REVISTA CIE

Revista de Investigación Educativa | Vol. 2, No. 1
ISSN: 3061-8657 | Enero-Junio 2026

ORIGINAL ARTICLE

# Self-perceived knowledge and skills in mechanical ventilation among undergraduate medical interns: a cross-sectional study

## Autopercepción del conocimiento y las habilidades en ventilación mecánica en médicos internos de pregrado: estudio transversal

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**Abstract**

Mechanical ventilation is an essential life-support tool whose proper application requires theoretical knowledge and practical skills that should be developed during undergraduate medical training; however, education in this area remains limited in many academic settings. The aim of this study was to assess the self-perceived level of knowledge, practical skills, prior experience, and satisfaction with mechanical ventilation training among undergraduate medical interns. A descriptive cross-sectional study was conducted involving 114 medical interns from a medical school in Mexico, using a 34-item questionnaire previously validated through the Delphi technique. The instrument evaluated four domains: theoretical knowledge, practical skills, prior clinical experience, and satisfaction with the training received. Results showed that only 39.38% of participants reported adequate theoretical knowledge, while 66.96% indicated insufficient practical skills to manage mechanical ventilators. Additionally, only 26.32% reported prior clinical experience with mechanical ventilation, and 86% expressed dissatisfaction with their current level of knowledge. These findings highlight the need to strengthen theoretical and practical mechanical ventilation training during undergraduate medical education.

**Keywords:** mechanical ventilation; medical education; undergraduate medical interns; self-perceived competencies; clinical simulation

**Resumen**

La ventilación mecánica es una herramienta esencial de soporte vital cuya correcta aplicación requiere conocimientos teóricos y habilidades prácticas que deberían adquirirse durante la formación médica de pregrado; sin embargo, la enseñanza en esta área presenta limitaciones en diversos contextos académicos. El objetivo de este estudio fue evaluar la autopercepción del nivel de conocimientos, habilidades prácticas, experiencia previa y satisfacción con la enseñanza de la ventilación mecánica en médicos internos de pregrado. Se realizó un estudio transversal descriptivo en 114 médicos internos de una facultad de medicina en México, mediante un cuestionario de 34 ítems previamente validado por técnica Delphi, que exploró cuatro dimensiones: conocimiento teórico, habilidad práctica, experiencia clínica previa y satisfacción con la enseñanza recibida. Los resultados mostraron que solo el 39.38% de los participantes reportó contar con conocimientos teóricos adecuados y el 66.96% refirió carecer de habilidades prácticas suficientes para el manejo del ventilador mecánico. Asimismo, únicamente el 26.32% señaló haber tenido experiencia clínica previa y el 86% manifestó insatisfacción con sus conocimientos actuales. Estos hallazgos evidencian la necesidad de fortalecer la formación teórica-práctica en ventilación mecánica durante el pregrado médico.

**Palabras clave:** ventilación mecánica; educación médica; médicos internos de pregrado; autopercepción de competencias; simulación clínica

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**Fecha de recepción:** 17/junio/2025 | **Fecha de aceptación:** 05/enero/2026 | **Fecha de publicación:** 30/abril/2026

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## INTRODUCTION

Mechanical ventilation represents one of the most complex and, at the same time, most decisive therapeutic interventions in the management of critically ill patients, as it involves a dynamic interaction between the ventilator, respiratory physiology, and the patient's individual clinical response. From a theoretical standpoint, this intervention cannot be reduced to the mere application of technical parameters; rather, it requires an advanced cognitive process that integrates pathophysiological knowledge, procedural skills, interpretation of graphical signals, and clinical decision-making in frequently uncertain scenarios. Recent literature consistently reports that appropriate mechanical ventilation management is directly associated with relevant clinical outcomes, including mortality, duration of ventilation, ventilator-associated complications, and patient safety (Walter, 2021; Coldewey et al., 2021).

Within this context, contemporary patient safety models have emphasized that a considerable proportion of adverse events related to mechanical ventilation do not stem exclusively from technological failures, but from human errors attributable to gaps in training, experience, and clinical competence. Systematic studies have identified configuration errors, inadequate alarm interpretation, and limited understanding of patient–ventilator interaction as frequent causes of preventable events that negatively affect clinical outcomes (Coldewey et al., 2021). These observations reinforce the need to conceptualize mechanical ventilation not merely as a technical act, but as a complex clinical competency whose development requires deliberate and structured educational strategies.

