



## Double checking: a second look

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### Abstract

**Rationale, aims and objectives** Double checking is a standard practice in many areas of health care, notwithstanding the lack of evidence supporting its efficacy. We ask in this study: 'How do front line practitioners conceptualize double checking? What are the weaknesses of double checking? What alternate views of double checking could render it a more robust process?'

**Method** This is part of a larger qualitative study based on 85 semi-structured interviews of health care practitioners in general internal medicine and obstetrics and neonatology; thematic analysis of the transcribed interviews was undertaken. Inductive and deductive themes are reported.

**Results** Weaknesses in the double checking process include inconsistent conceptualization of double checking, double (or more) checking as a costly and time-consuming procedure, double checking trusted as an accepted and stand-alone process, and double checking as preventing reporting of near misses. Alternate views of double checking that would render it a more robust process include recognizing that double checking requires training and a dedicated environment, introducing automated double checking, and expanding double checking beyond error detection. These results are linked with the concepts of collective efficiency thoroughness trade off (ETTO), an in-family approach, and resilience.

**Conclusion(s)** Double checking deserves more questioning, as there are limitations to the process. Practitioners could view double checking through alternate lenses, and thus help strengthen this ubiquitous practice that is rarely challenged.

When it comes to everything, everything is always double checked. So I'd say we're pretty safe. (Nursing leader)

### Introduction

Double checking is a standard practice intended to improve patient safety. It is used in different areas of health care, such as medication administration [1–3], radiotherapy [4] and blood transfusion [5]. Some studies have found double checking to be a useful practice [6], which has been endorsed by agencies and individuals [7–10]. The confidence in double checking exists in spite of the lack of evidence substantiating its effectiveness. Alsulami, Choonara and Conroy [11] undertook a systematic review of double checking and found that there is a paucity of evidence, particularly randomized controlled trials, to justify the practice of double checking. Armitage noted that Leape had identified double checking as a 'sacred cow' that 'zaps time and is ineffective' [12,13].

Double checking can be seen to loosely cover related concepts, such as (1) reviewing one's own work; (2) reviewing one's own or a colleague's work together with another colleague; and (3) independently reviewing a colleague's work, although universally accepted definitions seem not to be consistent in the literature [7,11,12]. Alsulami, Choonara and Conroy have defined a double check as 'a procedure that requires two qualified health professionals, usually nurses, independently checking the medication before administration to the patients' [11]. Grissinger refers only to double checks, comments on the difficulty in finding your own mistakes, and that double checks should be performed independently [7]. The Institute for Safe Medication Practices (ISMP) stated that an independent double check is a two-person process, whereby 'the first practitioner does not communicate what he or she expects the second practitioner to see' [14]. Paparella adds 'Ask a roomful of ED nurses to explain the double check process for high-alert medications and one is bound to get a variety of answers about the correct procedure' [15]. A Canadian Patient

Safety Institute (CPSI) study noted that mandating double checking without understanding its process 'has created a false sense of security in our health care system' [16]. In a study of UK children's hospitals, Conroy, Davar and Jones [2] concluded that 'the practice of double checking is largely based on what seems to be common sense' (p. 24). Overall, double checking is a term that seems to be subject to various interpretations.

Patient deaths have been attributed in part to a failed double checking process [17]. ISMP Canada published instructions on how to undertake an independent double check [14], and the American parent ISMP later published a bulletin [18] to further clarify independent double checks. The ISMP highlights that double checking has been critiqued for the increased workload it brings in time-pressured environments; the variability in double checking practice resulting in errors not being found; and the difficulty in finding errors through double checking when the error rate is very low [14]. This Institute maintains that double checking is effective, but only if it is a true independent double check, and only if it is judiciously used. Furthermore, double checking as a patient safety tool is recognized as being only moderately effective. Additionally, a study in 2014 revealed that double check compliance is variable [19]. Paparella noted 'Studies on the nature and value of an independent double check in today's health care environment in light of added technologies would be a welcome addition to the safety literature' [15].

We ask 'How do front line health care practitioners conceptualize double checking? What are the weaknesses in the double checking process? What are alternative ways to view and practice double checking in order to enhance patient safety?' The study adds to the literature by demonstrating that double checking is loosely defined, and by further examining the limitations of the double checking process, proposing alternate views of double checking to help enhance patient safety, and providing theoretical background to these issues.

