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Review

Silver-impregnated external-ventricular-drain-related cerebrospinal fluid infections: a meta-analysis

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SUMMARY

Background: Cerebrospinal fluid (CSF) infection is the primary complication associated with placement of an external ventricular drain (EVD). The use of silver-impregnated EVD catheters has become commonplace in many neurosurgical centres.
Aim: To assess the effect of silver-impregnated EVD catheter usage on catheter-related CSF infections.
Methods: A meta-analysis was performed by systematically searching Medline, Embase and the Cochrane Library. All randomized controlled trials (RCTs) and non-RCTs comparing silver-impregnated and plain EVD catheters were identified and analysed.
Findings: Six non-RCTs were included. The crude infection rate was 10.8% for plain catheters and 8.9% for silver-impregnated catheters [pooled odds ratio (OR) 0.71, 95% confidence interval (CI) 0.46–1.08; $P = 0.11$]. In a microbiological spectrum analysis, silver-impregnated catheters demonstrated a significantly lower rate of CSF infections caused by Gram-positive organisms (2.0% vs 6.7% in the silver-impregnated and plain catheter groups, respectively; pooled OR 0.27, 95% CI 0.11–0.63; $P = 0.002$).
Conclusion: The antimicrobial effects of silver-impregnated EVD catheters may be selective, and may need to be evaluated further in a prospective, controlled manner.

Introduction

Insertion of an external ventricular drain (EVD) is a common neurosurgical procedure. It is mainly used to control intracranial pressure in patients who have sustained traumatic brain injury or subarachnoid haemorrhage, and can be life-saving in these situations.[1–3]

Unfortunately, EVD insertion is associated with a number of serious complications that include malplacement, haemorrhage and cerebrospinal fluid (CSF) infection, which has been reported to be in excess of 20% in certain series.[1,4,5] Infection-related increases in morbidity, mortality and associated

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healthcare costs are well recognized, and a number of strategies have been implemented with the aim of reducing infection rates.[6,7]

Use of antibiotic-impregnated EVD catheters has been shown to reduce infection rates, and evidence for their use has been further supported by a recent meta-analysis.[8] However, from these data, it has been suggested that antibiotic-impregnated EVD catheters may have selective effects on Gram-positive organisms, as no significant reduction in Gram-negative infections was observed.[8]

Silver is a broad-spectrum antimicrobial that exerts its effects by disrupting microbial proteins, altering membrane permeability or interfering with the respiratory electron transport chain.[9,10] These antimicrobial properties have been exploited to reduce infection, and silver impregnation has reduced EVD-related CSF infection significantly.[1] However, the efficacy of commercially available silver-impregnated EVD catheters has been questioned as they failed to prevent colonization of bacteria *in vitro*;[11] while potentially effective within the first few days, silver EVDs may not confer benefit beyond this point, for example in those requiring prolonged periods of drainage. Furthermore, not all clinical studies have demonstrated protective effects of silver impregnation against CSF infection.[12] Therefore, this meta-analysis aims to determine if sufficient evidence is available to support the role of silver-impregnated catheters in reducing EVD-associated infection.

Methods

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement.[13] Electronic searches of Medline, Embase and Cochrane databases until October 2014 were performed using procedure terms (external ventricular drainage OR ventriculostomy OR EVD), outcome terms (infection OR ventriculitis) and catheter type terms (silver). No language restrictions were applied. In addition, a manual search through the references of identified papers was performed to ensure that all relevant studies were identified.

Studies were included in the meta-analysis if they were a randomized or cohort study (including prospective and retrospective designs), comparing silver-impregnated catheters with plain catheters, with documented details of microbiological results associated with CSF infection and/or raw data regarding the number of infections for each type of catheter (silver-impregnated and plain). The comparison of antibiotic-impregnated catheters with any other type of catheter (plain or silver-impregnated) was not an aim of this study.

CSF infection was defined as confirmed positive microbiological culture of the CSF itself (i.e. excluding those where the EVD tip was used).

Data extraction and quality assessment

Two authors (RA and LF) reviewed the title and abstract for each eligible study independently. Relevant data were extracted into a standard data collection sheet by LF and verified independently by RA. Disagreements were resolved by discussion, and a consensus opinion was sought with the senior author where necessary. The extracted data included: first author's surname; year of publication; study design; type of catheters used; patient demographics (age, sex); pathology/indication for EVD; number of patients included; number of patients with CSF infection; number of patients unaffected by CSF infection; and microbiological results (types of organism cultured and number of patients associated with each type of micro-organism).

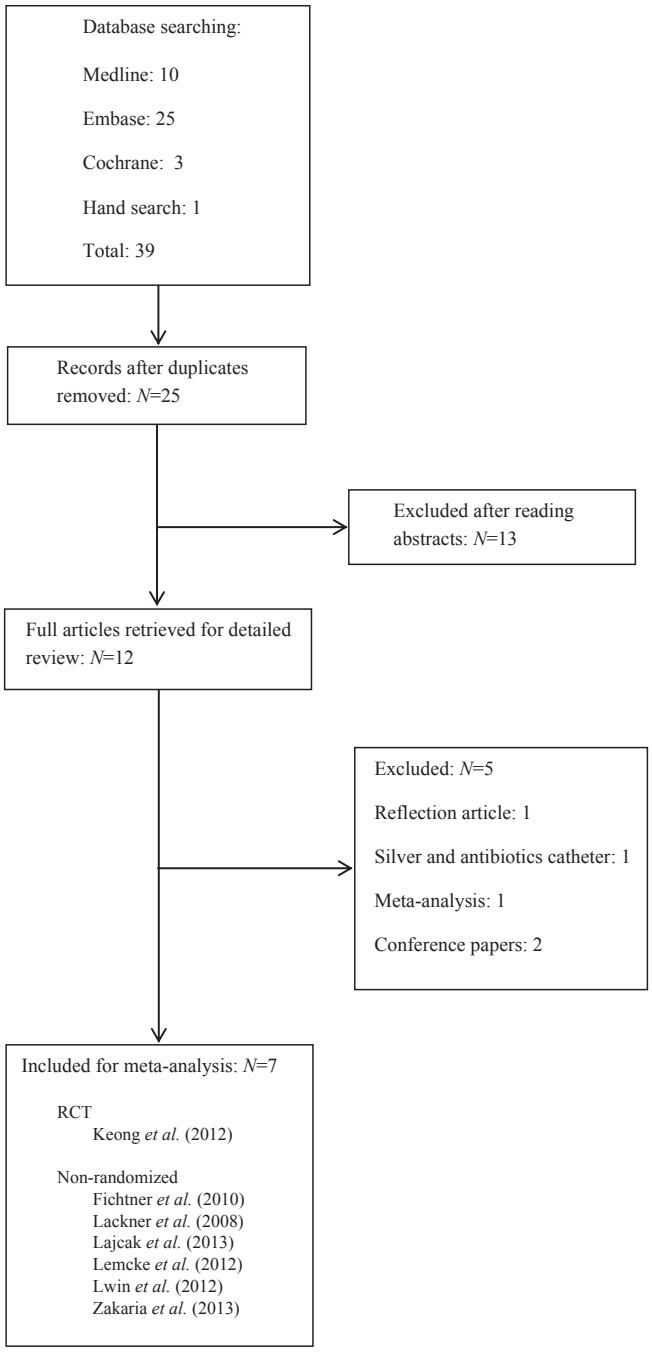

Figure 1. PRISMA flow diagram. RCT, randomized controlled trial.

Statistical analysis

Analyses were performed using StatsDirect Version 2.7.9 (England: StatsDirect Ltd, 2013). Descriptive statistics were