

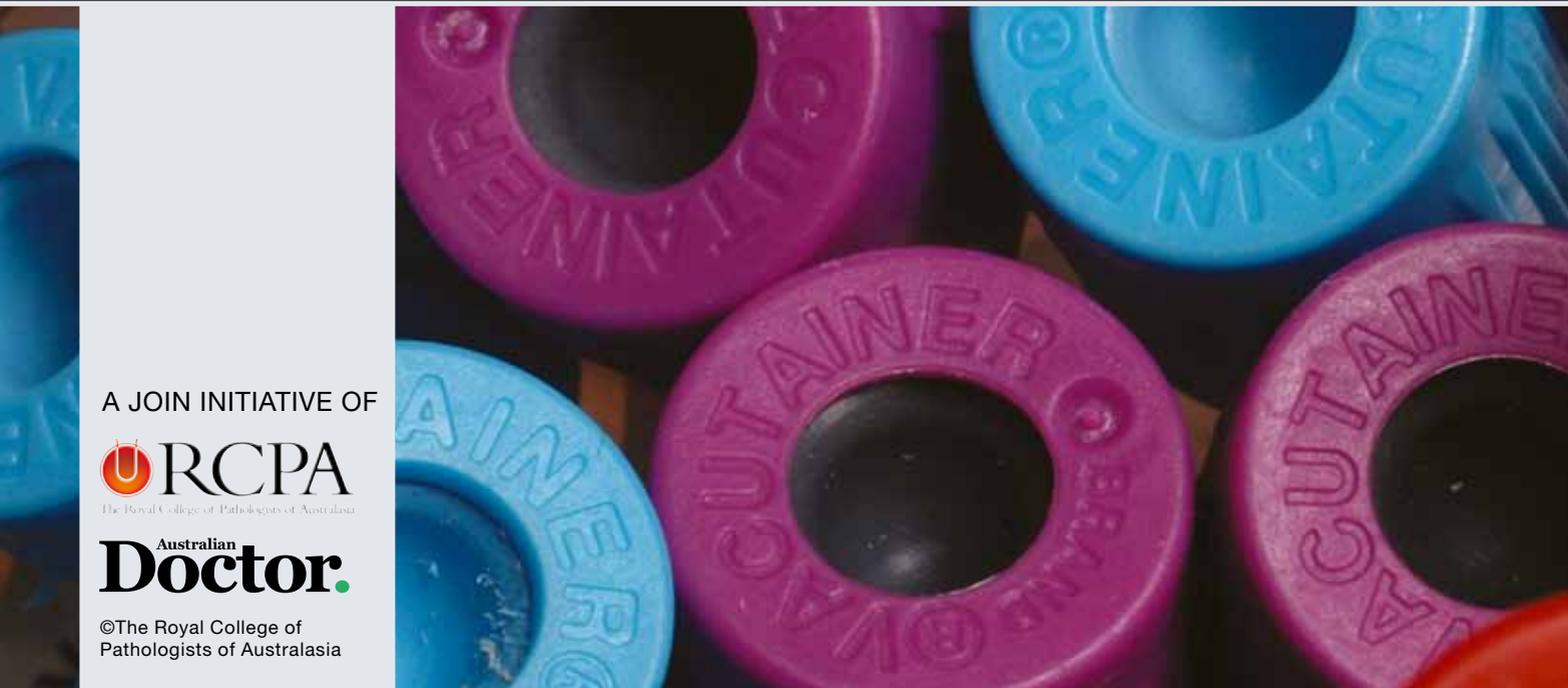


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Point of Care Testing



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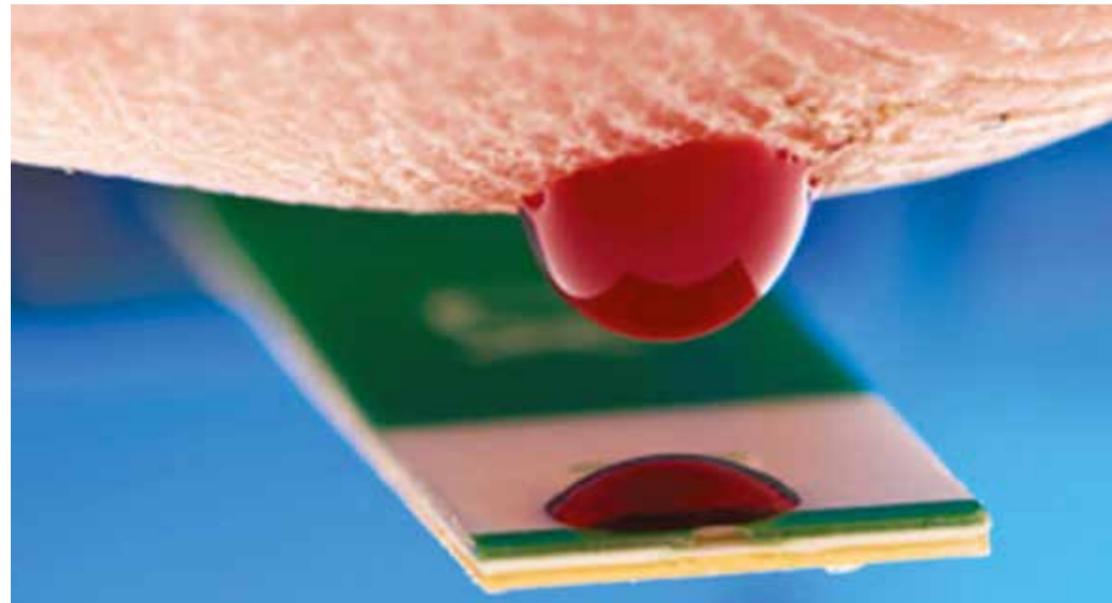
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What is point of care testing?

In general terms, point of care testing (POCT) is the testing of a sample from a patient, performed in the surgery/clinic, at or near the time of consultation, in order to facilitate a prompt clinical decision regarding patient management.

The history of laboratory medicine has, in some ways, come full circle. Originally samples were tested by the treating physician adjacent to the patient (eg, direct microscopy of freshly voided urine). In the latter half of the 20th century in OECD countries, pathology moved to large highly automated, centralised pathology laboratories. Now, thanks to advanced technologies, miniaturisation and microprocessors, it is possible to perform sophisticated sample analysis for a wide array of analytes in real time while consulting with a patient.

Spectrum of POCT

There is a wide range of POCT devices on the market spanning the pathology disciplines of haematology, immunology, microbiology and chemical pathology.

Modern POCT devices use a variety of conventional laboratory analytical processes to analyse samples. The internal complexity of these devices is often masked by a relatively simple end-user interface. POCT devices can be broadly categorised into three groups:

- Devices that are relatively simple to use (eg, home glucose meters and pregnancy testing devices).
- Devices with moderate complexity, some of which use cartridge-based testing (eg, devices that can be relatively easily used by trained healthcare professionals in a clinic setting).
- Instruments with high complexity that may require significant pre-test specimen processing. Examples of this group are benchtop blood gas analysers or molecular-based POCT devices.