## Methods

This study emerged from a larger research project on incident reporting in a multi-campus teaching hospital in Ottawa Canada, which has been published elsewhere [20,21]. The overall qualitative study interrogated health care providers and leaders about their views and practices related to incident reporting in specific, and patient safety more generally. In semi-structured interviews, participants spoke of double checking while describing near miss events. We thus pursued a deeper analysis of the data on double checking, attempting to understand the different views and practices of double checking, and considering its implications for patient safety. Their descriptions and responses to the researchers' probing about the double checking practice form the backbone of this paper.

Data collection was undertaken in General Internal Medicine (GIM) and Obstetrics and Neonatology (OBS/NEO) between spring 2012 and fall 2014. Our data collection in each department started with our attendance to a quality review meeting where the researchers were introduced to key personnel who would later become interviewees. These key informants helped us extend our sample by contacting managers and practitioners. Over a period of 5 months in each division, two researchers (both independently

**Table 1** Interviewees by generic job title

Job category GIM		Job category OBS/NEO	
Doctors	11	Doctors	8
Nurse leaders	5	Nurse leaders	15
Bedside nurses	15	Bedside nurses	15
Pharmacy	3	Midwives	3
Physiotherapists	3	Respiratory therapy	4
Nursing support	3		
Total	40	Total	45

**Table 2** Weaknesses and alternate views of double checking

Weaknesses of double checking
Inconsistent conceptualization of double checking
Double (or more) checking as a costly and time-consuming procedure
Double checking trusted as an accepted and stand-alone process
Double checking preventing reporting of near misses
Alternate views of double checking
Recognizing that double checking requires training and a dedicated environment
Introducing automated double checking
Expanding double checking beyond error detection

and together) confidentially interviewed 85 participants, as shown in Table 1.

This study underwent ethics review at both the hospital site of the case study, and the researchers' university. Interviews lasted about 45 minutes, and were captured on a digital voice recorder and transcribed verbatim. Atlas ti software (GmbH, Berlin, Germany) was used to code the data. The analytical approach was both inductive and deductive [22]. The first four themes presented were inductively derived (informed principally by the data), whereas the second three themes were deductively derived (indications in the data were further developed based on extant literature). Iteratively moving between the data and the literature, we identified themes of weaknesses in and alternative views of the double checking practice.

## Results

The analysis we conducted concentrated on two broad themes with respect to double checking: weaknesses in double checking, as well as alternative ways to view the practice. The themes are presented in Table 2 and are discussed below. While the interviewees were identified by generic job title, the views they expressed did not depend on job title. In other words, we found that front line members of the same profession held different views of what constitutes a double check. A similar result was found with leaders, who did not hold consistent views of double checks. These views are explored through quotations of the interviewees.

## Weaknesses in double checking

These themes were informed by the data, and as such were inductively derived.

### Inconsistent conceptualization of double checking

During our analysis of the data, we found it intriguing that the notion of double checking was mentioned by some (but not all) interviewees as a safety practice, and that those who mentioned this notion referred to different approaches to double checking. Not one interviewee clarified what was meant by double checking – it was taken as understood. However, in the analysis, general categories of double checking emerged from the interviews, as presented below.

**Double checking oneself:** Used in this way, double checking referred to practitioners looking over their own work, as a procedure intended to find potential mistakes with what they had done.

Say you draw up the wrong amount of medication and you're just about to administer it to your patient but you do your double check and you find you drew up the wrong amount . . . I double, triple check myself a lot. (OBS/NEO bedside nurse 8).

Here, the practitioner is going through his/her own work, checking it again, without the help of a peer.

**Double checking with a peer:** Some interviewees referred to double checking as involving a colleague looking over a situation with them to see if there were any problems.

So when we get [the medication] from pharmacy and then it's ordered through the doctors, we double check it with another nurse. So we look through our drug manual . . . we go through those 5 checks with another nurse, we do it together and then we sign off on the MAR [Medication Administration Record]. (OBS/NEO bedside nurse 15).

