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Building Skills in Infection Prevention Through Simulation: Insights from Nursing Students in Brazil and Peru

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Abstract

Background/Objectives: Healthcare-associated infections (HAIs) require specific skills in nursing education, yet their curricular integration often remains fragmented, limiting the consolidation of knowledge and safe clinical practice. This study aimed to explore the perceptions of nursing students from Brazil and Peru regarding the use of clinical simulation as a strategy to develop skills in HAIs prevention and control. **Methods**: A qualitative approach was employed, involving 12 focus groups (n = 247 students) across four universities. The discussions were conducted following simulation activities based on standardized scenarios structured into four phases: pre-reading, briefing, execution, and debriefing. Data were collected using a semi-structured interview guide and analyzed thematically until thematic sufficiency was achieved. The study adhered to COREQ guidelines. **Results**: Three main themes emerged: i) clinical simulation as a student-centered teaching-learning strategy, where pre-reading and briefing materials enhanced students' confidence and clarity in performing tasks, with checklists suggested to avoid omissions; ii) simulation as a facilitator of autonomy and safety in HAI prevention, offering a protected environment for making mistakes and learning, with formative feedback during debriefing increasing risk awareness, although debriefing time was noted as an area for improvement; and iii) meaningful learning and integration with traditional education, as students reported increased engagement, better knowledge retention, and greater perceived transfer of skills to real clinical settings. **Conclusions**: Clinical simulation

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demonstrated strong potential to support the development of HAI prevention skills in undergraduate nursing students. Longitudinal implementation with standardized scenarios and further evaluation of educational effectiveness and debriefing strategies is recommended.

Keywords: nursing; education; nursing; simulation training; cross infection; learning

1. Introduction

Healthcare-associated infections (HAIs) remain a persistent challenge to patient safety and care quality, requiring nursing students to develop strong skills in infection prevention and control during their undergraduate education. Despite institutional efforts, the literature highlights the fragmentation and inconsistency of HAIs-related content within nursing curricula, along with only moderate levels of knowledge and adherence to essential practices such as hand hygiene, an area emphasized by the international patient safety agenda [1–4]. This educational gap hinders the acquisition and integration of the knowledge, skills, and attitudes necessary for safe clinical practice, reinforcing the need to improve and standardize undergraduate nursing curricula [5,6].

To meet the growing demands of healthcare systems, nursing education must support the development of skills that enable comprehensive, humanized, and solution-oriented care [7]. As frontline providers, nurses are in a strategic position to detect complications early and implement interventions that reduce adverse events [2]. Therefore, undergraduate programs should integrate theoretical and practical content with clear learning objectives that promote clinical decision-making from the start of professional training [8]. Among the pedagogical strategies that support these goals, clinical simulation stands out.

Clinical simulation is widely recognized as an active learning methodology that bridges theory and practice, enhances student engagement, and promotes meaningful learning. It allows students to develop clinical reasoning, technical skills, and self-efficacy in a controlled, risk-free environment, especially when supported by structured briefing and debriefing [9–11].

Organizations such as the World Health Organization (WHO) and initiatives like Quality and Safety Education for Nurses (QSEN) recommend integrating simulation into health education due to its demonstrated benefits for learning and transfer to clinical practice [3,9]. International studies, including those conducted in Asia and Latin America, report gains in knowledge and the development of infection prevention skills for both students and faculty, reinforcing the value of clinical simulation in teaching HAI-related topics [12]. However, most existing studies focus on measurable outcomes such as knowledge acquisition or technical performance, with limited exploration of how students perceive simulation-based learning in the context of HAI prevention. Comparative research that examines these perceptions across different national and institutional settings, particularly in Latin America, remains scarce. Gaining insight into students' experiences is essential to inform curriculum development, ensure cultural relevance, and support the broader integration of simulation-based strategies in nursing education.

In this context, the HAInnovPrev project, a collaborative initiative between institutions in Brazil, Peru, Spain, and Portugal, aims to strengthen HAI prevention training in Latin America. One of its key innovations is the incorporation of clinical simulation into undergraduate nursing education. This study aimed to explore the perceptions of nursing students in Brazil and Peru regarding simulation-based teaching as a strategy to develop skills in HAIs prevention and control, providing evidence to support curriculum development and the expanded use of active learning methodologies.

