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Learning by Visualize a Nurse-Led CCOS Using the Functional Resonance Analysis Method

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Objectives: Quality improvements (QIs) in dynamic and complex health care contexts require resilience and take variability into account in quality improvement. The Functional Resonance Analysis Method (FRAM) helps us understand resilience and gain insight into (un)desirable variability in the complex system of daily practice. We explored how using FRAM in the Deming cycle of a QI project can help professionals and researchers learn from, reflect upon, and improve complex processes. We used FRAM in a Dutch hospital to study a QI: Critical Care Outreach Service (CCOS).
Methods: The aim was to use FRAM before and after implementation to create a FRAM model and reflect to health care professionals the mismatch between Work As Imagined (WAI) and Work As Done (WAD). The WAI FRAM model was co-created with professionals before the implementation of CCOS. We used descriptions of tasks and processes for ICU nurses and verified them in 30-minute semistructured interviews (N = 2). WAD was created by input of semistructured interviews with key professionals in CCOS (N = 21) and 3 nonparticipant observations of trained CCOS nurses. We validated WAD in 2 dialogue sessions with key professionals (N = 11). Data collection continued until saturation.
Results: Juxtaposing the WAI and WAD models showed that WAD contained additional functions and highlighted unexpectedly complex functions. Reflecting on the application of FRAM with health care professionals revealed opportunities and challenges, especially time investment.
Conclusions: FRAM helps professionals outline processes and tasks (WAI), learn from, and reflect upon their daily practice (WAD). FRAM models help professionals identify variability proactively to improve practices that enhance resilient performance.

Key Words: patient safety, FRAM, quality, critical care outreach, leadership

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BACKGROUND

Health care professionals, processes, and systems need to adapt to continuously varying circumstances[1] to successfully design and implement long-term quality improvement (QI). The ability to adapt is described as resilience and refers to the "mechanism" to proactively "adjust its functioning prior to, during, or following changes and disturbances so that it can sustain [the] required operation."[2] Key to this definition is the ability of systems to act upon disturbances as unforeseen, unpredicted, and unexpected demands.[2] Resilience also refers to a personal ability to adapt to complex dynamics in context and hence resume everyday operations.[3–5] Health care is a complex environment that demands resilience in everyday processes—resulting in performance variability—as most care processes cannot be fully standardized in a predictable, linear manner,[5,6] as is sometimes incorrectly assumed by traditional QI methods. Even in straightforward processes supported by information and communications technology, deviation is common, as ethnographic studies have shown.[7,8] Thus, the ability to adapt and adjust to match conditions and contexts is critical for sustainable QI.[3] It is important to gain insight into how professionals, teams, and organizations act resiliently in the complex context of designing and implementing QI.[1] To study this in depth and understand more about the "value" of FRAM, we collected data in a case study where a nurse-led Critical Care Outreach Service (CCOS) is designed and implemented.[9,10]

Traditional QI evaluation methods usually focus on judging success by measuring the compliance of people and the effectiveness of the improvement. Mostly, the effectiveness of QI is measured linearly: at the beginning (T-0 situation) and after a certain timeframe (T-1 situation) to measure the pursued results. This aligns with hospitals' traditional approach toward accounting and compliance in quality and safety. However, the success of QI should include the ability to adapt to the complex health care context, which needs resilience and variability to perform well.[11,12] Hence, some argue the necessity of including methods to comprehend everyday performance, especially those that enable a profound understanding of how people, processes and systems are related and interact.[13] After all, dealing with the difference between

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imaginary (documented) care and mundane practices is important. Studying interacting mechanisms in the design and implementation processes of QI projects teaches us more about resilience and the tailoring to envisioned changes in complex, dynamic health care practices.[1,13] This understanding stimulates reflection and learning and thereby reveals desirable and undesirable variability in everyday practices,[1,14] which in turn can contribute to success in dealing with the differences.