Here, there is a reference to 'we do it together' when performing the double check; there is a sense of a team (of two) effort in the double checking.

**Double checking as an independent double check:** This reference to double checking in our study is the type of double checking that much of the literature addresses. Here, practitioner A checks practitioner B's work independently, so as not to be unduly influenced by practitioner B's expected results.

It was an IV solution, and if it did go up it would have been quite significant and the nurse, in double checking and recalculating what the physician had ordered the error was caught. (OBS/NEO nursing leader 13)

Here, we see that the term independent double check is not specifically referred to by name, but is described as one practitioner checking the work of another, independently of the results of the first practitioner. The implication that the checker performs the calculation in duplicate of the initial calculation is clear. Here we note that practitioner A and practitioner B need not have been from the same job category – a nurse could check a nurse's work, but could also check a doctor's work, or a pharmacist could check a nurse's work, etc.

With these various categories of double checking emerging through an analysis of the data, it is clear that what is meant by a double check is inconsistent. This inconsistency in views and

practices is the first weakness associated with double checking. Other weaknesses were identified with the process of double checking, as explored below.

### Double (or more) checking as a costly and time-consuming procedure

In some situations, double checks were seen as insufficient, and additional checks were added.

We double check [breast milk]; I know we've added a third check, just to make sure any mistakes don't happen. (OBS/NEO bedside nurse 9)

Some practitioners, when asked about patient safety, were not convinced that double checks were good enough.

Medications are lost, the orders aren't transcribed, they've missed this one, even though they've signed it off, it hasn't been transcribed here, and so there's a double check, a triple check, the pharmacy checks. So I mean they built in double checks for many of these things, but often double checking is not enough, you need a triple or quadruple. (GIM doctor 2).

However all these checks came at a cost.

I know this is terrible to say, but it almost increases the work that we have to do because now, all of a sudden, we have to find two people to co-sign the breast milk syringes, whereas before we weren't doing that, we were just showing the bottle to somebody and then giving the milk. So now all of a sudden we have to hunt down people, have them co-sign it, it's a pain for them, it's a pain for us. (OBS/NEO bedside nurse 12)

The above nurse recognized that while the double checking protocol was well intended, it substantially impacted nursing daily work, whether one was the nurse looking for someone to double check, or the nurse being sought to double (or triple) check. Furthermore, the ability to perform an independent double check could be very difficult in a busy environment, despite best efforts to block time for checking.

So I blocked off certain days that I would just be checking so I was in the area. I was doing my checking function of all the drugs going to the patients – there was quite a lot of noise and I was interrupted every 5 minutes for about half an hour so I kept having to stop, give my input, and then start again. And I still made a mistake . . . (GIM pharmacy 2).

These checks were not infallible.

Do errors still happen, yes. 'Baby Smith, baby Jones, baby Smith/baby Jones. Okay I'll sign it in a minute', and they take baby Smith's and baby Jones' and then baby Jones gets baby Smiths' . . . Why? Because they're busy, because they're trying to save time, because they've got way too much to do. (OBS/NEO nursing leader 3)

Heavy workload, coupled with the problem of finding both time and a quiet environment in which to concentrate implied that the introduction of a double (or higher) check may not have resulted in a robust patient safety tool.

### Double checking trusted as an accepted and stand-alone process

Participants often referred to double checking as a standard institutional procedure.

So the double checking of medications for example is a standard practice (OBS/NEO nursing leader 1)

It was viewed as a process that could be relied upon to find mistakes.

We have the double checking system so that's what we do – so the mistakes are found. (OBS/NEO Bedside Nurse 13)

The trust in the double checking process was evident – it was often used on its own as a procedure to assure safety. Sometimes the nursing managers needed to 'reinforce the rules about double checking' (OBS/NEO nursing leader 1), as a nurse who did not follow the double checking process would be seen to be at fault. Reliance on double checking was well entrenched not only in nursing and pharmacy, but also among doctors.

Obviously we put upon ourselves the expectation that we've done our best, double checked our orders . . . but at the same time we do realize that mistakes are gonna happen and hopefully somebody else will catch them before they reach the patient. (GIM doctor 10)

This quote indicates that the doctor trusted that double checking would have caught problems that they might have missed.

