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In situ diagnostic methods for catheter related bloodstream infection in burns patients: A pilot study

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ABSTRACT

Background: One of the most common and potentially fatal complications in critically ill burns patients is catheter related bloodstream infection (CR-BSI). Lack of in situ diagnostic techniques requires device removal if CR-BSI is suspected with 75–85% of catheters withdrawn unnecessarily.

Aims: To assess the sensitivity, specificity and accuracy of two in situ diagnostic methods for CR-BSI in an adult ICU burns population: Differential Time to Positivity (DTP) and Semi-Quantitative Superficial Cultures (SQSC).

Methods: Both arterial (AC) and central venous (CVC) catheters were studied. On clinicians' suspicion of CR-BSI, the CVC and AC were removed. Superficial semi-quantitative cultures were taken by removing the dressings and swabbing within a 3 cm radius of the CVC and AC insertion sites, as well as inside each hub of the CVC and AC. Peripheral blood was taken for qualitative culture and the catheter tip sent for semi-quantitative culture. DTP was considered positive if culture of lumen blood became positive at least 120 min before peripheral blood with an identical pathogen. Superficial and tip cultures were identified as positive if ≥15 CFUs were grown. CR-BSI was confirmed when both catheter tip culture and peripheral blood culture were positive with the same micro-organism.

Results: Sixteen patients (88% male) with an APACHE II score of 22.0 (7.3) were enrolled. The mean age was 45.7 (16.9) years with mean total burn surface area 32.9 (19.4)%. Fifty percent had airway burns. ICU stay was 19.9 (11.1) days. All 16 survived ICU discharge with a hospital survival of 93%. There were 20 episodes of CR-BSI in these 16 patients. For these 20 episodes the exposure time (line days) was 113.15. The CR-BSI rate was 15.6 per 1000 catheter days (95% CI 1.9–56.4). For diagnosis of CR-BSI in either AC and CVC, SQSC had a sensitivity of 50% [95% CI 3–97], specificity 83.3% [95% CI 67–93], PPV 14.3 [95% CI 1–58], NPV 96.8 [95% CI 81–100], accuracy of 81.6% [95%CI 65–92] and diagnostic odds ratio 5.0 [95% CI 0.3–91.5]. To

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diagnose tip colonisation (>15CFU), sensitivity of SQSC was 75% [95% CI 22–99], specificity 88.2% [95%CI 72–96], PPV 42.7 [95% CI 12–80], NPV96.8% [95% CI 81–100], accuracy 86.8% [95% CI 71–95] and diagnostic odds ratio 22.5 [95% CI 1.9–271.9]. For combined DTP blood cultures, sensitivity for CR-BSI was 50% [95% CI 3–97], with specificity 97% [95% CI 82–100], PPV 50% [5% CI 3–97%], NPV 97% [95% CI 82–100], accuracy 94.3% 95% CI 79–99] and diagnostic odds ratio 32 [95% CI 1.1–970.8].

Conclusion: Both DTP and SQSC displayed high specificity, NPV and accuracy in a population of adult burns patients. These features may make these tests useful for ruling out CR-BSI in this patient group. This study was limited by a low number of events and further research is required.

1. Introduction

Patients with severe burns admitted to hospital and particularly those admitted to the intensive care unit are at high risk of developing treatment related complications in addition to those as a consequence of their primary injury. One of the most common and potentially fatal complications in this patient group is catheter related blood stream infection (CR-BSI), generally from the central venous or peripheral arterial catheter [1,2].

Recognition of CR-BSI in this patient cohort is difficult. In particular many patients will have a prominent inflammatory response in which a raised temperature is invariably present. For the clinician managing the critically ill patient with severe burns the assessment of intravascular devices (IVD) as a source of sepsis remains difficult. Many clinicians choose to remove the suspect IVD rather than risk the complications of untreated CR-BSI. Reinsertion may be associated with morbidity particularly if other vascular access sites are limited. Whilst the Centre for Disease Control (CDC) does not recommend routine catheter exchange, this is common practice in burns patients [3,4]. Although there is no evidence to support this practice in any intensive care population, this may be currently justified on the basis of significantly higher infection rates in selected patients [1,5,6].

In general the diagnosis of CR-BSI is still largely retrospective since it is dependent on IVD removal to culture of a device segment, in addition to blood. Accurate clinical assessment to predict the presence of infection in IVDs is known to be poor, and a large proportion (75–85%) of catheters are therefore removed unnecessarily, the majority being sterile [7,8]. Thus techniques for the in situ diagnosis of CR-BSI, which do not require device removal, have been examined.

In situ techniques include catheter internal hub and skin cultures (quantitative or semi-quantitative cultures of skin surrounding the portal of entry and hub of device) either separately or combined. These have been shown to have a very high negative predictive value in excluding the catheter as a source of sepsis when IVD infection is highly suspected, but less so when used in daily surveillance but not in the burns population [9]. Paired quantitative blood cultures drawn through the device and peripheral blood exhibit high sensitivity and specificity in the diagnosis of CR-BSI but are technically difficult, expensive and time consuming to perform. Lastly differential time to positivity (comparing the time to culture positivity from blood drawn simultaneously from device and peripherally), which can be easily performed on modern automated culture machines and has shown good sensitivity and specificity [10]. This technique displays similar accuracy to that of quantitative cultures but is substantially more accessible to clinicians. Although all these methods have been described previously in other patient groups, mainly haematology/oncology cohorts their use in diagnosing CR-BSI in burns patients is to our knowledge unexplored [10–12].

This pilot study had two aims. Firstly, to assess the sensitivity, specificity, negative and positive predictive values and accuracy of differential time to positivity (DTP) and semi-quantitative superficial cultures (SQSC) for the diagnosis of CR-BSI (either AC or CVC) in an adult ICU burns population. The accuracy of these tests was compared to an accepted 'gold standard' of CR-BSI, i.e. IVD removal with positive culture of tip and matching organism growth on peripheral venous blood culture with no other obvious source of the infection. [13] We chose to examine both the arterial catheter (AC) as well as central venous catheters (CVC) as sources of CR-BSI as they have been previously shown to have similar rates of infection [2,14]. Our second research aim was to compare and contrast these in situ methods for diagnosing CR-BSI or catheter tip colonisation in the ICU burns patient cohort.

2. Materials and methods

Patients who had suffered major burn injuries and admitted to the ICU were analysed separately from data taken from a larger prospective non randomised single centre study, The Sepsis Associated with Vascular access–Easier Diagnosis (SAVED study) [15]. During data collection those patients who had a diagnosis of burns were identified and additional demographic data was collected; including percentage body surface area (%BSA) burn and thickness, presence or absence of inhalational injury, whether the patient had been fully grafted on discharge or during the ICU stay. This allowed identification of appropriate records from the original data set.

The SAVED study compared the predictive value of two in situ methods for the diagnosis of CR-BSI and catheter tip colonization (CTC) in a heterogeneous sample of critically ill patients with clinically suspected CR-BSI. The study was a prospective study carried out between August 2008 and May