The Functional Resonance Analysis Method (FRAM) can be used to understand resilience in everyday practices of a complex dynamic system and gain insight into both desirable and undesirable variability.[6,15] Originating from sociotechnical engineering, it is used in the Safety-II paradigm focusing on the presence of safety in complex dynamic systems, rather than the absence of safety. Thus, learning about everyday practice is key, including managing error in contrast to analyzing error.[6,11] FRAM enables a deeper understanding of what works in everyday performance, facilitating insight into effective strategies, risk mitigation, and opportunities for adaptation to maintain performance[6,11] (referred to as work-as-done [WAD]) and shows how it relates to the envisioned processes (coined work-as-imagined [WAI]). Also, FRAM visualizes complexity by overseeing essential process activities and their interactions or interrelatedness to reveal resilience and variability.[12,14,16]

Research shows that FRAM has been useful for health care professionals, policymakers, and management to improve quality and safety of care, as it helps them understand current practices (WAD) and learn about the effects of variability and the barriers/enablers to handle complexity.[12,15] Specifically, identification of specific workarounds, personal aids, and incrementally developed control mechanisms are helpful in quality improvements.[17] In health care, FRAM has been used for multiple aims, such as prospective risk assessment,[18] improving persistent safety issues,[19–21] incident investigation,[16] translation of guidelines into local policy,[22] or as participatory improvement intervention.[23]

We aim to (1) obtain a deeper understanding of how CCOS is conducted in daily practices (Work-as-Done) and how this relates to predefined procedures (Work-as-Imagined) and (2) examine the applicability of a Safety-II approach using FRAM in a QI. Our research question was: How can FRAM be applied in a QI project and how supports FRAM reflection and learning on the implementation and evaluation process of a QI project of health care professionals?

METHODS

This study was approved by the Medical Ethical Council Midden-Brabant (registration NW2020-12). Participants gave voluntary informed consent. For reporting, we used the revised Standards for Quality Improvement Reporting Excellence 2.0 framework.[24]

Design and Setting

We describe a QI project on implementing a Critical Care Outreach Service (CCOS) led by CCOS-trained nurses (CCONs). Hereby we focus on the design (Plan) and evaluation (Study) phase according to the Deming cycle, a model for systematic learning and continuous QI.[25] Generally, the CCOS included 5 components of outreach derived from a recent international Delphi study. Box 1 (Appendix 1, http://links.lww.com/JPS/A660) describes the aim and components of the Dutch CCOS.[10] In the Plan phase, FRAM was used to visualize the desired process (WAI) of CCOS. In the Study phase, FRAM was used to visualize the results (WAD) 3 months after CCOS implementation, based on semistructured interviews and observations.

The setting was a Dutch teaching hospital with 782 beds, including a 36-bed level 3 ICU, 540,000 outpatient visits annually, approximately 1550 vocational and/or bachelor-trained nurses, and 394 doctors.

Functional Resonance Analysis Method

FRAM design starts by identifying the main functions (actions) in the complex process of CCOS, depicted as a hexagon that displays the complexity (see Fig. 1).[12]

Multiple linked hexagons show the interrelatedness of functions. An entire process is visualized by coupling functions through the input and output of hexagons. This provides insight into variability and interdependency.

Data Collection

Plan Phase (WAI)

The aim of the QI project was to improve an existing ICU outreach service into a structured nurse-led CCOS based on the evidence provided by an Australian ICU Liaison nurse.[9,10] Two months before implementation, we constructed the WAI model, collecting digital and printed documents describing the usual care processes of the existing service and conducted a literature review on the ICU liaison nurse role. Existed literature and process descriptions were input for the CCOS project team for the first draft of the CCOS design and making an education plan for ICU nurses. A focus group, comprising the project leader, team members, and the ICU manager, discussed the draft, and a summary of their group output was used to refine the CCOS project design. The final CCOS design was visualized in a draft WAI model, as imagined by the initiators. Then an experienced FRAM researcher (N.D.) used the FRAM Model Visualizer (FMV) 0.4.1 to create the final WAI. The CCOS was introduced in October 2019, based on this WAI model. The professionals and the organization learned to work with the CCOS system in the following 3 months.

Study Phase (WAD)

The WAD model was based on semistructured interviews and observations and used to evaluate the implementation.

