Immediate pathology results now available for all remote Northern Territorians

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Abstract

Introduction: The Northern Territory (NT) Point-of-Care Testing Program commenced in 2008 in 36 remote health centres in the NT. Using the Abbott i-STAT point-of-care testing (POCT) device, this program provides immediate pathology results to participating health centres enabling rapid diagnosis and treatment or monitoring of a range of acute and chronic conditions.

In 2015, under the direction of the NT Department of Health, the program was expanded to every remote health service in the Territory. The large-scale rollout, doubling the program's size to 72 remote health services, required careful planning and innovation.

Methods: A team of scientists, professional practice nurses and rural medical practitioners who make up the NT POCT Program Management Committee coordinated the expansion. Strategies to rollout the program included: accessible training options including weekly teleconference training sessions; development of a website providing 24/7 Territory-wide access to training materials including web-streamed videos; on-site visits to provide initial device set-up, training and coordination; and the introduction of an innovative method to assist with consumable ordering (a primary obstacle for remote health services).

A survey was implemented during the rollout to determine the satisfaction of new staff completing POCT training. The analytical quality of POCT was monitored throughout the rollout period and results were compared to key performance indicators achieved by laboratories. A series of patient cases were reviewed and documented to demonstrate the cost effectiveness of POCT and provide examples where POCT had produced a defined clinical benefit.

Results: In the initial 6 months of the rollout, 158 new remote staff were trained as device operators with survey respondents expressing high satisfaction with the quality of training. The analytical quality of POCT results remained stable during the rollout period and of equivalent standard to Australian laboratories.

Improvements in outcomes for acutely ill remote patients were identified through POCT enabling more rapid diagnosis and treatment. Cost savings through preventing unnecessary medical evacuations using POCT were substantial.

Conclusion: The NT POCT Program now provides equity of access to POCT for all remote Territorians, reducing the health care disadvantage for Australians living in remote locations compared to urban areas. The strategies employed can be used to implement similar POCT networks in other areas of remote Australia and internationally.

What is known about the topic?

- Point-of-care pathology testing provides an effective means of obtaining immediate pathology testing for patients in remote locations.

What does this paper add?

- Provides insight into the successful strategies and challenges of coordinating a major rollout of a point-of-care testing network.
- Provides new information on the benefits of using point-of-care testing in remote locations.

Introduction

Australians living in remote areas experience a significantly higher burden of disease and avoidable hospitalisations compared to those living in urban areas.[1] Geographical isolation and its impact on access to health services and infrastructure are major factors contributing to the health disadvantage experienced by Australians living remotely.[2,3] The limited access to basic pathology testing for the prevention and management of chronic conditions and the triage of acute illness is a significant deficiency in health service delivery in remote locations. The nearest pathology laboratory is often located hundreds of kilometres from the remote community, with patients waiting several days and sometimes weeks for pathology results to be reported to their treating doctor.[2,4,5]

Point-of-care testing (POCT) allows pathology testing to be conducted during a patient visit with results immediately available for patient care.[6] POCT has a particular niche in rural and remote communities where access to mainstream laboratory services is generally poor and patient loss to follow-up is high.[5,7] For medical emergencies in these sectors, the speed of POCT provides critical practical and operational benefits.

The Northern Territory (NT) POCT Program commenced in 2008 as a partnership between the Flinders University International Centre for Point-of-Care Testing (ICPOCT), then known as Community Point-of-Care Services, and the NT Department of Health (DoH). The Abbott i-STAT (Abbott Point of Care, USA) device was initially introduced to 36 services to alleviate the shortfall in essential pathology tests due to a collapse in air services providing transport of pathology samples to laboratories.

The i-STAT device measures a range of pathology tests for emergency medical situations including electrolytes, urea, creatinine, cardiac troponin I, glucose, lactate, haemoglobin and blood gases. The i-STAT also tests for International Normalised Ratio (INR) for the management of patients on warfarin therapy. Warfarin is a common anticoagulation medication used in remote NT to treat the symptoms of Rheumatic Heart Disease, such as atrial fibrillation, which is highly prevalent in remote Indigenous communities.[8] The i-STAT device requires a small venous or capillary sample of less than 100 µL with all results available in 10 minutes or less.