Benefits of POCT

POCT is ideally suited to circumstances where a small number of analytes (single analyte or single cartridge)

need to be tested, and where time is critical. The time factor may relate to:

- The need to make an urgent clinical decision (eg, hypoglycaemia, cardiac troponin etc).
- Efficient patient flows (eg, in emergency departments, or radiology departments to check creatinine prior to administration of IV contrast agent).
- The window of opportunity relating to patient factors such as patients who may be unable or unlikely to return for results/treatment, or patients living in rural and remote areas.

While the operation of POCT devices is often promoted as being 'simple', just as with traditional laboratory testing there is a significant body of work that operates in the background to help ensure that accurate and reliable results are achieved. More information on the requirements needed to establish and operate a quality POCT service can be found in a number of publications by the Royal College of Pathologists of Australasia and the Australasian Association of Clinical Biochemists, together with a useful recent review.^{1-4,5}

Some limitations of POCT

While the total range of tests available on POCT devices is quite large, each individual device often has quite a limited test menu. Thus POCT devices can be very useful when only a single analyte or cartridge is required. A far wider range of clinically appropriate tests can be performed by a standard pathology laboratory on just one EDTA and one serum specimen. An example would be suspected pancreatitis, where a POCT lipase test may help establish a diagnosis. However, far more valuable information critical for patient management could be obtained by laboratory testing on the two tubes of blood — FBC and differential, electrolytes, liver function tests, amylase, lipase, and a blood group and crossmatch if required.

