Point of Care Testing Error in the ICU

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Background

Point-of-care testing (POCT) first arose in the 1970s, as self-calibrating blood gas measurement machines moved from the central lab to the ICU. Quality control factors, then as now, dictated operation by trained personnel. Sources of error reported in the literature are varied: Operator incompetence, nonadherence to procedures, and use of uncontrolled reagents or equipment are common issues.1 Analysis-stage error can arise from expired test strips in glucose meters,2 plasma versus whole-blood samples in ABG analysis,3 and plasma osmolality in hematocrit measurements.4 These errors are amplified through incoherent regulation, rapid result availability, and immediate clinical implications of the results.1 We discuss POCT error in the context of two clinical cases.

Patient 1: 46 yo F admitted for peritonitis who underwent abdominal washout and resection of perforated bowel. SICU course significant for septic shock and difficulty with ventilator weaning. On several POCT ABGs drawn over a few days at different arterial sites, discrepancy was noted between pulse oximetry (SpO2) values and oxygenation lab values (paO2 and SaO2) obtained from POCT ABG (figure 1). At the time care was delivered, the assumption was made that oxygenation as measured by pulse oximetry was less accurate than POCT ABG values, as we rarely have suspicion of ABG values, but commonly experience spurious pulse oximetry values. An investigation of potential causes of a falsely elevated SpO2 was undertaken (figure 2). This failed to reveal any reasonable explanation for the discrepancy between SpO2 and the POCT ABG paO2 values. On the 5th day described here, inconsistencies in patient 2’s POCT ABG and SpO2 were noted. After demonstrating the discrepancy on simultaneous draws from patient 2, patient 1’s care was focused on SpO2 values and POCT ABGs were no longer used (figure 3).

Patient 2: 59 yo M sustained polytrauma in an encounter with a forklift. On HD3 serial POCT ABGs showed paO2 in the 50-60 mmHg range while SpO2 remained at 100% (figure 4). This apparent discrepancy in oxygenation values raised suspicion for error. Potential errors of SpO2 were eliminated as in figure 2. Because of very high suspicion for erroneous ABG POCT values, a single ABG draw was tested simultaneously on different POCT machines and central laboratory testing, demonstrating a notable difference in oxygenation values between the POCT and central lab, but consistency among the POCT (figure 5). This procedure was repeated with yet another POCT machine and again showed a large discrepancy in oxygenation. At this point oxygenation interventions were made to patient 1 and patient 2 based on pulse oximetry values. Central lab was used for repeat ABGs as necessary.

Case Reports

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Discussion

In the two cases discussed here, POCT error led to an inappropriately aggressive course of respiratory support. These errors increased the risk of oxygen free-radical tissue damage because of high FiO2, created a risk of barotrauma and hemodynamic instability with elevated PEEP, and prolonged exposure to intubation and thus increased the risk of ventilator-associated pneumonia. Additionally, a blood transfusion was given per surviving sepsis guidelines based on SaO2<70% measured during the time of other suspect measurements. In both cases the recognition of error allowed alternative measurements to be preferred and changed the direction of care.

This error was reported to our lab and appropriately investigated. All suspect samples came from the same lot number of ABG cartridges. Further investigation was unable to consistently demonstrate a pattern of errors within a particular lot number, particular POCT devices, or specific operators. Quality control showed the devices in the ICU to be accurate. Cartridges of the suspicious lot number were removed from use. The conclusion was that a consistent operator error such as not allowing cartridges to come to room temperature or simply sporadic cartridge malfunctions within the lot number was responsible.

The serial and low-volume nature of the work makes pattern recognition very difficult, a recognized weakness of POCT versus central lab testing. Detecting POCT errors is typically a matter of allowing alternative measurements to be preferred and changed the direction of care.

Point of Care Testing Accuracy

• ABG accuracy is estimated from measured pH, pCO2, and hemoglobin utilizing empiric equations. These calculated estimates have been found to vary as much as 6% saturation from measured values.
  • Self-calibrating cartridges automatically control all functions of the testing cycle including fluid movement within the cartridge, calibration, and continuous quality monitoring. s-STAT analyzer automatically performs a quality check using an internal electronic simulator every 8 hours.
  • Linear testing is performed periodically comparing POCT devices with central machines based on institutional policy.
  • PO2 measurements are particularly sensitive to temperature error. The temperature corrected pH, pCO2, and pO2 are calculated using complex algorithms.
  • Exposing the sample to air allows CO2 to escape which causes pCO2 to decrease and pH to increase. This causes HCO3 and total CO2 to be underestimated.

POCT Accuracy

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References


Abbreviations

PaO2 arterial partial pressure of oxygen
FiO2 fraction of inspired oxygen
SpO2 peripheral arterial oxygen saturation
SaO2 arterial blood oxygen saturation
pH hydrogen ion concentration
pCO2 partial pressure of carbon dioxide
HCO3 bicarbonate ion
SaO2 arterial blood oxygen saturation