS hospital granted access for the study carried out in compliance with research governance requirements. Data were anonymised at the time of data collection.

4 Provisional Findings and Analysis

4.1 The artifact

The prescribing chart at the centre of this case study is one of the many found in English National Health Service (NHS) hospitals (many hospitals in England are still using paper charts). Despite a drive to standardise tools and documentation in the NHS, it is customary for hospitals to design or customise paper charts, though they are all more or less similar in their design (Academy of Medical Royal Colleges 2011). The drug chart is a multidisciplinary document for orders, reviews and administration of medicines. It has space for doctors to enter items of medication, for pharmacists to document their review of these items, and for nurses to annotate what medicine was given, and at what time and whether the patient refused any regular item prescribed. It does not usually have space for documenting rationales for the prescription.

PRESCRIBERS - PRINT your name legibly and sign all prescri

Regular Medicines

		Month & Year:	Date						
Drug (4)		Dose		6					
Additional Instructions		Route		8					
				12					
Print Name & Contact		Date		14					
				18					
Sign	Pharm	Supply	22						
Drug (5)		Dose		6					

When required medicines

Drug		Dose	Route	Date					
				Time					
Frequency	Medicine in 24 hrs	Instructions		Date	Dose				
				Route					

Figure 1. An example of a hospital drug chart.

The chart is a structured document for data input; it includes tick boxes and coded boxes; it has separate sections for different types of medications (e.g. Figure 1). In particular, medicines to be given on a regular basis (typically, more than once a day) are written separately from those to be given as and when needed (known as PRN - *pro re nata*). These sections of the chart are in accord with different rules for the administration of the medicine. For PRN medications, nurses are granted the right to make their own decision on whether the item is appropriate on the basis of their own assessment of the patient. Although nurses are expected to use their judgement when giving *all* prescribed medication to patients (as per national guidance), not just performing a task “in strict compliance with the written prescription” (NMC 2007) (a doctor’s ‘order’), in practice, medication prescribed as Regular tends to be given as prescribed.

4.2 Structure and dynamics: provisionality of decisions

“... the idea of letting any patient sit in pain is not acceptable” (Student nurse)

Any pain management is ‘a bit of an experiment’, or a ‘therapeutic trial’. We describe in this section how this ‘therapeutic trial’ revolves around the use of the drug chart, and the uncertainties and tensions that emerge when usual practice meets patients with dementia.

Pain medication is given to reduce suffering. It is also a means to restore or maintain quality of life, as with less pain the patient may be more independent. But to this purpose, it may be better *not* to give the medicine, as it is likely to increase confusion and make falls more likely (loss of independence). In the working life of the ward, the objective is also to get the patient in a condition to be discharged from hospital as soon as medically fit, without further complications. So from the start the decision on whether to prescribe pain medication is a matter of trade-offs. Patients with severe dementia may not tell whether they have pain or what type of pain, but they may show signs of possible pain. The question would be: could it be pain? If the patient responds to pain medication, then it may have been pain. Also, some medical conditions are known to be painful (e.g. a broken bone), thus the patient is likely to be in pain and some pain medication would be appropriate.

“What you commonly do is prescribe something regularly and then something else for breakthrough pain and for as required use between doses...” (Medical consultant).

In this interview snippet, the doctor suggests reliance on routine, or common practice (‘what we usually do’) that shapes the act of prescribing in this (and indeed probably many) clinical context. She also implicitly makes reference to the structure of the drug chart, with separate sections for Regular and PRN medication orders. This structure opens up a number of possibilities, in connection with the division of labour between doctors and nurses involved in managing the patient pain.

Writing items in the PRN section of the chart is equivalent to the doctor asking the nurses to decide whether the analgesic drug is needed. As the medical consultant explains: *“I’d certainly want nursing views to predominate [on analgesia] rather than doctors’ views, on the basis that it’s our job to prescribe the relevant analgesia etc., but it isn’t our job to make the assessment of pain and give the drugs because we’re not there enough [to communicate with the patient], certainly not at my level”*.

Given the uncertainty, the written prescription is there to be regularly reviewed and possibly changed. Two main aspects of the use of the chart reveal a strategy to deal with the uncertainty. First, any use of the PRN or Regular item by the nurse is to be used by the doctor as an indicator for a review of the prescription, as explained in these extracts:

“So you’d start somebody at a dose that you know isn’t going to control their pain but it’s a start, [...] and then we add up how much they’ve needed over two or three days period [both from PRN, or Regular the patient did not refuse], then we convert that back and we change the Regular prescription” (medical consultant).