Standard laboratory testing is not fool-proof, and POCT shares many of the challenges associated with standard laboratory testing. Issues include:

Pre-test

- Correct patient preparation and identification.

- Correct specimen collection (eg, heparinised sample or fresh whole blood etc).
- Pre-analytical specimen preparation (required for some devices/analytes).

Test

- Trained and competent staff performing the test.
- Complete instrument maintenance, quality control and quality assurance.
- Reagents that have been correctly prepared and stored and that are in date.

Post-test

- Correct recording of test results and action taken regarding results in the patient's medical record.

On a per test basis, generally it is far more cost-effective (reagents and labour) for pathology tests to be performed in large, centralised, highly automated NATA-accredited laboratories. However, this does not take into consideration the inherent delay in accessing the results (typically up to 24 hours for most common analytes requested by GPs) and the impact of this delay on the patient, or the clinical team/facility. Even when this delay has been considered by large-scale trials, such as the 2009 Point of Care Testing in General Practice Trial, POCT was still not found to be cost-effective for a number of common tests relevant to general practice, and often resulted in more testing and more GP visits, with minimal reduction in travel or other costs to the patient.⁶

Considerations prior to establishing a POCT service

Considering all clinical settings, POCT certainly has a place. However, it is essential to use an objective process weighing up the potential benefits, the limitations, and the costs, in order to make an informed decision regarding the use of POCT. A simple guide to this has been outlined in a previously published paper, and includes asking three simple questions:

1. What is the problem that clinicians are hoping to solve by using a POCT device?
2. Is a POCT device really the best option? (Consider that much of the Australian population has ready



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access to high-quality NATA-accredited pathology laboratory services where a significant portion of the costs are covered by Medicare)

3. If a POCT device is the best option, which POCT device best meets the clinical needs and is cost-effective in each particular instance.⁷

Case studies

The setting for all cases below is a rural general practice in a town of 1500 people, where the nearest pathology laboratory is in the regional centre 70 minutes away by road. Pathology specimens are normally despatched at 6pm each night, and results for common tests are usually available the next morning. The practice has purchased a number of POCT devices that can assay a range of analytes, and has ensured that practice staff are fully trained to operate the devices. The POCT service is overseen by the pathology provider, and practitioners are members of the Australian Point of Care Practitioner's Network.

CASE 1

A 45-year-old female presents to her GP with a two-hour history of moderately severe lower chest/epigastric pain/discomfort. She describes the pain as dull and aching rather than burning. It has been intermittent for the past three weeks and usually settles on lying down. However, yesterday the pain was quite severe and lasted for one hour and today the pain is worse and hasn't settled with rest. She is a non-smoker, but has a history of moderate hypertension (on treatment), has a BMI of 36, a poor diet, depression and a sedentary lifestyle. She also has a strong family history of cardiovascular events, including maternal hypercholesterolaemia, maternal myocardial infarction at age 51 with subsequent four vessel coronary artery bypass surgery, and a maternal grandfather who died of a stroke at age 47.

While the differential diagnostic possibilities in this case are broad-ranging — including gastrointestinal

causes such as reflux, peptic ulcer disease, gallbladder pathology, oesophageal spasm, and pancreatic pathology, and could include psychological issues including anxiety and panic attacks — there is a need to exclude myocardial ischaemia.

On examination, there is no localised tenderness and an ECG shows sinus rhythm with no ischaemic changes.

Given the strong family history, individual patient risk factors, and nature of the pain, the GP follows the National Heart Foundation acute coronary syndrome (ACS) treatment algorithm and decides to perform a blood test for cardiac troponin on a POCT device in the surgery.⁸

Venous blood is drawn into a heparinised blood collection tube, well mixed to avoid clotting, and tested following standard procedures on the surgery's POCT analyser.⁹

The cardiac troponin I for this patient measures 0.05mcg/L (reference range established by the pathology laboratory is <0.04 for this POCT device). Note that the units of measurement and reference range for this POCT troponin assay are in mcg/L whereas the reference range for a laboratory troponin result may be in ng/L — particularly if a high-sensitivity cardiac troponin assay is being used in the laboratory.¹⁰

The surgery's POCT device does not have a high-sensitivity troponin assay, therefore the ACS treatment algorithm cannot be interpreted with a positive troponin result and the troponin would need to be measured at four and eight hour time points using this POCT, or retested using a high-sensitivity troponin assay.⁸ However, according to the algorithm, this patient does fit into the category of intermediate- (or possibly high-) risk non-ST elevated acute coronary syndrome.

