The Hidden Cost of Catheter Related Blood Stream Infections in Patients on Parenteral Nutrition

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Abstract

Background & Aims

Parenteral nutrition (PN) is a valuable and life-saving treatment for patients with intestinal failure. While its use is increasing, it has been demonstrated to be a risk factor for intravenous catheter-related blood stream infection (CRBSI) - a significant, serious and potentially fatal complication of PN use. CRBSI can have serious secondary consequences for patients, though, there is a paucity of literature

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describing these. The aim of this study is to audit the incidence of, and evaluate the consequences of, complications associated with CRBSI

Methods

Medical records were examined for all parenterally fed patients diagnosed with a CRBSI from 01/01/16 to 31/12/17 in a UK tertiary referral centre for patients requiring intravenous nutritional support. Patients were identified prospectively; data relating to the infection and complications was collected retrospectively.

Results

114 episodes of CRBSI were recorded in 80 patients. 57 occurred during an inpatient admission, 57 occurred in the community and resulted in admission. 21 different adverse events occurred as a result of the CRBSI. The complications identified were varied with the most common being acute kidney injury, deranged electrolytes and urinary tract infections. Other significant complications included DVT, pulmonary abscess and infective endocarditis. 35% of episodes resulted in delayed discharge and 12% required escalation to a critical care bed. The financial impact is estimated at over £800,000 per annum.

Conclusions

The findings demonstrate a plethora of complications which can arise following CRBSI, which pose a significant health risk to parenterally fed patients who already have reduced physiological reserve. Moreover, these findings represent additional financial and resource burden to the health service. The adverse events resulting from CRBSIs should, therefore, be audited to improve outcomes: well-resourced specialist centres are best placed to provide this service.

Introduction

Parenteral nutrition (PN) is a valuable and life-saving treatment for patients with intestinal failure and its use is increasing with the advances in home PN services(1). PN is an independent risk factor for intravenous catheter-related blood stream infection (CRBSI)(2), whilst also being a risk factor for many other adverse physical, social and psychological conditions(3,4).

Despite efforts to reduce CRBSI associated with PN use, and a target of <1 episodes per 1000 catheter days(5), infections are still an important clinical problem. Inpatient rates are reported between 1.5-10.0 episodes per 1,000 parenteral nutrition days and home PN rates between 0.38-4.58 episodes per 1000 catheter days(6-8). Inconsistency in the descriptive terms used in the literature can create difficulty in comparison but it remains that, although there is variability in the reported rates of CRBSI, it is a significant, serious and potentially fatal complication of PN use.

CRBSI can have serious secondary consequences for the individual patient. In critical care, CRBSI has been shown to increase length of ICU stay and length of ventilation when compared to similar patients with central lines who did not develop a catheter related infection(9). An observational study of patients on home PN reports infective endocarditis, pneumonia, septic shock and venous thrombosis as complications of CRBSI(10). Complications of CRBSI also lead to a significant increased cost[10]. Reported excess healthcare costs associated with CRBSI vary(9, 11) and it is unclear whether the reported costs include the treatment of complications resulting from the CRBSI or just the treatment of the CRBSI alone.

Aim

The aim of this study is to audit the incidence of, describe and evaluate the cost of complications associated with CRBSI in patients on PN at Leeds Teaching Hospitals.

Methods

All patients on PN with confirmed CRBSI at Leeds Teaching Hospitals between 01/01/16 - 31/12/17 were studied. At Leeds Teaching Hospitals a CRBSI is diagnosed using paired blood cultures with a differential time to positivity of ≤2 hours. The nutrition team record all CRBSIs in the Trust prospectively. Subsequently, electronic medical notes of all episodes were examined, and relevant data were extracted retrospectively. A complication of a CRBSI was defined as an adverse medical event which occurred within 90 days after diagnosis, investigation or management of the infection or at any time during an admission for a CRBSI. Complications were excluded if any other reasonable cause was demonstrated. All patients who developed a CRBSI as an outpatient were admitted for management. Subsequently, all events relating to the admission for these patients were considered to be a consequence of the infection. An estimate of the financial burden of CRBSI's was made using data on cost of beds per day, and costs of the treatment of the complications, provided by the financial department of the hospital trust.

