

Quality Improvement Report

Developing a reflection and analysis tool (We-ReAlyse) for readmissions to the intensive care unit: A quality improvement project



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ABSTRACT

Background: Readmissions to the intensive care unit are associated with poorer patient outcomes and health prognoses, alongside increased lengths of stay and mortality risk. To improve quality of care and patients' safety, it is essential to understand influencing factors relevant to specific patient populations and settings. A standardized tool for systematic retrospective analysis of readmissions would help healthcare professionals understand risks and reasons affecting readmissions; however, no such tool exists.

Purpose: This study's purpose was to develop a tool (We-ReAlyse) to analyze readmissions to the intensive care unit from general units by reflecting on affected patients' pathways from intensive care discharge to readmission. The results will highlight case-specific causes of readmission and potential areas for departmental- and institutional-level improvements.

Method: A root cause analysis approach guided this quality improvement project. The tool's iterative development process included a literature search, a clinical expert panel, and a testing in January and February 2021.

Results: The We-ReAlyse tool guides healthcare professionals to identify areas for quality improvement by reflecting the patient's pathway from the initial intensive care stay to readmission. Ten readmissions were analyzed by using the We-ReAlyse tool, resulting in key insights about possible root causes like the handover process, patient's care needs, the resources on the general unit and the use of different electronic healthcare record systems.

Conclusions: The We-ReAlyse tool provides a visualization/objectification of issues related to intensive care readmissions, gathering data upon which to base quality improvement interventions. Based on the information on how multi-level risk profiles and knowledge deficits contribute to readmission rates, nurses can target specific quality improvements to reduce those rates.

Implications for clinical practice and research: With the We-ReAlyse tool, we have the opportunity to collect detailed information about ICU readmissions for an in-depth analysis. This will allow health professionals in all involved departments to discuss and either correct or cope with the identified issues. In the long term, this will allow continuous, concerted efforts to reduce and prevent ICU readmissions. To obtain more data for analysis and to further refine and simplify the tool, it may be applied to larger samples of ICU readmissions. Furthermore, to test its generalizability, the tool should be applied to patients from other departments and other hospitals. Adapting it to an electronic version would facilitate the timely and comprehensive collection of necessary information. Finally, the tool's emphasis comprises reflecting on and analyzing ICU readmissions, allowing clinicians to develop interventions targeting the identified problems. Therefore, future research in this area will require the development and evaluation of potential interventions.

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Introduction

Patients readmitted to intensive care units (ICUs) have a longer length of hospital stay, poorer overall health prognoses, and a 2–11-fold higher risks of mortality (Al-Jaghbeer et al., 2016; Kramer et al., 2013). In addition to causing increased physical and mental stress for patients and their relatives (Kaben et al., 2008; Kauppi et al., 2018; Tam et al., 2014), such readmissions incur additional costs and strain limited ICU resources (Brown et al., 2012; Kramer et al., 2012; Renton et al., 2011). In times of severe staff shortages, particularly in nursing, it is critical to emphasize that ICU readmissions are linked to moral distress (Kauppi et al., 2018), which can lower job satisfaction and increase the intention to leave. Furthermore, ICU readmissions are strongly connected to patient characteristics such as patient complexity or turnover (admission/discharge), which are associated with higher nurse workloads (Musy et al., 2021).

Previous studies with heterogeneous definitions of ICU readmission reported ICU readmissions rates between 3.1 % and 13.4 % (Kaben et al., 2008; Makris et al., 2010). Early readmissions (within 48 h of ICU discharge) are considered an indicator of ICU performance (Australian Council on Healthcare Standards, 2007), with higher rates potentially indicating either over-hasty discharge or inadequate continuity of care, e.g., insufficient communication between the ICU and the general unit (Makris et al., 2010; Niven et al., 2014). Even though ICU readmissions are not always preventable, as unexpected complications can occur at any time, preventive measures should be observed to avoid them wherever possible. For instance, the implementation of a medical emergency team (MET) has proven to be beneficial in reducing readmission rates (Bergamasco et al., 2017).

To establish effective prevention and improve patient care and safety, it is key for healthcare professionals to understand risk factors influencing structures and processes relevant to their patient populations and settings.

Several studies described patient characteristics associated with increased risk of ICU readmission (Rosenberg and Watts, 2000; van Galen et al., 2016; Wang et al., 2021) — predictive factors include older age, male gender and longer length of ICU stay (Wang et al., 2021). Other papers discuss influential organizational level factors. E.g., Metnitz et al. (2003) described that the risk of ICU readmission is higher for after-hour and weekend discharges. Other relevant reports deal with key aspects for secure ICU discharge, such as guidelines for handover, a clear setup and defined use of electronic healthcare records (EHR), as well as knowledge and clinical experience in staff members (Bogardus et al., 2001; Brown et al., 2018; DeVon et al., 2004; Makris et al., 2010; Wibrandt and Lippert, 2020). However, their impact on ICU readmission remains unclear.

