Point of Care: The Journal of Near-Patient Testing and Technology
Critical care nurses' views and experiences of pre-analytical factors influencing point of care testing; a qualitative study
--Manuscript Draft--

Manuscript Number:	
Full Title:	Critical care nurses' views and experiences of pre-analytical factors influencing point of care testing; a qualitative study
Article Type:	Original Study
Keywords:	Point of care; nursing; qualitative; focus groups
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Manuscript Region of Origin:	UNITED KINGDOM
Abstract:	The main users of point of care testing devices placed outside the central laboratory are clinicians, predominantly nurses. Understanding the factors influencing sample accuracy is important to ensure appropriate clinical decision making. Previous studies focus on the analysis process, however, errors can also occur during the pre-analytical phase, linked to user knowledge, skills and other factors associated with the wider context of care. This study explored adult critical care nurses' views about point of care testing, the challenges they experience and their suggestions on how the pre-analytic phase might be improved. Using a qualitative design, four focus group discussions took place with 60 critical care nurses studying at two London based Universities between April and July 2019. Anonymized and verbatim-transcribed focus group data were uploaded into NVivo11 and underwent a standard process of inductive thematic analysis. Findings suggest that nurses' concerns focus on three key areas: Training and competence; Sample frequency and volume; and impacts on patients, relatives and staff. Critical care nurses view POCT as a necessary task, which aids timely patient management. However, the process can detract nurses from performing other care duties. Being able to draw less blood was identified as an important way to increase patient comfort and to reduce risks. Collaborative working is key to ensure that improvements made to the pre-analytical process reflect users' needs. Ensuring best use of nurses' time by streamlining pre-analytical processes and ensuring equipment is readily available for use is important to ensure other clinical priorities can be achieved.

12th June 2020

To the Editor

Please accept submission of this paper entitled:

"Critical care nurses' views and experiences of pre-analytical factors influencing point of care testing; a qualitative study"

I hope that this paper will be considered suitable for publication within the journal and look forward to receiving the reviewers' comments.

Yours sincerely

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Title

Critical care nurses' views and experiences of pre-analytical factors influencing point of care testing; a qualitative study

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Abstract

The main users of point of care testing devices placed outside the central laboratory are clinicians, predominantly nurses. Understanding the factors influencing sample accuracy is important to ensure appropriate clinical decision making. Previous studies focus on the analysis process, however, errors can also occur during the pre-analytical phase, linked to user knowledge, skills and other factors associated with the wider context of care.

This study explored adult critical care nurses' views about point of care testing, the challenges they experience and their suggestions on how the pre-analytic phase might be improved. Using a qualitative design, four focus group discussions took place with 60 critical care nurses studying at two London based Universities between April and July 2019. Anonymized and verbatim-transcribed focus group data were uploaded into $NVivo_{11}$ and underwent a standard process of inductive thematic analysis.

Findings suggest that nurses' concerns focus on three key areas: Training and competence; Sample frequency and volume; and impacts on patients, relatives and staff. Critical care nurses view POCT as a necessary task, which aids timely patient management. However, the process can detract nurses from performing other care duties. Being able to draw less blood was identified as an important way to increase patient comfort and to reduce risks.

Collaborative working is key to ensure that improvements made to the pre-analytical process reflect users' needs. Ensuring best use of nurses' time by streamlining pre-analytical processes and ensuring equipment is readily available for use is important to ensure other clinical priorities can be achieved.

Keywords

Point of care; nursing; qualitative; focus groups

Introduction

Point of care testing (POCT) refers to laboratory testing that occurs close to the patient, enabling blood and other samples to be analyzed rapidly at the bedside (Shaw 2016). Since POCT devices are placed outside the central laboratory, the main users in a hospital setting are clinicians, predominantly nurses (Fitzgibbon et al., 2008). In critical care units (intensive care units (ICUs) and emergency departments (EDs)) nurses are frequent POCT users. One survey of critical care nurse consultants by Lamb et al. (1995) reported that, in 35% of the ICUs they studied, nurses exclusively performed POCT, whilst 32.5% used a combination of technicians and nurses.

