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Diagnostic assessment of procedural skills in first-year residents: identification of critical gaps through clinical simulation.

Evaluación diagnóstica de habilidades procedimentales en residentes de primer año: identificación de brechas críticas mediante simulación clínica.

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Summary.

Introduction: Entry into a medical specialty program implies that residents are proficient in basic diagnostic and therapeutic procedures, as expected in the national graduation profile for general practitioners. However, previous studies indicate a self-perception of low practical preparedness, attributed to limited exposure during undergraduate studies. This study evaluated procedural skills in first-year residents using clinical simulation to identify training gaps from the beginning of their postgraduate training. **Methods:** Eighty-three residents from two cohorts (2024 and 2025), representing eleven specialties, were evaluated. Practical tests were administered in four procedures: aseptic technique (n=83), interrupted suture (n=48), lumbar puncture (n=35), and orotracheal intubation (n=34). The evaluations were conducted in a simulated environment using checklists based on international standards and criteria defined by clinical and teaching experts. Individual performance was classified for diagnostic purposes as competent (≥70%), insufficient, or maximum score. **Results:** Competence was 88.0% in aseptic technique, 95.8% in suturing, 73.5% in orotracheal intubation, and 65.7% in lumbar puncture. Marked differences were observed between techniques, with greater difficulty in complex or infrequent procedures. Lumbar puncture showed the highest percentage of insufficient performance. **Conclusion:** Clinical simulation allowed for the objective evaluation of residents' initial procedural skills, revealing discrepancies between perceived preparedness and actual performance. This strategy provides objective data for designing targeted interventions, identifying lumbar puncture as a critical priority (34.3% with insufficient performance). This approach potentially contributes to strengthening clinical safety and optimizes the allocation of training resources from the time residents enter the specialty.

Keywords: Clinical simulation, postgraduate medical education, procedural skills, diagnostic assessment, medical residents, patient safety.

Abstract.

Introducción: El ingreso a un programa de especialidad médica supone que los residentes manejan procedimientos diagnósticos y terapéuticos básicos, tal como se espera en el perfil de egreso nacional para médicos generales. Sin embargo, estudios previos señalan una autopercepción de baja preparación práctica, atribuida a una limitada exposición durante el pregrado. Este estudio evaluó habilidades procedimentales en residentes de primer año mediante simulación clínica, con el fin de identificar brechas formativas desde el inicio del posgrado. **Métodos**: Se evaluaron 83 residentes correspondientes a dos cohortes (2024 y 2025), pertenecientes a once especialidades. Se aplicaron pruebas prácticas en cuatro procedimientos: técnica aséptica (n=83), sutura interrumpida (n=48), punción lumbar (n=35) e intubación orotraqueal (n=34). Las evaluaciones se realizaron en un entorno simulado mediante listas de cotejo basadas en estándares internacionales y criterios definidos por expertos clínicos y docentes. El desempeño individual se clasificó con fines diagnósticos como competente (≥70 %), insuficiente o puntaje máximo. **Resultados**: La competencia fue de 88,0% en técnica aséptica, 95,8% en sutura, 73,5% en intubación orotraqueal, y 65,7% en punción lumbar. Se observaron diferencias marcadas entre técnicas, destacando mayor dificultad en procedimientos complejos o poco frecuentes. La punción lumbar presentó el mayor porcentaje de desempeño insuficiente. C**onclusión**: La simulación clínica permitió evaluar objetivamente las habilidades procedimentales iniciales de los residentes, revelando discrepancias entre la percepción de preparación y el desempeño real. Esta estrategia aporta datos objetivos para diseñar intervenciones dirigidas, identificando la punción lumbar como prioridad crítica (34,3% con desempeño insuficiente). El enfoque contribuye potencialmente a fortalecer la seguridad clínica y optimiza la asignación de recursos formativos desde el ingreso a la especialidad.

Palabras clave: Simulación clínica, educación médica de posgrado, habilidades procedimentales, evaluación diagnóstica, residentes de medicina, seguridad del paciente.

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1. Introduction

Training in clinical procedures is an essential component of safe and high-quality medical practice. In Chile, the National Single Examination of Medical Knowledge (EUNACOM) establishes a set of minimum competencies that all graduates must master, including a series of basic diagnostic and therapeutic procedures. However, international studies have shown that first-year residents exhibit deficient procedural skills upon entering specialty programs. Chipman et al. reported that first-year postgraduate residents (PGY1) in surgery achieved only 49% performance in basic skills assessed through simulation (1), while Stepaniak et al. documented significant deficits in fundamental patient safety techniques in 114 newly admitted residents, with compliance rates of only 66% in hand hygiene and 52% in correct patient identification (2). This situation has been perceived by both students and clinical faculty, who recognize a significant gap between theory and practice during the internship years.

