Implementing a Perpetual Anesthesia Setup Standardized for the Trauma Room in a Level I Trauma Center

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“Change is not made without inconvenience, even from worse to better.”
—Richard Hooker (1554-1600)

The trauma room in a level I trauma center is a dynamic environment that provides little room for error. Significant variability can exist if anesthesia providers set up the room differently. Standardization provides a system that is consistent, reliable, and cost-effective.

This study examines the process of creating and implementing a standardized anesthesia setup in the trauma room of a level I trauma center. As a result of this study, the medication cart and airway setups have been standardized. Providers are encouraged to only draw up medications that will be immediately used and to ensure that prefilled syringes have been incorporated into the pharmacy formulary.

Using the EZ Endo prestyleted endotracheal tube (ETT) vs a regular ETT with stylet has yielded an annual cost savings of $2,613. Ensuring that items such as an esophageal temperature probe, humidifier, and nasogastric tube are available but unopened has provided a savings of $1,989.25 per year. The reservoir bag has been changed to a latex-free bag, and 3 central line kits including an arterial line kit are routinely stocked. An ultrasound machine dedicated for central line access, GlideScope, rapid fluid infuser, and Airtraq laryngoscope have all been incorporated into the permanent setup in the trauma room.

Keywords: Anesthesia, level I trauma center, prefilled syringes, standardization, Theory of Reasoned Action.
and encourage faster turnover of operating rooms. In the complicated milieu of the operating room, this can lead to a variety of adverse outcomes. Anesthesia providers may be assigned to a trauma case without having time to adequately assess the room's setup. A provider's tendency toward shortcuts, especially when faced with an emergency situation like a trauma case, can lead to serious outcomes because critical items or steps may be overlooked.7

According to the Joint Commission Journal on Quality and Patient Safety, a fundamental goal of safety is to “reduce non-evidence-based variation and standardize clinical practice patterns on the basis of scientific evidence.”8 Standardization forces consistency; in turn, consistency leads to familiarity with a system and safer patient care.9 In addition, standardization reduces reliance on memory and allows new anesthesia providers to use a system more efficiently and safely.10 Standardization is especially warranted in a teaching facility where anesthesiologists, CRNAs, and trainees coexist. A standard system allows practitioners to have confidence that the items they need during a trauma case, regardless of who initiated the setup, will be available.

The impetus for this study stems from the lack of a standard anesthesia setup at VCUMC. Before 2011, the trauma setup exhibited significant day-to-day variance because there was no consistency with regard to what airway equipment and anesthesia supplies should be readily available in an emergency situation. Anesthesia providers are notoriously compulsive but variant about how they prepare their setup. For example, many providers view drawing up medications they may never use as wasteful. In contrast, some providers will draw up a plethora of medications in anticipation of use, which are ultimately thrown away at their expiration 24 hours later, thereby creating waste in the trauma room.

In addition to providing departmental cost savings, a perpetual setup can also save time. A standardized setup ensures that the anesthesia provider's time is not needed for basic setup tasks such as drawing up medications, labeling them to comply with standards or placing stylets in endotracheal tubes (ETTs). Utilizing prefilled syringes purchased from a company that prepares and labels them using strict isolation procedures guarantees medications are available for immediate use. A prestyled ET, maintained in its package, saves time and also provides a cost-benefit because the ETT remains sterile and thereby does not need to be discarded daily because of outdateding. In the trauma room, the authors chose to conduct a descriptive study. The first step was to assess the current system. Over the course of 2 months, the trauma room was photographed at random intervals to provide visual representation of the significant variance that existed (Figure 1). Next, a 23-question survey was created and distributed to anesthesia providers to elicit their preferences regarding an ideal trauma anesthesia setup (Table 1). The survey was anonymous, with job description and years of experience as the only demographic data collected. The following groups were asked to participate: attending anesthesiologists, CRNAs, and anesthesia residents in their second and third year of residency. First-year anesthesia residents are not assigned to cover the trauma room and were excluded from the study. In addition, CRNAs who are per diem or only work in the outpatient, ambulatory setting were excluded because they do not cover trauma cases.

