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

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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

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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, Spitellie PH, Lee LA, Cheney FW. Injuries and liability related to central vascular catheters: a closed claims analysis [review]. Anesthesiology 2004;100:1411–18

CME Eliminating Arterial Injury During Central Venous Catheterization Using Manometry

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BACKGROUND: Unintended arterial puncture occurs in 2%–4.5% of central venous catheterizations, resulting in arterial injury in 0.1%–0.5% of patients. Routine performance of manometry during catheterization may successfully identify unintended arterial puncture and avoid arterial cannulation and injury.

METHODS: We conducted a retrospective review of all cases of central venous catheter placement during a 15-yr period after implementation of a safety program requiring mandatory use of manometry to verify venous access. Arterial injuries were defined as unintended arterial cannulations with a 7-French or larger catheter or dilator. Arterial punctures were defined as the unintended placement of an 18-gauge catheter or needle into the artery. Data were reviewed for all arterial injuries during the entire 15-yr period. In addition, data on both arterial puncture and subsequent arterial injury were evaluated during the final year of analysis.

RESULTS: A total of 9348 central venous catheters were placed during the observation period. During the full 15 yr of observation, there were no cases of arterial injury. During the final year of assessment, 511 central venous catheters were placed, with arterial punctures in 28 patients (5%). Arterial puncture was recognized without manometry in 24 cases. Arterial puncture was identified only with manometry in 4 cases, with no incidents of arterial injury.

CONCLUSIONS: Consistent use of manometry, to verify venous placement, during central venous catheterization effectively eliminated arterial injury from unintended arterial cannulation during the 15-yr assessment.

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In the United States, more than 5 million central venous catheters are inserted annually for monitoring, fluid resuscitation, drug administration, dialysis and diagnostic studies, with complications occurring in 3%–25% of patients.[1,2] Large-scale retrospective reviews of central venous catheterizations identified unintended arterial puncture in 2%–4.5% of patients and large-bore catheter cannulation in 0.1%–0.5% of patients.[3,4] Arterial injuries result from the placement of a large bore catheter or a dilator into an artery, risking stroke or death, even if immediately recognized. Although the occurrence of arterial injury is relatively infrequent, the potential severity of outcome in these patients makes eliminating this risk a worthwhile goal.

Performing central venous catheterization may be hindered by the inability to adequately assess the vasculature. The standard approach to differentiating venous from arterial cannulation is to assess the color and flow of the blood in an 18-gauge (or smaller) catheter or needle.[5] Color and flow may be unreliable indicators due to profound hypotension, arterial desaturation, or catheter kinking or occlusion. Ultrasound guidance aids in the localization of the vessels and effectively reduces catheterization complications.[6] Ultrasound has been consistently promoted as the primary technique for safely performing central venous catheterization[6,7]; however, it is infrequently used in clinical settings, even when the technology is available. A recent survey of the Society of Cardiovascular Anesthesiologists members revealed that 67% never or almost never used ultrasound when performing central venous catheterization, with only 15% always or almost always using ultrasound.[8] Interestingly, most of those surveyed had experienced vascular complications during central venous catheterization, including carotid puncture (75%), carotid injury (3%), stroke (1%), and hemothorax (4%). The most common reasons for not using ultrasound were a perception that it was unnecessary (46%), lack of availability (18%), and time delay with addition of ultrasound (16%).

Manometry is a simple and efficient technique to verify venous placement during catheterization. A 50 cm extension set is attached to an 18-gauge

