Effectiveness of point-of-care testing for therapeutic control of chronic conditions: results from the PoCT in General Practice Trial

Tanya K Bubner, Caroline O Laurence, Angela Gialamas, Lisa N Yelland, Philip Ryan, Kristyn J Willson, Philip Tideman, Paul Worley and Justin J Beilby

ABSTRACT

Objective: To compare the clinical effectiveness of point-of-care testing (PoCT) and that of pathology laboratory testing, as measured by therapeutic control in chronic conditions.

Design: Multicentre, cluster randomised controlled trial using non-inferiority analysis.

Setting: 53 Australian general practices in urban, rural and remote areas across three Australian states, September 2005 to February 2007.

Participants: 4968 patients with established type 1 or type 2 diabetes, established hyperlipidaemia, or taking anticoagulant therapy.

Intervention: The intervention group (3010 patients in 30 practices) had blood and urine samples tested by PoCT devices in their general practices, and the control group (1958 patients in 23 practices) had samples tested by their usual pathology laboratories.

Main outcome measures: The proportion of patients and of tests with results in the target range, and change in test results from baseline.

Results: For the proportion of patients with results in the target range, PoCT was found to be non-inferior to pathology laboratory testing for measuring glycated haemoglobin (HbA_{1c}), urine albumin, albumin–creatinine ratio (ACR), total cholesterol and triglyceride levels but not for high-density lipoprotein (HDL) cholesterol level and international normalised ratio (INR). For the proportion of tests with results in the target range, PoCT was found to be non-inferior to pathology laboratory testing for measuring all variables except HDL cholesterol. For the proportion of patients showing an improvement in their test result from baseline, PoCT was non-inferior to pathology laboratory testing for HbA_{1c}, total cholesterol and triglyceride levels, but not for HDL cholesterol level.

Conclusions: This study provides important evidence for those considering the introduction of PoCT into general practice. For all tests except INR and HDL cholesterol, the PoCT approach demonstrated the same or better clinical effectiveness than pathology laboratory testing.

Trial registration: Australian Clinical Trials Registry ACTRN12612607000628448.

MJA 2009; 190: 624–626

Point-of-care testing (PoCT) provides the treating general practitioner with immediate test results and has the potential to improve monitoring of chronic conditions, therapeutic control and clinical efficiency, and to enhance clinical decision making within the timeframe of the consultation.[1-3] PoCT not only provides an alternative method of pathology testing, but also allows a different style of patient management compared with traditional pathology laboratory testing. Demand for PoCT in general practice is increasing; however, there is a little evidence about its benefits, particularly relating to clinical outcomes.

We undertook a large multicentre, cluster randomised controlled trial to determine the safety, clinical effectiveness, cost-effectiveness and satisfaction with PoCT in general practice. As part of this trial, we investigated whether therapeutic control was the same or better in patients with chronic conditions managed using PoCT compared with pathology laboratory testing. Here, we report this clinical effectiveness component of the larger trial.

METHODS

Study design

The Point of Care Testing in General Practice Trial has been described previously, with details of the methods, rationale, recruitment process and baseline characteristics.[4] Random allocation to the intervention or control group was at the practice level and was stratified by geographic area (urban, rural or remote).

Trial intervention

Each practice in the intervention group was provided with a CoaguChek S analyser (Roche Diagnostics) to measure international normalised ratio (INR), a DCA 2000 analyser (Siemens HealthCare Diagnostics [formerly Bayer Australia], Melbourne, Vic) to measure glycated haemoglobin (HbA_{1c}), urine albumin level and albumin–creatinine ratio (ACR), and a Cholestech LDX analyser (Point of Care Diagnostics, Sydney, NSW) to measure blood lipid levels (total cholesterol, triglyceride and high-density lipoprotein [HDL] cholesterol). The devices were selected based on analytical performance and other criteria, such as track record in published literature and evaluation under Australian conditions.

Practice staff who undertook PoCT were trained to be competent in using each device, and internal quality control (IQC) and external quality assurance (EQA) tests were conducted. Practices allocated to the intervention group were required to participate in a quality management program designed for the trial, involving an accreditation process, and IQC and EQA testing to monitor the analytical performance of the PoCT devices. The accreditation process and training were based on the *Interim standards for point of care testing in general practice* developed by the Australian Government Department of Health and Ageing.[5]

All pathology laboratories utilised by the general practices also participated in the trial. Pathology laboratories participated in their own EQA program and were accredited by the National Association of Testing Authorities.

