

Decentralized clinical biochemistry - introducing point-of-care testing to the emergency environment

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Patient outcomes can be significantly influenced by the length of stay in the admission and Emergency Department (ED); the longer the time before diagnosis and treatment, the greater the risk of mortality for the most seriously ill individuals.

In an ideal situation, patients are discharged from the hospital after ruling out a medical problem during the initial assessment, or rapidly referred to the appropriate department if further investigations and treatment are necessary.

Professor Patrick Plaisance discusses how decentralized clinical biochemistry – point-of-care testing – can help, and the effect it has had in the ED at Lariboisière University Hospital in Paris.

Introduction

The length of stay in the ED is a significant issue. The longer a seriously ill patient remains in the department,

the more likely it is that their condition will deteriorate, increasing the risk of mortality.

To minimize the likelihood of this happening, patients need to be referred as quickly as possible to the most appropriate department for further investigations and treatment. Other patients can be discharged home as soon as a serious medical issue has been ruled out.

To minimize the duration of stay in ED, hospitals need to look at the patient pathway, from the moment of arrival in the department until discharge, to see where it may be possible to save time.

Some elements are hard to control, for example the wait for a bed or an unexpected outcome from a specialist consultation. Where additional tests and examinations are requested, which account for 25 % of the time spent in ED (Fig. 1), improvements may be feasible but are more complicated to introduce as several departments are involved.

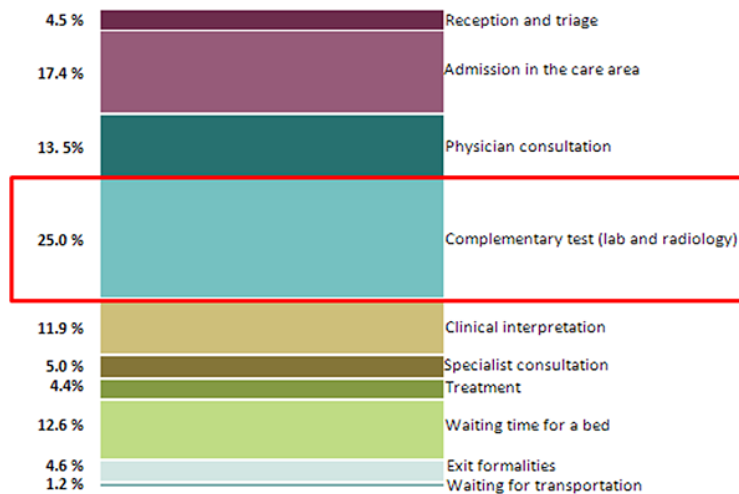


Fig. 1: The percentage ED waiting time for each part of the patient pathway.

Then there is the biology journey – the analysis of biological fluids – which can be a complex, time-consuming procedure. A medical requisition is needed, where medical staff collaborate to ensure samples are taken soon after arrival and sent to the central laboratory for analysis straight away.

If samples are stored prior to transfer to the laboratory, and there is a delay while the analysis is performed and the results validated and reported, meeting recommended turnaround times (TAT) can be challenging.

For example, the Clinical and Laboratory Standards Institute states that blood gas analysis results should be available within 30 minutes, and it is a similar situation for cardiac biomarkers, where the European Society of Cardiology recommends a TAT of 30 minutes for troponin, although 60 minutes is considered acceptable.

If troponin results cannot be generated within 60 minutes, then a decentralized laboratory may be the solution.

Making the case for decentralized biology

Decentralized clinical biochemistry is a topic of great interest, enabling ED doctors and other paramedical staff to perform rapid point-of-care testing (POCT), helping to meet TAT targets. But how do we expect to benefit from it and be sure of its reliability?

There are two major pinch points in the emergency department: biochemistry testing and imaging. In both cases, waiting times can have a considerable impact on the duration of stay, which can be doubled, tripled, or even quadrupled.

It may be difficult to reduce waiting times for procedures such as ultrasound and MRI scans, which are time-consuming and require a radiologist to perform and interpret the examination; therefore the focus needs to be on decentralized clinical biochemistry – the implementation of testing at the point of patient care.

As far back as 2001, McCord et al [1] published an evaluation of point-of-care measurement of a panel of cardiac markers – myoglobin, creatine kinase (CKMB) and troponin I – compared to a central laboratory strategy to rule out acute myocardial infarction (AMI) in patients presenting at the emergency department.

In patients with non-diagnostic ECGs, CKMB, troponin I and myoglobin were measured on arrival at the ED and at 90 minutes, 3 and 9 hours, using a point-of-care device.

Standard central laboratory testing of CKMB was performed at the same time intervals, and the sensitivity and negative predictive values of the different approaches compared.

