

Point-of-care creatinine testing for the detection and monitoring of chronic kidney disease:

Diagnostic Technology Update

Oghenekome Gbinigie¹, Christopher P. Price², Carl Heneghan², Ann Van den Bruel², Annette Plüddemann²

¹John Radcliffe Hospital, Oxford OX3 9DU.

²Diagnostic Evidence Co-operative Oxford, Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, OX2 6GG.

Correspondence: Dr. Annette Plüddemann; e-mail: annette.plueddemann@phc.ox.ac.uk

Clinical Question

What is the accuracy and utility of creatinine point-of-care (POC) tests in the detection and monitoring of Chronic Kidney Disease (CKD), compared to standard practice using laboratory blood tests?

Advantages over Existing Technology

Creatinine POC testing could facilitate primary care CKD screening, allowing rapid results, and immediate feedback to the patient; and up-to-date renal function testing would allow immediate dose reduction of medications excreted via the kidneys in patients with renal impairment¹. POC creatinine testing allows patients to monitor their renal function at home, facilitating more frequent testing and earlier detection of deterioration.

Details of Technology

Our search identified 10 creatinine POC devices, a summary of their properties can be found at <http://www.oxford.dec.nihr.ac.uk/reports/horizon-scanning/point-of-care-creatinine-testing-for-the-detection-and-monitoring-of-chronic-kidney-disease>. Creatinine POC devices allow rapid (as fast as 30 seconds) measurement of creatinine levels from fingerprick blood samples.

Patient Group and Use

- Screening for CKD in high risk patients.
- Adjustment of doses of renal excreted medication and monitoring renal function in patients with CKD.
- Detection of acute kidney injury and acute-on-chronic renal failure.

Importance

CKD has an annual incidence rate of 1,701 per million population in the UK and a prevalence of 6% . Incidence increases with age and >2% of the NHS budget is spent on renal replacement therapy (dialysis and transplantation)(<http://www.nice.org.uk/nicemedia/live/12069/42117/42117.pdf> NICE clinical guideline 73.). NICE emphasises early detection through screening at-risk groups, e.g. patients with Diabetes.

Previous Research

Accuracy compared to existing technology

Most studies reviewed found creatinine POC devices to be reliable alternatives to laboratory testing, however some noted a tendency of devices to underestimate renal impairment^{2 3 4}, as well as poor inter-device concordance⁵.

A study⁶ comparing creatinine levels from two Nova Statsensor devices (A and B) against laboratory values in 401 consecutive patients undergoing contrast CT scans showed correlation between the two POC devices differed between two study centres (mean $r=0.93$; $p < 0.0001$], vs mean $r=0.84$; $p < 0.0001$). There were significant differences between creatinine levels measured by POC devices and laboratory methods (Overall $r=0.89$; $p < 0.0001$), with better correlation with normal renal function (venous creatinine level $\geq 106 \mu\text{mol/L}$, $r=0.91$) compared with impaired renal function (venous creatinine level $< 106 \mu\text{mol/L}$; $r=0.63$).

A study of 100 patients evaluating the Nova Statsensor in community CKD screening found a 13% (7/53) false negative rate for detecting eGFRs $< 60 \text{ mL/min}$ using the Nova Statsensor compared to laboratory methods, meaning these CKD patients would be missed in screening.

eGFRs calculated from Nova Statsensor creatinine values were compared with laboratory measurements in 113 patients undergoing contrast enhanced radiology scans. The mean POC creatinine value was slightly lower than the laboratory value: $62.8 \pm 17.6 \mu\text{mol/L}$ (range 30–121) versus $72.5 \pm 21 \mu\text{mol/L}$ (range 36–142) ($p < 0.0001$). Another study comparing Nova Statsensor creatinine values to laboratory analysis in 161 patients (non-, pre- and post-dialysis patients), found good concordance ($R^2=0.9328$). Although creatinine POC values were consistently lower than laboratory measures, the authors concluded that the device provided reliable measurement across a clinically relevant range.

Correlation between eGFRs calculated from creatinine values generated by the POC i-STAT and laboratory values¹¹ using 40 discarded and anonymised samples, (eGFR values calculated using the CKD-EPI formula). Excellent inter-device agreement was found ($r^2=0.99$), with an average bias of $-2.18 \text{ mL/min/1.73m}^2$.

