Chapter 7
Using Serious Gaming to Improve the Safety of Central Venous Catheter Placement:
A Post-Mortem Analysis

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ABSTRACT

Serious gaming a tool that can be used to train new physicians in a manner that keeps patients out of harm's way. This is especially true when teaching procedures, which in the medical community if often done in a "see one, do one, teach one" manner. Additionally, many teachers focus on technical aspects of the procedure and may leave out or de-emphasize non-technical portions of the procedure such as hand washing and patient positioning. This chapter per the authors investigates the utility of serious gaming in teaching physicians technical procedures. The chapter begins with game development and will end with a discussion of the results of the prospective randomized study.

INTRODUCTION TO THE CENTRAL VENOUS CATHETER

Approximately 5 million central venous catheters (CVCs) are placed by physicians annually in the United States.(Gould, 2003) These catheters are often placed in critically ill patients to infuse potent medications, blood products, and/or to provide high concentration total parenteral nutrition (TPN). CVC's are placed under sterile conditions, usually with ultrasound guidance, in a repetitive technical pattern. Regrettably, as with any medical procedure, complications occur; in this case at a rate of anywhere between 5%-26% of the time (Merrer, De Jonghe & Golliot, 2001; Raad, Darouiche & Dupuis, 1997). Common complications due to CVC placement include infection, pneumothorax (air trapped in the lung), arterial

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puncture (carotid, subclavian, or femoral vessels), thrombosis (local blood clot) and embolism (mobile blood clot) with occurrence rates that are often inversely correlated with clinical experience.(Fares & Block PH, 1986; Sznajder, Zveibil, Bitterman & Weiner, 1986) The subsequent costs of catheter-related complications are high, with a single catheter-related infection, for example, costing between $4,000 - $56,000.(H. S. et Al, 2010) Guidelines and recommendations are continually being established and updated regarding CVC placement in an attempt to minimize these complications, including the use of principles such as aseptic technique and antibiotic-coated catheters.(Anesthesiology, 2010) While much has been done regarding training practitioners in the technical skills of CVC placement using part-task trainers (i.e., mannequins)(Dong, Suri, Cook, Kashani, Mullon, Enders, Rubin & Ziv, 2010; Rosen & Uddin, 2009), successfully locating and cannulating a central vein is but one part of the process. In fact, many key steps designed to prevent untoward effects involve non-technical skills such as proper hand hygiene technique, ergonomic kit set up, and manometry are learned by practitioners through an apprenticeship model (i.e., see one, do one, teach one) which can lead to non -standardized practices or even perpetuate poor practices.

Healthcare practitioners are increasingly being trained in realistic and highly interactive simulated environments so they can learn not only psychomotor skills (e.g., lumbar puncture, endotracheal intubation), but also key management and non-technical steps which make their tasks safer (Toff, 2010). Simulation, for example, has been proven an effective teaching tool in a variety of healthcare environments including laparoscopy (Aggarwal, Ward & Balasundaram, 2007; Fried, Feldman & Vassiliou, 2004), bronchoscopy (Blum & Powers, 2004), and in team-training exercises in areas such as ACLS (Fletcher, Flin, McGeorge, Glavi & Maran, 2003; Wayne, Didwania, Feinglass, Fudala & Barsuk, 2008). Additionally, it has been shown that skill retention when using simulators is often superior to standard practices and that the use of simulation reduces the learning curve of many standardized procedures. (Andreatta P, Chen Y, Marsh M, 2010; Stefanidis D, Korndorffer J, Sierra R, 2005) Likewise, it has been shown that not only can simulators improve outcomes, but they can improve efficiency of performing procedures as well (Aggarwal, Ward & Balasundaram, 2007; Barsuk, McGahie, Cohen, Balachandran, 4AD; Britt & Reed, 2007). One specific simulation modality that has yet to be fully utilized to improve performance is serious gaming.

Serious gaming as an instrument for learning is being increasingly utilized in health care fields and may lead to better skill-based outcomes.(C. C. et Al, 2009) Gaming as a training tool for physicians has not been widely available as it is relatively novel and game development can be expensive. However, more opportunities are becoming available as development becomes less expensive.("C Programming Tutorial," n.d.; "Java Made Easy," n.d.) The aim of this project was to create an interactive screen-based game for internal jugular venous cannulation and CVC placement that incorporates the non-technical aspects of the procedure. We then sought to test the hypothesis that simulation-based training with the CVC game would be superior to traditional clinical training received by junior anesthesia residents at a major academic center, as measured by a standardized rating tool.

What Went Right

Game Development

The CVC serious game was our department's first venture into the gaming world, and as such required partnering with an entity with some experience in developing serious games. Through a chance occur-