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Short report

Preventing ventriculostomy-related infections with antibiotic-impregnated drains in hospitals: a two-centre Dutch study

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SUMMARY

This observational cohort study assessed the effect of the introduction of antibiotic-impregnated external ventricular drains (AI-EVDs), as opposed to plain silicone EVDs, on the occurrence of ventriculostomy-related infections (VRIs) in two Dutch hospitals, with no other changes to their clinical practice. VRI was defined using the criteria of the Centers for Disease Control and Prevention, and with a culture-based definition. A propensity-score-adjusted competing risks survival analysis showed that introduction of AI-EVDs did not significantly decrease the risk of VRIs in routine care, nor affect the bacterial aetiology, even after adjustment for confounding and competing events.

Introduction

External ventricular drains (EVDs) are frequently used in neurosurgical patients to monitor intracranial pressure and drain cerebrospinal fluid (CSF).[1] Although placement of a catheter is a successful strategy to manage secondary hydrocephalus, the development of meningitis or ventriculitis is not uncommon, with incidences up to 22% being reported.[2] Ventriculostomy-related infections (VRIs) are often caused by coagulase-negative staphylococci (CoNS), *Staphylococcus aureus* or other Gram-positive cocci (e.g. *Enterococcus faecalis*).[2–4] Antibiotic-impregnated EVDs (AI-EVDs) have been developed to prevent VRIs; they consist of a silicone matrix

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impregnated with antimicrobials to prevent drain colonization by Gram-positive bacteria.

Several trials have been conducted to date, but these have not unequivocally shown a benefit of AI-EVDs in routine care settings. This study aimed to compare the occurrence and bacterial aetiology of VRIs in neurosurgical patients treated with AI-EVDs vs plain EVDs in two Dutch hospitals.

Methods

Study design and participants

This study is a post-hoc analysis of a previous investigation on surveillance methods for VRIs.[4] Patients who received an EVD from January 2012 to December 2013 in Hospital A, and from April 2012 to April 2013 in Hospital B were included. All adult patients (age ≥18 years) who received an EVD were eligible for inclusion. Exclusion criteria were death, discharge or transfer to another hospital within 24 h of drain placement, first drain placed elsewhere or pre-existing meningitis.

The incidence of VRIs in patients who received an AI-EVD, impregnated with 0.15% clindamycin and 0.054% rifampin (Bactiseal, Codman, Johnson & Johnson, Raynham, MA, USA), was compared with the incidence of VRIs in patients who received a standard silicone drain. Hospital A converted to AI-EVDs in October 2012. In Hospital B, patients admitted between April and September 2012 received either a standard silicone drain or an AI-EVD, as decided by the treating physician; from 1st September 2012, almost all patients received an AI-EVD. All EVDs were placed under peri-operative antibiotic prophylaxis, and drain management practices did not change during the study. Demographic characteristics and clinical, therapeutic and microbiological data were collected from the patients' medical records. Approval and a waiver of informed consent were obtained from the Institutional Review Board of the University Medical Centre Utrecht.

Outcomes

The primary endpoint of this study was the occurrence of VRIs. This was defined according to modified criteria from the Centers for Disease Control and Prevention (CDC) for healthcare-associated meningitis, as described previously.[4] In addition, a culture-based definition was applied, defining infection as the occurrence of a single positive CSF culture irrespective of the micro-organism isolated. For both definitions, infection must have developed when the drain was *in situ*, or within seven days of drain removal.[4] Moreover, the distribution of causative micro-organisms was assessed, along with their antimicrobial resistance profiles.

Statistical analyses

To evaluate the effect of AI-EVDs on the occurrence of infection, a propensity-score (PS)-adjusted competing risks analysis was performed, considering mortality as the competing event. The latter accounts for possible bias introduced by non-informative censoring. PSs were used to adjust for confounding factors, and were estimated by regressing treatment status (AI-EVD vs plain EVD) on age, sex, American Society of Anesthesiologists' classification, Acute Physiology and Chronic Health Evaluation score, indication for drain placement, prior neurosurgery in the last 30 days and emergency of drain placement; all were selected based on the literature and clinical judgement.[5] To

Table I
Overview of patient characteristics and outcomes

Characteristics [*N* (%) unless otherwise indicated]	Plain EVD (*N* = 65)	AI-EVD (*N* = 116)
Age in years (mean, SD)	55.9 (16.3)	62.5 (11.7)
Male	27 (41.5%)	46 (39.7%)
APACHE IV score (median, IQR)[a]	75.5 (51–88)	70.5 (48–94)
ASA classification[b]		
I	5 (7.7%)	14 (12.1%)
II	9 (13.8%)	24 (20.7%)
III	11 (16.9%)	26 (22.4%)
IV	6 (9.2%)	17 (14.7%)
V	4 (6.2%)	2 (1.7%)
Indication for first drain		
Hydrocephalus after intracerebral haemorrhage	56 (86.2%)	85 (73.3%)
CSF leakage	–	1 (0.9%)
Tumour or peri-operative	5 (7.7%)	18 (15.5%)
Trauma	1 (1.5%)	2 (1.7%)
Other	3 (4.6%)	10 (8.6%)
Drain placed on day of hospital admission	41 (63.1%)	68 (58.6%)
Admitted to ICU on first day of drainage	48 (73.8%)	88 (75.9%)
Emergency placement of first drain	49 (75.4%)	98 (84.5%)
Duration of surgery for first drain in min (median, IQR)	31 (21–114)	33 (20–61)
Prior neurosurgery in last 30 days	10 (15.4%)	22 (19.0%)
Number of drains placed[c]		
1	54 (83.1%)	96 (82.8%)
2	10 (15.4%)	16 (13.8%)
≥3	1 (1.5%)	4 (3.4%)
Outcomes		
Infection by CDC definition	10 (15.4%)	17 (14.7%)
Infection by CB definition	9 (13.8%)	18 (15.5%)
Censored as death under CDC definition	17 (26.2%)	42 (36.2%)
Censored as death under CB definition	17 (26.2%)	39 (33.6%)
Total drain duration in days (median, IQR)	8 (5–13.5)	9 (5–14)

EVD, external ventricular drain; AI-EVD, antibiotic-impregnated external ventricular drain; SD, standard deviation; APACHE, Acute Physiology and Chronic Health Evaluation; IQR, interquartile range; ASA, American Society of Anesthesiologists; CSF, cerebrospinal fluid; ICU, intensive care unit; CDC, Centers for Disease Control and Prevention; CB, culture-based.

[a] Missing (*N*, %): AI-EVD 16 (13.8%), plain EVD nine (13.8%).

[b] Missing (*N*, %): AI-EVD 33 (28.4%), plain EVD 30 (46.2%).

[c] Number of drains placed prior to development of ventriculostomy-related infections.