Regular review

Point of care testing

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Point of care testing, otherwise referred to as near patient, bedside, or extra laboratory testing, is not new. Many of the early "diagnostic tests" were first done at the bedside—for example, urine testing. Over the past few years, however, analytical systems have been developed that enable a wide range of tests to be done quickly and simply without the need for sophisticated laboratory equipment.[1]

The key objective of point of care testing is to generate a result quickly so that appropriate treatment can be implemented, leading to an improved clinical or economic outcome (figure). This article sets out the requirements for delivering an effective point of care testing service and reviews the evidence of the clinical and economic effectiveness of point of care testing.

Summary points

- Point of care testing requires trained operators to ensure a good quality service
- Testing is effective only if action taken on the result
- Testing has been shown to reduce hospital stay, improve adherence to treatment, and reduce complications Although point of care testing is more expensive than laboratory testing, it produces wider economic benefits

Methods

I searched the literature with Medline and Embase using the key phrases "point of care testing," "bedside testing," "near patient testing," and "extra laboratory testing." I also hand searched relevant laboratory medicine and disease related journals (such as those on diabetes) and health technology assessment reports.

Technology

Two broad types of technology support point of care testing: small bench top analysers (for example, blood gas and electrolyte systems) and hand held, single use devices (such as urine albumin, blood glucose, and coagulation tests). The bench top systems are smaller versions of laboratory analysers in which vulnerable operator dependent steps have been automated—for example, automatic flushing of sample after analysis, calibration, and quality control. Hand held devices have been developed using microfabrication techniques. They are outwardly simple but internally complex devices that do several tasks—for example, separate cells from plasma, add reagents, and read colour or other end points.

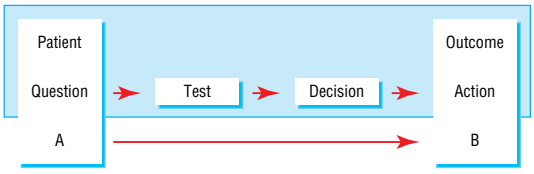
Organisation and management

Even with the most sophisticated device, reliable results can be obtained only if the patient is prepared appropriately and the correct technique is used. As point of care testing is likely to be done by staff with limited technical background, training and quality control are critical.[2 3]

Point of care testing should be organised by laboratory staff and follow the line set out in the box. Wherever possible, point of care testing equipment should be linked to the laboratory information system to enable real time monitoring of performance and integration of results into the patient's electronic record. This approach should meet all the requirements associated with clinical risk management and clinical governance[4]; furthermore, it recognises all of the stakeholders in point of care testing. Point of care testing should be guided by a multidisciplinary team that includes all stakeholders.

Clinical outcomes

The effect of point of care testing can be assessed in terms of the benefit to the diagnostic or treatment strategy and thus overall health outcome.[5] The box gives some examples of clinical outcomes. Any test will be beneficial only if appropriate action is taken on the result. Thus, the rate limiting step in reducing length of hospital stay may not be delivery of a test result,[6] but acknowledgement of the result (communication, appreciation, and action).[7]



Objective of point of care testing

Organisation of point of care testing service

- Identify the clinical need
- Prepare a detailed specification
- Analyse costs and benefits
- Survey technology available (and its performance)
- Procure equipment and consumables
- Ensure equipment can be connected to laboratory information system
- Train all users of point of care testing system
- Provide certification for competent operators
- Regularly monitor quality control and document performance
- Document any problems
- Enter result in patient record
- Notify requester of result
- Act appropriately on result
- Provide continuing education and recertification
- Audit use and problems and take appropriate action

Few formal studies have linked the use of point of care testing to outcomes.[8] In some situations the natural course of the disease or an acute clinical episode suggests that rapid provision of the test result would be beneficial—that is, there is evidence of outcome by association. Two such examples are tests to measure blood gas and electrolyte concentrations in patients in intensive care and to measure blood paracetamol concentrations in patients with paracetamol poisoning.

Self testing

Evidence from the Diabetes Control and Complications Trial and United Kingdom Prospective Diabetes Study makes an irrefutable case for point of care testing,[9 10] although it has been argued that there is too much testing.[11] Similarly, routine monitoring of blood glucose concentrations in women with gestational diabetes to minimise the complications to mother and baby requires point of care testing.[12] There is also evidence that knowledge of patients' glycated haemoglobin concentration at the time of their consultation can improve glycaemic control,[13] probably through improved education and therefore adherence to treatment.

Improving adherence to treatment could be one of the most valuable contributions of point of care testing, particularly when there are no other signs and symptoms to indicate the effectiveness of treatment. Sawicki showed an improvement in anticoagulation status and other patient outcome measures in patients receiving anticoagulants.[14] A small study has also shown that point of care measurement of anticonvulsant drug concentrations leads to a more rapid achievement of optimal concentrations. Point of care testing may also be useful for osteoporotic patients who are taking drugs to improve bone mineral density and those with other diseases where adherence to treatment is poor.

