

Researching Collective Mindfulness and Health IT: A Framework and Translation to Context-Specific Questions

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Abstract. To improve patient safety, hospital organisations are encouraged to run their operations in line with high reliability organisations' collective mindfulness principles and practices. For the same safety goals, they also implement health information technology (IT). However, little is known about whether, or how, health IT can impact organisational mindfulness, and thereby safety. We propose that research in this area can be approached through a simple framework of overarching, umbrella questions, then carefully translated into nuanced context-specific questions and study designs. The framework and approach we propose provides a structure for comparing results from studies of collective mindfulness and health IT, across different clinical contexts and IT applications.

Keywords. Patient safety, collective mindfulness, health IT, research methods

1. Introduction

Hospital organisations are encouraged to become high reliability organisations (HROs) to improve patient safety [1, 2]. The HRO approach to reliability and safety takes a resilience perspective, relying on an organisational capacity to detect and recover from errors or near misses [3]. In particular, five dimensions have been identified at collective (organisational or group) level in HROs contributing to reliability and safety, in aggregate known as 'collective mindfulness': *preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and underspecification of hierarchical structure* [4]. Through 'mindful organizing' – such as enhancing staff alertness to risks and resourcefulness – organisations can enhance their resilience. Research suggests, for example, that higher mortality after surgery is associated with some hospitals acting less resiliently, or 'failing to rescue' [5]. Collective mindfulness²

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² Collective mindfulness [4] is not equivalent to an aggregate of individuals' mindfulness [6] but more akin to processes of organisational learning. However, for the purpose of our research, and the improvement of patient safety, both individual and collective mindfulness are important. For brevity, in this paper with collective mindfulness we refer to both individual and group level mindfulness.

builds on individuals' mindfulness – i.e. awareness of interdependency of actions and capacity for interpretations beyond familiar categories [6]. Both individuals' and collective mindfulness are critical, since the “locus of resilience” is across individuals, groups and systems [7].

Health information technology (IT) is introduced in hospitals worldwide with the aim of improving safety [8]. Health IT can fundamentally change work practices, and it is reasonable to ask whether this can affect an organisation's capacity for collective mindfulness. For example, IT can facilitate information flows, thus potentially enhancing organisational mindfulness [9]. However, it can also disrupt existing (e.g. face to face) communication processes, and/or increase opacity over organisational interdependencies, thus potentially hindering mindfulness. Research on mindfulness with IT in the workplace is limited and fragmented [10], and very little is known of the consequences of *health IT* for collective mindfulness in healthcare settings.

Over the past year we have launched a program of research to study the impact of health IT on collective mindfulness in hospitals. The initial focus of this work is medication safety. In this research in progress we have been exploring the impact of electronic medication management systems of different kinds – including electronic prescribing and administration systems (EPMA; also known as computerized provider order entry – CPOE) and ward-based automated dispensing cabinets (ADCs) on collective mindfulness in its various dimensions. Our current study sites are children's hospitals in Sydney (Australia), implementing a range of IT applications for medications. In this paper we describe the development of a framework of research questions and methods, and how we adapted these to specific clinical settings in these children's hospitals (paediatric ICU, paediatric oncology).

2. Methods

The aims of our research are to improve patient safety in hospital inpatients by: 1. developing theory and methods for evaluation of individual and collective mindfulness associated with health IT; 2. investigating whether and how technology can support organisational resilience; 3. providing (locally/nationally-adjusted) guidance for technology implementation aimed at achieving and sustaining resilience.

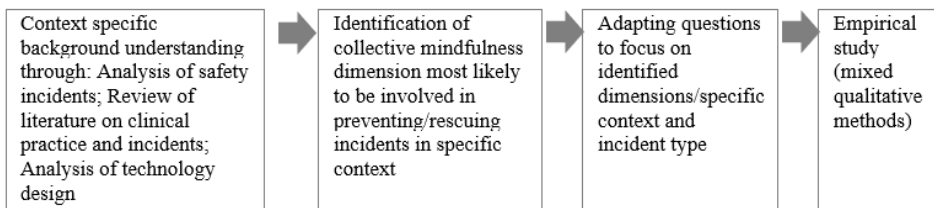
To address these aims we pose six overarching questions (Table 1), underpinned by sociotechnical assumptions and human factors understanding of technology in the workplace [11, 12]. These questions constitute a framework to plan collective mindfulness studies of the implementation of different health IT applications in different clinical contexts. Q1 and Q2 are about understanding current practices, with Q2 focused on the role of information systems in use before health IT implementation. Q3 focuses on the changes introduced with the health IT implementation, and the role of the new technology. Q4 reminds us to expand the unit of analysis to patients and their families, as they have an important role in maintaining patient safety. Q5 is about future improvements. And since improvement interventions are difficult to implement beyond national borders - as countries differ in structures, processes, technology and legislation, Q6 addresses generalizability of research findings across nations.