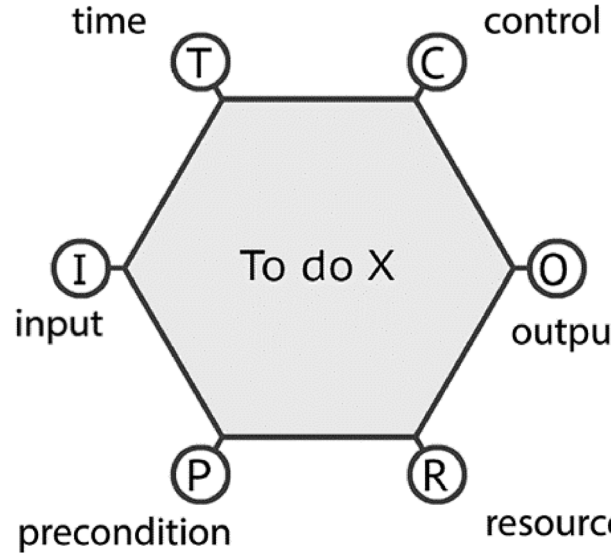

FIGURE 1. A function and its 6 aspects. (1) Input: initiating stimulus of the activity; (2) output: outcome of the stimulus and emerging change; (3) time: time aspects affecting the function; (4) control: controlling or monitoring aspects; (5) precondition: conditions that must be met before the function begins; and (6) resource: materials and people needed for executing the function.[12]

Interviews

One researcher (N.D.: female, PhD) with expertise in FRAM modeling conducted interviews with 20 professionals involved in the CCOS process, including the CCONs, using a predefined topic list (see Appendix 2, http://links.lww.com/JPS/A661). All invited agreed to participate (see Table 1). In accordance with FRAM, at least 2 professionals per involved discipline were interviewed to gain insight into variability in their role in the CCOS process and their interactions with others involved. Interviewees were purposively selected: the ICU and general ward team leaders provided the initial point of approach for recruitment, and additional professionals were recruited through interviewees. Through the team leaders, we recruited the ward nurses from 2 wards that often consulted CCONs. Interviews lasted 30 to 60 minutes. All interviews were audiotaped and summarized. We conducted interviews until no new information emerged (saturation).

Observations

Adopting an open, curious yet neutral stance,[26,27] one researcher (M.M.: female, MSc) undertook nonparticipant observation of CCONs (N = 3) for 20 hours in total, to understand the CCOS processes. Nonparticipant observation is "a way to understand the complexity of healthcare work that might otherwise be poorly understood or ignored, how workarounds influence work practices and safety, and is of fundamental importance, to practitioners wishing to understand resilience in the face of conflicting workplace pressures."[28] Eligible participants had worked at least 2 shifts as a CCON and had not been interviewed previously. We invited 8 CCONs by email and included the first 5 who responded. Two day shifts and one nights shift were observed for 5 to 8 hours per shift. The field notes taken during nonparticipant observation were written up afterward in thick descriptions, which were sent to participants as a member check.[29,30] All respondents agreed with the thick descriptions.

TABLE 1. Interviewees: Key Professionals in CCOS

Sample Details	N (19)
Key professionals	
- ICU nurse with specialist ICU training *(trained CCONs)*	4
- ICU nurse practitioner (NP)	2
- General ward nurse	4
- Nursing coach in clinical reasoning skills	3
- Nurse coordinator (a general nurse coordinating admissions from emergency room [ER] to general wards during evening and night shifts. She also supports ER staff in regular nursing activities)	1
- Intensivist	1
- Nurse practitioner/physician assistant general ward	3
- Physician general ward	1
Age, y	
- 20–30	4
- 31–40	7
- 41–50	5
->50	3
Gender	
- Women	15
- Man	4
Educational level	
- Vocational	6
- Bachelor	6
- Master	7

Dialogue Sessions

Next, we held 2 dialogue sessions to discuss WAD and potential clinical implications. We invited all the interview participants as well as other professionals and managers involved in the CCOS process (N = 46). Of the 67 potential participants invited, 11 (16,4%) accepted the invitation: CCONs (N = 6), ICU nurse practitioners (N = 2), nurse practitioner on general ward (N = 1), nurse managers (N = 1), and nursing coach (1). Due to the COVID-19 ban on in-person meetings, the second dialogue session was held online. Both sessions lasted an hour. Notes were taken, transcribed and summarized. The dialogue sessions successfully validated WAD and identified ideas for further improvement of CCOS.

