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Review Study: Education and Training Requirements for Laboratory Medicine Nurses in General and Emergency Settings

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Abstract:

Background: Nurses have a pivotal role in implementing laboratory medicine in clinical practice, requiring proficiency in interpreting diagnostic results, particularly in stressed emergency settings. Developments in healthcare technology between 2015 and 2025 have increased such needs, but training gaps persist. **Aim:** The review establishes training and educational needs for laboratory medicine nurses in general and emergency environments, including evidence-based recommendations. Methods: A systematic review using PubMed, CINAHL, and Cochrane Library was conducted, with qualitative and quantitative methods. Thematic synthesis and descriptive analysis were used, with quality established using the Johns Hopkins Levels of Evidence. **Results:** The main findings highlight gaps in nurses' preparedness for laboratory medicine activities, especially in the emergency setting. CPD, simulation-based education, evidence-based practice (EBP), and interprofessional education are priorities but are underpinned by cessation of funding, time constraints, and non-standardized curricula. Emergency nurses require specialized training in practical testing and rapid diagnostics. **Conclusion:** Improved and standardized training courses, increased funding for CPD, and interprofessional education are required to equip nurses with laboratory medicine demands to optimize patient outcomes.

Keywords: laboratory medicine, nursing education, emergency settings, simulation training, interprofessional education.

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Introduction

Nurses have a crucial role in the health care setting as a bridge between clinical practice and diagnostic routes, particularly in the context of laboratory medicine. Laboratory medicine involves the testing of body fluids, tissue, and other specimens for the diagnosis, management, and monitoring of disease, and thus is essential for nurses to possess a solid knowledge of laboratory tests and their clinical implications. This knowledge is imperative in proper result interpretation and in making timely decisions, especially where risk is high, such as in EDs. Between 2015 and 2025, advancements in healthcare technology, including point-of-care testing (POCT) and automated diagnostic systems, have vastly expanded the demands on nurses to integrate laboratory medicine into practice (Frenk et al., 2010). All these advancements aside, studies again and again point to a glaring gap: that most nurses are not adequately trained in laboratory medicine, particularly in emergent situations, where timely and accurate decision-making can be a matter of life and death (Zhang et al., 2024). Figure 1 summarizes the training pathway for emergency nurses in laboratory medicine.

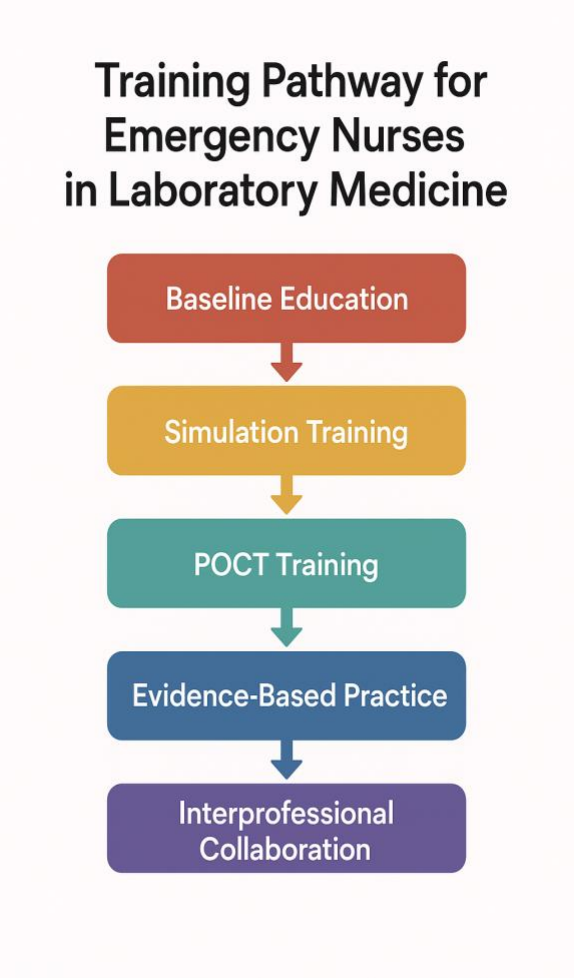

Figure 1. Training Pathway for Emergency Nurses in Laboratory Medicine.

