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Resilient Health Care as the basis for teaching patient safety – A Safety-II critique of the World Health Organisation patient safety curriculum

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1 INTRODUCTION

Patient safety should form a core part of the education of healthcare professionals [1]. However, how do we teach patient safety, and what can or should be the role of recent developments such as Resilient Health Care (RHC) in patient safety education? These are important questions but coming up with an answer is far from straightforward. Patient safety and even more so RHC are fairly recent fields of scientific inquiry; and patient safety is not a uniform domain but has grown out of influences from a wide range of disciplines, each with their own goals, methods, traditions and terminology.

To a certain extent, patient safety has a long history, but as a scientific discipline it is very young. In the 19th and early 20th century pioneers such as Semmelweis, Nightingale and Codman demonstrated that dramatic reductions in patient harm, and improvements in patient safety were possible [2]. However, these early efforts were isolated cases, and there were no attempts to connect systematically such findings into a coherent body of knowledge of patient safety. From the late 1960s and then increasingly from the 1980s patient safety was typically regarded as an aspect of the quality of care [3]. Quality improvement (QI) in healthcare took inspiration from the automotive and manufacturing sectors, and found expression in the Model for Improvement, widely disseminated by the Institute for Healthcare Improvement based in the US [4]. Patient safety as a scientific discipline entered its breakthrough period with the publication of key reports in the US and the UK in 1999 and 2000 respectively [5, 6], although these reports relied on data provided by earlier studies such as the Harvard Medical Practice study in the US in 1984 [7] and the Quality in Australian Health Care Study in 1995 [8].

While QI approaches remain important for improving patient safety, increasingly health systems and researchers looked for inspiration towards high-risk industries, such as aviation, and the related disciplines of human factors and safety science. This led to the development of, for example, healthcare incident reporting systems [9], hospital safety culture assessments [10], and the use of proactive risk assessment techniques based on Failure Mode and Effects Analysis (FMEA) [11] and Human Reliability Analysis (HRA) [12]. These approaches introduced a risk-based perspective into healthcare typically found in industries dealing with low-frequency, high-severity type of situations. This complements QI approaches, which usually focus on standardisation, elimination of waste and improvement of efficiency. However, it is important to bear in mind that in practice QI, human factors and safety science often go hand in hand in patient safety improvement initiatives, and that QI frequently provides scaffolding for activities inspired from other disciplines [2, 3]. Similarly, insights generated by methods and tools developed in high-risk industries can provide additional diagnostic support to QI initiatives, and help explain why certain interventions work and others do not [13, 14].

RHC is an even more recent area of scientific inquiry, whose origin could be equated with the publication of the first edited book “Resilient Health Care” in 2013 [15]. RHC is based on principles of Resilience

Engineering (RE), which is also a fairly young discipline, and where the origin can be traced back in similar fashion to the publication of an edited book in 2006 [16]. RE, and by extension RHC, are schools of thought within safety science that regard systems (such as health systems) as complex and adaptive rather than tractable and deterministic. RHC offers a new vision of patient safety [17], which might be particularly attractive, because there is increasing evidence suggesting that progress in patient safety has been limited despite the significant effort and resources that have been expended [18-20].

While there has been sustained research effort in patient safety over the past 20 years, education in patient safety is not surprisingly lagging behind. University level courses in patient safety appeared at scale only after 2010. The World Health Organisation (WHO) undertook a significant international effort in order to compile a patient safety curriculum that could be used by educators worldwide. The WHO patient safety curriculum was published in 2009 initially intended for use at medical schools. An updated multi-professional patient safety curriculum was published in 2011, and this is intended to be used for higher education across health professions [21]. The WHO patient safety curriculum is an important contribution to improve the quality of education in patient safety, because many course faculty members from clinical backgrounds might be unfamiliar with basic concepts from quality improvement, safety science and human factors. As such these efforts are to be applauded in their aim of providing an agreed patient safety curriculum and the development of teaching resources made available to educators. However, a survey of the adoption of the WHO patient safety curriculum in low and middle-income countries produced mixed results, with the majority of organisations reporting that they were not yet delivering the curriculum [22]. These findings highlight the need for consideration of both the content of a patient safety curriculum as well as the local infrastructure necessary for successfully delivering education.