Institutional review board approval was not obtained because the study was for intradepartmental and quality improvement purposes. Providers had 1 month to complete the survey, which was collected by the departmental secretary. Of a potential 101 providers who practice trauma anesthesia, 67 practitioners returned their surveys: 18 anesthesiologists, 39 CRNAs, and 10 residents, yielding a collective 66% response rate. Individual response rates were as follows: anesthesiologists, 45%; CRNAs, 93%; and anesthesia residents, 42%. Statistical analysis was conducted utilizing Statistical Package for the Social Sciences (SPSS). Missing data were excluded from analy-
1. Occupation: Anesthesiologist
   CRNA
   Resident: CA-2 or CA-3

2. Number of years:
   Giving anesthesia
   Giving anesthesia [< 1%] [2-5%] [5-10%] [> 10%]
   at VCUMC [< 1%] [33%] [30%] [20%]

3. Do you believe it is necessary to have a standardized trauma setup? YES [95%] NO [0.03%]
4. Do you consistently draw up the same medications for every trauma? YES [95%] NO [0.03%]
5. Do you routinely draw up epinephrine for trauma cases? YES [69%] NO [27%]

6. If yes, to what final concentration do you dilute your epinephrine?
   10 µg/mL [62%] 100 µg/mL [12%] I do not dilute epinephrine. [< 1%]

7. Do you routinely make a phenylephrine drip? YES [33%] NO [58%]
8. If yes, to what final concentration do you dilute the phenylephrine?
   40 µg/mL [28%] 80 µg/mL [< 1%] 120 µg/mL [< 1%]

9. Do you prefer: Prefilled syringes [80%] To draw up your medications [20%]

10. Please select the following medications that you have drawn up for trauma cases: (Check all that apply.)

   **Induction agents**
   - propofol [60%]
   - thiopental [92%]
   - etomidate [92%]
   - ketamine [92%]
   - thiopental [82%]
   - etomidate [72%]
   - ketamine [72%]

   **Muscle relaxants**
   - vecuronium [77%]
   - cisatracurium [82%]
   - pancuronium [69%]
   - succinylcholine [69%]
   - cefazolin [67%]
   - calcium chloride [67%]
   - calcium gluconate [67%]

   **Emergency drugs**
   - propofol [60%]
   - thiopental [92%]
   - etomidate [92%]
   - ketamine [92%]
   - thiopental [82%]
   - etomidate [72%]
   - ketamine [72%]
   - atropine [77%]
   - lidocaine [82%]
   - sodium bicarbonate [69%]
   - epinephrine [69%]
   - calcium chloride [67%]
   - calcium gluconate [67%]

   **Sympathomimetics**
   - phenylephrine [80%]
   - ephedrine [80%]
   - norepinephrine [72%]
   - albuterol [95%]
   - ephedrine [80%]
   - norepinephrine [72%]
   - albuterol [95%]
   - phenylephrine [80%]
   - ephedrine [80%]
   - norepinephrine [72%]

   **Miscellaneous**
   - lab tubes [40%]
   - lab sheets [42%]
   - sterile gloves [38%]
   - IV kit: 1 or 2 [28%]
   - EKG stickers [42%]
   - tape [32%]
   - Bristojects [32%]
   - IV kit: 1 or 2 [28%]

   **Other (write in)**
   - scopolamine
   - lab tubes
   - lab sheets
   - sterile gloves
   - IV kit: 1 or 2

11. How many blades do you routinely set up in the trauma room? 2 blades [75%]
12. What intubating equipment would you like to be part of the trauma room setup? (Check all that apply.)

   **Blades**
   - MAC 3 [65%]
   - MAC 4 [72%]
   - Miller 2 [46%]
   - Miller 3 [90%]
   - Miller 4 [< 1%]

   **Alternative airway**
   - GlideScope [40%]
   - Fiberoptic scope [< 1%]
   - LMA Fastrach [33%]
   - Bullard [2%]
   - Airtraq [46%]

13. How many ETTs do you typically set up? (Check one.)
   a. 1 b. 2 [70%] c. 3 [28%] d. > 3 [8%]

14. Do you consistently use a stylet when preparing your ETT? YES [98%] NO [2%]
15. What size ETTs would you like to see consistently available? 7.5 [80%] 8.0 [90%]
16. Do you set up oral airways? YES [97%] NO [3%]
17. If so, what size? a. 7 [< 1%] b. 8 [40%] c. 9 [80%] d. 10 [52%]
18. Do you set up nasal trumpets? YES [38%] NO [62%]
19. If so, what size? a. 28F b. 30F [16%] c. 32F [28%] d. 34F [52%]

20. Do you like to lay down towels over the top of the anesthesia cart and anesthesia machine? YES
21. Which of the following would you like available on the top of the anesthesia cart? (Top 3 items in bold)
   - A-line kit [80%]
   - lab tubes 4x4s
   - blood slips [40%]
   - EKG stickers [42%]
   - lab sheets 4x4s
   - sterile gloves
   - IV kit: 1 or 2

22. Arterial lines, do you prefer (Check one): ARROW catheter [72%] 20G Angiocath [13%]
23. Comments: ____________________________________________________________

Table 1. VCUMC Trauma Room Survey

Abbreviations: EKG, electrocardiogram; ETT, endotracheal tube; G, gauge; VCUMC, Virginia Commonwealth University Medical Center.
Note: Results indicated in brackets or boldface type. Also, some response totals are greater than 100% because providers were allowed to select more than one option.
The survey included questions about provider preferences regarding airway equipment, arterial line and intravenous supplies, stocked medications, prefilled syringes, and drugs to be drawn up.