Another view is the front line worker seeing him/herself as part of a larger process, and double checking having a role to play in collective work. 'I am part of that chain right. Like I have to recheck what I'm giving and not just rely on someone else' (GIM bedside nurse 11). In contrast to the doctor quote above, this assertion that the nurse will 'not just rely on someone else' to ensure safety was rarely espoused. Generally, double checking was seen as an accepted and stand-alone process, as guarding against patients being subjected to mistakes. The view here was that errors would be identified in the double checking process.

### Double checking as preventing reporting of near misses

A near miss is a problem that is caught and stopped before it causes harm. Double checking is an intervention that can catch problems before they cause harm to the patient, and as such often prevents the reporting of near misses.

So that's a near miss because she's done her check at the last minute before she hung [a high risk medication] and connected it, or it's been double checked by the second RN, between the 2 of them they've identified that. Those probably don't get in our [incident reporting] system. (OBS/NEO nursing leader 1)

The double check process was seen as a risk mitigation technique, and reporting the near miss was not viewed as beneficial. Near misses in this context are events that would have reached (and possibly harmed) the patient were it not for the double check. However, given that the patient was not harmed, the view was that an incident report was not necessary – the absence of a bad outcome determined that an incident report was not logged. However, double checking not triggering an incident report was not confined to an outcome interpretation:

GIM pharmacy 2: We always get somebody else to double check before something is prepared and dispensed to a patient.  
Interviewer: Does that second check ever trigger one of these reporting forms?

GIM pharmacy 2: No, not at that level, because it hasn't left the department.

Here, the reason for not reporting the problem caught by the double check was not outcome determined – there was no reference to the absence of a bad outcome justifying non-reporting. The reason given here was that the medication had not yet left the department. As such, when the problem caught by the double check was kept local, there was no need to report the problem. Generally, the principle of reporting – into an incident reporting system – a problem caught through double checking was not widely held.

### Alternative views on double checking

These themes were informed by the interviewees' responses, but were further developed through the literature, and as such resulted from both inductive and deductive analyses.

### Recognizing that double checking requires training and a dedicated environment

At this hospital, corporate induction training covered the concept of double checking. Specifically, nurses received training on independent double checks (whereby nurses do calculations independently and compare results) in the pharmacy portion of their corporate orientation; but there is no formal training on double checking specifically at the unit level. However, while training is necessary, it alone is not sufficient to enable front line health care workers to perform a double check as intended. The local environment is equally important in ensuring a double check can be conducted. The difficulty associated with performing a double check, in an environment where the checker was distracted, was not as evident as first thought.

[After I missed a medication error that I had double checked], it made me step back and realize you need to concentrate, and maybe I should have said to those people 'you'll need to wait twenty minutes, once I'm done this you'll have my total attention'. And it really makes you in the future think 'well I'm not gonna do that again'. (GIM pharmacy 2)

Unlike a cursory view, an independent double check is a cognitive activity requiring the double checker's concentration. This pharmacy employee learned by experience that double checking was not a routine activity; it needed more attention than was initially assumed. The importance and the process of conducting independent double checking could be communicated through local training, specific to the unit. Having a physical environment that minimizes distraction coupled with training, both necessary, could be effective at helping strengthen double checking as a safety tool.

### Introducing automated double checking

So far, we have discussed the double checking process as involving individuals – people checking their own or other people's work. However, the checking process can also involve computerization.

GIM pharmacy 1: We don't check the MARs routinely unless something comes up. It would just be by chance that we would discover errors or if nurses identify errors and bring them to us and we discover it.

Interviewer: Some computer algorithm [could] check the MAR against the pharmacy list.

GIM pharmacy 1: Yeah [but only] if you have an electronic MAR . . . That would eliminate a lot of errors I think.

The Medication Administration Records or MARs were paper carbon copies, which had many problems, such as illegible doctor handwriting, difficult to read carbon copies, lost papers, in addition to not being routinely checked.

Eliminating the need for human intervention when a computer could do the job more efficiently and reliably is a positive aspect to the double checking process.

### Expanding double checking beyond error detection

Double checks to this point have been concerned with catching problems and thus preventing harm to patients. However, double checking need not be used exclusively to find problems. Double checking was used to share opinions and best practice.

