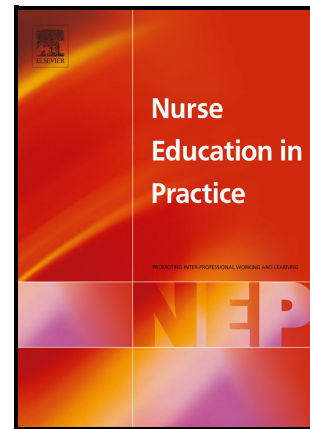


ROOT CAUSE ANALYSIS FOR  
UNDERSTANDING PATIENT SAFETY  
INCIDENTS IN NURSING STUDENT  
PLACEMENTS: A QUALITATIVE CONTENT  
ANALYSIS

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PII: S1471-5953(22)00176-7

DOI: <https://doi.org/10.1016/j.nepr.2022.103462>

Reference: YNEPR103462

To appear in: *Nurse Education in Practice*

Received date: 20 January 2022

Revised date: 27 September 2022

Accepted date: 28 September 2022

Please cite this article as: Carmen Ropero-Padilla, Víctor M González-Chordá, Desirée Mena-Tudela, Pablo Roman, Águeda Cervera-Gasch and Miguel Rodríguez-Arrastia, ROOT CAUSE ANALYSIS FOR UNDERSTANDING PATIENT SAFETY INCIDENTS IN NURSING STUDENT PLACEMENTS: A QUALITATIVE CONTENT ANALYSIS, *Nurse Education in Practice*, (2022) doi:<https://doi.org/10.1016/j.nepr.2022.103462>

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ROOT CAUSE ANALYSIS FOR UNDERSTANDING PATIENT SAFETY  
INCIDENTS IN NURSING STUDENT PLACEMENTS: A QUALITATIVE  
CONTENT ANALYSIS

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**Funding sources:** This study was funded by the project grant 19CO1/000156 from  
Ministerio de Educación y Formación Profesional.

## **Abstract**

*Aim:* to explore nursing students' experiences with the use of RCA technique in patient safety-related incidents during clinical placements. A secondary descriptive qualitative content analysis

*Background:* Patient safety education for nursing students is an international priority. While early detection and intervention strategies, such as the root cause analysis technique, have been found to be effective for near misses and errors, little is known about how these strategies facilitate nursing students understand how patient safety incidents happen.

*Design:* A secondary qualitative content analysis was conducted as part of a larger patient safety research project.

*Methods:* Data were collected from nursing students at [Hidden for blinding purposes]. This study included 108 third-year undergraduate nursing students enrolled in the Care Management in the Socio-Health Care Settings for the academic years 2017-2018 and 2018-2019. During hospital clinical placements, nursing students were asked to do a coursework describing a patient safety incident and using the root cause analysis technique for its analysis. A content analysis was used to provide an in-depth analysis of the collected data.

*Results:* Two main themes were identified after the data analysis process: (i) patient safety incident as learning events: highlights how these incidents were turned into learning opportunities and how the root cause analysis guided them in identifying and addressing critical incidents to prevent similar situations in the future; and (ii) strategies for improving patient safety culture: depicts how nursing students realised that following protocols and evidence-based practice reduces incidents related to patient safety and the value of reporting errors in avoiding and minimising the recurrence of similar mistakes.

*Conclusions:* The root cause analysis technique is a versatile and flexible learning resource for nursing students that can help them understand complex patient safety

incidents while also fostering critical and problem-solving thinking, teamwork and systematic communication.

*Keywords:* nursing; nursing education; patient safety; qualitative research; root cause analyses

## **Introduction**

Patient safety is defined as the reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum, where an acceptable minimum refers to the collective notions of given current knowledge, resources available and the context where care was delivered weighed against the risk of non-treatment or other treatment (WHO, 2009). Some authors, however, argue that this taxonomy would be underdeveloped since patient safety could be conceptualised broadly or narrowly, also with different approaches relying on the discipline (Edozien, 2013). In this manner, Kim et al. (2015) define patient safety from a nursing perspective as actions taken to prevent and eliminate damages that may affect patients and their families while health care professionals provide health care.

It is generally agreed that patient safety concerns began with the publishing of the report “To Err is Human” (Institute of Medicine, 2000), which estimated that medical errors caused up to 98,000 deaths in the United States of America each year. This report contends that the problem is not bad people in health care, but rather that good people are working on unsafe systems that must be improved. Four years later, the World Health Organization (WHO) established the World Alliance for Patient Safety and began to propose strategies to improve aspects such as nosocomial infections and surgical safety, as well as conduct related research and promote citizen participation.

