Point of care troponin decreases time in the emergency department for patients with possible acute coronary syndrome: a randomised controlled trial

Conrad Loten,[1] John Attia,[1,2] Carolyn Hullick,[1] John Marley,[3] Patrick McElduff[4]

[1]John Hunter Hospital, Newcastle, Australia
[2]Centre for Clinical Epidemiology and Biostatistics, University of Newcastle, Newcastle, Australia
[3]Faculty of Health Sciences, The University of Queensland, Brisbane, Australia
[4]Hunter Medical Research Institute, School of Medicine and Public Health University of Newcastle, Newcastle, Australia

Correspondence to
Dr Conrad Loten, Emergency Physician, Hunter New England Health, John Hunter Hospital, Locked Bag 1, Hunter Region Mail Centre, Newcastle 2310, Australia;
conradloten@gmail.com

Accepted 22 April 2009

ABSTRACT

Objective To determine the effect of cardiac troponin I testing with a point-of-care (POC) device versus central laboratory on length of stay (LOS) in emergency department (ED) patients presenting with possible acute coronary syndromes (ACS).

Methods A 12-week randomised controlled trial at two metropolitan ED in eastern Australia with a combined annual census of 80 000. Participants were all patients presenting with possible ACS. Exclusions were a diagnosis of ACS before arrival, ST elevation and failure to wait for complete assessment. Randomisation was by week when POC was made available. Primary outcome was LOS from patient arrival to physical departure from the ED. The proportion of patients meeting a government target of less than 8 h stay was compared. Analysis was by intention to treat.

Results Despite underutilisation of POC, LOS was shorter during weeks when it was available. The time savings translates into approximately 48 minutes (95% CI 12 to 84) per average LOS of almost 7 h, which did not reach statistical significance (p=0.063), or an absolute increase of 10% (95% CI 4.3 to 16.6) in the number of people discharged from the ED within the target LOS of less than 8 h, which did reach significance (p=0.007). These savings were more pronounced in the setting without 24 h central laboratory availability.

Conclusions POC testing for troponin in the ED tended to reduce the LOS for possible ACS patients. The degree of this benefit is likely to be markedly dependent on its acceptance and uptake by attending personnel, and on the ED setting in which it is used.

Measurement of troponin in the emergency department (ED) has become essential in risk stratification and diagnosis of acute coronary syndromes (ACS).[1–3] Bedside testing might be expected to improve the speed of this process and reduce patient length of stay (LOS). Clear evidence for this, however, remains to be demonstrated. Singer *et al*[4] showed in a non-randomised trial that patients were booked for admission earlier with point-of-care (POC) troponin testing in the ED; the result was available on average in 15 versus 83 minutes for the laboratory result. However, there are many factors that might mitigate this benefit, including:

- Increased use of clinical staff time to run the assay and maintain the device.
- Procedural failures (eg, rejected cartridges).
- Clinicians' willingness to trust a non-laboratory assay in the process of discharging patients with a potentially lethal condition.[5 6]
- Delay in patient flow including hospital access block.

In 2008 a large multicentre randomised controlled trial in the USA showed only limited improvement in patient stay at some centres and lengthened stay at others.[7]

Previous studies had shown variable changes in time to decision, therapy and LOS.[8–12] Many addressed the use of multiple assays rather than troponin alone or were also trials of new diagnostic protocols.[13] Murray *et al*,[14] in a randomised controlled trial looking at multiple POC tests including older cardiac biomarkers, showed a reduced LOS for ED patients, greatest if they were destined to be discharged. Most studies have been observational, including before and after methodologies, and these may suffer from the Hawthorne effect.[15]

OBJECTIVES

We sought to test in a randomised controlled trial whether POC troponin testing would decrease patient LOS in the ED for patients arriving with possible ACS.

METHODS

Setting

Two ED in Newcastle, Australia, from November 2007 to January 2008. The larger site, John Hunter Hospital (JHH) has acute interventional angiography and cardiac surgery. Neither has a chest pain observation unit. Undifferentiated chest pain comprises 5–8% of total presentations. All patients are initially seen by ED staff and are assessed according to Australian Heart Foundation guidelines, with second troponin taken a minimum 8 h after the onset of symptoms.[16] The Department of Health has set a benchmark LOS in emergency of 8 h, to be met in 80 % of cases.

