Benefits of point-of-care testing in the Emergency Department

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Summary

This article explores the potential benefits of point-of-care testing in the ED. Price and St. John provide a detailed description on how to approach four common aspects of point-of-care testing (POCT) in the ED, specifically, the challenges of adopting POCT, the impact of POCT on clinical decisions, the impact of POCT on operational decision making and outcomes and the impact of POCT on resource allocation decisions.

The key to successfully using POCT in the ED lies in demonstrating the diagnostic accuracy of the technology and immediately acting on the results as they become available.

Introduction

Overcrowding in the Emergency Department (ED) is a widely acknowledged problem that is just one of the many pressures on the ED and has arisen through a number of causes, including an aging population and increasing referrals from primary care. Overcrowding has impacts on the remainder of the hospital in which it is located but most importantly, it is associated with an adverse impact on patient mortality. Sun et al used bootstrap sampling to study nearly one million visits to the ED and found that overcrowding was associated with increased inpatient death [1]. Singer et al reviewed 41,256 admissions from the ED, finding that mortality “generally increased with increasing boarding time, from 2.5 % in patients boarded less than 2 hours to 4.5 % in patients boarding 12 hours or more (p < 0.001)” [2].

There is an extensive literature offering solutions to this problem, including:

(i) Reducing the number of people needing to go to the ED.
(ii) Improving the efficiency of the ED.
(iii) Specifically, discharging patients from the ED more quickly [3].
Point-of-care testing (POCT) enables more rapid clinical decision making in the process of diagnosis, (rule-in or rule-out), treatment choice and monitoring, and prognosis, as well as operational decision making and resource utilization. Thus, for all of the above it is possible to consider a role for POCT to help address the pressures on the ED.

Ways to reduce the number of people presenting to the ED include providing a more integrated spectrum of services from self-help and self-care, through telephone contact, primary care and walk-in centers to hospital-based emergency departments and major trauma centers [4]. POCT could be provided in all of these care settings and enable decisions to be made more quickly if there was a potential need for referral, and the use of POCT in urgent care centers [5] and paramedical vehicles [6] has been described. It has also been suggested that urgent care centers could be used for the treatment of non-urgent conditions, thereby reducing the number of attendances at the hospital [7].

However, more attention has been directed at solutions (ii) and (iii) where the use of POCT is to facilitate earlier and more rapid decision making, which in theory should lead to a more efficient ED, such as earlier discharges, and potentially increase the capacity of the ED to treat more patients.

**Challenges of adopting POCT in the ED**

It is always important to determine the unmet clinical need that will be addressed by the use of any test, and how the test will actually be used in the clinical pathway. This is equally true for POCT as it is for laboratory testing. Since the whole purpose of POCT is usually to shorten the time to decision making and thus of the overall clinical pathway, then consideration must be given to how this will impact on the operation of the ED. This point is emphasized by Rooney and Schilling who in their discussion of the effective use of POCT in the ED highlight the fact that “clinical pathways and ED logistics may need substantial modification to maximize the clinical and economic benefits of rapid TATs provided” [8].

Quality management of POCT is an important aspect of the wider quality management of services provided by the ED. It can be a challenging environment for POCT with a wide range of potential operators and the need to demonstrate competence [9]. As the range of tests employed in the ED expands, the need to maintain the equipment may also become more challenging.

The introduction of more rapid assessment, including the co-location of a primary care physician in the ED, supported by POCT can improve patient flow in the ED [10]. The practical challenges of improving patient flow can be addressed with the application of lean thinking, which also has the advantage of providing information on resource utilization, as well as helping to guide where inefficiencies occur and resources might be saved [11, 12].

Furthermore, there are often perceived economic challenges with the introduction of POCT due to a fixation on just the cost of the test (almost always the POCT is more expensive than the laboratory equivalent) rather than considerations of the cost of the overall pathway which POCT can reduce [13].

Assuming these challenges can be overcome and that care pathways and associated processes can be changed within the ED to optimally use the provision of more rapid test results from POCT, then more rapid testing can impact on clinical, operational and economic outcomes.