We have a third check by pharmacy . . . Sometimes the pharmacist has better suggestions, you know, instead of giving point such and such, what about this or how about this . . . She's just recommending what she would think. (OBS/NEO nursing leader 14)

I think double checking is also just verifying what we're doing. "I'm thinking of doing this, what do you think" and someone else might say 'no I think such and such is a better way of doing it'. And again to me that's not a near miss, it's not a mistake. I think we just give a higher standard of care or better quality because we're always looking for the best practice and double checking gives us that. (OBS/NEO bedside nurse 9)

Here, the idea behind the double check was not to comply with a standard or to catch a mistake, but to share opinions on how best to accomplish the work. While 'formal' double checking would fall into the category that most practitioners espoused (finding a problem), this 'informal' double checking to help share best practices and offer opinions is a novel interpretation, and could have a positive influence on patient care and safety.

Overall, the problems with double checking seen through the themes Inconsistent conceptualization of double checking, costs to double checking, trust in double checking as an accepted and stand-alone process, double checking preventing reporting of near misses, and alternate views of recognizing that double checking requires training and a dedicated environment, introducing automated double checking, and expanding double checking beyond error detection provide insight on a process that is rarely questioned.

## Discussion

In this section, we further develop the results and provide theoretical interpretations. Double checking in its different forms is seen as a trusted practice [23–25], and has been shown to be helpful in a number of studies and ISMP advisories [7–9] in spite of the lack of supporting evidence [2,11]. Some advisories allude to double checking being misunderstood and/or overrated [18]. 'Double-checking requires that one fallible person monitor the work of another imperfect person' [26 p1647]. As such, it can be subject to social psychological concepts of groupthink (where

one tends to align one's opinions with the majority) [27], and the investigative term 'what you look for is what you find' [28]. Double checking has other weaknesses that are worthy of exploration.

Literature has addressed some of these problems. Armitage undertook a qualitative study of double checking, and found that the double checking process is rarely questioned, but that those who do not follow it are blamed [12]. He also found that often people involved in double checking (1) defer to authority, by trusting that a checker with a more senior position would be trusted more than one in a junior position; (2) enter a phase of 'auto processing', where the act of checking is given little active thought; (3) reduce their level of individual responsibility [12]. These concerns, as well as the idea of redundancy diffusing responsibility, were identified as weaknesses of double checking when seen through the high reliability and normal accident safety theories [26]. Larger issues can go unrecognized because of double checks finding problems, and practitioners solving those problems at an individual level [21]. This hospital had a policy to report near misses [21] although the present study highlighted the challenge of reporting a near miss that was caught through a successful double check. ISMP warns 'do not use double checks as a means of fixing problems when more fundamental redesign is needed' [18].

What is meant by a double check was ambiguous, as seen in the categories of double checking oneself, double checking together with a peer, and independent double checking. As previously stated, it is important to note that interviewees did not clarify types of double checking, this notwithstanding their corporate training. However, while there is a growing literature on double checking [7,11,14,15,18,26], definitions are difficult to find that cover the spectrum of what front line practitioners call double checking. In Alsulami, Choonara and Conroy's study, only 1 of 48 nurse respondents to a survey was able to correctly define an independent double check [29]. Dickinson, McCall, Twomey and James found that 'There was . . . confusion regarding what constituted a double-check and the process of double-checking' [30]. Researchers and practitioners need to pay better attention to the issue of definition and to clarify what is meant by double checking.

The costs of having to employ multiple checks, and the additional workload double checking adds to the front line are strong themes in critiques of double checking, as seen in our study through the various quotes in the section exploring the costs of double (or more) checking. Lack of time was one of the dominant themes in a study of double checking by Armitage [12]. This has been found elsewhere, as in the intensive care unit (ICU):

Most hospital policies require that two nurses manually check every patient controlled analgesia (PCA) order change against the electronic medical record (EMR) order. In the ICU, we observed PCA orders changed, on average, four times per patient and it takes 8 to 10 min for one nurse to find another nurse to confirm the orders match. With 20 patients in this ICU, confirming orders relies on heroism and wastes 8 to 10 nursing hours a day, one full time equivalent of nursing time per unit [31].