Given developments in safety science and RHC in recent years, it is timely to revisit the WHO patient safety curriculum from an RHC perspective. RHC is considered a major advance conceptually and empirically in thinking about the fundamental nature of safety by an increasing number of scholars [15, 23-25]. We aim to establish the extent to which the WHO curriculum already incorporates RHC thinking, to identify areas where RHC could contribute to the WHO patient safety curriculum, and to determine the future directions for teaching patient safety based on RHC principles.

In this paper we provide a critique (in the sense of constructive analysis) of the WHO patient safety curriculum from a Safety-II perspective. In the next section (Section 2) we provide a brief overview of the WHO patient safety curriculum. Then, we outline the principles of RHC and Safety-II, which we use to structure our critique (Section 3). The critical analysis of the WHO patient safety curriculum from a Safety-II perspective is described in Section 4. In Section 5, we outline key considerations for the development of an RHC module that could be included in the WHO patient safety curriculum. We provide reflections and implications for teaching patient safety in the concluding section (Section 6)

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2 OVERVIEW OF THE WHO PATIENT SAFETY CURRICULUM

The WHO patient safety curriculum in the 2011 multi-professional edition is the output of a large number of international collaborators and organisations. The audience for the patient safety curriculum are educators in higher education providing education and training to students across the health professions. The guidance document contains two main parts: part one explains the underlying rationale for the curriculum and describes different ways in which it might be used; part two provides the actual content.

Box 1: WHO Patient Safety Curriculum Topics

Patient Safety Topics

1. What is patient safety?
2. Why applying human factors is important for patient safety
3. Understanding systems and the effect of complexity on patient care
4. Being an effective team player
5. Learning from errors to prevent harm
6. Understanding and managing clinical risk
7. Using quality-improvement methods to improve care
8. Engaging with patients and carers
9. Infection prevention and control
10. Patient safety and invasive procedures
11. Improving medication safety

Part two of the WHO patient safety curriculum contains eleven topics covering a range of patient safety issues, see Box 1. Topics 1 – 8 provide thematic content about patient safety, and topics 9 – 11 discuss how to improve patient safety in three high-risk areas that have experienced high numbers of adverse events. The topics include an introduction to epidemiological research studying the extent of patient harm worldwide, the basics of human factors, an introduction to risk management principles, standard quality improvement tools, and engagement with patients and carers. The three areas with a high rate of adverse events are: infection prevention and control, procedural interventions and medications management.

The patient safety topics of part two of the curriculum provide flexibility to course faculty members. They are not meant to be followed to the letter but can be adapted based on the specific needs. Teaching faculty

can pick and mix topics depending on the time available and the specific relevance to their students. Importantly, the WHO patient safety curriculum does not assume that the topics are to be taught as a whole patient safety "module" but recognises and promotes that patient safety can be integrated into a diverse range of existing modules and courses. For example, a non-medical prescribing module aimed at experienced (non-medical) clinicians could include introductory patient safety material and then the topic on improving medication safety; and a nursing course might include different patient safety topics embedded throughout the nursing curriculum.

In summary, the WHO curriculum is a good starting point for integrating flexibly patient safety topics across a range of higher education curricula for different healthcare professions.

3 PRINCIPLES OF RHC AND SAFETY-II

The literature on RHC is growing, and includes now five edited books, a White Paper [26] and many articles published in peer reviewed journals. The main driver behind the development of RHC is the recognition that standard safety management principles and practices might not be best suited for dealing with modern systems. This is because many of the approaches that represent current best practice have been developed between the 1940s and 1980s, when systems were arguably less complex and more tractable than those of today.

In order to argue the case for RHC, the underlying principles have been referred to as Safety-II, and traditional safety management approaches have been lumped together and are referred to as Safety-I. This has been criticised as an oversimplification [27]. However, it is probably fair to say that many of the common (Safety-I) approaches currently in use regard safety as the absence of adverse outcomes or as the freedom from unacceptable levels of risk, and in much Safety-I thinking the system is assumed to be responsive to linear interventions and prescriptions. Hollnagel pointed out that in this view, safety is paradoxically defined by the absence of something, and is, therefore, impossible to study directly [28]. Safety-II, on the other hand, regards safety as the presence of something – namely, the presence of abilities: the abilities to adapt, to monitor, to anticipate and to learn [29, 30].