Analysis (WAI and WAD)

We (M.M. and N.D.) analyzed the data from interviews and observations in 3 steps. First, we identified the main activities and professionals who executed these functions. If a function was present in WAD, we identified the 6 aspects of its hexagon (see Fig. 1).

The second step was to interpret the model and understand how resilient performance is shaped throughout the CCOS process. We analyzed variability and interdependency in terms of both functions and aspects by juxtaposing WAD and WAI, and tried to understand the resilient behavior of professionals. We also conducted theoretical thematic analysis[31] on the interview and observation data to flexibly yet systematically identify common themes across different data sources.[31,32] We used Hollnagel's potentials of resilience (monitoring, responding, anticipating, learning) as sensitizing concepts to understand and interpret data.[12] All data were coded and, subsequently, axial coding identified the common themes. Finally, a focus group including the CCOS project team and researchers reflected on the value of FRAM for quality improvement.

RESULTS

First, an overview is presented of both models based on the functions, aspects, and executing professionals (Figs. 2 and 3). Then, we discuss the most apparent themes derived from the thematic analysis. Finally, we reflect on the use of FRAM in the QI processes and how it fits with the Safety-II paradigm.

WAD and WAI: Variability, Interdependence, and Relatedness.

Figures 2 and 3 show the FRAM WAD and WAI models.

Juxtaposing WAD and WAI shows some slight or nuanced differences in content (blue, #) or major changes (red, ♥). Table 2 illustrates some of these differences or changes (see Table 1 in the supplements for the complete table, http://links.lww.com/JPS/A659).

Some WAD functions differed slightly from WAI. An example is WAD function 1. WAI functions 1 and 2 were done together in practice, which the interviews and observations confirmed. WAD also contained new functions, such as mutual handover between CCONs (WAD function 5), reading patient files (WAD function 8), and prioritizing ward visits (WAD function 9). Data showed that gathering and using information was a more complex process than initially imagined (WAI function 1) and that these steps were vital to manage time well, anticipate, and respond effectively.

In WAD, some functions were either unexpected (see WAD functions 1 and 18a) or showed major changes in content (see WAD functions 7, 17, and 20).