Creatinine values from 31 discarded blood samples were compared using the i-STAT and with central laboratory values (in a multi-site radiology department¹². Linear regression analysis showed excellent correlation; r^2 of 0.99. The authors concluded that i-STAT POC devices could help improve operational efficiency, providing accurate, up-to-date creatinine/eGFR values in patients presenting for scans requiring contrast media.

Impact compared to existing technology

in a screening study of individuals at high risk of CKD (previous diagnosis of diabetes or hypertension, age > 50 years, first-degree relatives with end-stage kidney disease), using point-of-care creatinine, proteinuria, haematuria and albuminuria testing, findings suggestive of CKD were identified in 20.4%⁴. Regarding acceptability, 99% found it convenient and 96% felt immediate results and feedback helped them understand their condition.

In a Dutch community pharmacy setting,¹ Forty-six elderly individuals using renal excreted drugs for diabetes or cardiovascular disease underwent POC creatinine testing, with subsequent dose

adjustment of renal excreted medications when creatinine levels were elevated. Of the 44 patients that underwent POC creatinine testing, 24 were eligible for dose adjustment and acceptability of POC testing by the study population was good.

What this technology adds

Creatinine POC tests could be integrated into a primary care initiative, with an annual (or more frequent) POC creatinine test for high risk patients, allowing immediate action on significant results. Creatinine POC testing in primary care could make for safer prescribing, theoretically reducing inappropriate prescription or dosages of medications excreted via the kidneys. However, there is currently no robust evidence that is able to demonstrate the technology's impact on patient outcomes and service delivery, including negative and unforeseen consequences.

Methodology

Standardised methodology was applied in writing this report, using prioritisation criteria and a comprehensive, standardised search strategy, and critical appraisal. Full details of these are available from www.madox.org.

Acknowledgements

The authors would like to thank Nia Roberts for helpful discussions.

Funding

This article presents independent research funded by the National Institute for Health Research (NIHR) Diagnostic Evidence Co-operative Oxford. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. The study sponsors had no role in the design, analyses or reporting of the study. The researchers retained complete independence in the conduct of this study.

Competing Interests

The authors declare no competing interests.

References:

¹ Geerts AFJ, De Koning FHP, De Vooght KMK, Egberts ACG, De Smet PAGM, van Solinge WW. Feasibility of point-of-care creatinine testing in community pharmacy to monitor drug therapy in ambulatory elderly patients. *Journal of Clinical Pharmacy & Therapeutics*. 2013; 38(5): 416-422.

² Morita S, Suzuki K, Masukawa A, Ueno E. Assessing renal function with a rapid, handy, point-of-care whole blood creatinine meter before using contrast materials. *Japanese Journal of Radiology*. 2011; 29(3): 187-193.

³ Schnabl KL, Bagherpoor S, Diker P, Cursio C, Dubois J, Yip PM. Evaluation of the analytical performance of the Nova StatSensor creatinine meter and reagent strip technology for whole blood testing. *Clinical Biochemistry*. 2010; 43(12): 1026-1029.

⁴ Shephard M, Peake M, Corso O, Shephard A, Mazzachi B, Spaeth B, Barbara J, Mathew T. Assessment of the Nova StatSensor whole blood point-of-care creatinine analyzer for the measurement of kidney function in screening for chronic kidney disease. *Clinical Chemistry & Laboratory Medicine*. 2010; 48(8): 1113-1119.

⁵ Straseski JA, Lyon ME, Clarke W, Dubois JA, Phelan LA, Lyon AW. Investigating interferences of a whole-blood point-of-care creatinine analyzer: comparison to plasma enzymatic and definitive creatinine methods in an acute-care setting. *Clinical Chemistry*. 2011; 57(11): 1566-1573.

⁶ Haneder SA, Gutfleisch A, Meier C, Brade J, Hannak D, Schoenberg SO, Becker CR, Michaely HJ. Evaluation of a handheld creatinine measurement device for real-time determination of serum creatinine in radiology departments. *World journal of radiology*. 2012 July; 4(7): 328-334.

¹¹ Naugler C, Redman L, Sadzradeh H. Comparison of estimated glomerular filtration rates using creatinine values generated by iSTAT and Cobas6000. *Clinica Chimica Acta*. 2014; 429:79-80.

¹² Lee-Lewandrowski E, Chang C, Gregory K, Lewandrowski K. Evaluation of rapid point-of-care creatinine testing in the radiology service of a large academic medical center: impact on clinical operations and patient disposition. *Clinica Chimica Acta*. 2012; 413(1-2):88-92.