The transition from undergraduate studies to residency represents a critical moment where the most significant training gaps become evident. Upon beginning residency, physicians are expected to be able to perform fundamental techniques safely, which poses significant challenges if training gaps exist from their undergraduate studies. Martin et al. demonstrated that objective assessment using OSATS (Objective Structured Assessment of Technical Skills) allows for the reliable and valid identification of procedural competencies (3), establishing the methodological basis for the evaluation of surgical skills. However, recent studies indicate that "currently there is no standardized competency-based assessment for use during residency training" (4), which makes it difficult to have clarity regarding the actual level of technical preparedness of graduates upon entering specialty programs.

In this context, clinical simulation emerges as an effective tool for evaluating procedural skills in safe, controlled, and reproducible environments (5, 6). International evidence demonstrates that simulation not only allows for the objective assessment of competencies in controlled scenarios but can also significantly improve the performance of novice residents (7). Barsuk et al. reported that first-year residents trained with simulation outperformed senior residents without specific training (95.7% vs. 65.4% in lumbar puncture skills) (8), suggesting that early diagnostic assessment followed by targeted training is more effective than traditional clinical experience. Implementing a diagnostic assessment upon admission allows for the establishment of an objective baseline, the identification of specific gaps by cohort or specialty, and the design of targeted training strategies that are relevant and aligned with the actual needs of the training programs (9).

This study aimed to implement a diagnostic assessment of procedural skills in first-year residents from various medical specialties, corresponding to the 2024 and 2025 cohorts, using clinical simulation as the primary assessment strategy. The findings will inform initial training interventions and strengthen technical preparedness during a critical stage of the transition to specialized clinical practice, potentially contributing to improved patient safety from the very beginning of postgraduate training.

2. Methods

2.1 Study design

A descriptive, cross-sectional observational study was conducted to evaluate basic procedural skills in first-year residents (PGY1) at the beginning of their postgraduate training. The design followed diagnostic assessment principles in medical education, using clinical simulation as an objective competency measurement tool (10).

2.2 Population and sample

Eighty-three residents from the 2024 and 2025 cohorts participated in the study, representing eleven medical specialty programs at a Chilean university. Inclusion was based on convenience sampling, considering only those programs whose program directors consented to participate in the diagnostic experience. Inclusion criteria were: being a first-year resident, being enrolled in a participating specialty program, and signing informed consent. Residents with prior formal experience in clinical simulation or those who did not complete the evaluation were excluded. The sample included residents from various specialties, although not all performed the same techniques, as each program director selected the procedures to be evaluated according to their specific relevance and pertinence to their area of training.

2.3 Procedures evaluated and variables

Four procedures were evaluated based on their applicability and alignment with the general practitioner profile defined in the EUNACOM exam: aseptic technique, interrupted simple suture, lumbar puncture, and orotracheal intubation. These procedures were chosen considering their frequency in clinical practice, their importance for patient safety, and their inclusion in the basic competencies expected upon graduation from medical school, according to the profile defined by the Association of Faculties of Medicine of Chile (ASOFAMECH) (11). Performance was assessed using checklists specific to each technique, measuring the execution of key steps previously defined by expert consensus. Results were classified into three categories for diagnostic purposes according to the percentage of compliance with the checklist: maximum score (≥90%), passing (70-89%), and insufficient performance (<70%), establishing a cutoff point of 70% in accordance with international standards of minimum competence (12).

2.4 Assessment instruments

The checklists used were developed by the teaching team at the Center for Simulation-Based Education (CEBS), based on current clinical protocols and international standards of practice. The instruments incorporate fundamental criteria from the internationally validated OSATS (Objective Structured Assessment of Technical Skills) scales (3), adapted to the local context through consensus among clinical and teaching experts using a modified Delphi methodology. Each checklist includes 15–25 critical items, organized sequentially according to the technique being assessed, with objective and observable criteria. The instruments have been systematically applied in undergraduate assessments for five years, demonstrating internal consistency and inter-rater reliability in previous internal analyses at the center, although it is acknowledged that they require formal external psychometric validation.