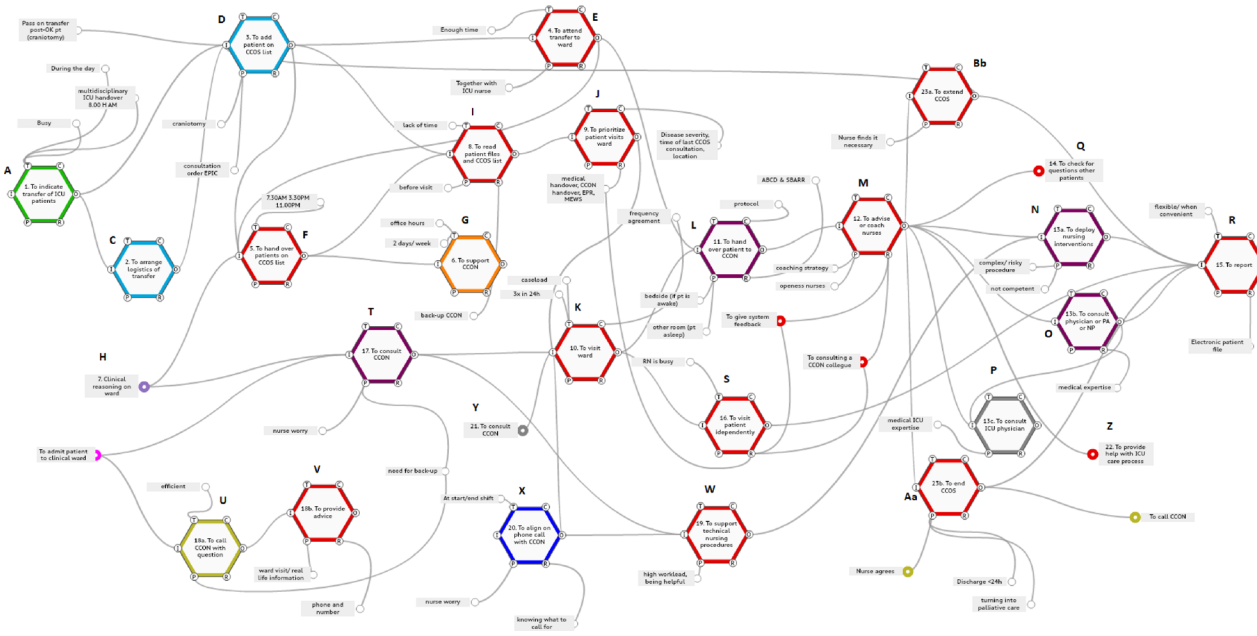

FIGURE 2. WAD CCOS model. Red: CCON; burgundy: ward nurse; orange: ICU nurse practitioner; light blue: ICU manager; dark blue: nurse coordinator; purple: nursing coach (in WAI also nurse coordinator); gray: physician/assistant physician/nurse practitioner; green: ICU physician (intensivist).

Interpreting and Reflecting on Variation in WAD: Thematic Analysis

Five main themes emerged from the thematic analysis: (1) accessibility, (2) communication and decision making, (3) efficiency, (4) coaching styles, and (5) collaboration.

Accessibility

Overall, the interpretation of WAD revealed that nurses experienced CCOS as a positive improvement. Nurses said that the CCONs helped them respond better when they recognized that their patient was deteriorating. They knew they could call on the CCON, because they could trust their ICU expertise and quick response.

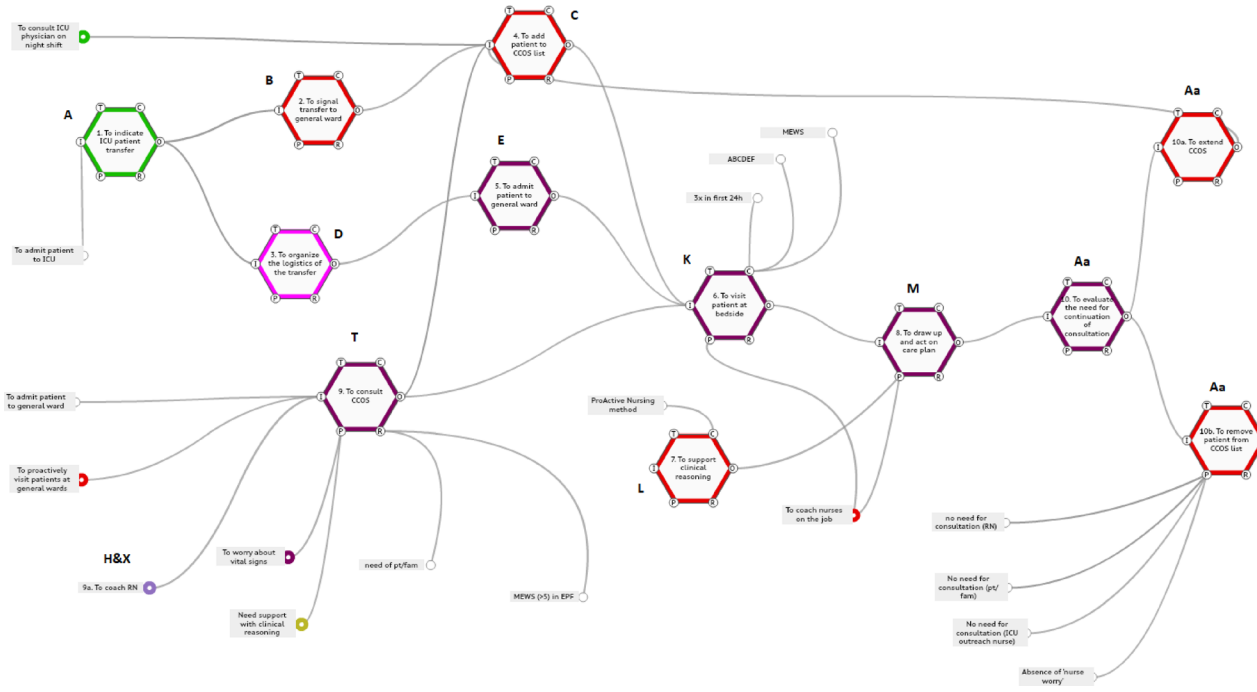

FIGURE 3. WAI CCOS model. *(N.B. the legend applies to WAD and WAI CCOS models!).* Red: CCON; burgundy: ward nurse; orange: ICU nurse practitioner; light blue: ICU manager; dark blue: nurse coordinator; purple: nursing coach (in WAI also nurse coordinator); gray: physician/assistant physician/nurse practitioner; green: ICU physician (intensivist).