Traditionally, the acquisition of competencies in mechanical ventilation has been considered part of training in specialties related to critical care medicine. However, this approach is insufficient when considering that, in real-world practice, initiation of ventilatory support frequently occurs in emergency departments, general hospital wards, or settings with limited specialist availability. Multicenter studies have documented that general practitioners, undergraduate medical interns, and residents often face the need to initiate or manage mechanical ventilation without having achieved an adequate level of formal preparation, thereby increasing the risk of clinical insecurity and management errors (Hayashi et al., 2022; Wiedermann & Lederer, 2023).

From an educational theory perspective, training in mechanical ventilation faces a structural challenge: the discrepancy between declarative knowledge acquired in academic settings and the ability to execute safe clinical decisions in real scenarios. This phenomenon has been widely described in medical education literature as the gap between "knowing" and "doing," particularly relevant in competencies involving high cognitive and technical complexity. Recent studies have shown that even when students and residents achieve acceptable performance on theoretical assessments, they encounter significant

difficulties when confronted with simulated or clinical scenarios requiring the simultaneous integration of multiple ventilatory variables (Hayashi et al., 2022; Schroedl & Vitale, 2022).

In this framework, the construct of self-perceived competence acquires theoretical and methodological relevance. Self-perception is defined as the subjective assessment individuals make regarding their level of knowledge, skills, and confidence to perform a specific clinical task. Although this construct does not necessarily equate to actual performance, its analysis is fundamental from an educational standpoint, as it influences decision-making, clinical behavior, and willingness to seek supervision or support. Recent studies have shown that low self-perceived competence is associated with increased clinical insecurity, whereas inflated self-perception not supported by actual competence may increase the risk of errors by generating a false sense of mastery (Takeda et al., 2023).

Available evidence suggests that, in the field of mechanical ventilation, medical students and trainees often report low levels of confidence and perceived competence, particularly in critical domains such as selection of ventilatory modes, adjustment of lung-protective parameters, and identification of patient–ventilator asynchronies. Studies conducted in diverse educational contexts have documented that these deficiencies persist even at the end of undergraduate training and during the early years of postgraduate education, reflecting structural limitations in traditional teaching models (Takeda et al., 2023; Wiedermann & Lederer, 2023).

In response to these limitations, contemporary educational theory has promoted the use of simulation-based approaches grounded in experiential and deliberate learning models. Simulation enables the recreation of complex clinical scenarios in controlled environments, facilitating cognitive integration, immediate feedback, and progressive competency development. Recent literature shows that mechanical ventilation training programs based on in-person or virtual simulation achieve significant short-term improvements in knowledge, confidence, and performance, particularly when aligned with competency-based objectives and structured assessments (Mireles-Cabodevila & Chatburn, 2023; Macedo et al., 2025).

Nevertheless, a critical analysis of this evidence reveals that most studies have focused on resident or postgraduate trainee populations, while the undergraduate level remains insufficiently explored. Moreover, although increases in knowledge and self-confidence following specific educational interventions have been documented, questions persist regarding the baseline level of preparation with which undergraduate medical interns enter real clinical settings. This gap is particularly relevant in middle-income countries, where opportunities for structured mechanical ventilation training are limited and heterogeneous.

From an integrative theoretical perspective, analyzing self-perceived knowledge and skills in mechanical ventilation allows the linkage of three fundamental dimensions of the educational process: theoretical knowledge, practical skills, and subjective perception of competence. The interaction among these dimensions is critical, as it influences future clinical behavior, self-regulated learning, and patient safety. The absence of systematic studies evaluating these dimensions jointly in undergraduate medical interns constitutes a relevant knowledge gap that scientifically justifies the present study.

Accordingly, contemporary theoretical frameworks suggest that mechanical ventilation represents a high-complexity clinical competency whose learning cannot rely solely on theoretical exposure or incidental clinical experience. The combination of training gaps, limited self-perceived competence, and the absence of homogeneous undergraduate curricular standards underscores the need for studies that rigorously characterize the level of preparation of medical interns. Generating such evidence is essential to guide the design of competency-based educational strategies aligned with patient safety principles and the real demands of contemporary clinical practice.