The questions call for qualitative methods in data collection and analysis, including interviews, ethnographic observations, analysis of hospital patient safety incident reports, and review of documentation of medication use.

Table 1. A framework to study the impact of health information technology on collective mindfulness.

<p>Understanding current practices</p> <p>Q1. How does mindfulness manifest in healthcare work practices?</p> <p>Q2. Does the current sociotechnical system support mindfulness? What role do existing tools (e.g. paper-based systems) have on staff 'rescuing' potential patient safety near misses?</p> <p>Understanding the change</p> <p>Q3. How do practices change with the implementation of health IT? What role has the new technology on maintaining mindfulness?</p> <p>Understanding patients' role in the sociotechnical system</p> <p>Q4. What is the role of patients in processes of collective mindfulness and 'rescuing' patient safety near misses in hospital? Does the role change with the introduction of new technology?</p> <p>Exploring improvements</p> <p>Q5. How can we improve system design and implementation strategies in order to support mindfulness in hospital inpatients for better and safer patient outcomes?</p> <p>Identifying potential for generalizability</p> <p>Q6. Are there specific factors that may affect processes and outcomes of mindfulness in different contexts?</p>

In planning for our current studies (research in progress), we applied these questions to the challenges of medication safety, and in particular to two different clinical contexts (paediatric oncology and ICU) and different types of medications (e.g. chemotherapy and 'drugs of dependence' such as opioids) and to IT applications implemented in these settings to improve medication safety. We adapted the framework to each of these settings by first identifying which medication safety incidents are specific/typical to each of these settings (which the IT may be aimed at preventing) and then drawing hypotheses on which of the five dimensions of collective mindfulness are likely to be most relevant to prevent or rescue such medication safety incidents (with or without the IT) (Figure 1).

**Figure 1.** Methods to adapt framework of questions to collective mindfulness dimensions.

3. Results

In this section we explain the context-specific medication safety challenges and the questions we ask for each of the two settings.

3.1. Oncology and a chemotherapy electronic prescribing/administration system

Oncology medications are a particularly risky area of medicine management [13], and especially complex in pediatrics. Prescriptions are set in terms of cycles, repeated a number of times on the basis of prescriptive protocols. Medications must be sequenced and timed correctly, upon clinical monitoring of patient response, to contain side effects [14]. The treatment can last for months or years. The medicine management work is distributed in time and place (inpatient and outpatient settings, home care), with a number

of people and roles involved. Thus, oncology medications present a high degree of interdependencies. Research has shown how EPMA systems can reduce oncology medication errors [14-16] although limited work has focused on their impact on ‘errors linked to interdependencies’ (e.g. erroneous scheduling of cycles) – which, we hypothesize, could be associated with problems in collective mindfulness, and in particular *sensitivity to operations*. Thus, we have adapted our questions (Table 2) with this collective mindfulness dimension in focus.

Table 2. The framework applied to medication safety and medication management systems, adapted to two different technologies, types of medications and clinical contexts.