Some examples of improved clinical outcomes from using point of care testing

Outcome	Example
Faster decision making	Chest pain, drug overdose
Starting treatment earlier	Drug overdose
Improved adherence to treatment	Diabetes
Reduced incidence of complications	Diabetes
Quicker optimisation of treatment	Anticoagulation
Reduced reoperation or readmission rate	Parathyroidectomy
Patient satisfaction	Fewer journeys, ownership of disease

Primary care

A systematic review by Hobbs et al found little evidence to support the use of point of care testing in primary care.[8] Most studies focused on technical performance of point of care testing devices rather than outcomes. One study comparing laboratory and point of care testing suggested that certain tests might be used to rule out the need for other tests—for example, in the case of suspected urinary tract infection.[15] Fenwick et al argued that urine leucocyte esterase and nitrite tests can effectively rule out patients with suspected urinary tract infection, which could reduce the inappropriate use of antibiotics as well as laboratory workload.[16] Similarly, point of care testing for *H pylori* infection may reduce the number of patients referred for endoscopy. Jones et al showed that such testing led to eradication therapy being started earlier and rationalised the treatment of other gastrointestinal disorders.[17]

Point of care tests for C reactive protein in patients with bacterial infection also led to earlier treatment, although they did not change prescribing patterns.[18] The authors concluded that although the test had some clinical benefits, the operational and economic benefits were greater.

The real challenge for point of care testing will come as the responsibility for ongoing care of chronic diseases is devolved to primary care, as has been suggested for patients with diabetes mellitus.[19] The only way that doctors will be able to have patients' results available at the consultation will then be through point of care testing.

Accident and emergency

Point of care tests have great potential for facilitating faster decision making and therefore more effective patient triage in the accident and emergency department. The main studies in accident and emergency have been on tests for measuring blood gas and electrolyte concentrations.[6] However, they found little clinical benefit compared with laboratory based testing. This may be because these tests are not the most appropriate for the patients who require rapid intervention or because provision of the test result is not the rate limiting step.[6]

Rapid analysis of cardiac markers may improve the recognition of patients who will benefit from early treatment as well as those who are at greatest risk of a later cardiac event.[20] Similarly, point of care tests for D-dimer can help identify patients at risk of a pulmonary embolism or deep vein thrombosis, with improved outcomes.[21] Recent evidence also suggests that early availability of serum protein S100 (a marker of brain damage) results in patients with head injury improves clinical outcome.[22]

Operating theatre

Rapid testing during surgery may reduce the length of an operation, which could reduce the clinical consequences of an extended operative period or time spent in a postoperative intensive care unit. For

Some examples of economic outcomes from use of point of care testing

- Reduced number of clinic visits
- Reduced length of hospital stay
- Earlier discharge from hospital
- Fewer unnecessary hospital admissions
- Better optimised drug treatment
- Less inappropriate use of drugs
- Reduced use of blood products
- Reduced use of staff, equipment, and estate
- Improved quality of life

example, point of care tests for ionised calcium during the anhepatic phase of liver transplantation could reduce the adverse effects of the citrate load from transfused blood. Similarly, assessment of coagulation status by point of care testing during cardiopulmonary bypass surgery reduces the requirement for blood products, postoperative blood loss, and the time spent in postoperative high dependency care.[23]

Intraoperative measurement of parathyroid hormone concentration improved the success of reoperative parathyroidectomy from 76% to 94%.[24] The test has also been shown to support the use of minimally invasive parathyroidectomy.

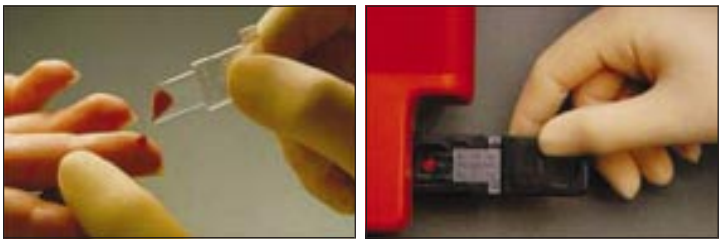
Economic outcomes

It is almost axiomatic that providing a more rapid result saves time and therefore money. However, there will be no saving unless the result is acknowledged and action taken. The economic benefit of point of care testing can be judged in terms of the short term gain from more effective use of resources in the immediate episode of care (box). For example, use of point of care testing to assess coagulation status and platelet function has been shown to reduce the requirement for blood products, with Despotis et al estimating that it could save over $250 000 (£170 000) a year in their institution.[25]

The long term gain is reflected in societal benefits, which have to be measured through quality of life indices—for example, prolonged life years or work years gained. Little formal data exist on quality of life, although the finding that point of care testing in diabetes delays the onset of complications implies economic and wider societal benefit.