Patients with diagnosed ACS or those considered to be at high risk of adverse events or ACS are admitted to cardiology. Intermediate risk patients are referred to the cardiology service for further evaluation, which may be as an inpatient. Low-risk patients are discharged for outpatient follow-up.

Selection of participants

All patients over 25 years of age who presented to the ED with possible ACS, and who had a troponin ordered, were consecutively enrolled. Patients were

identified by triage coding and were collected on a prospective database being used to audit the ACS pathway. Exclusions were:

- Transfer from another hospital with known ACS or known elevated troponin.
- ST elevation on arrival, as troponin seldom affects initial management in this case.
- Departure against medical advice.

Study design

This was a cluster randomised controlled trial in which the unit of randomisation was weeks using a single computer-generated block of 12 for each site. A sealed envelope opened each Monday morning determined the availability of the device.

Clinical staff were not forced to use POC and still had the option of sending samples to the laboratory as usual. Before the trial, a validation study for the POC system was conducted, which included training in its use for all medical and nursing staff. The machine had been in the department for 4 months before the trial started and personnel were familiar with its use.

Ethics permission, and exemption from patient consent, was granted by our regional ethics committee and the study was registered a priori with the Australian/NZ controlled trials registry (ACTRN12607000475448; http://www.anzctr.org.au/). The primary and secondary outcomes were registered as were the exclusion criteria listed under the patient selection subheading.

Troponin measurement

The POC system (i-Sta;, Abbott Laboratories, Abbott Park, Illinois, USA) requires 10 minutes to analyse a sample.[17–19] Two units allowed for simultaneous samples to be run without delay. Results are automatically downloaded to a research database.

The central laboratory used the Beckman Coulter Accu TnI assay (Beckman Coulter, Fullerton, California, USA).[20 21] Samples from the ED are marked high priority, and delivered by pneumatic tube. The minimum time from sample dispatch to result is 50 minutes. At the larger site (JHH), this is available 24 h a day; the second study hospital (Belmont) laboratory closes at midnight, and uses a courier until 08:00 hours adding approximately 1 h to the turnround time.

Outcome measures

The primary outcome measure was patient LOS. This was assessed by downloading data from the ACS audit computer database. Length of stay was the time of physical arrival to departure from the ED, either to an inpatient bed or discharge. Statistical analyses were performed using SAS (version 9, SAS Institute) and Stata (version 10, Stata Corp) software.

Statistical analysis

Univariate analyses of continuous data were performed using student t-tests when the assumption of normality was appropriate and Wilcoxon rank sum tests when the assumption was not valid. Categorical data were analysed using χ^2 tests. Shared frailty models were used to compare differences in the LOS between treatment groups. The shared frailty model is a survival analysis technique, which, in this context, allows for the adjustment of clustering within a randomised week.[22] The model was fit in Stata using the command streg group, *d*(weibull) frailty (γ) shared(week), where group is the treatment group variable and week is the clustering variable. Length of stay was also analysed as the percentage of patients meeting the target of 8 h or less. The primary analysis was intention to treat, meaning that patients were analysed according to the week of randomisation regardless of whether they had their troponin measured by POC or not. A secondary, 'per-protocol' analysis of LOS was also conducted using all patients but was analysed according to whether the POC machine was used or not, irrespective of week of attendance.

The original sample size estimate assumed a SD of 1.5 h, p=0.05, power of 80%, 1 : 1 randomisation, and a design effect of 3, yielding approximately 300 participants per group to allow detection of a difference of approximately 35 minutes, and approximately 450 participants per group to allow the detection of a difference of approximately 30 minutes.

RESULTS

A total of 1194 patients with possible ACS attended the study hospitals during the 12-week period (figure 1).

Patients in both groups were similar with respect to age, troponin level, gender and the hospital they attended (table 1). One patient received a POC measurement during a non-allocated week.

In the weeks randomised to no POC, 445 patients had a valid troponin measure versus 467 patients in the weeks randomised to availability of POC. No patients were lost to follow-up. All patients were analysed as allocated. Figure 2 shows box plots of the LOS by the week and presence of intervention.