The next step involved looking outside VCUMC to investigate the anesthesia trauma setups in other hospitals. The purpose of interviewing the other centers was to determine if there were new ideas or components that could be incorporated into the VCUMC trauma anesthesia setup. The primary author conducted a phone interview with a staff anesthesia provider (either CRNA or anesthesiologist) in 8 national trauma centers of comparable size. Table 2 describes the questions asked of each hospital. Of the 8 hospitals interviewed, 90% of the centers had a standard trauma anesthesia setup including designated airway equipment and medications. In addition, 90% of the hospitals kept a difficult airway cart either in the trauma room or directly outside, and 75% of the hospitals used prefilled syringes.

This information was presented to senior departmental anesthesia leadership as a recommendation for how other institutions approach their trauma anesthesia setup. Finally, the information collected from the in-tradeartmental survey, which reflects the majority preferences of the department, and suggestions gleaned from interviewing the other hospitals helped to formulate the basic trauma setup for VCUMC.

### Results

Strategies that reduce error can enhance patient safety and potentially provide a cost-savings benefit. ORs are estimated to generate 25% to 30% of total hospital waste, with plastic accounting for 40% of that waste. A 2010 University of California, San Diego study reviewing anesthetic drug use over a 2-week period revealed that the calculated cost of discarded drugs is $13.51 per case. The average cost of waste for discarded drugs is $10.86. A focus on economics, without sacrificing patient safety, should play a role in the development of a standardized system.

Two specific areas of interest in the VCUMC survey were anesthetist preference to draw up epinephrine and opinions regarding prefilled syringes because both these areas could impact patient safety and provide cost savings. Epinephrine is a medication that can be diluted twice from its original vial form (1 mg/mL) to form a more dilute concentration (10 µg/mL). Clinicians at VCUMC will frequently double dilute epinephrine because many perceive that it allows them to titrate the medication more efficiently when administering lower doses. Preparing a medication that requires a multistep preparation increases the risk of error because providers may inappropriately perform this task. The survey revealed that 69% of VCUMC providers prefer to have epinephrine drawn up. Recognizing this as a preference, the information was taken a step further to ascertain if providers preferred prefilled syringes, which would diminish the risk of medical error that can occur when providers draw up their own medications, especially when in a production pressure environment.

In a multicenter European study conducted by Cousins et al., it was reported that the second most frequent medication error was preparing an intravenous medication with the wrong diluent. Utilizing prefilled syringes minimizes the risk of provider error from incorrectly drawing up or diluting a medication. Gillerman and Browning reviewed 25,481 anesthetics over the course of a year to determine the amount of waste that occurs when medications are drawn up and then discarded. They tracked usage of thiopental, succinylcholine, rocuronium, atracurium, midazolam, and propofol and discovered that the cost of unadministered drugs was $165,666. An estimated $42,000 of that waste could have been avoided. Prefilled syringes can provide cost savings by decreasing the amount of drugs that are drawn up, not used, and then discarded.

Prefilled syringes cost, on average, $4.50 per syringe, however they have an extended expiration of 6 months versus a drawn-up medication, which expires in 24 hours. The survey results revealed that more than 80% of VCUMC providers preferred prefilled syringes. This information was presented to the pharmacy department, which yielded the addition of prefilled vecuronium, rocuronium, succinylcholine, ephedrine, and phenylephrine to the anesthesia pharmacy formulary. Also, based on feedback from the survey the following medications were added to the trauma room cart: phenytioin, scopolamine, mannitol, and vasopressin. The shelf life of prefilled etomidate is 21 days, thereby making it an inefficient choice in prefilled formulation because the medication would potentially expire before its clinical use.

On April 26, 2011, in a letter to the presidents of the ASA, American Association of Nurse Anesthetists, American Academy of Anesthesiologist Assistants, and Anesthesia Patient Safety Foundation, Dr. Mark Chassin, president of The Joint Commission, removed the prohibition against prelabeling syringes as long as practice is
in conjunction with departmental policy. In accordance with the VCUMC Department of Anesthesiology policy, prelabeled fentanyl, midazolam, and etomidate syringes are now kept in the anesthesia cart. A vial of etomidate is placed next to the prelabeled syringe for immediate use if necessary. Figure 2 depicts the setup for medications in the trauma room anesthesia cart. According to Weinger\textsuperscript{13} it takes an anesthesia provider 13 seconds to administer a prepared emergency drug and 35 seconds to draw up a completely unprepared medication. Ideally, a prelabeled syringe will cut this time in half.