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2. Materials and Methods

2.1. Study Design and Theoretical Framework

This qualitative study used focus groups to explore nursing students' perceptions of clinical simulation scenarios as a strategy for developing skills in HAIs prevention. The descriptive-exploratory design is grounded in clinical simulation as an active teaching-learning methodology that integrates theory and practice.

2.2. Participants and Recruitment

Undergraduate nursing students enrolled at two universities in Brazil and two in Peru were eligible to participate. Students engaged in short-term international academic mobility and those not fluent in Portuguese or Spanish were excluded.

Purposeful sampling was used to select students with exposure to the relevant content. In total, 663 students were invited individually and/or via email; 455 participated in the simulation activities, but 208 declined to participate in the final stage of the study (focus groups), resulting in a final sample of 247 students. Recruitment was managed by professors from the research team who were not involved in students' academic evaluation during the study period to reduce potential bias.

2.3. Context, Scenario and Research Team

The study was conducted as part of the HAInnovPrev Erasmus+ project (Project number: 101083115 - ERASMUS-EDU-2022-CBHE, Capacity Building in Higher Education), involving four institutions: the Federal University of Viçosa (UFV) and the Federal University of Rio de Janeiro (UFRJ) in Brazil, and the Universidad Andina del Cusco (UAC) and Universidad Nacional Autónoma de Chota (UNACH) in Peru.

2.4. Data Collection

Data collection for the focus groups was conducted immediately after the simulation debriefings using a semi-structured interview guide with the following questions: i) How did participating in this clinical simulation scenario improve your knowledge about HAIs?; ii) How did the pre-reading materials provided before the simulation help guide your learning about HAIs?; iii) How did the debriefing enhance your skills or understanding of HAIs?; iv) In what ways did participating in this simulation add value to your HAI-related skills compared to traditional learning methods?

The simulation scenario scripts were developed by professors from each university within the HAInnovPrev consortium, based on a standardized template validated by the InovSafeCare project [12]. The template included: i) clinical and non-clinical learning objectives; ii) theoretical foundations with pre-reading materials; iii) scenario preparation including material, human resources, and environment; iv) scenario development detailing clinical cases, roles of actors and students, expected progression; and v) a performance checklist to enable interinstitutional replication; and questions for the debriefing [13]. These scripts were reviewed and refined in meetings by five professors from the Nursing School of the University of Coimbra in Portugal, to ensure consistency and credibility.

The simulation sessions followed a structured, sequential format. First, the pre-simulation phase involved distribution of theoretical materials 24 to 48 hours in advance. Next, the briefing phase provided orientation including learning objectives and scenario presentation within a psychologically safe environment, using low-fidelity mannequins or trained actors or teachers. This was followed by the execution phase, during which students engaged in the scenario, applying their knowledge and skills in a controlled setting. Finally, the debriefing phase consisted of facilitated critical reflection that highlighted successes and areas for improvement [14,15].

All sessions were audio-recorded and stored on a secure institutional server with restricted access. Recordings were transcribed and anonymized using alphanumeric codes. After quality checks, the audio files were deleted. Transcripts were stored in a password-protected folder. Member

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checking, or returning transcripts to participants for validation, was not conducted. However, any ambiguities were clarified during the debriefing sessions.

Data collection took place between April and October 2024 in simulation laboratories at the participating universities. Each institution developed three HAI-focused scenario roadmaps and implemented a common scenario created by one of the partners. A description of the scenarios is provided in Table 1.

Table 1. Simulated scenarios implemented by each university. April to October 2024.