Intention to treat analysis

Length of stay for the two groups is shown as a Kaplan–Meier curve in figure 3; the data had a skewed distribution and non-parametric methods of statistical analysis were used. Patients were also clustered within randomised weeks and therefore a survival analysis technique using a frailty model was considered appropriate to take account of the correlated data. Figure 2 shows the median LOS by week for each centre, and indicates that there were no major differences in LOS from week to week at each centre due to other factors, for example, staffing levels, access block, etc.

In the weeks when POC was available, patients tended to have a shorter LOS than in the weeks when POC was not available, irrespective of whether LOS was measured as

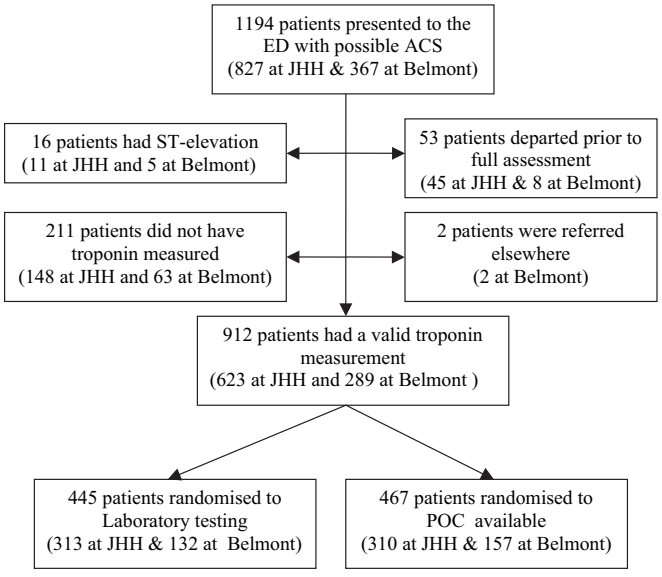

Figure 1 Random assignment of patients. ACS, Acute coronary syndrome; ED, emergency department; JHH, John Hunter Hospital; POC, point of care.

Table 1 Characteristics of patients included in the trial

Baseline characteristic			Laboratory, no POC (n=445)	POC available (n=467)
Age (years)		Median (min, max)	62 (25, 99)	60 (25, 101)
Troponin level		Median (min, max)	0.2 (0, 18.5)	0.2 (0, 24.3)
Gender	Female	n (%)	224 (50.3%)	223 (47.8%)
	Male	n (%)	221 (49.7%)	244 (52.2%)
Hospital	JHH	n (%)	313 (70.3%)	310 (66.4%)
	Belmont	n (%)	132 (29.7%)	157 (33.6%)
Method	POC (±) laboratory	n (%)	1 (0.2%)	212 (45.4%)
	Laboratory only	n (%)	444 (99.8%)	255 (54.6%)

JHH=John Hunter Hospital; **POC**=point of care.

a continuous variable or as the percentage of patients meeting the target of less than 8 h (figure 2, table 2).

The median LOS was 6.4 h in the POC group compared with 7.2 h in the central laboratory group; as a percentage meeting the target time of 8 h or less, the values were 71% and 60%, respectively. After adjustment, the observed difference between groups for LOS as a continuous measure was no longer statistically significant (p=0.063), but the percentage meeting the target of less than 8 h remained significant (p=0.007). Confidence intervals for the median times (table 2) are calculated from simulation methods, whereas the p value is based on the non-parametric Wilcoxon rank sum test. This explains the discrepancy between the significance of the time difference (48 minutes, with CI not overlapping 0) and the non-significance of the direct p value (p=0.063); such discrepancies between methods can occur when the result is on the borderline of significance and, in order to avoid type 1 error, we have chosen the more conservative test.

Given that the gains from POC may be more evident in sites where laboratory facilities are not available around the clock, we performed a subgroup analysis by site. The difference between the POC and laboratory groups was greater at the site without 24-h laboratory services (Belmont) compared with the site with such services (JHH); again, after adjustment for clustering, the difference was not statistically significant when LOS was measured as a continuous variable, but was significant when measured as percentage meeting the less than 8-h target (table 2).

Per-protocol analysis

Approximately half of patients (45.4%) during the POC allocated weeks actually had a POC troponin performed. This lower-than-expected uptake may have biased the results towards the null, that is, minimised the potential difference between the groups. In order to explore this, we performed a 'per-protocol' analysis, comparing those who actually had a result on the POC machine to those who had a laboratory result, regardless of week. This analysis showed no significant difference between the two groups (see table 3); in fact, the point estimate for LOS was slightly higher for the POC group than the central laboratory group.

