Published in final edited form as:

Anesth Analg. 2013 July ; 117(1): 3–5. doi:10.1213/ANE.0b013e318259ef55.

They Did What...?

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At first perusal, the report by Vannucci and colleagues from Washington University¹ may leave the reader incredulous that in this day, a guidewire, an integral part of the Seldinger Technique,² was "lost" in not one, but four patients, and that the loss was only diagnosed in postoperative radiographs as late as 48 hours after insertion. To people familiar with the literature on medical errors in general, or with central venous catheterization in particular, however, it should not be surprising at all that such a well-documented and preventable complication continues to occur repeatedly, even within the walls of a highly regarded institution.³

Then again, if it is true that retained guidewires are not a particularly surprising occurrence, one might also wonder why the editors of *Anesthesia & Analgesia* would take valuable pages in the Journal to publish an article focusing on this familiar complication of vascular access procedures. Certainly, the case series is not the first report of a retained guidewire; the four described cases are neither the largest published case series, nor do they describe the longest unrecognized period of guidewire retention.^{4,5} The latter distinction goes to a published report documenting a duration of 150 days prior to recognition of a retained guidewire!⁶ Moreover, as the authors note, although a mandated root cause analysis was undertaken by the institution in response to these "sentinel events," additional qualitative data-gathering efforts may have led to further insights about factors contributing to the errors.⁷

The value of bringing this report to the attention of readers lies in the following. Access of the central venous circulation via the Seldinger technique is a ubiquitous procedure that may mistakenly be considered mundane by some. Clinical care has evolved such that a greater intensity of illness is seen in operating rooms, coupled with the need for a greater number and variety of central vascular access procedures, e.g., additional catheters required for

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The authors declare no conflicts of interest.

DISCLOSURES:

Name: Robert B Schonberger, MD, MA

Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript

Attestation: Robert B Schonberger approved the final manuscript

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Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript

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This manuscript was handled by: Sorin J. Brull, MD, FCARCSI (Hon)

postoperative care, placement of percutaneous pulmonary artery vents and coronary sinus catheters, etc. The multiplicity of central venous access devices now often necessitates a “double stick” technique that may introduce more than simply additive complexity to the catheterization process, and these procedures may be further complicated by other procedures occurring simultaneously, e.g., echocardiographic evaluation, surgical draping, distraction by other health care providers, etc. Finally, the omnipresent specter of production pressure⁸ coupled with operator fatigue increases the risk of significant complications that can occur even with truly “mundane” tasks.⁹

Perrow, in his book *Normal Accidents: Living with High Risk Technologies*,¹⁰ emphasizes that accidents are the “normal state” in highly complex settings. He argues persuasively that accidents can never be removed entirely from a system. Only the interval between these adverse events can be lengthened, and even then, only modestly in some systems. Disasters such as the Three Mile Island Nuclear Power Plant accident, the Apollo 13 mishap, and the capsized ferry *Herald of Free Enterprise* (which resulted in the largest loss of civilian life on a British passenger ship since the *Titanic*), have great similarities to the events in the operating rooms at Washington University. In the case of the *Herald of Free Enterprise*, in addition to inadequate ship design, the sinking of the ferry was preceded by a large number of deviations from the ship’s standard docking and debarkation protocol.¹¹ Analogously, inadequacy of the design of the central venous catheterization kits that invited easy confusion between guidewires of different lengths, the design of a work station area that enhanced rather than minimized distractions, unplanned incidents during the course of catheterization (e.g., hemodynamic instability), and operations management issues (e.g., urgent cases scheduled later in the day with the accompanying potential for operator fatigue added to the time pressure of starting cases in anticipation of on-call changes in care teams) likely contributed to such errors. One of Perrow’s arguments, later reinforced in James Reason’s famous “Swiss cheese model” of accidents,¹² is that across diverse types of systems from passenger ships, to the Apollo spacecraft, to the operating rooms at a top-flight institution, errors happen more frequently when organizational defenses against adverse events are diminished.

