Results From 16 Years of Quality Surveillance of Urine Albumin to Creatinine Ratio Testing for a National Indigenous Point-of-Care Testing Program

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• ***Context.***—**The burden of chronic kidney disease in Indigenous Australians is 7.3 times higher than that of non–Indigenous Australians. If chronic kidney disease is detected early and managed, deterioration in kidney function can be reduced. Urine albumin to creatinine ratio is a key marker of early renal damage.**

Objective.—**To report on 16 years of analytic quality of urine albumin to creatinine ratio testing on Siemens DCA devices enrolled in the national Quality Assurance for Aboriginal and Torres Strait Islander Medical Services point-of-care testing program.**

Design.—**Quality Assurance for Aboriginal and Torres Strait Islander Medical Services participants are required to test 2 quality assurance samples each month across two 6-monthly testing cycles per year. Participants also test 2 quality control samples monthly.**

Results.—**The percentage of urine albumin, creatinine, and albumin to creatinine ratio results for quality assurance point-of-care testing that were within assigned allowable limits of performance averaged 96.9%, 95.9%, and 97.5%, respectively. The percentage acceptable quality control results for urine albumin and creatinine averaged 93.5% and 86.8%. The median imprecision for urine albumin, creatinine, and albumin to creatinine ratio quality assurance testing averaged 5.5%, 4.1%, and 3.3%, respectively, and the median within-site imprecision for quality control testing averaged 5.4%, 4.3%, and 5.7%, respectively, for the low sample and 4.0%, 4.1%, and 4.5%, respectively, for the high sample.**

Conclusions.—**For 16 years the DCA system has proven to be reliable and robust and operators at Aboriginal medical services have demonstrated they are able to conduct point-of-care testing for urine albumin to creatinine ratio that consistently meets analytic performance standards.**

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The burden of chronic kidney disease in Indigenous Australians is 7.3 times higher than in non–Indigenous Australians and the onset of kidney disease occurs at an earlier age in Indigenous Australians. Rates of kidney disease are highest in very remote areas (37%) compared to major cities (12%).[1]

Kidneys may become damaged permanently by chronic conditions such as high blood pressure or elevated blood glucose levels that occur in people with poorly controlled diabetes. End-stage kidney disease (ESKD) occurs when the kidneys have little or no remaining function. People with ESKD require dialysis or kidney transplant, expensive options that have a marked impact on quality of life.[2] In 2011–2015 ESKD was 6.8 times more common in Aboriginal and Torres Strait Islander people than in non-Indigenous people.[3]

If chronic kidney disease is detected early and managed, deterioration in kidney function can be reduced and may even be reversed. An increased amount of albumin in the urine (albuminuria) is a key marker of kidney damage. Urine albumin to creatinine ratio (ACR) accurately predicts renal and cardiovascular risks in population studies, with the urine ACR test widely accepted as a key marker for early renal disease (microalbuminuria).[4] Kidney Health Australia recommends annual measurement of urine ACR in Indigenous people with diabetes, with a urine ACR of between 22.1 and 221 mg/g (2.5–25 mg/mmol) in males and 31 to 310 mg/g (3.5–35 mg/mmol) in females indicative of microalbuminuria.[5]

Point-of-care (POC) testing allows pathology testing to occur on site in health services with results available rapidly for immediate clinical management. Urine ACR POC testing has been available in the national Quality Assurance for Aboriginal and Torres Strait Islander Medical Services

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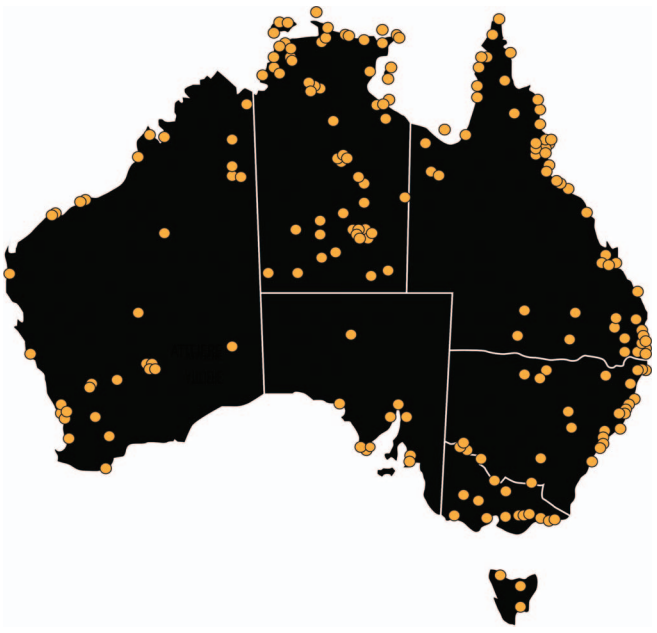

