Use of Total Intravenous Anesthesia (TIVA) versus Inhaled Volatile Anesthesia (INVA) in Elective Non-cardiac Surgery

Bethany Pennington, PharmD, BCPS
October 21, 2022

Co-PI: Allison Janda, MD

Disclosures

Grant / Research (current):

- Patient-Centered Outcomes Research Institute (PCORI) Project Program Award (PLACER-2020C3-21106)– *Co-investigator, "Trajectories of Recovery after Intravenous Propofol vs. Inhaled Volatile Anesthesia (THRIVE)"*

THRIVE

Background

- Practice patterns and variations of agents used with TIVA and INVA-based techniques are not well described.

- A further understanding of general anesthetic practices in the US will be informative for a large multi-center pragmatic randomized controlled trial comparing patient recovery experiences with TIVA and INVA
  - Trajectories of Recovery after Intravenous propofol versus inhaled VolatilE anesthesia (THRIVE) Trial.

THRIVE

Aims and Hypothesis

- We proposed to analyze the patterns of TIVA use in patients undergoing elective non-cardiac surgery across MPOG centers and to understand potential sources of variation in practice patterns.

- We hypothesize that institution, clinician, and patient/case level variables are associated with TIVA use.

THRIVE

Aims

- **Aim 1**: Identify variables associated with TIVA use.
  - Determine the associations observed
  - Explore the relative contribution of each level to variation in TIVA use accounting for the nested structure of the data

- **Aim 2**: Describe the frequency, variation and duration of administration of agents used during TIVA and inhaled-volatile based anesthetic (INVA) techniques.

- **Aim 3**: Describe the frequency, variation and duration of administration of agents used during TIVA and INVA techniques in homogenous surgical subgroups.

THRIVE

Aim 1: Identify variables associated with TIVA use.

Explore the relative contribution of each level to variation in TIVA use

TIVA: administration of only IV anesthetic agents with < 5 minutes administration of volatile anesthetic agents or nitrous oxide gas between anesthesia start and anesthesia end, as documented in the anesthesia record.

INVA: administration of an inhaled anesthetic for ≥ 5 minutes (either a volatile anesthetic agent or nitrous oxide gas) at any time between anesthesia start and anesthesia end, as documented in the anesthesia record.

Using a multi-level statistical model, we will estimate the variation contribution of TIVA use which emerges from institution-, clinician- and patient/case-levels.

THRIVE

Candidate Variables of Interest

- **Patient/Case-level**
  - Age, Sex, Race, BMI
  - ASA status
  - Surgical procedure type by body region
  - Extent defined by Anesthesia Base Units
  - Anesthesia duration
  - Year of procedure
  - Elixhauser comorbidities
  - History of alcohol or drug use
  - CRNA case (Yes/No)
  - Anesthesiology resident case (Yes/No)
  - Attending only case (Yes/No)
  - Average attending staffing ratio (for all cases)
  - Out of hours cases (evenings and weekends)
- **Clinician-level**
  - Attending anesthesiologist annual case volume for all cases during the study period defined by anesthesiologist attending at start of case
  - Proportion of outpatients cases over study period
  - Proportion of GA cases over study period
  - Average number of days/working/week signed into a case over study period
- **Institutional-level**
  - Institution annual case volume
  - Academic vs. Non-Academic Institutions
  - Bed size
  - Institutional proportion of cases with CRNAs
  - Institutional proportion of cases with residents
  - Institutional proportion of cases with attending only