## METHODS, TECHNIQUES AND INSTRUMENTS

This study was conducted using an observational, cross-sectional, and descriptive design, with the aim of evaluating self-perceived levels of knowledge and skills in mechanical ventilation among undergraduate medical interns. This methodological approach was considered appropriate for exploring, at a specific point in time, the subjective perception of competencies acquired during medical training, without seeking to establish causal relationships or intervention effects.

The target population consisted of undergraduate medical interns affiliated with the Faculty of Medicine of Tampico "Dr. Alberto Romo Caballero" at the Autonomous University of Tamaulipas, Mexico. A non-probabilistic convenience sampling method was used, including those interns who voluntarily agreed to participate during the data collection period. This type of sampling is commonly employed in exploratory studies of perception and medical education, particularly when evaluating defined and accessible academic populations.

Data were collected using a self-administered questionnaire implemented through the Google Forms platform. The instrument was based on a questionnaire previously developed and validated by Tallo et al. (2017) using the Delphi technique, which was translated and adapted into Spanish following methodological guidelines for assessing self-perceived competencies in educational contexts. The questionnaire comprised 34 items distributed across four conceptual dimensions: theoretical knowledge of mechanical ventilation, practical skills in ventilator management, prior experience with mechanical ventilators, and satisfaction with the

training received during undergraduate medical education.

The instrument began with an informed consent section, followed by basic sociodemographic variables, including age, sex, and academic status, with response options corresponding to undergraduate medical intern (UMI) and social service medical trainee (SSMT). Subsequently, items were primarily formulated in a dichotomous format ("yes/no" or "true/false"), with the exception of one polytomous item designed to assess decision-making in a clinical scenario related to mechanical ventilation. This structure enabled direct capture of participants' self-perceptions regarding specific competencies.

To strengthen content validity within the local context, the questionnaire underwent review by intensive care specialists. Additionally, a pilot test was conducted in a sample of 12 social service medical trainees, allowing assessment of clarity, comprehension, and functionality of the instrument. As no relevant inconsistencies or difficulties were identified during this phase, no further modifications were required prior to application to the final sample. Data collection was carried out by distributing the questionnaire via social media platforms, using an electronic link and a QR code specifically targeted to the undergraduate medical interns included in the study. Participation was voluntary and anonymous, and confidentiality of the information provided was guaranteed. The data collection period lasted two weeks, at the end of which responses from 114 undergraduate medical interns were obtained.

Data analysis was performed using Microsoft Excel and SPSS statistical software version 26. A descriptive analysis of the sample's sociodemographic variables was conducted, as well as performance across each of the four domains evaluated by the questionnaire. Results were reported using frequencies, percentages, and 95% confidence intervals, with the aim of providing a precise estimate of response variability and facilitating analytical interpretation within the study context.

From an ethical standpoint, the study was reviewed and approved by the Research Ethics Committee of the Faculty of Medicine of Tampico "Dr. Alberto Romo Caballero" at the Autonomous University of Tamaulipas. All participants provided electronic informed consent prior to completing the questionnaire, in accordance with ethical principles for research involving human subjects and current regulatory provisions regarding confidentiality and voluntariness.

## RESULTS AND DISCUSSION

A total of 114 undergraduate medical interns participated in the study. Of the analyzed population, 57.9% were female and 42.1% male, with a mean age of 24 years. These data reflect the typical composition of the medical intern cohort within the institutional context evaluated.

Regarding theoretical knowledge, the results revealed relevant deficiencies in fundamental concepts of mechanical ventilation. The majority of participants (81.6% ± 7.2%) reported lacking knowledge of

technical regulations associated with the use of medicinal gases, although 56.1% (± 9.1%) stated that they could identify the main graphical resources provided by mechanical ventilators. Nevertheless, essential respiratory mechanics concepts were largely unknown: 60.5% (± 9.0%) did not identify the concept of respiratory system resistance, 58.8% (± 9.1%) were unfamiliar with compliance, and 61.4% (± 9.0%) did not recognize the concept of time constant. Furthermore, more than half of the interns were unfamiliar with basic principles of mechanical ventilation in patients with chronic obstructive pulmonary disease, and this proportion increased significantly in the case of acute respiratory distress syndrome, where 71.9% (± 8.3%) reported lack of knowledge. Similarly, 70.2% (± 8.4%) were unfamiliar with the principles of positive end-expiratory pressure, and fewer than half of the participants reported knowing the principles of ventilator weaning.