Continuous (quality) improvement is crucial to ensure that improvements are sustainably maintained or short-term solutions are sought after. Key elements for continuous improvement include: underlying knowledge, policies for leadership, tools and methods and applications in daily work (Silver et al., 2016). Well-defined data analysis makes it possible to uncover weaknesses in processes and understand what actions are needed to address them. This leads to greater efficiency and effectiveness of processes, which can translate into improved quality and staff satisfaction. A tool for systematic reflection on ICU readmissions to monitor readmission rates and analyze the risks for ICU readmissions, supports the gain of knowledge of readmission rates, risk factors and process structure. The sensitization to risk profiles and process structures may reduce ICU readmissions. Therefore, the aim of this study was to develop and test a tool that guides systematic reflection and analysis of ICU readmissions. By highlighting areas for possible improvement, this may improve care quality.

Method

Setting and context

The study was conducted by a mixed surgical and medicine department (68-beds in 3 general units) in one of the five University Hospitals in Switzerland between September 01, 2020, and February 28, 2021. The department treats patients from three clinical specialties (visceral or abdominal surgery, hepatology, and gastroenterology), referred to here as “general unit”. Patients in critical condition, e.g., following surgical procedures and/or acute condition deterioration, are cared for in cooperation with the Department of Intensive Care Medicine, which includes a 37-bed-intensive ICU and a 20-bed intermediate ICU.

In 2020, the general unit’s early ICU/ Intermediate Care Unit (IMC) readmission rate (rate of readmissions within 48 h after discharge) was 3.7 % (n = 25 of 674 initial admissions from ICU/IMC to the general unit). Readmitted patients had a mean age of 61 ± 15 years, a primary diagnosis of malignant pancreatic neoplasm or hepatocellular carcinoma; their mean Acute Physiology and Chronic Health Evaluation (APACHE) II score was 18.14 ± 8.89 .

Design

In this quality improvement project, the primary goal was to develop and test a tool, that reflects ICU readmissions from a general unit to identify possible causes that led to an ICU readmission and to derive possible quality improvements from the tool-generated information.

Tool development process

Tool development started in September 2020 with a scoping literature review to explore risk factors and causes of ICU readmission. Fig. 1 illustrates the development process.

We searched Medline (via PubMed), Cochrane Library, and CINAHL (via EBESCOhost) using the following keywords: “patient readmission,” “readmission,” “intensive care units,” “ICU,” “transfer,” “adverse” and “mortality.” Included literature were: 1) clear description of potential causes and risk factors for ICU readmission; 2) medical, surgical, or mixed ICU environment; 3) ICU readmissions related to the same hospital stay (ICU transfer rate >1); and 4) written in English, German, or French. Literature was excluded if they were from low- and middle-income countries, focused on pediatric, neonatal, neurointensive or coronary care units, examined readmission characteristics after surgical procedures other than those of our population or setting (e.g., heart surgery), did not include an abstract or were published before 2000. Appendix A provides a flow chart of the literature review process, along with an overview of the included studies.

The literature review’s findings were discussed by the clinical expert panel and expanded by clinical expert consensus. The clinical expert panel included five members: two physicians (one surgeon and one ICU physician), two clinical nurse specialists (one from the general unit, one from the ICU) and one advanced practice physiotherapist. All were actively involved in direct patient care and had multiple years of experience working with the study population. Based on these processes’ results, a first draft of the tool was prepared in December 2020. The tool’s contents reflected both our literature review findings and the clinical expert panel consensus. Overall, we used Vincent and Taylor-Adams’ root cause analysis (RCA) approach as a conceptual framework for the tool’s development (see Fig. 2) (Taylor-Adams and Vincent, 2004; Vincent et al., 2000).

To assess the tool’s applicability, understandability, and completeness, and to gain insights into possible root causes for ICU readmissions in the study population, the first author tested the tool draft(s) on a convenience sample of ICU readmissions that occurred between January and February 2021. As segments of the tool must be completed by staff members directly involved in each readmission case, it was crucial to