The WHO recently published its action plan for patient safety 2021-2030, with the slogan “Towards the elimination of avoidable harm in health care” (WHO, 2021). This action plan presents human factors and ergonomics (HFE) capacity development as key to the creation of high-reliability, resilient healthcare systems and organisations. Along the same lines, it also includes the need to improve education, knowledge and skills on patient safety of health professionals as a strategic approach (WHO, 2021). Patient safety remains thus one of the most critical dimensions of healthcare quality as well as an international challenge for both health organisations and higher education institutions (Kirwan et al., 2019).

Human error in healthcare is defined as the failure to accomplish a planned action as intended or the use of an erroneous strategy to reach the objective (Kohn, 2000). In this context, an adverse event occurs when an error causes harm to a patient, whereas near misses eventuate when the harm to the patient does not occur (WHO, 2009). The traditional approach to dealing with adverse events is based on the study of individual failures caused by lack of knowledge or skills (Mira et al., 2015). Nevertheless, adverse events are usually a consequence of a sequence of errors and a complex array of system factors (in example work processes, organisational culture, team relationships, communication systems, risk management systems or technology, among others). Current patient safety strategies are based on the importance of HFE as a “bridging discipline” that establishes common ground between behavioural and physical elements involved in the relationship between humans and their working environments, with the aim of optimising system performance and people’s well-being (Waterson & Catchpole, 2016).

Adverse drug reactions, thromboembolism, vascular and urinary catheter infections, nosocomial pneumonia, decubitus ulcers and falls are the most common adverse events

in clinical practice (Jha et al., 2013). While all clinical staff, including trainees, are prone to making mistakes and causing an adverse event, there have been specific studies on the main errors and adverse events where nursing students are involved. Echeverría-Bickel et al. (2020), for example, implemented an adverse event reporting system for nursing students at the Los Andes University (Chile) in 2012. They conducted a descriptive analysis of adverse events reported up to 2018 and observed that the most common types of errors and adverse events were associated with medication administration. Similarly, García-Gómez et al. (2020) studied 1,638 errors and adverse events reported by nursing students at the University of Malaga between 2011 and 2018. Errors in medication administration, as reported by Echeverría-Bickel et al. (2020), were among the most commonly reported, along with errors in follow-up or monitoring, invasive intervention events, undetected allergies and biological accidents (sharp or needle-stick injuries) (García-Gómez et al., 2020).

When adverse events or near misses occur, it is important to analyse the sequence of human errors and identify the most influential causes, or root causes, so that interventions or improvements in work systems could be implemented to reduce the risk of similar human errors and new adverse events. The root cause analysis (RCA) is an incident analysis approach consisting of a set of reactive patient safety techniques (such as Ishikawa diagram or Five Whys, among others) that posits that problems are best managed by attempting to rectify or remove root causes rather than simply addressing immediate outcomes (Peerally et al, 2017). The available evidence, however, is conflicting in terms of the effectiveness of the RCA to improve patient safety (Kellogg et al, 2017; Martin-Delgado et al., 2020; Shah et al., 2022). This might be due to the questionable quality of many RCAs, their susceptibility to political hijacking, their proclivity for producing poor risk controls, poorly functioning feedback loops, failure to

aggregate learning across incidents and confusion about blame and responsibility (Peerally et al, 2017). Conversely, the RCA remains popular among health professionals and some quality agencies consider it as the reference standard for investigating adverse events (Ocelly, 2010; The Joint Commission, 2022).

On the other hand, improving patient safety education for healthcare students, including nursing students, is a worldwide priority (WHO, 2011). In fact, there are numerous competency frameworks (Cronenwett et al., 2007; European Union Network for Patient Safety, 2010; Walton et al., 2006). In this vein, the WHO (2011) proposed the Multi-professional Patient Safety Curriculum, which includes 11 topics to guide patient safety education and cover topics such as general patient safety concepts, leadership and risk management, as well as specific topics such as infection prevention, invasive procedures and medication administration. There are also patient safety competency frameworks for nursing, such as the Quality and Safety Education for Nurses (QSEN) initiative, which was developed in the United States and establishes six competencies that should be included in nursing curricula (Cronenwett et al., 2007). Besides this, it is worth mentioning the Patient Safety Competency Framework for Nursing Students, which was developed in Australia and includes nine core competencies (person-centred care, therapeutic communication, cultural competence, teamwork and collaborative practice, clinical reasoning, evidence-based practice, preventing, minimising and responding to adverse events, infection prevention and control and medication safety) (Levett-Jones et al., 2017).