“Say, the doctors prescribe morphine [Regular], [...] it could be via tablet, it could be via liquid or it could be an injection, now we’ll give that for a couple of days so that it gives the doctor some indication of how much to put in the syringe [Regular]” (staff nurse)

Thus, data are building up over time, as written on the chart; these make patterns that may aid in reducing the uncertainty.

Second, in order for items (medications) to be decided on, other items need to be made available first – that is not necessarily used and tested, but *just be made available*. If used, then one assumes they were needed, and if needed, depending on how much and how often, they can be replaced by others; if available but not used, one assumes they are not needed and that therefore pain may not be a problem for the patient.

It should be noted that nowhere in the chart this strategy is explained. This strategy of titration is learned in clinical practice. Since it is not inscribed and planned for in the chart, data points are interpreted with knowledge of the practice. Such data points (or ‘small data’) taken out of their clinical context and pooled into big data set may be open to misinterpretation (Lichtner et al. 2015).

4.3 Resources for action, in time

The chart is structured with time frames – e.g. it covers a week of a prescription. Each column must bear a date, each administration a time. Times of administrations are inscribed in the chart and usually match the hospital routine of the drug round (they are entrained with the drug rounds). If the drug is given at another time, this should be written by hand.

The data points in practice are very uncertain. Because people forget to write the exact time, or write it up after the event, etc. So, in theory a digital system that records automatically the point of administration (such as a Barcoded Medicine Administration System) should produce better ‘small data’ for these experiments.

The drug chart tells of the patient’s time in the ward. In relation to pain, at any one time the chart shows the patient trajectory up to that time. But it also shapes the action at that point in time, as well as future steps, thus *making the patient history* for the conduct of the therapeutic trial. At each point in time the thinking is both retrospective and prospective.

Problems with this strategy and the use of the chart as described above lie in the difficulties or inability of the patient to ask for more PRN pain relief, or communicate a refusal of a regular item. As the ward pharmacist commented, *the problem is that patient may not ask* for pain relief. The chart design does not provide space to explicitly document the inherent uncertainty of nurses’ assessment nor warn on how ‘data points’ have been produced (whether the patient was actually assessed).

5 Discussion and Initial Conclusions

Increasingly the literature on decision making in clinical practice challenges the view of decisions as discrete acts of evaluating objective data and medical knowledge. Instead it shows how decisions are dynamic, shared, situated and informed by rules and routines (Goodwin 2014). They are accomplished through practice (rather than done as one action point), conducted over time and space and distributed to include medical technologies, protocols and policies (Berg 1997). Those views on clinical decision making are reflected in management, organization and information systems literature critiquing rationalistic notions of decision making (Langley et al. 1995), and emphasizing sensemaking, improvisation (Ciborra 1999; Weick et al. 2005; Weick 1998) and the distributed nature of cognition (Hutchins 1995; Richard J. Boland et al. 1994; Stigliani and Ravasi 2012). In this paper we show how this decision making practices are about ‘deciding’ to conduct experiments, and how affordances of artifacts are used for these purposes. Although it may be obvious to clinicians that “[e]very act of prescribing is an experiment” (Aronson 2012) - a therapeutic trial where $n=1$ (Sackett 2011), little is known of how these trials are conducted in practice, especially in hospital contexts (Goodwin 2014; Ross et al. 2012).

The activity of taking care of patients in a hospital, who may be experiencing pain, involves a multi-disciplinary team, is dependent on resources and sociotechnical structures - the drug chart with its inscribed regulations, the power granted to the nurse, the daily routines. Patient care is also inherently time dependent. The passing of time is an essential element to pain management. In pain management the unfolding of the activity over a drug chart produces patterns (signals, or ‘pain cues’) over time that can inform later actions. These structures, with their constraints and enabling features, afford possibilities for action and the subsequent outcomes, and mediate the joint work of doctors and nurses. Research has shown how the design of ‘choice architectures’ may ‘nudge’ prescribers to write more accurately their prescriptions (King et al. 2014).

Our analysis of how the drug chart mediates the practice of pain management reveals the main underlying assumption of this strategy in a situation of uncertainty, i.e. the reliance on patient feedback. Using both Regular and PRN drugs at the same time is a strategic move for the conduct of the analgesic trial. The initial prescription is a temporary order and both doctors and nurses expect that it will be revised during the patient’s stay in hospital. The clinicians are aware that the initial prescription may not be enough to control the patient pain, but titrating upwards (rather than downwards) is a strategy that takes into account side effects of medications. The strategy works best if the patient is able to tell whether the medicine is working. This may not happen in patients with dementia.

