Striving for high reliability in healthcare: a qualitative study of the implementation of a hospital safety programme

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ABSTRACT

Background Healthcare leaders look to high-reliability organisations (HROs) for strategies to improve safety, despite questions about how to translate these strategies into practice. Weick and Sutcliffe describe five principles exhibited by HROs. Interventions aiming to foster these principles are common in healthcare; however, there have been few examinations of the perceptions of those who have planned or experienced these efforts.

Objective This single-site qualitative study explores how healthcare professionals understand and enact the HRO principles in response to an HRO-inspired hospital-wide safety programme.

Methods We interviewed 71 participants representing hospital executives, programme leadership, and staff and physicians from three clinical services. We observed and collected data from unit and hospital-wide quality and safety meetings and activities. We used thematic analysis to code and analyse the data.

Results Participants reported enactment of the HRO principles 'preoccupation with failure', 'reluctance to simplify interpretations' and 'sensitivity to operations', and described the programme as adding legitimacy, training, and support. However, the programme was more often targeted at, and taken up by, nurses compared with other groups. Participants were less able to identify interventions that supported the HRO principles 'commitment to resilience' and 'deference to expertise' and reported limited examples of changes in practices related to these principles. Moreover, we identified inconsistent, and even conflicting, understanding of concepts related to the HRO principles, often related to social and professional norms and practices. Finally, an individualised rather than systemic approach hindered collective actions underlying high reliability.

Conclusion Our findings demonstrate that the safety programme supported some HRO principles more than others, and was targeted at, and perceived differently across professional groups leading to inconsistent understanding and enactments of the principles across the organisation. Combining HRO-inspired interventions with more targeted attention to each of the HRO principles could produce greater, more consistent high-reliability practices.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The implementation of interventions to instil the five high-reliability organisation (HRO) principles is a common strategy to improve reliability and safety in healthcare organisations, yet there is little empirical research on the perceptions of those who have experienced these programmes.

WHAT THIS STUDY ADDS

⇒ A hospital-wide safety programme that applied a set of HRO-inspired interventions led to variable understanding and enactments of the five HRO principles across the organisation.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

⇒ We provide insights into the design and implementation of HRO-inspired safety programmes in healthcare and call for greater attention to each of the HRO principles to provide a stronger foundation for healthcare organisations to achieve highly reliable practices.

INTRODUCTION

In an effort to improve safety, healthcare leaders frequently look to high-reliability organisations (HROs); organisations that maintain exceptionally safe operations despite hazardous conditions in industries such as nuclear power and aviation.[1] [2] Weick and Sutcliffe identified five principles characterising HROs: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to

Table 1 Definitions of high-reliability principles

Principle	Definitions[3]
Preoccupation with failure	Recognising small risks, errors or deviations that could be a symptom of larger problems and acting on them. This process requires that organisations identify and specify mistakes they do not want to make and call attention to them when they do occur.
Reluctance to simplify interpretations	Taking steps to counteract the tendency to minimise or explain away problems. This includes bringing together different perspectives and talking about new ways of doing things.
Sensitivity to operations	Being aware of the 'big picture', specifically how all components of work fit together, watchfulness for moment-to-moment changes in conditions, and how problems in one area can spread to other areas. It requires close attention to what is happening in the present.
Commitment to resilience	Building organisational capacity to deal with unexpected events when regular planning fails by containing an error early to limit further problems.
Deference to expertise	Decentralised decision-making in high tempo times and drawing on the 'right' expertise regardless of hierarchy with expertise changing depending on the situation.

operations, (4) commitment to resilience and (5) deference to expertise (table 1).[3–5] Importation of strategies from other industries into healthcare, however, is a complex endeavour requiring translation and significant adaptation.[6]

Healthcare safety programmes aiming to enhance reliability have achieved some improvements in outcomes.[7–12] However, neither individual healthcare organisations nor the field of healthcare has achieved highly reliable performance.[13 14] This may result from limited evidence regarding *how* organisations become highly reliable, and in particular, how interventions purported to enhance reliability are interpreted across the wide range of healthcare professionals and how these interventions support enactment of the HRO principles.

This paper reports on a qualitative study of a hospital-wide safety programme, 'Caring Safely'. Caring Safely was implemented in 2015 at a Canadian paediatric referral centre (to be referred to as 'the hospital') in conjunction with a large multihospital improvement collaborative.[15] The collaborative aims to eliminate preventable harms including serious safety events, hospital-acquired conditions[16 17] and employee injuries.[7] Caring Safely is the hospital's name for the programme that comprises a suite of interventions endorsed and taught by the collaborative, including several harm prevention practice bundles and a set of interventions aimed at instilling HRO principles and fostering reliability (see table 2). Further information about Caring Safely implementation is available in online supplemental file 1. This specific set of HRO-inspired interventions has been implemented in approximately 2000 healthcare organisations in North America,[18] with many leaders from this collaborative reporting their organisation being at the mature stage of HRO implementation.[19] However, the experiences and perceptions of the range of healthcare professionals tasked with enacting the HRO principles in practice have not been systematically explored. This is of particular importance, given that different professional groups have been found to interpret safety culture and performance differently.[20 21] Our study aimed to explore how each HRO principle was understood, and perceived to be practised, by healthcare professionals in different clinical contexts, in response to the Caring Safely programme.

METHODS

We conducted a single-site qualitative study using interviews, direct observation and document analysis. We focused on hospital leadership, Caring Safely steering committee members (executives, safety leaders and staff, and directors) and three clinical units: medical specialty, intensive care and surgical. The units were purposively selected to reflect diversity in acuity, specialisation and earlier versus later engagement with Caring Safely.

Two authors, LR and JG, conducted 74 semistructured interviews (72 individual interviews, 1 interview with two participants, 1 interview with three participants and 6 follow-up interviews, ranging 26–74 min), with 71 participants with different professional backgrounds and roles (table 3). All Caring Safely steering committee members and hospital executives were invited to participate. We used purposive sampling to recruit participants with varied professional backgrounds and roles (eg, clinical, managerial, quality and safety, medical trainees) from the three units. Interviews were audio recorded and transcribed verbatim. Questions addressed individuals' understanding and feelings about Caring Safely, experiences implementing the interventions and perceptions of impacts on their behaviours. An interview guide is available as online supplemental file 3. To explore participants' understanding and experience of the HRO principles, we shared definitions of the principles during the interviews and asked participants to reflect on if, and how, they observed them in practice and whether and under what conditions the Caring Safely interventions enabled their enactment.