2.5 Evaluators and procedure

The evaluation was conducted during the first week of residency program orientation (the institutional induction period prior to clinical contact) at CEBS facilities under standardized conditions. The evaluators were CEBS-certified instructors and senior residents with teaching experience, who participated in a two-hour prebriefing session to standardize observation criteria and the application of checklists (13). Each evaluator supervised only one type of procedure throughout the session, ensuring consistency in the application of criteria within each technique. Evaluations were performed individually, with a time limit per procedure (15–20 minutes), at rotating stations that simulated real clinical conditions. High-fidelity mannequins, sterile surgical materials, and standard medical equipment were used to maximize the validity of the evaluation in the simulated context.

2.6 Data Analysis

Data were recorded in real time using electronic forms and subsequently transferred to Microsoft Excel® spreadsheets for analysis. Descriptive statistics were performed, calculating absolute frequencies and percentages by technique, cohort, and specialty. Categorical variables were presented as proportions expressed as percentages. The analysis was supplemented with descriptive statistics by specialty when the sample size allowed.

2.7 Ethical considerations

The study was approved by the Ethics Committee of the Faculty of Medicine at Clínica Alemana - Universidad del Desarrollo. All participants signed an informed consent form prior to the evaluation, which explained the diagnostic purpose of the study, data confidentiality, and the right to withdraw at any time without academic consequences. Anonymity was guaranteed through data coding, and it was ensured that individual results would be used exclusively for educational and research purposes, without impacting the residents' formal academic evaluation.

3. Results

A total of 83 first-year residents, from the 2024 and 2025 cohorts, participated in the diagnostic assessment of procedural skills. The distribution by procedure assessed varied according to specialty, as each program director defined which techniques were relevant for their residents. All participants were assessed in aseptic technique, while the remaining procedures had partial participation (Table 1).

Regarding performance, most residents achieved competence in the most basic procedures, such as aseptic technique and interrupted simple suturing. However, more complex or less frequent procedures in undergraduate studies, such as lumbar puncture and orotracheal intubation, showed higher rates of insufficient performance and a lower proportion of residents with peak performance (Table 2).

Table 1. Distribution of participating residents by procedure evaluated.

Procedure	Residents evaluated	% of total (n=83)
Aseptic technique	83	100%
Simple interrupted suture	48	57.8%
Orotracheal intubation	34	41.0%
Lumbar puncture	35	42.2%

*Source: CEBS Records, induction 2024–2025.

Table 2. Performance results by procedure.

Procedure	Maximum score	Competent (≥70%)	Insufficient (<70%)	% Total competition
Aseptic technique	24.1% (20/83)	63.9% (53/83)	12.0% (10/83)	**88.0%**
interrupted simple suture	31.3% (15/48)	64.6% (31/48)	4.2% (2/48)	**95.8%**
Orotracheal intubation	0% (0/34)	73.5% (25/34)	26.5% (9/34)	**73.5%**
Lumbar puncture	11.4% (4/35)	54.3% (19/35)	34.3% (12/35)	**65.7%**

* Diagnostic classification based on the percentage of compliance with the checklist by resident.

Aseptic technique demonstrated 88.0% overall competence (24.1% maximum score plus 63.9% competent), while simple suturing reached 95.8% competence (31.3% maximum score and 64.6% competent). Conversely, orotracheal intubation showed lower performance, with 73.5% overall competence and 26.5% insufficient performance; notably, no resident achieved the maximum score for this procedure. Lumbar puncture was the most challenging procedure, with only 11.4% of residents achieving the maximum score and more than a third (34.3%) demonstrating insufficient performance, resulting in the lowest overall competence rate (65.7%).

These results allow us to visualize relevant differences between the techniques evaluated and suggest specific gaps in the prior training of residents, which justifies the need for targeted training interventions.

4. Discussion

The results of this diagnostic assessment confirm the existence of significant gaps in procedural skills upon entry into postgraduate medical training programs. While most residents demonstrated acceptable performance in basic techniques such as aseptic technique (88.0% proficiency) and simple suturing (95.8% proficiency), more complex procedures—such as lumbar puncture (65.7% proficiency) and orotracheal intubation (73.5% proficiency)—showed significantly higher rates of insufficient performance, highlighting critical gaps that require immediate intervention. This finding is consistent with international evidence documenting procedural deficiencies in first-year residents (1,2). Our results, particularly the 34.3% with insufficient performance in lumbar puncture and the complete absence of peak performance in orotracheal intubation, reinforce these observations and underscore the critical need for an objective assessment upon entry to identify these gaps before residents encounter real patients.