Having said that, there are effective educational interventions in the literature to improve nursing student's knowledge, skills and attitudes towards patient safety (Breitkreuz et al., 2016; Cantero-López et al., 2021; Kim et al., 2019), as well as qualitative studies on the moral courage of students when confronted with errors and



advertises events alongside their mentors (Brown et al., 2020). The Multi-professional Patient Safety Curriculum Guide (WHO, 2011) includes recommendations on how to plan programs, design courses or teach patient safety concepts and recommends moving forward with the implementation of HFE in undergraduate healthcare education to improve patient safety education (Sheehan et al., 2022). While it is true that some studies used techniques such as RCA with nursing students to patient safety training (Cantero-López et al., 2021; Dolansky et al., 2013) or to foster critical thinking by analysing real-life scenarios (Carter et al., 2014), little is known about the nursing students' experiences with the use of RCA during clinical placements from a qualitative perspective, which could facilitate the development of more specific strategies and interventions closer to the student body that improve the preparation of future nurses on patient safety. Thus, the main objective of this study was to explore nursing students' experiences with the use of RCA technique in patient safety-related incidents during clinical placements.

## **Materials & Methods**

### *Design*

A secondary descriptive qualitative content analysis on patient safety-related incidents was conducted as part of a larger patient safety research project, the intervention and results of which are available in Cantero-López and collaborators (2021). This design involves reusing qualitative data derived from a previous study to bring new substantive and methodological insights and maximise learning from existing data (Heaton, 2008). Secondary qualitative analysis can be methodologically challenging (Davidson et al., 2019); however, concerns that secondary analysts may be blind to contextual factors and concerns of the primary researchers and participants can be ameliorated by close

liaison with the primary research (Coltart et al., 2013). All primary researchers of the original study (Cantero-López et al., 2021) were co-investigators in this study.

### *Setting*

This study was conducted with third-year nursing students enrolled in the Care Management in the Socio-Health Care Settings at [Hidden for blinding purposes]. This subject includes both theory and practice classes, as well as hospital clinical placements, with topics such as patient safety culture, preventing medical errors and adverse events and supporting quality improvement initiatives. The patient safety-related content is taught during the theory classes and students must consider a real case (the case of the Denver nurses) (Smetzer, 1998) using the RCA technique in one practice session (see Suppl. Table S1). During hospital clinical placements in adult inpatient units, nursing students must create a portfolio and include a coursework describing a patient safety incident (what, when, who and why about an adverse event or near misses) as well as using the RCA technique for its analysis. The RCA generally consists of seven critical steps: describe the problem, collect evidence, determine the cause, identify root causes, anticipate new evidence-based solutions, implement solutions and assess the impact, taking into account that a particular situation may have multiple root causes (Santen et al., 2019). The RCA includes different techniques, and the Ishikawa diagram was used in this case (Cantero-López et al., 2021). This analysis frequently yields valuable insights, including increased awareness of faulty processes and leads to critical opportunities for improving patient safety (Boussat et al., 2017; Rosier et al., 2020).

### *Participants*

A convenience sampling approach was used, and the selection criteria included those students who: (i) fully completed their clinical placement work, (ii) attended at least 80% of their clinical placements and (iii) voluntarily agreed to participate. All students

were allocated based on the university criteria and the development of this study did not affect the clinical placements of the students.

#### *Data collection*

Data collection took place between 2017 and 2018. Participants were asked to complete a clinical placement coursework about patient safety, which had to be submitted into the virtual classroom and managed by one of the main researchers. These documents did not include any personal details of students. They were asked to add a one-page summary of one observed occurrence in this activity, detailing what happened, when it happened, who was involved and why they considered it a critical learning incident. The aim of this assignment was for students to gain better understanding of the multiple causes of incidents related to patient safety using the RCA technique (Heher, 2017). Each clinical placement coursework was labelled with a “ST” (student) and the number of participants, rather than their demographic data to ensure anonymity. Data collection was continuously analysed through an iterative process.