THRIVE

Methods: Inclusion & Exclusion Criteria

Inclusion criteria	Exclusion criteria
1. Adult patients (≥18 years) undergoing elective noncardiac surgical procedures from January 1, 2016 - December 31, 2021 with a case duration lasting ≥ 60 minutes. 2. General anesthesia with a tracheal tube or laryngeal mask airway [Technique Code 1,2 or 3 from Anesthesia Technique: General Phenotype]	1. No documentation of TIVA, halogenated gas, or nitrous throughout case 2. Emergency surgery (ASA E Modifier) 3. Obstetrics cases 4. Lung, Liver or heart transplantation 5. Cardiac surgeries 6. Cardiopulmonary bypass used 7. Location Tags: Facility Type - Office-based anesthesia, OB-GYN - Labor and Delivery, OB-GYN - Obstetric OR, OB-GYN-IVF-only room, Other-Pediatric, Radiology-MRI, Service Specific Room-Cardiac OR 8. Body Region: Other Procedures, Obstetrics, or Radiologic Procedures 9. Non-operative procedures and MRIs 10. ASA Class 5 or 6 11. Organ harvest (Anesthesia CPT 01990) 12. Absence of an actual or predicted anesthesia CPT 13. Active propofol infusion prior to patient in room 14. Patient arrived to the OR already intubated (phenotype) 15. Patient not extubated prior to departure from the OR (phenotype)