Drug chart’s design hides the uncertainty inherent in the prescribing process, or as Goodwin (2014 p. 47) noted in relation to regulatory bodies prescribing guidance – the way they articulate practice “negates the level of uncertainty” which is instead a recognised dimension of clinical practice. The chart design embodies the drug prescription as a decision without uncertainty and assumes each single person accountable for their decisions (Goodwin 2014).

However, compared to digital charts, a paper chart (albeit structured) affords relative flexibility, e.g. side annotations would be possible. Under uncertainty it would be reasonable to expect paper flexibility to support sensemaking. Yet, the affordances of paper are not taken advantage of, or if so as exceptions. This seems to contradict some of the research on the affordances of paper (Sellen and Harper 2002). It does, however, underscore the point that we can always reject or ignore affordances (Fayard and Weeks 2014) and that affordances are perceived within a socio-cultural context (Markus and Silver 2008; Petrakaki et al. 2016; Pozzi et al. 2014). The healthcare professionals in our study deal with the uncertainties or provisionality of decisions in a different way: they make a therapeutic trial, or an experiment, using the chart structure to record actions/non actions, generating this way data that reduces uncertainty over time. The chart structures and solidifies messiness of pain management, by transforming patients' experiences into 'data points' (gathering 'small data'). Thus, it simultaneously reduces and obfuscates uncertainty.

Furthermore, the paper chart demands that all staff be located in one place (usually at the bedside) for the analysing and adjusting of medication for each and every patient. This, can be seen as a constraint (or constraining affordance) but it could also be argued that through this the chart facilitates face-to-face group decision making. The chart affordances are relational to its environment; a chart positioned somewhere else, not at the bedside, may afford something else. This has implications for the chart's digitalisation. The ease of access and ability to be viewed by many people in different places at the same time is seen as one of the biggest advantages of electronic records, but this is likely to influence (negatively perhaps) group dynamics and processes of sensemaking.

5.1 Future research

Our findings lead us to propose the following challenges to IS scholars:

- How can electronic information systems be designed, so they afford dealing with provisionality of decisions and uncertainty in clinical practice, and support retrospective and prospective thinking?
- How should 'small data' collected in everyday practice under conditions of uncertainty be recorded and incorporated into 'big data'? What are the implications of uncertainty and provisionality of decisions for the quality of data recorded locally and the veracity of 'big data' that draws on it?

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7 References

- Abrishami, P., Boer, A., and Horstman, K. 2014. "Understanding the Adoption Dynamics of Medical Innovations: Affordances of the Da Vinci Robot in the Netherlands," *Social Science & Medicine* (117:Supplement C), pp. 125-133.
- Academy of Medical Royal Colleges. 2011. "Standards for the Design of Hospital in-Patient Prescription Charts." Retrieved 24 February 2016, from <http://www.aomrc.org.uk/projects/standards-for-the-design-of-hospital-in-patient-prescription-charts.html>
- Anderson, C., and Robey, D. 2017. "Affordance Potency: Explaining the Actualization of Technology Affordances," *Information and Organization* (27:2), pp. 100-115.
- Angelelli, C. V. 2004. *Medical Interpreting and Cross-Cultural Communication*. Cambridge: Cambridge University Press.