Figure 1. *General location of Indigenous medical services participating in the Quality Assurance for Aboriginal and Torres Strait Islander Medical Services program in 2018.*

(QAAMS) Program since 2003.[6] In this program, Aboriginal health professionals (Indigenous health workers who live and work in the community and have a qualification in primary health care) conduct POC testing on clients with diabetes, on site, at Indigenous medical services across Australia. There are currently 180 devices performing urine ACR POC testing, with most located in rural and remote Australia, where access to pathology testing and fast turnaround for results are difficult to obtain.[7]

There are limited data in the global literature on the performance of the urine ACR test. This article reports on the analytic quality for urine ACR testing on DCA devices enrolled in the QAAMS Program for 16 years (2003–2018).

METHODS

The quality management framework for QAAMS involves training and competency certification for all device operators, monthly quality control (QC) and external quality assurance (QA) testing, and continuous technical support for field operators.

Point-of-Care Testing Device

From the inception of the QAAMS program, 2 models of the Siemens DCA (Siemens Healthcare Diagnostics Inc, Tarrytown, New York) POC testing device have been used. Until mid-2009, urine ACR testing was conducted by using the DCA 2000 model. From mid-2009 the DCA 2000 was gradually replaced by the DCA Vantage, with the DCA Vantage the only model in use from the start of 2015. Both models use identical analytic methodology. Urine albumin is measured via immunoturbidimetry (using polyclonal goat antiserum) and urine creatinine is determined via spectrophotometry using the Benedict-Behre chemical reaction (where creatinine complexes with 3,5-dinitrobenzoic acid). Urine ACR is a calculated value that, in Australia, is reported in the units of mg/mmol. The DCA Vantage has a larger display screen, improved functionality for data entry, and the capacity for electronic transfer of results.

Training of Device Operators

Device operators in QAAMS are trained by using 1 of 3 methods: Face-to-face (on-site clinic visits and annual workshops), teleconference/videoconference, or online training using e-learning. Each flexible method of training involves a theory section consisting of a training presentation and/or training videos that takes the participant through the principles and practice of patient, QC, and QA testing, followed by a written competency assessment. The theory section is then followed by a practical component where participants are required to successfully complete a patient, QC, and QA test. Completion of both the theory and practical sections certifies the participant as a qualified POC testing device operator in QAAMS for 2 years.

Operators in the QAAMS Program have access to a wide range of training resources. These include a hard copy training manual and posters depicting simple step-by-step instructions on how to conduct patient, QC, and QA tests. Training videos are available on the QAAMS Web site (qaams.org.au; accessed January 14, 2020), and a USB device containing the training videos is also provided to operators.

Quality Assurance Testing

Participating QAAMS services receive their QA kits at the start of each calendar year from the Royal College of Pathologists of Australasia Quality Assurance Programs (RCPAQAP). Each urine ACR QA kit contains 24 lyophilized samples and 24 tubes of reconstitution fluid. The 24 samples comprise 6 linearly related levels that are tested in duplicate during each 6-monthly cycle per year (January to June and July to December). The QA samples cover a range of approximately 1 to 28 mg/dL (10–280 mg/L) for urine albumin and 17 to 226 mg/dL (1.5–20 mmol/L) for urine creatinine. Each QA sample has an assigned target value and limits for acceptable performance set by the RCPAQAP that are as follows: ±0.4 up to 3.0 mg/dL (±4.0 up to 30.0 mg/L) and ±12% above 3 mg/dL (>30.0 mg/L) for urine albumin; ±9.1 up to 113 mg/dL (±0.8 up to 10.0 mmol/L) and ±8% above 113 mg/dL (>10.0 mmol/L) for urine creatinine; and ± 4.42 mg/g (±0.50 mg/mmol) up to 31 mg/g (3.50 mg/mmol) and ±15% above 31 mg/g (3.50 mg/mmol) for urine ACR. QAAMS participants are required to test 2 specific samples each month throughout the two 6-monthly testing cycles per year.

