

## **Risk, predictive, and preventive factors for non-infectious ventriculitis and external ventricular drain infection**

**Tzu-Fen Huang MD<sup>1\*</sup>, Yu-Kai Su MD<sup>1,2,3,4,\*</sup>, Chien-Hua Tseng MD<sup>5,6,7,¶</sup>**

<sup>1</sup> Division of Neurosurgery, Department of Surgical Medicine, Shuang Ho Hospital, Taipei Medical University, New Taipei City 235041, Taiwan

<sup>2</sup> Taipei Neuroscience Institute, Taipei Medical University, Taipei 110301, Taiwan.

<sup>3</sup> Department of Surgery, School of Medicine, College of Medicine, Taipei Medical University, Taipei 110301, Taiwan

<sup>4</sup> Graduate Institute of Clinical Medicine, Taipei Medical University, Taipei 110301, Taiwan.

<sup>5</sup> Division of Critical Care Medicine, Department of Emergency and Critical Care Medicine, Shuang Ho Hospital, Taipei Medical University, Taipei 110301, Taiwan

<sup>6</sup> Division of Pulmonary Medicine, Department of Internal Medicine, School of Medicine, College of Medicine, Taipei Medical University, Taipei 110301, Taiwan

<sup>7</sup> Division of Pulmonary Medicine, Department of Internal Medicine, Shuang Ho Hospital, Taipei Medical University, New Taipei City 235041, Taiwan

\* These authors contributed equally to this work.

¶ Corresponding author: Chien-Hua Tseng, MD, PhD

Division of Critical Care Medicine, Department of Emergency and Critical Care Medicine, Shuang Ho Hospital, Taipei Medical University, Taipei 110301, Taiwan

Address: No. 291, Zhongzheng Rd., Zhonghe District, New Taipei City, 23561, Taiwan (R.O.C.)

Telephone: +886-2-2249 0088

Fax: +886-2-2248-1121

E-mail: [17339@s.tmu.edu.tw](mailto:17339@s.tmu.edu.tw)

**Keywords:** ventriculitis, external ventriculostomy drain, antibiotics, chlorhexidine gluconate bathing, needle-free connector

## **Abstract**

**Objective:** External ventricular drain (EVD) is utilized for monitoring intracranial pressure or diverting cerebrospinal fluid (CSF). However, confirmation of an infection is not immediate and requires obtaining culture results, often leading to the excessive use of antibiotics, contributing to issues such as antibiotic resistance. This study aimed to compare non-infectious ventriculitis and EVD infection in terms of risk factors, predictors, prognosis, and effectiveness of care bundle interventions.

**Methods:** This retrospective study was conducted at a 1006-bed medical center in northern Taiwan from January 2018 to July 2022. It included all adult patients admitted to the intensive care unit who underwent EVD placement. Standard EVD insertion protocols and care bundles have been implemented since 2018, along with the initiation of chlorhexidine gluconate bathing since 2011.

**Results:** In total, 742 EVD cases were identified. The CSF outputs peaked between days 2 and 5 after EVD placement, and they continued to increase persistently for 1 week leading up to the onset of fever and neuroinflammation. Non-infectious ventriculitis typically occurred around 8 days after EVD placement, whereas EVD infection generally manifested after 20 days. Aneurysmal subarachnoid hemorrhage was strongly associated with the development of non-infectious ventriculitis (adjusted odds ratio [OR] 2.6, 95% confidence interval [CI]: 1.5, 4.4). Alcoholism (adjusted OR 3.6, 95% CI: 1.1, 12.1) and arteriovenous malformation (adjusted OR 6.9, 95% CI: 1.8, 27.2) significantly increased the risk of EVD infection. The EVD infection rate significantly decreased from 3.6% (14/446) to 1.0% (3/219) ( $p=0.05$ ) after the implementation of chlorhexidine gluconate bathing.