LR and JG observed events associated with both Caring Safely and general safety activities (table 3). The observations were ethnographically informed. We were attentive to details such as space, people, objectives, interactions, activities, time, goals and feelings.[22] Notes made during each observation were later transcribed. We collected documents including safety

Table 2 Summary of key interventions comprising the Caring Safely programme and associated high-reliability organisation principles

Intervention	Details	Associated high-reliability organisation principles
Board training in safety[40 41]	Two-day training offered by the collaborative twice yearly. Content included: epidemiology of harm in hospitals, safety culture, interpretation of data and strategies for effective safety governance.	Board training promotes the principles of **preoccupation with failure** and **sensitivity to operations** by equipping those responsible for governance with an understanding of foundational concepts necessary to recognise threats to safety and the status of organisational safety and reliability, and the ability to interpret and respond to safety events and harm data.
Leadership Methods training[1 8 36 40–45]	One 2-hour training for all managers, directors and senior leaders. Content included: methods for leader rounding (to observe frontline practice and to influence staff regarding the importance of safety efforts), giving effective feedback, prioritising safety issues and enabling just culture. An organisation-wide Daily Safety Brief intervention was taught and implemented as part of the Leadership Methods training.	The set of practices taught in this training foster the principles of **preoccupation with failure, sensitivity to operations** and **commitment to resilience** by encouraging direct observation and interaction with frontline work and creating structures and processes that establish situational awareness for the purposes of anticipation and real-time problem-solving and learning.
Error Prevention training[40 42 44 45]	One 3-hour interactive workshop for all staff. Content included: overview of harm in healthcare, how safety events occur, and tools for effective teamwork and communication behaviours. Tools include: Introduction by Name and Role, Assertion Tool, Mindfulness Tool, Verification and Resolution Tools, Tool for Escalating Information, Closed-loop communication and Handoff Tool.	The set of individual and team practices taught in this training support the principles of **preoccupation with failure** and **sensitivity to operations** (eg, identifying small anomalies and practising mindfulness when conducting safety critical or error-prone tasks), **reluctance to simplify interpretations** (eg, maintaining critical thinking and a questioning attitude to promote verification of information) and **deference to expertise** (eg, explicit use of tools that facilitate communication of information or assertion of concern across hierarchical levels and professional boundaries).
Safety Coach programme[36 44–46]	One 2-hour training and ongoing meetings to develop volunteer peer coaches. Content included: a review of Error Prevention (expected safety behaviours and tools) and strategies for giving effective feedback. Safety coaches were expected to act as a coach in the course of regular work, by giving immediate positive feedback when safety behaviours were observed, reviewing safety behaviours, and accompanying tools, or pointing out missed opportunities to act safely or use the tools. Documentation of coaching encounters, including date, area, safety behaviour and coaching type, via a REDCap survey, was encouraged to track coaching activity centrally.	The Safety Coach programme reinforces the same principles as Error Prevention training (above), by equipping volunteer coaches with skills for making behaviours explicit and giving positive feedback when the skills are successfully used, or for providing coaching when opportunities to use the tools have been missed.
Cause Analysis[36 40–42]	Complete overhaul of safety event classification and analysis system. Five staff attended a 2-day training on the Serious Safety Event Classification system.[47] A formal Root Cause Analysis system that entails individual interviews with all involved staff, formal classification of all proximal and root causes, and a three-meeting model for event review leadership to include objective peers in establishing causal mechanisms and corrective actions.	This Cause Analysis model promotes the principles of **reluctance to simplify interpretations** by using individual interviews with all staff involved in an event and by introducing objective peers into the steps in which causal mechanisms are articulated and existing assumptions and practice questioned. The focus on all staff participating and having input on corrective action also reflect **commitment to resilience** and **deference to expertise**.
Healthcare-acquired conditions (HACs)*[36 42]	Prevention bundles[48] targeting each HAC as recommended by the safety collaborative.	The programmes related to the implementation of HAC bundles relied on principles of **reluctance to simplify interpretations**, **sensitivity to operations** and **deference to expertise** in that senior leaders used rounding to learn from frontline staff about gaps in knowledge and practice, so that educational programming and auditing systems could be designed to achieve highly reliable performance of bundle practices.
Serious Patient and Employee Safety Events	Multimodal continuous improvement: culture and leadership interventions described above in addition to continuous improvement resulting from Cause Analysis.	The Leadership Methods, Error Prevention and Safety Coach programmes all aim to prevent these events and thus support the principles as listed above. In addition, the system created to respond to harm events fosters **commitment to resilience** by establishing structures and processes around accountability for implementation of corrective actions and collective learning from events.

*Caring Safely HACs include (1) central line-associated bloodstream infection, (2) surgical site infection, (3) pressure injury, (4) catheter-associated urinary tract infection, (5) fall resulting in serious harm, (6) peripheral intravenous catheter injury and (7) unplanned extubation.

coaching encounters, 'good catch' reports that document close calls and near misses (ie, situations that could have caused harm, but did not), organisation-wide notifications about safety events and patient safety meeting agendas. Data were collected between April 2017 and February 2019.

Table 3 Interview participants and observations

Interview participants

Role	Medical specialty unit	Surgery unit	Critical care unit	Steering committee/leadership	Other	Total
Managers, directors and executives	3	2	1	9		15
Quality Improvement and Patient Safety staff	3	4	1	4	2	14
Nurses	7	6	6			19
Other clinicians and support staff*	4	2	5			11
Physicians	2	2	2	1		7
Medical trainees	1	1	1		2	5
Total	20	17	16	14	4	71

Observations	Number of observations	Duration range of each observation	Total hours
Education and training sessions	7	2–3 hours	19
Safety Coach meetings	6	30 min–1 hour	5
Unit-level safety and quality meetings	14	30 min–3 hours	14
Daily Safety Brief	7	15–30 min	3
Hospital-level safety and quality meetings	6	1–2 hours	8

*Pharmacists, occupational therapists, dietitians, research staff, social workers.