Previous evidence from the NT POCT Program indicates the i-STAT is (i) analytically sound and equivalent to laboratory standards and (ii) has been well accepted by trained remote area nurses who conduct POCT at participating sites, with the volume of tests conducted increasing significantly each year since inception.[9,10]

In 2015, the NT Government made the decision to undertake a major rollout of the i-STAT device to the remaining 36 remote health centres (22 DoH remote health centres and 14 Aboriginal Community Controlled Health Centres [ACCHS]), more than doubling the Program's size to 72 remote health services. The decision to expand the NT POCT Program was due, in part, to the findings of a coroner's inquest into the death of a young man due to a cardiac event, in which the coroner argued the life of a young man may have been saved if POCT for troponin had been available.[11]

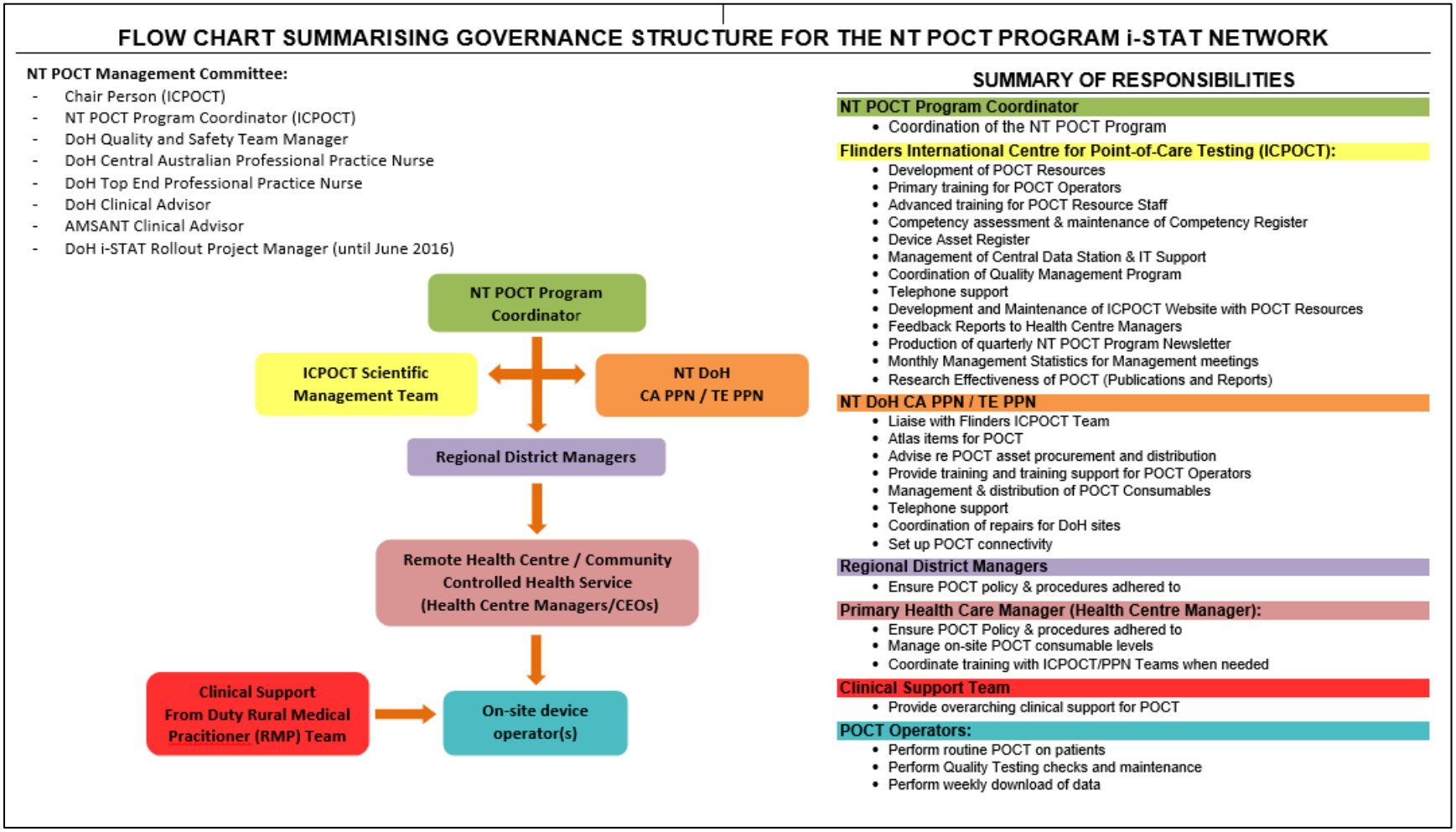
Methods

The NT POCT Program Management Committee comprises a team of scientists, Professional Practice Nurses and Rural Medical Practitioners (RMP) with the governance structure of the Program outlined in Figure 1. The ICPOCT co-ordinates the management of the following services for the i-STAT: ongoing training and competency assessment of health professional staff; management of a quality testing program; technical support; surveillance of de-identified patient results; coordination of monthly meetings and production of reports for the NT POCT Program Management Committee; and assessment and documentation of agreed research outcomes. To assist the rapid and effective rollout of new i-STAT devices to the 36 new health services, an i-STAT Rollout Project Manager was appointed to support the implementation.

A primary logistic obstacle for existing remote health services has been i-STAT consumable ordering and delivery, due mainly to the short expiration of stock, remote location of the services, limited fridge storage space and high turnover of remote staff. To assist with consumable ordering for rollout sites, several centralised hubs were established to enable the distribution of smaller numbers of consumables to surrounding health services. Additionally, regular statistics were provided as monthly feedback reports to each Primary Health Centre Manager (PHCM) to highlight the following statistics across the previous month: cartridge usage, individual operator usage of the i-STAT, common errors and participation rates in quality testing. The feedback report was designed to assist the PHCM to order stock, identify additional staff training requirements and ensure quality testing was completed timely. A survey was sent to all PHCMs receiving the report to obtain their feedback on its content and design.