Prioritization of training interventions

The data obtained allow for the establishment of a clear hierarchy for planning educational interventions based on risk and urgency. Lumbar puncture emerges as the most critical priority, not only due to its high rate of insufficient performance (34.3%), but also because of the safety implications associated with its inadequate execution, including the risk of neurological injury, infections, and hemorrhagic complications (14). Orotracheal intubation, with 26.5% insufficient performance and no

peak performance, represents the second priority, considering that it is a life-threatening emergency procedure where technical competence can determine critical patient outcomes (15). In contrast, procedures with competence rates above 90% (aseptic technique and simple suturing) require reinforcement and refinement interventions rather than basic training, thus optimizing the allocation of educational resources. Structured bootcamp programs have been shown to significantly improve the confidence and competence of first-year residents through intensive simulation (16), validating this approach for targeted interventions. This stratification of priorities makes it easier for program directors to make informed decisions about where to focus initial training efforts, potentially contributing to improved patient safety.

Implications for patient safety and training

Early identification of these procedural gaps through simulation has potential implications for patient safety. Evidence shows that simulation-trained residents outperform senior residents without specific training in procedures such as lumbar puncture (8), suggesting that early diagnostic assessment followed by targeted training is more effective than unstructured clinical experience. Our findings, where only 65.7% of residents demonstrated competence in lumbar puncture, reinforce the need to implement structured simulation programs prior to clinical contact. The diagnostic strategy implemented offers additional advantages by enabling the identification of residents with multiple procedural deficiencies, who require more intensive remedial programs. This individualized approach improves training equity and reduces variability in initial preparation, critical aspects for maintaining uniform quality standards across residency programs.

Methodological strengths and limitations

One of the main strengths of this initiative is its ability to generate objective and usable information for immediate pedagogical decision-making. The use of checklists based on OSATS criteria (3), applied by trained evaluators, ensured consistency and objectivity in the measurement. Implementation during the first week of residency allows for early interventions before inadequate technical habits become entrenched, maximizing the formative potential of the corrections. However, this study has limitations that should be considered. The selection of procedures and participants was based on convenience, limiting the generalizability of the results to other contexts. The checklists, although based on international standards, require external formal psychometric validation to strengthen their scientific robustness. The cross-sectional design does not allow for the evaluation of competency progression or the impact of subsequent interventions. Furthermore, the evaluation was limited to technical aspects in a simulated environment, without measuring actual clinical performance or including components of clinical reasoning or decision-making regarding the indication of procedures. The results reflect simulated competencies that, while predictive, do not equate to a direct impact on clinical safety.

Future perspectives and replicability

The findings of this study lay the groundwork for developing a standardized diagnostic assessment model that could be implemented in other medical training programs. The strategy proved feasible, acceptable to residents and programs, and generated valuable information for educational planning. Future studies should include longitudinal follow-up to evaluate the impact of interventions designed based on these diagnoses, as well as cost-effectiveness analyses of different targeted training modalities.

The implementation of this diagnostic assessment could be expanded to include other critical procedures and develop specific competency profiles by specialty, thus contributing to the standardization of technical preparation in the transition from undergraduate to postgraduate studies and potentially contributing to strengthening healthcare safety from the very beginning of specialized professional practice.

5. Conclusions

- There are significant gaps in procedural skills at the start of residency, especially in complex procedures such as lumbar puncture and orotracheal intubation, while basic techniques show high levels of competence.
- Diagnostic assessment through clinical simulation is an effective, objective, and safe strategy for systematically identifying the initial technical skills of residents in a controlled environment.
- The results allow for prioritizing training needs, focusing educational resources on procedures with the highest risk to patient safety and the greatest performance deficits.
- Early implementation of this assessment promotes educational equity by detecting and correcting differences in initial preparation before contact with real patients, strengthening resident confidence and clinical safety.
- Diagnostic assessment in simulation is a valuable, replicable and adaptable tool that facilitates individualized training plans and establishes an objective baseline for monitoring the development of skills during residency.
- The diagnostic assessment of procedural skills through simulation represents an essential component for evidence-based educational planning, optimizing the transition from undergraduate to postgraduate studies and potentially contributing to strengthening patient safety from the beginning of specialized professional practice.

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