We applied a thematic analysis approach to identify patterns across the data.[23] LR and JG initially read four interview transcripts and, through discussion, developed a coding guide. The codes were derived directly from the data and using HRO literature as a theoretical framework to help identify how the HRO principles appeared in the data.[3 5 24] We were attentive to the explicit language of, and implicit ways of talking about, each principle. Using the coding guide, LR and JG each coded half of the remaining transcripts and observation notes. The research team met regularly to discuss the coding guide and share examples of coded data. We made notes of team discussions and how they influenced analytical insights. The coding guide was iteratively modified to reflect ongoing analysis and team meetings. Analysis and interpretation of data was guided by the constant comparison method as we worked across the data to understand patterns related to each HRO principle and Caring Safely interventions.[25]

RESULTS

Findings are organised by HRO principle (table 1). For each, we present participants' understanding of the principle, perceptions of how it was typically enacted (or not) in practice and its perceived relation to Caring Safely interventions. Additional example quotes are available in online supplemental file 2.

Preoccupation with failure

Caring Safely interventions described as supporting preoccupation with failure include Error Prevention training, sharing safety stories at meetings and serious safety events on the hospital intranet. A 'good catch' intervention, which entailed a good catch reporting tool, sending a personal thank you copied to managers and hospital-wide recognition of a small number of good catches, was also described as supporting this principle. These interventions allowed for the identification of errors and contributing factors as well as creating awareness of vulnerabilities, both necessary for preoccupation with failure. Further, the Safety Coach programme supported and recognised staff efforts to identify, and act when faced with, potential failures. Our participants expressed some concerns that the Caring Safely interventions maintained an emphasis on understanding past errors rather than supporting the implementation of changes to prevent future errors.

Participants noted that many of these practices existed prior to Caring Safely, but that formally labelling them as Caring Safely interventions brought attention to the participant's role in identifying and communicating potential safety issues.

> We're acknowledging the good catches in this culture. I think it's encouraging people to be more honest… report accurately as opposed to not reporting…[Good catch reporting] gets people's attention and change happens through that. I think, in general, the culture is better, and I think we're doing better by our patients by having Caring Safely. (56, Pharmacist)

Participants described challenges maintaining a consistent mindset of wariness, doubt and continuous attention in the face of pressure to be efficient. One pharmacist shared that she often felt pressured to sign off on a prepared medication even when the printed label could not be read properly. The number of safety issues and high-risk practices in the hospital context requires clinicians to make decisions about being preoccupied with failure or moving forward with their responsibilities. One nurse questioned the value of preoccupation with failure as follows:

> Preoccupation with failure, is, sometimes you have to say, like, "oh, okay, that one wasn't a big deal", because if you focus on every single little mistake, you would be terrified to do anything. (60, Nurse)

Our analysis demonstrated that the Caring Safely interventions were more often targeted at, and taken up by, nurses compared with other groups. While all staff members were required to attend the Error Prevention training, nurses underwent up to several additional hours of training on harm prevention bundles (depending on area and population HAC prevalence) in various formats including annual education days, in-services and self-directed e-learning modules. Despite inviting all staff members, nurses volunteered to take on safety coaching roles at much higher rates than other groups, with nurses comprising more than 80% of the coaches. Nurses more commonly spoke of supportive strategies, such as consistently reinforcing error prevention techniques, encouraging reporting and celebrating good catches, being exhibited by their leaders and safety coaches. Nurses, occupational therapists and pharmacists also described increased comfort proactively discussing safety issues. In contrast, physicians and medical trainees described little or no follow-up after participating in Error Prevention training.

Limited explicit education about HRO principles contributed to varied reactions to the word *failure*. Participants deliberated about what gets defined as *failure* in unpredictable environments where non-preventable morbidity and mortality are daily realities. In healthcare, *treatment failure* is commonly used to reflect limitations of current treatment, not errors in care, potentially adding inconsistency in how *failure* (as an HRO principle) is perceived.

> Something happened, you have not failed. Preoccupation with failure, I think, needs to be reworked. Because the biggest failure is death. Death is something that happens here, morbidity is something that happens. We need to be thinking about reducing it all the time, but we can't prevent all deaths. (32, Physician)

Reluctance to simplify interpretations

Some participants, mostly nurses, valued the Caring Safely error prevention strategies of 'taking personal responsibility for safety' (eg, using the Assertion tool) and 'maintaining a questioning attitude' as providing a structured, organisationally supported approach to bringing together different perspectives to increase awareness of problems and potential solutions. Participants did not use the HRO language of reluctance to simplify interpretations, but did emphasise the underlying ideas, such as being open to new information, listening carefully to each other, respecting sceptics and challenging the status quo:

> I think the best thing about what Caring Safely did was to affirm the need and the legitimacy of saying, I don't really understand what you're saying, or I don't agree with what you're saying…I think medicine is still very hierarchical. (60, Nurse)

Another example is the implementation of a harm prevention bundle that required providers to discuss daily whether a patient's central line can be removed. On the medical specialty unit, this discussion evolved to include concerns about line function and ways to minimise accessing the line. We interpreted this evolution as encouraging the discussion to go beyond the simplified view of whether the central line should stay in or be removed.

Despite Caring Safely strategies to encourage reluctance to simplify interpretations, interprofessional and structural challenges persisted. Some noted limited opportunities to speak during rounds or variable engagement by the range of professionals in clinical discussions due to, for example, healthcare providers being present on the unit at different times.

Finally, similar to reactions to the word *failure*, some participants reacted to the term *simplify* in the absence of HRO conceptual understanding. For example, surgeon participants viewed simplification as positive, so reluctance to simplify interpretations was seen as antithetical to their practice.