Due to the significant number of remote staff from the rollout sites requiring training a series of flexible training options were developed. Primarily, training was delivered via weekly teleconference training sessions, open to all remote staff and hosted via GoToMeeting (www.gotomeeting.com), a teleconference software program that allows the trainee to view and listen to an interactive training presentation and ask questions. Alternative training options included on-site, face-to-face training sessions with a member of the NT POCT Program Management Committee or self-directed training using the training resources provided on the newly developed i-STAT webpage, hosted by the ICPOCT and providing 24/7 access to training materials including videos, step-by-step posters, troubleshooting guides and clinical protocols. After attending a training session, each trainee was required to undertake a competency assessment involving a theoretical and a practical component to test their key knowledge and ability to perform tests on the i-STAT device and obtain results of acceptable quality.

Figure 1 Governance Structure of Northern Territory Point-of-Care Testing Program



ICPOCT= International Centre for Point-of-Care Testing, DoH= Department of Health, AMSANT= Aboriginal Medical Services Alliance Northern Territory, CA = Central Australia, TE= Top End, PPN= Professional Practice Nurse.

During the i-STAT rollout period, a questionnaire to gauge satisfaction with the quality of training and to evaluate trainee confidence with using the i-STAT device was sent electronically via SoGoSurvey (www.sogosurvey.com.au) to each trainee. The survey was not compulsory and respondents could remain anonymous. The survey contained a series of short questions with respondents rating their level of satisfaction with aspects of training according to a 10-point sliding scale. A 'yes/no' question was asked about whether the trainee felt confident in using the i-STAT device and three open questions were included to obtain comments on the effectiveness of training, suggested improvements and operator's experience with patient testing using the i-STAT. Results were analysed by the SoGoSurvey software.