TABLE 2. WAD and WAI: Variability, Interdependence, and Relatedness

	Work as Done (WAD)		Work as Imagined (WAI)	
	Function*	**Professionals**	**Function***	**Professionals**
A #	Function 1: Indicate ICU patient transfer. CCONs are mostly used in the 8.00 AM handover. Signal potential patients. CCONs not used when there is no time (T). Then ICU NPs do the honors. Intensivist and ICU NP decide on transfers to the ward (O).	Intensivist, ICU NP, CCON ♣	Function 1: Indicate ICU patient transfer. CCON used in the handover of every shift, during which intensivists discuss all ICU patients and decide who will be discharged. Function 2: Signal patients fit for transfer. CCON notes the patients the intensivist has assessed as "fit for transfer" and adds them to the CCOS list.	Intensivist, NP ICU, CCON
F #	Function 5. Handover of patients on CCOS list. Shift handovers between CCONS take place 7:30 AM, 3:30 PM and 11:00 PM (T). Handovers share coworker knowledge of a patient's condition and coaching requests (R), which helps to anticipate and prioritize (O).	CCON #		
H ♥	Function 7. Clinical reasoning support. Nursing coaches decide whether nurses should call a CCON (O) if they are worried about a patient's condition (P). Due to time constraints (T) coaches do not participate in the medical transfer.	Nursing coach ♣		
I #	Function 8. Read patient files and CCOS list. Patients' files (R) provide a global overview of patients on the CCOS list (O), which helps to anticipate and prioritize the patients at risk. CCON tries to read before ward visits (T) but cannot always and if she lacks time postpones reading until the patient visit (T).	CCON #		
J #	Function 9. Prioritize ward visits. CCON prioritizes which patients must be visited first (O), based on insight into the patient's condition (I) based on medical handover (R), CCON handover (R), MEWS scores (R) and patient file (R).	CCON #		
T #	Function 17. Consult CCON. Nurses consult a CCON when they need to make sense of a worrisome situation (P), especially outside office hours (T), when physicians have limited availability (P). CCON is quickly on site (P) and has the expertise to structure and interpret the situation (R).	Ward nurse ♣	Function 9. Coach nurses on the job. If a ward nurse is worried about the condition of a patient, needs support in clinical reasoning, and/or the patient/family needs support, the ward nurse may ask for a consult and pages a CCON.	Ward nurse
U ♥	Function 18a. Call CCON for quick questions. Ward nurses consult CCON by telephone for quick questions on technical interventions and protocols, which do not need a visit (P). Sometimes it is more efficient (T) to call someone with much technical expertise (R), than searching protocols for relevant information.	Ward nurse ♥		

(Continued next page)

TABLE 2. *(Continued)*

Work as Done (WAD)			Work as Imagined (WAI)	
	Function*	Professionals	Function*	Professionals
X ♥	Function 20. Align with CCON on telephone. Nurse coordinators do not attend the medical handover as it is time consuming (T). They sometimes advise nurses to call CCONs (O) or will call CCONs (O) themselves if they are concerned about the patients' condition (P). Nurse coordinators consider the CCON a certain backup, especially when technical help is needed (e.g., inserting IV) (P). Some CCONs try to be helpful (P) if they have time (T). Other CCONs consider such tasks not their job.	Nurse coordinator ♣	Function 9a. Advise: call the CCON. A nursing coach or nursing coordinator might be concerned about a patient and advises the ward nurse to ask for help from a CCON. Nursing coaches/coordinators attend ICU handovers where they might signal patients potentially at risk for deterioration so that these patients get placed on the CCOS list.	Nursing coach, nursing coordinator

* Functions are numbered and suggest a certain sequence. Please interpret this sequence very loosely to respect the complexity of practice. Green (♣): WAD function and/or professional is the same as in WAI. Blue (#): WAD function and/or professional differs slightly from WAI, but does not change the process much. Red (♥): WAD function and/or professional differs from WAI.