Overarching questions applied to medication safety and IT systems for medications	EPMA in oncology setting – questions refined to this context	ADC in ICU setting - questions refined to this context
Q1. How does mindfulness manifest in <i>medicines management practices, including their prescribing, dispensing and administration?</i>	Q1. How does mindfulness manifest in managing the <i>interdependencies inherent in children patients' chemotherapy treatments?</i>	Q1. How does mindfulness manifest in <i>DD management practices, including supplying, controlling, administration and documentation?</i>
Q2. Does the current sociotechnical system support mindfulness in <i>medicines supply and use?</i> What role do existing tools (e.g. paper-based systems) have on <i>'rescuing' potential risks in the medicines use process?</i>	Q2. Does the current sociotechnical system support mindfulness in <i>chemotherapy supply and use?</i> What role do existing tools (e.g. paper-based chemotherapy protocols) have on <i>maintaining awareness of the treatment process?</i>	Q2. Does the current sociotechnical system support mindfulness in <i>DD supply and use?</i> What role do existing tools have on <i>'rescuing' potential risks in the DD use process, such as those posed by unaccounted use?</i>
Q3. How does the practice of <i>medicines use</i> change with the implementation of IT? What role has the new technology on maintaining mindfulness in <i>medicines use?</i>	Q3. How does the practice change with the implementation of <i>EPMA</i> systems? What role has the new technology on maintaining <i>awareness of the treatment process, and in particular in consideration of its potential for adding opacity or transparency over interdependencies?</i>	Q3. How does the practice of <i>DD use</i> change with the implementation of <i>ADCs?</i> What role has the new technology on maintaining mindfulness in <i>DD use?</i>
Q4. What is the role of patients in processes of <i>'rescuing'</i> in <i>using medicines</i> in hospital? Does the role change with the introduction of new technology?	Q4. What is the role of <i>patients' families in hospitals</i> maintaining <i>awareness of interdependencies?</i> Does the role change with the introduction of new technology?	Q4. What is the role of <i>patients' families</i> achieving <i>safety/security of DD?</i> Does it change with the introduction of new technology?
Q5. How can we improve system design and implementation strategies in order to support mindfulness and medication safety in hospital inpatients for better and safer patient outcomes?	Q5. How can we improve system design and implementation strategies in order to support mindfulness and awareness of <i>interdependencies in the treatment process</i> for better and safer patient outcomes?	Q5. How can we improve system design and implementation strategies in order to <i>reduce the potential risks to mindfulness associated with the introduction of automation?</i>
Q6. Are there specific factors that may affect processes and outcomes of mindfulness and <i>rescuing in medicines use</i> in different nations?	[to be explored with future studies in Europe in 2020]	[to be explored with future studies in Europe in 2020]

Note: *italics* indicates adaptation of generic framework to specific setting. Abbreviations - ADC: automated dispensing cabinets; DD: drugs of dependence, e.g. opioids; EPMA: electronic prescribing and administration system; ICU: intensive care unit.

3.2. Intensive care and an automated dispensing cabinet for drugs of dependence

‘Drugs of dependence’ (DD) can be dangerous. In hospitals, DD misuse can lead to harm to staff and patients, and legal and financial consequences for the organisation [17]. Documentation of DD use in paper registries, for control and legal purposes, is very time consuming, especially in wards where DD are used frequently, such as intensive care units (ICU). Automated dispensing cabinet (ADCs) are introduced in hospital pharmacies and/or in clinical wards to improve control of medications [18, 19] and reduce the burden of documentation. However, as most health IT, they may generate unwanted effects on workflows and introduce new mechanisms for errors, such as the nurse not recognizing a wrong drug in the ADC drawer, assuming it to be as expected – a phenomenon known as automation bias [20]. It is necessary that healthcare professionals maintain awareness of risks to prevent harm occurring. Thus in this context, we adapted our questions (Table 2) to investigate specific technology-related mechanisms for errors (automation [21, 22], ‘equivocality’ [23]) and collective mindfulness dimension essential to counter these (*reluctance to simplify* [4]).

4. Discussion and conclusion

With our research we are proposing a framework of questions to structure the study of the impact of health IT on collective mindfulness in hospitals. The questions must be translated to the specific clinical contexts and IT applications, as each can be expected to have specific patient safety risks and different potential impacts of the technology on the varied dimensions of collective mindfulness. For example, a workflow management system, such as an EPMA system, implemented in paediatric oncology, is expected to support (and semi-automate) the distributed work of the different clinicians involved in a patient’s treatment, and to affect the management of the many interdependencies that characterize oncology care. This clinical context invites a study focus on *sensitivity of operations*, and the potential for increased opacity (or transparency) over interdependencies. Instead, a technology such as automated dispensing cabinets (ADCs), implemented in an ICU, where there is high use of dangerous drugs of dependence, is expected to change specific tasks (e.g. retrieving medications at the time of administration). New risks brought by ADCs are associated with automation effects such as individuals’ premature cognitive commitment (‘mindlessness’). Thus, it invites a focus on collective mindfulness strategies put in place to counter these effects, such as *‘reluctance to simplify’*. By the process of translation, we hope to be able to drill into the many varied ways that health IT may affect collective mindfulness in different organisational settings. We will use the framework of overarching questions to then ‘reassemble’ the distinct findings into a larger picture of whether and how health IT affects collective mindfulness in healthcare. As our studies progress, and with them our understanding of collective mindfulness with health IT, we may refine our original questions. We invite others wishing to investigate this territory to position their findings in this framework, to ‘test’ it and contribute to our collective understanding.