THRIVE

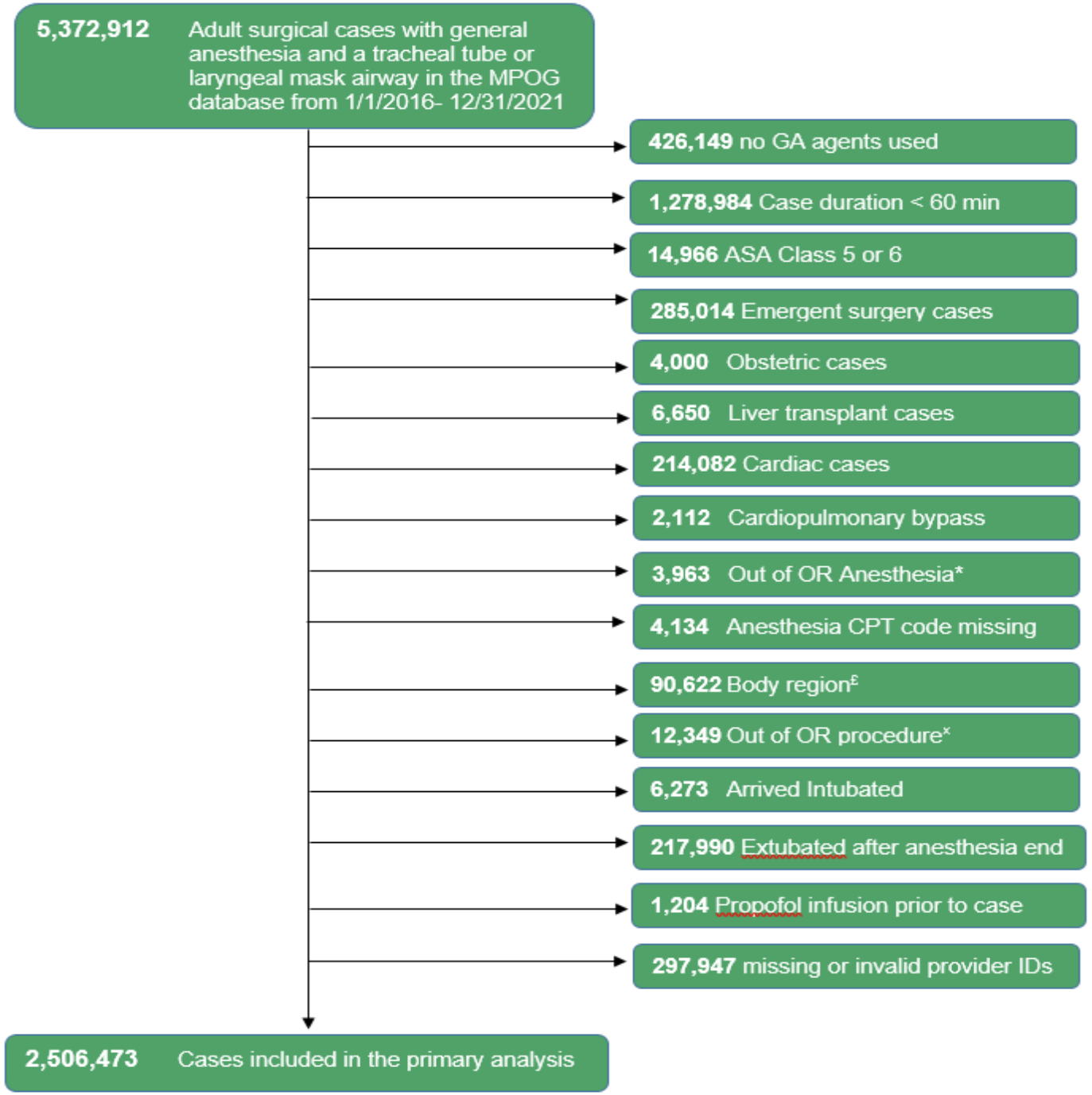
Methods- Statistical Analysis

Assessment of variance between: patients, clinicians, institutions

- Multilevel multivariable mixed-effects models were performed with patients nested within clinicians nested with institutions to assess the association between TIVA administration and relevant patient-, clinician-, and institutional-level factors
- Using intraclass correlation coefficients, variance partition coefficients, and median odds ratios

THRIVE

Results



THRIVE

Results

- 2,506,473 patients across 50 MPOG institutions with 5,826 providers were included
  - 169,175 (**6.8%**) received TIVA
  - 2,337,298 (**93.3%**) received INVA

- Patient characteristics were similar between groups

THRIVE

Results

- Preliminary *unadjusted* generalized linear mixed models showed:
  - 47.8% of the variation was explained by patient factors
  - 17.8% by the primary attending
  - 34.4% by the institution

- Over **50%** of the variation was explained by clinician and institution

- *Adjusted* MORs for receiving TIVA:
  - **2.2** between randomly selected **primary attending**
  - **2.8** between randomly selected **institutions**

THRIVE

Results

- Following multivariable modelling, these are the factors strongly associated (adjusted odds ratio, <0.8, or >1.2) with a statistically significant *increased* or *decreased* likelihood of receiving a TIVA.

*all *P* values < 0.001

Factor	Descriptor	OR	95% CI
Gender	Female Male	Reference **0.55**	 (0.544,0.558)
Race	White Black	Reference **0.74**	 (0.724, 0.756)
Case Hours	Out of Hours	**0.75**	(0.736,0.77)
Body Region	Urologic Male Reproductive Burn Head Neck Thorax-Extrathoracic Thoracic Spine and Spinal Cord	**0.71** **0.69** **0.35** **3.11** **1.99** **2.02** **6.53** **5.36**	(0.684,0.735) (0.625, 0.756) (0.275, 0.436) (3.033, 3.194) (1.936, 2.05) (1.964, 2.08) (6.318, 6.746) (5.206, 5.523)
Comorbidity	Cerebrovascular	**1.34**	(1.284, 1.394)
Year of procedure	2016 2017 2018 2019 2020 2021	Reference **1.29** **1.38** **1.59** **1.61** **1.63**	 (1.254, 1.324) (1.34, 1.415) (1.543, 1.629) (1.566, 1.657) (1.586, 1.679)
Affiliation	Academic	**4.54**	(1.338, 15.427)

Summary

- **Institution and clinician** accounted for over **half** of the variation of TIVA administration
- These data may serve as a model for understanding general anesthesia practice variation and provide context for planned randomized trials like THRIVE.
- More evidence is needed to inform whether this practice variation is irrelevant, or a target for practice improvement

Limitations

- MPOG does not include ALL institutions across the US
- Most institutions were university-affiliated

Future Directions

- Aim 2 and Aim 3 statistical analyses
- Qualitative interviews with clinicians

THRIVE

Thank you

Allison Janda MD
Douglas Colquhoun, MB ChB, MSc, MPH
Graciela Mentz, PhD
Nan Lin, PhD
Michael L Burns, MD PhD
Sachin Kheterpal, MD, MBA
Michael Avidan, MBBCh, FCA SA