#### *Data analysis*

The data were assessed for their suitability for inclusion in this study, that is, whether they provided evidence to address the new research question, which was congruent with the aim of the primary study (Heaton, 2008). The primary dataset was led by the second, third and fifth authors to reduce the risk of misrepresentation when reanalysis is removed from the context of the original research (Thorne, 1998). The original datasets, research processes and contexts, as well as the reports of findings made in relation to those data, were also familiar to the first, fourth and final authors of the current study. The ATLAS.ti 9.0 software was used to conduct an inductive content analysis on the written descriptions in terms of giving an in-depth analysis. The purpose of this software is to store and manage the data collected for research to keep the information

organised and to facilitate authors' process of systematisation qualitative data, identifying codes and quotations. The data analysis includes the following stages (Graneheim & Lundman, 2004; Krippendorff, 2019): (i) review and familiarise with the data; (ii) find relevant statements; (iii) establish the significance of the statements in relation to the context; (iv) group and arrange the identified significance into theme clusters. This stage identifies the most common patterns or trends; (v) a comprehensive and in-depth analysis of participants' thoughts and feelings on each theme and individual participant; and (vi) enable the researcher to construct a fundamental framework or theory (Figure 1). Two authors [*Hidden for blinding purposes*] individually analysed written descriptions before meeting together to compare, correlate and discuss the emerging themes to attain conformability. In the event of a discrepancy, a third researcher [*Hidden for blinding purposes*] was consulted to ensure that the collected data were reliable and consistent.

#### *Ethical considerations*

This study was approved and authorised by [*Hidden for blinding purposes*] (Reference no. 19CO1/000156). Before conducting the study, participants provided informed consent and the data collection design ensured confidentiality and anonymity. Participants were also informed that their experiences, opinions and perspectives would have no bearing on their academic grades. Basic demographic data were collected without the risk of identifying participants and were only used to describe the study population. All nursing students were encouraged to report adverse events observed following the adverse events reporting system guidelines in their placements.

#### *Rigour*

Following Lincoln and Guba's (2006) criteria, trustworthiness of this study was enhanced by attending transferability, conformability, dependability and credibility. A

full description of the methodology and data collection process is provided, as well as direct quotes when presenting the findings, to ensure dependability and credibility. Our emphasis on describing the context, sample and issues that nursing students experienced contributed in the transferability of our findings to similar contexts. The co-authors discussed preliminary ideas about themes and sub-themes and the iterative analytic process contributed to the conformability and dependability of our findings.

## **Findings**

### *Participant characteristics*

One hundred and eight third-year nursing students completed their clinical placement coursework, with a participation rate of 98%. The mean age of the sample was  $22.54 \pm 5.92$  years, with women accounting for 78.8% (n=79).

### *Types of clinical incidents*

Clinical practice for students took place mainly in operating theatre, dialysis units, hospitalisations wards and oncology units, but also in units such as radiotherapy, radiology, preventive medicine, emergencies and delivery rooms. In this matter, some of the factors that contributed to the occurrence of these patient safety-related incidents, mentioned by students, were insufficient professional knowledge or training, lack of human or material resources, inappropriate management, failure to follow evidence based-practice recommendations, lack of information, mistakes in the patient's medical record or inadequate communication, among others (Table 1).

Conversely, the qualitative analysis revealed two major themes that are summarised in Table 2. Students perceived the incidents as learning and reflection opportunities, despite the fact that they were initially detrimental to patient safety. Furthermore, critical thinking allowed the students to identify several ways to prevent these situations

or errors through the RCA, which supported the students in recognising difficulties and improving patient safety. Students also highlighted some strategies to mend these patient safety-related incidents using evidence-based practice, as well as recording and reporting such incidents.

*Theme 1. Patient safety incident as learning events*

This first theme highlights how these incidents that could have had or did have a negative impact on patient safety were turned into learning opportunities for nursing students. In this sense, this theme also includes how the RCA guided them in identifying and addressing critical incidents to prevent similar situations in the future.

*Sub-theme 1.1. Moral courage in patient safety incidents*

Most nursing students stated that making mistakes or observing misconducts from other nurses helped them to think critically about the incident itself and be aware of which actions or attitudes they should avoid, as well as pay attention to avoid making the same mistakes in the future:

*“I am aware that a sterile technique is required when inserting a central venous catheter. During my dialysis placement, however, I observed nurses failing to maintain the necessary sterility in the patients’ central venous catheter manipulations and disconnections. Some of the reasons given by nurses included a lack of time and staff, as this procedure requires two people to be carried out properly and sterilely. Even so, I decided to do my best to carry out this procedure correctly while maintaining sterility”*

