Emerging uses of handheld blood gas analyzers

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LEARNING OBJECTIVES

Upon completion of this article, the reader will be able to:

1. Define point-of-care testing and its advantages compared to central laboratory diagnostics.
2. List the various settings in which POC testing supports.
3. Discuss the uses and impact of POC testing in various settings.
4. Describe the benefits of POC lactate testing in sepsis.

Point-of-care testing (POCT) achieved significant attention over the past several years, associated in part with technological advancement, the SARS-CoV-2 pandemic, and the growing demand for rapid test results.[1] Point-of-care (POC) is defined as the ability to provide expedient lab results at or near a patient's bedside.[2] These instruments support a broad range of clinical settings and offer an increasing array of testing analytes. Analyzers are typically small and often portable and include compact benchtop systems and handheld devices.[1] Rapid and reliable results can minimize delays in clinical decision-making and support expedient patient management. Advancements in technology such as wireless connectivity, smaller devices, and microfluidics, have facilitated creation of portable and user friendly POCT devices.[3]

POCT is routinely used for blood gas analysis and other measures of clinical assessment using sample types, arterial, venous, and capillary. Near patient devices have become an important tool in the evolving healthcare landscape, supporting assessment for blood gas levels, electrolytes, metabolites, and other analytes often within minutes.[4]

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The quick turnaround time using POCT supports accelerated clinical decision-making in critical hospital settings including the emergency department, critical care units, and operating rooms. Handheld devices offer intriguing prospects for use outside the hospital setting, including physician offices, specialty clinics, rural community health centers, disaster sites, ambulances and paramedic services, or large social gatherings such as sport or entertainment events.[1]

Use of a handheld device can often minimize delays associated with workflow for critical analytes, including sample transport and processing, by providing a timely lab result near the patient's location. This can be particularly important in time-sensitive scenarios like respiratory distress, trauma care, and other potentially life-threatening emergencies.[1] However, its utility could also provide value in less critical settings, as the rapid turnaround time of a handheld analyzer could enhance workflow efficiency and support valuable cost-savings.

The role of handheld and near patient devices continues to expand, offering the potential of improved outcomes and streamlined workflow across diverse settings.[5] Importantly, POCT should not be perceived as a replacement for lab-based testing but as a complimentary method of addressing needs beyond the scope or existing capabilities of the central lab.

POCT outside the hospital setting

Handheld blood gas analyzers have been widely implemented by emergency responders for the early identification of critically ill patients at the point of contact or during transport, including in ambulances, medical helicopters, or during interfacility transfer.[6] Increasingly, testing by first responders includes metabolic status, informing on critical care conditions like respiratory failure and sepsis;[6] providing results such as oxygenation status, lactate levels, and electrolytes; supporting informed triage for interventions such as hemodynamic resuscitation, oxygen therapy, and ventilatory support.

In the case of sepsis, there is a profound impact of timely intervention to reduce morbidity and mortality.[7] The Surviving Sepsis Campaign includes blood lactate testing as a potential aid in the diagnosis of sepsis as levels of serum lactate help to inform resuscitation measures.[8] The emphasis on early recognition of sepsis and rapid initiation of treatment reflects a commitment to improving patient outcomes.[7] It starts with a clinical assessment and laboratory tests such as lactate, which per the 1-Hour Bundle, Surviving Sepsis Campaign are pivotal to understanding the status of sepsis and initial intervention.[9] Studies have shown that for every hour of delay in starting antibiotics in sepsis or septic shock, mortality rates can increase significantly.[10] This statistic demonstrates the urgency and importance of adhering to these new guidelines.

In cases of severe illness, early blood gas results can serve as a "heads-up," ensuring that the receiving team is ready to deliver advanced care without delay, during critical transitions.