This review aims to critically examine the training and educational needs for laboratory medicine nurses across general healthcare settings as well as emergency contexts and provide evidence-informed recommendations for enhancing nursing education to address these needs.

Methodology

This systematic review compiles peer-reviewed material between 2015 and 2025, from databases such as PubMed, CINAHL, and the Cochrane Library. Inclusion criteria were studies that focused on the education and training needs of nurses in laboratory medicine, for general and emergency departments, with qualitative, quantitative, or mixed methods designs. Thematic synthesis was utilized to synthesize qualitative data, and descriptive summary was used on quantitative data. The quality of methods for studies was assessed using the Johns Hopkins Levels of Evidence and Quality Guide **(**Al Atiyyah et al**.**, 2024).

Literature Review

Importance of Laboratory Medicine in Nursing Practice

Laboratory medicine constitutes the cornerstone of modern healthcare, providing critical information that informs patient assessment, diagnosis, and management. Nurses in general healthcare practice use laboratory data to monitor patients with chronic conditions such as diabetes mellitus, renal impairment, or cardiovascular disease, enabling on-time adjustments in treatment plans (Higuchi et al., 2015). For instance, hemoglobin A1c trend interpretation or electrolyte imbalance enables nurses to make patient care adjustments accordingly.

On the other hand, emergencies necessitate rapid interpretation of lab findings to guide immediate interventions, such as fluid administration in severe electrolyte imbalances or antibiotics in suspected sepsis **(**Beshbishy, 2024**).** However, studies recognize that nurses tend to lack confidence in interpreting complex lab results, such as arterial blood gases or coagulation studies, for a lack of adequate preparation (Belcik, 2011). This shortage varies particularly critically in the emergency department, where time and the necessity of rapid decision-making for the worse amplify the impact of errors. For example, a delay in identifying abnormal potassium levels could produce fatal arrhythmias, emphasizing the necessity of addressing training shortages **(**Beshbishy, 2024**).**

Continuing Professional Development (CPD)

Continuing Professional Development (CPD) is a cornerstone of maintaining and enhancing nurses' competence in laboratory medicine. CPD entails structured learning activities, such as workshops, online courses, and certification, to update nurses on emerging clinical practices and technologies. A metasynthesis of 25 qualitative studies validated that nurses in general embrace CPD as a way of updating their knowledge of laboratory medicine, particularly new diagnostic equipment like POCT devices (Mlambo et al., 2021). However, significant barriers to participation are time pressures, financial limits, and under-resourcing of institutions. In the UK, the Nursing and Midwifery Council (NMC) mandates 35 hours of CPD within three years for revalidation purposes, but CPD course finances dropped from £205 million in 2015–16 to £83 million in 2017–18, limiting access to courses considerably (Mlambo et al., 2021). For emergency nurses, the need for CPD is particularly urgent because the delay in interpreting life-critical laboratory results, i.e., troponin levels in suspected myocardial infarction, can shorten or lengthen patients' lives directly (Asselta, 2023). Tailor-made

CPD programs focusing on rapid diagnostic interpretation and practice on POCT devices are the solution to the gap.