We believe this was due to a selection bias in using the POC device during the weeks it was available. In particular POC appears to have been used for patients who were less likely to be in need of hospitalisation; 91% of patients who had their troponin measured by the POC device were discharged, compared with 70% of patients when both methods were used and 67% of patients when troponin was only measured by the laboratory.

DISCUSSION

We demonstrated time savings of approximately 48 minutes, out of an average LOS of almost 7 h, although this was not significant after adjusting for clustering. Using the Health Department target of discharge within 8 h, we found a statistically significant absolute increase of 10% meeting this outcome in the POC group. This may be a small increase but represents 6–12 h in ED monitored beds each day with attendant effects on safety and efficiency of patient treatment.[23] As expected, the difference was more marked at the site where pathology was not available around the clock; it is in these situations when the most potential gains could be made.

It is important to note that the difference seen between the two groups in our study probably represents an underestimate of the potential gains. This is evidenced by the fact that the majority of patients during the POC allocated weeks (53%) continued to receive only the laboratory troponin measure. The potential reasons for this are:

- Mistrust of the POC machine. Nursing staff anecdotally noted that doctors were often not acting upon the results of

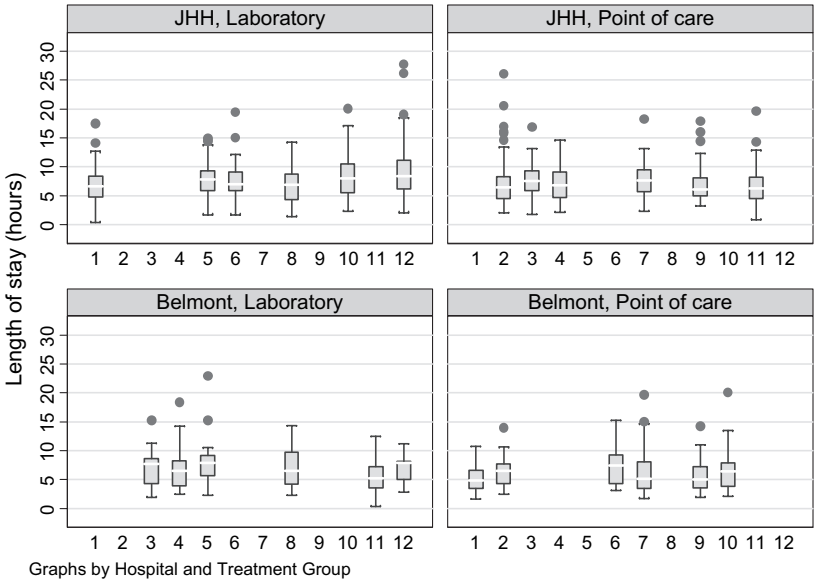

Figure 2 Box plots of length of stay by hospital and treatment group. JHH, John Hunter Hospital.

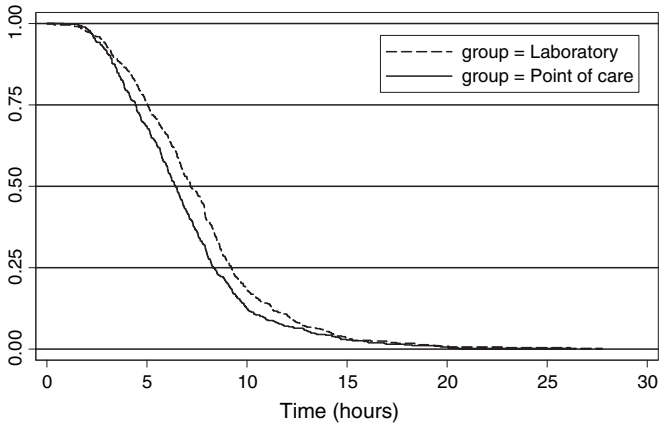

Figure 3 Kaplan–Meier curve of length of stay by treatment group.

the POC system, but rather waiting for a confirmatory result from the laboratory.