(ST025)

*“During my placements, I witnessed that some nurses did not conduct vesical catheterisations with a sterile technique. They did not wash their*

*hands properly as a pertinent aseptic measure and when I asked them why they did not do this procedure sterilely, they referred the materials needed and the time spent. Then I told them that if I had to do a vesical catheterisation, I would use a sterile technique” (ST017)*

Although they could see critical incidents as a learning opportunity, they pointed out that they did not have the moral courage as nursing students to inform or tell their mentors that they were making errors in their practice:

*“Although I was aware of my error because we did not provide care in accordance with hospital policy at the time of the incident, I did not argue with the nurse about the need to change our behaviour to reduce the risk to the patients. I assumed the procedure to avoid conflicts with resignation, despite the fact that we were aware that we were causing potential harm to the patients with this poor practice, in addition to not being what policies recommend, but my situation as a nursing student kept me out of the debate” (ST061)*

#### *Sub-theme 1.2. Root cause analysis for identifying and preventing errors*

In this vein, nursing students suggested that after critically thinking about the different situations that happened, the RCA made it easier for them to identify the main barriers related to human and organisational errors (Figure 2). Likewise, the analysis and reflections of these nursing students facilitate them in improving patient safety in future interventions:

*“Because of the potential consequences for the patient of administering a higher-than-necessary dose of heparin, I believe that this critical incident deserves an RCA to explore the human errors and system failures that*

*occurred and, as a result, to be able to provide alternatives that help in the prevention and improvement of patient safety in drug administration”*

(ST099)

*“I was shocked when I saw the labelling and discovered that it did not correspond to the heparin dosage that should be administered, but what struck me the most was the nurses’ indifference. I was concerned about the potential risk to patient safety, so I reasoned that using methods to ensure the safety of the renal patient’s treatment, such as carrying out a checklist, might be a wise practice”* (ST099)

*“Carrying out the RCA process after administering expired medication to a patient made me realise and identify which human and organisational errors occurred in this situation and how this encouraged me to research some measures to prevent it in the future. Also, I believe the RCA is an effective and easy-to-use method for any nurse or healthcare professional, not just students. I believe it will be useful to me when I work as a nurse”*

(ST005)

## *Theme 2. Strategies for improving patient safety culture*

This theme shows how nursing students realised that following protocols and evidence-based practice reduces incidents related to patient safety. In addition, reporting errors was identified as a critical step in avoiding and minimising the recurrence of similar mistakes.

### *Sub-theme 2.1. Good practice from evidence-based experiences*

Nursing students mentioned that, although using protocols, training courses and evidence-based practices prevent critical incidents and improve patient safety, nursing



professionals did not always provide care based on these criteria due to a variety of reasons such as lack of time, human and material resources, among others:

*“The central venous catheters were manipulated sterilely in the chronic patients’ room. However, in the dialysis acute department, the central venous catheters were manipulated without sterile technique, which is against policy. Nurses claimed that this was due to poor economic distribution and a lack of resources” (ST008)*

In this matter, students observed a lack in reporting patients updates and conducting an appropriate handover between healthcare professionals, compromising the patient safety. They believed that this behaviour was sometimes the result of overconfidence or routine habits:

*“During one session, the nurse noticed hardening in the patient's arteriovenous fistula around the puncture site and decided to puncture higher up. In the nursing records, however, she only wrote “difficult puncture”, without mentioning the presence of hardening or the change in the area. Moreover, during the handover, the nurse did not inform her colleague of what happened and she did not check the previous record for any change or incident, nor did she assess the arteriovenous fistula prior to the puncture, resulting in the patient experiencing unnecessary discomfort and pain” (ST056)*

#### *Sub-theme 2.2. Transparency after an error*

On the other hand, while students described reporting errors as an important aspect of avoiding and preventing future failures, they observed a lack of clinical competency

when reporting them, as well as a deficiency of person-centred care by nursing professionals:

*“I noticed that the syringe and vial numbers did not match, and I was surprised that the nurses did nothing about it, despite knowing that people had been vaccinated incorrectly. “It doesn’t matter”, I was told, because there were only five people and that it was not worth the effort to inform or notify them of the event” (ST023)*

*“A patient identification error occurred while I was doing my placements in the radiology service. A computed tomography scan was done on a patient who did not require one. When the nurse realised the error, he immediately informed the radiologist; however, the patient was not informed, and the error was not reported to the error notification system” (ST045)*

