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Research paper

'True Blood' The Critical Care Story: An audit of blood sampling practice across three adult, paediatric and neonatal intensive care settings

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ABSTRACT

Background: Anaemia is common in critically ill patients, and has a significant negative impact on patients' recovery. Blood conservation strategies have been developed to reduce the incidence of iatrogenic anaemic caused by sampling for diagnostic testing.
Objectives: Describe practice and local guidelines in adult, paediatric and neonatal Australian intensive care units (ICUs) regarding blood sampling and conservation strategies.
Methods: Cross-sectional descriptive study, conducted July 2013 over one week in single adult, paediatric and neonatal ICUs in Brisbane. Data were collected on diagnostic blood samples obtained during the study period, including demographic and acuity data of patients. Institutional blood conservation practice and guidelines were compared against seven evidence-based recommendations.
Results: A total of 940 blood sampling episodes from 96 patients were examined across three sites. Arterial blood gas was the predominant reason for blood sampling in each unit, accounting for 82% of adult, 80% of paediatric and 47% of neonatal samples taken ($p < 0.001$). Adult patients had significantly more median [IQR] samples per day in comparison to paediatrics and neonates (adults 5.0 [2.4]; paediatrics 2.3 [2.9]; neonatal 0.7 [2.7]), which significantly increased median [IQR] blood sampling costs per day (adults AUD$101.11 [54.71]; paediatrics AUD$41.55 [56.74]; neonatal AUD$8.13 [14.95]; $p < 0.001$). The total volume of samples per day (median [IQR]) was also highest in adults (adults 22.3 mL [16.8]; paediatrics 5.0 mL [1.0]; neonates 0.16 mL [0.4]). There was little information about blood conservation strategies in the local clinical practice guidelines, with the adult and neonatal sites including none of the seven recommendations.
Conclusions: There was significant variation in blood sampling practice and conservation strategies between critical care settings. This has implications not only for anaemia but also infection control and healthcare costs.

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1. Introduction

1.1. Background

Anaemia is common in critically ill patients admitted to the ICU[1–3] with almost 95% of patients having an abnormally low haemoglobin level by ICU day three.[3] The damaging effects of anaemia include increased risk of cardiac morbidity and mortality, as well as a generalised decrease in oxygen carrying capacity to the organs and tissues.[2] Critically ill patients are at particular risk for adverse consequences from anaemia given the cardiovascular, respiratory and metabolic compromise frequently encountered during critical illness.[1]

The aetiology of anaemia during critical illness is multifactorial. Its severity is influenced by frequent phlebotomy, sepsis, gastrointestinal bleeding, coagulation disorders, blood loss from vascular procedures, renal failure, nutritional deficiencies, bone marrow suppression and impaired erythropoietin response.[1,2,4] For at least 40 years medical literature has highlighted the importance of an iatrogenic contribution to the anaemia seen in hospitalised patients due to blood sampling, and its potential negative impact upon recovery.[1,5–10]

Blood samples from critically ill patients are routinely collected via arterial and central venous access devices, by peripheral venepuncture or heal/finger prick.[5,11] Blood draws from intravascular devices increase blood loss due to the need to first withdraw a clearing or 'discard' volume from the device, to ensure the resultant sample is whole blood and not partially medication or infusion fluid. Monitoring of blood flow, acid-base status, oxygen transport, coagulation, visceral organ function and the development of healthcare associated infection are a few of many reasons for diagnostic blood testings.[6] Previous reports of blood removed from critically ill adult patients for testing average between 41.5 mL and 377 mL per day.[1,2,6,12] The described daily average blood sampling volumes varied depending upon the population studied, the length of stay evaluated and the methodology of the study; with the highest volumes commonly occurring in the immediate post-operative period.[1,2,6,12]