With respect to practical skills, the results showed a limited perception of competence in performing basic tasks related to ventilator management. More than half of the interns (57.9% ± 9.2%) indicated that they would have difficulty turning on a mechanical ventilator, while 70.2% (± 8.4%) expressed concern for patient safety if advanced airway management were required under their care. Ventilator configuration in pressure-controlled and volume-controlled modes was perceived as unsafe by 77.2% (± 7.7%) and 76.3% (± 7.8%) of participants, respectively. Additionally, 74.6% (± 8.1%) reported being unable to establish adequate sedation in mechanically ventilated patients, and 70.2% (± 8.4%) had not used specific pain assessment scales in this context. Indicators related to advanced monitoring showed the greatest limitations: fewer than 25% of participants considered themselves capable of calculating static or dynamic compliance of the respiratory system, measuring plateau pressure, or identifying auto-PEEP, reflecting limited familiarity with critical ventilatory safety parameters.

Analysis of prior clinical experience revealed very limited exposure to mechanically ventilated patients. Fewer than half of participants reported having observed mechanical ventilator use in real clinical contexts, and a large majority stated that they were unable to interpret basic clinical scenarios related to respiratory failure. This lack of practical exposure appears to be directly reflected in perceived insecurity and in the limitations observed across knowledge and skill domains.

Regarding teaching received during medical training, most interns considered the information provided in their academic program to be insufficient. Although a relevant proportion acknowledged the presence of qualified instructors, dissatisfaction with the level of knowledge acquired and the perceived urgent need for educational reinforcement predominated.
Consistently, the vast majority agreed that learning mechanical ventilation should not be omitted during undergraduate training, even when other professionals may assume this role in the clinical environment (Figure 1).

When responses were grouped according to the four evaluated pillars—knowledge, practical skills, prior experience, and satisfaction with training—a global profile characterized by a low level of perceived preparation emerged (Figure 2).

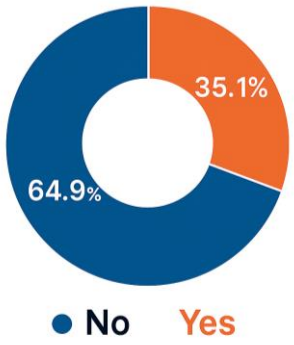


**Figure 1.** *Self-perceived adequacy of mechanical ventilation training*

Less than half of participants reported adequate theoretical knowledge, approximately two-thirds acknowledged insufficient practical skills, prior clinical experience was the most deficient component, and although satisfaction with training showed relatively higher values, it remained below desirable levels for a critical clinical competency such as mechanical ventilation.

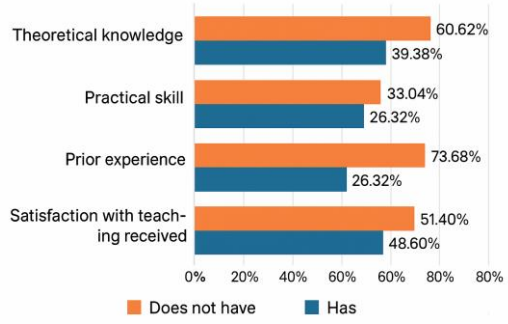


**Figure 2.** *Distribution of the level of self-perceived preparedness in mechanical*

The findings of this study demonstrate substantial deficiencies in self-perceived theoretical knowledge, practical skills, and clinical experience in mechanical ventilation among undergraduate medical interns, consistent with recent international literature on medical education and critical care training (Hayashi et al., 2022; Wiedermann & Lederer, 2023). The high proportion of participants reporting lack of knowledge of fundamental respiratory mechanics concepts aligns with studies showing low baseline competence in mechanical ventilation even among advanced trainees when education relies predominantly on theoretical content without structured practical integration (Hayashi et al., 2022; Schroedl & Vitale, 2022).