## **Discussion**

This study aimed to explore nursing students’ understanding of the multiple causes of patient safety-related incidents using an RCA technique. After analysing our results and similarly to previous studies (Carter et al., 2014; Holdsworth et al., 2015; Shah et al., 2022), the students identified the RCA as a versatile and flexible resource to examine clinical situation as a whole rather than the immediate task at hand. Although it has recently been reported that this strategy may be perceived as challenging at times, particularly in terms of time investment (Hibbert et al., 2018), our students emphasised the potential benefits of using this strategy to revamp quality improvement in their daily clinical practice not only during placements, but also after graduation. Overall, the RCA enabled most participants to learn from a myriad of patient safety incidents during placements, prompting problem-solving and critical thinking while practising, as well as

including teamwork, communication and decision making under challenging environments (Dolansky et al., 2013; Hibbert et al., 2020).

A significant number of identified patient safety incidents were consistent with earlier findings, such as medication errors, improper equipment handling and biological accidents (Echeverría-Bickel et al., 2020; García-Gómez et al., 2020). However, the students frequently diminished their role and moral courage and forced themselves to remain silent, even when they were certain that clinical practices were incorrect (Brown et al., 2020). As according to the findings of Bickhoff and collaborators (2017) as well as Ion and collaborators (2015), a lack of training for reporting concerns and moral courage to speak up when it was most needed were key factors influencing the decision to object to poor practice. One possible explanation for this would be the perception of a power disparity and hierarchical interaction between students and their mentors, where mentors are positioned above students and instil dread of consequences, such as bad clinical placement grades (Bhurtun et al., 2019; Porteous & Machin, 2018). Despite the fact that their placement experience is highly reliant on the relationship between students and mentors, there is still a need to treat students as equals and encourage positive mentor-student relationships to create secure environments, as they have been shown to be more likely to challenge poor practices and ensure high-quality mentoring standards (Newton et al., 2017; Visiers-Jiménez et al., 2022).

In this regard, while current evidence suggests that the most used RCA recommendations are weak and therefore less likely to reduce event recurrence (Kellogg et al., 2017; Kwok et al., 2020), this process enabled students to identify and prevent potential errors in patient care during clinical placements. Whereas RCA training and easy-to-use tools are required for current healthcare professionals, this process may serve as an important educational resource and learning opportunity for nursing students

by increasing self-confidence, knowledge and organisation-safety culture (Boussat et al., 2017; Martin-Delgado et al., 2020). Sensitive to the negative consequences of blaming healthcare professionals and the moral importance of holding individuals accountable, these findings appear to be consistent with previous research that found that a just culture may have a significant impact on both improving patient safety and supporting healthcare professionals in learning from their mistakes, while also acknowledging the role that individuals play in this process (Khatri et al., 2009; Parker & Davies, 2020).

Interestingly, several students claimed that these strategies were important for improving patient safety or, in other words, for promoting an organisational safety culture. These findings are consistent with previous research, which found that strategies developed as a result of an RCA improve patient safety culture and can be adapted to the peculiarities of different healthcare settings, though evidence of its effectiveness in preventing recurrence is still limited (Boussat et al., 2017; Martin-Delgado et al., 2020). In this manner, our results suggest that strategies for dealing with procedure- and communication-related errors were more prevalent among nursing students, including the importance of training, protocols, patient record management and open and systematic communication (Burgener, 2020; Steven et al., 2014). To build healthcare safety systems, openness in adverse event reporting and root cause analysis is essential; lessons will not be learned if root cause cannot be discussed openly without fear of retribution (Au, 2018). These strategies are relevant not only for a patient safety culture, but also for students' on-going moral distress since it is argued that healthcare providers can become a "second victim" after an adverse event (Rinaldi et al., 2016). Conversely, this is a multifaceted issue that entails both additional educational and organisational support to ensure adequate patient safety training in nursing curricula, the

dissemination of lessons learned and a proper vicarious learning experience to acquire appropriate clinical competencies when reporting errors from a person-centred and interprofessional approach (Currie et al., 2015; Tella et al., 2014). In summary, this study contributes to the existing literature on the use of an RCA process to understand patient safety-related incidents in clinical placements and incorporates new evidence about its importance in fostering moral courage and a patient safety culture among nursing students.