- Unfamiliarity. Physicians perhaps needed more training than was given as part of the validation study and more time to effect behaviour change than the 4 months that had elapsed.
- Time pressure on staff. Although the POC machine is faster, providing results in 10 minures, this was time required of the medical or nursing staff who could have otherwise continued with their other work.

These factors may have led to a complex pattern of POC use, as evidenced by the fact that the per-protocol analysis showed no significant difference, and indeed a trend to paradoxically longer times for the POC group. The increased use of the POC device for patients ultimately discharged suggests the presence of selection bias. These patients tend to stay longer while waiting for biomarkers, whereas more obviously unwell patients have earlier disposition decisions. The per-protocol analysis may also be confounded given the difference in LOS between sites (regardless of troponin type) and the difference in POC use between sites. For these reasons, we believe that the per-protocol analysis is not reliable.

By reducing the time to availability of the test result, POC testing for troponin holds the promise of speeding up patient treatment and disposition. Despite this, uptake has been slow in many ED. A 2004 survey of one third of all US hospitals over 150 beds found that uptake of POC was less than expected by manufacturers. Cardiac markers were more frequently evaluated but then not adopted than any other test panel.[24] While the study was not designed to examine the reasons behind this effect, our findings support the possibility that a variable degree of clinician enthusiasm and trust in POC troponin is one of the reasons behind its less than universal implementation.[2]

Table 2 Comparison of the LOS outcome between patients randomised to POC versus laboratory (intention to treat analysis)

LOS	Patient population	Laboratory	POC	Difference (95% CI)	Adjusted p value*
Median	JHH	7.2	6.8	0.4 (−0.3 to 1.1)	0.260
	Belmont	7.2	5.7	1.5 (0.4 to 2.6)	0.101
	Combined	7.2	6.4	0.8 (0.2 to 1.4)	0.063
n (%) <8 h	JHH	181 (57.8)	206 (66.5)	8.6% (1.0 to 16.2)	0.051
	Belmont	88 (66.7)	125 (79.6)	13.0% (2.7 to 23.1)	0.007
	Combined	269 (60.4)	331 (70.8)	10.4% (4.3 to 16.6)	0.007

*Adjusted for clustering.
JHH=John Hunter Hospital; **LOS**=length of stay; **POC**=point of care.

Table 3 Comparison of LOS between patients whose troponin was measured using POC and those whose troponin was measured in the laboratory (per-protocol analysis)

LOS	Laboratory (n=699)	POC (n=213)	p Value	Adjusted p value*
Median (min, max)	6.7 (0.35, 27.8)	7.1 (1.6, 20.1)	0.244	0.403
Number (%) <8 h	462 (66)	138 (65)	0.725	0.631

*Adjusted for clustering by week and by site.
LOS=length of stay; **POC**=point of care.

LIMITATIONS

Neither institution in this study has a dedicated chest pain unit. Patients remain in the ED until they are either discharged or transferred to an inpatient bed. This may limit external validity with respect to those ED that operate physically separate areas for chest pain assessment.

We used cluster randomisation by weeks rather than by individual patients. Individual randomisation was thought to be impractical due to likely protocol violations. The significant disadvantage was that the intervention was not mandatory and approximately half the patients seen during allocated weeks did not receive a POC reading, potentially reducing any measured effect, and biasing our results towards the null.

CONCLUSIONS

There was a non-significantly shorter LOS for those allocated to the POC group, particularly in the setting where central laboratory services are not available 24 h a day; this effect reached significance when LOS was measured as percentage discharged within 8 h rather than as a continuous variable, and remained significant after adjusting for clustering by site and week. There was also a paradoxical trend to longer times in the 'per-protocol' analysis, indicating a complex pattern of behaviour around ordering POC tests. This may have been selective use of the POC assay for patients who seemed at lower risk and were more likely to be discharged. We suggest that successful introduction of POC testing for troponin requires not just a comprehensive training and maintenance programme but also an effective initiative to change the clinical culture surrounding its use.

Acknowledgements The authors acknowledge the hard work of Linda Murray and Amanda Chapman; the study research nurses.

Contributors CL and CH conceived the study; CL, CH, JA and JM designed the methodology; CL and CH oversaw the conduct of the trial; CL, JA and PM processed the data. All authors contributed substantially to the manuscript.

Funding This study was funded by the NSW government, Department of Health.