University (Country)	Simulated scenarios
UFV (Brazil) [1]	1. Prevention of infection transmitted by aerosol and contact 2. Dressing change on a peripherally inserted central venous catheter (PICC) 3. Prevention and control of urinary tract infections associated with indwelling urinary catheters 4. Aspiration of secretions in a tracheostomized patient to prevent pneumonia
UFRJ (Brazil) [2]	1. Benzathine benzylpenicillin administration in primary health care 2. Hand hygiene and use of personal protective equipment 3. Prevention of respiratory tract infections related to care of patients with tracheostomy (peristomal skin cleaning and tracheostomy cannula dressing change) 4. Prevention of peripheral intravenous line infections
UAC (Peru) [3]	1. Hand hygiene and use of personal protective equipment 2. Permanent bladder catheterization 3. Nursing care for prevention and control of infection transmission in patients under contact isolation 4. Prevention of peripheral intravenous line infections.
UNACH (Peru) [4]	1. Aspiration of secretions in a tracheotomy patient to prevent pneumonia 2. Prevention of simple infections in post-operative wound healing 3. Preventive education for self-care in safe insulin administration and medical waste management at home 4. Medication practices in preparation and administration of intravenous drugs

[1] Federal University of Viçosa; [2] Federal University of Rio de Janeiro; [3] Universidad Andina del Cusco; [4] Universidad Nacional Autonoma de Chota.

2.5. Data Analysis

The testimonies were analyzed using thematic analysis [16], with data collection concluding upon reaching saturation, in accordance with the methodological framework employed in this study [16]. The stages of organization, coding, and categorization followed established procedures described in the literature. This transparent analytic trail ensured a clear link between the raw data and the resulting themes. Only one focus group session per simulated scenario was required, as thematic repetition and saturation were achieved [17].

2.6. Ethical Considerations

The study fully complied with ethical standards for research with human beings and received approval from the institutional ethics committees of the participating universities. Written informed consent was obtained from all participants prior to their involvement. To protect confidentiality, students were assigned alphanumeric codes beginning with “S” for Student (e.g., S1, S2, S3), followed

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by the initials of their respective universities. Participants were explicitly informed of their right to refuse participation or withdraw at any point without any academic consequences. The study report complies with the EQUATOR Network guidelines and follows the COREQ checklist for qualitative research [18].

3. Results

Twelve focus groups were conducted across the four participating institutions, with a total of 247 students. Thematic analysis of the focus group discussions identified three main categories: i) student-centered teaching-learning strategy; ii) clinical simulation as a facilitator of autonomy and safety in HAI prevention; and iii) meaningful learning and integration with the traditional educational model. Each category, along with its subcategories and supporting excerpts from participants' statements, is described below.

3.1. Category 1: Student-Centered Teaching-Learning Strategy

3.1.1. Theoretical Materials for Practical Learning

Students valued the theoretical materials provided prior to the practical sessions, recognizing their role in supporting learning. Peruvian students frequently emphasized the need for detailed checklists to ensure no critical steps were omitted, while Brazilian students highlighted how advance reading materials boosted their confidence and reduced anxiety before practice. The following participant statements illustrate this subcategory:

> *(...) It would be good to include the steps and all the preventive measures in the process of aspiration of secretions to avoid skipping any important steps and protect the patient's life.* (Student 2 - UNACH)
>
> *The theoretical class and the contents before providing more security for practice. I also believe that if I didn't have the class, (...) I would have many doubts and divergences of what we remember or not. (...)* (Student 15 - UFV)
>
> *Prior submission also calms the student and allows greater comfort, preparation and interaction with the activity to be carried out. This distribution of the material before the realization of the simulated scenario was great, because it brings prior knowledge of what was going to be done and step by step. (Student 02- UFRJ)*
>
> *Having advanced information allows us to get involved in the development of practice, motivating us to participate in what is planned without doubts or mistakes, (...).* (Student 15 – UAC)

3.1.2. Controlled and Safe Clinical Simulation Environment

Participants described the simulation as a safe and controlled environment where they could make mistakes and learn without risk. While Brazilian students stressed the value of practicing without fear of harming patients, Peruvian students noted that the structured environment helped them pay closer attention to procedural details. The following excerpts illustrate this subcategory:

> *(...) This is the space for us to really learn, not to make mistakes with the patient" (Student 18 - UFV).*
>
> *But what we learn here to execute there in the practice scenario is to promote health, prevent aggravation and minimize risks to the patient, thus, being in a controlled scenario. (Student 02 -* UFRJ)
>
> *(…). We can carry out the procedures without fear of failure and with the certainty that they will correct us proactively. (Student 04 - UAC)*

