

# The Role of Laboratory Parameters in Guiding Pharmacological Interventions in Emergency Pre-Hospital Settings

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## Abstract

In emergency pre-hospital settings, rapid decision-making is crucial to improve patient outcomes. This study aimed to assess the role of point-of-care testing (POCT) in guiding pharmacological interventions by paramedics, in collaboration with laboratory specialists and pharmacists. A mixed-methods approach was used, incorporating a retrospective cohort analysis of 150 patient cases and qualitative interviews with 20 healthcare professionals. Findings indicated that POCT significantly reduced the time to treatment, decreased adverse events, and shortened hospital stays. Thematic analysis highlighted enhanced decision-making, improved interprofessional collaboration, and challenges in implementation, including logistical and training barriers. Addressing these challenges is essential to maximize the benefits of POCT in pre-hospital care.

**Keywords:** Point-Of-Care Testing, Pre-Hospital Care, Paramedics, Pharmacological Interventions, Interprofessional Collaboration, Emergency Medical Services, Patient Outcomes

## Introduction

In emergency medical settings, timely and informed decision-making is crucial to improving patient outcomes. Paramedics, who are often the first healthcare providers to assess and manage patients in pre-hospital settings, face unique challenges when deciding on pharmacological interventions during transport. In many cases, the effectiveness of these interventions depends on rapid access to critical patient data, such as laboratory parameters. Such information can provide insights into the patient's physiological status and support paramedics in making accurate treatment decisions. However, due to the dynamic nature of pre-hospital care, paramedics frequently have to make these decisions with limited diagnostic resources, highlighting the importance of effective interprofessional collaboration between paramedics, laboratory specialists, and pharmacists (Bledsoe et al., 2006).

Laboratory parameters can play a pivotal role in guiding pharmacological interventions, particularly when treating conditions such as hypoglycemia, electrolyte imbalances, or coagulopathies. For example, point-of-care testing (POCT) for blood glucose levels or lactate measurements has been demonstrated to significantly enhance the ability of paramedics to provide appropriate treatment during emergency response (Claret et al., 2015). The integration of laboratory diagnostics into pre-hospital care, either through POCT or rapid

communication with hospital-based laboratory specialists, allows for a more targeted pharmacological approach, potentially reducing complications and improving patient outcomes.

Despite the potential benefits, significant challenges remain in utilizing laboratory parameters effectively in pre-hospital settings. These include logistical issues related to the availability of testing devices, communication barriers between paramedics and laboratory teams, and the need for specialized training to interpret laboratory data accurately. Addressing these challenges requires a multidisciplinary approach, where laboratory specialists and pharmacists work collaboratively with paramedics to enhance diagnostic capabilities and optimize medication administration in emergency settings (Goldman et al., 2018).

## Literature Review

The role of laboratory parameters in guiding pre-hospital pharmacological interventions has been an area of growing interest, particularly with advancements in point-of-care testing (POCT). POCT devices have revolutionized the ability to obtain critical laboratory data rapidly, allowing paramedics to make more informed treatment decisions (Reddy Jr et al., 2018). Studies have shown that POCT for markers such as blood glucose, lactate, and electrolytes can significantly improve the accuracy of pharmacological interventions in pre-hospital settings (Claret et al., 2015). This is particularly important in managing conditions like hypoglycemia, where rapid glucose measurement can facilitate prompt administration of dextrose, potentially reducing the risk of neurological damage (Rostykus et al., 2016).

Another area of research has focused on the use of lactate measurements in pre-hospital care. Elevated lactate levels are often indicative of tissue hypoperfusion and can guide the administration of fluids or vasopressors in critically ill patients (BouChebl et al., 2017). The ability to measure lactate levels in the field has been shown to improve early identification of patients with sepsis or shock, leading to more timely and appropriate pharmacological interventions (Younger and McClelland, 2014). This highlights the value of laboratory diagnostics in enhancing the quality of care provided by paramedics.

The integration of laboratory diagnostics into pre-hospital care also involves significant collaboration between paramedics, laboratory specialists, and pharmacists. Effective communication and coordination are essential for ensuring that laboratory results are accurately interpreted and used to guide pharmacological interventions (Goldman et al., 2018). Pharmacists play a crucial role in this process by providing expertise on drug interactions, dosing, and contraindications based on laboratory findings. For example, electrolyte imbalances detected through POCT can guide the administration of medications such as potassium or calcium, with pharmacists ensuring that the correct dosages are given to avoid complications (Jurado and Steelman, 2013).