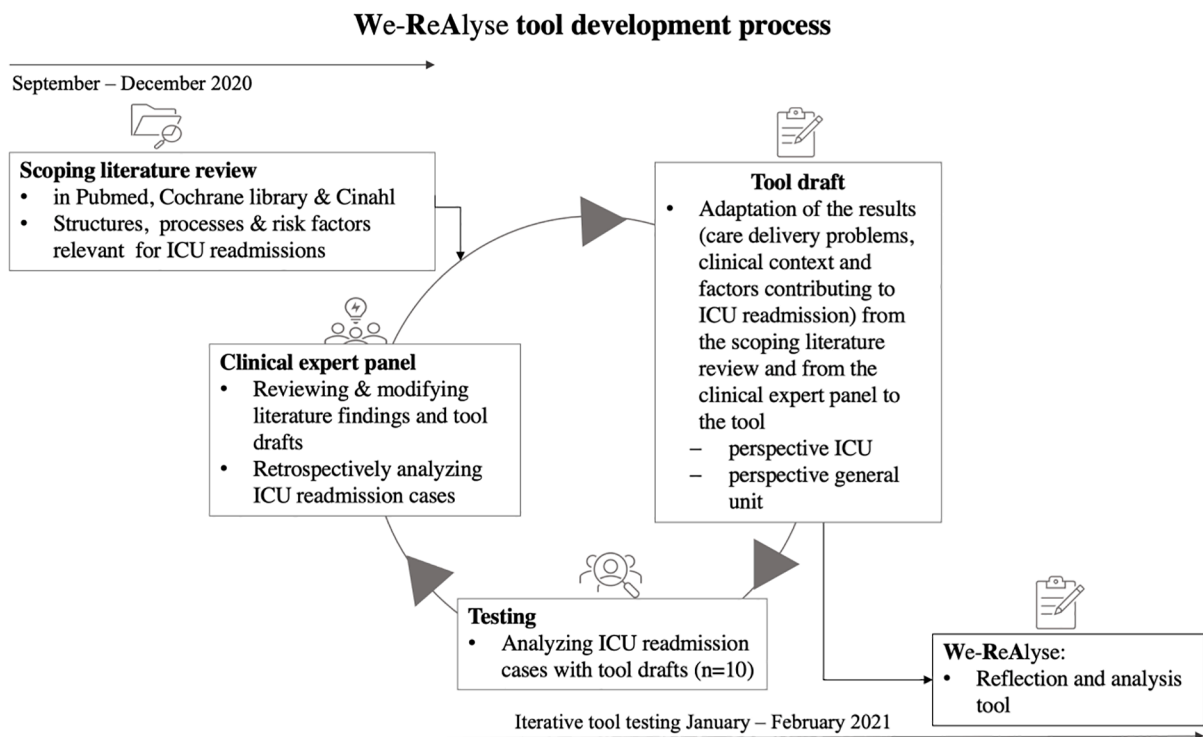


Fig. 1. Illustration of the We-ReAlyse tool development process. A clinical expert panel (two physicians, two clinical nurse specialists, one advanced practice physiotherapist), tested, reviewed, and modified the tool, which was named We-ReAlyse.

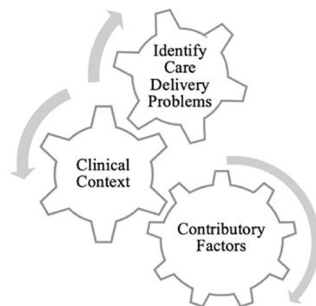


Fig. 2. The framework of Reason (1995) and Taylor-Adams and Vincent (2004) guided our investigation and analysis process.

collect all information promptly after each event. Therefore, the nurse manager of the general unit informed the first author by e-mail or telephone immediately when each ICU readmission occurred. ICU readmissions were defined as the admission of an adult patient (≥ 18 years old) to the ICU who had been previously admitted there during the current hospitalization (index ICU admission). For our purposes, length of stay on the general unit before ICU readmission was irrelevant.

Afterwards, the clinical expert panel reviewed this test's results and focused on whether the tool's information was adequate for a comprehensive reflection and analysis of each ICU readmission case. Where necessary, the tool draft was modified after mutual agreement. This process was repeated twice, and the clinical expert panel reached a consensus on the final version of the tool, which we ended up naming We-ReAlyse (The acronym We-ReAlyse is derived from the German terms "Wiedereintritte" ('readmission') "reflektieren" ('reflect') and "analysieren" ('analyze')).

Ethics

The Ethics Committee on Human Research Bern waived the

requirement for ethics approval (Req-2020-00665). All extracted patients and the participating staff data were coded. The expert panel and staff members interviewed during testing all participated voluntarily.

Results

Based on the categories provided by Taylor-Adams and Vincent (2004) we classified the influencing factors, structures and processes that contribute to ICU readmission into three categories: care delivery, clinical context, and contributory factors. The results are presented in Table 1 for the ICU perspective and in Table 2 for the general unit perspective. The expert panel also made five key recommendations that influenced the tool's development process:

- The reflection process should involve systematically querying all relevant contributing factors, structures, and processes. To keep the reflection holistic, pre-selection should be avoided.
- Reflection should chronologically reconstruct the case from the time of initial admission to the general unit until the time of ICU readmission: only a chronological reconstruction may provide insights into the contributing factors' interrelationships.
- Interprofessional and/or interdepartmental discussions of the individual cases are recommended. In addition to providing varied perspectives on ICU readmissions, the participants evaluate possible causes and reflect on whether/how each ICU readmission may have been prevented. Nurses play a key role, as they spend the most time with the patients.
- Analyses of isolated parameters are not useful in this context. Instead, successive measurements highlight trends and allow interpretation (e.g., based on changes in blood pressure or laboratory values).
- Additionally, to consulting the EHR, recording perspectives and insights of the involved healthcare professionals (nurses, physicians, therapists etc.) are recommended.

