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Assessing Data Integration and Quality for the Evaluation of Point-of-Care Testing Across Rural and Remote Emergency Departments in Australia

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Abstract

In Australia, New South Wales Health Pathology's implementation of managed Point-of-Care Testing (PoCT) services across rural and remote emergency departments (EDs) has the potential to significantly improve access to results for certain types of pathology laboratory tests and help to deliver timely patient care. The aim of this study was to assess the quality of the datasets, including the integration of PoCT results into clinical systems, as a precursor to the application of an evaluation framework for monitoring the delivery of PoCT services and their impact on patient care. Three datasets, including laboratory, ED presentations and hospital admissions data were extracted from the relevant clinical information systems. Each dataset was assessed on six dimensions: completeness, uniqueness, timeliness, validity, accuracy, and consistency. Data incompleteness was the largest problem. Assessing the PoCT data integration and data quality is a precondition for the evaluation of PoCT and for monitoring and improving service delivery.

Keywords:

Point-of-Care Testing; Data Accuracy; Australia

Introduction

Point-of-Care Testing (PoCT) refers to pathology laboratory tests performed near patients and outside a traditional laboratory [1]. PoCT can be conducted in a variety of contexts within the community by patients themselves (typically in their own homes), or in medical environments (hospital bed side, general practice or pharmacies) by clinical personnel who are not necessarily trained in laboratory sciences [1]. The types of tests available range from a consumer-friendly dip stick or prick tests (e.g. home pregnancy tests or glucose meters) to moderately complex (often cartridge based) devices used by trained clinical personnel, to highly sophisticated instruments that can only analyse specifically prepared specimens [2].

Existing evidence shows that the key advantages of a PoCT service are greater access to laboratory testing, especially in regional and remote areas [3; 4], and faster test result turnaround times (TAT) expediting the efficiency of clinical decision making and treatment [5-8]. PoCT has been heralded as being 'ideally suited to [time-critical] circumstances [involving] a small number of analytes (single analyte or single cartridge)' (p.3)[2]. It is thus considered to be particularly valuable for emergency departments (EDs) in helping to meet health professionals' demands for rapid test results which can expedite patient flow and prevent overcrowding [7]. The majority of PoCT studies have been conducted in urban (most often teaching) hospitals which have regular access to a formal clinical laboratory [9; 10]. However, as a number of researchers have highlighted, the prospective benefits commonly attributed to PoCT (faster TAT and treatment onset times and shorter length of stay [LOS]) are very likely to be evidenced in underserved rural communities [1; 11; 12].

Traditionally, hospitals in rural and remote areas suffer from the 'tyranny of distance' and without on-site laboratory support face extended wait times for laboratory results alongside difficulties in specimen collection and transport [11; 12]. The introduction of PoCT in rural community based health services and hospitals has led to almost immediate access to results, enhanced clinical decision making, faster treatment onset, and disposition to dedicated wards reducing mortality rates and achieving optimal health outcomes [4; 11-13]. These benefits and the potential for improved outcomes rely on careful planning, readily defined roles of stakeholders and a model of clinical care that has been adapted to cater for successful integration of PoCT services [12].

Australia is the third least densely populated country in the world (less than 2.9 people/km^2). With approximately one-third of the population living outside major cities, it has one of the lowest population densities outside its major cities [14]. NSW is the most populous state (6.9m) in Australia with more than 800,000 km^2 land [15]. NSW Health Pathology (NSWHP) is implementing PoCT services across rural and remote EDs, including to areas with extremely limited access to health care services [1; 4; 11]. By the end of 2015, almost 400 PoCT devices had been delivered to 175 EDs in non-metropolitan areas of NSW. To our knowledge this is one of the world's largest managed PoCT services [4; 16]. The rollout of this PoCT service offers the scope for a systematic investigation of the impact of PoCT implementation in rural and remote EDs to explore the operational impacts, evaluate patient outcomes and cost benefits and to develop an evaluation framework to aid PoCT expansion into additional health services such as ambulances and home care.

