A pharmacoepidemiological method for assessing clinician performance during esophagogastroduodenoscopy procedures sedated with propofol

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Background: Despite the explosive growth of endoscopic sedation, little has been done to understand how clinicians control propofol during these procedures. Anesthesia providers must balance the desire for rapid induction and avoidance of over sedation, evolving a strategy that is optimal with respect to the expectations of the endoscopists. While multiple pharmacokinetic models have been delineated for propofol, a data-driven approach to assessing the facility of a clinician at the task of propofol administration has yet to emerge. Two objective measures for evaluating quality of control are proposed. The first considers adjustments to the initial plan. This is determined by considering what propofol delivery would have been had no changes been made from the initially recorded bolus and infusion. The cumulative absolute value of this difference (expressed in mg) is termed the adjustment dose. The second measure is the propofol trajectory error. At each time point, the cumulative propofol for each patient is ranked from 0 (lowest observed) to 1 (highest observed). The trajectory error is the standard deviation of the ranking over the procedure. If a particular patient is consistently at the 50^{th} percentile for propofol delivery for the entire procedure, the tracking error is zero, however, if the patient is at the 34^{th} percentile initially and at the 65^{6h} percentile 20 minutes later, the trajectory error is 0.26. The upper limit for trajectory error is

0.5. The trajectory error permits comparisons of propofol consumption in patients of differing ages and weights.

To make an aeronautical analogy, adjustment dose is how much we “fight the stick”, while trajectory error is how much we deviate from our filed flight plan.

Methods: Data was extracted from the Penn Data Analytics database for all esophagogastroduodenoscopy cases from Jan 2016 to December 2017; cases with only bolus delivery were excluded, leaving 13,503 cases. Patterns in choice of initial bolus and infusion rate were assessed. Timed delivery entries were converted to continuously sampled infusion rates. Scores for adjustment dose and trajectory error were determined for each of these cases.

Results: Median adjustment dose 26 mg (12 – 56); a histogram is presented in figure 1. Median trajectory error was 0.26 (0.23 – 0.28); a histogram is presented in figure 2. Correlations between the two measures and age or weight and were close to zero, as was the correlation between measures.

Conclusions: While there is considerable similarity in the initial bolus and infusion rates during endoscopic sedation, there is a larger diversity in adjustment dose and trajectory error. Further, these measures are minimally correlated with age and weight, or with each other, suggesting they are measuring properties of the controller, rather than the controlled, and that they are measuring distinct aspects of the control. These measures may prove useful in assessing the skill of anesthesia providers in delivering endoscopic sedation, or in assessing the performance of automated systems.

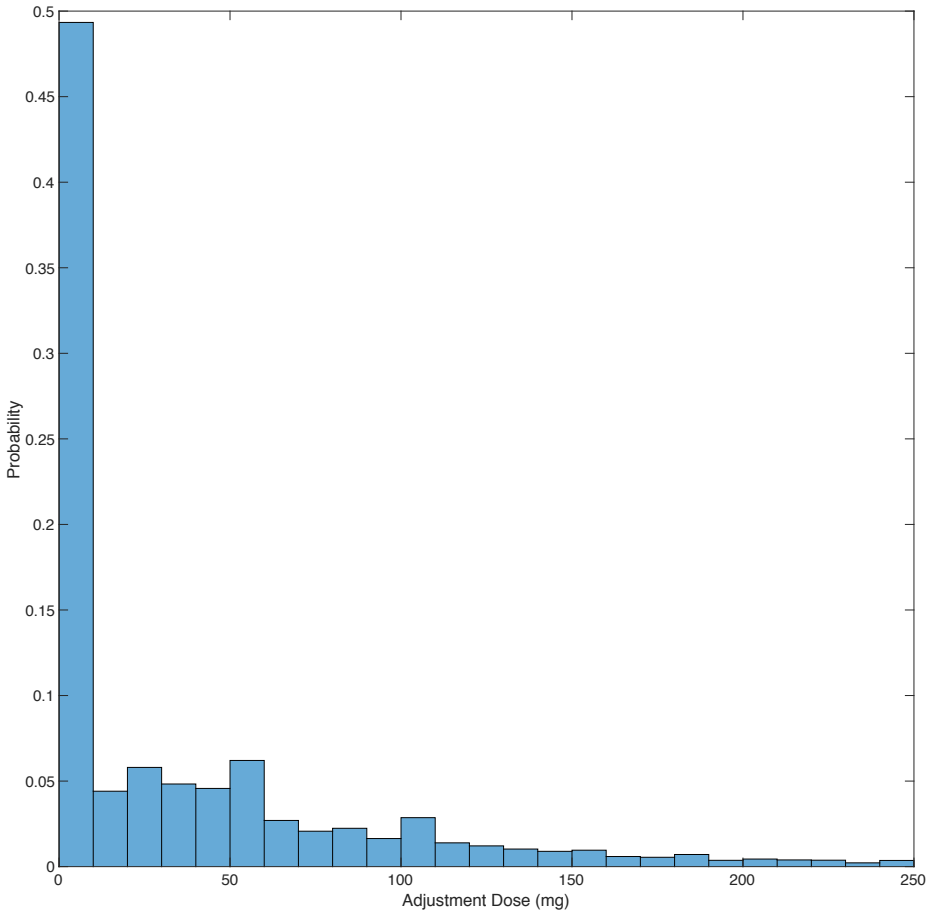
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Probability
0
50
100
150
200
250
Adjustment Dose (mg)