Ethics approval Ethics permission, and exemption from patient consent, was granted by our regional ethics committee.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. **Fesmire FM,** Decker WW, Diercks DB, *et al*. American College of Emergency Physicians Clinical Policies Subcommittee (Writing Committee) on Non-ST-Segment Elevation Acute Coronary Syndromes. Clinical policy: critical issues in the evaluation and management of adult patient with non-ST-segment elevation acute coronary syndromes. *Ann Emerg Med* 2006;**48**:270–301.
2. **Anderson JL,** Adams CD, Antman EM, *et al*. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non–ST-elevation myocardial infarction 2007. *J Am Coll Cardiol* 2007;**50**:1–157. (see section *2.2.8.2.1.2 Bedside Testing for Cardiac Markers*).
3. **Morrow DA,** Cannon CP, Jesse RL, *et al*. National Academy of Clinical Biochemistry Laboratory Medicine Practice Guidelines: clinical characteristics and utilization of biochemical markers in acute coronary syndromes. *Clin Chem* 2007;**53**:552–74.
4. **Singer AJ,** Ardise J, Gulla J, *et al*. Point-of-care testing reduces length of stay in emergency department chest pain patients. *Ann Emerg Med* 2005;**45**:587–91.
5. **Straface AL,** Myers JH, Kirchick HJ, *et al*. A rapid point of care marker testing strategy facilitates the rapid diagnosis and management of chest pain patients in the emergency department. *Am J Clin Pathol* 2008;**129**:788–95.

6. **Cramer GE,** Kievit PC, Brouwer MA, *et al*. Lack of concordance between a rapid bedside and conventional laboratory method of cardiac troponin testing: impact on risk stratification of patients suspected of acute coronary syndrome. *Clin chim acta* 2007;**381**:164—6.
7. **Ryan RJ,** Lindsell CJ, Hollander JE, *et al*. A multicenter randomized controlled trial comparing central laboratory and point-of-care cardiac marker testing strategies: the Disposition Impacted by Serial Point of Care Markers in Acute Coronary Syndromes (DISPO-ACS) Trial. *Ann Emerg Med*. Published Online First. 2008 Aug 6. doi:10.1016/j.annemergmed.2008.06.464. (accessed 5 Nov 2008).
8. **Lee-Lewandrowski E,** Corboy D, Lewandrowski K, *et al*. Implementation of a point-of-care satellite laboratory in the emergency department of an academic medical center. Impact on test turnaround time and patient emergency department length of stay. *Arch Pathol Lab Med* 2003;**127**:456—60.
9. **Kendall J,** Reeves B, Clancy M. Point of care testing: randomised controlled trial of clinical outcome. *BMJ* 1998;**316**:1052—7.
10. **Singer AJ,** Viccellio P, Thode HC Jr. Introduction of a stat laboratory reduces emergency department length of stay. *Acad Emerg Med* 2008;**15**:324—8.
11. **Renaud B,** Maison P, Ngako A, *et al*. Impact of point-of-care testing in the emergency department evaluation and treatment of patients with suspected acute coronary syndromes. *Acad Emerg Med* 2008;**15**:216—24.
12. **Caragher TE,** Fernandez BB, Jacobs FL, *et al*. Evaluation of quantitative cardiac biomarker point-of-care testing in the emergency department. *J Emerg Med* 2002;**22**:1—7.
13. **McCord J,** Nowak RM, McCullough PA, *et al*. Ninety-minute exclusion of acute myocardial infarction by use of quantitative point-of-care testing of myoglobin and troponin I. *Circulation* 2001;**104**:1483—8.
14. **Murray R,** Leroux M, Sagba E. Effect of point of care testing on length of stay in an adult emergency department. *J Emerg Med* 1999;**17**:811—14.
15. **Gillespie R.** *Manufacturing knowledge: a history of the Hawthorne experiments*. Cambridge: Cambridge University Press, 1991.
16. **Aroney C,** Aylward P, Kelly AM. Guidelines for the management of acute coronary syndromes. *Med J Aust* 2006;**184**(8 Suppl):S1—32.
17. **Apple FS,** Murakami M, Christenson R, *et al*. Analytical performance of the i-STAT cardiac troponin I assay. *Clin Chim Acta* 2004;**345**:123—7.
18. **Bock JL,** Singer AJ, Thode HC Jr. Comparison of emergency department patient classification by point-of-care and central laboratory methods for cardiac troponin I. *Am J Clin Pathol* 2008;**130**:132—5.
19. **Apple FS,** Ler R, Chung A, *et al*. Point-of-care i-STAT cardiac troponin I for assessment of patients with symptoms suggestive of acute coronary syndrome. *Clin Chem* 2006;**52**:322—5.
20. **Venge P,** Lagerqvist B, Diderholm E, *et al*. Clinical performance of three cardiac troponin assays in patients with unstable coronary artery disease (a FRISC II substudy). *Am J.Cardiol* 2002;**89**:1035—41.
21. **Morrow D,** Rifai N, Marc S, *et al*. Evaluation of the AccuTnI Cardiac Troponin I Assay for Risk Assessment in Acute Coronary Syndromes. *Clin Chem* 2003;**49**:1396—8.
22. **Klein JP,** Moeschberger ML. *Survival analysis techniques for censored and truncated data*. New York: Springer, 1997.
23. **Graff LG,** Wang Y, Borkowski B, *et al*. Delay in the diagnosis of acute myocardial infarction: effect on quality of care and its assessment. *Acad Emerg Med* 2006;**13**:931—8.
24. **Diller W.** Status Check: Point-of-Care Testing in Hospitals, Start Up 2004, http://sis.windhover.com (accessed 27 Aug 2008).