Table 1

Care delivery problems, contributing factors and clinical context relevant to ICU readmissions based on the framework of the [Taylor-Adams and Vincent \(2004\)](#) from the ICU perspective.

Care Delivery Problems	Clinical Context	Contributory Factors
<p>Individual Staff</p> <ul style="list-style-type: none"> • Handover visit information: lack of transparency regarding the patient's required resources^E • Incomplete reporting within the transfer report regarding relevant topics (e.g., when did the patient last have a bowel movement, how often was the patient mobilized)^E • Medical staff are inadequately informed prior to the transfer: Patient-specific information (medical history, current nursing priorities, current medications, etc.)^E • Characteristics of the receiving RN: work experience and education level^E • Handover of patient information to general unit's documentation system, e.g., regarding medication management^E; may be incomplete, incorrect 	<p>Patient Characteristics:</p> <ul style="list-style-type: none"> • Presence of tracheostomy and/or delirium at discharge^{E,L} • Symptoms at time of transfer (Lab results, vital signs etc.)^{E, L} • Interventions provided on last ICU day, e.g., dialysis^E • Use of addictive substances, e.g., alcohol and psychotropic substances^E • Uncontrolled fluid imbalances at time of transfer^{E,L} • Abnormal scores recorded at the admission/discharge time for <ul style="list-style-type: none"> ◦ physiological conditions (e.g., Simplified Acute Physiology Score (SAPS) II/III)^{L, E} ◦ Therapeutic Intervention Scoring System (TISS-28)^{E,L} ◦ Mobility^{E,L} (e.g., ICU Mobility Scale) ◦ Respiratory failure (SOFA-Score)^L • Central venous catheter present at transfer^{E,L} • Presence of drainage tube(s) at transfer^E • Signs of neurocognitive or behavioral disturbances (e.g., agitated), mobility limitations and pain (e.g., unadjusted pain management) prior to handover from ICU and at time of ICU readmission^E • Impaired intestinal transit function (e.g., constipation for several days)^E 	<p>Organization and Management Factors</p> <ul style="list-style-type: none"> • Length of ICU stay, ICU admission time and discharge time, day of discharge^{E,L} • Differing understandings/expectations regarding the patient's readiness to transfer (especially between nursing staff and physicians)^E • Short-term discontinuation of i.v. medications shortly before transfer (with no adaptation of the medication for the ward setting)^E • Short period between extubating and transfer to the general unit^E <p>Patient Characteristics:</p> <ul style="list-style-type: none"> • Older Age, male gender^{E,L} • Path to ICU admission (e.g., general unit, emergency)^E • Initial ICU diagnosis, reason for ICU admission^{E,L} • Reason for ICU readmission (to allow assessment of whether the diagnosis is for onset of a new condition or deterioration of an existing one)^E • Systemic Inflammatory Response Syndrome (SIRS)^{E, L} <p>Task Factors, Work Process</p> <ul style="list-style-type: none"> • Advanced practice nurse (APN) support involved during transfer^E • Handover/transfer process: involved people, tasks, competencies^{E,L} • Existence of clear decision criteria for transferability^{E,L} • Additional burdens on the RN responsible for the discharge, e.g., stress due to care team absences, need to supervise students, etc.^E • Interruptions of transfer process, e.g., need to delegate transfer-related tasks^E <p>Work Environment factors:</p> <ul style="list-style-type: none"> • Bed occupancy/patient load^{E,L} • Relevant information not transferred between units (e.g., mismatched documentation standards, use of different assessments in ICU vs. general unit)^{E,L} • Patient data transparency between departments (e.g., to compensate for documentation system differences)^E <p>Institutional Context:</p> <ul style="list-style-type: none"> • Cost reduction pressure (negative)^{E,L}

^E = Expert Panel; ^L = Literature Review.

Table 2

Care delivery problems, contributing factors and clinical context relevant to ICU readmissions from the general unit's perspective, based on Taylor-Adams and Vincent (2004) framework.