Monitoring a combination of myoglobin and troponin I using POCT demonstrated a sensitivity and negative predictive value at 90 minutes of 96.9 % and 99.6 % respectively, allowing AMI to be rapidly excluded within 1.5 hours of presentation at the ED.

Neither the sensitivity nor the negative predictive value was improved by measuring CKMB, or additional testing at 3 hours. Crucially, the median time from sampling to results was reduced from 71 minutes for central laboratory testing to just 24 minutes for the point-of-care device, a difference of almost 50 minutes.

In the UK, Goodacre et al [2] reported the results of a multicenter study investigating whether using a point-of-care cardiac biomarker panel would increase the rate of successful discharge home after emergency department assessment, reducing the length of stay in the ED.

Patients presenting with acute chest pain due to suspected AMI underwent diagnostic assessment using a point-of-care biomarker panel comprising CKMB, myoglobin and troponin I, measured at baseline and 90 minutes, compared with standard central laboratory testing.

Point-of-care assessment was shown to increase successful discharge home and reduce the median length of stay, significantly decreasing the number of patients remaining in the department after 4 hours, although overall hospital bed use was unaltered.

Lee-Lewandrowski et al [3] investigated the effect of point-of-care testing for D-dimer, successfully showing that although the number of patients presenting at the department was fairly constant, the length of stay decreased from almost 8.5 hours to just over 7 hours.

Similarly, a 2013 publication by Jang et al [4] reported that point-of-care testing of a comprehensive metabolic panel considerably decreased the duration of stay.

Patients were classified according to the Emergency Severity Index (ESI), and all ESI 1 patients – critically ill individuals requiring immediate treatment – were excluded from the study.

Compared with central laboratory testing, point-of-care testing reduced the length of stay in the ED, an effect that was particularly noticeable with ESI 2 and 5 patients, which saw a decrease of 115 and 122 minutes respectively.

Point-of-care testing also has an impact on patient referrals and admissions. Lee-Lewandrowski [3] reported that POCT not only decreased the length of stay, but reduced the number of patient admissions from 36.5 to 22.7 %, a significant change with benefits for both patients and the hospital.

Early rule-out of a medical problem provides peace of mind and allows patients to be discharged sooner, allowing those individuals requiring further investigation to be referred more quickly to a short-stay observation unit, often avoiding admission to a ward.

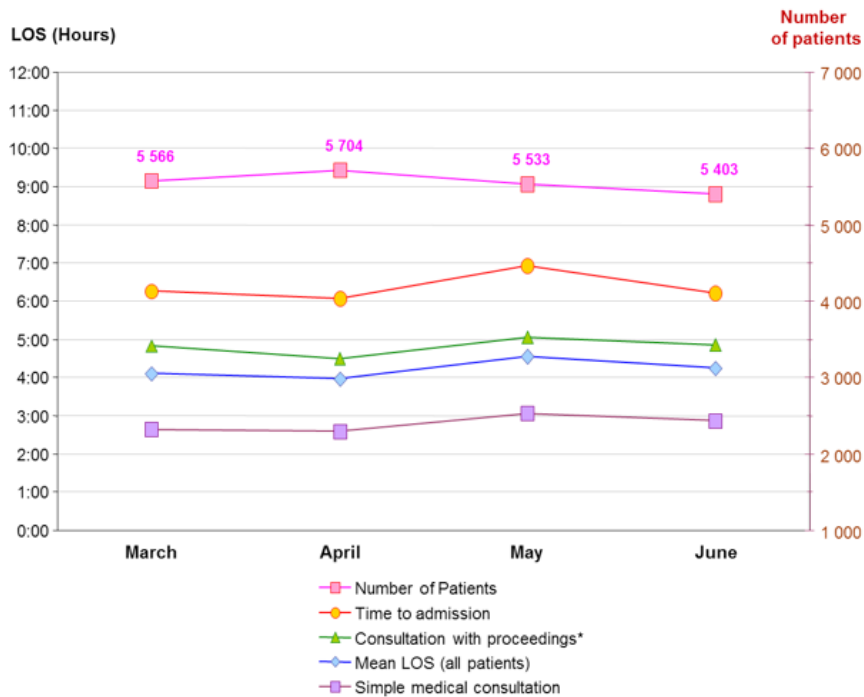
Implementing decentralized clinical biochemistry

The ED at Lariboisière University Hospital in Paris, France, cares for around 72,000 adult patients each year, as well as further 20,000 individuals attending the associated Policlinic.

Within the department there is a reception area, a medical-traumatology care unit, a Service d'admission des urgences vitales (SAUV) unit for life-threatening emergencies, and a Unité d'Hospitalisation de Courte Durée (UHCD), a 24-bed short-stay unit.

