# Stroke Volume Variation Guided Intra-Operative Fluid Individualization and Optimization for Neurosurgical Operations

Jie Zhou, MD, MS, MBA, Narden Gorgy, Lindsey Kummerer, Linda S Aglio, MD, MS

Department of Anesthesiology, Perioperative and Pain Medicine, Brigham and Women's Hospital, Boston, MA 02115

## Introduction

Fluid management for neurosurgical operations can be tedious due to the location and type of procedures. Fluid restriction techniques have shown benefits in a variety of surgical specialties. We have demonstrated in the past that stroke volume variation (SVV) is superior to some other parameters for intra-operative fluid management. We have implemented a protocol for neuroanesthesia team to utilize the SVV (target of 15-18%) to track patient volume status for lengthy neurosurgical cases. However, it is unknown if variance of anesthesia management may affect patient outcomes.

## Materials and Methods

With IRB approval, we retrospectively reviewed a series of neurosurgical skull base tumor cases performed by one experienced neurosurgeon, during which SVV using Vigileo$^{TM}$ were recorded. Anesthesia management included total intravenous anesthesia with total intravenous anesthesia with propofol, remifentanil, and phenylephrine infusions. Cases of one anesthesiologist with more restrictive fluid management approach (Restrictive Group, RG) were compared with cases of other anesthesiologists with conservative fluid management approach (Conservative Group, CG). Patient demographics, length of the operations, fluid in’s and out’s, including colloid and crystalloid, urine output, and estimated blood loss were calculated. Other medication usage including propofol, phenylephrine, diuretic, and beta blocker agents were recorded. Intra-operative hemodynamic data (SV, SVV, CO, SVR) and perioperative laboratory data including BUN, creatinine, and lactic acid were also recorded and analyzed. Student t- test was used. Significance was accepted as *P* value less than 0.05.

## Results

The patients in the RG received negative fluid load intra-operatively which was significantly different from that of the patients in CG. Patients in the RG received significantly less crystalloid. Fluid management for the restrictive group was mainly based on 25% albumin. Phenylephrine consumption was significantly higher in the RG than that of CG.

| | | Restrictive Group (n=21) | Conservative Group (n=36) | *P* value |
|---|---|---|---|---|
| Demographics | Age (year-old) | 47.7 ± 12.5 | 52.7 ± 15.9 | 0.199 |
| | Weight (kg) | 80.2 ± 17.5 | 86.5 ± 28.3 | 0.309 |
| | Height (cm) | 168.9 ± 9.4 | 169.5 ± 10.7 | 0.820 |
| | BMI (kg/m²) | 28.1 ± 5.4 | 28.8 ± 7.0 | 0.456 |
| Intraoperative Fluid Management | Length of Operations (min) | 657 ± 173 | 611 ± 200 | 0.556 |
| | Total Crystalloid (mL) | 925 ± 376 | 1698 ± 864 | 0.000* |
| | 25% Albumin (mL) | 200 ± 169 | 84 ± 90 | 0.006* |
| | 5% Albumin (mL) | 0 ± 0 | 150 ± 349 | 0.012* |
| | Packed Red Blood Cell (units) | 0.2 ± 0.6 | 0.3 ± 0.8 | 0.412 |
| | Fresh Frozen Plasma (units) | 0.2 ± 0.5 | 0.3 ± 0.8 | 0.317 |
| | Platelets (units) | 0.0 ± 0.0 | 0.0 ± 0.2 | 0.324 |
| | Cryoprecipitate (units) | 0.1 ± 0.4 | 0.0 ± 0.0 | 0.329 |
| | Urine (mL) | 1855 ± 867 | 1499 ± 996 | 0.165 |
| | EBL (mL) | 409 ± 409 | 290 ± 303 | 0.288 |
| | Propofol (g) | 65.1 ± 2.7 | 49.5 ± 2.7 | 0.046* |
| | Phenylephrine (mg) | 20.5 ± 18.0 | 10.2 ± 12.0 | 0.025* |
| | Fluid in-out (mL) | -1010 ± 946 | 296 ± 991 | 0.000* |