Care Delivery Problems	Clinical Context	Contributory Factors
<p>Individual staff</p> <ul style="list-style-type: none"> • Transfer report: sharing of all relevant data on care-related topics, allowing general unit to set appropriate nursing care priorities^{E,L} • The level of patient information the medical staff has (medical history, current nursing priorities, current medications, etc.) prior to transfer^{E,L} • Delays in emergency medical care for decompensating patients^{E,L} • Reduced awareness of changes in the patient situation^{E,L} • Late recognition of problems from outside the specialist area^{E,L} • Failure to seek help (e.g., from the medical emergency team (MET))^{E,L} • Professional experience: inexperienced staff failing to recognize early signs of developing medical emergency^{E,L} • Lack of a shared therapy concept^E • Failure to monitor, observe, or react adequately to changes in patient's condition^{E,L} • Delay in diagnosis^{E,L} • Incorrect risk assessment (e.g., regarding alcohol dependency-related delirium and post operation delirium)^E • Failing to follow an agreed-upon protocol (without clinical justification)^{E,L} <p>Team factors</p> <ul style="list-style-type: none"> • Insufficient or missing process for patient handover within care teams' professional groups^{E,L} • Lack of immediate (medical) contact persons after transfer; no timely prescriptions^E • Missing background information for appropriate care^E 	<p>Patient characteristics:</p> <ul style="list-style-type: none"> • Older age, male gender^{E,L} • Reason for admission^E • Co-morbidities^{E,L} • History of ICU admissions^E • Presence of tracheostomy and/or dialysis and/or delirium^{E,L} • Specific lab results/trends as early indicators of complications^{E,L} • Increasing pain^E • Uncontrolled fluid imbalances^{E,L} • Details of worsening of condition (slow/acute) (e.g., vital signs last 24 hours before readmission)^E • Documented or clinically suspected: Medical-Emergency-Team criteria 72 hours after ICU discharge; SIRS criteria 72 hours after ICU discharge with or without documented or clinically suspected infection^{E, L} • Complex cognitive support (e.g., assessment and intervention related to cognition because of dementia, acute confusion, or delirium; repeated medical therapy for cognitive support)^{E,L} • Ability to perform activities of daily living before readmission^{E,L} 	<p>Organization and management factors</p> <ul style="list-style-type: none"> • Differing understandings/expectations regarding the patient's readiness to transfer (especially between nursing staff and physicians)^E • Infrastructure, logistics (e.g., long distances between treated patients)^E • Patient cannot be observed continuously (e.g., max. nursing care at night every 2 hours on the general unit)^E • Inability of the receiving unit to deliver the needed level of care^{E, L} <p>Task factors, Work process</p> <ul style="list-style-type: none"> • Pre-existing delirium management procedures^E • Appropriate pain management^{E,L} • Involvement of nurses in expanded roles^E • Transfer-related decision-making process^E • Standard transfer process (involved people, tasks, competencies etc.)^E • Existence of a handover checklist^E • Knowledge of the patient's wishes regarding procedures, resuscitation status/advanced care planning (ACP) clarified^E • Availability of a therapy concept^E <p>Work environment factors:</p> <ul style="list-style-type: none"> • Patient-to-nurse ratio at the time of patient transfer to the general unit^{E,L} • Breakdown in care continuity after ICU discharge^{E, L} • Workload on the general unit at time of readmission, e.g., number of complex patient situations, Skill-Grad-Mix^E • Inter-departmental patient data transparency (e.g., to compensate for documentation system incompatibilities)^E

^E = Expert Panel; ^L = Literature Review.

We-ReAlyse – the ICU readmission analysis and reflection tool

The developed tool consists of six main steps via which to chronologically process the patient's pathway from ICU discharge to the moment of readmission. It includes both open and closed questions. In addition to EHR data, it asks for insights from the staff involved, as an interprofessional analysis and reflection is indispensable to obtain a holistic case view with a completed form from all involved healthcare professionals.

Both the consensus of clinical experts and the testing indicate that most of the necessary information is obtained by nursing staff, who spend the most time with patients. Therefore, most steps are dedicated to registered nurses (RN).

The complete versions of the tool are provided in [Appendix B](#) (in German) and [Appendix C](#) (in English). The following steps summarize the core information of the We-ReAlyse tool.

Step 1: Record patient characteristics

First, data on patient characteristics are collected to assess the extent to which these might have influenced the patient's ICU readmission. These include, for example, age, gender, reason for hospital admission/need for treatment, comorbidities, and evidence of noxious agents.

Step 2: Record organizational factors

Identifying possible organizational influencing factors, i.e., conditions under which failures occur and/or continuity of care and/or treatment is at risk. Examples include: (1) Times of admission to the ICU and discharge to the general unit; (2) Details of the ICU readmission (stated reason for readmission, transferring unit, times of ICU admission and discharge (length of ICU stay)).

Step 3: Record clinical conditions (last stay on the ICU/before readmission)

Record clinical conditions known to increase the risk of ICU readmission. These are needed to assess the patient's clinical condition just before transfer to the general unit. Examples include vital signs and laboratory parameters, the presence of a tracheostomy, fluid balance, gastrointestinal function, the presence of central venous catheters, and the quantity and quality of drains in place.