Testing

Results for HbA_{1c}, urine albumin and ACR, total cholesterol, triglyceride and HDL cholesterol, and INR tests performed between September 2005 and February 2007 were sent to the trial team. Over this period, patients presented to their GPs for testing according to their usual schedule. The intervention group had their tests performed with a PoCT device in the practice and were given the results immediately. Those in the control group had their tests performed by the usual pathology laboratory, and received

1 Target ranges by condition and test

Condition and test	Target range
Diabetes[6,7]	
HbA_{1c}	⩽ 7%
Microalbuminuria[7]	
Albumin–creatinine ratio	< 3.6 (female) < 2.6 (male)
Urine albumin	< 20 μg/min
Hyperlipidaemia[9]	
Total cholesterol	< 4.0 mmol/L
Triglycerides	< 2.0 mmol
HDL cholesterol	> 1.0 mmol/L
INR[8]	
Atrial fibrillation and other conditions	2.0–3.0
Prosthetic heart valve	2.5–3.5

HbA_{1c} = glycated haemoglobin proportion.
HDL = high-density lipoprotein.
INR = international normalised ratio. ◆

the results either by telephone or at a follow-up visit.

During the first 6 months of the study, intervention patients had dual tests performed, by PoCT and their usual pathology laboratory, to assess whether the two methods had clinically acceptable agreement.

Ethical approval and registration

The trial was approved by five relevant independent Australian Human Research Ethics Committees and registered with the Australian Clinical Trials Registry (ACTRN 12612605000272695).

Statistical analysis

Two approaches were taken to measure therapeutic control for each test. The primary outcome was the proportion of patients with results in the target range, based on results of the most recent test. The secondary outcome was the proportion of tests with results in the target range. The therapeutic target ranges used for the seven tests were based on published clinical guidelines (Box 1).[6-9] In addition, the study investigated any reduction in the test result from baseline (for HbA_{1c}, total cholesterol and triglyceride levels) and any increase (for HDL cholesterol level).

Analysis was performed using an identity binomial model. If this model failed to converge, a logistic regression model was used to obtain estimates of the proportion within target range in each treatment group, and the variance of the difference was estimated using the delta method. Adjustment was made for prespecified baseline covariates[4] and for clustering at the practice level using generalised estimating equations. Multiple imputation was used to impute missing values for baseline covariates and the last test result. Statistical significance was assessed at the 0.05 level using a one-sided test for non-inferiority, and results are presented with 90% two-sided confidence intervals.[10] The non-inferiority margin for the difference in percentages (intervention minus control) was determined a priori by an expert clinical group to be –7%. No adjustments were made for multiple comparisons.

RESULTS

Data were contributed to the study by 53 general practices and 23 pathology laboratories. The practices were located across three states of Australia, in urban (8 intervention, 9 control), rural (9 intervention, 6 control) and remote (13 intervention, 8 control) areas. Practice characteristics were similar across treatment groups: 10% of the intervention practices and 8.7% of the control practices were solo practices; 40% (intervention) and 39.1% (control) had more than three GPs; 96.7% (intervention) and 91.3% (control) bulk billed; and 90% (intervention) and 95.7% (control) were accredited.

From these practices, 4968 patients (3010 intervention and 1958 control patients) participated in the study. Of the patients, 3819 had hyperlipidaemia, 1967 had type 1 or type 2 diabetes, and 944 were taking anticoagulant therapy (some patients had more than one condition). Patient baseline characteristics were similar in the different treatment groups (detailed elsewhere[4]).

Analysis of the proportion of patients whose test results were in the target range showed that PoCT is non-inferior to pathology laboratory testing (ie, the same or better) for HbA_{1c}, urine albumin level, ACR, total cholesterol and triglyceride levels, but not for INR and HDL cholesterol level (Box 2).

A similar analysis of the proportion of tests that gave results in the target range showed that PoCT is non-inferior to pathology laboratory testing for HbA_{1c}, urine albumin level, ACR, total cholesterol and triglyceride levels and INR but not for HDL cholesterol level (Box 2).