NSWHP's commitment to the evaluation of PoCT services stems from the need to monitor and enhance the design, implementation and sustainability of the service and ensure the achievement of value for money, the delivery of improved efficiency, effectiveness and optimal patient outcomes. Undertaking an evaluation of PoCT services across rural and remote EDs in NSW involves the examination of data availability and quality. The Royal College of Pathologists of Australasia's (RCPA) PoCT Quality Framework in 2014

recommended that an information management system must be developed to manage information generated by, entered into and transmitted from the PoCT devices to the Laboratory Information System (LIS) and then electronic Medical Records (eMR) systems [17]. It is also one of the key objectives of NSWHP's implementation. The aim of this study is to assess the quality of the datasets, including the integration of PoCT results into clinical systems, as a precursor to develop and apply a robust PoCT services evaluation framework.

Methods

Study design and setting

This was a retrospective before and after cohort study using laboratory and emergency department (ED) data. The study period was from January 2012 to the April 2015. The post implementation period started from January 2014. The evaluation was conducted across EDs in three Local Health Districts (LHDs) in NSW; Far West, Murrumbidgee and Western NSW LHDs (Figure 1). A total of 68 EDs were included in this study (seven in Far West, 26 in Murrumbidgee and 35 in Western NSW).

Laboratory services are provided by Pathology West NSW to hospitals and EDs in these LHDs. The PoCT implementation included the delivery of devices to many EDs that do not have support of a 24/7 laboratory onsite, based on a test profile of 1) Electrolytes, 2) Urea and Creatinine (EUC), 3) Blood gases + lactate + haemoglobin, 4) Troponin and 5) International Normalized Ratio (INR)/ Prothrombin Time (PT).

Figure 1: Local health districts, New South Wales, Australia [18]

PoCT data reconciliation and integration

The PoCT management system 'AQURE' stores data relating to every PoCT test ordered at the study EDs. PoCT tests in AQURE can be included in the LIS data but only if the patient demographic data entered into the PoCT device at the time of testing can be matched to an individual patient by the AQURE middleware which receives this information directly from the Hospital Patient Administration System (HPAS). This process is referred to as data reconciliation for this project. If reconciled, the PoCT results will be integrated into the LIS (Figure 2) and then into the patient's eMR. The AQURE data in the LIS was available from the 1st January 2014 after the PoCT implementation.

Data sources and linkage

Three datasets were extracted from clinical information systems. Laboratory data, including the reconciled PoCT data from AQURE, were extracted from the LIS, while ED and inpatient data were extracted from two information systems: Emergency Department Information System (EDIS) and HPAS. Three datasets were linked using a unique and non-identifiable patient Medical Record Number (MRN), as well as their gender and age. This process is depicted in Figure 2. The shaded area shows the ED presentations with laboratory testing including PoCT.

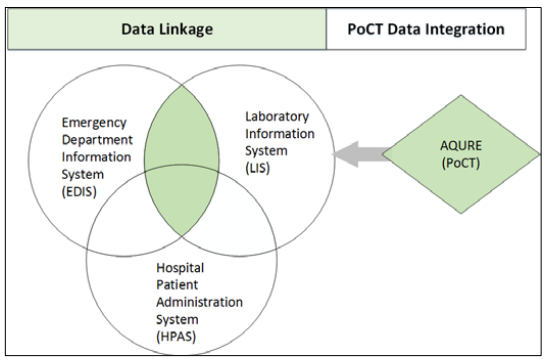

Figure 2: PoCT data integration and data linkage

Data quality assessment

Each dataset was assessed across six dimensions: completeness, uniqueness, timeliness, validity, accuracy, and consistency (Table 1). Consistency was assessed in the linked data across three data sources. The issue of completeness was also examined for the rate of reconciliation for PoCT tests from AQURE that were verified through a match with an individual ED presentation and uploaded to LIS.

Table 1: Data quality dimensions [19; 20]

Dimension	Definition
Completeness	The proportion of stored data against the potential of "100% complete"
Uniqueness	Nothing will be recorded more than once based upon how that thing is identified
Timeliness	The degree to which data represent reality from the required point in time.
Validity	Data are valid if it conforms to the syntax (format, type, range) of its definition.
Accuracy	The degree to which data correctly describes the "real world" object or event being described.
Consistency	How well data agree across different data sets, and the extent of agreement between different data sets that are measuring the same thing

Ethics approval

Ethical approval for this study was granted by the Greater Western Area Health Service Human Research Ethics Committee (LNR/15/GWAHS/26). Site Specific Assessment approval to conduct research within each of the LHDs was provided by the Far West LHD (LNRSSA/15/GWAHS/48), Murrumbidgee LHD (LNRSSA/15/MLHD/8) and Western NSW LHD (LNRSSA/15/GWAHS/49).