Results

114 episodes of CRBSI were recorded in 80 patients with a median of 1 episode per patient (IQR: 1-2). The mean age of patients at diagnosis of CRBSI was 54 (21-83) years old. 59/114 (51.8%) of the patients were male. 57 CRBSIs were developed as an outpatient and 57 were developed during an inpatient admission. For an outpatient admitted because of a CRBSI the median length of admission was 18 days (IQR: 13-25). The line was removed in 66% of the 114 episodes, of these 43% were PICC lines and a new line(s) was inserted in 75% of cases. There were 21 different adverse events identified as a complication of the CRBSI. These occurred a total of 101 times (table 1). 69% of CRBSI episodes resulted in the patient missing PN for an average of 6.5 days (IQR:2-13) while 12% of infections lead to cessation of

Commented [DB1]: Use mean, rather than average. Put in an age and the entire range e.g. 54 (range 46-80) years.

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the PN regime. When the CRBSI was developed during an admission 35% had evidence of resultant delayed discharge.

~~**Table 1. Adverse events occurring as a result of CRBSI in adult patients on PN.**~~

~~*MRSA = Methicillin Resistant Staphylococcus Aureus, VRE = Vancomycin Resistant Enterococci, ESBL = Extended Spectrum Beta-Lactamase.*~~

Financial implications

A standard ward bed costs £220 per day and with a total of 1979 admission days, the cost amounts to £435,380. A high dependency bed costs £1459 per day, with a total of 23 days, this amounts to £33,557. An intensive care bed costs £1820 per day, with a total of 50 days, this amounts to £91,000. The estimated total cost of treatment of complications (excluding bed costs) is £275,469. The total incurred cost of treating the complications resulting from 114 CRBSI's, over the 2 years, is therefore £835,406. This equates to an average of £7,328 being incurred, per CRBSI episode, as a result of the complications alone.

Causative Organisms

The most common cultured organisms causing the CRBSI were a mixed culture (23/114), coagulase negative Staphylococcus (21/114), Klebsiella sp. (16/114), Escherichia Coli (9/114), Enterobacter sp. (6/114), Methicillin Sensitive Staphylococcus aureus (MSSA) (6/114), Candida sp. (5/114), Staphylococcus Epidermidis (5/114) and the remaining 28 included 14 other species including MRSA and Pseudomonas.

Discussion

The findings demonstrate a plethora of adverse events occurring with CRBSIs, many of which incur significant risk to the patient.

The documented adverse events can be categorised into four different groups dependent on whether they were caused by the infection itself, by the treatment of the infection, due to hospital admission for the infection or as a result of missing PN. Here we will discuss these categories separately.

Adverse Events Associated with the Infection and Septic State

Acute kidney injury (AKI) occurred in over one fifth of patients with a CRBSI in this study. AKI is a common problem throughout hospitalised patients affecting 13-18% of all admissions in developed countries(12) and has been demonstrated to increase morbidity and mortality(13) highlighting a significant health risk to these patients. AKI increases the risk of chronic kidney disease (CKD) and end-stage renal failure (ESRF)(14) and, hence, development of AKI is a significant complication in parenterally fed patients who are already at increased risk of impaired renal function(15,16).

Deep seated infections resulting from CRBSIs such as candida endophthalmitis and infective endocarditis had a significant harmful outcome for the patients. A case of endocarditis resulted in development of a pulmonary abscess, whilst the patient who developed endophthalmitis consequently had permanently reduced visual acuity. Previously reported complications that can occur as a result of such deep-seated infections include death, heart failure and blindness(17,18).