Reduction in the length of hospital stay has been seen as one of the main advantages of point of care testing. The rapid availability of a result reduces the time to make decisions, thereby allowing more rapid triage, treatment, or discharge. In addition, point of care testing can be used to guide whether a patient needs admitting to hospital, as has been suggested for patients with chest pain.[26]

Few studies have examined economic outcomes, although many studies have shown that point of care testing is more expensive than the laboratory equivalent.[13] This is not unexpected because point of care testing loses the potential benefits of the economy of scale (automation, etc) in a central laboratory provision. Studies of economic outcomes are needed in which the results of tests are acted on quickly and the economics of the complete patient episode are built into the assessment.



Point of care haemoglobin analysis

Point of care tests will become widely used only if the potential savings can be realised. While waiting lists remain, movement of resources away from beds and staff seems unthinkable. However, in the short term, point of care testing can help to reduce the length of hospital stay. In the longer term, use of these tests to improve patient management and therefore reduce the disease burden will also benefit the healthcare system.

Another factor in determining use of point of care tests will be the rationalisation of pathology services. The creation of large core laboratories as the centrepiece of multitrust pathology consortiums will increase the demand for point of care testing unless transport of specimens and information technology facilities are radically improved.

Conclusion

The technology now exists to enable a wide range of diagnostic tests to be provided at the point of care. The need for such testing clearly exists and will increase as the practice of medicine changes and individuals take greater responsibility for their health. Rapid provision of results can facilitate better clinical decision making, improved patient adherence, and greater patient satisfaction, all of which lead to improved clinical outcomes. Although the cost of producing a result at the point of care may be greater than for laboratory testing, point of care tests have wider patient, operational, economic, and societal benefits.

Competing interests: CPP is a member of the strategic advisory board for Bayer Diagnostics and a consultant in outcomes research to the same company. He is also a member of the scientific advisory board of Kalibrant.

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Lesson of the week

Delayed presentation of handlebar injuries in children

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Initial assessment of children with abdominal trauma from bicycle handlebars may provide false reassurances

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Accidents represent the largest single cause of death in childhood. Although head injuries are the major cause of mortality and morbidity after bicycle accidents in children, abdominal injuries are not uncommon. Bicycle accidents account for 5-14% of blunt abdominal trauma in children.[1–3] In general, injuries to the spleen, liver, or kidneys are readily evident soon after the accident; however, injuries to the bowel and pancreas often present late and result in greater morbidity.

Case reports

Case 1

An 11 year old boy fell off his bicycle and sustained a handlebar injury to his upper abdomen. He attended his general practitioner on the same day because of abdominal pain and vomiting, which was treated with an antiemetic drug. For the next 18 days the boy had vomiting, anorexia, weight loss, and increased epigastric pain. He was then referred to the local surgical unit for assessment.

Examination showed that he was anxious and pale, with a tender epigastrium and a palpable mass in his upper abdomen. His white blood count was 12.9×10^9/l and his serum amylase concentration was 2850 U/l. A diagnosis of traumatic pancreatitis was made and the boy was transferred to the regional paediatric surgical centre.

An ultrasound scan showed a large pancreatic pseudocyst (4.9 cm in diameter) lying between the body of the pancreas and the stomach. The boy was initially treated conservatively with total parenteral nutrition. However, over the next seven days his serum amylase concentration remained high and serial ultrasound scans showed an enlarging pseudocyst. Contrast enhanced computed tomography of the abdomen confirmed that the boy had a pancreatic pseudocyst measuring 11 cm×8 cm×7 cm. Endoscopic retrograde pancreatography showed complete disruption of the pancreatic duct at the junction of the head and body of the pancreas. Distal pancreatectomy was undertaken in cooperation with the hepatobiliary surgeons, and a drain was inserted into the lesser sac. The boy made steady progress and was discharged home 10 days after surgery with the drain in situ. One week later he was reviewed in outpatients; his symptoms had resolved and his drain was removed.

Case 2

A 10 year old boy presented to his local, out of hours general practitioner service with abdominal pain and vomiting two hours after sustaining blunt abdominal trauma from his bicycle handlebars. Examination showed that he had an abrasion to the left of his umbilicus with no evidence of any peritonism (figure), and he was therefore discharged home.

The boy's abdominal pain and vomiting worsened over the next 36 hours and he was therefore referred to the local surgical unit. During examination he was noted to be dehydrated and tachycardic. He had generalised abdominal tenderness and peritonism. Plain radiographs of his chest and abdomen suggested free air in the right upper quadrant. Initial blood tests showed a neutrophilia of 18.2×10^9/l and a raised urea concentration of 10.1 mmol/l, but his serum amylase value was normal. Some free fluid was noted on abdominal ultrasonography, but no solid organ injury was seen.

The boy was transferred to the regional paediatric surgical centre. Contrast enhanced computed tomography of his abdomen confirmed free air and fluid within the peritoneal cavity. There was dilatation and thickening of his proximal small intestine but no free