Results

During the study period, there were 570,538 ED presentations, 262,806 inpatient admissions, and 727,168 laboratory tests, including PoCT tests, across three LHDs.

Completeness

Laboratory data including PoCT data integration

In Far West LHD, only one of the seven EDs had PoCT results reconciled and integrated into the LIS and eMR. In Murrumbidgee, data were provided for all 26 EDs. In Western NSW LHD, limited PoCT results were reconciled and integrated into the LIS and eMR at five EDs.

When comparing the LIS dataset with information from AQURE it was found that the LIS data contained fewer patients having PoCTs. Out of 68 EDs, 13 did not have compliant systems resulting in a proportion of PoCT tests that were unable to be reconciled. The average reconciliation rate across 55 EDs over the period encompassing the two to 13 months post the implementation of PoCT was 28.6%, increasing from 20.2% in the second month post the implementation of PoCT to 48.6% in the 13th month post PoCT.

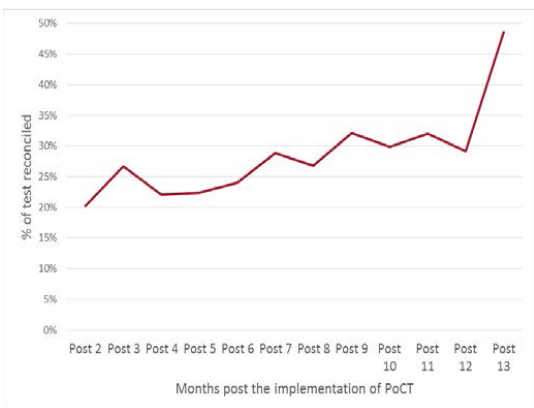

Figure 3: Reconciliation rate of PoCT ordered across 55 EDs in the 2 to 13 months post the implementation of PoCT

ED data

For Far West LHD, the extract only included one ED, with no data for the other six EDs in this LHD. Due to a lack of systems compliant with HIE, ED data for Western NSW LHD were limited to 11 EDs with complete data available from December 2014 onwards.

Murrumbidgee was the only LHD which confirmed the availability of all ED data (Figure 4). However, the number of patient presentations per month in 2012 (range from 1968 to 2597) was much lower than those after January 2013 (range from 4647 to 6293). The median length of stay per month in 2012 (range from 85 to 114 minutes) was much higher than that afterwards (range from 70 to 85 minutes). In terms of the completeness of the data fields, Murrumbidgee was the only LHD that provided a variable distinguishing between 'planned' and 'unplanned' ED presentations.

Inpatient data

The inpatient data extracted from HPAS was confirmed as containing information relating to all inpatient stays in Murrumbidgee. In Far West LHD, the inpatient data were again limited to one site. In Western NSW LHD inpatient data were available for 33 out of 35 sites in this LHD.

Uniqueness

No duplications were identified in the datasets.

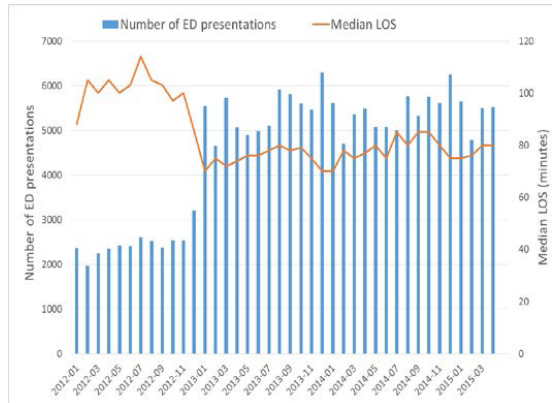

Figure 4: Number of ED presentations and Median LOS in Murrumbidgee LHD

Timeliness

Laboratory data related to laboratory tests up to May 2015, while ED and inpatient data related to presentations/episodes of care up to April 2015. Analysis was performed between September and December 2015. Therefore, the data were regarded as adequate.Validity

Construct validity is the extent to which data measure what they claim to be measuring. It was found that overlapping data in the ED and Laboratory data, such as patient MRN, gender, date of birth and patient location were in agreement. No overlap between data that was not supposed to relate to each other was found.