> We are surgeons. We definitely don't have a reluctance to simplify. We want to simplify as much as possible. Anything that's complicated we don't like. We don't like long stories when we get our patient stories. We like 'this is the issue, this is how we're going to fix it, this is how we're going to move on. (65, Physician)

Sensitivity to operations

Participants highlighted practices associated with sensitivity to operations related to both bringing people together to create a clear picture of the situations they face (eg, Daily Safety Brief (DSB), preoperative huddles) and error prevention techniques that support alertness and attention in clinical practice. Hospital leaders overwhelmingly described sensitivity to operations as relevant to their roles, compared with other principles. They viewed Caring Safely as creating practices that allowed real-time conversations about safety and improved understanding of frontline experiences.

> I think as a senior team, we are way more sensitive to operations now. My colleagues in [the executive] office who had zero line of sight on what happens at the frontlines are far more sensitive to the complexity of what happens on the frontlines. (72, Leader)

The DSB was the Caring Safely intervention that leaders associated most with sensitivity to operations. The brief was described as facilitating communication by bringing together leadership of different groups to discuss safety issues.

> [The DSB] has given me much more insight, confidence, and understanding of the organization as a whole. I think it also created connections and relationships that enable a better conversation, and [identifies] people to follow-up directly with. (66, Leader)

Despite enthusiasm for the DSB, participants acknowledged limitations. A safety leader noted that those with important insights (eg, managers) were not included. Observations showed the DSB tended to focus on census and access, evidence of shallow sensitivity to operations. Clinical representatives often stated 'nothing to report and nothing anticipated', whereas representatives from facility management and security departments reported similar information each day, such as elevator maintenance, fire drills and code calls. A leader described the DSB as "drift[ing] periodically into a bed management meeting" (72, Leader).

Consequently, some participants expressed concern that leaders did not sufficiently recognise the implications of the demands at the point of care.

> Sensitivity to operations, I think that maybe needs some work, if I were to be honest. I think there's still a pretty big disconnect between decision-makers and frontline. (17, Quality Improvement and Patient Safety (QIPS) staff)

Participants described challenges of maintaining organisation-level perspective and awareness of organisational demands and strains, which partly constitutes sensitivity to operations. One manager noted: "our frontline clinicians probably have the least awareness of the big picture" (64, Leader) due to limited opportunities to engage in organisation-level practices. The following quote demonstrates challenges of sensitivity to operations across professional boundaries.

> …the pharmacy technicians and the nurses interact quite a bit electronically. I'm not sure that they really understand each other's day-to-day functions, and what the time pressures for what the other roles are… So, that would be an example of where I feel the frontline isn't really seeing eye to eye, but there's nothing really from above to help them see eye to eye. (49, Pharmacist)

The Mindfulness and Resolution tools were described as promoting better in-the-moment understanding by creating space that allows for awareness of one's actions while counteracting distractions and casualness that impede sensitivity to operations, as noted here:

> There is no doubt because when it's so busy and you've got multiple people asking you multiple things at the same time, it's not humanly possible to manage all that on a consistent basis without risking errors from occurring. Definitely [Mindfulness tool] became a huge Caring Safely behaviour for me. (39, Nurse)

This quote highlights an individual behaviour focus. In contrast, clinicians' descriptions of other activities not connected to Caring Safely demonstrate collective aspects of sensitivity to operations, such as paying close attention to day-to-day operations and interacting to build a clear picture. One example is the multispecialty preoperative huddle, where individuals introduce themselves and share information. Other examples are nurses' descriptions of supporting each other with patient care and communicating about high-risk procedures.

> [Nurses] pick up on, okay, this [nurse] has been in this room for an hour, I'm going to go check on his other kids because he's obviously busy right now…maybe there's four [nurses] helping this one sick kid, then the other nurses will often go and help and check on the other [patients]. (61, Nurse)

Frontline participants noted challenges maintaining awareness and alertness to moment-to-moment changes, as well as negative consequences of activities designed to promote sensitivity to operations, such as the preoperative huddle impacting operating room time. An organisational push for efficiency affected their ability to collectively cultivate a big picture understanding or to stop in the face of an anomaly and reassess, as exemplified by the following observation note describing a discussion about the Mindfulness tool during a Safety Coach meeting:

> Someone in the meeting states that frontline nurses do not want to be seen as slowing things down and they do not want to have to ask families to wait. They are uncomfortable and resistant to doing this. The meeting coordinator says that in her experience families are generally understanding if the nurse explains why they have to wait, but then a manager responds that they have had some families who always complain that care is too slow, taking too long, and those interactions can really impact how the nurses react and their willingness to use [Mindfulness tool] in situations where they feel there is time pressure. (Observation 22)

Commitment to resilience

Participants often interpreted commitment to resilience as *personal* resilience, associated with addressing clinician burnout and providing support following the experience of a safety event.

> We're starting to see more and more the commitment to resilience, and how we support our staff to be resilient in such a complex healthcare environment. There's been a lot of work on resiliency and joy, and decreasing the amount of burnout in the staff, too, or efforts to do that. (20, QIPS staff)

Clinicians took pride in their ability to problem-solve in the face of unexpected events. However, this emphasised individual management of organisational processes. For example, a pharmacist described an incident where a required medication was not available on a unit, and she drew upon her knowledge to work around current structures and obtain the medication from another unit. Some clinicians viewed individual resilience as central to their clinician identities and attributed it to training and experience.

> We would hope that all of us, as surgeons, are trained, because unexpected events happen frequently in our business. (53, Physician)

> I wonder how to practice to build capacity to deal with the unexpected. Because in the [critical care unit], we're just thrown into that. We have to be resilient and to deal with the unexpected, but was there a way to build capacity, I don't know. Because you just kind of acquire this as you go, like, through experience, and you learn and grow as you go along. (45, Pharmacist)

Caring Safely created comparatively few opportunities for collective training (ie, simulation training) and learning to build a repertoire for resilience. During the data collection period, there was one large-scale simulation of an armed person/hostage situation. Observations of senior-level discussions following the event demonstrated the perceived importance of the simulation, but also the extensive resources it required. Concerns were expressed about the lack of resources for collective professional development, as well as for staffing to create buffers in the system to blunt disruption and provide slack for redeploying resources to respond in ways that systematically address underlying problems.