**Impact of POCT on operational decision making, and outcomes, in the ED**

Rapid access to results through the adoption of POCT should, inevitably, impact operational decisions and outcomes. We consider operational outcomes as being time and setting based, examples of which are the time taken to rule in or rule out a condition or the time to discharge the patient from the ED, or avoidance of the need to attend the ED, e.g., through access to testing in primary care or an urgent care center. Reducing these times then has an obvious impact on resource utilization. Given the relevance of these points to issues such as overcrowding, it is not surprising that the majority of...
evidence on the use of POCT in the ED focusses on the operational and resource utilization benefits.

Early simulation studies of ED activity have shown that reducing the time-to-result for cardiac marker tests from 120 minutes down to 10 minutes can impact on the length of stay, average number of diversion days, average number of diversion hours per day, and percentage of diversion days, while also increasing the productivity of the ED on a daily basis [14]. Observations before and after studies of all patients presenting to the ED over a given period of time have shown a reduction in the median length of stay (from 466 to 406 minutes) with a greater effect in patients being admitted, compared to those being discharged [15].

Jarvis et al compared the process performance of a “nurse-led triage model” with samples analyzed in the laboratory to a “consultant-supported rapid assessment model” with POCT. They found a reduction in the median time for patients to be declared ready to leave the emergency department of 53 minutes (down from 129 to 76 minutes) [16]. Kankaanpää made similar observations in a larger study of an ambulatory population attending the ED, which was conducted in three phases: (i) current practice supported by laboratory testing, (ii) introducing POCT, and (iii) introducing an “early assessment team”. They found that POCT reduced the median length of stay by 29 minutes with the addition of the early assessment team reducing the total median time saved to 46 minutes (the baseline median length of stay was 3 hours 51 minutes) [17].

In a critical review, Holden found POCT in the ED setting led to a reduction in the length of stay, waiting time and the number of patients leaving without being seen [18]. This observation should be viewed against a backdrop of the data from a National Hospital Ambulatory Medical Care survey, covering over 360 million weighted ED visits to 364 hospitals. The survey found that a blood test added 72 minutes to the length of stay, and imaging analyses added between 56 and 64 minutes depending on the imaging modality employed (all expressed as adjusted marginal effects). Treatment interventions added an average of 24 minutes when performing a procedure and 15 minutes when giving a medication [19]. In some cases, faster delivery of results has been achieved with the creation of a STAT laboratory within, or close to the ED [20, 21], while in other instances, POCT is integrated into the ED setting.

Interfacing POCT equipment to a clinical order communication system has also reduced the time to reporting of results, with POCT results available in 23 minutes, while laboratory results were available in 60 minutes [22]. Alternatives for providing rapid return of results from the laboratory include the use of an air tube system, although Nørgaard and Mogensen found that even in this situation POCT delivered results faster (by 46 minutes) [23]. As might be expected, the adoption of POCT requires practice and process changes in order to deliver improved outcomes.

Impact of POCT on clinical decisions in the ED

Some specific examples of the use of POCT in the ED are given in Table I; this listing makes the implicit assumption that blood electrolyte, gas and glucose measurements have an established utility in the emergency setting to assess patient status at the time of admission in a particular spectrum of patients.