To help minimize waiting times, the department operates a fast-track pathway where a referral doctor prescribes relevant biological examinations and "advance" reports, so that test results are readily available by the time the patient reaches the appropriate treatment unit.

While prescribing tests and reports may be easy, implementation is not always straightforward. Lariboisière University Hospital is located in a historic building which, although very attractive, has practical limitations.



* Laboratory tests, X-rays, Tomodensitometry, echography

Fig.2: LOS: Length of stay in the Emergency Department.

To try to decrease the length of stay, the department focused on improving those elements of the patient pathway likely to provide the most benefit, beginning with biological tests.

Two instruments were installed in the SAUV unit – an immunoassay analyzer and a blood gas analyzer – connected to the laboratory software to enable remote monitoring by the biochemists and hematologists responsible for results.

Doctors, paramedical staff and laboratory scientists collaborated to define precise indications for point-of-care testing and establish an appropriate protocol, measuring troponin, D-dimer, blood gases and carboxyhemoglobin, and monitoring for kalemia.

All 70 nursing staff were taught to use the instruments, with four reference nurses receiving advanced training, allowing them to perform maintenance procedures. Based on training level, individual instrument access codes were issued, to ensure traceability.

Establishing the benefits

A 6-month evaluation study was undertaken, analyzing all samples by both POCT and central laboratory testing, with the exception of blood gases where immediate results were required.

Good communication between the emergency department and the laboratories, with clearly defined responsibilities – practical and financial – was essential from the onset.

The analyzers were checked every morning by the nurses, who assumed responsibility for taking patient samples, placing them on the instrument for analysis and collecting the results.

Maintenance, replenishment of consumables and quality checks were overseen by managers, and stock control by the biochemistry and hematology laboratories.

During the course of the study, the need to train new staff early on to ensure that there was always sufficient

cover for nurses on leave was highlighted. There was also a minor issue with clots forming due to failure to mix the samples before analysis, which was swiftly resolved.

Instrument location was another factor to consider – a dust-free site is required – as well as the practicalities of having two laboratories, with different consultants, managing the same instrument.

Department staff were very happy with the analyzers, finding them easy to use, and results were available much sooner, making the patient pathway more fluid.

All results were validated by the central laboratories. The biochemistry laboratory found that POCT troponin testing had a negative predictive value of 100%, and despite the instrument being readily available in the emergency department, the number of tests carried out remained the same as before; there was no unnecessary additional testing.

In hematology, the number of tests was also comparable to centralized clinical biochemistry, and the correlation between POCT and laboratory results for D-dimer was excellent.

The laboratory went on to perform a more detailed study, reporting good correlation between results for whole blood versus plasma with both citrate and EDTA anticoagulants.

When the overall study results were reviewed, POCT had decreased the time to result by over 1.5 hours compared to central laboratory testing, reducing LOS in ED from 6 hours to around 4.5 hours.

Length of stay was even reduced for high-dependency ESI 2 patients, as diagnosis and referral to a continuous or intensive care unit was much quicker.

When should decentralized biology be adopted?

A number of factors were taken into consideration when deciding to adopt POCT and which analytes to measure. Firstly, without an in situ laboratory, taking a sample, transporting it to the central laboratory and then waiting for the results is time-consuming and can cause a delay of more than 2 hours.

In this situation, it makes sense to consider POCT. For patients presenting with cardiac-sounding chest pain and an inconclusive ECG, monitoring cardiac biomarkers has the potential to aid early rule-out, allowing the patient to be more rapidly discharged or referred.

Blood gas analyzers, already used in intensive care to monitor patients with dyspnea, could be used to monitor patients on non-invasive ventilation, as well as metabolic disorders such as diabetes and kalemia.

For most tests, results are available in less than 20 minutes – which is far quicker than central laboratory testing – helping to avoid any unnecessary delay in diagnosis and treatment.

Conclusion

Decentralized clinical biochemistry offers many potential benefits, particularly in a suboptimal hospital environment with long distances between wards and laboratories and no pneumatic tube transport system, leading to delayed results.

Careful examination of each individual link in the workflow is necessary to establish the extent to which decentralized clinical biochemistry may be able to save time.

The point-of-care tests offered should reflect the patient traffic and conditions most commonly seen in the department, and it is vital to interact with the biologists, who validate and sign off all results.

In SAUV, there is a great deal of interest in point-of-

care testing for high-dependency patients, but it is also beneficial for those who are not so seriously ill – ESI 4 and 5 patients – helping to reduce the length of stay in the department.

POCT testing is also a key tool for chest pain units, enabling earlier rule-out of AMI. What is important to us now is to continue our impact studies, further investigating the potential benefits of implementing point-of-care testing.

References

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