Building on Farinas’ vascular catheterization techniques,¹³ Seldinger’s seminal article led to the modern era of vascular catheterization.² It was not until two decades later that clinicians were able to routinely utilize the Seldinger approach to obtain vascular access in daily practice. The fulcrum of the technique is the use of a guidewire to establish a transcatheter pathway to a vascular space, with the pathway then progressively dilated to permit the introduction of an intravascular catheter. The benefit of the wire is obvious, but as documented in the current report, so are its liabilities. Interestingly, Gooding and Corrsen at the University of Alabama (Birmingham), one of whom later published the first report of a retained metal stylet during central venous cannulation,¹⁴ developed a needle with a 6–8 Fr introducer mounted on the shaft that allowed direct catheterization of a central vein without a guidewire.¹⁵ Given the proximity of their hospital to Huntsville, Alabama (“Rocket City, USA”), it may not be altogether surprising that their device calls to mind great similarities with the shape of a Saturn 5 rocket! (Figure 1) Due to the potential for major vascular complications related to needle size, this technique was not adopted clinically, and the Seldinger approach remains the technique of choice.

So what are the lessons the clinician should take away from the report of Vannucci et al? The first important point calls to mind the aforementioned work of Perrow. We can never remove accidents from a complex system. This point reverberates across the present case series. After two episodes of loss of a guidewire, Washington University made a number of adjustments, including formal didactic training to prevent guidewire loss. Regardless of these educational interventions, two more episodes occurred. Despite the commonly (and

erroneously) held clinical notion that central vascular access is a mundane procedure, it is in fact associated with significant morbidity and mortality, and the tight interactions among the several steps involved make accidents stubbornly inevitable in the face of our best attempts to prevent them. Nevertheless, while admitting to the global inevitability of errors during vascular access, it would seem absurd not to consider any individual error as eminently preventable. The process of preventing such errors is ongoing. In no small part, this process would seem to require the courage of practitioners like Vannucci et al to submit, and the wisdom of editors to accept for publication, descriptions of even well-known complications such as retained guidewires. Further emphasizing the need for such work, as the authors note, the recently drafted American Society of Anesthesiologists' guidelines on central venous access as well as other major reviews of central venous cannulation do not address in detail the issue of guidewire retention.¹⁶⁻¹⁸

The second important lesson is that a situational awareness has to be omnipresent to accomplish central venous catheterization procedures with a minimal complication rate. Particularly in a teaching environment, such situational awareness necessitates that the attending physician remain vigilant in his or her supervisory role when trainees are either performing the catheterization or are themselves supervising others during line placement. Urgent and complex surgical procedures coupled with hemodynamic or respiratory instability suggest the benefit of the presence of a separate care provider to manage organ failure while the vascular access is being undertaken. Distraction should be at a minimum for the catheterization team. This includes limiting conversations unrelated to patient care in the immediate vicinity of the proceduralist. Conducting an echocardiographic examination during the vascular access procedure may be helpful or even necessary at times, but also poses two threats: 1) it may lead to distraction for the proceduralist, and 2) it may increase the potential for an inadequate transesophageal echocardiographic examination. Additionally, in an era of "double sticks" with two or more guidewires on the field, care must be taken to account for all guidewires and their safe removal. Mandating a formal "guidewire count" at the conclusion of line placement would seem both reasonable and practical in such contexts. While not eliminating the problem of guidewire retention, such counts could both increase situational awareness and reduce the time prior to diagnosing a retained guidewire, when it does occur.

This brings us to the third important lesson, which the authors appropriately advocate. Use of the electronic medical record (EMR) should be an indispensable part of documenting patient care and can serve as another method of drawing the clinician's attention to potential lapses in safety. Advances in medical informatics and the development of clinical decision-support tools enabled by the EMR have the potential to further improve care and reduce the frequency of preventable errors.^{19,20}

Finally, again as the authors report, efforts must be made to inform consulting radiologists of the wires, tubes, and devices that are present in any patient receiving a radiograph. This is one area in which the decision-support tools enabled by the EMR could be easily employed, for example, by creating an automatic alert for radiologists that a recent attempt at line placement has occurred since prior radiographs.^{21,22} Such notifications would enable the radiology team to more critically evaluate postoperative chest radiographs and limit the duration of retained guidewires.

"They did what...?" *What they did* is to call our attention to important subtleties in clinical care. Regardless of how many times we perform the Seldinger technique, it is never mundane, routine, or commonplace. To think so places our patients at extraordinary risk.

Acknowledgments

Funding: This work was supported in part by National Institutes of Health grant T32 GM086287, P.I. Laura E Niklason

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Figure 1.

Upper Panel: Gooding and Corrsen's design of a needle-introducer set that did not require a guidewire for central venous cannulation (Reproduced with permission from *LWW*)

Lower Panel: A drawing of the Saturn V Rocket used during the Apollo program (Image from the *National Aeronautics and Space Administration*).