From this initial distinction, a number of important differences can be identified. Firstly, Safety-I approaches to safety management are often reactive and are triggered when an accident or an adverse event occurs. This is certainly the case in healthcare, which has been criticised for relying almost exclusively on reactive safety management [31]. Industry best practice also encourages proactive risk-based safety management principles. Such approaches seek to identify hazards and contributory factors, and aim to control the risk associated with these hazards to acceptable levels through barriers and defences [32]. Hence, these proactive approaches still have as their focus (hypothetical) major accident scenarios and adverse outcomes. Safety-II, on the other hand, aims to promote continuous proactive safety management by strengthening the resilience capacities, i.e. by supporting individuals, teams and organisations to anticipate

changes, to achieve success in a complex world through dynamic trade-offs, and to learn from everyday experience [33].

Secondly, the focus of learning from experience within Safety-I is on learning from past accidents and incidents, i.e. on learning from the extraordinary to try to ensure they do not happen again. The learning that is derived in this way often takes the form of barriers and risk controls intended to constrain behaviour and to safeguard against deviations so that an accident does not repeat itself. On the other hand, learning from experience based on a Safety-II approach is concerned with understanding everyday work, i.e. the ordinary adaptations and trade-offs that people make on a day-by-day basis in order to achieve success [34, 35].

The last key difference is how performance variability is approached. In Safety-I, performance variability is often regarded as something negative that contributes to failures, and that should therefore be constrained through standardisation and protocols. Performance variability from this perspective is usually referred to as violations. Within Safety-II, performance variability is regarded as inevitable and useful, it is considered both the reason for success as well as the reason for failure [36]. Performance variability in the form of dynamic trade-offs is required because of the inevitable tensions, contradictions and competing priorities that always exist in a complex system [37-39].

A useful way to structure the following critique of the WHO patient safety curriculum is to use these key distinctions and differences between Safety-I and Safety-II thinking as summarised in Table 1 (based on [33].

Table 1: Comparison of key aspects of Safety-I and Safety-II (based on [33])

Aspect	Safety-I	Safety-II
Definition of safety	Absence of adverse outcomes, absence of unacceptable levels of risk	Things going right, presence of resilience abilities
Safety management principle	Reactive following incidents, risk-based, control of risk through barriers	Proactive, continuously anticipating changes, achieving success through trade-offs and adaptation
Learning from experience	Learning from incidents and adverse outcomes, focus on root causes and contributory factors	Learning from everyday clinical work, focus on understanding work-as-done and trade-offs
Performance variability	Potentially harmful, constraining performance variability through	Inevitable and useful, source of success and failure

standardisation and procedures

4 CRITIQUE OF THE WHO CURRICULUM

4.1 Definition of Safety

The WHO patient safety curriculum contains definitions of key terms and concepts and this provides an early indication of the thinking that underlies the different topics in the curriculum. The list of definitions is quite extensive, but we can restrict the analysis to consideration of a few key concepts:

Table 2: Definitions adopted in the WHO Patient Safety Curriculum

Concept	Definition
Patient Safety	The reduction of risk of unnecessary harm associated with health care to an acceptable minimum.
Risk	The probability that an incident will occur.
Incident	An event or occurrence that may cause or causes injury.
Violation	Deliberate deviation from an operating procedure, standard or rule.
Reportable Circumstance	A situation in which there was significant potential for harm, but no incident occurred.
Contributing Factor	A circumstance, action or influence that is thought to have played a part in the origin or development of an incident or to increase the risk of an incident.

