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Vascular access strategy for delivering long-term antimicrobials to patients with infective endocarditis: device type, risk of infection and mortality

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SUMMARY

Background: This paper reports the use of different vascular access devices and the incidence of intravascular catheter-related infection (CRI) in patients receiving intravenous antibiotics for infective endocarditis (IE).

Aim: To examine whether rates of infection vary with type of vascular access device, and assess the impact of CRI on mortality in IE.

Methods: A prospective observational service evaluation of all inpatients who received intravenous antibiotics for IE was performed. In total, 114 inpatients were evaluated. All cases of CRI [including exit-site infection, intravascular catheter-related bloodstream infection (CRBSI) and mortality] were recorded. Tunnelled and non-tunnelled central venous catheters (CVCs), and peripherally inserted cannulae were used for antibiotic delivery.

Findings: There were 15 episodes of CRI, 11 of which were CRBSI (all associated with CVC use). The remainder comprised uncomplicated exit-site infections. Use of tunnelled CVCs [hazard ratio (HR) 16.95, 95% confidence interval (CI) 2.13–134.93; $P = 0.007$] and non-tunnelled CVCs (HR 24.54, 95% CI 2.83–212.55; $P = 0.004$) was associated with a significantly increased risk of CRI. Risk of mortality increased significantly with *Staphylococcus aureus* as the cause of IE ($P < 0.001$) and CRBSI ($P = 0.034$).

Conclusion: Risk of CRI in patients with IE is linked to the type of vascular access device used. Rates of CRBSI were greatest with CVCs, while peripheral venous cannulae were not associated with CRBSI or serious sequelae. Many patients (40%) tolerated complete treatment courses delivered via peripheral cannulae. These findings confirm the importance of device selection in reducing the risk of CRI; a potentially modifiable variable that impacts on outcome and mortality in IE.

Introduction

Infective endocarditis (IE) continues to be associated with significant morbidity and mortality despite improved diagnostic abilities and advances in antimicrobial therapy. Due to the low incidence of IE, there is a lack of randomized studies to support

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clinical practice, although comprehensive guidelines exist. Prolonged periods of intravenous antimicrobial therapy are necessary for the treatment of IE. In spite of appropriate antimicrobial therapy, IE has an inhospital mortality of approximately 20%.[1] A previous UK IE guideline has recommended administration of antimicrobials via a large central vein,[2] and Evidence-based Practice in Infection Control (EPIC2) guidelines for prevention of healthcare-associated infection recommend a tunnelled or totally implanted central venous catheter (CVC) for patients requiring long-term venous access.[3] Tunnelled and cuffed vascular access devices are intended for use where long durations of intravenous treatment are necessary (usually in excess of three months),[4] and the benefits of these devices may not be realized if used for shorter periods. Routine use of tunnelled CVCs (e.g Hickman catheters) for antibiotic delivery in IE patients is common. Whilst this may be perceived as being more comfortable for patients and avoids repeated cannulation, central venous access can be associated with adverse outcomes, particularly catheter-related infections (CRIs) that are perilous to patients and can lengthen hospital stay.

Infection resulting from bacterial colonization of intravenous catheters remains a major problem worldwide. In England, one-third of hospital-acquired bacteraemias of known source were associated with intravascular devices, of which CVCs accounted for 31%.[5] CRI includes both localized exit-site infection and systemic intravascular catheter-related bloodstream infection (CRBSI). CRBSI is acknowledged to be one of the most dangerous complications of health care.[3] The excess rate of mortality directly attributable to nosocomial bacteraemia (among surgical intensive care patients without IE) has been reported to be as high as 35%.[6] There are currently no national data concerning IE and its complications in the UK, so details of CRI in this population do not exist.

National guidelines acknowledge the importance of intravascular device selection in reducing healthcare-associated infection,[3] but the preferred route of vascular access for delivery of extended courses of antimicrobial therapy is not known. CVCs have not been compared with peripheral cannulae for delivery of extended courses of antimicrobial therapy. Attributable mortality or morbidity related to CRI in an IE population has also not been studied previously. The authors questioned whether tunnelled CVCs were the safest means of delivering extended courses of antimicrobials to IE patients, and performed a prospective service evaluation with the aims of determining: (1) the types of vascular access devices used in IE treatment; (2) the rates of CRI and the impact of device type on CRI; and (3) the effect of CRI on outcome.

Methods

Setting

Leeds General Infirmary (LGI) is part of Leeds Teaching Hospitals NHS Trust (LTHT), and is a tertiary referral centre for cardiology.

Design

This was a prospective observational service evaluation of all inpatients who received intravenous antibiotics for IE.

Data collection

The Leeds Endocarditis Service, a multi-disciplinary team of clinicians including microbiologists and cardiologists, was established in 2004 to assist in the diagnosis and management of IE. All patients with IE were reviewed by this team at the bedside on at least a weekly basis. Data concerning inpatient stay and treatment were recorded. Many patients were treated with a variety of vascular access devices; the total number of catheter days *in situ* was calculated for each device, and episodes of CRI were related to the type of device infected. Infection rates were expressed as CRI per 1000 catheter-days. In all cases of CRBSI, the culprit device was removed.

Inclusion and exclusion criteria

All patients aged >16 years with possible or definite IE according to the modified Duke criteria,[8] managed by the Leeds Endocarditis Service in the LGI between 1 January 2005 and 31 March 2007, were included. The only exclusion criterion was treatment of IE with oral antimicrobials.

Definitions

Catheter types

CVCs without a cuff or subcutaneous tunnelled portion intended for short-term use were categorized as 'non-tunnelled CVCs' in this investigation. Those with a tunnelled portion with or without a cuff (e.g. Hickman catheters) were categorized as 'tunnelled CVCs'.

Catheter-related infections

A diagnosis of CRI required the correlation of clinical findings with laboratory results.

- Intravascular CRI: Included CRBSI and uncomplicated exit-site infection but not lone intravascular catheter colonization.
- Intravascular CRBSI: CRBSI was defined as isolation of an organism from at least one bottle of a pair of blood culture bottles plus:
  - a semiquantitative culture of the removed catheter tip positive for the same organism (>15 colony-forming units) as the blood culture isolate; or
  - a differential time to positivity of paired peripheral and through-line blood cultures >2 h in favour of through-line cultures (CVCs only)[9]; or
  - exit-site infection with exit-site culture positive for the same organism as blood cultures.
- Uncomplicated exit-site infection: >1 cm erythema and/or purulent exudate at the exit site of the catheter with no positive blood cultures.

Main outcomes measured

There is no consensus on the optimal period during which to assess death after receiving treatment for an episode of IE. The defined primary endpoints were CRI, time to CRI (as a 'survival' variable) and 30-day all-cause mortality. In this investigation, 30-day mortality was defined as death occurring from the date of admission up to 30 days postdischarge from hospital, regardless of cause. The standard definition of 30-day mortality