Analytical quality of each i-STAT device was monitored during the rollout using quality control testing material provided by the manufacturer. Key performance indicators of quality were accuracy (measured by the closeness of agreement of the mean value obtained by participating services and the target value assigned by the manufacturer [Abbott] for each quality control test) and the observed between-service imprecision, expressed as a coefficient of variation (CV%), for each test. The resultant CV%s were compared to the imprecision achieved by Australian laboratories enrolled in the Royal College of Pathologists of Australasia (RCPA) Quality Assurance Programs.

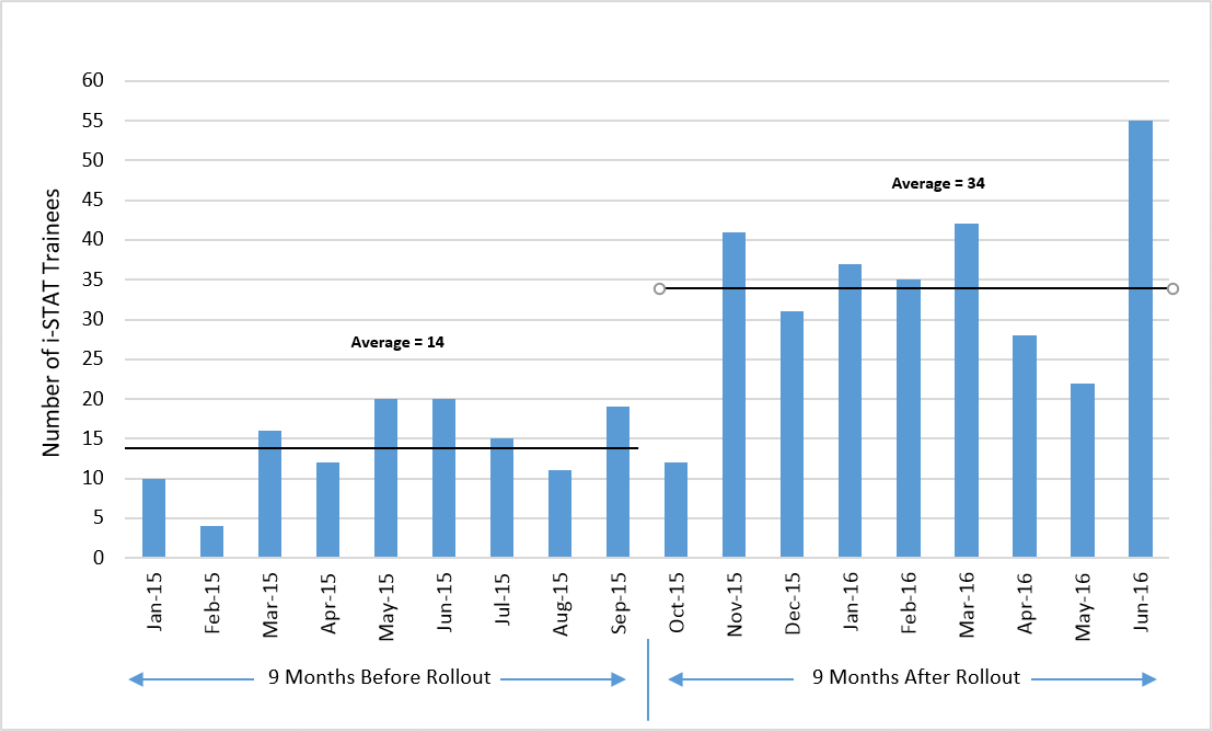
An initial cost effectiveness study was commissioned by the NT POCT Management Committee and undertaken by a medical registrar, Ming Chen, across 27 remote health centres. The primary outcome measure was evacuations prevented by using the i-STAT either to stabilise a patient on-site or to rule out a cardiac event using the troponin I test. In addition, by auditing and reviewing clinical presentations, patient cases were identified whereby the i-STAT produced an improvement in clinical outcome.