It can be seen from the definitions that safety and patient safety are defined with reference to risk and harm, and risk in turn is defined as the likelihood that an incident will occur, i.e. also with reference to unwanted outcomes. Even though these definitions are slightly different than what is commonly found in safety-critical industries (e.g. [40]), they fall comfortably within the traditional Safety-I paradigm. Similarly, the curriculum refers to deviations from procedures as "violation", which has a negative connotation. From a Safety-II perspective the concept of violations is problematic, because Safety-II suggests that deviations from procedures and rules occur on an everyday basis, and are usually the mechanism through which healthcare professionals achieve success [33]. Safety-II frames deviations positively as the ability to adapt to the inevitable variability found in complex systems, and so considers less deviations by themselves problematic, but rather the lack of appreciation that exists about the gap between work-as-imagined and work-as-done, i.e. between procedures and protocols, and how care is actually delivered [41, 42]. Finally, the definitions of a reportable event and the contributory factors are indicative of a focus on learning from

adverse outcomes and the identification of deficiencies in the system. This again sits uncomfortably with the Safety-II perspective, which aims to learn from everyday clinical work about how the resilience capacities can be strengthened [34, 35].

4.2 Safety Management Principle

Topic 3 "Understanding systems and the effects of complexity on patient care" describes a systems approach that forms the basis for patient safety management. This topic has the potential, in principle, to provide an excellent fit with Safety-II, which includes consideration of healthcare as a complex adaptive system [43]. Within the topic it is recognised that there are many interactions and dependencies in a health system, which "make it difficult, if not impossible to predict the behaviour of the system based on knowledge of its component parts" (p. 122). An example is alluded to, where two healthcare professionals need to work together in order to create a solution to a problem without creating the conditions for adverse effects in a different time or place. From this recognition it appears only a small step to Safety-II principles, but ultimately the development of this topic misses this opportunity, and instead presents "a systems approach to errors" (p. 126) rather than considering further how people anticipate changes and make trade-offs to achieve success.

The systems approach described in topic 3 is based on Reason's Swiss-Cheese analogy [44], and lays the foundation for later chapters by putting the focus on system deficiencies that create latent failure conditions. The systems approach is also used to argue for concepts of a just culture [45], i.e. it is used as a decision principle to determine issues of accountability in case of adverse events. The safety management principle is expanded on in topic 6 "Understanding and managing clinical risk". The learning objective for this topic is to "know how to apply risk management principles by identifying, assessing and reporting hazards and potential risks in the workplace" (p. 163). This is refined through presentation of a 4-step risk management process based on standard risk management principles.

As before, the underlying principles described in topic 3 and topic 6 are derived from Safety-I thinking, and the approach aims to identify and reduce risk. The topic does not provide detail about how risks might be controlled, but focuses on aspects such as incident reporting. In contrast RHC proposes that it is not possible to foresee and eliminate all potential risks. Rather, the ability of clinicians to anticipate and to adapt safely to changes is required, and this ability should be supported by organisational processes and cultures [37]. This is analysed further in the next sub-section.

4.3 Learning from Experience

The analysis of the definitions adopted and of the safety management paradigm already indicates that learning from experience within the WHO patient safety curriculum is framed within a Safety-I paradigm with a focus on learning about contributory factors and root causes of incidents and patient harm events. The main topic on learning from experience carries, unsurprisingly, the title "Learning from errors to prevent

harm" (topic 5). The topic is based on the well-known human error taxonomy of Reason's Generic Error Modelling System [32], which distinguishes between slips, lapses, mistakes and violations.

Learning from experience from this perspective is about understanding the contributory factors - usually referred to as performance influencing factors or performance shaping factors in the literature [12] - that make human error more likely. The proposed approach for learning from experience is based on the development of a reporting culture, where healthcare professionals are encouraged to report errors and near misses through incident reporting systems. This demonstrates the underlying assumptions about what is and is not important to look at for improving safety.

The practical problems with learning from incidents in healthcare have been discussed widely in the literature, and include issues such as lack of feedback to healthcare professionals, fear of blame, poor usability of incident reporting systems, and lack of visible improvements and learning resulting from incident reports [31, 46-49]. At a more fundamental level, learning from experience that focuses only on incidents and adverse outcomes appears severely limited from a Safety-II perspective [35, 50]. When organisational learning is restricted to learning from incidents, there is a risk of overlooking the positive contribution of performance variability (see below). Within Safety-II, learning from experience should be directed at understanding everyday clinical work by making visible the mechanisms and strategies that healthcare professionals employ to anticipate changes and to adapt their behaviour through dynamic trade-offs [51-53]. This understanding of work-as-done can then support the development of organisational interventions that aim to improve these capabilities, rather than narrowly focusing on barriers to reduce risk [54].