THRIVE

References

1. Kronzer VL, Jerry MR, Ben Abdallah A, et al. Changes in quality of life after elective surgery: an observational study comparing two measures. Qual Life Res. 2017;26(8):2093-2102.
2. Helsten DL, Ben Abdallah A, Avidan MS, et al. Methodologic Considerations for Collecting Patient-reported Outcomes from Unselected Surgical Patients. Anesthesiology. 2016;125(3):495-504.
3. Avidan MS, Maybrier HR, Abdallah AB, et al. Intraoperative ketamine for prevention of postoperative delirium or pain after major surgery in older adults: an international, multicentre, double-blind, randomised clinical trial. Lancet. 2017;390(10091):267-275.
4. Wildes TS, Mickle AM, Ben Abdallah A, et al. Effect of Electroencephalography-Guided Anesthetic Administration on Postoperative Delirium Among Older Adults Undergoing Major Surgery: The ENGAGES Randomized Clinical Trial. JAMA. 2019;321(5):473-483.
5. Mashour GA, Ben Abdallah A, Pryor KO, et al. Intraoperative ketamine for prevention of depressive symptoms after major surgery in older adults: an international, multicentre, double-blind, randomised clinical trial. Br J Anaesth. 2018;121(5):1075-1083.
6. Kronzer VL, Jerry MR, Ben Abdallah A, et al. Preoperative Falls Predict Postoperative Falls, Functional Decline, and Surgical Complications. EBioMedicine. 2016;12:302-308.
7. Schraag S, Pradelli L, Alsaleh AJO, et al. Propofol vs. inhalational agents to maintain general anaesthesia in ambulatory and in-patient surgery: a systematic review and meta-analysis. BMC Anesthesiol. 2018;18(1):162.
8. McGain F, Bishop JR, Elliot-Jones LM, Story DA, Imberger GL. A survey of the choice of general anaesthetic agents in Australia and New Zealand. Anaesth Intensive Care. 2019;47(3):235-241.
9. Lim A, Braat S, Hiller J, Riedel B. Inhalational versus propofol-based total intravenous anaesthesia: practice patterns and perspectives among Australasian anaesthetists. Anaesth Intensive Care. 2018;46(5):480-487.
10. Yoshiyasu Y, Lao VF, Schechtman S, Colquhoun DA, Dhillon S, Chen PG. Survey of anesthesiologists on anesthetic maintenance techniques and total intravenous anesthesia for endoscopic sinus surgery. Int Forum Allergy Rhinol. 2020;10(2):153-158.
11. Pandit JJ, Andrade J, Bogod DG, et al. 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: protocol, methods, and analysis of data † ‡. British Journal of Anaesthesia. 2014;113(4):540-548. doi:10.1093/bja/aeu312
12. Madhivathanan P, Kasivisvanathan R, Cohen A. Training in total intravenous anaesthesia: a regional survey. Anaesthesia. 2010;65(5).
13. Benchimol EI, Smeeth L, Guttmann A, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. PLoS Med. 2015;12(10):e1001885.
14. Bender SP, Paganelli WC, Gerety LP, et al. Intraoperative Lung-Protective Ventilation Trends and Practice Patterns: A Report from the Multicenter Perioperative Outcomes Group. Anesth Analg. 2015;121(5):1231-1239.
15. Colquhoun DA, Shanks AM, Kapeles SR, et al. Considerations for Integration of Perioperative Electronic Health Records Across Institutions for Research and Quality Improvement: The Approach Taken by the Multicenter Perioperative Outcomes Group. Anesth Analg. 2020;130(5):1133-1146.
16. Merlo J, Chaix B, Ohlsson H, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. J Epidemiol Community Health. 2006;60(4):290-297.
17. McNeish DM, Stapleton LM. The effect of small sample size on two-level model estimates: A review and illustration. Educ Psychol Rev. 2016;28(2):295-314.
18. Benjamini Y, Hochberg Y. Controlling the false discovery rate: A practical and powerful approach to multiple testing. J R Stat Soc. 1995;57(1):289-300.

THRIVE