

CMC PRO: Manometry Should Routinely Be Used During Central Venous Catheterization

Andrew B. Leibowitz, MD*

Marc A. Rozner, PhD, MD†

In the beginning, the specialty of Anesthesiology emphasized analgesia, amnesia, hypnosis, and optimization of operating conditions, usually through muscle relaxation to prevent unwanted muscle tone or movement. During the last half-century, Anesthesiologists added attention to intraoperative hemodynamic stability, active minimization of perioperative morbidity and mortality, patient satisfaction, operating room throughput, and length of postoperative stay. Underlying all of these issues is every Anesthesiologist's desire to avoid any complication specifically attributable to the administration of Anesthesia. Two important results stand out: 1) the risk of significant Anesthesia-related morbidity and mortality typically is orders of magnitude lower than that of the surgical procedure for which the Anesthesia is provided and 2) our Anesthesiology devices and medications have an enviable efficacy and safety profile. This is why our specialty is held as the model for overall patient safety in medicine.¹

In fact, Anesthesiologists have created a myriad of technologies, practice guidelines, and alternative techniques to identify and mitigate a wide range of problems that occur exceedingly rarely. Malignant hyperthermia has an incidence of 1/50,000,² but it has resulted in tens of thousands of dantrolene carts and tomes of hospital policy (with attendant maintenance costs) dedicated to the purpose of treating this very rare event. The combination of "can't intubate and can't ventilate" occurs, at most, in only about 1/1000–1/5000 patients,³ but it has spawned multiple iterations of difficult airway algorithms,^{4,5} nearly 800 journal articles that include the term "difficult airway" since 1980 and an entire industry devoted to performing ventilation and tracheal intubation in just those few patients. Intraoperative awareness during general anesthesia might occur in 1/500–1/1000 patients (this is the subject of intense argument and investigation).⁶ Nevertheless, it has resulted in another industry that manufactures and sells highly touted (and expensive) monitors that might, at best, be marginally effective.^{7,8} Many other rare events (e.g., pulmonary aspiration, postoperative visual loss, epidural hematoma, and local anesthetic toxicity) also have resulted in routine drug prophylaxis, standards, guidelines, practice parameters, advisories, etc.

Let's face it, Anesthesiologists are amazingly risk averse, and preventing rare events and complication is, in large part, what our specialty is all about. So, now we turn to the subject of central venous catheterization and the investigation reported herein by Ezaru et al.⁹

This study, entitled "Eliminating arterial injury during central venous catheterization using manometry" reports the experience of a university-affiliated Veterans Administration hospital that implemented "mandatory utilization of manometry to verify venous placement" in response to a sentinel event of arterial cannulation. This retrospective study encompassed 16 years with two different data collection schemes. For the first 15 yr, 9348 central venous catheters were inserted without any arterial cannulation with a large bore catheter (7F or larger). During the final year of reported cases, the database was refined and revealed that in the 511 central venous catheters placed, arterial puncture (with 18-gauge or

From the *Mount Sinai Medical Center, New York, New York; and †University of Texas MD Anderson Cancer Center, Houston, Texas.

Accepted for publication August 14, 2008.

Address correspondence and reprint requests to Marc A. Rozner, PhD, MD, University of Texas MD Anderson Cancer Center, 1400 Holcombe Blvd, Mail Code 0409, Houston, TX 77030. Address e-mail to mrozner@mdanderson.org.

Copyright © 2009 International Anesthesia Research Society
DOI: 10.1213/ane.0b013e31818e4347

smaller needle) occurred in 28 patients (5%) and was recognized without manometry in only 24 of these occasions. Arterial puncture, however, was identified through the use of manometry in these remaining four cases, so there was no incident of arterial dilation or cannulation with a large bore catheter.

Criticisms of this study will include the nature of a retrospective database review, which is subject to all of the problems suffered by every retrospective study. Next, the study took place in a Veteran's Administration hospital, wherein attending physicians performed only two-thirds of the central line placements; perhaps this accounts for the 5% rate of arterial puncture noted during the final year of the study, or that recognition of initial arterial puncture could result only after applying manometry. However, this 5% is in line with other reports of unintended arterial (real or simulated) puncture based upon routine use of anatomic landmarks,¹⁰⁻¹⁴ even with ultrasound guidance.^{11,15}

On the other hand, the retrospective nature of this study should not dissuade one from accepting its results, because every arterial dilation and cannulation would likely have become a high-profile event and, therefore, not escaped the attention of the institution or these investigators. We do not know of any data suggesting this problem is more or less likely in veterans or Veterans Administration hospitals, so this experience likely represents the patient population at large. Considering the number of teaching hospitals' residents and fellows, as well as the widespread use of physician extenders in nonteaching facilities, perhaps more than one-third of all central line placements are not performed by attending physicians. Also, perhaps many attending physicians will have relatively less experience than the group reporting the data in this study, and, thus, will have a greater risk of complications when performing the procedures themselves. Unfortunately, the study did not identify the primary operator in all of the cases involving arterial puncture, but, again, this fact might be unimportant.

Several articles have been published regarding the incidence of arterial puncture and cannulation which confirm these authors' experiences. Unintentional arterial puncture with something larger than the traditional 20-22-gauge "finder needle" occurs in 0.5%-11.4% (mean 5.9%) of all central line attempts.¹³ Rarely will this event result in patient harm. Vessel dilation and cannulation with a 7F or larger catheter has been reported in 0.1%-1% of all central line attempts.¹⁶ The results of this error can be devastating and include hemothorax, pseudoaneurysm, stroke, and death.¹⁷ In fact, in their review of 14 years of hospital data, Shah et al.¹³ report repairing 11 arterial injuries after unrecognized arterial cannulation with a large bore instrument (their total number of central lines for this period was not shown). In three of their cases, infusions were started before the arterial position of the cannula was identified, and all the three patients developed neurological symptoms.