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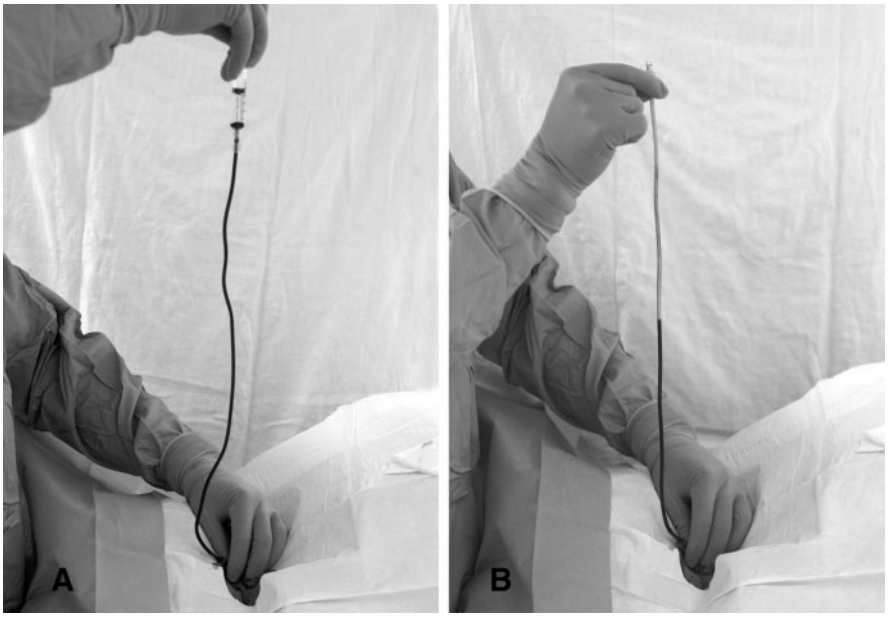

Figure 1. Manometry verification of central venous location is demonstrated, including syringe aspiration into a 20-in. IV tubing (A) and visualization of a descending column of blood (B) to verify venous placement.

catheter or needle and the blood column in the elevated tubing is assessed. Performing manometry avoided carotid injury in a series of >3000 patients undergoing internal jugular cannulations.[9] This technique provides an effective assessment tool that could be readily used at the bedside without special equipment or training. We describe a 15-yr experience using manometry as part of a mandatory safety protocol to identify unintended arterial punctures in patients undergoing central venous catheterization at a university hospital. These data expand on results from an earlier report describing 11 yr of data, published as an abstract.[10]

METHODS

A retrospective review of anesthesia department quality assurance and workload databases at a university-affiliated Veterans' Administration hospital was conducted from January 1, 1992 to December 31, 2006. In 1991, unintended arterial cannulation during central venous catheterization resulted in patient stroke and subsequent death. This led to the implementation of a policy mandating manometry to verify venous placement before vessel cannulation. The hospital's Quality Improvement Department made central venous catheterization safety a performance measure for the anesthesia department and also monitored the outcomes.

During the catheterization procedure, the vein is cannulated with an 18-gauge catheter over the needle. After catheter placement, a 20-in. sterile IV tubing extension set with a syringe at one end is connected to the intravascular catheter and filled by aspiration of the syringe (Fig. 1A). The syringe is then disconnected, the IV tubing held vertically, and the blood column observed. Visualization of a descending column of blood indicates the catheter placement within a vein (Fig. 1B). With venous placement, the column of blood moves with respiration, rising with coughing and descending with inspiration during spontaneous ventilation. Alternatively, during mechanical ventilation, the column of blood rises with inspiration and descends during exhalation if the catheter is IV. Regardless of the mode of ventilation, the overall movement of the blood column with IV placement is downward. Visualization of an ascending column of blood regardless of respiratory cycle indicates that the catheter is placed in an artery. Visualization of a static column of blood suggests catheter kinking, vessel wall impingement or partial catheter placement in the vessel. In this case the catheter is adjusted until continuous flow is demonstrated in the tubing and movement of the column of blood occurs. If this cannot be achieved, the catheter is removed and insertion reattempted. Guidewires are inserted only after a descending column of blood in the extension tubing is demonstrated. At this point, central venous catheterization is completed. Manometry adds <1 min of additional time to the catheterization procedure.

After January 1, 1992, all central venous catheters, by policy, were to be placed with this verification technique. Physician staff members were informed that procedural violations would not be tolerated. Compliance was monitored by direct observation by the department leadership, which remained constant over the entire 15-yr period. Also, certified registered nurse anesthetists and anesthesia technicians assisting with these procedures were expected to remind physicians of the requirement if necessary and/or report any noncompliance.

All available data for central venous catheterizations were reviewed. Collected data included catheter location, catheter size, and experience level of staff performing catheterization. Staff members were divided into attending anesthesiologists and trainees, including medical students, residents, and fellows. All

Table 1. Characteristics of Central Venous Catheterization Procedures

Characteristic	Number (%) total $n = 9348$
Location	
Internal jugular	9144 (98)
Subclavian	87 (1)
Femoral	117 (1)
Catheter size (French)	
7	4793 (51)
8.5–9	4403 (47)
18	152 (2)
Staff performing procedure	
Attending anesthesiologist	6291 (67)
Supervised trainee	3057 (33)

procedures performed by trainees were supervised by an attending anesthesiologist. Arterial injury with a large-bore catheter and subsequent morbidity and mortality data were also collected. Arterial injury was defined as the occurrence of unintended cannulation of an artery with a large-bore catheter (7 French or larger) or a dilator.