Deference to expertise

Participants expressed a shared understanding of 'where the expertise lies' across the hospital. However, this understanding was most often equated with experience, seniority and professional background as represented through the formal hierarchy rather than an HRO understanding of expertise with the problem at hand.

Many participants described 'chain of command' and its correlation to expertise as the guiding logic for dealing with unexpected situations, demonstrating the strong emphasis on hierarchy and clinical specialisation:

I think from a medical standpoint we know who to reach up to and how to find our fellow staff and get them down there. The nurses have all the cellphone numbers of all the other attendings, so we can get that, and the off-service attendings if I need cardiovascular surgery quickly or someone else. (65, Medical Trainee)

Nurses similarly shared numerous examples of reaching out to more experienced nurses or charge nurses when dealing with something unexpected. Given the wide range of roles in the hospital, participants also discussed deference to expertise as knowing who had what expert knowledge based on professional training and role, within and across professional groups:

I think with the interprofessional teams, so [occupational therapists], [physical therapists], dietitians, they're all very accessible because we have our standard ones that are associated with the units. (19, Nurse)

The above examples demonstrate key properties of expertise in HROs: respect for domain-specific knowledge and experience as well as the ability to obtain expert assistance. However, for physicians, their conception of deference to expertise was challenged given structures of medical education embedded in academic teaching hospitals and the need for consultations with other specialties:

Where we have problems is that because there are parallels, structures of levels of expertise, sometimes you say all right, well, consult this 'ology' because they're more expert, but then you suddenly get somebody with a lower level of expertise. That's where I think some of the going up the chain of command comes up. [We are] trying to have staff-to-staff communication as opposed to you are an emergency doctor with 10 years of experience, and suddenly, the [first-year resident] in whatever 'ology' trumps you. (69, Leader)

Our data demonstrate limited examples of deference to expertise, within or beyond Caring Safely. One participant noted that Caring Safely's enhanced error investigation process afforded opportunities for inclusive discussions about errors.

When you look at our Serious Safety Events process, before, experts got in a room and said, this is what should have happened…vs now, it's reviewed by people who are peers and where the expertise actually exists, and you learn a lot more around what is really happening vs what should be happening. (22, QIPS staff)

The following quote demonstrates one example of deference to expertise not directly related to Caring Safely:

My [patient] needed [procedure] and the staff physician said, well, I haven't done it in a few years, but I can try it. And, I was like, the [respiratory therapist] can

try, because they do it every day and they're available … So, even though, in theory, the staff physician is the top, if you haven't done a skill in a year, I've only got two limbs to work with, I'm not letting you blow a vein … You're going to the person with the right expertise, not necessarily the person who has the longest years of service. (60, Nurse)

Overall, participants did not express changes to their understanding of expertise or a broader sense of fluid empowerment based on being well suited for a specific problem at hand when discussing the Caring Safely programme.

DISCUSSION

Our findings provide insights into how the HRO principles are variably understood and enacted in practice in response to Caring Safely, a hospital safety programme based on a widely adopted, HRO-focused suite of interventions. We demonstrate that Caring Safely supported some HRO principles more than others, was targeted at, and perceived differently across professional groups, reinforced individual approaches to reliability and safety, and provided variable attention to structural and social factors that impact adoption.[26]

Our analysis illustrates how Caring Safely interventions supported preoccupation with failure, reluctance to simplify interpretations and sensitivity to operations through both implementing of new Caring Safely interventions and reinforcing or adding legitimacy to pre-existing practices. Our findings bring attention to how quality and safety interventions interact in practice and contribute to high reliability.[14] The range of interventions helped specific groups enact HRO principles in different ways relevant to their role and context, such as nurses with preoccupation with failure (by making failures and threats more discussable) and executives with sensitivity to operations (by enhancing awareness of frontline experience). However, the lack of deliberate and focused attention to each of the principles or investment in education related to behavioural and cognitive underpinnings of high reliability limited habitual and robust uptake of reliability-enhancing practices.[27]

Although Caring Safely includes interventions intended to instil the HRO principles commitment to resilience and deference to expertise (see table 2), participants did not perceive these principles being addressed by Caring Safely. These principles may be particularly challenging to address given resource constraints and entrenched hierarchies in healthcare,[28 29] however, prior research suggests that after-action reviews done with a systems and learning orientation may be a source of resilience.[30] There is also evidence that practices of 'dynamic delegation' used by trauma teams may build capability for deference to expertise.[31] We observed that expertise was regularly conflated with formal authority instead

of domain-specific expertise and that error prevention strategies tended to target individual behaviours as opposed to organisational approach to resilience. Though safety efforts must include both individual accountability and system approaches,[32] overemphasis on individual action hinders the collective actions foundational to HROs.[33 34]

We identified inconsistent understanding of the HRO principles among professionals. In some cases, this understanding directly conflicted with how they are enacted in HROs. Some observed deviations from the intended understanding may reflect reasonable modifications in healthcare; however, others may result from a limited attention to the HRO principles and associated concepts in Caring Safely programme design. It may not be necessary for all hospital employees to be deeply familiar with the HRO principles by name, but differing understanding of expertise, failure, resilience, and simplification may unintentionally result in fragmented, hierarchical, and individualised approaches to safety. Furthermore, interventions were targeted at, and taken up by, certain groups, particularly nurses, more than others. These variations may contribute to a piecemeal approach limiting the shared understanding of HRO principles and inhibiting improvements in reliability.[1 25 35] Variations also reveal the importance of consistent and comprehensive (ie, cross-profession) leadership support and specific accountability measures.[1 36 37]

Finally, the focus on efficiency was consistently described as an obstacle to enacting the HRO principles, echoing other examples of safety-efficiency trade-offs.[38] We also found variation in how participants perceived safety issues and experienced the principles related to professional norms, clinical experience and training, and care contexts.[20] All of which alter or inhibit enacting the HRO principles and reflect the influence of context on implementation efforts.[39]

Based on our findings, Caring Safely, and other similar programmes, could take three steps to more systematically instil the HRO principles. First, place greater emphasis on teaching the principles to leaders and staff, describing what they mean for everyday work, and pairing them with interventions that place less emphasis on individual training (eg, Error Prevention training) and more on collective problem-solving and scenario-based training to foster mindful interpersonal interactions. Second, provide more sustained coaching on interventions like root cause analysis, DSB and rounding, to turn them into learning-oriented habits that get more members of the care team engaged, and thinking about and acting to enhance safety and reliability (ie, embodying the principles). Third, strive for greater fidelity to the HRO principles by ensuring leaders are not only trained to support intervention implementation, but are provided ongoing feedback (eg, through surveys or audits) on the extent to which the HRO principles are being enacted.