- Aronson, J. K. 2012. "Balanced Prescribing - Principles and Challenges," *Br J Clin Pharmacol* (74:4), pp. 566-572.
- Beane, M., and Orlikowski, W. J. 2015. "What Difference Does a Robot Make? The Material Enactment of Distributed Coordination," *Organization Science* (26:6), pp. 1553-1573.
- Beckman, C. M., Haunschild, P. R., and Phillips, D. J. 2004. "Friends or Strangers? Firm-Specific Uncertainty, Market Uncertainty, and Network Partner Selection," *Organization Science* (15), pp. 259-275.
- Berg, M. 1997. *Rationalizing Medical Work: Decision-Support Techniques and Medical Practices*. Cambridge: MIT Press.
- Bloomfield, B. P., Latham, Y., and Vurdubakis, T. 2010. "Bodies, Technologies and Action Possibilities: When Is an Affordance?," *Sociology* (44:3), pp. 415-433.
- Burton-Jones, A., and Volkoff, O. 2017. "How Can We Develop Contextualized Theories of Effective Use? A Demonstration in the Context of Community-Care Electronic Health Records," *Information Systems Research* (28:3), pp. 468-489.
- Campbell, E. M., Sittig, D. F., Ash, J. S., Guappone, K. P., and Dykstra, R. H. 2006. "Types of Unintended Consequences Related to Computerized Provider Order Entry," *Journal of the American Medical Informatics Association* (13:5), pp. 547-556.
- Ciborra, C. U. 1999. "Notes on Improvisation and Time in Organizations," *Accounting, Management and Information Technologies* (9:2), pp. 77-94.
- Closs, S., Dowding, D., Allcock, N., Hulme, C., Keady, J., Sampson, E., Briggs, M., Corbett, A., Esterhuizen, P., Holmes, J., James, K., Lasrado, R., Long, A., McGinnis, E., O'Dwyer, J., Swarbrick, C., and Lichtner, V. 2016. "Towards Improved Decision Support in the Assessment and Management of Pain for People with Dementia in Hospital: Systematic Review and Observational Study," *Health Services & Delivery Research* (4:30).
- CQC. 2014. "Cracks in the Pathway: People's Experiences of Dementia Care as They Move between Care Homes and Hospitals," Care Quality Commission.
- Faraj, S., and Azad, B. 2013. "The Materiality of Technology: An Affordance Perspective," in *Materiality and Organizing: Social Interaction in a Technological World*, P.M. Leonardi, B. Nardi and J. Kallinikos (eds.). New York: Oxford University Press, pp. 237-258.
- Fayard, A.-L., and Weeks, J. 2014. "Affordances for Practice," *Information and Organization* (24:4), pp. 236-249.
- Gibson, J. J. 1979. *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
- Goodwin, D. 2014. "Decision-Making and Accountability: Differences of Distribution," *Sociology of Health & Illness* (36:1), pp. 44-59.
- Han, P. K. J., Klein, W. M. P., and Arora, N. K. 2011. "Varieties of Uncertainty in Health Care," *Medical Decision Making* (31:6), pp. 828-838.
- Hillen, M. A., Gutheil, C. M., Strout, T. D., Smets, E. M. A., and Han, P. K. J. 2017. "Tolerance of Uncertainty: Conceptual Analysis, Integrative Model, and Implications for Healthcare," *Social Science & Medicine* (180:Supplement C), pp. 62-75.
- Hsinchun, C., Chiang, R. H. L., and Storey, V. C. 2012. "Business Intelligence and Analytics: From Big Data to Big Impact," *MIS Quarterly* (36:4), pp. 1165-1188.
- Hutchins, E. 1995. *Cognition in the Wild*. Cambridge, Mass.: MIT Press.
- King, D., Jabbar, A., Charani, E., Bicknell, C., Wu, Z., Miller, G., Gilchrist, M., Vlaev, I., Franklin, B. D., and Darzi, A. 2014. "Redesigning the 'Choice Architecture' of Hospital Prescription Charts: A Mixed Methods Study Incorporating in Situ Simulation Testing," *BMJ Open* (4:12).
- Langley, A., Mintzberg, H., Pitcher, P., Posada, E., and Saint-Macary, J. 1995. "Opening up Decision Making: The View from the Black Stool," *Organization Science* (6:3), pp. 260-279.
- Lichtner, V., Dowding, D., Allcock, N., Keady, J., Sampson, E., Briggs, M., Corbett, A., James, K., Lasrado, R., Swarbrick, C., and Closs, S. 2016. "The Assessment and Management of Pain in Patients with Dementia in Hospital Settings: A Multi-Case Exploratory Study from a Decision Making Perspective," *BMC Health Services Research* (16:427).