While there are many non-cardiac causes of a slightly elevated troponin result, the POCT troponin result is above the 99th percentile reference range.^{10,11} In this clinical setting, the GP decides to transfer the patient to the coronary care unit in the regional hospital 70 minutes away via ambulance with continuous cardiac monitoring. Subsequent laboratory testing of the patient showed a significant troponin

rise, confirming MI, and the patient suffered an episode of ventricular tachycardia during her stay in the CCU.

Take-home messages

- POCT testing of troponin can be useful in cases of acute coronary syndrome at times when results for standard laboratory testing of troponin will be delayed (> 60 minutes).¹¹
- Troponin assays have different sensitivities and it is essential to understand the test being used (regardless of POCT or laboratory) when applying results to published guidelines and algorithms.
- Troponin assays may have different reference ranges and different units – even for assays manufactured by the same company.
- High-sensitivity troponin assays may have different reference ranges based on sex (males typically higher cut-off than females).¹²
- Manipulation of cut-off values (away from the 99th percentile) may help improve the sensitivity of some POCT troponin assays.¹³

Discussion

While this POCT helped to immediately justify the cost and inconvenience of monitored ambulance transfer, a negative result would not have been reassuring, and the GP would have the same decision-making uncertainty as if no testing had been done.

CASE 2

A 65-year-old male farmer presents to his GP for his six-monthly appointment for repeat prescriptions. He is a smoker with a 100 pack-year history, has a BMI of 29 and is a non-insulin dependent diabetic managed with oral hypoglycaemic agents.

The patient hadn't taken his blood glucose readings for the past month, as he had run out of glucose meter strips. Prior to this, he had been writing them on the back of an envelope at least a few times each week and readings were between 7mmol/L and 15mmol/L.



He stated that his wife was afraid that he would have a 'hypo' while out in a paddock, and thus she ensured that he had regular meals and sent him with packed biscuits and cake whenever he was away from the farmhouse.

As part of the overall health assessment for this patient, the GP sent samples to the pathology laboratory including blood for FBC, E/LFT, HbA_{1c}, cholesterol, triglycerides and a urine specimen for an albumin:creatinine ratio (ACR).

However, seeking to seize the opportunity of the patient and his wife being in the surgery, POCT was done on blood to measure glucose and HbA_{1c}, and on urine for the ACR.

The patient's random blood glucose was 12.0mmol/L, HbA_{1c} was 98mmol/mol (11.1%) and ACR was 4.0mg/mmol (normal < 2.5).

Immediate access to the patient's results, which demonstrated very poorly controlled diabetes with evidence of renal damage, enabled the GP to provide

education to the patient and his wife regarding strategies to optimise management of his diabetes and overall health. Useful guidelines can be found on the websites of the Australian Diabetes Council and the RACGP.^{14,15}

Take-home messages

- POCT testing of HbA_{1c} and albumin/creatinine ratio can improve the management of patients with diabetes who have difficulty accessing healthcare services and where results from standard laboratory testing are unavailable while the patient has access to healthcare.¹⁶
- While POCT results for these analytes may not have the same sensitivity as standard laboratory tests, the results are suitable to provide real-time information to improve the clinical care and long-term health of these patients, and generally can be used when applying results to published guidelines and algorithms.

CASE 3

A 54-year-old male with a history of hypertension and atrial fibrillation presents to his GP because of easy bruising on his forearms and abdomen over the past 36 hours. He has been treated with warfarin since the diagnosis of AF 12 months prior, and has been stable on his current dose with an INR of 2.3-2.5. On questioning, he also admitted tiredness and lethargy over the past two weeks, but attributed this to increased pressure from deadlines at work. He denies any trauma or any changes to his diet or medications.

On examination, the patient appeared pale and there was moderate bruising and petechiae over the abdomen and forearms.