The lack of understanding of ventilatory principles applied to specific clinical conditions, particularly acute respiratory distress syndrome, is especially relevant, given that these conditions constitute frequent indications for mechanical ventilation in hospital settings. Previous studies have indicated that limited understanding of these principles is associated with difficulty selecting lung-protective ventilatory strategies and increased clinical insecurity during decision-making (Takeda et al., 2023; Walter, 2021). In this sense, the results reinforce the notion that fragmented theoretical knowledge does not automatically translate into functional clinical competence.

Regarding practical skills, the study demonstrates a marked gap between declared knowledge and perceived ability to perform essential operational

tasks, such as configuring ventilatory modes, adjusting alarms, and performing advanced patient monitoring. This observation is consistent with research documenting similar limitations among residents and early-career physicians, particularly in contexts lacking formal competency-based programs and standardized practical assessments (Schroedl & Vitale, 2022; Coldewey et al., 2021). The low self-perceived competence in advanced monitoring, including plateau pressure and auto-PEEP measurement, is particularly concerning due to its direct implications for patient safety and prevention of ventilator-induced lung injury (Coldewey et al., 2021; Walter, 2021).

The limited prior clinical experience reported by the evaluated interns is consistent with findings from studies conducted across diverse educational systems, where exposure to mechanically ventilated patients during undergraduate training is restricted and predominantly observational (Hayashi et al., 2022; Macedo et al., 2025). This lack of early exposure to real or simulated ventilatory scenarios contributes to delayed acquisition of critical competencies and reinforces perceived insecurity when confronting complex clinical situations, a phenomenon widely described in studies on the transition from undergraduate to postgraduate training (Macedo et al., 2025).

A relevant finding of the present study is the high level of dissatisfaction with the training received, despite recognition of qualified teaching staff. This apparent contradiction suggests that the issue lies not solely in available human resources, but in the pedagogical model employed. According to recent literature, programs lacking deliberate strategies to integrate theory, supervised practice, and structured feedback tend to generate negative perceptions of self-efficacy and clinical preparedness, even when academic content is formally included in the curriculum (Wiedermann & Lederer, 2023; Takeda et al., 2023).

Multiple studies have demonstrated that implementation of simulation-based educational strategies, both in-person and virtual, significantly improves knowledge, confidence, and performance in mechanical ventilation among populations with limited experience (Mireles-Cabodevila & Chatburn, 2023; Ippolito et al., 2023). Additionally, programs based on virtual reality, online simulators, and competency-structured curricula have proven to be effective and scalable alternatives for developing complex clinical skills, even in resource-limited settings (Lee & Han, 2022; Kim & Yoo, 2025; Al Kahf et al., 2026). These findings contrast with the situation observed in the present study, where training appears to rely primarily on conventional theoretical strategies.

Overall, comparison of the present results with available evidence confirms that low perceived preparation in mechanical ventilation among undergraduate medical interns is not an isolated phenomenon, but rather a local manifestation of a

widely documented educational problem at the international level. The concordance between the study findings and prior reports reinforces their relevance and underscores the need to strengthen mechanical ventilation training from early stages of medical curricula through pedagogical approaches oriented toward progressive clinical competency development and patient safety improvement.

## CONCLUSIONS

The results of this study reveal a relevant discordance between the competency demands inherent to contemporary clinical practice and the preparation perceived by undergraduate medical interns at the completion of their basic training. This finding suggests that undergraduate medical education does not guarantee the comprehensive development of the theoretical and practical competencies required to safely and effectively manage clinical scenarios involving mechanical ventilation.

Limited acquisition of essential theoretical foundations, together with low self-perceived ability to perform key operational tasks, highlights insufficient integration between conceptual learning and practical application. Additionally, reduced exposure to real or simulated clinical situations during undergraduate training appears to contribute significantly to perceived insecurity among medical interns, which may negatively affect early professional performance and quality of care. This scenario is particularly relevant given that mechanical ventilation is a high-risk intervention requiring well-consolidated clinical competencies from the earliest years of medical practice.

From an academic and methodological perspective, the findings support the need for a critical review of undergraduate medical curricula, with particular emphasis on high-complexity clinical competencies. Incorporation of structured educational strategies that promote integration of theoretical knowledge with supervised clinical practice, as well as progressive skill development through active learning methods, emerges as a necessary pathway to address the identified gaps. In this regard, assessment of interns' perceived preparedness provides valuable information for planning and prioritizing educational interventions aimed at strengthening fundamental clinical competencies.

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