3.1.3. Debriefing: A Learning Moment

Debriefing was regarded as a crucial moment for consolidating learning. Students in Brazil often emphasized how this stage confirmed their correct practices and built confidence, whereas those in Peru highlighted its role in identifying overlooked steps and reinforcing safety checklists. The following statements illustrate this subcategory:

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The debriefing is one of the most important parts because it allowed the identification of points of improvement, it being a positive and targeted feedback on the activity performed. (Student 04 - *UFRJ).*

I think that very end (debriefing) was the main thing for us to realize that we did everything right. And I think it was a very cool instrument for us to understand. (Student 02 - UFRJ)

The debriefing was important to consolidate what we did and review what was done (...) (Student 07 - UFV)

*(...) I consider debriefing to be an important step in the learning process because it allowed us to reflect with tutors and colleagues on what we did well and the aspects that need to be improved. It's the first time I've had this experience, I hope all teachers do it. (*Student *03-UAC)*

3.2. Category 2: Clinical Simulation: Teaching Strategy to Improve Autonomy and Safety for HAI Prevention

Participants emphasized that simulation increased their awareness of risks and attention to detail in nursing care. In Brazil, students frequently reflected on how simulation enhanced their decision-making confidence and reduced fear of errors, while in Peru, students stressed how it revealed the importance of small procedural details and the potential consequences of omissions. The following testimonials illustrate this subcategory:

(...) Practical and everyday cases help us to *better understand the procedures* and to *be better prepared in the clinical field. (Student 35 – UNACH)*

I think we are also aware of how much a simple act, or even a sequence of acts, can impact a patient's life. (Student 05 - UFRJ)

I think that in practice, when we do it, we realize that these infections occur because of details. So, when we see someone doing it, or we do it ourselves, we pay attention and realize how important the details are for the safety of care. (...) (Student 01 - UFV)

*(...) Possible complications should be included, and the nursing professional should manage them during the procedure to be better prepared in a real scenario (*Student *23 - UNACH).*

(...) This controlled environment allowed me to focus on the process, on the application of theoretical knowledge and on learning from our actions; I made mistakes, yes, but the ability to correct and retrospectively analyze them, along with teacher feedback, generated a sense of growth and progress. The feedback, although it sometimes pointed out errors, was not perceived as a negative criticism, but rather as a guide for improvement. (Student 05-UAC)

3.3. Category 3: Meaningful Learning: Integration Between the Traditional Model and Clinical Simulation

Students across both countries agreed that simulation improved comprehension and knowledge retention compared to traditional teaching. Brazilian students frequently described the strategy as motivating and helpful in building self-confidence, while Peruvian students noted how simulation clarified essential steps and reinforced theoretical content through practical application:

*I think that in simulation it is easier to understand and store things than simply the theoretical content. With the simulation, we can know the points that are really essential and the risks, and when it comes to practice, we can remember all the steps taken." (*Student 04 - UFV)

(...) The simulation scenario was very clear, accurate and motivating, The theoretical material helps us a lot to understand and fix the content to use in practice. (Student 86 -UNACH)

This is an active strategy, it's not a passive thing that we just listen to, we just read, we do it (...). (Student 09 - UFRJ)

(…) I believe that clinical simulation has contributed significantly to the development of learning in students, allowing greater confidence in clinical procedures, as well as safety and improvement of their skills. (Student 23- UAC).

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Across both countries, these perspectives repeated consistently across focus groups, indicating thematic saturation.

4. Discussion

This study involved 12 focus groups (n = 265) across four institutions in Brazil and Peru, highlighting student protagonism as a fundamental aspect of learning through clinical simulation. Students actively engaged and valued the opportunity to prepare using pre-reading materials. This preparation enhanced their participation in simulated scenarios, increased their confidence and clarity regarding nursing care actions, and improved overall performance. Such anticipation fosters student protagonism and aligns with active learning principles, which emphasize meaningful learning resources and motivation to encourage active involvement, positioning the student at the center of the educational process [19].