A secondary analysis was performed for central venous catheters placed in 2006. Additional database information was available on the occurrence of arterial puncture and subsequent complications from arterial puncture for this 1-yr period. Arterial punctures were defined as the unintended placement of an 18-gauge catheter or needle into the artery. These data were not available for the previous years of assessment. During this 1-yr assessment, data on arterial puncture with or without subsequent arterial injury and the incidence of arterial injury were both recorded.

RESULTS

A total of 9348 central venous catheterizations were performed with manometry during the 15-yr assessment period. Large-bore catheters used for these procedures included 7 French double-lumen and triple-lumen catheters, 8.5 and 9 French sheath introducers for pulmonary artery catheterization (Arrow International, Reading, PA), and 18 French cannulas used for veno-veno bypass in liver transplantation (Edwards Lifesciences LLC, Irvine, CA). Catheterization details are shown in Table 1. The vast majority of catheters were placed in the internal jugular vein. Most catheters were 7–9 French, with $<2\%$ using 18 French catheters. Two-thirds of catheters were placed by attending anesthesiologists. Thirty-eight individual anesthesiologists were involved in performing and/or supervising the placement of central venous catheters.

Arterial Injury

There were no arterial injuries with any of the central venous catheterizations over this 15-yr period. Predictive analyses could not be performed since arterial injury did not occur.

Arterial Puncture

From January 1, 2006 to December 31, 2006, 511 central venous catheters were placed. Similar to data for the full study, central venous catheters placed in 2006 were primarily 7 French ($n = 159$, 31%) and 9 French ($n = 297$, 58%), with a minority 18 French ($n = 55$, 11%). Arterial punctures occurred with the 18-gauge catheter in 28 patients (5%). Catheter location and staff performing the procedures were similar for those cases resulting in arterial puncture (Table 2). There were no clinical sequelae associated with arterial puncture in any of the patients. Arterial puncture was easily identified by bright red blood spurting from the catheter in 24 patients. In 4 of the 28 patients, arterial puncture was not identified based on blood flow and color but only after performing manometry. Two of these 4 cases were performed by attending anesthesiologists and 2 by supervised trainees.

DISCUSSION

This report provides 15 yr of data from more than 9000 patients who underwent central venous catheterization guided by manometry to verify venous, rather than arterial, needle placement before vessel dilation. Previously published reports of 0.1%–0.5% incidence of arterial injury with central venous catheterization would predict between 9 and 47 cases of arterial injury in this sample. Indeed, a subanalysis of patients with recorded arterial puncture during the final year of the review predicted a potential incidence of 0.8% arterial injuries, for as many as 56 possible cases for the entire 15 yr period. The use of manometry resulted in no cases of arterial injury, regardless of catheter location and training level of the staff member performing the catheterization. This excellent outcome occurred despite the variations in catheter location and size used in this study, as well as the presence of multiple practitioners of varying levels of training. The occurrence of arterial puncture and predicted potential arterial injury without manometry in the current report were similar to reports of mechanical complications with catheterization.[4]

These data support and extend the data previously published on manometry verification of venous placement, by providing a larger sample size and a variety of catheterization procedures and providers. Data reported by Fabian and Jesudian[9] included only internal jugular catheterizations. Although the vast majority of procedures in the current study likewise involved internal jugular catheterization, more than 200 procedures with subclavian or femoral sites were also reported, with similarly good outcome at these sites. Data on arterial puncture from the single year of observation reported similar catheter location and staff performing procedures that did and did not result in arterial

Table 2. Central Venous Catheterizations in 2006

	Location (%)			Staff (%)	
	Internal jugular	Subclavian	Femoral	Attending	Trainee
All catheterizations $n = 511$	504 (98)	3 (1)	4 (1)	327 (64)	184 (36)
Catheterizations resulting in arterial puncture $n = 28$	28 (100)	0	0	20 (71)	8 (29)

puncture. These data suggest that vigilance in preventing arterial injury is needed for all attempts at central venous catheterization, regardless of location or experience of staff performing the procedure.