POCT in natural disasters

While use of POCT is increasingly being utilized in the pre-hospital settings, significant potential for use in disaster situations exists.[1,11] Natural disasters such as fires, floods, tornadoes, and hurricanes are increasingly impacting much of the U.S. population.[12] The need for an urgent and broad response to a large number of impacted individuals necessitates use of portable equipment in these resource-limited settings. Handheld, easy to use, compact analyzers that offer a range of analyte testing can support on-site assessment of patients and aid critical triage and transport decisions.[1] Some POCT devices offer a battery-operated option, allowing access to testing at the patient's side when infrastructure may be fractured. This could be particularly useful in situations where hospitals are on "diversion," when a patient may require an admission, or when referral to either a regional or more distant tertiary care center may offer more advanced care.

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For example, in the case of wildfires, first responders with a blood gas analyzer can immediately assess the respiratory status of a patient who has suffered from smoke inhalation, supporting intervention for those in most urgent need and reducing unnecessary use of precious resources such as oxygen. For burn injury victims, blood gas analysis can help with acid-base balance, guiding further hemodynamic resuscitation.[11]

The ability to deliver immediate, actionable data makes POCT a valuable tool for triage, treatment, and timely transport decisions during mass casualty and disaster response operations. Accurate and easy to use analyzers are essential in these settings.

Emergency department (ED) triage

In the ED and critical care settings, fast and accurate diagnostics are vital for clinical decision-making and support improved outcomes.[14] Blood gas POCT analyzers are indispensable to assess metabolic status (i.e., pH), electrolyte levels (i.e., potassium and calcium), and cardiopulmonary presentation (i.e., pO2).[11]

While most of these tests can be conducted in the core lab, preanalytical errors, and time to results can be a barrier to prompt decision-making and a drain on resources, especially when time is of the essence.[15] In contrast, a POCT analyzer offers significant utility, delivering rapid information, often within minutes, by either a venous or arterial blood draw or capillary sample. Further, POCT can help alleviate some of the common preanalytical sample errors that frequently occur in STAT samples, enabling greater efficiency and reducing the likelihood of delays resulting from rejected patient samples. This actionable data, at the point of care, can support quick clinical responses, especially in a fast moving and high-pressured environment.

Implementation of a POCT program will often require collaboration across various departments, which may include laboratory personnel, clinical staff, leadership and, in many institutions, an appointed point-of-care coordinator. This internal collaboration can help to ensure that protocols are standardized, quality controls are consistently followed, and patient results are promptly reported to clinicians.

Software solutions available with POC devices help automate labor intensive processes such as data management, monitoring of quality control trends, and user training requirements. POCT devices connected to electronic health

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record systems allow data to be easily accessible to clinicians and ensure compliance with medical record storage requirements. While POCT does occasionally raise concerns about cybersecurity, engaging and aligning with IT colleagues early on can help mitigate these concerns and reduce valuable time spent evaluating vendors.

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Elite athletics and large social gatherings

The use of POCT within elite athletics and large social gatherings (i.e., sporting events, entertainment venues, and conventions) has gained traction. The performance of elite athletes may be optimized using POCT devices during training when relying on a distant central lab would be logistically challenging or impossible. Moreover, medical teams at large social gatherings can use POCT devices to quickly assess acutely symptomatic people including athletes, performers, event staff, spectators, and attendees. This data may be particularly helpful for conditions such as dehydration, electrolyte abnormalities, and even early sepsis.[16, 17]

POCT could allow on-site medical teams to determine if patient transportation to a medical facility is required. This maximizes the efficient use of emergency medical transport services, particularly under circumstances where roads are not easily navigable due to crowds or closures. The portable handheld devices have also shown great utility during remote or long-distance events such as marathons, mountain biking, or road racing, where having access to quick results at the point of care, could provide insight into an athlete's condition.[18]

Conclusion

POC diagnostics have experienced tremendous recent advances. Contemporary devices are capable of rapidly testing a broader range of analytes using convenient analyzers making them a valuable tool across diverse clinical settings. From emergency departments and critical care units to disaster zones and social gatherings, this technology supports medical care in more environments than ever before.

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