So, if a simple, quick, and inexpensive method of risk prevention such as manometry was successful in even a fraction of cases, it is quite hard to understand any objection to incorporating it into practice. To put this into perspective, using the lower limit of incidence, if a hospital performs just 2000 central catheterizations per year, and the incidence of this problem is 0.1% (two cases), and manometry is only half as effective as reported, then one major morbidity, or perhaps mortality, will be avoided per year in that facility. Relative to many other rare events, which cause concern to us as Anesthesiologists, the payback here is tremendous.

Since time and cost seem negligible, what could be the objection(s) to routine manometry? First, this methodology might create a break in sterility. To perform tubing manometry with most current central line kits, an extra step of locating a sterile tubing set to create the manometer becomes necessary. Because some tubing kits are nonsterile packages with only sterile fluid pathways, this step might create some confusion with a resultant break in sterility. However, some kits already contain manometry tubing and all kits with Raulerson syringes have a transducing adaptor. If tubing manometry becomes a standard, then commercial reconfiguration will rapidly follow. Second, many practitioners will state that there is a potential difficulty in performing routine manometry, especially if one's practice is to use the metal 18-gauge needle for guidewire access instead of an 18-gauge angiocatheter. This technique would then entail delicate attachment of the manometry tubing to the metal needle (M.A.R.'s technique) or insertion of the guidewire through the metal needle and exchange (over the wire) of the metal needle to an 18-gauge angiocatheter (A.B.L.'s method). We attest to the ease of incorporating this extra step into practice having collectively performed several hundred central venous catheterizations in our practices since adapting manometry as a standard.

We agree with Ezaru et al. and argue that use of tubing manometry for all elective central vein catheterizations to ensure entry into a vein, rather than artery, before vessel dilation, will prevent patient injury. Surely, anyone who insists that their personal safety record obviates the need for manometry likely has the dexterity to add manometry to their practice with less difficulty than it takes to argue against it.

REFERENCES

1. Hallinan JT. Once seen as risky, one group of doctors changes its ways. *Wall Street J* 2005;A1. Available at: <http://onlinewsj.com/article/0,,SB111931728319164845,00.html>. Accessed 14 July, 2008
2. Rosenberg H, Fletcher JE. An update on the malignant hyperthermia syndrome [review]. *Ann Acad Med Singapore* 1994;23(6 suppl):84-97
3. Vasdev GM, Harrison BA, Keegan MT, Burkle CM. Management of the difficult and failed airway in obstetric anesthesia [review]. *J Anesthesia* 2008;22:38-48
4. Henderson JJ, Popat MT, Latto IP, Pearce AC. Difficult Airway Society. Difficult Airway Society guidelines for management of the unanticipated difficult intubation [see comment]. *Anaesthesia* 2004;59:675-94

5. American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway [erratum appears in *Anesthesiology* 2004;101:565]. *Anesthesiology* 2003;98:1269–77
6. American Society of Anesthesiologists Task Force on Intraoperative Awareness. Practice advisory for intraoperative awareness and brain function monitoring: a report by the American Society of Anesthesiologists Task Force on intraoperative awareness [review]. *Anesthesiology* 2006;104:847–64
7. Avidan MS, Zhang L, Burnside BA, Finkel KJ, Searleman AC, Selvidge JA, Saager L, Turner MS, Rao S, Bottros M, Hantler C, Jacobsohn E, Evers AS. Anesthesia awareness and the bispectral Index. *N Engl J Med* 2008;358:1097–108
8. Myles PS, Leslie K, McNeil J, Forbes A, Chan MTV. Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial. *The Lancet* 2004;363:1757–63
9. Ezaru CS, Mangione MP, Oravitz TM, Ibinson JW, Bjerke RJ. Eliminating arterial injury during central venous catheterization using manometry. *Anesth Analg* 2009;109:130–4
10. Schaffartzik W, Neu J. Injuries in anaesthesia—results of the Hannover arbitration procedure 2001–2005. *Anaesthesist* 2007;56:444–8
11. Lamperti M, Cortellazzi P, D’Onofrio G, Subert M, Falcone C, Filippini G, Caldiroli D. An outcome study on complications using routine ultrasound assistance for internal jugular vein cannulation. *Acta Anaesthesiol Scand* 2007;51:1327–30
12. Bailey PL, Whitaker EE, Palmer LS, Glance LG. The accuracy of the central landmark used for central venous catheterization of the internal jugular vein. *Anesth Analg* 2006;102:1327–32
13. Shah PM, Babu SC, Goyal A, Mateo RB, Madden RE. Arterial misplacement of large-caliber cannulas during jugular vein catheterization: case for surgical management. *J Am Coll Surg* 2004;198:939–44
14. Reuber M, Dunkley LA, Turton EP, Bell MD, Bamford JM. Stroke after internal jugular venous cannulation. *Acta Neurol Scand* 2002;105:235–9
15. Augoustides JG, Diaz D, Weiner J, Clarke C, Jobes DR. Current practice of internal jugular venous cannulation in a university anesthesia department: influence of operator experience on success of cannulation and arterial injury. *J Cardiothorac Vasc Anesth* 2002;16:567–71
16. Kusminsky RE. Complications of central venous catheterization. *J Am Coll Surg* 2007;204:681–96
17. Domino KB, Bowdle TA, Posner KL, Spittellie PH, Lee LA, Cheney FW. Injuries and liability related to central vascular catheters: a closed claims analysis [review]. *Anesthesiology* 2004;100:1411–18