Simulation-Based Training

Simulation-based education has become a game-changing technique for laboratory medicine skills training, offering low-stakes space for nurses to exercise critical thinking and decision-making. Simulations, ranging from high-fidelity mannequins to virtual reality environments, allow nurses to master realistic skills, ranging as the interpretation of blood gas results in a simulated cardiac arrest. A. A systematic review carried out by Hayden et al. (2014) revealed that simulation training on its own improves nurses' skills in laboratory test interpretation during emergencies, with the participants indicating enhanced accuracy and confidence in decision-making. For example, simulation training has been revealed to reduce errors in CBC test findings, which are vital in identifying infection or anemia in emergencies (Adib-Hajbaghery & Sharifi, 2017). In addition, simulation can facilitate interprofessional learning, and nurses can work with laboratory technicians and physicians in simulated clinical scenarios to improve collaboration and communication (Marion-Martins & Pinho, 2020). Despite its benefits, simulation-based training remains inaccessible in many organizations owing to financial limitations and insufficiently trained facilitators, particularly in resource-limited contexts.

Evidence-Based Practice (EBP)

Evidence-Based Practice (EBP) is required for integrating laboratory medicine into practice, where clinical decision depends on the best possible research. EBP requires nurses to formulate research questions, critically appraise literature, and apply results to patient care, for instance, using laboratory data to guide sepsis treatment. However, nurses are sometimes confronted with barriers to the use of EBP, including a lack of education, limited research databases to access, and time constraints (Baiomy & Khalek, 2015). In Saudi Arabia, a qualitative study found that emergency nurses might be unaware of how to build research questions or apply EBP when using laboratory results due to inadequate education on conducting research (**Alnaji & Alkhaldi, 2024**). EBP integration in nurse residency programs has also been promising in addressing the gaps. For instance, Asselta (2023) stated that the formalized EBP curriculum for an emergency department residency program improved nurses' competence in clinical decision-making based on laboratory results, which saw enhanced patient outcomes, such as reduced time to antibiotics administration in sepsis.

Interprofessional Education

Interprofessional education (IPE) ensures collaboration among nurses, laboratory workers, and other healthcare providers, enhancing diagnostic accuracy and efficiency. Based on a review of 107 studies, there is a strong positive influence of IPE on the outcomes of patient care via the minimization of diagnostic errors and enhancement of teamwork (Barr et al., 2008). Within acute settings, where timely coordination is essential, IPE enables nurses to collaborate with laboratory staff to rapidly interpret emergent results, such as lactate in patients presenting suspected shock (Yoder & Pesch, 2020). For example, interprofessional simulation of nurses and lab staff has been shown to improve the speed and accuracy of POCT result interpretation. However, it is difficult to implement IPE, like differences in schedules among healthcare professionals, a lack of training faculty, and organizational resistance to embracing interprofessional curricula (NLN, 2015a). These challenges can be overcome with resources assigned

and institutional dedication to developing collaborative learning environments.

Specific Training Needs in Emergency Situations

Emergency settings create unique challenges for nurses, where they are required to interpret lab results under adverse time constraints. A cross-sectional survey among 2,055 Chinese nurses indicated that 91.19% of them required additional training in responding to infectious disease emergencies, particularly on using POCT for rapid diagnosis, including the identification of viral markers in suspected outbreaks (Zhang et al., 2024). Similarly, a study in India pointed to the imperative for ongoing training in obstetrical emergencies, with the focus that nurses trained in the interpretation of lab markers, such as fetal hemoglobin, could reduce maternal and neonatal mortality by enabling faster intervention (Kabi et al., 2021). These findings underscore the need for intensive, scenario-based training that simulates real emergencies, like management of septic shock or acute respiratory distress syndrome, where laboratory results guide instant treatment decisions.

Gaps in Current Training Programs

Nursing education has progressed significantly, but there remain glaring gaps in preparing nurses for laboratory medicine tasks. Research indicates that nursing school programs are lacking in standardized education for interpreting lab results, and nurses are thus not trained to handle copious amounts of diagnostic information (Beauvais et al., 2017). During emergency department visits, this lack of training in point-of-care testing (POCT) is particularly concerning, since POCT tools such as glucometers or handheld blood gas analyzers are instrumental for rapid diagnostics (Kavanagh & Szweda, 2017). In addition, mentors report challenges in assessing students' competency in lab medicine due to inaccurate assessment measures, which stifles the development of uniform education standards (Pramila-Savukoski et al., 2020). Such drawbacks show the need for a more structured and inclusive approach to nursing education in lab medicine. Table 1 and Figure 2 summarize the training and education needs for nurses in laboratory medicine.