Just over a decade ago, seminal work by Vincent et al.,[2] and Corwin et al.,[3] described the challenges associated with blood conservation practices throughout ICUs and the resulting overprescription of packed red blood cell (PRBC) transfusions. Current evidence suggests that PRBC transfusions are associated with infectious and inflammatory complications, significant financial costs, worse clinical outcomes and transfusion errors.[1,7] A recent Australian retrospective cohort study[13] described the annual total hospital-associated cost of PRBC transfusions as AU$77 million; with the inpatient costs of those who received a blood transfusion 1.83 times higher than those not transfused, after adjusting for confounders. The use of PRBC remains a significant financial burden on the Australian healthcare system.[10] Because of these burdens and risks, the National Health and Medical Research Council[10] have championed the development of clinical protocols across healthcare facilities to minimise and direct the correct use of blood products and other supportive therapies.

While phlebotomy and blood testing to inform clinical decision making is vital, strategies have been developed to minimise unnecessary iatrogenic blood loss. Clinical practice strategies and technologies available in Australia include closed-system sampling enabling safe return of arterial and central line clearing volumes to the patient, small-volume phlebotomy tubes, frequent clinical evaluation of routine or repetitive testing, use of noninvasive methods where possible (e.g. end tidal carbon dioxide [$ETCO_2$], oxygen saturations [SpO_2]), bundled scheduling of blood tests to minimise loss of 'clearing' volume, routine charting of cumulative daily phlebotomy blood loss, and point of care bedside microanalysis.[1,4,6,12] Randomised controlled studies and clinical controlled trials have been undertaken surrounding the efficacy of individual conservation strategies to prevent and/or treat the associated anaemia, including the use of small-volume phlebotomy tubes,[14] closed-system sampling enabling safe discard return[5,15–18] and a combined approach.[4,19] Other strategies commonly advocated in clinical settings, such as point of care bedside microanalysis, have less rigorous observational studies to support their use.[20–22] The evidence to support and encourage the use of these blood conservation strategies in critical care settings has not been summarised in international clinical practice guidelines (CPG), such as the CPG developed for the prevention of catheter-related bloodstream infection.[23–25] Instead, clinicians are guided by the provision of local CPGs, developed within the hospital or ICU based on varied quality of evidence, often combining peer-reviewed research, local tradition and expert opinion.[26,27]

Although phlebotomy amounts can be dramatically reduced by the use of blood conservation strategies, research suggests they are not widely practiced in all adult, paediatric and neonatal ICUs.[1] Landmark studies[2,3] describing the importance of blood conservation strategies to prevent iatrogenic anaemia for critically ill patients were published almost a decade ago. Our study aim was to investigate the blood conservation practice across ICUs in Australia and their direct financial consequences.

1.2. Objectives

There were three study objectives:

1. To describe current blood sampling practices in adult, paediatric and neonatal ICUs;
2. To provide an estimate of direct pathology costs associated with blood sampling practices in adult, paediatric and neonatal ICUs; and
3. To compare local CPG and current practice regarding blood conservation strategies in adult, paediatric and neonatal ICUs, with international evidence-based recommendations.

2. Methods

2.1. Study design

A cross-sectional, descriptive study was completed over one week in July 2013.

2.2. Participants and setting

Blood sampling practice was audited within three Queensland ICUs: the adult ICU at the Royal Brisbane and Women's Hospital (RBWH), Brisbane, Australia; the paediatric ICU at the Royal Children's Hospital (RCH), Brisbane, Australia; and the neonatal ICU at the RBWH, Australia. Each of the ICUs are tertiary-referral centres for the area. Data were collected on all inpatients in the three ICUs on each of seven days over one week. There were no other inclusion or exclusion criteria. University and hospital ethics approval was gained for this study (HREC/13/QRCH/32 and GU: NRS/21/13/HREC).

2.3. Blood sampling audit

2.3.1. Data collection and measurement

In order to describe blood sampling practice in the critical care settings, the main outcomes collected were the amount, frequency and type of blood sampling from all patients during the audit period. To quantify these outcomes, an audit was developed and

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