| | | Restrictive Group | Conservative Group | *P* value |
|---|---|---|---|---|
| Intraoperative Hemodynamic Data | SVV Mean (%) | 14.0 ± 2.2 | 14.6 ± 4.7 | 0.483 |
| | CVP Mean (mmHg) | 3.9 ± 2.4 | 11.6 ± 9.0 | 0.000* |
| | SVR Mean (dyn·s/cm$^5$) | 993 ± 238 | 1036 ± 284 | 0.604 |
| | CO Mean (L/min) | 6.7 ± 1.6 | 5.8 ± 1.7 | 0.064 |
| | Beginning SVV (%) | 13.2 ± 3.1 | 16.1 ± 9.0 | 0.066 |
| | Ending SVV (%) | 11.4 ± 5.3 | 13.1 ± 5.1 | 0.316 |
| | SVV Delta (%) | -1.7 ± 5.8 | -3.1 ± 9.3 | 0.410 |
| | Beginning SV (mL) | 89.4 ± 27.7 | 80.3 ± 28.2 | 0.247 |
| | Ending SV (mL) | 91.9 ± 28.0 | 91.9 ± 32.7 | 0.975 |
| | SV Delta (mL) | 2.4 ± 27.4 | 11.6 ± 30.1 | 0.255 |
| | Beginning SVR (dyn·s/cm$^5$) | 1081 ± 260 | 969 ± 382 | 0.213 |
| | Ending SVR (dyn·s/cm$^5$) | 910 ± 254 | 952 ± 275 | 0.713 |
| | Beginning CO (L/min) | 6.2 ± 2.0 | 6.0 ± 2.1 | 0.709 |
| | Ending CO (L/min) | 8.5 ± 2.1 | 6.6 ± 2.2 | 0.005* |
| Pre-op Labs | BUN (mg/dL) | 15.5 ± 7.1 | 16.1 ± 7.8 | 0.807 |
| | Creatinine (mg/dL) | 0.9 ± 0.3 | 0.9 ± 0.2 | 0.894 |
| Intra-op Labs | BUN (mg/dL) | 14.7 ± 6.9 | 16.2 ± 7.7 | 0.365 |
| | Creatinine (mg/dL) | 0.8 ± 0.3 | 0.8 ± 0.2 | 0.887 |
| | Lactic Acid (mmol/L) | 1.5 ± 0.8 | 1.5 ± 0.9 | 0.885 |
| Immediate Post-op Labs | BUN (mg/dL) | 13.2 ± 7.1 | 14.3 ± 5.8 | 0.497 |
| | Creatinine (mg/dL) | 0.9 ± 0.3 | 0.8 ± 0.2 | 0.651 |
| | Lactic Acid (mmol/L) | 2.3 ± 1.5 | 1.8 ± 0.8 | 0.182 |
| Post-op Day 1 Labs | BUN (mg/dL) | 14.1 ± 7.9 | 14.3 ± 6.3 | 0.872 |
| | Creatinine (mg/dL) | 0.9 ± 0.3 | 0.8 ± 0.2 | 0.616 |
| Discharge | Post-op Day | 3.4 ± 1.8 | 4.9 ± 4.1 | 0.045* |

## Discussion

While average SVV was maintained at the similar level for both groups, the colloid-based fluid management approach with RG was significantly superior to the CG in reducing the length of hospital stay. At the same time, high dose of phenylephrine does help with urine production. We speculate that patients in the RG may have a higher oncotic pressure which could prevent brain edema in the surgical site and surrounding area.

Given the dosages of propofol consumption, it was obvious that the patients in the RG were maintained at a deeper anesthetic plane. However, this approach could also provide protection to the brain tissue since the neurosurgeons often apply significant amount of retraction in order to get access to the skull base lesions.

This study implied that the outcome of these lengthy neurosurgical operations are multi-factorial. Simply protocols such as with SVV target may not generate the same outcome. As other investigators have pointed out, clinical judgment and vigilance while using these parameters is absolutely critical since all of the values need to be interpreted with caution. Intra-operative neurophysiological monitoring could trigger significant interference to contour-based SVV monitoring devices.

The authors are calling for larger scale clinical trials and application in the field of neuroanesthesia, which are needed to guide clinical applications and determine the usability in such subspecialty cases.

## References

Zhou. *J Neurosurg Anesthesiol* 2011;23(3):272
Soriano SG, et al. *Anesthesiol Clin N Am* 2002;20(1):137
Chen CM, et al. *Neurosurg Rev* 2011;34:281-96
Liu N, et al. *Anesth Analg* 2011;112(3):546-57