The study also found that PoCT is non-inferior to pathology laboratory testing in relation to the proportion of patients showing an improvement in their test results from baseline for:

- HbA_{1c} (57.3% [PoCT] v 44.9% [pathology laboratory]; difference, 12.4% [90% CI, 6.5% to 18.4%], $P < 0.001$);
- total cholesterol level (74.2% v 57.4%; difference, 16.8% [90% CI, 12.3% to 21.4%], $P < 0.001$); and
- triglyceride level (54.9% v 51.1%; difference, 3.8% [90% CI, –0.9% to 8.6%], $P < 0.001$);

2 Percentage of patients and tests with results in the target range

	Percentage of patients with results in target range				Percentage of tests with results in target range			
Test	Intervention % (no.)	Control % (no.)	Difference % (90% CI)	*P*	Intervention %	Control %	Difference % (90% CI)	*P*
INR	57.0% (572)	61.5% (372)	–4.5% (–10.4% to 1.5%)	0.24	55.8%	57.6%	–1.8% (–4.5% to 0.8%)	< 0.001
HbA_{1c}	65.5% (1182)	56.2% (785)	9.3% (2.9% to 15.7%)	< 0.001	64.1%	54.7%	9.4% (4.0% to 14.7%)	< 0.001
Urine albumin	75.0% (1182)	68.0% (785)	7.0% (–1.8% to 15.7%)	0.004	74.5%	66.4%	8.1% (0.5% to 15.8%)	< 0.001
ACR	77.4% (1182)	74.2% (785)	3.2% (–6.2% to 12.6%)	0.04	77.0%	72.6%	4.4% (–4.1% to 12.8%)	0.01
Total cholesterol	38.7% (2356)	21.6% (1463)	17.0% (13.0% to 21.1%)	< 0.001	34.9%	20.9%	14.0% (10.8% to 17.2%)	< 0.001
HDL cholesterol	73.5% (2356)	82.7% (1463)	–9.2% (–14.2% to –4.3%)	0.77	74.5%	83.5%	–9.1% (–13.4% to –4.8%)	0.79
Triglycerides	70.9% (2356)	68.8% (1463)	2.0% (–2.0% to 6.1%)	< 0.001	67.0%	65.4%	1.7% (–1.8% to 5.1%)	< 0.001

INR = international normalised ratio. HbA_{1c} = glycated haemoglobin proportion. ACR = albumin–creatinine ratio. HDL = high-density lipoprotein. ◆

but not for:

- HDL cholesterol (29.0% v 36.7%; difference, –7.7% [90% CI, –12.9% to –2.5%], $P = 0.58$).

INR was not included in the analysis as a reduction in INR may or may not be an improvement, depending on whether the previous INR result was below, within or above the target range. The urine albumin level and ACR were also not included, as it was not a requirement of the trial design.

In addition, we found no evidence of effect modification by geographic location for any of the outcome measures.

DISCUSSION

The results of the non-inferiority analyses in this study are encouraging. For most tests and outcome measures, the influence of PoCT on therapeutic control was found to be the same or better than pathology laboratory testing. Although results for HbA_{1c}, urine albumin, ACR, total cholesterol and triglyceride levels were consistent in terms of demonstrating non-inferiority, INR produced mixed results. The study was unable to conclude that PoCT is the same or better than laboratory testing for therapeutic control of HDL cholesterol levels. In addition, assessment of the increase in HDL cholesterol levels from baseline to the end of the study found no improvements in either the PoCT or pathology laboratory group; in fact, both groups showed a decrease in mean HDL cholesterol.

This study had some limitations. The proportion of patients and of tests with results in the target range are commonly used in measuring clinical effectiveness of anticoagulant therapy. However, measuring the time spent in the range may have provided a different result. The non-inferiority margin of –7% may have been too conservative. Low-density lipoprotein cholesterol is another important subfraction of a lipid profile that was not part of the trial design,[11] and an investigation including all subfractions could be an area for further research.

A strength of the study is that it was a multicentre, randomised controlled trial, with a large number of participants who provided a large dataset for analysis.