Another area of economic concern regarded the waste incurred from throwing away unused items. Some anesthesia providers routinely opened up 3 to 4 ETTs, many of which were thrown out daily. In a 2005 study, Browder et al\textsuperscript{18} examined the safety of using open, prepared ETTs in the emergency department. They concluded that prepared ETTs are safe from bacterial contamination if used within 48 hours. Assuming a policy of discarding at least two ETTs plus stylet daily (as has been the common practice at VCUMC), the department has incurred $3,460.20 in ETT acquisition costs alone for a perpetually set up trauma room. As a result of the survey the department has switched to having 2 unopened EZ Endo prestyleted ETTs (size 7.5 and 8.0) available in the trauma room. Using these unopened, prestyleted ETTs will provide a departmental cost savings of approximately $2,613 per annum. Incidentally, the realization of this cost savings in the department of anesthesiology prompted a hospital-wide conversion to prestyleted endotracheal tubes, which are ready to be opened at the time of care.

Further items of waste include esophageal temperature probes, Humidvent humidifiers, and nasogastric tubes being opened and discarded by the next provider setting up the room. As a result of the survey the department has switched to having 2 unopened EZ Endo prestyleted ETTs (size 7.5 and 8.0) available in the trauma room. Using these unopened, prestyleted ETTs will provide a departmental cost savings of approximately $2,613 per annum. Incidentally, the realization of this cost savings in the department of anesthesiology prompted a hospital-wide conversion to prestyleted endotracheal tubes, which are ready to be opened at the time of care.

Figure 2. Reorganized Anesthesia Cart

Unfortunately, compliance was not initially achieved. Many providers continued to set up the trauma room in their usual fashion, ignoring the new system. Three weeks into the project, the laminated pictures were removed and discarded. Following this incident, additional departmental education was conducted, and compliance has improved over time.

Discussion

There are many reasons anesthesia providers may resist adhering to a standard trauma setup. Factors such as economics, resistance to change, and production pressures can affect a provider's decision to comply with standardization. The National Institute for Health and Clinical Excellence\textsuperscript{19} in its pamphlet, \textit{How to Change Practice}, identified specific barriers to clinical change: lack of awareness/knowledge, motivation, and acceptance or beliefs. Addressing the barriers of lack of awareness and motivation were accomplished through continuing education. A current literature review on cost-effective anesthesia and standardization was presented at a de-
Anesthesia providers may not perceive standardization as a necessity. Some clinicians prefer to have control over their setup and anesthetic choice. In addition, anesthesia providers have varying professional backgrounds and experiences, which may affect the value they place on what specific supplies should be readily available in an emergency. Ignoring standardization is inefficient practice and can increase the likelihood of provider error in the face of an emergency.

To successfully implement permanent change, a researcher must understand and address perceived provider attitudes. If an anesthesia provider can appreciate the importance of a task, he or she may be more willing to comply. Fishbein and Ajzen developed the Theory of Reasoned Action (TRA) in 1975 to predict behavioral intentions and/or behavior. The TRA has been successful in the prediction of activities involving an explicit choice among alternatives. The theory provides insight into identifying and understanding an individual’s underlying motivations behind his or her behavioral choices.

The National Institute for Occupational Safety and Health has referenced the TRA as a foundation for understanding how an individual’s beliefs may affect his or her decision to comply with safe practices. The TRA has been cited in the literature for its ability to explain provider behaviors with regard to healthcare practice. If a universal consensus regarding a standard system exists, then perhaps individual providers will be more apt to follow the standardized setup. In the case of creating a standardized trauma anesthesia setup it was the authors’ hope that engaging the department in the process would lead to greater provider compliance with the new system.

**Conclusion**

Anesthesia is a dynamic practice that requires constant evaluation and reevaluation to create safeguards. While change is not always warranted, analyzing a system and seeking cost-saving measures can be beneficial for both the patient and the department. Standardization provides consistency and a universal system, which improves patient safety and can lead to departmental cost savings.

**REFERENCES**

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<table>
<thead>
<tr>
<th>Product</th>
<th>Cost savings</th>
<th>Savings by operating room</th>
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<td>EZ Endo prestylized ETT vs regular ETT with separate stylet</td>
<td>$1.31</td>
<td>Trauma (242 cases)</td>
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<td>Latex-free circuit vs circuit containing latex breathing bag</td>
<td>$1.33</td>
<td>All (21,549 cases)</td>
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**Table 3.** Cost Savings From Conversion to Less Expensive, Safer Products in the Trauma Room and Operating Rooms

Abbreviation: ETT, endotracheal tube.


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