Our findings should be considered in light of this study's limitations. First, this study was conducted at a single site, potentially limiting direct transferability of our findings. However, given that Caring Safely relies on a widely adopted HRO-inspired set of interventions consistent with current approaches aimed at achieving high reliability in healthcare, our findings can provide insights for organisations engaging in similar work. Second, although data collection occurred over a 2-year period, for interventions aimed at culture change, this is a relatively short timeline. Mindsets and practices have likely continued to evolve in association with Caring Safely.

CONCLUSION

Our findings demonstrated that Caring Safely heightened enactment of high-reliability practices. However, these enactments were often fragmented and narrow. Therefore, HRO-inspired programmes may benefit from supplementing existing intervention-focused approaches to becoming an HRO with more targeted attention to each of the five HRO principles. Specifically, providing guidance, structure, and support for individuals and groups to engage more fully with the HRO principles and what they mean to each other may enable more consistent, shared understanding of HRO principles and provide a stronger foundation for healthcare organisations to more successfully move along the journey toward high reliability.

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Supplemental File 1: Summary of selected Caring Safely program process measures

Table 1: Organizational interventions process measures

Intervention	Process measures
Board training in safety	1-2 Trustees and 1-2 Executives attended each of six two-day sessions over three years
Leadership Methods training	Approximately 700 individuals trained over study period
Error Prevention training	Fifty volunteer trainers trained approximately 9,000 staff over the study period, which corresponds to approximately 90% of all staff in the organization
Safety Coach program	Two-hour training reviewing expected safety behaviours and providing strategies for effective coaching, and periodic ongoing meetings to develop volunteer peer coaches (approximately 600 trained during study period – more than 80% of safety coaches were nurses). Encounters documented via a REDCap survey (approximately 1400 coaching encounters tracked over study period). Information collected includes: type of coaching encounter (i.e., review a tool, point out use of a tool, or provide constructive feedback on how someone could have used a tool), location of the coaching encounter, and the professional group of the person being coached.
Cause Analysis	Seven senior leaders met weekly to review potential Serious Safety Events (SSEs), approximately 50 potential SSE cases reviewed per year, to assign the SSE designation to those meeting the criteria (5-20 per year), and to charter Root Cause Analysis teams. Proposed corrective actions were reviewed, approved, and tracked through to completion (average 40 per year).
Patient and Family Engagement	Approximately eight family advisors engaged across various activities (e.g., Quality subcommittee of the Board of Directors, Executive Quality committee, Caring Safely steering committee, creation of patient story videos and participation in live events such as orientation and town halls).

Table 2: Harm data collection, Bundle implementation, and Audit process measures

Activity	Process measures
Central line associated bloodstream infection (CLABSI)	Outcomes data collection, bundle implementation, and regular bundle compliance audits* established across 12 clinical units
Surgical site infection	Outcomes data collection for selected procedures, bundle implementation, and regular bundle compliance audits* established for most surgical procedures.
Pressure Injury	Outcomes data collection, bundle implementation, and regular bundle compliance audits* established across 12 clinical units.
Catheter associated urinary tract infection	Outcomes data collection and bundle implementation in intensive care units.
Falls resulting in serious harm	Outcomes data collection, bundle implementation, and regular bundle compliance audits* established across 11 clinical units.
Peripheral intravenous catheter (IV) injuries	Hospital-wide bundle implementation initiated close to end of study period.

Unplanned extubations	Outcomes data collection and quality improvement work in progress across three intensive care units prior to study and throughout the study period (external prevention bundle became available toward end of study period).
Adverse drug events	Outcomes data collection and quality improvement work across multiple aspects of medication safety in progress prior to and throughout study period.
Serious employee harms	Outcomes data (Lost Time Injuries/Days Away and Transferred Injuries) collection initiated. Outcomes data collection established organization-wide, and implementation/audit of prevention practices for top three serious employee harms (Overexertion, Slips/Trips/Falls, and Patient Behavioural Events) in progress at end of study period
Patient serious safety events	Outcomes data collection and related quality improvement work in place throughout study period.

Table 3: Summary of early program goals and results

Three-year goals were established at start of Caring Safely implementation. Full program maturity expected in six to nine years based other collaborative hospital experience implementing the same program. Goals included adherence to HRO principles and harm reduction.	
Early program goal	**Early results**
Serious patient safety events: Reduce the rate of serious safety events by two-thirds (12-month rolling average of serious safety events per 10,000 adjusted patient days).	69% reduction in Serious safety event rate from year 1 to year 3
Serious employee injury: Reduce the rate of serious employee injury (Lost Time Injuries/Days Away and Transferred Injuries 12-month rate) by 20%.	20% reduction in serious employee injury from year 1 to year 3
Hospital acquired conditions (HACs): Reduce the incidence of HACs significantly (with "significantly" meaning statistical process control chart centreline shifts).	30% reduction in central line blood stream infections by year 3 (highest incidence HAC)

*Regular compliance audits of each type of harm ranged from a minimum of 20 per month hospital-wide to up to 200 per month hospital-wide for high-frequency harms like CLABSI. Audits were completed via direct observation and documentation review by a mix of Healthcare Acquired Condition (HAC) champions, educators, quality leaders, and peers. In practice, alternative terms were used for "compliance audits" by different teams, such as "observation," "education," and "coaching.