At the start of each month, each service is emailed a monthly summary report that summarizes their QA testing performance for the previous month. The reports, the design of which has been specifically tailored for the QAAMS Program to ensure cultural safety and enable easy interpretation of the report, contain tabular and graphical information on analytic performance.

The quality of the QA testing is monitored monthly by the QAAMS quality coordinator and scientists from the RCPAQAP. At the completion of each testing cycle the following key performance indicators are calculated:

1. Percentage acceptable results (the percentage of results within the allowable limits of performance); this indicator provides a measure of the accuracy of QA testing for urine ACR.
2. The median within-site imprecision (coefficient of variation [CV%]); this indicator is defined as the ratio of the standard deviation (SD) to the mean, expressed as a percentage, and is used as a standard measure of imprecision across all proficiency testing programs run by the RCPAQAP, as well as QAAMS.

Quality Control Testing

Participants in QAAMS are required to test QC samples monthly. The samples used are the Siemens Urine ACR Quality Control "low" and "high" samples. These samples contain 2 levels of albumin and creatinine, the "low" QC reflecting a normal urine ACR value and the "high" control reflecting microalbuminuria.

The allowable performance limits for QC testing are as follows:

Urine albumin, within ±12.5% from the target value (set by the manufacturer for each lot number of QC) for acceptable analytic performance (color coded as the "green" zone on the QAAMS QC interpretation guide); between ±12.5% and 17.5% from the target value for the warning or "yellow" zone, where analytic performance needs to be monitored; and greater or less than 17.5% from the target value for unacceptable analytic performance ("red" zone). Point-of-care testing operators must stop patient testing if their QC test result is in the red zone, contact the QAAMS quality coordinator, and not resume patient testing until the reason for poor performance has been identified and rectified.

Urine creatinine, within ±7.5% from the target value for the green zone, between ±7.5% and 12.5% from the target value for the yellow zone, and greater or less than 12.5% from target for the red zone.

Urine ACR, within ±15% from the target value for the green zone, between ±15% and 20% from the target value for the yellow zone, and greater or less than 20% from target for the red zone.

The QC limits of acceptability equate to between-site goals for total allowable error encompassing error due to inaccuracy and imprecision.[8,9] Within-service imprecision (CV%) for QC testing is reviewed at 6-monthly intervals for each service and compared with the analytic goals set by the program.

QAAMS participants now enter both QC and QA results electronically via the QAAMS Web site and receive immediate feedback on the analytic quality of testing. Feedback is provided via the color-coded system, outlined above. Results submitted electronically on the QAAMS Web site are also available immediately for review by the Quality Coordinator.

Support Services

As part of its quality management service, QAAMS provides a telephone support hotline, staffed by QAAMS scientists during normal business hours from Monday to Friday. QAAMS scientists also offer continued training, support, and advice tailored to each service based on their analytic performance, which is reviewed monthly by the QAAMS Quality Coordinator and RCPAQAP scientists.

RESULTS

The Results section comprises data from both the superseded DCA 2000 (2003–2015) and the DCA Vantage (2009–2018).

Number of POC Testing Devices and Quality Assurance Tests for Urine ACR

Since the inception of urine ACR testing in the QAAMS Program in 2003, the number of POC testing devices (DCA 2000 and/or DCA Vantages) conducting urine ACR testing at enrolled services has progressively increased from 30 in 2003 to 178 in 2018 (Figure 1). During the 32 testing cycles from 2003 to 2018 a total of 26,294 urine ACR QA samples were tested.