Given that crowding in the ED can lead to an increase in time to treatment [24], it is reasonable to hypothesize that the introduction of POCT in the ED will reduce the time to treatment – and thus improve clinical outcomes. In a review of the literature covering the introduction of POCT into the ED, Rooney et al concluded that POCT “when used effectively, may alleviate the negative impacts of overcrowding on the safety, effectiveness, and person-centeredness of care in the ED” [8]. Of course, it goes without saying that, in any clinical scenario, decision making in the ED can only improve effectiveness and efficiency if the results are accessed and acted upon. Yet there are instances reported where laboratory results have not been accessed [25, 26]. The lack of follow-up of test results for patients treated in the ED ranged from 1.0 % to 75 % when calculated as a proportion of tests in a review of the incidence of missing test results [26].
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| NTpro-BNP/BNP| • faster access to diagnosis  
• faster access to treatment  
• less time spent in hospital | • faster access to diagnosis  
• faster access to treatment  
• greater efficiency of the care process | • reduced referrals for echocardiography  
• reduced crowding in ED  
• meeting more ED efficiency targets  
• reduced likelihood of admissions | • reduced crowding in ED  
• reduced cost of care  
• meeting more ED efficiency targets |
| Troponin     | • less time to diagnosis  
• less time spent in ED | • less time to diagnosis  
• greater efficiency of the care process | • reduced time to discharge  
• reduced length of stay in ED  
• reduced likelihood of admissions  
• reduced “cost” of diversions | • reduced “cost” of diversions  
• reduced crowding in ED  
• reduced cost of care  
• meeting more ED efficiency targets |
| D-dimer      | • faster access to diagnosis  
• faster access to treatment | • faster access to diagnosis  
• faster access to treatment | • reduced referrals for ultrasonography  
• reduced length of stay in ED  
• reduced likelihood of admissions | • reduced cost of care |
| Glucose      | • faster access to diagnosis  
• faster access to treatment | • faster access to diagnosis  
• faster access to treatment | • faster triage  
• reduced “cost” of diversions | • reduced “cost” of diversions  
• reduced cost of care |
| Ketones      | • faster access to diagnosis  
• faster access to treatment  
• reduced risk of complications | • faster access to diagnosis  
• faster access to treatment  
• reduced risk of complications | • reduced likelihood of admission | • reduced cost of care |
| Pregnancy test| • faster access to imaging  
• reduced risk of adverse events | • faster access to imaging | • improved ED efficiency  
• reduced “cost” of diversions | • reduced “cost” of diversions  
• reduced cost of care |
| Creatinine   | • reduced risk of kidney damage | • reduced time to CT  | • reduced time to CT | • reduced cost of care |
| Lactate      | • shorter time to diagnosis of sepsis  
• shorter time to treatment | • shorter time to treatment | • reduced length of stay | • reduced cost of care |
| Influenza    | • shorter time to treatment | | • reduced length of stay | • reduced cost of care |
The introduction of POCT has been shown to improve the speed of access to further investigational interventions; examples have included the use of a pregnancy test to enable faster access to imaging in women of child-bearing age [20], and faster completion of IV contrast CT scanning [27]. The mean time to receipt of urea and creatinine results from the time of admission to the ED in patients being considered to receive contract media was 11.4/4.9 minutes (mean/SD) compared to 46.8/38.5 minutes when using the laboratory service [28]. Rapid access to influenza results in a pediatric ED also led to a reduction in the number of investigations as well as reduced antibiotic use, increased antiviral use and a reduction in the time to discharge [29].

In the case of treatment interventions, the introduction of POCT for lactate in adult ED patients with suspected sepsis has been shown to reduce the time to administration of IV fluids but not antibiotics. The investigators showed a significant reduction in mortality and ICU admissions, which they concluded was “likely due, at least in part, to POC testing” [30].

Patients presenting with a constellation of symptoms, including breathlessness and chest pain, may have tests for troponin, natriuretic peptide and D-dimer. In a narrative review Nayer et al concluded that natriuretic peptide measurements were helpful in the diagnosis of patients presenting to the ED with dyspnea as well as in the management of a number of clinical conditions [31]. Bingisser et al, in another review, drew similar conclusions, but pointing out there was little data to demonstrate patient and provider benefits [32]. Pecoraro in a systematic survey of immunoassay-based POCT reported on nine studies of natriuretic peptide measurement in the ED [33], concluding that they were accurate when compared with laboratory-based tests. Rapid diagnosis of acute heart failure and prompt initiation of effective treatments, such as intravenous vasodilators, is associated with improved patient outcomes. This requirement was highlighted in the ADHERE registry study, which showed that a delay in the treatment of heart failure was associated with a 250 % increase in acute mortality, and >150 % increase in both hospital and Intensive Care Unit length of stay [34].