Supplemental File 2: Quotes and observations associated with each HRO principle

HRO Principle	Representative quotes and observations
Preoccupation with failure	
Identifying errors and contributing factors to prevent future failures.	I think that the Caring Safely, recognizing small risks and just the little things like [Verification and Resolution tool], and things like that. I think even the little risks that have been brought forward to my attention, I hadn't considered them, so I think Caring Safely has certainly brought slight preoccupation with failure. (42, Pharmacist) With Caring Safely there is more of a recognition that there are mistakes that are made. We're human, we make mistakes, and so shifting to just the fact that it was so pushed in terms of doing the training. There was just so much buzz about Caring Safely that I think it just brought to light that, yes, mistakes are made, we need to figure out how to prevent mistakes, and then how to address medical errors, which I don't think was quite here before, the full initiative, like, just by means of exposure to even the title alone just brought more awareness to that. (71, Social worker) The recognition when someone says "I have a concern" is a little bit different. One of the staff physicians just took Error Prevention last week and she came up to me at the end of the week and she said, I understand now why everybody is saying to me I have a concern. Now I actually have to pay attention. That's why everybody is saying that. That's true. That is why everybody is saying that, because they're concerned, and, yes, you should pay attention. I think it's getting there. (17, Quality Improvement and Patient Safety (QIPS) staff)
Insufficient effort, investment, and support to redress past errors to prevent future errors.	Right now, we're having so many issues with our pumps. They're shutting down. We have brought this to our executives for the last three years and because of budgeting we're just now in the conversations, three years later, about replacing the pumps…We still have our patients put on pumps with really critical medications like Epinephrine, Dopamine, things like that, that are going to life-sustaining medications…So, are we managing those unexpected things to happen? Are we doing a good job of it? No, because we're not preoccupied, because it is going to fail, and we're not preoccupied without the fact that this is going to actually result in an event that is going to be either really bad for the patient. (74, QIPS Staff) During a unit safety meeting there is discussion about an event where a patient had a missed treatment and then needed to receive another treatment with sedation. There is discussion that this event was not classified as a serious safety event as it did not meet the criteria. One person commented that their concern was less about the decision about the classification and more that they do not have enough organizational support to implement the recommendations which lands on the local units. (Observation 36).
Variation in exposure and uptake across professions.	During a unit quality meeting discussing the safety reports and good catches the [nurse practitioner] asks if the good catches come mostly from nursing or are other professions becoming involved in this. The [quality improvement] lead answers that it continues to be very nursing heavy, but there are some from pharmacy as they tend to catch a lot of medication errors through reconciliation. (Observation 22) The respiratory therapists, they are very similar to nursing in the [critical care unit] in how they use [Error Prevention tools] and talk about it. They don't have any safety coaches yet in the respiratory therapist group, we're still building our safety

	coach team, and we also don't have any physicians yet as safety coaches. So, that will take it up a next layer. (34, Nurse) The safety coaches, I haven't had much to do with the safety coaches because we practice within the medical realm as the nurse practitioner. I know the safety coaches. They're on the unit and they are more nursing focused. So even though I am a nurse practitioner my role is more in the medical realm. The safety coaches were more for the frontline nurses. So, we didn't have a lot of interface, I don't have a lot of interface with the safety coaches but I am aware of their presence and I am aware of what they're modelling in the unit for the frontline nurses. (39, Nurse)
(Over) preoccupation with failure.	I don't think anyone wants to be preoccupied with failure, it just sounds negative. I would rather frame it in a positive to say, like, a conscious…Do you want people to be consciously thinking about it? You want it in the forefront of their mind, so a very deliberate focus on success or something. (71, Social worker) Everybody is worried about failure, but it is very hard when you have these random events in very different patient settings and operations to try to come up with something that correlates with what went wrong. So, people are definitely preoccupied with it, but it almost makes you more crazy than leading to an answer. (65, Medical Trainee)
Reluctance to simplify interpretations	
Organizational and peer support for different perspectives to increase awareness of problems and potential solutions.	We have two safety coaches in the office, they'll be like, oh, that's [using the Assertion Tool], good job, just talking. Sometimes it's joking too, but then you also think, oh, what do you think about this situation? This is my concern. How should I bring this forward? We are talking more about safety because I think also, we have acknowledged that this is how we get some changes made too. (30, Occupational therapist) During a safety coach meeting the quality and safety leads share examples of 'good catches'. One of them is an instance of a case in the [critical care unit] where the patient was being transferred to the operating room. The anesthesiologist noticed at handover that not everyone was present so said 'let's wait a few minutes for everyone to be here for handover', recognizing the importance of different perspectives to increase awareness of situation. (Observation 10)
Lack of safety to speak up and challenge assumptions.	I think the problem with some of the principles as it is, I'm not sure we yet have a culture, at least in surgery, where people really feel in power to [speak up]. You know, if you have a climate that is hostile towards speaking up. If it's not a culture that embraces people questioning things, people won't. So, it's that simple. (57, Physician) I think that there's been more of a push to bring everyone to the table. But sometimes, I think, as a bedside nurse, you don't feel this is, like, your perspective is being shared. It's very hard to get bedside nurse's perspective just based on shift work and being able to get away from the bedside. (36, QIPS Staff)
Sensitivity to operations	
Senior leaders insufficient understanding of demands at point of care.	I think it's getting better in that we're seeing more [vice presidents] come to the units, and they've been doing some shadowing off and on recently. But I do still feel like, sometimes, and no fault of their own, but they're just so far removed and so high up…And things for nurses to remember, and our kids are getting more acute, and we're getting busier, and our census is trending up. So, we're stretched already and people are stressed and adding those things on, it might look like a good time

	on paper, or it might look like a good process on paper, but actually taking it to the frontline and the people that are going to have to do it, it's not always as easy as it might seem on paper. (19, QIPS Staff)
Challenges of consistently maintaining awareness and alertness to moment-to-moment changes.	During a safety coach meeting on a medical specialty unit, a patient safety staff member is doing a presentation about the [Mindfulness tool]. A slide listing all of the potential conditions that should lead to people using [Mindfulness tool] is shown to the group. Conditions listed include fatigue, safety critical process, time pressure, something new or unfamiliar or distracted. One of the unit managers notes that these conditions are so common for nurses (i.e., there is almost always time pressure and distractions and there are so many different [medication] orders, that they often have to give new medications) that if frontline nurses are expected to do [Mindfulness tool] in these conditions they would always be using [Mindfulness tool]. There was no response from anyone else in the meeting about this observation and the conversation moved onto discussing more reasons why staff may not use [Mindfulness tool]. (Observation 22)