4.4 Performance Variability

Performance variability plays a key role in the WHO curriculum as a contributory factor to adverse events. For example, topic 1 is introduced with the tragic case of 37-year old Caroline Anderson who died four weeks after giving birth from bacterial meningitis, which had spread when an epidural abscess burst. The analysis of this case in topic 1 finds several instances of deviation from recommended practice, such as incomplete record keeping, hurried diagnosis, failure to recognise the severity of the patient's condition, and inadequate infection control practices.

Topic 2 introduces human factors and is intended to enable students to analyse such deviations further by looking for systems failures that contribute to these human errors. Topics 5 (learning form incidents) and 6 (clinical risk management) provide the conceptual frame for analysing the perceived root causes of Caroline Anderson's death, and for creating safety barriers to ensure that such an event does not repeat itself in the future. Finally, topic 9 attempts to put the knowledge and skills developed in previous topics into practice but focuses predominantly on hand hygiene and other "safe" behaviours.

While the WHO curriculum recognises that people can prevent mistakes (e.g. topic 4 on being an effective team player), performance variability is predominantly understood in the traditional sense as something undesirable, a potential contributor to adverse events, which should be targeted through interventions in order to constrain it and bring practice back in line with existing guidelines. From a Safety-II perspective, this approach does not appreciate the gap between work-as-done (i.e. the performance variability) and work-as-imagined (i.e. the protocols, procedures and guidelines). Protocols, procedures and guidelines are assumptions about how clinical work should be done under ideal situations. These assumptions usually fall short of capturing the complexity of everyday clinical work due to the large variation in demands and the complexity of the interactions of the different parts in the healthcare system [37, 41]. When one observes work-as-done, as many of the contributions within Safety-II applied to healthcare have demonstrated (e.g. [55-58]), it is possible to provide insights about how healthcare professionals translate gaps and tensions in their everyday work into safe and good quality care by making adaptations and trade-offs. As a result, performance – within a Safety-II frame – is by default variable, and this is generally useful, but can, at times, also lead to failure.

A potential criticism of this view is that accountability for performance variability that leads to failures might not be clearly determined, i.e. one might ask whether an individual who violates a good protocol or procedure should not be held to account for their actions. However, our analysis above demonstrates that this presupposes that protocols can be followed under all situations, which often is not the case. Hence, the debate about accountability is often done in hindsight and reinforces the existing work-as-imagined perspective. In addition, empirical studies suggest that people usually "violate" protocols (i.e. adapt their behaviour) *because* they feel accountable, i.e. because they feel responsible for the patient under their care, rather than from reckless intent [59]. This is not to suggest that there never is reckless behaviour, but this is probably the exception, and not the kind of everyday performance variability that is the foundation of RHC.

5 OUTLINE OF THE RHC TOPIC

One approach to integrate RHC thinking into the WHO patient safety curriculum is to develop a dedicated chapter on this topic, which teaching faculty can pick flexibly as they do with the other topics. The benefit of this approach is that it does not disrupt the curriculum, but instead adds additional RHC material to it seamlessly. On the other hand, this approach leaves the problematic issues outlined in the critique above unaddressed in the other parts of the curriculum.

The WHO curriculum starts every topic with a vignette, but these are all instances of adverse events. An RHC topic should include vignettes about everyday clinical work and the dynamic trade-offs that people have to make. Two examples are provided in Box 2.

Box 2: RHC Vignettes

RHC Vignettes

Sujan, M. A., Furniss, D., Anderson, J., Braithwaite, J., & Hollnagel, E. (2019). Resilient Health Care as the basis for teaching patient safety–A Safety-II critique of the World Health Organisation patient safety curriculum. *Safety Science, 118,* 15-21.