Images in emergency medicine

Emergency retinal pallor

A 76-year-old woman presented with sudden visual loss in her right eye. There was no history of malaise, neck stiffness, temporal scalp tenderness, jaw claudication, limb weakness or headache. Visual acuity measured 6/60 right eye and 6/9 left eye. There was a central, sectoral area of retinal pallor involving the right macula. The optic nerve appeared swollen nasally (figure 1). The left eye was unremarkable.

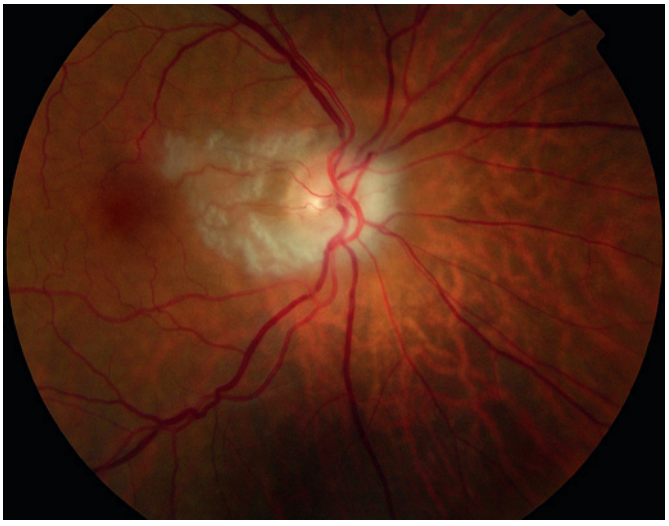

Figure 1 Right eye funduscopy showing central, sectoral area of retinal pallor and nasal optic nerve swelling.

Full blood count was normal. Erythrocyte sedimentation rate measured 122 mm/h and C-reactive protein 26 mg/l. Giant cell arteritis (GCA) was confirmed on temporal artery biopsy histology. Cilioretinal infarcts have a similar aetiology to anterior ischaemic optic neuropathy and, although GCA usually presents as anterior ischaemic optic neuropathy, it must be excluded as a potential cause. This emergency ophthalmic presentation, with raised inflammatory markers, requires urgent steroid treatment to avoid other serious GCA sequelae including contralateral blindness, aortitis and fatal brainstem infarctions.

P Moradi, A Chandra, N Islam

Queen's Hospital, Romford, UK

Correspondence to Phillip Moradi, Moorfields Eye Hospital, London EC1V 2PD, UK; pmoradi@hotmail.com

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; not externally peer reviewed.

Accepted 27 April 2009

Emerg Med J 2010;**27**:198. doi:10.1136/emj.2009.073320

Point of care troponin decreases time in the emergency department for patients with possible acute coronary syndrome: a randomised controlled trial

Conrad Loten, John Attia, Carolyn Hullick, et al.

Emerg Med J 2010 27: 194-198
doi: 10.1136/emj.2008.069427