POCT can speed up clinical decision-making and optimize patient health outcomes in general areas (Fitzgibbon 2009; Shaw 2016) and in critical care (Giuliano & Grant, 2002). A literature review by Rooney & Schilling (2014) also found that POCT has the potential to improve the timely discharge of patients from the ED, expedite triage of urgent patients, and decrease delays to treatment initiation. Other studies have also linked POCT to improved turnaround times in critical care areas and a decrease in iatrogenic blood loss (Giuliano & Grant, 2002).

Whilst POCT can be invaluable in a time critical situation, there is the potential for inaccuracies, which subsequently impact clinical decision making (Fitzgibbon 2009). Most studies to date have investigated this issue from the perspective of the analyzer itself, both within and outside of critical care (Auvet et al., 2016; Shaw 2016). However, the pre-analytical phase is the most vulnerable part of the total testing process and errors that occur during this period can lead to problems further downstream (Lippi et al., 2017). The pre-analytic phase includes all activity related to obtaining, handling and delivering the sample to the analytical device. Errors during this phase may be attributed to user knowledge, skills and other factors associated with workload and the wider context of care (Gregory & Buckner, 2014; Auvet et al., 2016).

Gregory & Buckner (2014) point out the importance of nurses' proactive participation in developing POCT to ensure the technology is helpful, rather than a hindrance. The implementation of POCT offers the potential for laboratory staff and nurses to work together more closely with the shared goal of improving patient care delivery and outcomes (Fitzgibbon, 2009). However, despite acknowledgement that incorporating nurses' views and experiences helps ensure systems are accurate, reliable and user friendly (Giuliano & Grant, 2002), no previous research has explored

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nurses' perspectives on the pre-analytical factors, which might influence the reliability and validity of POCT in a critical care setting.

The aim of this study was to explore adult nurses' views and experiences of POCT use in critical care (intensive care unit (ICU) and emergency departments (ED)). The objectives were to explore:

- What POCTs are commonly used

- What challenges nurses experience during POCT

- How the pre-analytic phase of POCT can be improved

Materials and Methods

The study employed a qualitative design, enabling the generation of knowledge grounded in human experience (Sandelowski, 2004). Inclusion criteria were adult nurses working in ICU or ED and studying for a specialist qualification at one of two London based Universities (Box I). Following ethical approval (ETH1819-0094), professional colleagues were asked to circulate study information to their student cohorts via email and during classroom sessions. No incentives for participation were offered. Contact details of the chief investigator were available on the study information sheet along with details about how to take part.

Box I: Inclusion & Exclusion criteria

Data were collected between April and July 2019. Four audio-recorded focus group discussions, each with 8-20 people studying on the same module took place either in the classroom or another agreed location at the respective university. Lasting no more than one hour, an experienced qualitative researcher facilitated all discussions, which in agreement with the module leaders took place during one of the participants' study days. A topic guide, informed by a review of the literature aided data collection, focused around five areas: samples taken and training received; timing, rationale and process; errors and their management; impacts on nurses and the wider team; suggested improvements. After describing sample characteristics, anonymized and verbatim-transcribed focus group data were uploaded into NVivo11 and underwent a standard process of inductive thematic analysis as described by Braun & Clark (2006).

Findings

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Data analysis revealed three key themes: training and competence; sampling frequency and volume; impacts.

Training and competence

Whilst all participants had received some training, the frequency of this varied. Keeping up with competency requirements was viewed as problematic with a large turnover of nursing staff. Many participants described not receiving any refresher training and some had not been formally assessed as competent. One participant said, "*We have to do it online to be reassessed…If you fail you have to do the essential training again…We have a self-assessment, I don't think we do it every year though, every two years, for all medical devices*".

Discussions highlighted that, whilst technical support is normally available, a significant amount of responsibility remains with the nurses. Participants explained that, "*All the calibration will be band 6/7 (senior nurses) but it's the techs who does all the training for the machines*". They stressed the need for user friendly systems and for training to include the whole process including how and why results can be inaccurate: "*I think it's a good thing to be able to use the machine, but it will be a better thing for all nurses to understand what the ABGs are actually saying, because we are taught to use the machine but not everybody is taught how to read or interpret the results, which I think would be extremely valuable to the nurses' work*".