However, several challenges hinder the effective use of laboratory parameters in pre-hospital settings. Logistical issues, such as the availability and reliability of POCT devices, remain a significant barrier (Claret et al., 2015). In addition, paramedics may require additional training to accurately interpret laboratory data and make informed treatment decisions. Studies have indicated that targeted education programs for paramedics on the use of POCT and the interpretation of results can enhance their ability to provide appropriate care (Blanchard et al., 2019). Furthermore, the collaboration between paramedics, laboratory specialists, and pharmacists must be strengthened through standardized communication protocols to ensure that laboratory data are effectively utilized (Goldman et al., 2018).

Overall, the literature suggests that the use of laboratory parameters in pre-hospital settings has the potential to significantly enhance patient outcomes by guiding pharmacological interventions. The benefits of POCT in providing rapid diagnostic information are well-documented, particularly in managing conditions such as hypoglycemia, sepsis, and electrolyte imbalances. However, the successful integration of laboratory diagnostics into pre-hospital care requires addressing logistical challenges, providing targeted training for paramedics, and fostering effective interprofessional collaboration.

## Methodology

This study was conducted in a tertiary hospital with a well-established emergency medical services (EMS) department, where paramedics, laboratory specialists, and pharmacists work closely to provide comprehensive pre-hospital care. The methodology employed a mixed-methods approach, combining quantitative data analysis with qualitative insights to assess the role of laboratory parameters in guiding pharmacological interventions during emergency response.

### Study Design

The study followed a retrospective cohort design, supplemented by semi-structured interviews with healthcare professionals involved in pre-hospital care. Data were collected from patient records over a 12-month period, focusing on cases where point-of-care testing (POCT) was utilized by paramedics. The quantitative component involved analyzing patient outcomes, specifically looking at the effectiveness of pharmacological interventions guided by laboratory parameters. The qualitative component aimed to capture the perspectives of paramedics, laboratory specialists, and pharmacists on the utility and challenges of using POCT in pre-hospital settings.

### Participants

The study included all patients who received emergency pre-hospital care involving POCT during the 12-month period. In addition, paramedics, laboratory specialists, and pharmacists working in the EMS department were recruited for the qualitative interviews. A purposive sampling strategy was used to ensure that participants had relevant experience in using POCT in emergency settings. A total of 150 patient cases were reviewed, and 20 healthcare professionals participated in the interviews.

### Data Collection

Quantitative data were collected from electronic medical records, focusing on patient demographics, presenting conditions, laboratory parameters obtained through POCT, pharmacological interventions administered, and patient outcomes upon hospital admission. Qualitative data were gathered through semi-structured interviews conducted with paramedics, laboratory specialists, and pharmacists. The interviews explored participants' experiences, challenges, and perceived benefits of using laboratory parameters in guiding emergency treatment. Each interview lasted approximately 30-45 minutes and was audio-recorded for transcription and analysis.

### Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics to evaluate the impact of POCT on pharmacological decision-making and patient outcomes. Logistic regression models were used to determine the association between the use of laboratory parameters and the likelihood of positive patient outcomes. Qualitative data were analyzed using thematic analysis, which involved coding transcripts and

identifying key themes related to the use of laboratory diagnostics in pre-hospital care. NVivo software was used to assist in organizing and analyzing the qualitative data.

### Ethical Considerations

Ethical approval for the study was obtained from the ethics committee. Informed consent was obtained from all healthcare professionals who participated in the interviews. Patient data were anonymized to protect privacy, and all procedures adhered to ethical guidelines for research involving human subjects.

## Findings

### Quantitative Findings

The analysis of 150 patient records revealed several key findings regarding the effectiveness of POCT in guiding pharmacological interventions during emergency pre-hospital care. The use of POCT was significantly associated with improved patient outcomes, including reduced time to treatment and decreased incidence of adverse events. The table below presents a summary of key quantitative findings:

| Variable                                       | POCT Group (n=75) | Non-POCT Group (n=75) | p-value |
|--|-------------------|-----------------------|---------|
| Time to Pharmacological Intervention (minutes) | 18.2 ± 5.4        | 27.6 ± 6.8            | < 0.01  |
| Incidence of Adverse Events (%)                | 12.0              | 26.7                  | < 0.05  |
| Hospital Length of Stay (days)                 | 4.3 ± 1.2         | 5.8 ± 1.5             | < 0.05  |

The results indicated that patients in the POCT group experienced significantly faster pharmacological intervention times compared to those in the non-POCT group ( $p < 0.01$ ). Additionally, the incidence of adverse events was lower in the POCT group (12.0%) compared to the non-POCT group (26.7%), suggesting that timely access to laboratory parameters can improve treatment safety ( $p < 0.05$ ). Furthermore, patients in the POCT group had shorter hospital stays on average (4.3 days vs. 5.8 days,  $p < 0.05$ ).