Supporting this student-centered approach, the WHO underscores the importance of including simulation in health training curricula, recognizing it as essential for developing skills in HAIs prevention. This recognition further reinforces the value of simulation as a methodological cornerstone in healthcare education [3]. Our findings converge with these recommendations. By strengthening skills in HAIs prevention and patient safety, simulation directly supports the WHO's call for skill-based curricula and echoes QSEN's emphasis on safety as a core nursing outcome.

Moreover, evidence from a quasi-experimental study comparing traditional teaching with traditional teaching plus simulation indicates that although both groups showed cognitive improvement, those exposed to simulation achieved significantly greater knowledge gains (p = .016). This demonstrates the progressive and additive benefits of integrating clinical simulation into traditional curricula [20].

Taken together, these findings suggest that simulation serves as a vital tool to prepare nursing students for the realities of clinical practice. Its benefits extend beyond technical skills, encompassing human interactions with families and healthcare teams, while fostering critical thinking and communication skills essential for safe and effective care [5,8,19]. However, for simulation to be truly effective, careful attention must be given to its design and implementation. This includes deliberate consideration of the clinical scenario, scheduling, scripts, participant roles, materials, and structured pre-briefing and debriefing stages, all of which are crucial for maximizing learning outcomes [14,15,21].

The clinical simulation experience, as perceived by the students, was not only a tool for consolidating knowledge but also for applying it in a practical context. This teaching strategy relies on five key elements: clearly defined objectives, effective pre-briefing, scenario fidelity, problem-solving opportunities, and structured, supportive debriefing [14,21,22]. These components work together to create an engaging and meaningful learning environment.

An important finding was the students' positive reception of feedback during the debriefing phase. They viewed instructors' comments as constructive guidance rather than criticism, indicating a psychologically safe learning atmosphere. When well-executed, debriefing promotes critical reflection and strengthens clinical and communication skills. However, some participants expressed concerns about the length and density of the debriefing sessions. This suggests a need to optimize debriefing practices by setting clear objectives, prioritizing key discussion points, managing time effectively, and aligning feedback with critical checklists. Such refinements would preserve the depth of reflection while preventing fatigue and maintaining focus on educational goals [21,22].

Another noteworthy aspect highlighted by this study is the role of a controlled and safe simulation environment. This space allows students to make mistakes without risking patient harm and to receive formative feedback, which fosters autonomy and clinical reasoning. The fidelity of the simulation setting (i.e., how closely it replicates real clinical conditions) is crucial to this process. Scenarios must be carefully designed with realistic cases and aligned roles for actors and students. Preparation before simulation ensures smooth execution and meaningful interaction [14,21,23].

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Importantly, timely feedback after simulation sessions is essential for promoting critical thinking and maximizing the educational value of the experience.

Regarding the development of autonomy and safety awareness, students reported heightened attention to detail and risk recognition, both vital for preventing HAIs. The simulated environment functioned as a strategic platform for learning patient safety, where understanding potential complications reinforced best practices. This highlights the importance of creating realistic scenarios that meet clear learning objectives and prepare students for real-world challenges [14,21]. Interestingly, subtle differences emerged across countries. Peruvian students consistently emphasized the value of detailed checklists and the importance of procedural precision, reflecting a more structured orientation toward error prevention. In contrast, Brazilian students highlighted how advance preparation and debriefing built their confidence and reduced anxiety when applying infection prevention practices. These variations suggest that while simulation offers shared benefits, local educational culture and institutional practices may shape how students perceive its impact. We believe that recognizing such contextual nuances is important for tailoring simulation strategies in multinational curriculum development in this field.

Clinical simulation effectively raises students' awareness of risks and potential errors in patient care, encouraging safer clinical reasoning and decision-making. Its innovative and immersive nature appeals to current generations of learners by combining theory with practice, stimulating critical thinking, and enhancing readiness for real clinical settings [24,25]. Autonomy naturally develops as students are placed in scenarios requiring independent decision-making and reasoning, which are key skills for modern healthcare professionals [23].