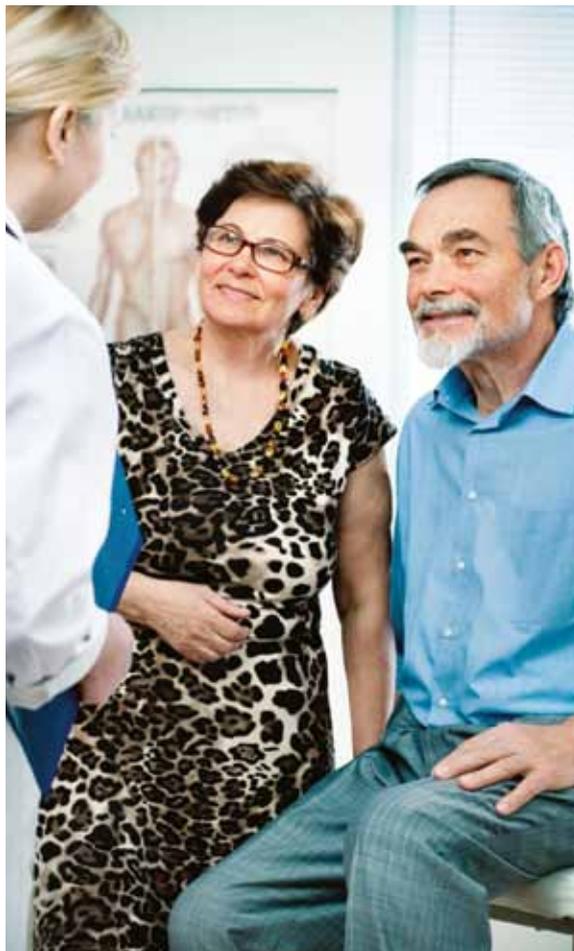
Even though bruising is not uncommon in patients on warfarin, petechiae are much less commonly reported, and pallor may indicate anaemia from occult blood loss.

The GP performed a POCT INR to exclude inadvertent over-anticoagulation. The POCT INR result was 2.0. A faecal occult blood test (POCT) was negative. Blood was collected for FBC, ELFT and coagulation studies and sent urgently to the pathology laboratory. (Iron studies can be ordered as a supplementary test on the ELFT sample should the FBC result show a microcytic anaemia.)

The GP received a telephone call from the laboratory advising significant results.

Pathology results

Haemoglobin	92g/L	(135-180)
Haematocrit	0.29	(0.38-0.52)
MCV	83fL	(80-98)
Platelets	25 x 10 ⁹ /L	(150-450)
White cell count	16 x 10 ⁹ /L	(4.0-11.0)
Neutrophils	0.9 x 10 ⁹ /L	(2.0-7.5)
Blasts	37%	
Lactate dehydrogenase	405 U/L	(80-250)



Results were consistent with acute myeloid leukaemia. The GP called the patient and his wife to the surgery to discuss the results. While waiting for their arrival, the GP arranged admission of the patient to the haematology unit of the tertiary hospital for bone marrow examination and specialist treatment. With the patient's permission, the GP provided information to the patient and his wife about the likely result and the likely clinical process over the next 24 hours.

In this case, the POCT INR was used to rapidly ascertain whether there was a problem with the patient's warfarin control or whether there was a

significant possibility of an alternate condition.

Take-home messages

- POCT INR can be useful in situations where there is a clinical need for a timely result that will influence patient management and where results from standard laboratory testing are unable to be provided within the required timeframe.
- While bruising in patients receiving warfarin therapy is not uncommon, the combination of pallor, bruising and petechiae in the presence of a low therapeutic INR and negative faecal occult blood test raises the possibility of an alternate underlying pathology.
- The use of POCT tests (INR and faecal occult blood) in this instance assisted in the clinical decision making process.

CONCLUSIONS

- POCT can be a useful tool in specific clinical settings.
- On a per-test basis, POCT tests are generally more expensive (consumables plus labour) than centralised laboratory testing.
- POCT tests may not have the same sensitivity or specificity as standard laboratory tests.
- POCT testing requires a significant level of oversight, governance, quality control, staff training and competence. There are documents and organisations (including pathology providers) to assist with this.
- Just like standard laboratory tests, POCT can have false positive and false negative results, so results must always be interpreted in conjunction with the clinical picture.
- Generally, POCT tests used by clinicians are not reimbursed by Medicare, so there may be a significant out-of-pocket expense for some patients having POCT tests who might otherwise be entitled standard laboratory testing that is billed directly to Medicare.

References

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