Percentage Acceptable Results

From the inception of the urine ACR program in QAAMS in 2003 until 2018, the percentage of urine albumin, creatinine, and ACR results for QA testing that were within the allowable limits of performance averaged 96.9% (SD, 1.7%; range, 93%–99.7%), 95.9% (SD, 1.7%; range, 91.4%–99%), and 97.5% (SD, 1.4%; range, 93%–99.6%), respectively.

The percentage acceptable QC results for urine albumin and creatinine averaged 93.5% (SD, 4.1%; range, 77%–99%) and 86.8% (SD, 3.8%; range, 79.1%–97%), respectively. From 2015 urine albumin and creatinine results only (and not ACR) were reported for QC testing on the DCA Vantage owing to a change in the testing reporting procedure on the device. Acceptable urine ACR QC results averaged 96.9% (SD, 2.6%; range, 88%–99.4%) from 2003 to 2015.

Imprecision

Figures 2 to 4 display the median within-site imprecision (CV%) for urine albumin, creatinine, and ACR QA and QC testing achieved during 16 years. Over the lifetime of QAAMS from 2003–2018, the median imprecision achieved for urine albumin, creatinine, and ACR QA testing averaged 5.5% (range, 3.8%–13 %), 4.1% (range, 3.2%–6.1%), and 3.3% (SD, 1.1%; range, 2.5%–7.6%), respectively. Since the inception of the urine ACR program the median within-site imprecision achieved for the "low" level of QC urine albumin, creatinine, and ACR testing averaged 5.4% (SD, 1.3%; range, 4.0%–8.8%), 4.3% (SD, 1.2%; range, 3.3%–9.1%), and 5.7% (SD, 1.3%; range, 4.4%–9.7%), respectively. For the "high" level of QC the imprecision averaged 4.0% (SD, 0.7%; range, 2.7%–5.7%), 4.1% (SD, 0.7%; range, 2.9%–6.7%), and 4.5% (SD, 0.5%; range, 3.8%–6.0%) during this period. In Australia the minimum analytic goal for imprecision of less than 10% for urine albumin and less than 6% for urine creatinine and less than 12% for urine ACR has been used in the QAAMS Program and the Point of Care Testing in General Practice Trial.[10]

DISCUSSION

The serious complications of diabetes, including nephropathy, continue to adversely affect Australia's Indigenous population. However, if kidney damage caused by diabetes is detected early and followed up with diligent clinical management of blood pressure (with angiotensin converting enzyme inhibitors or angiotensin II receptor blockers), glycemic control, and lipids, progression of the early disease can be prevented.[11]

The role of the urine ACR test in detecting chronic kidney disease is well established in the Australian Indigenous health setting, with Kidney Health Australia including this test in their recommendations for detection of microalbuminuria in Aboriginal and Torres Strait Islander peoples. The use of the DCA Vantage in the QAAMS Program offers convenient and timely access to urine ACR testing for Indigenous people.

Although urine ACR testing is now widespread and recommended globally, there are limited studies on the analytic quality of this key marker of early renal disease. These data from the QAAMS Program fill this important gap. During 16 years of continuous field use in the Indigenous setting, the DCA device has proven to be reliable, and robust and trained health professional staff at Aboriginal medical services across Australia have demonstrated that they are able to conduct urine ACR POC testing that consistently meets analytic performance standards, ensuring results of acceptable analytic quality are available for patient care.