Accuracy

To determine the accuracy of the data, the contents of all fields were analyzed and suspect entries identified. Such entries were further analyzed by the research team and, after liaison with Pathology West and the LHDs, data deemed to be inaccurate were removed from the dataset.

Consistency

Consistency is particularly pertinent to this analysis, as a high level of consistency is required to enable triangulation of data from different sources through data linkage (Figure 2). It was found that after the accuracy of the data had been established matching data fields in the ED and Pathology data, such as patient MRN, gender, date of birth, were in agreement. Therefore, the data were regarded as consistent.

Discussion

High quality data are required for accurately evaluating the impact of health interventions. Through data quality assessment, limitations and deficiency of datasets can be identified. Evaluation of data quality revealed a number of limitations related to the completeness of available data. Murrumbidgee was the only LHD that was able to supply all ED presentations for the period January 2013 to April 2015. The Western NSW LHD was only able to provide ED data from 10 of 35 sites. However, the completeness of these data could not be verified by the LHD. In Far West LHD data from only one hospital, only one ED was confirmed as containing all ED presentations over the entire study duration. Murrumbidgee

LHD was the only data source which allowed the distinction between 'planned' (arranged in advance) and 'unplanned' (emergency) ED presentations. This distinction can have an important effect on data analyses and interpretation.

Data linkage provides numerous opportunities to extend our understanding of health care phenomena. Nevertheless, as the challenges of integrating PoCT into hospital networks attest, linked data needs to be carefully assessed for quality. Ensuring the quality of linked data should therefore incorporate data profiling techniques to examine the quality of each dataset separately [20; 21]. This could involve the application of algorithms that identify missing data, duplicates, data formatting and compliance with logic rules (e.g. patient was admitted before they were discharged). It should also incorporate an interrogation of key variables using descriptive statistics to examine the range of findings, percentiles and outliers for consistency and validity [22].

The process of data linkage using hospital, patient and laboratory data involves key ethical, privacy and confidentiality issues involving data governance processes and approval from the appropriate Human Research Ethics Committees (HREC). It also involves controls to protect the integrity of the data and ensure that no identifiable data is publicly available.

Assessing data integration and data quality provided the basis for targeted recommendations for improvement. First, data incompleteness is the largest problem in these rural and remote LHDs. This problem is universal across three clinical information systems: the LIS, EDIS and HPAS. LIS data completeness is also dependent upon the reconciliation of data from HPAS with patient information entered on the PoCT device at the time of testing. Secondly, the reconciliation rate of available PoCT data were only 28.9% although it has been increased from 20.2% in the second month post the implementation of PoCT to 48.6% in the 13th month post PoCT. One of the key recommendation from Royal College of Pathologists of Australasia for quality use of PoCT include the capacity for seamless and automated transfer of results to patients' electronic medical records [17]. Lack of electronic medical record systems in these rural and remote EDs could be one of main reasons for the low reconciliation rate, in addition to 1) incorrect entry of patient identifications into PoCT devices and 2) lack of resources to ensure that MRNs are available for new patients or that the patient visit is updated in HPAS at time of PoCT.

Conclusion

The NSWHP implemented one of the world's largest PoCT services across rural and remote EDs. It has the potential to significantly improve access to on-the-spot results for certain types of laboratory tests as a means to deliver timely patient care. Assessing PoCT data integration and data quality is a key precondition for evaluating the implementation of PoCT services and for further monitoring and improving the services into the future. Although our study was based on Australian rural and remote sites, the data integration and quality issue is not unique to these Australian sites, but of relevance to researchers and implementation teams globally.

This study not only provided a rigorous assessment methodology but also highlighted the value of linking routinely collected datasets from different clinical information systems in data quality assessment and subsequently in evaluation of the PoCT implementation.

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References

[1] J.H. Nichols, Point-of-care testing, in: *The Immunoassay Handbook: Theory and applications of ligand binding, ELISA and related techniques,* D. Wild, ed., Elsevier Oxford, UK, 2013, pp. 455-463.