Step 4: Record information related to the transfer from the ICU to the general unit (from the ICU nurse's point of view)

The transfer process is examined in more detail from the perspectives of the responsible intensive care and general unit nurses. In this context,

the extent to which nursing-relevant information is passed on during the transfer to the general unit is determined. The guiding question here is: "Can the handover between nurses ensure the required continuity of care after transfer?" In addition, patient data from shortly before the transfer are recorded, including neurocognitive-, behavioral-, mobility-, and pain scores. Furthermore, any nursing or medical issues the patient had at the time of ICU discharge is recorded (e.g., delirium, dysphagia, and wounds). Moreover, context and task factors that may promote ICU readmission are recorded: workload of the general unit RN, how the general unit physician in charge was involved in the transfer, etc.

Step 5: Record information related to the transfer from the ICU to the general unit (from the general unit nurse's point of view)

Focus on capturing inadequate care arising from deficiencies in staff knowledge, experience, and skills. In addition, we examine any changes in the patient's condition and actions to counter deterioration.

Step 6: Identify root causes and opportunities for improvement

Asked the involved staff to describe possible root cause(s) of the ICU readmission, as well as to suggest how the case could have been positively influenced, i.e., staffing, care coordination, medication changes etc.

Step 7: Interdisciplinary and interdepartmental case analysis review

After analyzing the case, the review panel members jointly evaluate the information provided by the tool to make a final judgment on what they consider the most influential contributors (care delivery problems, clinical context, contributory factors) to ICU readmission. This is recommended to provide objective perspectives on the case, to evaluate possible root causes and to reflect whether—and if so, how—the ICU readmission may have been prevented.

Identified improvement opportunities

During the testing period, ten ICU readmissions were included and analyzed with progressing drafts of the tool. The interprofessional and interdepartmental discussions of these cases not only helped to further develop the tool but gave us a chance to determine likely contributing factors as well as clinical context details that were potential targets for quality improvement within the study setting (see [Table 3](#)).

Table 3

Key insights about possible root causes and main influencing factors for ICU readmissions in the study site based on testing (n = 10) with the We-ReAlyse tool.

Clinical context	In four readmissions the main reason for ICU readmission was acute neurocognitive dysfunction, e.g., delirium, hepatic encephalopathy. The six others presented respiratory or gastrointestinal problems (e.g., gastro-intestinal bleeding) and sepsis. In seven cases, the primary diagnosis on admission to the general unit was hepatological (e.g., due to decompensated liver cirrhosis or partial liver resection (hepatocellular carcinoma)).
Care Delivery Problems	Incomplete/insufficient documentation often made it impossible to determine the extent to which the patients' problems had changed during their stay at the general unit. Regarding handover reporting, deficits in involved staff members' knowledge, experience and clinical skills hindered the continuity of care after discharge from the ICU: these staff did not request/provide many details necessary for the continuation of the care plan. Therefore, relevant information to ensure continuity of care after transfer was often discussed insufficiently. This led to misunderstandings about the extent of care necessary to maintain the patient's stability outside the intensive care unit.
Contributory Factors	Differences between the general unit's and the ICU's EHRs made access to the required information difficult and time-consuming. Clinical decisions, which are highly relevant to ICU readmissions, were rarely documented. When the ICU physicians discharge a patient to the general unit, they do not give that unit's treating physicians a verbal handover report to ensure continuity of treatment. There is no systematic handover process between the ICU RN and the general unit RN to clarify any points that might reduce continuity of care. Often, nursing-specific aspects such as self-care deficit syndrome and nursing workload/case complexity were insufficiently considered during the discharge process and the assessment of readiness for discharge.

Note. ICU = intensive care unit, RN = registered nurse; EHR = electronic healthcare record.

Discussion

We developed and tested a comprehensive reflection and analysis tool to gather information for retrospective analysis of ICU readmissions from a general unit comprising visceral surgery, hepatology, and gastroenterology patients. Target information included relevant details of the clinical context, any care delivery problems, and contributing factors as three broad dimensions. Practice and literature indicate, that the use of readmission rates as a quality of care indicator is a controversial issue (Maharaj et al., 2018). Therefore, readmissions as complex events warrant investigation to gather more information in order to improve the quality of care.

The importance of a comprehensive perspective

The We-ReAlyse tool differs from other research in the field, which often relies on patient factors, single physiological parameters, and/or clinical interventions to predict ICU readmissions, without regards to care delivery problems or other contributory factors (Jo et al., 2015; Ponzoni et al., 2017). The fact that no single aspect can lead to a readmission is also acknowledged by Taylor-Adams and Vincent (2004): "... the notion of a root cause seems a gross oversimplification. Usually there is a chain of events and a wide variety of contributory factors leading up to the eventual incident. The investigation team needs to identify which of these contributory factors have the greatest impact on the incident and, more importantly still, which factors have the greatest potential for causing future incidents." Therefore, during the tool development process, it was important to conduct a comprehensive examination of ICU readmissions. This was achieved via a literature review, discussion in the clinical experts panel and a testing phase. The framework of Taylor-Adams and Vincent (2004) allowed to distinguish three broad dimensions that can strongly influence ICU readmissions: clinical context, care delivery problems, and contributing factors.