Anticipation and adaptation in the hospital pharmacy

The lead technician informs the hospital dispensary manager that the CT scanner has been down, and that there are 37 patients waiting for an appointment. The CT scanner is expected to be fixed later in the day, and once patients start to move through the process again, there is going to be a sharp increase in workload for the hospital pharmacy to provide the required drugs. The dispensary manager thanks the lead technician for the heads up and goes to see the pharmacy director to discuss how the pharmacy could prepare for this. They decide to prioritise fast-track medications and medications for patients to take out, and to accept delays on standard medications. They also arrange for a ward-based pharmacy technician to come to the dispensary to help dispensing drugs, in order to free up the senior dispensary assistant to provide support with checking patients' own drugs, which will relieve pressure on the pharmacist doing the final checking of drugs.

Reformulating success in emergency care

By default, the mission of clinicians working in the Emergency Department (ED) and of the ED as a whole is to provide optimal care in accordance with clinical guidelines and hospital procedures. In the case of a patient presenting to the ED with kidney pains, the ED clinician might make an initial diagnosis of acute kidney cholic resulting from kidney stones, order tests and an ultrasound investigation based on this initial diagnosis, and then refer the patient to urology once the diagnosis has been confirmed. On a winter afternoon, when the ED is particularly busy, patients have been waiting for long periods, and all cubicle spaces are occupied, the clinician is faced with a dilemma. After initial assessment and formulation of the likely diagnosis, they would need to keep the patient in the ED until all test and investigation results have come back and the diagnosis has been confirmed. This could require some time, and put additional burden on the overcrowded ED. The clinician subjectively assesses their level of confidence in their diagnosis and any risks to the patient, and then decides to refer the patient to urology, where test results can be followed up. If the diagnosis does not hold up, the patient might have to be moved again. The clinician offloads effort to another department freeing up resources in the ED, and implicitly defines success as the provision of reasonable care rather than optimal care.

The first vignette illustrates how people anticipate and adapt to changes in demand and capacity [53]. The lead technician holds important information about the unavailability of the CT scanner and its expected return to service and anticipates that this will have knock-on effects on other departments such as the pharmacy. The lead technician provides this information to the pharmacy team, who prepare for and adapt to the expected changes in order to minimise disruption and to continue to deliver their service. The pharmacy adapts through a number of strategies, including both formal pre-defined responses (from previous learning) and informal ad-hoc responses. The pre-defined response in this scenario is the decision to prioritise some medications over others (fast-track vs standard track-medications). Ad-hoc adaptations

include making dynamic trade-offs over where to deploy staff and which tasks to prioritise. In the scenario this is illustrated by the recall of the ward-based technician to the pharmacy, and the support provided to the pharmacist by the senior dispensing assistant.

The second vignette provides an example of adaptation in the busy ED environment. The ED clinician has protocols and clinical pathways to follow, which are designed to ensure – under ideal conditions – that the right patient gets to the right place first time. However, when the ED gets very busy the clinician starts to make trade-offs based on their subjective assessment of the level of confidence they have in their diagnosis, and they start to offload effort to other departments in an attempt to free up resources in the ED. This allows the clinician to ensure that critically ill patients can be seen in a timely fashion. The ED clinician accepts that in some instances patients might not end up in the right place, which can affect patient experience and cause frustration in other parts of the hospital, but this might be less critical than not being able to attend to an acutely ill patient in one of the ED cubicles. In this way, the clinician makes a trade-off, and redefines dynamically what success looks like.

The learning objectives related to the RHC topic focus on the key aspects outlined in Table 1. Students should understand safety as the presence of abilities in the healthcare system, which enable success under varying conditions and situations where there are multiple competing priorities. They should recognise the strategies for anticipation and adaptation present in work-as-done, and they should be able to contribute to organisational learning from experience by providing a window onto their everyday clinical work. Finally, students should appreciate the fundamental role of performance variability underpinning both success and failure.

Hence, following the format used in the WHO curriculum, we can begin to define learning objectives and learning outcomes as described in Table 3.

Table 3: RHC Learning Objectives and Learning Outcomes

Learning Objectives	Understand the nature of performance variability and how healthcare systems anticipate and adapt to changes, how they monitor their response, and how they learn from experience in order to improve patient safety.
Learning Outcomes: Knowledge and Performance	
Knowledge requirements	Understand the term safety as the ability to succeed. Appreciate the role of performance variability and dynamic trade-offs. Recognise the difference between work-as-imagined

	and work-as-done. Understand how local adaptations can place demands on other parts of the healthcare system.
Performance requirements	Identify resilience strategies within their role and context. Contribute to learning from experience by discussing everyday work and the trade-offs that are made, and by reflecting on the gap between work-as-imagined and work-as-done.