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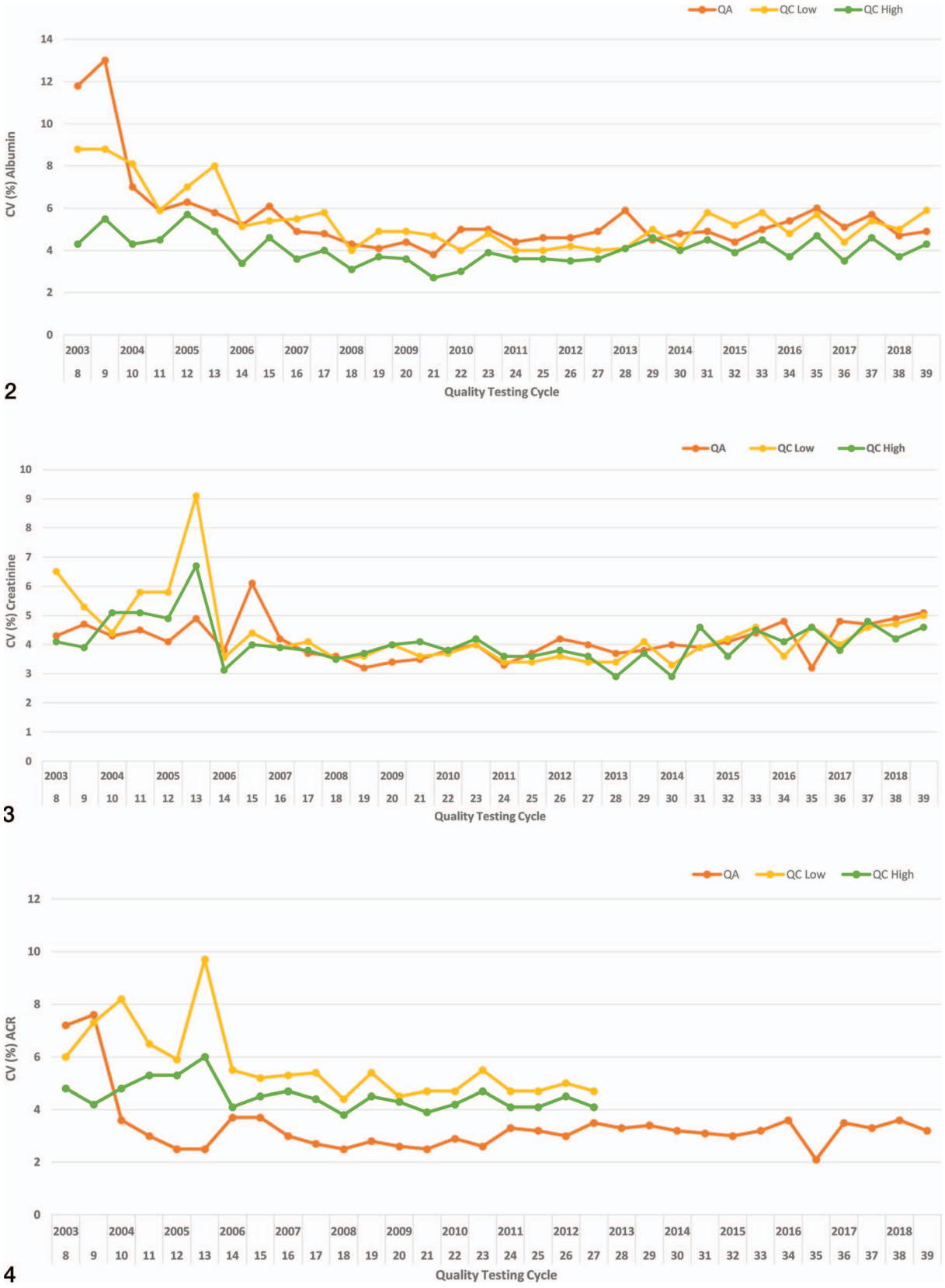

Figure 2. *Median within-site imprecision (CV%) achieved by participating Quality Assurance for Aboriginal and Torres Strait Islander Medical Services for urine albumin Quality Assurance and Quality Control testing during a 16-year period from 2003 to 2018. Abbreviations: CV%, coefficient of variation; QA, quality assurance; QC, quality control.*

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Figure 3. *Median within-site imprecision (CV%) achieved by participating Quality Assurance for Aboriginal and Torres Strait Islander Medical Services for urine creatinine Quality Assurance and Quality Control testing during a 16-year period from 2003 to 2018. Abbreviations: CV%, coefficient of variation; QA, quality assurance; QC, quality control.*

Figure 4. *Median within-site imprecision (CV%) achieved by participating Quality Assurance for Aboriginal and Torres Strait Islander Medical Services for urine albumin to creatinine ratio Quality Assurance and Quality Control testing during a 16-year period from 2003 to 2018. Abbreviations: ACR, albumin to creatinine ratio; CV%, coefficient of variation; QA, quality assurance; QC, quality control.*