I would say we're probably still working on sensitivity to operations. There would be some people that would definitely see that, and other people that very much just are looking at what you're doing day to day, just because it … sometimes it is just making it through that day. Things have been very busy, and acuity is high. (33, Nurse) |
| **Commitment to resilience** | |
| Focus on personal resilience. | I think it's like there's a lot of talk about resiliency. In [medical unit] if there have been situations which have been difficult, unexpected, there's always a debriefing and always other people are brought in to discuss it. We have a chance to talk. And so I do feel like there is that kind of mentor-ism, especially in [medical unit]. Resilience is a big thing. (42, Pharmacist)

So, we've had other programs being introduced since Caring Safely. We have a really unbelievable Peer Support program, which I think has been just amazing really to have that kind of immediate support for people who are going through stress or crisis, maybe a second victim to an error. So, really paying attention to how clinicians are affected, or providers are affected when errors do happen, or just realizing that people are very stressed and traumatized by the continuous stress of just the complexity of the care. (76, Leader) |
| Emphasis on an individualized approach to resilience rather than a collective or system-oriented approach. | But the unexpected, we don't … for instance, we don't staff for unexpected volumes. We staff for what our previous year had showed we should staff for. We go back. We don't staff for, things like that, we won't staff for if a code orange were to happen. We can't. Financially we can't. There's a lot of … we couldn't do it. It wouldn't be possible. (74, QIPS Staff)

If I called any of my colleagues and said, bad stuff is happening, I cannot handle this on my own, I need you to come, I have no doubt in my mind that they would come. But it is all part of that paradigm of the way you solve this is by asking more, and more, and more of people. (47, Physician) |
| **Deference to expertise** | |
| Expertise equated with years of experience and organization position. | Honestly if I run into a problem I run outside and try to find someone who I know wasn't hired with me or after me, because they have more experience and they have probably seen it…If something arises that I haven't seen before I just find someone who has been here longer. (54, Nurse) |

| | It's not simply a case of someone that has been here 25 years, they may not be the expert. And I think sometimes we gravitate toward experience as qualifying one as an expert. (72, Leader)

I'll take daily safety brief as an example. It's very small handful of people that are on that call. It's supposed to go up to that one person's director on call to share the information…what is going to happen at the hospital today and what to anticipate in the hospital today. But I think personally, it shouldn't…they're not getting to the actual safety issues…Having managers and local managers or even charge nurses talking about…I anticipate that this one patient is going to be very challenging or I anticipate that this one, something is going to actually impact our hospital today. Those type of things are supposed to trickle up to director on call. I don't know how often they do…They have the in-depth knowledge of what's happening whereas we don't include and involve those folks. (74, QIPS Staff) |
|---|---|
| Examples of navigating formal authority and hierarchy. | The benefit of the chain of command is when things get hot, you go up your chain of command and then back down. That's not to say there isn't ongoing communication, but just use that chain of command to your benefit so you're talking to somebody who has had some experience likely and will get what your issues are who can either reassure you or redirect, and then bring in some help so those are my two. (51, Physician)

We'll get a consult service, for example, they make a recommendation, we don't agree with them. Like, our new chief was like, guys, it's a recommendation, we don't have to follow it. That is like, oh my god, but we'll make them angry. We'll wake the beast. That's not the way medicine works. If you're asking for an opinion, it's an opinion, but you can choose to do something differently. And I don't think we do that here. I think that's changing… (62, Dietitian) |

Supplemental File 3: Interview guide

Manager and Frontline Staff Interview Guide

1. What is your professional position at [hospital]?
    Probe: how long have you been working at [hospital], roles/units worked in

2. How have you been engaged so far in the Caring Safely initiative?
    Probe: Caring Safely education participant
    Leadership training
    Safety coach
    Healthcare Acquired Conditions (HAC) lead/implementor
    Serious Safety Event (SSE) committee

3. Can you describe your experiences in this role?
    Probe: history of initiative and your involvement, nature of activities, changes in knowledge/practices, challenges, resistance

4. What changes are occurring in your unit to address Caring Safely goals? In the hospital?
    Probe as relevant to HAC (surgical site infections; central line associated bloodstream infections; pressure injuries) or SSE (serious safety event) work; error prevention behaviours; patient safety meetings;
    Probe: Whether changes are or are not happening – what factors are impacting on change or lack of change?

5. Can you tell me about what happens on your unit when something unexpected occurs? How do you respond? Do you have any specific examples?

6. One of the key components of Caring Safely is high reliability organizing and the goal of becoming a high reliability organization.

    The following are the five principles of a High Reliability Organization (HRO):
    Preoccupation with failure – recognizing small risks, errors or deviations as significant, something to pay attention to, treat any lapse as a symptom that something may be wrong with the system
    Reluctance to simplify – take steps to create more complete and nuanced pictures and bring together differing perspectives, talk about new ways of doing things
    Sensitivity to operations – awareness of 'big picture' situation and coordination and knowing where expertise resides
    Commitment to resilience – practicing to build capacity to deal with the unexpected
    Deference to expertise – decentralized decision making in high tempo times and drawing on the 'right' expertise

    Probe for each principle:
    Are you familiar with this principle?
    Do you perceive this principle being relevant to your work at [hospital]? Why or why not?
    Can you give examples of how it has applied to your work or you have seen it in practice?
    Do you perceive that changes have occurred related to this principle at [hospital] due to Caring Safely?

7. Is there anything that I have not yet asked you that you think would be useful to share about your perceptions and experiences about Caring Safely at [hospital]?

*Separate interview guides were adapted for different participant groups including hospital executives, Caring Safely steering committee members, unit managers and clinicians. Guides were also iteratively adapted over the course of data collection to reflect ongoing analysis. This guide was created for unit-based managers and clinicians and adapted midway through data collection.