Results

The NT POCT Program model now operates in 72 remote health facilities in the Territory (51 DoH remote health centres and 21 ACCHS).

In the initial 6 months of the rollout, 337 remote staff completed i-STAT training; 158 from new services and 179 from existing services. A comparison of operators trained before and after the rollout period is illustrated in Figure 2. The number of remote staff completing i-STAT training each month averaged 14 per month before and 34 per month after the rollout commenced.

Figure 2 Total remote staff completing i-STAT training before and during the rollout period



Responses to the monthly feedback report survey indicated 77% of responding PHCMs (n=22) felt the reports were informative and 86% indicated they were a useful tool in assessing the effectiveness of the i-STAT at their remote health service. Prior to accessing feedback reports, the level of PHCM satisfaction with their knowledge of on-site i-STAT use was rated as: satisfied 27%, unsure 36%, unsatisfied 23% (and 14% did not answer). Since the feedback reports have been available, the level of satisfaction improved to: satisfied 63%, unsure 23%, unsatisfied 0% and 14% did not answer.

The training satisfaction survey was completed by 50 Remote Area Nurses, 3 Aboriginal Health Practitioners and one RMP, a response rate of 34% (54/158). Of the 54 respondents, 44 completed training remotely via teleconference and GoToMeeting presentation software and ten attended a face-to-face training session either on-site or centrally in Alice Springs or Darwin. Approximately 50% of respondents indicated they also used website resources as a useful adjunct to complete training. Fifty (93%) respondents indicated they had a better understanding of how to use the i-STAT post-training.

A summary of responses to the 10-point sliding scale questions is summarised in Table 1. The average weighted score was greater than eight out of ten for each question indicating high satisfaction with the training session, instructors and resources. Comments to open response questions were overwhelmingly positive including:

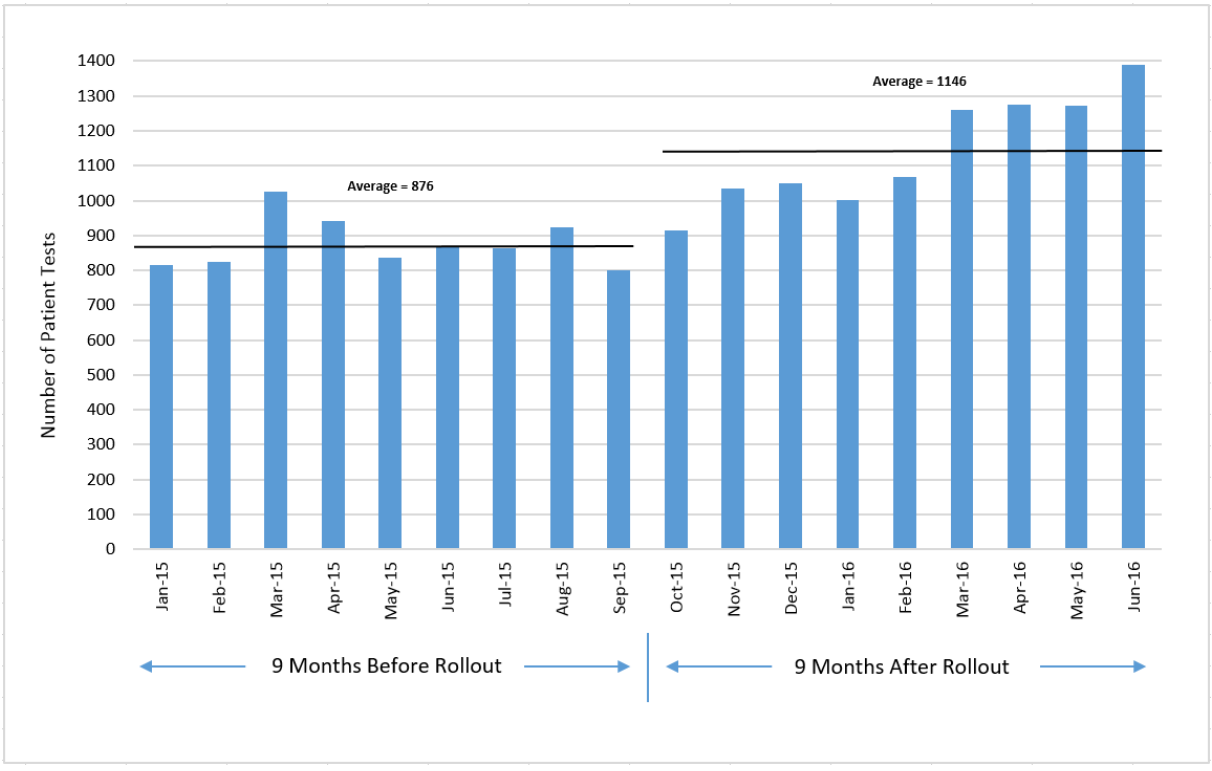
> "I have used the i-STAT for 15 years, but still learnt new information (in the training session), very informative and interactive"
>
> "I was very satisfied with training and would recommended for anyone wanting to use the i-STAT equipment, thank you very much for your tutorial"
>
> "… the i-STAT is very accurate and such a great tool, especially when handing over to the doctor over the phone; great trainers, knowledgeable and put their audience at ease".