While clinical factors such as patient characteristics (Aung et al., 2019; Tam et al., 2014; Timmers et al., 2012) and contributing factors, e.g., the handover process (Wibrandt and Lippert, 2020), have been widely researched for various ICU readmission prediction models (Loreto et al., 2020; Ouanes et al., 2012), other factors, including care delivery problems, which are equally important, have been under-investigated. Nevertheless, as the possible worsening of the disease itself may require an ICU readmission, the tool captures patients' general characteristics and overall condition. Previous studies found that older age, male gender, admission diagnosis, severity of illness, certain comorbidities, and surgical procedures can increase the probability of ICU readmission (Makris et al., 2010; Metnitz et al., 2003; Quinn et al., 2017; Timmers et al., 2012). Such clinical factors are not only better researched, but also easier to record in clinical documentation; difficulties in care delivery are both less-researched and less-documented. For example, "breakdown in continuity of care" is difficult to assess because there is no stable basis upon which to compare ICU and general unit care interventions, i.e., care delivery varies hugely between these two-unit types: while general units use care plans with planned and documented care interventions, ICUs work with care bundles and shift transfer reports. However, these factors/information are needed in order to assess problems in care delivery (usually resulting from staff actions or inactions) which may lead to an ICU readmission (Taylor-Adams and Vincent, 2004).

We identified several important care delivery problems affecting ICU readmissions. This included an understanding of involved health professional who acted outside safe practice environment, had made erroneous decisions (after the event), lacked expertise, or failed to ask for help when it was needed. Most importantly, the tool allowed us to identify the context of each patient's deterioration and the involved staff. Documented deterioration describes the patient's condition, and the related documented care delivery may reveal a lack of expertise and a need for further training among the involved staff. Furthermore, by asking specific questions and performing specific tasks, the We-ReAlyse

tool can help build up an overview of a specific situation. Providing an understanding of the relevant processes and mechanisms may also help both, ICU and general unit staff dealing with ICU readmissions (Winkel et al., 2017). In addition, it is advisable to establish a framework for continuous learning and development. This may include training programs, mentoring and coaching, and knowledge-sharing initiatives to sustain a culture of continuous improvement (Asif et al., 2019; Silver et al., 2016). In relation to the identified key issues of ICU readmissions, it would be useful to offer dedicated training on delirium in acute care, as well as mentoring and coaching of nurses in the transfer process.

Nurses experience

The involved RNs' experience and intuition, and their understanding of the patient, the context of each decision-making situation, their interpretation and reflection on previous cases play important roles in their recognition and management of clinical deterioration (Johansen and O'Brien, 2016; Tanner, 2006; Thompson et al., 2009). According to van Galen et al. (2016), while unplanned ICU admissions are primarily related to staff failures regarding monitoring and intervention, lack of time to notice and report changes also plays a notable role (Thompson et al., 2009; van Galen et al., 2016). In addition to mismatches between needs and resources, root causes may include organizational deficiencies and expertise deficits not only among healthcare professionals, but also among their supervisors and collegial consultants. In addition, heavy workload and fatigue reduce awareness of clinical deterioration (Makris et al., 2010; Massey et al., 2008; Sturm et al., 2019). Amongst care delivery problems, the We-ReAlyse tool captures other contributing factors described in the literature, as the transfer from the ICU to the general unit. Further, discharging patients from the ICU often requires complex decision-making to balance patient needs with the receiving units' available resources. Coupled with complex transfer processes, premature transfers greatly increase the risk of ICU readmission (de Grood et al., 2018; Elliott, 2006; Rosenberg and Watts, 2000).

Faulty processes and possible causes

Several studies already emphasize transfers as high-risk events, involving numerous opportunities for omitted or faulty processes (Hägström et al., 2009; Niven et al., 2014). If even one occurs, it can influence the treatment on the general unit, which can ultimately lead to ICU readmission. Therefore, we chose to study factors arising during the transfer period that increase the risk of error and patient deterioration. Both our clinical experts and the literature identified factors such as poor clinical handoff (e.g., incomplete information sharing) between healthcare professionals as major contributors (Baker et al., 2009; Haggström et al., 2009; Niven et al., 2014). Furthermore, the transfer process's main purpose is to ensure that patients receive the care they need to avoid ICU readmission (Azevedo et al., 2022), readmission may indicate a failure of that process.

Because it is not enough to know individual factors or parameters, the We-ReAlyse tool does not exclusively reflect EHR information but is enriched by the perspectives and information of the people involved from the general unit as well as from the ICU. Since the groundbreaking *To Err Is Human* report (Institute of Medicine Committee on Quality of Health Care, 2000), there has been a greater emphasis on detecting and assessing adverse events as functions—and indicators—of system performance. This promotes comprehensive adverse incident management. In addition, many hospitals conduct morbidity and mortality conferences (MMC) (Giesbrecht and Au, 2016). Initially arising from surgical and anesthesiology literature, MMCs are used as a platform for presenting incidents to health care providers (Orlander et al., 2002). Therefore, we have designed every aspect of the We-ReAlyse tool as a basis for systematic and holistic discussion to clarify the objectives of interprofessional and interdepartmental discussions of ICU readmissions as adverse events.