### Qualitative Findings

The thematic analysis of qualitative data from interviews with healthcare professionals identified several key themes related to the use of POCT in pre-hospital care. These themes, along with sub-themes and participant quotes, are summarized below:

#### Theme 1: Enhancing Decision-Making in Emergency Care

##### - Sub-theme 1.1: Improved Confidence in Treatment Decisions

- "Having access to POCT results in the field gave me more confidence in choosing the right medication for the patient." (Paramedic 3)

##### - Sub-theme 1.2: Faster and More Accurate Interventions

- "The lactate levels helped us identify patients in shock much earlier, allowing us to administer fluids faster." (Paramedic 7)

#### Theme 2: Interprofessional Collaboration

##### - Sub-theme 2.1: Improved Communication Between Teams

- "The communication between paramedics and laboratory specialists has improved because we now understand how crucial these results are." (Laboratory Specialist 2)
- Sub-theme 2.2: Role of Pharmacists in Supporting Field Decisions
  - "Pharmacists were invaluable in interpreting some of the more complex results and ensuring we used the correct dosages." (Paramedic 10)

### Theme 3: Challenges in Implementing POCT

- Sub-theme 3.1: Logistical and Training Barriers
  - "We still need more training on how to effectively use POCT devices and interpret the results." (Paramedic 5)
- Sub-theme 3.2: Equipment Availability
  - "There have been times when POCT devices weren't available, which limited our ability to make quick decisions." (Paramedic 8)

### Theme 4: Impact on Patient Outcomes

- Sub-theme 4.1: Reduced Adverse Events
  - "Using POCT helped reduce adverse events because we could adjust our treatment plans in real-time based on accurate data." (Pharmacist 4)
- Sub-theme 4.2: Shorter Hospital Stays
  - "Patients who received early, targeted interventions often had shorter hospital stays, which is a clear benefit." (Laboratory Specialist 4)

## Discussion

The findings from this study demonstrate the significant impact of using point-of-care testing (POCT) in pre-hospital emergency care. Quantitative results showed that the use of POCT was associated with improved patient outcomes, including faster pharmacological intervention times, reduced incidence of adverse events, and shorter hospital stays. These findings underscore the value of integrating laboratory diagnostics into pre-hospital care to enhance timely and effective decision-making.

The reduction in time to pharmacological intervention among patients in the POCT group highlights the critical role of rapid diagnostic information in emergency settings. The availability of laboratory parameters, such as blood glucose and lactate levels, enabled paramedics to make informed decisions more quickly, leading to improved treatment outcomes. This is consistent with previous literature, which emphasizes the importance of timely diagnostics in managing critical conditions such as hypoglycemia and sepsis (Reddy Jr et al., 2018; Rostykus et al., 2016). Moreover, the decrease in adverse events in the POCT group suggests that having access to accurate laboratory data reduces the risk of inappropriate or delayed treatment, which can have significant consequences in emergency situations.

The qualitative findings further illustrate the benefits of POCT, particularly in enhancing decision-making and fostering interprofessional collaboration. Paramedics reported increased confidence in their treatment decisions when POCT results were available, which aligns with the quantitative improvements observed in patient outcomes. The collaboration between paramedics, laboratory specialists, and pharmacists was identified as a key factor in the successful use of POCT. Pharmacists played a crucial role in interpreting complex results and ensuring appropriate medication dosing, which highlights the value of involving multiple healthcare professionals in pre-hospital care. Effective communication and teamwork are essential

for maximizing the benefits of POCT, as demonstrated by the positive experiences shared by participants (Goldman et al., 2018).

Despite the clear advantages of POCT, challenges remain in its implementation. Logistical barriers, such as the availability and reliability of POCT devices, were frequently mentioned by paramedics. The need for additional training on the use and interpretation of POCT results was also highlighted as a barrier to effective utilization. Addressing these challenges is crucial for expanding the use of POCT in pre-hospital settings. Targeted education programs and ensuring the availability of reliable POCT devices could significantly enhance the ability of paramedics to provide timely and effective care (Johnson et al., 2021). Additionally, establishing standardized communication protocols between paramedics, laboratory specialists, and pharmacists could further improve the integration of laboratory diagnostics into pre-hospital care.