[2] Royal College of Pathologists of Australasia, Point of care testing, *Common Sense Pathology* **April 2015** (2015), 1-8.

[3] S. Glover and B.V. Bajorek, Exploring point-of-care testing of capillary blood in warfarin management, *Journal of Pharmacy Practice and Research* **38** (2008), 300-304.

[4] M. Shephard, Point-of-Care testing in Australia: The status, practical advantages, and benefits of community resiliency, *Point of Care* **12** (2013), 41-45.

[5] E. Lee-Lewandrowski and K. Lewandrowski, Point-of-care testing in the Emergency Department, in: *Point-of-Care Testing: Needs, Opportunity and Innovation,* C. Price, A. St John, and L.L. Kricka, eds., AACC Press, Washington, DC, 2010, pp. 397-410.

[6] V. Pecoraro, L. Germagnoli, and G. Banfi, Point-of-care testing: where is the evidence? A systematic survey, *Clinical Chemistry and Laboratory Medicine* **52** (2014), 313-324.

[7] K.D. Rooney and U.M. Schilling, Point-of-care testing in the overcrowded emergency department - Can it make a difference?, *Critical Care* **18** (2014).

[8] L. Li, A. Georgiou, E. Vecellio, A. Eigenstetter, G. Toouli, R. Wilson, and W. JI, The impact of pathology testing on Emergency Department length of stay: A multi-hospital longitudinal study applying a cross-classified random effect modeling approach, *Academic Emergency Medicine* **22** (2015), 338-346.

[9] M. Bradburn, S.W. Goodacre, P. Fitzgerald, T. Coats, A. Gray, T. Hassan, J. Humphrey, J. Kendall, J. Smith, and P. Collinson, Interhospital variation in the RATPAC trial (Randomised Assessment of Treatment using Panel Assay of Cardiac markers), *Emergency Medicine Journal* **29** (2012), 233-238.

[10] P. Collinson, S. Goodacre, D. Gaze, and A. Gray, Very early diagnosis of chest pain by point-of-care testing: comparison of the diagnostic efficiency of a panel of cardiac biomarkers compared with troponin measurement alone in the RATPAC trial, *Heart* **98** (2012), 312-318.

[11] K. Blattner, G. Nixon, C. Jaye, and S. Dovey, Introducing point-of-care testing into a rural hospital setting: thematic analysis of interviews with providers, *J Prim Health Care* **2** (2010), 54-60.

[12] M. Shephard, R. Tirimacco, and P. Tideman, Point-of-Care testing in remote environments, in: *Point-of-Care Testing: Needs, Opportunity and Innovation,* C. Price, A. St John, and L.L. Kricka, eds., AACC Press, Washington, DC, 2010, pp. 373-386.

[13] P.A. Tideman, R. Tirimacco, D.P. Senior, J.J. Setchell, L.T. Huynh, R. Tavella, P.E.G. Aylward, and D.P.B. Chew, Impact of a regionalised clinical cardiac support network on mortality among rural patients with myocardial infarction, *Medical Journal of Australia* **200** (2014), 157-160.
[14] Australian Bureau of Statistics (ABS), Outcomes of ABS Views on Remoteness Consultation, Australia, Jun 2001, in, 2016.
[15] Australian Bureau of Statistics (ABS), Population by Age and Sex, Regions of Australia, 2011 Census (3235.0), in, 2012.
[16] NSW Health Pathology, Point of care testing, in, 2015.
[17] Royal College of Pathologists of Australasia (RCPA), *Point of Care testing: Elements of a quality framework*, RCPA, Surry Hills, 2014.
[18] Head Medical, New South Wales Health, in.
[19] Data Quality Dimensions Working Group, *The Six Dimensions of EHDI Data Quality Assessment*, DAMA UK, 2013.
[20] T.L. Strome, *Healthcare Analytics for Quality and Performance Improvement*, John Wiley & Sons, Inc, Hoboken, NJ, USA, 2013.
[21] T.C. Redman and M. Daugherty, *Data Quality: The Field Guide*, Digital Press, Greenwich, CT, USA, 2000.
[22] R.C. Hawkins, Laboratory turnaround time, *Clinical Biochemist Reviews* **28** (2007), 179-194.

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