Nevertheless, there are several limitations in this study to consider. First, student clinical placement work may not fully capture patient safety incidents and the strategies pursued, including some inadequate descriptions in their self-reported written learning events. As a result, biases of perspective may have been introduced in some cases, which may have an impact on what needed to be included in clinical placement work. Rather than concluding the issue, this study provides an opportunity to address nursing students' perspectives in better detail in future academic years to gain a deeper understanding of how the RCA is incorporated in their clinical practice or to determine what hurdles are observed in implementing their strategies. Likewise, it will be worthwhile to explore the experiences and perceptions of mentors, senior charge nurses and other health service managers regarding barriers encountered when reporting errors and providing high-quality mentoring standards.

## **Conclusions**

This study has shown that the RCA technique constitutes a flexible and versatile learning resource for nursing students who faced several incidents related to patient safety. In general, this process helped students in understanding complex patient safety-related incidents while also fostering critical and problem-solving thinking, teamwork and systematic communication. Our findings highlight the importance of vicarious

learning as well as the relevance of a mutually respectful mentor-student relationship for providing a positive learning environment and promoting moral courage. The results of this study point to the importance of healthcare organisations and nursing education providing further support to both mentors and students through patient safety training, easy-to-use resources, improved communication systems and proper implementation of identified strategies. Having said that, using an RCA approach to strengthen nursing curricula is a useful process since it allows students to develop self-confidence and patient safety awareness. Therefore, not only would including the RCA process in nursing students' learning process from their degree enable them to incorporate it into their clinical placements, but it will also foster a stronger organisational safety culture when they graduate.

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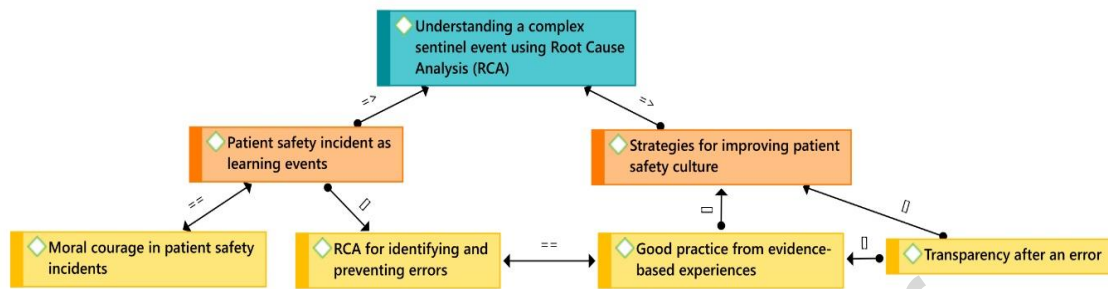
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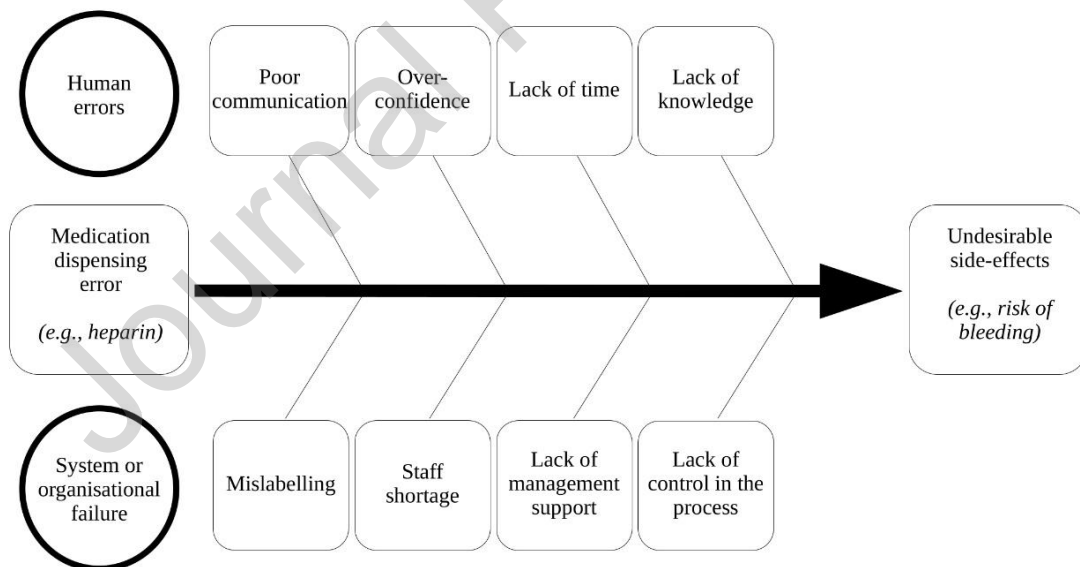
## FIGURES