One full-time equivalent in one unit due to a double checking procedure has an opportunity cost, which might not be adequately accounted for. Overall, the cost of double checking should be a prime consideration before requiring the procedure.

Double checking was relied upon by some to catch mistakes that they themselves could miss, seen in our study through the quotation by the doctor discussing double checking as a stand-alone process. Relying on others to catch one's mistakes can be seen through a construct named the Efficiency Thoroughness Trade Off (or ETTO) [32]. Hollnagel argued that in a resource-constrained environment, efficiency and thoroughness cannot be simultaneously achieved. He elaborates the ETTO concept for groups involved in distributed work, which he calls 'Collaborative ETTO'. A person in the group prioritizing thoroughness would *make an effort* to confirm that the input he/she receives is correct, and consider the possible side effects of what he/she produces as output for the next person. A person in the group prioritizing efficiency would *trust* that the input he/she receives is correct, and that the next person will perform any necessary checks and verifications. Hollnagel remarks 'For distributed work, for the social fabric, there is never enough time to check everything. It is therefore necessary to trust what others do. Trading off thoroughness against efficiency is in practice the only means available to save time and resources . . . It's as if everyone reasons in the following way "I can allow myself to be efficient, because the others will be thorough" ' [32]. He continues

If only some people do that, the system may be able to correct itself and to find a balance of functioning that is both reasonably effective<sup>1</sup> and reasonably thorough. But if everyone begins to work in this way, for instance because of systemic pressures, the net result may be that something goes wrong. Yet the reason for that is not that anyone did anything that was manifestly wrong or incorrect. The reason is more likely that everyone did their own bit of ETTOing, quite as they normally do [32].

It should be noted, however, that even in our study, a nurse articulated the responsibility to prioritize thoroughness over efficiency, in stating that his/her responsibility is 'not to rely on someone else', but to ensure that the input is correct for the collective process undertaken.

When problems found through double checking are not seen as potentially systemic – that is, when they are confined to a single department or unit – there may be the perception that no one else needs to know about the problem. The view is that 'We understand it better than others, and we have fixed it to our satisfaction, so no one else needs to know' – not as a deception, but as the way normal work proceeds [21]. This was seen in our study, as a double check revealing a problem with a drug before it left the pharmacy was considered not to be worth reporting. This practice has been termed 'in family' in accident investigations [33,34], as the information that was kept (often informally, without a paper trail) to a single department would have been useful to other departments, although this was not known to the department holding the information until a disaster struck. 'In family' thinking can have organization-wide consequences. To avoid an 'in family' approach to double checking and reporting in health care, communication could take place with other departments, such as recording an incident discovered through an 'in family' double check in an organization-wide incident reporting system.

<sup>1</sup> Effective was likely intended to be efficient (personal communication).

Double checking should not be discarded altogether, however. It can be an effective process, especially if it is one of a set of safeguards used in combination to ensure safety, that is, not the only tool in use. Wheeler *et al.* reflected on a medication error revealed during a simulation.

During one of the in situ simulations, a nurse incorrectly prepared the amiodarone, resulting in a significant dosing error. This was identified as a knowledge gap and a systems issue, and steps were taken to correct this latent safety threat using: different package labelling; the addition of a backup clinical pharmacist to the code team; the use of independent double-checking of all code medications; continued staff education and training [35].

Note that there are a variety of corrective actions mentioned, highlighting that double checking need not be a single tool used in isolation.

Training on how best to perform an independent double check could well improve its effectiveness. In our study, a pharmacy worker reflected that being interrupted while performing a double check was a dangerous situation, and implied that he/she did not realize so until he/she experienced it. ISMP states that an independent double check is where 'two people separately check each component of the work process . . . So holding up a syringe and a vial and saying, "This is 5 units of insulin, can you check it?" is not effective' [18]. Reports on mortalities in radiotherapy [36] and medication administration [17] highlighted that there was little training on the expected double checking procedure [29,36]. Double checking may actually require a specific skill set, which is not often acknowledged [37]. Training on double checking has been recommended in various medical contexts [19,29,30]. However, an intervention consisting of training, while necessary, is insufficient to render double checking more robust; attention to the physical environment is also important.