The dilators used to aid in the insertion of the large bore catheters are sometimes blamed when arterial injuries occur. Some authors believe that after the guidewire is placed in the vein, the stiff dilator will bend the wire, go through the vein and into the artery.[11,12] Oropello et al.[11] have advocated changes in the design of the dilators in order to make them shorter and possibly reduce the incidence of arterial injury. Our results argue against this hypothesis of the dilator "jumping" from the vein into the artery since verifying venous placement with manometry would not prevent this mechanism of arterial injury. In fact, no other venous verification technique (transduction, real-time ultrasound, fluoroscopy) would prevent the dilator from exiting the vein and causing an arterial injury since that would occur after the venous verification takes place. Previous reports showed that venous verification before dilation is paramount in avoiding arterial injury[4,6,9,10] and that the potential role played by the length or size of the dilator is over-stated.

Despite the success of manometry for avoiding arterial injury in the current report, it is important to recognize that this technique does not prevent the occurrence of arterial puncture. Ready identification of arterial punctures and needle removal, however, typically prevents the development of complications. It is also important to recognize that manometry does not diminish the value of ultrasound. Ultrasound evaluation provides a comprehensive assessment of venous structures and allows for a more efficient procedure for practitioners with limited experience or in patients with difficult anatomy.[6]

However, the poor adoption of ultrasound reported by Bailey et al.[8] suggests a need to promote a more user-friendly and efficient alternative. The ability to routinely use manometry for all central venous catheter placements makes manometry an attractive technique to prevent serious and potentially life-threatening complications, such as arterial injury. Data from this study support the benefit of consistent use of manometry for all central venous catheter placements. Inclusion of this simple and efficient technique into a standard safety protocol for central venous catheterization may increase the likelihood of compliance by practitioners.

This report is limited by the inherent flaws of observational studies, including limited access to patient variables and outcomes and inability to verify accuracy of data. Although only a limited number of outcome measures was available from the accessed database for this study, the current analysis provides a long experience with routine use of manometry in all patients receiving central venous catheters.

It has now been more than 20 yr since manometry was first described,[9] but neither manometry nor other venous verification techniques such as real-time ultrasound are widely used in clinical practice.[8] This is mainly due to additional time required to perform them and to the perception that arterial injuries are rare complications of central line insertions that do not justify additional steps for safety. Our experience is the largest published to date that shows that arterial injuries are completely preventable despite the involvement of multiple practitioners and trainees, but only if the verification procedure is simple, efficient and performed without fail. In the current maturing health care environment that emphasizes patient safety and zero tolerance for preventable errors, even the low risk of arterial injury during central venous catheterizations should no longer be accepted.

In summary, manometry is a simple technique that rapidly and effectively identifies venous access during central venous catheterization. Standard use of manometry during catheterization can eliminate the risk of arterial injury from unrecognized arterial cannulation. Manometry can be successfully used by practitioners with different levels of experience and for all catheterization locations.

REFERENCES

1. McGee DC, Gould MK. Preventing complications of central venous catheterization. N Engl J Med 2003;348:1123–33
2. Domino KB, Bowdle TA, Posner KL, Spitellie PH, Lee LA, Cheney FW. Injuries and liability related to central vascular catheters: a closed claim analysis. Anesthesiology 2004;100:1411–8
3. Golden LR. Incidence and management of large-bore introducer sheath puncture of the carotid artery. J Cardiothorac Vasc Anesth 1995;9:425–8
4. Jobes DR, Schwartz AJ, Greenhow DE, Stephenson LW, Ellison N. Safer jugular vein cannulation: recognition of arterial puncture and preferential use of external jugular route. Anesthesiology 1983;59:353–5
5. Mark JB, Slaughter TF. Cardiovascular monitoring. In: Miller RD, ed. Miller's Anesthesia. Philadelphia: Churchill Livingstone, 2005:1265–362
6. Hind D, Calvert N, McWilliams R, Davidson A, Paisley S, Beverly C, Thomas S. Ultrasonic devices for central venous cannulation: meta-analysis. BMJ 2003;327:361–7