The tool development and testing phases indicated that the lack of compatibility/interoperability between the general and the ICU department's EHR systems increases the risk of adverse events. When a transfer occurs, patient data (e.g., shift events and medications applied) are loaded from the originating unit's EHR system to the receiving unit via portable document format (PDF). However, PDFs are associated with various negative effects on transfer processes: for example, as searches of this format are non-transparent and time-consuming, staff members may avoid them or discount their results when making decisions. Furthermore, during testing, we noticed a tendency for necessary information to be either incompletely documented or missing. Within the current study this issue was apparent in both nurse- and physician-generated records. Both the experience and qualifications of the attending nurse and physician influence the content and the quality of the information. Within the tool, in addition to the EHR data, the professional staff's narrative notes were very helpful in addressing missing data. As this was particularly true for staff omissions or failures in the care process, these notes were key to identifying the factors behind ICU readmissions.

Such input is vital to understanding and responding to adverse events (Vincent, 2003). As a potential source for adverse events as well as a risk for information loss, each piece of missing EHR information is another barrier to continuity of care (Brown et al., 2018). In our case, the general unit and the ICU used not only different documentation—an immediate source of interoperability issues—but also different assessments and documentation guidelines. This made information exchange and extraction difficult, time-consuming and error-prone. For example, the two departments assessed different aspects of cognitive disruption: the ICU focused on delirium, assessed via the Richmond Agitation-Sedation Scale (RASS) (Sessler et al., 2002); the general unit focused on confusion, evaluating patients with the NEECHAM Confusion scale (Champagne et al., 1987). The result was two sets of information that did not correlate.

Strengths and limitations

The expert panel participants were a diverse group regarding professional backgrounds and experience. Their interactions and discussions created broad support for the development of the tool. We consider it very likely that the We-ReAlyse tool will allow us to capture all possible relevant factors for the specific clinical area. Furthermore, both the testing and the interdisciplinary and cross-departmental case discussions regarding ICU readmissions helped us to achieve the necessary focus to support the reflection. In addition, the tool allows a comprehensive and systematic analysis, that may lead to increased quality of care and help healthcare professionals to identify possible sources for adverse events, e.g., care delivery problems, clinical contexts, and other ICU readmission-contributing factors. Finally, although medical records are commonly used as a source of research data, the documentation within them tends to be subjective, vague, and otherwise deficient (Brown et al., 2018; Brown et al., 2014). Their value regarding insights providing quality of care delivered is also limited. Therefore, readmission data extracted from medical records alone should not be considered in isolation, as they may reflect the quality of documentation rather than that of care (Bogardus et al., 2001; DeVon et al., 2004).

The study also has certain limitations that deserve discussion. First, the tool was only tested on 10 ICU readmissions. Due to the Covid-19 pandemic, it could not be tested under routine conditions: certain relevant information about the ICU perspective could not be collected. Furthermore, it must be mentioned that the pandemic made “usual” care impossible for several months. E.g., variations in the number of ICU beds (depending on the number of Covid-19 patients and available nursing staff) and the cancellation of elective surgeries likely reduced the number of planned ICU admissions from the general unit.

Considering that organizational and process structures of hospitals vary greatly between hospitals, the tool's generalizability will be

limited, i.e., it will require tailoring to contextual needs (e.g., staff involved in the transfer process, use of medical emergency teams). In addition, the We-ReAlyse tool is very comprehensive. Further testing is needed to optimize. Furthermore, as our primary objective was to design a tool suitable for everyday clinical use, we largely omitted institutional contextual variables (e.g., bed pressure, bed occupancy). These are also associated with ICU readmissions and might have been exacerbated during testing due to the Covid-19 pandemic (Tam et al., 2014; Timmers et al., 2012).

Conclusion

The tool combined a systematic reflection, data collection and analysis to identify circumstances of ICU readmissions. Therefore, possible interventions can be derived to reduce or prevent readmissions to the ICU. Our RCA has shown that ICU readmissions are highly complex, with multifactorial geneses; and as their influencing factors can include unpredictable clinical deterioration, some are unavoidable. The objective of our tool's guided reflection and analysis is to determine which ones are preventable via targeted interventions. Further, analyzing the clinical context, care problems and other readmission factors will aid ICU discharge planning, minimize premature transfers and help determine adequate care levels for patients on other units (Al-Jaghbeer et al., 2016; Nates et al., 2016; Taylor-Adams and Vincent, 2004; van Galen et al., 2016).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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