Etiologies of Early Ventricular Shunt Malfunctions and Proposal of a New Quality Metric

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Introduction

Complications from ventriculoperitoneal shunting are well-known and costly. In this era of quality, outcomes, and pay-for-performance, hospital administration and physicians are searching for clinically useful outcome measures or quality metrics, such as the Surgical Activity Rate (SAR) and the Revision Quotient (RQ), and the 30-day shunt malfunction rate (1).

The purpose of this study was to analyze in detail the etiologies of early shunt failure (within 90 days) in our pediatric hydrocephalus population, and to determine the proportion of shunt failures that potentially could have been prevented. We believe that such detailed analysis is a requisite for the creation of any so-called quality metric within neurosurgery.

Methods

All shunt surgeries from January 1, 2010 to Dec 31, 2014 excluding endoscopic surgeries as well as non-definitive procedures (i.e., shunt taps, external ventricular drain placement, externalization, or complete removal existing of shunt system) were collected. An "index surgery" was defined as implantation of a new shunt or revision or augmentation of an existing shunt system. Patients receiving a new shunt or a revision or augmentation of the existing shunt marked a new index surgery.

Study Questions

1. What is the 90-day shunt revision rate?
2. What was the etiology of each failure and was it potentially preventable?
3. Are there any demographic, clinical, or procedural variables that are associated with preventable shunt failures?

Definition

Preventability was defined as infection, malposition of the proximal or distal catheter (e.g., preperitoneal), or an inadequately assembled or secured shunt that resulted in postoperative migration or disconnection and failure.

Results

During the study period, there were 927 de novo or revision shunt operations in 525 patients. Of the 927 surgeries, 202 (21.8%) required a return to the operating room within 90 -days. Sixty-seven cases (33% of failures) were due to potentially preventable etiologies (Table 3).

The children who failed secondary-to-preventable-causes were younger (median, 3.1 yrs vs 6.7 yrs, p=0.009) and were more likely to fail within 30 days of index surgery (80.6% vs 64.4%, p=0.022). The most common causes of preventable shunt failure were inaccurate proximal catheter placement (33/67, 49.3%) and infection (28/67, 41.8%). No variables were found to be predictive of preventable shunt failure with multivariate logistic regression

Table 1. Reasons for preventable shunt revisions (n=67)

Description	N (%)
Inaccurate proximal catheter	33 (49.3%)
Infection	28 (41.8%)
Inaccurate distal catheter	4 (5.9%)
Unsecured shunt	2 (2.9%)

Conclusions

To date, many of the risk factors for shunt failure and causes of shunt revision surgery are beyond the influence and control of the surgeon. With this study, we have demonstrated that a significant proportion of 90-day shunt failures at our institution—33%—were preventable. We propose the Preventable Shunt Revision Rate as a specific, meaningful, measurable, and—hopefully—modifiable quality metric for shunt surgery in children.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of preventing shunt malfunction, 2) Discuss, in small groups, the key attributes of a quality metric, 3) Identify an effective strategy to prevent early shunt malfunction.

References

1. Barton SE, Campbell JW, Piatt JH, Jr.: Quality measures for the management of hydrocephalus: concepts, simulations, and preliminary field-testing. J Neurosurg Pediatr 11:392-397, 2013