Table 1. Training and Education Needs for Nurses in Laboratory Medicine

Aspect	Training Need	Methods	Outcomes	References
General Settings	Understanding laboratory test principles and result interpretation	Didactic lectures, e-learning modules, case studies	Improved diagnostic accuracy, enhanced patient monitoring	Higuchi et al., 2015; Belcik, 2011; Katherine Renpenning et al., 2016
Emergency Settings	Rapid interpretation of POCT and critical laboratory results	Simulation drills, scenario-based training, and interprofessional workshops	Faster decision-making, reduced diagnostic errors	Asselta, 2023; Zhang et al., 2024; Yoder & Pesch, 2020
Evidence-Based Practice	Skills in formulating research questions and applying EBP to laboratory medicine	EBP workshops, journal clubs, mentorship programs	Increased EBP adoption, better clinical outcomes	Baiomy & Khalek, 2015; Alnaji & Alkhaldi, 2024; Asseri et al., 2024
Interprofessional Skills	Collaboration with laboratory technicians and physicians	Interprofessional simulations, team-based learning	Enhanced teamwork, reduced diagnostic delays	Barr et al., 2008; Marion-Martins & Pinho, 2020; NLN, 2015a
CPD Requirements	Regular updates on laboratory medicine advancements	Short-term courses, webinars, and on-the-job training	Sustained competence, compliance with revalidation requirements	Mlambo et al., 2021; Sajjadnia et al., 2015; Monajati et al., 2014
Simulation Training	Hands-on practice in low-risk environments	High-fidelity simulators, virtual reality, and role-playing	Improved critical thinking, confidence in laboratory tasks	Adib-Hajbaghery & Sharifi, 2017; Hayden et al., 2014; Kononowicz et al., 2019
Mentorship and Assessment	Clear criteria for assessing laboratory medicine competence	Structured mentorship programs, standardized assessment tools	Consistent evaluation, improved student outcomes	Pramila-Savukoski et al., 2020; Tuomikoski et al., 2019; Docherty & Dieckmann, 2015

Figure 2. Framework of Training Needs for Nurses in Laboratory Medicine

Discussion

The literature taken as a whole emphasizes the pressing need for additional training and education in laboratory medicine for nurses in overall healthcare settings as well as emergency settings. The rapid pace of technological development of diagnostic technologies, such as point-of-care testing and automated laboratory systems, has created the need for nurses to become competent in interpreting and reacting to laboratory results. However, the literature reports that gaps in training continue to persist, particularly in emergency rooms where the stakes are highest. CPD is needed to keep nurses abreast of these advancements, but factors such as time constraints, limited funding, and inadequate institutional support significantly hinder participation. For example, the UK's sharp cuts in CPD funding from £205 million in 2015–16 to £83 million in 2017–18 left numerous nurses without access to be needed training, especially in specialized fields such as laboratory medicine (Sajjadnia et al., 2015; Mlambo et al., 2021). Beating these challenges requires sustained investment in CPD programmes and flexible delivery methods, such as web-based modules or in-workplace education, to accommodate nurses' busy schedules.

Simulation training is one particular method that has shown particularly great value, especially among emergency nurses who may have to react immediately to high-pressure choices from laboratory results. Simulation enables safe practice of interpreting complex information, such as arterial blood gas or electrolyte panel, in a setting that simulates real emergency conditions (Kononowicz et al., 2019). Studies show that simulation training not only improves technical competence but also critical thinking and confidence, reducing errors in high-stakes environments such as trauma care or septic shock (Adib-Hajbaghery & Sharifi, 2017). But the cost of simulation technology and trained facilitators limits its mass deployment, particularly within low-resource settings. Greater virtual reality and low-cost simulation technologies available can democratize this training process to reach more broadly.