The study also highlights the importance of reducing hospital length of stay through early and targeted interventions. Patients in the POCT group had shorter hospital stays on average, suggesting that timely treatment in the pre-hospital phase can have a lasting impact on the overall course of care. This finding is particularly relevant in the context of healthcare resource utilization, as reducing hospital stays can alleviate pressure on hospital capacity and lower healthcare costs.

Overall, the integration of POCT into pre-hospital care has the potential to significantly improve patient outcomes by enabling faster, more informed decision-making and fostering collaboration among healthcare professionals. However, to fully realize these benefits, it is essential to address the logistical and educational challenges identified in this study. Future research should focus on developing strategies to overcome these barriers and further explore the impact of POCT on specific patient populations and conditions.

## References

1. Bledsoe, B. E., Porter, R. S., Cherry, R. A., & Armacost, M. R. (2006). Paramedic care, principles & practice. *Prehospital Emergency Care*, 10(4), 522-523.
2. Claret, P. G., Bobbia, X., Roger, C., Sebbane, M., & De La Coussaye, J. E. (2015). Review of point-of-care testing and biomarkers of cardiovascular diseases in emergency and prehospital medicine. *Acta Cardiologica*, 70(5), 510-515.
3. Goldman, J., Kitto, S., & Reeves, S. (2018). Examining the implementation of collaborative competencies in a critical care setting: Key challenges for enacting competency-based education. *Journal of Interprofessional Care*, 32(4), 407-415.
4. Reddy Jr, B., Hassan, U., Seymour, C., Angus, D. C., Isbell, T. S., White, K., ... & Bashir, R. (2018). Point-of-care sensors for the management of sepsis. *Nature biomedical engineering*, 2(9), 640-648.
5. Rostykus, P., Kennel, J., Adair, K., Fillinger, M., Palmberg, R., Quinn, A., ... & Daya, M. (2016). Variability in the treatment of prehospital hypoglycemia: a structured review of EMS protocols in the United States. *Prehospital emergency care*, 20(4), 524-530.

6. BouChebl, R., El Khuri, C., Shami, A., Rajha, E., Faris, N., Bachir, R., & Abou Dagher, G. (2017). Serum lactate is an independent predictor of hospital mortality in critically ill patients in the emergency department: a retrospective study. *Scandinavian journal of trauma, resuscitation and emergency medicine*, 25, 1-7.
7. Younger, P., & McClelland, G. (2014). Evaluation of pre-hospital point-of-care testing for lactate in sepsis and trauma patients. *Journal of Paramedic Practice*, 6(10), 526-531.
8. Jurado, L. V., & Steelman, J. D. (2013). The role of the pharmacist in the intensive care unit. *Critical care nursing quarterly*, 36(4), 407-414.
9. Johnson, M., Thompson, L., & White, R. (2021). Enhancing paramedic education for point-of-care testing. *Journal of Emergency Medical Services*, 46(2), 54-60.
10. Blanchard, I. E., Kozicky, R., Dalgarno, D., Simms, J., Goulder, S., Williamson, T. S., ... & Lazarenko, G. (2019). Community paramedic point of care testing: validity and usability of two commercially available devices. *BMC emergency medicine*, 19, 1-10.

#### ملخص

في بيئات ما قبل دخول المستشفى في حالات الطوارئ، يعد اتخاذ القرار السريع أمرًا بالغ الأهمية لتحسين نتائج المرضى. هدفت هذه الدراسة في توجيه التدخلات الدوائية من قبل المسعفين، بالتعاون مع المتخصصين في المختبرات (POCT) إلى تقييم دور اختبار نقطة الرعاية والصيدالدة. تم استخدام نهج مختلط الأساليب، يتضمن تحليل مجموعة بأثر رجعي لـ 150 حالة مريض ومقابلات نوعية مع 20 متخصصًا في الرعاية الصحية. أشارت النتائج إلى أن اختبار نقطة الرعاية قلل بشكل كبير من الوقت المستغرق للعلاج، وخفض الأحداث السلبية، وقصر مدة الإقامة في المستشفى. سلط التحليل الموضوعي الضوء على تعزيز عملية اتخاذ القرار، وتحسين التعاون بين المهن، والتحديات في التنفيذ، بما في ذلك الحواجز اللوجستية والتدريبية. إن معالجة هذه التحديات أمر ضروري لتعزيز فوائد اختبار نقطة الرعاية في الرعاية قبل دخول المستشفى.

الكلمات الرئيسية: اختبار نقطة الرعاية، الرعاية قبل دخول المستشفى، المسعفون، التدخلات الدوائية، التعاون بين المهن، خدمات الطوارئ الطبية، نتائج المرضى