Function aspects: (P): precondition; (C): control; (T): time; (R): resource; (I): input; (O): output

ABCDE, airway, breathing, circulation, disability, exposure; EPR, electronic patient record; MEWS: modified early warning score for clinical deterioration; SBARR, situation, background, assessment, recommendation, reflection.

Outside office hours, when doctors were hard to access, nurses found this very helpful. Having to wait for a physician is why nurses wanted to execute meaningful assessments and interventions.

Communication and Decision Making

Physician assistants (PAs) and nurse practitioners (NPs) felt that the handovers were more structured and complete with CCON interventions. Nurses said that 1-on-1 bedside coaching by CCONs in applying the ABCDE method (Airway, Breathing, Circulation, Disability, Exposure) and SBARR (Situation, Background, Assessment, Recommendation, Reflection) was helpful to present handovers coherently. This allowed PAs and NPs to make better decisions about preventing clinical decline.

Efficiency

Standard post-ICU follow-up seemed to benefit because ward nurses could rely on the expertise of ICU nurses. However, both nurses and CCONs considered visiting low-risk, stable patients 3 times within 24 hours of transfer from ICU to the ward as excessive. It became clear that some stable patients were removed from the CCOS list after the second visit to make more time available for sicker patients. This happened more often with larger caseloads. Nevertheless, the CCOS support was guaranteed, and as soon as a nurse called, the CCON would come.

Coaching Styles

Nurses reported that CCONs had different coaching strategies. For example, most CCONs had a clear focus on interactively guiding nurses in interpreting, assessing, and intervening. Some CCONs used a master-apprentice approach and others just told nurses what to do. Dialogue sessions revealed that coaching required certain competences, which were sometimes lacking and resulted in the different coaching approaches. The competences included knowledge on the content of CCON and skills to teach and reflect.

Collaboration

Frictions were observed in collaborations between nurse coordinators and CCONs. Some nurse coordinators did not know that they were expectedly to identify patients at risk. As a result, the CCON was not informed when a patient was eligible for a CCOS consultation. Therefore, some CCONs took the initiative to check whether there were any other eligible patients, which often turned out to be the case, or CCONs were called for tasks that fell outside their responsibility, such as IV insertion. Some CCONs took over these tasks to be helpful, especially when nurse coordinators were busy. As a result, it was assumed by default that certain tasks were done by CCONs.

Reflecting on Using FRAM in QI

FRAM is a comprehensive QI tool that facilitates the explicit delineation of WAD, enhancing comprehension of daily practices and enabling identification of potential areas for improvement.[6,11] However, our study was more labor-intensive than anticipated. The QI advisers and researchers spent 60 hours in total on data collection (45 hours), analysis (13 hours), and dialogue sessions (2 hours). The scale of the process and the unexpected large number of professionals involved exceeded the average time investment for conducting FRAM (25–35 hours).[12] However, this great investment, combining data from interviews and observations, offered richer insights into the complexity of everyday practices. Observations provided real-time understanding of the variations

beyond interviews, and in turn, interviews provided insights into "the why."

WAI and WAD visualizations were helpful in that they made practices tangible. Providing the time and space to reflect with those involved on how WAD allowed professionals to develop an understanding of each other's stories was beneficial, as it created awareness about their processes, and how quality was ensured.

We learned that applying FRAM requires training[33] in both the methodology and the theoretical background of resilience. Especially, the project leader must grasp resilience and variability to interpret data well. Without this knowledge, the project risks becoming an "old school" process analysis focused on input and output (Safety I thinking) instead of variability.

DISCUSSION

This paper shows how FRAM helps health care professionals in a QI process to learn from and reflect on everyday practices. By using FRAM during the design (Plan) and evaluation (Study) phases of the Deming cycle of QI.[25] health care professionals were able to reflect on every aspect of the complex mundane practices visualized in WAI and WAD FRAMS.

Our findings show that WAD differed from the upfront "designed" process (WAI) and consisted of considerably unexpected functions and aspects. A closer inspection revealed that WAD also highlighted unexpectedly more complex functions that were overlooked or taken for granted in the initial development of the CCOS, as well as activities that are common to health care professionals but are vital for resilient performance in the complex daily practice. In addition, WAD showed strong variation. Variation was induced by easy access to CCONs, availability of physicians, coaching styles of CCONs, friction between roles, and expectations in the partnerships involved.