Interprofessional education (IPE) is also another reasonable alternative for improving nurses' competence in lab medicine. Through collaboration among nurses, lab technicians, and doctors, IPE enhances the quality and promptness of diagnostic procedures, particularly in emergency zones where immediate coordination is essential (Reeves et al., 2016). For example, interprofessional simulations where nurses interpret POCT results alongside laboratory staff have been shown to reduce delays in diagnostics, such as in the diagnosis of acute kidney injury or sepsis (McKinley Yoder & Pesch, 2020). However, challenges such as non-overlapping professional timetables, inadequately trained faculty, and resistance to interdisciplinary curricula are still limitations to IPE implementation (NLN, 2015a).

There is a need for institutions to provide resources and leadership focus to overcome these barriers and incorporate IPE in nursing education.

The problem highlighted in much of the literature is the lack of uniform curricula and assessment tools for laboratory medicine in nursing education. Most schools of nursing fail to offer extensive training in the interpretation of laboratory tests, and hence, the graduates are unprepared to navigate the nuances of modern diagnostic practice (Schoening et al., 2021). This is particularly relevant in emergency units, where nurses need to become skilled at point-of-care testing and rapid diagnostic interpretation to enable life-saving interventions (Kavanagh & Szweda, 2017). Besides, mentors struggle to measure students' competency through ambiguous assessment criteria, which comes at the expense of compromising training quality and consistency (Pramila-Savukoski et al., 2020). Developing national guidelines and standardized assessment tools is crucial to ensure nurses are similarly trained in laboratory medicine duties across different clinical settings. Figure 3 provides an overview of the barriers vs. solutions in nurse training for laboratory medicine.

Figure 3. Barriers vs. Solutions in Nurse Training for Laboratory Medicine

Recommendations

To fill in gaps in nurses' training in laboratory medicine, as observed, a strategy that is multi-faceted is required. National standards will need to be set to uniform curricula in nursing so that core competencies in point-of-care testing (POCT) and evidence-based practice (EBP), such as interpreting complete blood counts, electrolytes, and blood gases, are learned by graduates to prepare them for diagnostic work (Bakr et al., 2024). High-fidelity simulators and virtual reality centers should be expanded to provide experiential training in general and emergency settings, with partnerships to reduce costs and expand access within resource-poor centers (Shin et al., 2015). Interprofessional mandatory training programs involving nurses, laboratory staff, and physicians should be implemented to foster collaborative diagnostic processes, supported by institutional policies that prioritize scheduling flexibility and faculty development (O'Neil, 2021). Increased investment by institutions and government in continuing professional development (CPD) is essential to meet revalidation demands, with disseminated delivery modes that are accessible, such as online learning, and incentives like paid study leave to overcome challenges like time (Mlambo et al., 2021). Finally, standardized assessment tools with clearly established criteria for assessing skills like POCT interpretation and EBP use, along with repeated mentor training, will ensure consistent evaluation across settings (Tuomikoski et al., 2019).

Conclusion

The urgent requirement for more training and education in laboratory medicine among nurses who work in general and emergency settings is highlighted in this review. While CPD, simulation-based instruction, and interprofessional learning can contribute much to improving nurses' competence,

persistent deficits in standardized curricula, funding, and measuring tools serve as a deterrent. Resolving these deficits will require collective effort by education institutions, healthcare facilities, and policymakers to have nurses gain the requisite knowledge and skills to deliver high-quality services in a more complex healthcare landscape. With investments in comprehensive training programs, standardized processes, and learning networks, the healthcare system can enable nurses to effectively integrate laboratory medicine into practice, ultimately leading to improved patient outcomes and better quality of care.

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