Table 1 Summary of training satisfaction survey responses

Question	No. responses	Average Weighted Score (0–Very Poor, 10–Excellent)
How would you rate the quality of the PowerPoint presentation provided during training?	46	8.7
How would you rate the quality of the Training Manual?	38	8.4
How would you rate the quality of the i-STAT "How To" Posters?	27	8.6
How would you rate the quality of the i-STAT "How To" website videos?	19	9.2
How would you rate the helpfulness of the trainer?	53	9.2
How would you rate the quality of instruction from the trainer?	53	9.2
How confident do you now feel about conducting patient testing on the i-STAT device?	54	8.9

During the rollout, the total number of POC tests increased across time as seen in Figure 3, with the monthly average before and after the rollout period being 876 tests and 1141 tests respectively, an increase of approximately 130%. The profile of tests remained stable before and after the rollout period, with INR the most frequently performed test (43%), followed by electrolytes (27%), troponin I (20%) and blood gases (10%).

Figure 3 Total monthly tests recorded 9 months before and 9 months during the rollout period



Results of analytical quality are summarised in Table 2. The quality of POCT remained stable during the rollout period and of equivalent standard to the laboratory. The accuracy of quality testing was excellent, with the mean value obtained by participants for all tests being very close to target set by the manufacturer. The imprecision (CV%) observed for sodium, potassium, chloride, glucose, urea,

creatinine, pH, lactate and troponin was better than or close to the median imprecision achieved by Australian laboratories. For the blood gas analytes, bicarbonate (TCO_2), pCO_2 and pO_2, the imprecision was slightly higher than the median imprecision but met the 90th percentile imprecision achieved by laboratories of 6.5%, 4.6% and 6.5% respectively.

Table 2 Representative example from lot number with highest number of repeats during the i-STAT rollout period