**Conclusions:** Younger patients, aneurysmal subarachnoid hemorrhage, or fever with neuroinflammation within 2 weeks of EVD placement are indicative of a higher likelihood of non-infectious ventriculitis, which may be managed conservatively with either no antibiotics or a shorter duration of antibiotic treatment. Conversely, patients with arteriovenous malformation, alcoholism, diabetes, extremely high CSF white blood cell count, or fever with neuroinflammation occurring after more than 3 weeks of EVD placement are more likely to necessitate antibiotic treatment for EVD infection. The implementation of chlorhexidine gluconate bathing decreased EVD infection rate.

## Figure Legends

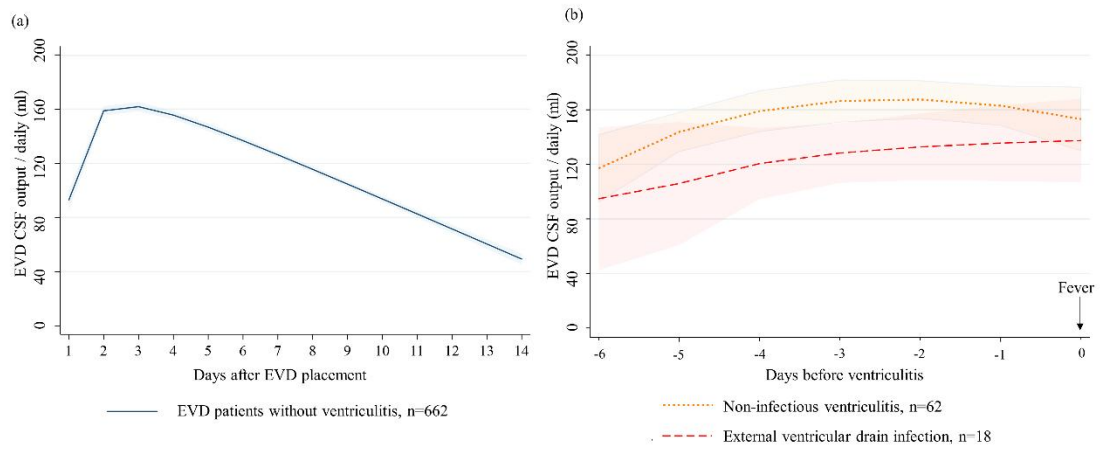


Figure 1. EVD cerebrospinal fluid daily output after placement and before ventriculitis and infection. EVD, external ventricular drain.

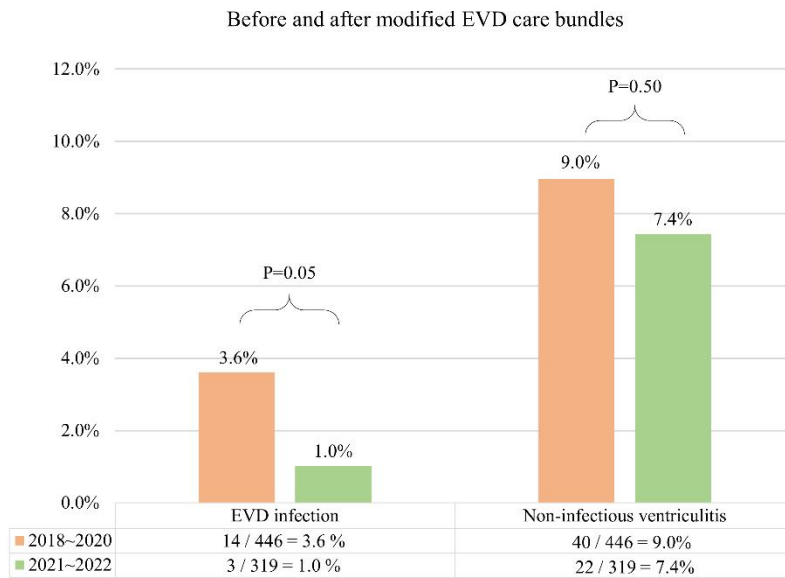


Figure 2. EVD infection and non-infectious ventriculitis rates before and after implementation of modified EVD care bundles. EVD, external ventricular drain.