- Lichtner, V., Dowding, D., and Closs, S. 2015. "The Relative Meaning of Absolute Numbers: The Case of Pain in-Tensity Scores as Decision Support Systems for Pain Management of Patients with Dementia," *BMC Medical Informatics and Decision Making* (1:111).
- Lipshitz, R., and Strauss, O. 1997. "Coping with Uncertainty: A Naturalistic Decision-Making Analysis," *Organizational Behavior and Human Decision Processes* (69:2), pp. 149-163.
- Logan, R. L., and Scott, P. J. 1996. "Uncertainty in Clinical Practice: Implications for Quality and Costs of Health Care," *The Lancet* (347:9001), pp. 595-598.
- Majchrzak, A., and Markus, M. L. 2013. "Technology Affordances and Constraints Theory (of Mis)," in *Encyclopedia of Management Theory*, E.H. Kessler (ed.). Thousand Oaks, CA:: Sage Publications.
- Manias, E. 2012. "Complexities of Pain Assessment and Management in Hospitalised Older People: A Qualitative Observation and Interview Study," *International Journal of Nursing Studies* (49:10), pp. 1243-1254.
- Markus, M. L., and Silver, M. S. 2008. "A Foundation for the Study of IT Effects: A New Look at Desanctis and Poole's Concepts of Structural Features and Spirit," *Journal of the Association for Information Systems* (9:10), pp. 609-632.
- May, E. L. 2014. "The Power of Analytics Harnessing Big Data to Improve the Quality of Care," *Healthcare Executive* (29:2), pp. 18-20, 22-14, 26.
- Mozaffar, H., Cresswell, K. M., Williams, R., Bates, D. W., and Sheikh, A. 2017. "Exploring the Roots of Unintended Safety Threats Associated with the Introduction of Hospital Eprescribing Systems and Candidate Avoidance and/or Mitigation Strategies: A Qualitative Study," *BMJ Quality & Safety* (26:9), pp. 722-733.
- NMC. 2007. "Standards for Medicines Management," The Nursing and Midwifery Council.
- Orlikowski, W. J., and Scott, S. V. 2008. "Sociomateriality: Challenging the Separation of Technology, Work and Organization," *The Academy of Management Annals* (2:1), pp. 433-474.
- Packard, M. D., Clark, B. B., and Klein, P. G. 2017. "Uncertainty Types and Transitions in the Entrepreneurial Process," *Organization Science* (28:5), pp. 840-856.
- Petrakaki, D., Klecun, E., and Cornford, T. 2016. "Changes in Healthcare Professional Work Afforded by Technology: The Introduction of a National Electronic Patient Record in an English Hospital," *Organization* (23:2), pp. 206-226.
- Pozzi, G., Pigni, F., and Vitari, C. 2014. "Affordance Theory in the IS Discipline: A Review and Synthesis of the Literature," in: *Twentieth Americas Conference on Information Systems*. Savannah.
- Richard J. Boland, J., Tenkasi, R. V., and Te'eni, D. 1994. "Designing Information Technology to Support Distributed Cognition," *Organization Science* (5:3), pp. 456-475.
- Ross, S., Hamilton, L., Ryan, C., and Bond, C. 2012. "Who Makes Prescribing Decisions in Hospital Inpatients? An Observational Study," *Postgraduate Medical Journal* (88:1043), pp. 507-510.
- Sackett, D. L. 2011. "Clinician-Trialist Rounds: 4. Why Not Do an N-of-1 Rct?," *Clinical Trials* (8:3), pp. 350-352.
- Schiavenato, M., and Craig, K. D. 2010. "Pain Assessment as a Social Transaction: Beyond the "Gold Standard"," *The Clinical Journal of Pain* (26:8), pp. 667-676.
- Sellen, A. J., and Harper, R. H. R. 2002. *The Myth of the Paperless Office*. Cambridge, MA: Emerald Group Publishing Limited.
- Skipper, J. K. 1965. "Communication and the Hospitalized Patient," in *Social Interaction and Patient Care*, J.K. SKIPPER and R.C. LEONARD (eds.). Philadelphia: J.B. Lippincott, pp. 61-82.
- Spinewine, A., Swine, C., Dhillon, S., Franklin, B. D., Tulkens, P. M., Wilmotte, L., and Lorant, V. 2005. "Appropriateness of Use of Medicines in Elderly Inpatients: Qualitative Study," *BMJ* (331:7522), p. 935.
- Stigliani, I., and Ravasi, D. 2012. "Organizing Thoughts and Connecting Brains: Material Practices and the Transition from Individual to Group-Level Prospective Sensemaking," *Academy of Management Journal* (55:5), pp. 1232-1259.

- Strong, D. M., Johnson, S. A., Tulu, B., Trudel, J., Volkoff, O., Pelletier, L. R., Bar-On, I., and Garber, L. 2014. "A Theory of Organization-Ehr Affordance Actualization," *Journal of the Association for Information Systems* (15:2), pp. 53-85.
- Timmermans, S., and Berg, M. 2003. "The Practice of Medical Technology," *Sociology of Health & Illness* (25:3), pp. 97-114.
- Weick, K., Sutcliffe, K. M., and Obstfeld, D. 2005. "Organizing and the Process of Sensemaking," *Organization Science* (16:4), pp. 409–421.
- Weick, K. E. 1998. "Improvisation as a Mindset for Organizational Analysis," *Organization Science* (9:5), pp. 540–545.