6 DISCUSSION AND CONCLUSION

The WHO patient safety curriculum is a major international effort that should not be overlooked by anyone seriously considering providing suggestions for teaching patient safety. The critique of the WHO patient safety curriculum from a Safety-II perspective demonstrated that the underlying principles are firmly rooted in Safety-I thinking, with a focus on adverse events, contributory factors, and interventions to control risk. The analysis also identified certain areas that could be very close to RHC thinking, such as understanding healthcare as a complex system, but there remain many aspects that cannot be reconciled easily with the principles of RHC, for example the problematic notion of violations.

The principles underlying the WHO patient safety curriculum are most closely associated with the work of Reason, who promoted the consideration of active failures and latent conditions in a systemic view of incidents [32]. By understanding the proximal and distal factors that could influence an error we can then put barriers and mitigations in place to help reduce the potential for bad outcomes [60]. RHC on the other hand has roots in thinking inspired by complexity science. It complements the notions of errors and causality, which are not universally applicable to all of healthcare, with performance variability and emergence [16].

The potential synergies and conflicts between the thinking behind the WHO patient safety curriculum and RHC need to be considered when thinking about how to approach teaching RHC principles to students. The most obvious way would be to develop an additional RHC topic that could stand next to the other topics covered in the WHO patient safety curriculum. An example of what this might look like was provided in the previous section. The benefit is that there is no disruption to the existing curriculum, and teaching faculty remain flexible in their choice of topics. However, this implies that students might be presented with conflicting views, such as whether to regard deviations from procedures (i.e. from work-as-imagined) as

undesired violations or as potentially useful adaptation. One might argue that this could be, in fact, a useful exercise for students, who should remain critical in their thinking about safety, being able to discern strengths and weaknesses of different perspectives and avoid accepting a particular school of thought without reflection. Such an extended curriculum could aim to promote discussion about the different situations that might require one approach or another.

A second, more radical approach, is to develop a patient safety curriculum specifically from the perspective of RHC. This much broader endeavour could take inspiration from the process of developing the WHO patient safety curriculum, if not from its content. A first step might consist of developing an international working group of relevant stakeholders. For example, a community of practice around RHC already exists in the form of the Resilient Health Care Net (www.resilienthealthcare.net), which brings together clinicians, patient safety researchers and safety practitioners from other safety-critical industries. Such a working group could start to identify and build consensus around relevant topics and learning objectives that should be included when teaching patient safety based on RHC thinking.

Patient involvement and consideration of the patient perspective and their contribution to patient safety are issues that both Safety-I and Safety-II have been struggling with. Most approaches focus on healthcare professionals as the central actors within the health system, and this is also largely reflected in the WHO curriculum, even though the WHO World Health Alliance for Patient Safety runs a programme on Patients for Patient Safety, which aims to enhance patient engagement in patient safety initiatives. In the UK, the Health Foundation (a charity) undertook a literature review on the evidence base for patient involvement in patient safety, and concluded that patients could contribute to identifying adverse events, play an active role in their own safety, and support the planning of change [61]. However, there is still an active debate about whether and how to include patients in patient safety, with some suggesting that from a safety engineering perspective patients should not be included as active participants in patient safety improvements because of the diversity of the patient population and the problems with safety interventions that rely on human redundancy (e.g. checking) [62]. Within RHC, the patient contribution is recognised in principle, for example when modelling sources of variability using the Functional Resonance Analysis Method (FRAM) [36]. However, there are as yet few contributions that demonstrate how such insights can then lead to improvements in practice [63].

The evidence for the impact and contribution of RHC in practice is still developing [25]. However, in our opinion RHC has sufficient theoretical development and maturity, an increasing number of documented case studies, and a good level of engagement from clinicians and risk managers to justify efforts for the development of an RHC curriculum. This can underpin and promote uptake of RHC principles in practice and contribute to developing an increasing evidence base about effective RHC applications and practices.

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