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Evaluating virtual reality simulators as a training tool for minimally invasive surgery

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TITLE: Evaluating virtual reality simulators as a training tool for minimally invasive surgery

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Minimally invasive surgery offers a number of advantages over traditional open surgeries, including faster patient recovery time, fewer side effects, and improved cosmesis. However, there are also a number of difficulties involved with performing this type of surgery, including poor visuo-spatial mapping, poor depth perception, and mechanical difficulties (e.g., the fulcrum effect). Considering the decrease in residency training hours required for surgical trainees in 2011 (Rajaram et al., 2014), it is essential that surgical trainees employ training methods that would best result in high accuracy and efficiency.

Simulator-based training addresses many of the issues of traditional master-apprentice surgical training methods (e.g., observer bias among those assessing trainee performance, the requirement of supervision from an expert surgeon who may not always be readily available, especially in remote surgical training centers). Virtual reality simulators such as LapSim and SimPraxis provide objective, accurate measures of performance, such as instrument angle and economy of movement. Additionally, simulators such as SimPraxis also evaluate *knowledge-based* performance, as well as technical performance. This is essential, because successful surgery does not depend solely on speed and efficiency of surgical techniques, but also on the quality of decision-making (e.g., should he/she convert to open surgery? Should he/she cut the tissue/organ?; Craig, Klein, Griswold, Gaitonde, McGill, & Halldorsson, 2012; Tran, Gupta, Poniatowski, Alanee, Dall'Era, & Sweet, 2013).

Human factors methods such as task analysis can be used to identify the critical pieces of knowledge required for successful surgery (Craig et al., 2012). These pieces of information can

then be used to inform development of a knowledge-based training module. Additionally, because certain studies suggest that simulators primarily benefit novice learners over intermediate or expert learners (Fairhust, Strickland, & Maddern, 2011), the present authors also suggest adaptive training, which would provide simpler tasks to novice surgical trainees and then become increasingly difficult as trainees achieve criterion-levels of performance. The advantages of adaptive training in simulated surgery are predicted to be consistent with previous findings involving "intelligent training systems" used in other domains such as combat training (Craig et al., 2012; Ryder, Santarelli, Scolatero, Hicinbothom, & Zachary, 2000).

The present authors present a view on simulated surgical training that is consistent with Ryder et al. (2000) and Craig et al. (2012). We suggest incorporating knowledge-based models into current simulator-based training, as well as the addition of adaptive training to tailor training at the individual level.