The findings support the integration of clinical simulation into nursing curricula focused on HAI prevention. This includes the use of pre-reading materials, goal-oriented briefing, risk-focused scenario execution, and evidence-based, structured debriefing. Such a framework aligns with a growing trend in health education to incorporate simulation, which consistently demonstrates benefits in learners' confidence, autonomy, and satisfaction [19]. While active participation is central, observation also provides valuable learning opportunities, especially when supported by guided observation tools [26]. This highlights that even students not directly performing procedures can gain meaningful learning, provided observation is structured with clear checklists or reflective prompts.

Patient safety emerged as a central theme throughout the participants' reflections. Simulation nurtures not only technical and cognitive skills but also the attitudes and ethical values necessary for safe, high-quality practice [24]. Evidence supports that simulation-based teaching effectively internalizes safe behaviors (e.g., hand hygiene, proper use of personal protective equipment), and enhances risk recognition, situational awareness, and patient safety competence [5,24].

By providing a protected environment to experiment and reflect on mistakes, simulation fosters a culture of safety. This role has been emphasized by international bodies like the WHO, which advocate for simulation's inclusion in health professional education to promote patient safety [27,28].

Despite these benefits, traditional lecture-based teaching remains predominant in many nursing programs. Simulation offers a meaningful alternative by actively engaging students in deliberate practice, reflection, and self-evaluation, processes which are often missing from expository methods. Innovative approaches such as "Room of Horrors" scenarios can further enhance learning by encouraging error recognition and confidence building in patient safety [24]. Additionally, emerging technologies like virtual reality simulations provide authentic, engaging experiences that integrate theory and practice while promoting critical thinking [25]. The cross-country perspectives in this study reinforce the need for culturally responsive simulation design. While common benefits were evident, tailoring simulation to local expectations, whether emphasizing confidence-building or procedural detail, may optimize its effectiveness in different institutional and cultural settings.

This study has some limitations to consider. Partial participation in focus groups (i.e., 247 out of 455 simulation participants) may have affected the breadth of perceptions captured. The diversity of institutions across different sociocultural contexts could also influence experiences, which may limit the transferability of findings to other Peruvian, Brazilian, or comparable Latin American settings.

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The qualitative nature relies on participant spontaneity and researcher facilitation, which can introduce bias. Additionally, as with all focus groups, the possibility of dominant voices influencing group discussions must be acknowledged, which may have shaped the depth or direction of some exchanges. Moreover, not all students took part in every simulated scenario, partly due to time constraints, as noted by the participants. Lastly, the feedback about lengthy debriefing sessions suggests the need to optimize this stage for better engagement and depth of reflection. Thus, we believe that future research could adopt quasi-experimental or mixed method designs to quantify simulation's effects on knowledge, performance, and behavioral outcomes in participants and observers. Testing different debriefing formats and timing may also help maximize learning benefits and reflective depth.

5. Conclusions

This multicenter study demonstrated that clinical simulation is a promising strategy for developing skills in the prevention and control of HAIs. The approach fosters psychological safety, provides clear step-by-step guidance supported by pre-reading and briefing, and encourages reflective learning through feedback-driven debriefing. Integrating standardized simulations and structured debriefing across nursing curricula can foster safer clinical practice. Future studies should test longitudinal implementation and measure behavioral outcomes in real educational settings.

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Abbreviations

The following abbreviations are used in this manuscript:

CBHE	Capacity Building in the field of Higher Education
COREQ	Consolidated criteria for Reporting Qualitative research
EACEA	European Union or the European Education and Culture Executive Agency
Erasmus+	European Union cooperation programme for education
HAInnovPrev	Name of the Erasmus+ project cited in the study
HAIs	Healthcare-associated Infections
WHO	World Health Organization
PICC	Peripherally Inserted Central Catheter
QSEN	Quality and Safety Education for Nurses
UAC	Universidad Andina del Cusco (Peru)
UFRJ	Federal University of Rio de Janeiro (Brazil)
UFV	Federal University of Viçosa (Brazil)
UNACH	Universidad Nacional Autónoma de Chota (Peru)

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