Analyte	Units	Lot Number	n	Target	Mean	CV%	Laboratory Median CV%
Sodium	mmol/L	301066	233	122.0	121.5	0.6%	0.9%^
Potassium	mmol/L	301066	233	2.9	2.9	0.8%	1.4%^
Chloride	mmol/L	301066	235	72	73	1.2%	1.2%^
Ionised calcium	mmol/L	301066	233	0.84	0.85	1.5%	1.3%^
Total CO_2	mmol/L	301066	235	17.0	16.2	5.9%	3.8%*
Glucose	mmol/L	301066	231	15.0	15.1	1.0%	2.1%^
Urea	mmol/L	301066	233	19.3	19.3	2.6%	2.5%^
Creatinine	µmol/L	301066	234	335.5	336.8	2.9%	2.7%^
HcT	%PCV	301066	234	17	16.6	3.5%	n/a
Haemoglobin	mmol/L	301066	234	58	56.3	4.6%	n/a
pH	n/a	301066	230	7.04	7.05	0.2%	1.4%*
pCO_2	mmHg	301066	226	61	59	3.9%	2.1%*
pO_2	mmHg	301066	223	83	86	6.5%	2.7%*
Lactate	mmol/L	301066	229	7.1	6.9	2.4%	4.6%*
Troponin I	ng/mL	011073	196	0.34	0.31	7.0%	7.7%^
INR	n/a	291067	274	2.2	2.2	7.1%	n/a

CV% = Coefficient of Variation percentage

^ Median imprecision achieved by laboratories in the Royal College of Pathologists of Australasia's (RCPA) General Chemistry and Therapeutic Drugs, Cycle 103, 2016.

* Median imprecision achieved by laboratories in the Royal College of Pathologists of Australasia's (RCPA) Blood Gas and Co-Oximetry, Cycle 57, 2016.

Results of the initial cost effectiveness study found that the evacuation of 80 patients were prevented specifically due to the availability of the i-STAT results on-site (equating to an estimated cost saving of $640,000). A further 474 troponin I tests provided reassuring results that the patient was not undergoing a cardiac event and thus did not require evacuation, resulting in an estimated cost saving of up to $3.8 million.

The audit and review of clinical presentations identified a number of patient cases where access to on-site POCT using the i-STAT resulted in an improvement in clinical outcome. One such example, involving serial electrolyte measurements on a patient with vomiting and diarrhoea is described:

Presentation: A mother presented to a remote clinic with a 22-month-old female child who had a 24-hour history of vomiting and diarrhoea, and a fever of 38.5°C. The mother also reported a member of her household had recently been treated for rotavirus. The child was alert and interactive and had been eating and drinking that day. A stool sample was sent to the nearest microbiology laboratory (over 900 kms away) for investigation of rotavirus. Paracetamol was administered and a temperature of 37.3°C recorded. The treating clinician allowed the patient to go home advising them to return the next day for review or to present earlier if the patient's condition deteriorated.

Follow up: The child returned to the clinic several hours later as the child's temperature had increased to 40.1°C. The RMP recommended further paracetamol therapy and requested electrolytes be

measured on the i-STAT: results showed a sodium of 140 mmol/L (reference interval 132-143) and a potassium of 2.7 mmol/L (reference interval 3.5-5.0).

The patient then experienced two episodes of diarrhoea. The RMP discussed the i-STAT results with an on-call paediatrician who prescribed 30 mls oral rehydration solution (ORS) at 15-minute intervals until the patient stabilised and requested her electrolytes be repeated the next day. After 3 hours of ORS, the patient's temperature had improved to 37.1°C and she began to stabilise. The patient presented the next morning with repeat i-STAT results of: sodium 141 mmol/L and potassium 2.4 mmol/L.

The patient's potassium level had further declined and her weight had slightly decreased; she was now afebrile with a temperature of 36.6°C. Based on the results, a paediatrician prescribed oral potassium (1ml/kg) and follow-up electrolytes the following day, with results being: sodium 144 mmol/L and potassium 2.8 mmol/L.

The patient regained muscle turgor and resumed eating and drinking well. Continued ORS treatment was prescribed. The following day the patient had improved significantly and her electrolyte results were: sodium 142 mmol/L and potassium 3.2 mmol/L.

The microbiology results were reported 2 days later and were negative for rotavirus.

Discussion

The use of the i-STAT device in a remote primary health care setting is an innovative use of POCT outside of the conventional tertiary hospital emergency department.