Sampling frequency and volume

The frequency of sampling and the amount of blood taken was discussed in all focus groups. Although there was variation depending on the clinical condition of the patient, blood volumes taken could add up to a substantial amount as illustrated in a quote from one of the ED nurses: "*If it is just a repeat VBG [venous blood gas], you are talking a couple of mls…the other bottles are like 4mls, some 3mls, its normally about 3 or 4 bottles*". In sicker patients, participants described frequent sampling, with significant volumes drawn for each sample: "*if they are really sick …each time 1 or 2 mls and you might be doing that 12 times? That's quite a lot*". This was particularly true where dead space volume had to be discarded, as explained by one person who said, "*if you are doing 12 blood gases and wasting 3 mls each time, you are wasting a lot of blood in one shift… If you are taking it from a central line, it can be 10 mls*".

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Impacts

Participants recognized the value of POCT for speeding up clinical decision making and care delivery commenting that "*I think its really good because once you have got your gas [sic] you can start to see if the patient is stable or not and you can decide where to put them, its part of your initial assessment, if you are concerned…so we can escalate concerns…It speeds it up hugely*". However, they identified a range of unwanted impacts related to the pre-analytical period. These included iatrogenic anemia due to frequent sampling, with one participant saying, "*we were told that we lose a unit of two of red cells over a month for patients in ICU because we take samples very frequently*". Despite this, few participants recognized the potential impact this had on the need for blood transfusion, highlighted by the following quote: "*I wouldn't say I've ever felt like I've had to transfuse somebody because I've done lots of blood gases*". Participants also pointed out the associated infection control and environmental issues, with one saying, "*all that waste, some of it is biohazardness waste too, there is also an impact on the environment*".

Participants wanted accurate results, which gave them clinical confidence and avoided delays to treatment, as highlighted by one participant who said, "*… its so important that I have to have that result*". They were, however, concerned about potential delays, which could impact on clinical decision making and treatment. Calibration times for the blood gas machine was something that frequently frustrated nurses as illustrated by the following quote: "*We carry a smartphone…I can literally access any point in the world on google maps in about 9 seconds when I'm on the tube, yet for a gas machine...I just don't understand how I can find out what the weathers like in Nairobi on my phone yet a gas machine takes half a year to calibrate*".

Participants also raised concerns related to the sampling process. For example, one person said, "*The sample, might then become haemolyzed and then you have to get a new one, so you are taking more blood and delaying the clinical decision making*". Others described the impact of having to take repeated samples on the patient: "*then we would have to rebleed the patient…it depends how sick they are.*" Comfort of the patient was a key concern, particularly within the ED, where more patients were awake and without an arterial line in situ: "*I don't like it, you have to keep going back and saying I'm really really sorry, you feel guilty for the fact that you are having to use them like a pin cushion. They are unwell enough as it is and then we have to keep poking them with a needle, I feel terrible doing that, I don't like doing it*".

The time taken for POCT also impacted other aspects of nursing care and the wider team. Participants pointed out that they frequently had to leave the bedside for significant periods. For example, one person said, "*If the gas machine doesn't work, you've got to go to another unit, You have to get another nurse to cover your side room, which means then that other nurse that you are working with is on their own in their bay… and also sometimes there is a queue in the other unit, so sometimes you can be away for like 10 minutes, even though you just want to run a gas, and that, for our unit anyway, that then impacts three nurses, which impacts three patients*".

This view was supported by others, who said, "*It affects other staff...my colleague next door, she is supposed to go on break in 10 minutes, I go to do a blood gas which take only 5 minutes, I go there, it's not working, I have to go to another department, she can't go to break, she can't do care for her own patient, and other people can't then have their break, it affects the whole team…Relatives can lose confidence in you if you are not there for them*". Participants also highlighted that time away from the bedside undertaking POCT meant omissions in care provision for both the patient and their family, as highlighted by one participant who said, "*The caring aspect of nursing, it actually takes that element away…the pressure area care, the mouth care, getting them a cup of tea…You have less time with your patient. It's that, time away from the patient*".

Participants wanted to be able to draw less blood as felt this would increase patient comfort, reduce iatrogenic anemia and unnecessary additional transfusions, reduce time required to process samples and reduce the risk of infection and other environmental hazards.