Figure 1: Conceptual map based on experiences with the use of root cause analysis in patient safety incidents



[ ]: is part of; ==: is associated with; =>: is cause of

Figure 2: Example of a root cause analysis for a haemodialysis patient



TABLES

Table 1: Examples of workplaces, situations and main causes identified by third-year nursing students

		Event categories	Examples							
Operating theatre (n=28)	Dialysis (n=22)	Hospitalisation (n=20)	Oncology (n=19)	Radiology (n=7)	Preventive medicine (n=2)	Emergencies (n=1)	Delivery room (n=1)	Procedure and treatment (n=39)	Delay of care, lack of reporting and documenting an error, failure to follow protocol/policies instructions when doing a procedure or providing care, lack of assessing patient's status (dysphagia, pain, etc.)	Insufficient knowledge/training
								Medication administration (n=30)	Forgetting to administer medication, wrong dosage, wrong medication, out of date medication	Lack of human/material resources
								Infection control (n=26)	Poor practice in hand hygiene between patients, incorrect use or not use of sterile measures, incorrect use of patient isolation measures	Inappropriate management/coordination between professionals/services
								Communication (n=13)	Errors or misinformation or omissions in the patient's medical record, wrong medication administer for inadequate communication between professionals, treating a wrong patient for inappropriate name checking	Failure to follow evidence-based practice recommendations about hand hygiene, policies, medication administration, etc.
								Equipment hazard and environmental	Use of inadequate equipment for the patient's characteristics,	Lack of information or mistake in the patient's medical record



safety (n=5)	delegation of procedures to non-qualified personnel, unobserved medication in patient's table	Inadequate communication between professionals and professionals with patients
Fall (n=1)	Use of incorrect moving and handling techniques	

Table 2: Themes, sub-themes and representative quotes

Patient safety incident as learning events	Moral courage in patient safety incidents	<i>“Since I am a nursing student, I was at odds with myself because I didn't know what was best, whether to tell anything or not. There are nurses who you can't really comment on anything” (ST033)</i>
		<i>“When I saw the inappropriate application of the respiratory isolation policy, I felt powerless because I couldn't do anything as a nursing student. I identified a significant gap in the possibility of doing something to improve patient safety” (ST015)</i>
	Root cause analysis for identifying and preventing errors	<i>“The RCA enabled me in identifying human and organisational errors when central venous catheters were manipulated because incorrect use was usual, allowing me to suggest preventive measures” (ST027)</i>
		<i>“This process made me aware of the lack of communication between nurses and patients when the nurse distributed mouthwashes, as well as the importance of mouthwash in avoiding discomfort after using nebulisers or inhalers, for example”</i>

		(ST044)
Strategies for improving patient safety culture	Good practice from evidence-based experiences	<i>“I suggested the nurse to use a sterile technique when I went to do a vesical catheterisation. The nurse was pretty distraught, saying that he did it without sterility but that I could do it sterile if I wanted”</i> (ST006)
		<i>“Working in the same unit for many years, performing the same care and procedures, causes many nurses to automate their care and become unconcerned about reviewing and correcting their care. I believe they are sometimes overconfident, which may jeopardise patient safety”</i> (ST094)
	Transparency after an error	<i>“In my case, I saw how a patient identification error during a CT scan was not reported to either the patient or the hospital error reporting system. The radiologist saw no significance in it, but I believe it should have been reported because what would have happened if iodine contrast had been used unnecessarily?”</i> (ST100)
		<i>“The main issue was a failure in communication between the nurse and the physician, who did not confirm the dosage to be given. She made no attempt to notify anyone in charge or the hospital error reporting system, possibly due to a lack of knowledge or a fear of repercussions or sanctions”</i> (ST082)

**Conflicts of interest:** none

#### **Author statement**

All the authors approved the final version of the article. Below, I detail the contribution of the authors:

- Carmen Roperopadilla: acquisition, analysis and interpretation of data of data, drafting the article
- Víctor M González-Chorda: conception and design of the study, analysis and interpretation of data, drafting the article
- Desirée Mena-Tudela: drafting the article
- Pablo Román: revising the article critically for important intellectual content
- Águeda Cervera-Gasch: revising the article critically for important intellectual content
- Miguel Rodríguez-Arrastia: acquisition, analysis and interpretation of data of data, drafting the article

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