One of the environmental changes to ensure an independent double check is a dedicated space where no interruptions are allowed, which can be challenging, as found in our study. Dickinson, McCall, Twomey and James' study

highlighted the importance of the location and design of medication rooms in health care settings. Attention is needed to ensure that the area is quiet, private, has adequate space, good storage and adequate resources to support safe drug administration. It is also important to ensure that the medication room is set aside for medication preparation only and does not become a gathering point for the health care team [30].

Establishing a physical environment to minimize distraction for cognitively intensive tasks is a step in strengthening the double checking process.

Computerized double checking is seen as a solution to overworked, undertrained, unreliable double checkers. In our study, a pharmacy worker alluded to an electronic MAR being safer, as many issues that are only serendipitously caught with a paper system could be programmed with a digital record. Accreditation Canada, England's National Health Service (NHS), as well as a provincial coroner recommend computerized checking, endorsing manual double checks only if computerization is not available [1,17,38]. However, computerized systems designed to replace the imperfect manual double checking process themselves are fallible [39,40]. Furthermore, an overreliance on computerized processes

can also be problematic. The findings from an experimental study on the use of smart pumps vs. bar-coded smart pumps is promising, with some reservations.

While pumps with barcoding hold a lot of promise, smart pump and IT vendors have not yet fully established an integrated approach that ensures connectivity between medication management technologies. Our findings show that until hospitals can achieve full connectivity between technologies, barcode pumps will help prevent certain errors that earlier pump versions could not address (eg, wrong patient errors), but will continue to permit others (eg, wrong drug) [41].

This quote highlights the well-known problem of systems integration of different vendors' equipment [42], but also demonstrates how the increased use of technology could help in finding problems currently relegated to double checking. A study investigating double checking for anaesthesia administration concluded that having a second anaesthetist double checking was rarely feasible, but that bar coding had great promise, although technical issues needed to be addressed [43]. Overall, while computerization may be helpful in double checking, it is not an infallible solution.

Double checking need not be exclusively confined to looking for problems. It could be used as a mechanism of knowledge transfer, as suggested by bedside nurses reflecting on exchanges with peers or pharmacists in our study. For example, as a way to increase 'capacity to bring in fresh perspectives on a problem and listen to the voice from below' [44], double checking could be a tool to ensure that best practice and novel solutions are communicated between those on the front line. If different perspectives are highlighted through double checking, this 'diversity of narratives can be seen as an enormous source of resilience in complex systems, not as a weakness. The more angles, the more there can be to learn' [34]. Overall double checking in this way '... might recognize, celebrate, and enhance the positive aspects of diversity that guarantee the emergence of resilience in complex situations' [45]. Using double checking in an innovative fashion could help align it as one of these emergent resilient patient safety efforts. The bedside nurses recognized the potential of a 'double check' to be fruitful exchanges of ideas towards best practice and safer care.

## Limitations and conclusion

This study has limitations. It was meant to explore the topic of double checking based on data derived from one case study and on the literature. As such, the findings are not generalizable to a variety of contexts. However, as is the case with qualitative studies, the purpose is not to provide generalizations, but to offer in-depth insight through 'thick, rich descriptions' [46,47] into the dynamics that can be transferred to other, similar environments [22].

This study has shown that double checking, while a trusted process in many areas of patient care, is not infallible. In addition to having a weak evidence base, the process has limitations. Weaknesses were highlighted in this study through themes of divergent conceptualizations, costs, trust in double checking as an accepted and stand-alone process and double checking preventing reporting of near misses. The ETTO explained how double checking can be problematic if all involved prioritize efficiency over thoroughness. 'In family' described how double checks confined to one area might be problematic to the larger organization. The highlighted

opportunity costs of double checking can be non-trivial. Alternative lenses were discussed whereby double checking can be seen as a specialized activity deserving of training and physical environment considerations, a process worthy of thoughtfully employed automation, and a practice that need not be confined exclusively to error detection, even a source of resilience.

As this study shows, double checking deserves more questioning, given the limitations to the process. Practitioners, who are aware of the weaknesses, could view double checking through alternate lenses, and help strengthen this ubiquitous process that is rarely challenged.

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