Discussion

Our findings align with the limited literature available on this topic. Nurses do appear to be the most frequent POCT users in critical care, with the most common tests performed being arterial and venous blood gas, hemoglobin and electrolyte analysis. Our findings support that the amount of blood taken depends mainly on the type of test required and the decision of the bedside nurse, supporting nurses as one of the biggest influences on POCT.

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Whilst findings from our study and those of others emphasize the value of POCT, they also highlight the potential for POCT to detract critical care nurses from performing other care duties (Lamb et al., 1995; Duffy et al., 2010; Gregory & Buckner, 2014; McNicol et al., 2018). Duffy et al. (2010) report that point of care (POC) documentation systems also distract nurses and negatively impact the nurse-patient relationship. The findings of McNicol et al. (2018) further support that patients notice this lack of engagement with the nurses when they are using POC information technology (IT) systems. Whilst POC documentation and IT have different purposes, there are obvious overlaps suggesting that these findings might also be true for nurses using POCT. Nurse distraction has the potential to lead to patient safety concerns, particularly in a critical care setting, where timely accurate decision making is essential to maintain patient safety.

Participants in our study expressed considerable frustration with some of the equipment and the technical support available to them; a frustration shared with other reports, for example in use of POC IT systems (McNicol et al., 2018). Training and ongoing assessment of competence is vital to avoid errors in the pre-analytic phase impacting on sample analysis. However, how to ensure nurses have the right knowledge and skill was identified as a particular concern from our study and has been highlighted in earlier work (for example, Miller & Miller, 2002). Nurses' focus is on patient care delivery, not quality control procedures. Ensuring that all nurses perform POCT in a consistent manner each time a test is carried out is a challenge (Fitzgibbon, 2009). Even where nurses performing POCT are well trained, measurement errors can occur due to the POCT device not being correctly maintained or calibrated, leading to erroneous results, which could have serious consequences for patients. A systematic review by Liikanen & Lehto (2013) suggests that distance learning can help achieve the requirements for training, however, this depends on nurses' motivation to complete e-learning and their ability to embed this into their busy working lives.

Whilst most nurses view POCT as a necessary task, which helps with patient management, it can detract from performing other nursing care duties (Lamb et al., 1995; Gregory & Buckner, 2014). The nursing time associated with POCT, particularly when devices are not working and/or there is a need to travel to other areas to analyze samples not only has a potential impact on the accuracy of the results, but also on time available to deliver patient care. This is at a time when there is a significant nursing resource shortage. Within the United Kingdom (UK), NHS nursing vacancies are estimated to be almost 44,000 (12% of the nursing workforce) (Roache, 2020) and internationally

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this issue is particularly significant in specialist areas such as ICU, perioperative care and emergency departments (Hayhurst et al., 2005; Khan et al., 2019). The more time spent on POCT means less time for providing fundamental aspects of nursing care, such as personal hygiene, medication administration and psychological support. The high turnover of staff also makes training more challenging.

Point of care coordinators have an important role in mitigating risks and optimizing the benefits of POCT (Fitzgibbon et al., 2009), however, much of the responsibility (particularly out of hours) still falls to the nursing staff. Our findings support the need for further collaborative working between nurses and laboratory staff, to ensure future practice models consider nurses' perspectives and reflect the whole process (including the pre analytical phase) to ensure patient safety (Miller & Miller, 2002).

Strengths and weaknesses

This is the first published study to report critical care nurses' views of the pre-analytical phase of POCT. Although small scale, the findings of this qualitative study have resonance with the very limited data available and identify important issues that need to be considered.

Conclusion

This study explored adult critical care nurses' views and experiences of POCT. Findings suggest that nurses' concerns focus on three key areas: training and competence; sampling frequency and volume; impacts on patients, relatives and staff. Being able to draw less blood was identified as an important way to increase patient comfort and to reduce risks. Ensuring best use of nurses' time by streamlining pre-analytical processes and ensuring equipment is readily available for use is important to ensure other clinical priorities can be achieved.

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Box I: Inclusion & Exclusion criteria

Inclusion	Exclusion
- Registered nurse (adult) - Working in an ICU or ED - Studying a specialist critical care module	Nurses studying modules not run by XXX* or XXX* Universities

*Names deleted for anonymity purposes

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