Naturally, WAD in our study differed from what had been conceived in WAI, much like the results of studies reported by Clay-Williams et al[22] and McNab et al.[23] However, previous CCOS studies have reported varying patient outcomes.[34–36] Unlike most other studies limited to describe WAD only,[33] our study made WAI explicit and comparable with WAD to provide a deeper understanding of everyday practices. We realized that WAI mainly presented the main features, whereas WAD provided insight into how a CCOS is embedded in complex organizational structures and systems. Our WAD made variations visible so that the professionals involved were able to address both desirable and undesirable variability, and resilience during dialogue sessions. This gave direction to improvements, which is precisely the relevance of using FRAM for QI in complex systems[16,23,37] where linear approaches fall short.[23,38] Thus, applying the Safety-II approach, our unique visualization of WAI and WAD includes lenses on complexity and resilience, which clarifies the dynamics of a complex context that affects a QI, in this case the CCOS, and engages professionals in proactive addressing risks and strengthen what goes well.[12,23,38,39]

Implementation science has the triple aim to describe, understand influences, and evaluate intervention outcomes in practice.[38] As a paradigm, Safety-II is based on complexity science.[40] The FRAM methodology is used to visualize the everyday practice complexity.[12] We used FRAM in a novel way, to learn how this method can contribute to a learning cycle with health care professionals as co-creators. Our study builds on the evidence[22,23] that FRAM is a promising method to use during multiple phases of implementing a QI. However, we agree on Sujan et al[41] that a reporting guideline may help both researchers and professionals get used to working with FRAM and to correctly interpret its multiple characteristics.

Strengths and Limitations

Our study combined observations and interviews, which we know yield different types of data.[29,42] This strength of our study gave us insight into both "work as reported" and "work as observed," which resulted in a more nuanced and complete picture of WAD.

Some limitations of the study must also be acknowledged. First, earlier research stated that a FRAM model should contain a maximum of 20 activities because it could easily become overwhelmingly complex.[43] This raised the question if this way of visualizing a complex system merely shows "one-moment" activities and so only a small part of actual reality.[44] However, in accordance with previous studies,[39] in the current study, health care professionals addressed in the dialogue session that the work-as-done model together with the thematic analyses, accurately represented their daily work and provided a practical-oriented base for further optimization of the CCOS process. Future research should further investigate whether by means of using FRAM complex adaptive systems can be entirely understood.[12]

Also, the COVID-19 pandemic influenced our study in 2 ways. Firstly, due to national and hospital regulations at that time, we were not able to conduct all 5 additional observations, limiting our insights into the WAD and potentially uncover further insights.[45,46] Secondly, it prevented us from engaging in reflective discussions with the involved professionals on their experiences with FRAM, hindering our ability to gain insights on the applicability of FRAM for learning and QI. In return, this could enhance the uptake of FRAM methodology in a QI setting, as well as the application for QI itself.[12,22,23] We strongly recommend for future research to prioritize evaluating the practical usability and applicability of FRAM in QI. Also, COVID-19 also forced the ICU to change its work routines, task division and, consequently, this influenced the CCOS.[47,48] Therefore, we were not able to further improve the CCOS (last phases of the Deming Cycle). The impact of the pandemic on the effectiveness of CCOS should be further studied.[47,48]

This study illustrates the clinical relevance of putting FRAM into practice, to learn how it can contribute to the adapting process of professional-led changes in complex systems. FRAM could potentially enhance the professionals' capability to deal with changes over which people have little control, such as a pandemic.

CONCLUSIONS

FRAM supports health care professionals to understand the complex processes and systems in the acute hospital care setting. FRAM contributes to engage health care professionals in this reflecting and learning cycle during the process of a QI. It helps users proactively identify desirable and undesirable variability and make improvements that foster resilient performance. Also, adding "work as observed" is very helpful in gaining nuanced, detailed insight in WAD. Although this study shows the cross-fertilizing benefits of combining implementation science and (Safety-II) complexity science in bringing research into practice, future studies could further explore FRAM as an implementation tool.

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