The challenges of managing this large remote POCT network have included: the inherent difficulties associated with the distribution of POCT consumables (testing cartridges and quality materials) with short expiration dates; delivering training to remotely located staff with a high rate of turnover; and lack of Medicare rebates available to offset costs of POCT.

The development of the monthly feedback report to PHCMs has assisted in optimising inventory control of consumables by minimising consumable wastage and improving the ordering process; the report represents a novel and effective means of assisting the management and monitoring of POCT on-site and is recommended for any location where POCT is monitored remotely by a POCT coordinator.

Having a wide range of accessible and flexible training options has also contributed to the success of this large-scale rollout. A future aim of the program is that all new health centre staff should be required to complete POCT training as part of their remote health orientation to ensure they are qualified to immediately conduct POCT when they commence work in a remote health centre.

As previously shown, the quality of POCT undertaken in remote primary care was sound for most analytes.[10] The increased imprecision of the blood gas analytes was due, in part, to new staff taking time to adapt to the strict timing requirements for performing the testing of blood gases; where the quality sample must be tested immediately once the vial is opened to prevent gaseous exchange that occurs with exposure to air and subsequent skewing of gas results. Staff obtaining these erroneous results during training received feedback on test technique and additional training.

There is significant real-time benefit for the immediate pathology results produced by POCT in reducing the number of medical retrievals and contributing to significant cost savings. The patient case described in this study emphasises the long turnaround time for laboratory results in remote locations and highlights the ability of the i-STAT to assist in the stabilisation of an acutely ill paediatric patient on-site. The case also provides an example of a cultural benefit of POCT as it demonstrates how an evacuation from a remote region was avoided, allowing a patient to be treated and remain in the community with their family.

The benefit to patient safety and quality of care when stabilising a patient, either prior to a delayed evacuation or allowing the patient to remain and be treated in the community, is an invaluable asset of POCT. A limitation of the cost effectiveness data provided in this study is that it was not a full economic evaluation as it did not take into account the cost of administering the POCT program and cost of POCT consumables. To address this limitation, a more detailed and comprehensive cost benefit analysis is now being undertaken through an Emergency Medicine Foundation (EMF) grant awarded to the Flinders ICPOCT.

This innovative POCT program now ensures that all remote Territorians have equity of access to immediate pathology test results for a range of acute and chronic medical presentations and adds value to the current knowledge on the topic of emergency medicine in remote health care in Australia. The strategies described here and lessons learnt can be translated by other health professionals wanting to establish similar POCT networks in other remote or low resource settings.

Acknowledgments

We acknowledge the significant contributions from all past and present members of the NT POCT Program Management Committee in ensuring the successful implementation of the NT POCT Program.

The NT POCT Program Management Committee sincerely thanks Ming Chen for her contribution in examining the cost effectiveness of the NT POCT Program.

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Presenter

Brooke Spaeth joined the International Centre for Point-of-Care Testing in February 2010 as a Research Assistant, after completing a Bachelor of Medical Science degree with Honours at Flinders University in 2009. As part of her degree Brooke completed the first university level topic offered on Point-of-Care Testing titled Application, Management and Effectiveness in 2008. Brooke's honours project with the Centre evaluated the implementation and effectiveness of Point-of-Care Testing in remote health centres of Northern Territory, which has since resulted in several research publications. Brooke is now the Point-of-Care Coordinator for the Northern Territory Point-of-Care Testing Program and has also been the Device and Quality Coordinator for the national Quality Assurance in Aboriginal and Torres Strait Islander Medical Services (QAAMS) Program. In 2015, Brooke was successful in her first grant from the Emergency Medicine Foundation to evaluate the cost effectiveness of the Northern Territory Point-of-Care Testing Program. Results from the grant research were positive with the research indicating potential cost savings to the Northern Territory health system were in excess of $20 million per annum. Brooke's other interests include Point-of-Care Testing for drugs of abuse in the workplace and also infectious disease; focusing on Point-of-Care tests for malaria in low resource settings and for reducing antibiotic prescription rates.