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References

- [1] S. Hines, K. Luna, J. Lofthus, M. Marquardt, and D. Stelmokas, *Becoming a high reliability organization: operational advice for hospital leaders*, AHRQ publication, Agency for Healthcare Research and Quality, Rockville, MD, 2008.
- [2] K.M. Sutcliffe and K.E. Weick, Mindful Organising and Resilient Healthcare, in: E. Hollnagel, J. Braithwaite, and R. Wears (Eds), *Resilient Health Care*, Ashgate, London, 2013, 145-156.
- [3] R. Amalberti, *Navigating safety: Necessary compromises and trade-offs-theory and practice*, Springer, 2013.
- [4] K.E. Weick, K.M. Sutcliffe, and D. Obstfeld, Organizing for High Reliability: Processes of Collective Mindfulness, *Research in Organizational Behavior* **3** (1999), 81-123.
- [5] B.T. Fry, M.E. Smith, J.R. Thumma, A.A. Ghaferi, and J.B. Dimick, Ten-year Trends in Surgical Mortality, Complications, and Failure to Rescue in Medicare Beneficiaries, *Annals of Surgery* (2019), Ahead of Print.
- [6] E.J. Langer, *Mindfulness*, Da Capo Press, 2014.
- [7] E. Hollnagel, J. Braithwaite, and R. Wears, *Resilient Health Care*, Ashgate, London, 2013.
- [8] E.L. Abramson, L.M. Kern, S. Brenner, M. Hufstader, V. Patel, and R. Kaushal, Expert panel evaluation of health information technology effects on adverse events, *J Eval Clin Pract* **20** (2014), 375-382.
- [9] N.C. Ramiller and E. Burton Swanson, Mindfulness routines for innovating with information technology, *Journal of Decision Systems* **18** (2009), 13-26.
- [10] S. Dernbecher and R. Beck, The concept of mindfulness in information systems research: a multi-dimensional analysis, *European Journal of Information Systems* **26** (2017), 121-142.
- [11] M. Berg, J. Aarts, and J. van der Lei, ICT in health care: Sociotechnical approaches, *Methods of Information in Medicine* **42** (2003), 297-301.
- [12] P. Carayon, Human factors of complex sociotechnical systems, *Applied Ergonomics* **37** (2006), 525-535.
- [13] S.N. Weingart, L. Zhang, M. Sweeney, and M. Hassett, Chemotherapy medication errors, *The Lancet Oncology* **19** (2018), e191-e199.
- [14] A.R. Chen and C.U. Lehmann, Computerized Provider Order Entry in Pediatric Oncology: Design, Implementation, and Outcomes, *Journal of Oncology Practice* **7** (2011), 218-222.
- [15] M. Aita, O. Belvedere, E. De Carlo, L. Deroma, F. De Pauli, L. Gurrieri, et al., Chemotherapy prescribing errors: an observational study on the role of information technology and computerized physician order entry systems, *BMC Health Services Research* **13** (2013), 522-522.
- [16] K.A. Elsaid, S. Garguilo, and C.M. Collins, Chemotherapy e-prescribing: opportunities and challenges, *Integr Pharm Res Pract* **4** (2015), 39-48.
- [17] K.H. Berge, K.R. Dillon, K.M. Sikkink, T.K. Taylor, and W.L. Lanier, Diversion of drugs within health care facilities, a multiple-victim crime: patterns of diversion, scope, consequences, detection, and prevention, *Mayo Clinic Proceedings* **87** (2012), 674-682.
- [18] C. Chapuis, M. Roustit, G. Bal, C. Schwebel, P. Pansu, S. David-Tchouda, et al., Automated drug dispensing system reduces medication errors in an intensive care setting, *Critical care medicine* **38** (2010), 2275-2281.
- [19] A. Boyd and B. Chaffee, Critical Evaluation of Pharmacy Automation and Robotic Systems: A Call to Action, *Hospital Pharmacy* **54** (2019), 4-11.
- [20] ECRI & ISMP, *Problems associated with automated dispensing cabinets*, Patient Safety Advisory, Pennsylvania Patient Safety Authority, 2005.
- [21] N. Sarter, D. Woods, and C. Billings, Automation surprises, in: G. Salvendy (Ed.), *Handbook of human factors and ergonomics*, New York: Wiley, 1997, 1926-1951.
- [22] D. Lyell and E. Coiera, Automation bias and verification complexity: a systematic review, *J Am Med Inform Assoc* **24** (2016), 423-431.
- [23] K. Weick, Technology as equivoque: Sense-making in new technologies, in: In: P.S. Goodman and L.S. Sproull (Eds.), *Technology and organizations*, Jossey-Bass, San Francisco, 1990, 1-44.