To our knowledge, this is the first randomised controlled trial to investigate PoCT in general practice using non-inferiority tests. Our results provide evidence that managing patients using PoCT for all tests except INR and HDL cholesterol results in the same or better therapeutic control than traditional pathology laboratory testing. The delivery of health care using PoCT provides an effective alternative to pathology laboratory testing, which in turn can enhance good management of chronic disease. In addition, our study helps redress the lack of evidence regarding the clinical effectiveness of PoCT in general practice.

ACKNOWLEDGEMENTS

The trial was funded by the Australian Department of Health and Ageing through the Pathology Section, Diagnostics Services Branch.

The PoCT Trial Management Committee members include: Justin Beilby, Jan Gill, Briony Glastonbury, Caroline Laurence, Roger Killeen, Pamela McKittrick, Andrew St John, Debbie Stanford, David Thomas, Phil Tideman, Rosy Tirimacco and Paul Worley.

COMPETING INTERESTS

None identified.

AUTHOR DETAILS

Tanya K Bubner, GradDipHlthServMg, BSocSc(HumServ), Research Officer[1]
Caroline O Laurence, PhD, MHlthServMg, Senior Research Fellow[1]
Angela Gialamas, BHSc, Research Associate[1]
Lisa N Yelland, BMa, CompSc(Hons), Statistician[2]
Philip Ryan, MB BS, Professor[2]
Kristyn J Willson, BSc(Hons), Senior Statistician[2]
Philip Tideman, FRACP, Cardiologist and Clinical Director[3]
Paul Worley, MB BS, PhD, Dean[4]
Justin J Beilby, MD, Executive Dean[5]

1 Discipline of General Practice, University of Adelaide, Adelaide, SA.
2 Discipline of Public Health, University of Adelaide, Adelaide, SA.
3 Integrated Cardiovascular Clinical Network SA, Flinders Medical Centre, Adelaide, SA.
4 School of Medicine, Flinders University, Adelaide, SA.
5 Faculty of Health Sciences, University of Adelaide, Adelaide, SA.

Correspondence:
caroline.laurence@adelaide.edu.au

REFERENCES

1 Grieve R, Beech R, Vincent J, Mazurkiewicz J. Near patient testing in diabetes clinics: appraising the costs and outcomes. *Health Technol Assess* 1999; 3: 1-74.
2 Hobbs F, Delaney B, Fitzmaurice D, et al. A review of near patient testing in primary care. *Health Technol Assess* 1997; 1: 1-229.
3 Guibert R, Schattner P, Sikaris K, et al. Review of the role and value of near patient testing in general practice: report to the Pathology Section, Diagnostics and Technology Branch, Commonwealth Department of Health and Aged Care. Melbourne: CDHAC, 2001.
4 Laurence C, Gialamas A, Yelland L, et al; members of the PoCT Trial Management Committee. A pragmatic cluster randomised controlled trial to evaluate the safety, clinical effectiveness, cost effectiveness and satisfaction with point of care testing in a general practice setting — rationale, design and baseline characteristics. *Trials* 2008; 9: 50.
5 Australian Government Department of Health and Ageing. Interim standards for point of care testing in general practice. Incorporating POCT trial guidelines. Canberra: DoHA, 2004.
6 Royal Australian College of General Practitioners. Diabetes management in general practice 2004/05. Sydney: RACGP, 2004.
7 NSW Health Department. Principles of care and guidelines for the clinical management of diabetes mellitus in adults. Sydney: NSW Health, 1996.
8 Gallus A, Baker R, Chong B, et al; Australasian Society of Thrombosis and Haemostasis. Consensus guidelines for warfarin therapy. *Med J Aust* 2000; 172: 600-605.
9 National Heart Foundation of Australia, Cardiac Society of Australia and New Zealand. Lipid management guidelines — 2001. *Med J Aust* 2001; 175 (9 Suppl): S57-S88.
10 Piaggio G, Elbourne D, Altman D, et al; for the CONSORT group. Reporting of noninferiority and equivalence randomized trials: an extension of the CONSORT Statement. *JAMA* 2006; 295: 1152-1160.
11 Michael Legg & Associates. Design for a trial and an evaluation framework for the introduction of point of care testing into general practice in Australia. Sydney: Michael Legg & Associates; March 2004.

(Received 8 Sep 2008, accepted 21 Jan 2009) ❑