Figure 1

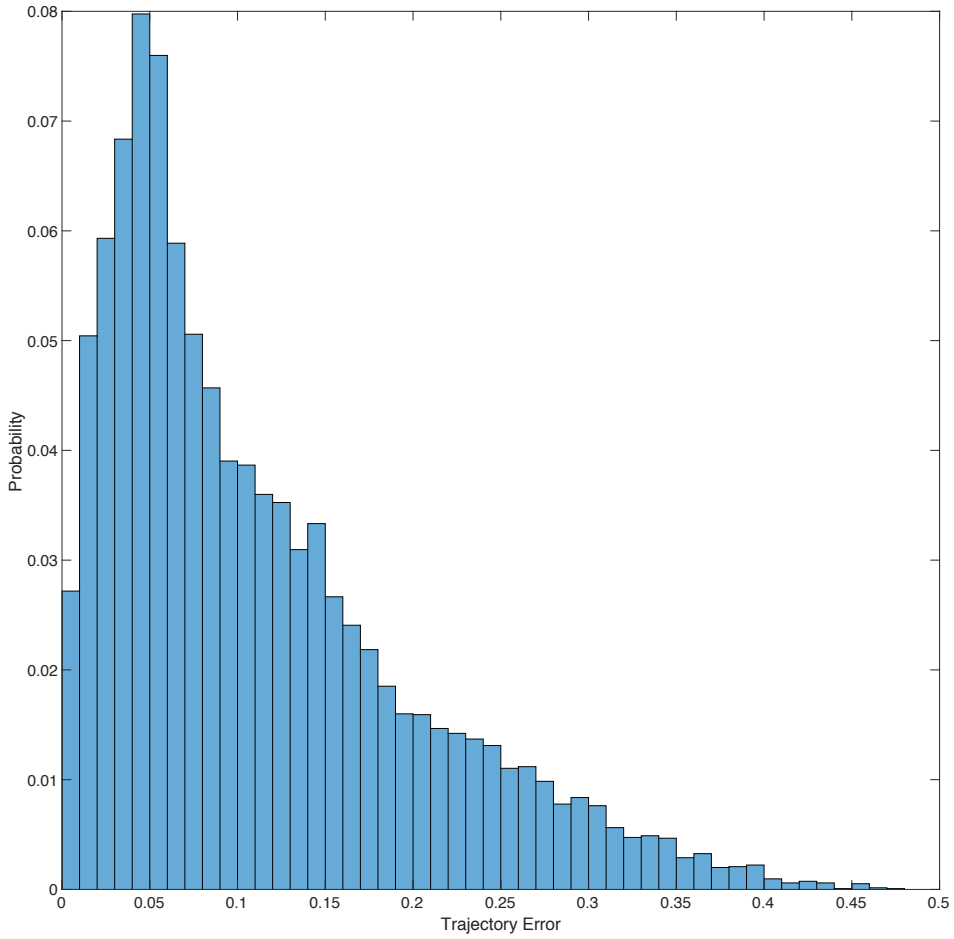
Probability
Trajectory Error
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

Figure 2