Other complications occurring as a result of the CRBSI included new onset atrial fibrillation, a tonic-clonic seizure, transient deterioration of polymyositis resulting in dysphagia and subsequently aspiration pneumonia. These highlight examples of the effect CRBSIs can have on pre-existing chronic and intermittent conditions, in an increasingly co-morbid population this demonstrates the potential synergistic impact CRBSIs can have on patient health.

Intensive care admission was required for seven (6%) patients and high dependency unit for four (4%) patients providing cardiovascular or respiratory support or both. This demonstrates the potentially life-threatening nature of CRBSIs, whilst representing extra cost in the treatment of these patients. With ICU beds in the trust costing eight times and HDU beds six times that of a normal ward bed, the excess cost of critical care beds over a two-year period equates to £108,000.

Adverse Events Associated with Hospital Admission

The results suggest that CRBSIs often resulted in delayed discharge for patients who contracted their infection during a hospital admission with estimated delays ranging from two days to six months. Aside from the obvious additional costs of prolonged hospital stay this also puts the patient at increased risk of contracting further hospital acquired infections. Five patients in this study were found to have contracted a multidrug-resistant bacterial colonisation during their admission. These include MRSA, VRE and ESBL producing bacteria.

Adverse Events Associated with Treatment of CRBSI

66% of patients had their infected line removed with the remaining being successfully salvaged. 75% of patients required another line either as replacement for their previous or for concurrent treatment and PN whilst salvaging the infected one. With recurrent line insertions come associated procedural risks of up to 20% in central lines(19). In this series seven deep vein thromboses occurred secondary to midlines and one patient developed a subclavian aneurysm as a result of a failed insertion of a central line. Although no further morbidity or mortality occurred as a result of these complications, they all required continued anti-coagulation for between three and six months.

Further complications related to treatment of the CRBSI include clostridium difficile infection likely resulting from antibiotic use and two Vancomycin prescribing errors resulting in stage 3 acute kidney injury.

Adverse Events Associated with Missed PN

A significant proportion of patients missed at least one day of PN; this poses a risk of dehydration and malnutrition, particularly in the septic patient. In the short term this may contribute to the acute kidney injury and electrolyte disturbances observed. In patients with longer periods without PN they risk malnutrition, including the risk of refeeding syndrome and the complications related to this such as impaired wound healing and hospital acquired infection(21).

A salutary example of the consequences of a CRBSI was a patient who was receiving PN to improve nutritional status prior to chemotherapy. A CRBSI resulted in cessation of PN and subsequent deterioration of nutritional status to the point where they were unable to receive cancer treatment. Before PN could be reinstated the patient deteriorated, with the cancer as their cause of death. Although this was an isolated incident, this case highlights the grave potential result of missing PN at a critical point.

Although the risk of CRBSI with parenteral nutrition is well recognised, data on the consequences of CRBSI development are scarce. Our study builds on the findings from previous studies which have described some complications resulting from CRBSIs (9,10). Centres that treat patients with parenteral nutrition need to have facilities to deal with the serious consequences of a CRBSI. There is no prior literature to compare the cost of complications resulting from CRBSIs; these findings highlight the need to consider the cost of complications of CRBSIs in service development for patients who depend on parenteral nutrition.

Limitations

As data were collected retrospectively this study is limited by the documentation of the clinical teams at the time of entry. Hence, some minor complications may have been omitted. As a descriptive study, conclusions could not be drawn regarding risk factors for developing complications. A further prospective, analytic study could explore this.

Conclusion

These findings demonstrate a plethora of complications which can arise following CRBSI. Many of the described complications pose a significant health risk to parenterally fed patients who already have reduced physiological reserve. Moreover, these findings represent additional financial and resource burden to the health service. The adverse events resulting from CRBSIs should, therefore, be audited to improve outcomes: well-resourced specialist centres are best placed to provide this service.

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