There are a large number of studies reporting on the performance of troponin POCT tests in the ED, summarized in ref [35]; 16 % of the studies reported an impact of POCT on mortality. The potential value of employing troponin POCT in the ED increases as the analytical sensitivity of the assays increases, with rule-out strategies for myocardial infarction now being reported down to one hour, albeit currently only with laboratory-based assays [36]. In a critical review of the case for the use of troponin POCT in the ED, Bingisser et al concluded that “reengineering overall procedures within the emergency department setting, to take full advantage of reduced therapeutic turnaround time, has the potential to improve the flow of patients through the emergency department, to shorten discharge times, and to reduce cost” [37].

Singer et al showed a significant reduction in the length of stay in the ED in a before-and-after study of POCT for troponin in the ED [38]. In a randomized trial Goodacre et al demonstrated an increase in the number of patients discharged home using a panel of cardiac markers

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<td>• increased awareness of infection</td>
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<td>• increased screening rate</td>
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<td>Blood gas</td>
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TABLE I. Some examples of tests employed in the ED and their potential benefits to different stakeholders
including troponin I [39]. Slagman et al in a comparison of a conventional POCT assay for troponin T compared with a high-sensitivity troponin T assay concluded that with the POCT assay “….a 99th percentile cut-off may be useful for rule-out of NSTEMI, but seems limited for routine rule-in strategies” [40].

POCT for D-dimer, together with the Wells score has been shown to have comparable diagnostic accuracy to a laboratory-based service in patients with suspected venous thromboembolism, enabling a quick decision to be made for patients requiring ultrasound scanning [41]. This can lead to a reduction in the length of stay in the ED, and fewer hospital admissions [42].

Finally, a number of POCT tests have been reported in the ED for use in screening patients for drugs of abuse and infectious diseases [43]. POCT for HIV has been considered as a way to reduce the proportion of the population who are unaware of their HIV status.

**Impact of POCT on resource allocation decisions in the ED**

While the literature on the cost effectiveness of POCT in the ED is limited, with concerns generally being expressed about the increasing cost of the test compared with its laboratory counterpart, it is now being recognized that the economic benefits of POCT are more likely to be realized through improving the efficiency of the ED, and the wider impact across the care pathway [13]. Thus, Asha et al investigated the cost effectiveness of introducing POCT in the ED, focusing on the time to disposition and showed that while the mean cost of POCT was greater ($12 (95 % CI $7 to $18)), the incremental cost-effectiveness ratio was $113 per hour saved in time to disposition decision for POCT, when compared with tests being sent to the central laboratory [46]. Clearly, savings will be greater if admissions to hospital can be avoided; however, there are clearly major challenges in realizing these savings.

**Conclusions**

There are considerable pressures on the ED, which contribute to crowding and poorer patient outcomes. The evidence would suggest that POCT, as well as the availability of other diagnostic modalities, can contribute to reducing the burden on the ED. While there may be benefits simply by introducing POCT in order to make results accessible more quickly, greater benefits to patient flow, as well as a broader range of health outcomes, will accrue from combining POCT with other changes in the organization of the ED workflow. The effects can also be enhanced through triage in the primary care setting by: (i) better signposting of patients with acute or urgent problems in primary care [47], (ii) the establishment of urgent care or emergency multidisciplinary units in the community [3, 48], or (iii) integration of primary care physicians into the ED setting [10]. It is likely that these solutions will help to reduce the crowding in the ED and both general practitioners and paramedics are now thinking about POCT in the community setting [49-51].

Intuitively the benefits from using POCT in the ED all derive from the rapid access to test results. However, the key to successful use of POCT in the ED lies in demonstrating the diagnostic accuracy of the technology, robust quality management of the POCT technology, acting on the results immediately the results become available and making the operational process changes to improve the efficiency and effectiveness of the care process.
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