7. Feller-Kopman D. Ultrasound-guided central venous catheter placement: the new standard of care? Crit Care Med 2005;33:1875–7
8. Bailey PL, Glance LG, Eaton MP, Parshall B, McIntosh S. A survey of the use of ultrasound during central venous catheterization. Anesth Analg 2007;104:491–7
9. Fabian JA, Jesudian MC. A simple method for improving the safety of percutaneous cannulation of the internal jugular vein. Anesth Analg 1985;64:1032–3
10. Bjerke R, Mangione M, Oravitz T. Major arterial injury need not be a risk of central venous catheterization (abstract). Anesth Analg 2004;98:SCA 98
11. Oropello JM, Leibowitz AB, Manasia A, Del Guidice R, Benjamin E. Dilator-associated complications of central vein catheter insertion: possible mechanisms of injury and suggestions for prevention. J Cardiothor Vasc Anesth 1996;10:634–7
12. Kulvatunyou N, Heard SO, Bankey PE. A subclavian artery injury, secondary to internal jugular vein cannulation, is a predictable right-sided phenomenon. Anesth Analg 2002;95:564–6

identify the exact cause of a problem such as vaginal spotting. If the patient is not bleeding heavily and a viable intrauterine pregnancy is visualized on bedside ultrasound, then any of the other etiologies for minor vaginal bleeding such as a cervical polyp may be safely left to the patient's primary obstetric provider for diagnosis. In many instances, it may even be better to have these types of diagnoses made by clinicians who are better prepared to manage a woman's longitudinal care. It is also very unlikely that a lubricated transvaginal ultrasound probe would induce severe bleeding from an occult cervical cancer. If such a lesion was in fact predisposed to significant hemorrhage from such minor trauma, then bleeding would be just as likely to occur after placement of a speculum or after bimaual examination. We agree that Papanicolaou tests can be performed on any patient undergoing a pelvic examination, pregnant or not. However, the impact of specific sampling techniques on results, the counseling needed for abnormal findings, and the required robustness of a follow-up system make this a test that few EDs feel comfortable incorporating into their routine care of women presenting to the ED with genital concerns.

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Four cases of inadvertent arterial cannulation despite of ultrasound guidance

To the Editor,

We read with great interest the publication by Stone et al [1] in the recent issue of the journal about the ultrasound detection of guidewire position for avoiding arterial guidewire placement. They demonstrated that guidewire visualization within the jugular vein predicted venous catheter placement with a sensitivity and specificity of 100% and 100%, respectively, in all 20 adult patients. As the author discussed, the use of real-time ultrasound guidance decreases complication, especially arterial puncture [2]. We are also confirming the venous placement of the wire in all cases using ultrasound sonography.

Recently, we encountered 4 cases of inadvertent arterial cannulation [3]. All procedures were performed after confirming the stria of internal jugular vein with ultrasound, and the puncture of the final case was performed under real-time ultrasound guidance. The vein was exactly punctured, and the existence of guidewire in the vein was confirmed with sonography at the pierced site. However, the guidewire might be migrated into carotid artery through the posterior vessel wall of internal jugular vein, and subsequent large-bore cannulation injured the artery at the proximal site. This risk was well documented by Blaivas and Adhikari [4]. They investigated the frequency of posterior vessel wall penetration by the needle during attempts to place central venous catheters with ultrasound imaging, and 64% of residents accidentally penetrated the posterior wall of the vein during cannulation.

We believe that the most important technique of real-time ultrasonographically guided catheterization might be visualization of both the vein and entire needle, especially the point of needle, in the same plane at the puncture [3]. The top of needle should be in the internal jugular vein completely. After the placement of guidewire, the confirmation of accurate placement would be difficult and the possibility of migration to the artery never be eliminated. At least, our experience reduced the sensitivity and specificity demonstrated by Stone et al [1].

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References

[1] Stone MB, Nagdev A, Murphy MC, Sisson CA. Ultrasound detection of guidewire position during central venous catheterization. Am J Emerg Med 2010;28:82-4.
[2] Leung J, Duffy M, Finckh A. Real-time ultrasonographically guided internal jugular vein catheterization in the emergency department increases success rates and reduces complications: a randomized, prospective study. Ann Emerg Med 2006;48:540-7.
[3] Kawashima S, Ishii Y, Itagaki T, Taniguchi M, Adachi Y, Sato S. Four cases of an inadvertent arterial cannulation with large bore catheters. J Clin Anesth (Jpn) 2009;33:1939-41 Japanese with English abstract.
[4] Blaivas M, Adhikari S. An unseen danger: frequency of posterior vessel wall penetration by needles during attempts to place internal jugular vein central catheters using ultrasound guidance. Crit Care Med 2009;37:2345-9.