Group Homework Session 7

Business Use Case on Surgery Simulation

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Executive Summary

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Project Description

The proposal is to implement a hepatic surgery simulator to reduce the occurrence of major bile duct injuries by 10% or greater.

Background: The performance of Laparoscopic surgery is a growing trend in surgical technique. To briefly describe the procedure, laproscopic surgery involves the use of minimally invasive incisions through which one (or several) plastic tubes (cannulas) or ports are inserted into the patient. The body cavity is then inflated with carbon dioxide gas to assist in visualization of the target organs or structures, which allows the physician to utilize cameras and specialized tools to perform surgery. This minimally invasive surgical technique is associated with less post operative discomfort since the incisions are much smaller; quicker recovery times; shorter hospital stays; earlier return to full activities; and less internal and external scaring than traditional open surgical techniques.

One specific type of laparoscopic surgery is seen in cholecystectomy, or gall bladder removal (commonly referred to a "Lap chole"). For training in the procedure, animals or cadavers are sometimes utilized. However, during the 2nd through 4th year of residency, physicians train through an apprenticeship in new techniques by operating on *real* patients. During this learning curve, complications are rare, but do occur. One example is a major bile duct injury, which is creates bile leakage. Umar states that, "…the injuries are usually encountered when comparatively inexperienced surgeons are operating; who are not familiar with the anatomy." Stephen Archer, a researcher who specifically addresses bile duct injuries states that, "…residency training decreases the likelihood of injuring a bile duct, but only by decreasing the frequency of early "learning curve" injuries." Use of innovative training methods could assist in prevention of this complication.

In 1998, Marescaux anticipated, "The ability to [virtually] practice a given gesture repeatedly will revolutionize surgical training, and the combination of surgical planning and simulation will improve the efficiency of intervention, leading to optimal care delivery". In 2010, there are many modern surgical simulator models available, but one particular model that is available is the **VapVR** as designed by Immersion Medical. Included in this proposal is a copy of the information sheet about the Immersions Laparoscopy simulator.

Goal: It is expected that through use of simulations and virtual practice through the use of a surgical simulator, *a 10% reduction in Major Bile duct injuries (and other complications) will be achieved.*

Environmental Analysis

The Navy Medical Center San Diego opened a Medical and Surgical Simulation Center (MSSC) in 2008. The facility uses high-fidelity human patient mannequins, 10 patient rooms and 1 operating room to train and assess the communication, interpersonal, professional, team work, physical exam and diagnostic reasoning skills of learners. It is anticipated to provide about 5,000 simulations per academic year and is open to all medical and nursing students, interns, residents, fellows as well as practicing professionals throughout the medical center. Some of the procedures performed at MSSC are laparoscopic surgery, bronchoscopy, and anesthesia problems. “The simulators are more than anatomically correct,” says Hospital Corpsman 1st Class Leonard Ray, director of professional education leading petty officer. “They have drug reactions enacted by a computer that monitors the student’s response. They have replaceable skin to practice injections and incisions. Some have pupils that dilate; they can bleed and even moan and cry.”

In 2006, the University of Maryland Medical Center opened a Surgical Simulation and Technology Center to bring together a diverse group of experts to solve important challenges in surgery, such as how to improve and expand minimally invasive surgical procedures that enhance patient care. The center uses surgical imaging to improve the surgeon’s ability to rehearse a procedure and understand the unique aspects of the patient’s anatomy before the operation begins. It uses an artificial intelligence program called the Maryland Virtual Patient to help new and experienced surgeons fine-tune their surgical judgment to be best able to handle complex cases.

A collaboration between the Center for Robotic Surgery at Roswell Park Cancer Institute (RPCI) and the University at Buffalo's School of Engineering and Applied Sciences has produced a robotic surgical simulator, RoSS. According to a press release from RPCI, RoSS, “addresses the quickly growing need for a realistic training environment for robot-assisted surgery, a field that is rapidly expanding and is expected to constitute a significant number of all surgeries within the next five to seven years.” (RPCI, 2010). Lockheed Martin developed the endoscopic sinus surgery simulator (ES3) in response to the need for a simulator to help train novice sinus surgeons. Computer graphics and haptic feedback are used in the ES3 to create a virtual surgical environment, and the system has been used to teach otolaryngology residents (Fried et al, 2005).

Alternatives

Box Trainers - The most common devices used for laparoscopic surgical training are box trainers. Box trainers have a video terminal component and a box object that is in the form of a body part like the abdominal area. The box has wholes and trainees use real surgery instruments that have a camera attached to them. The instrument cameras provide feedback to the video terminal. The trainees watch the video terminal as they insert the instruments into the box and practice the procedure.

Box trainers have advantages and disadvantages. Box trainers are a proven technology, and they cost less in total than other training devices (1). According to a study on resident’s perceptions of skills training the approximate costs of the different methods were 125,000 for virtual computerized devices, $12,000 per animal model, and 18,000 for the box trainers (2). Another advantage is that box trainers allow students to train with real surgery instruments (1). Box trainers also provide very good physical sensory feedback to the trainees (1). Box trainers do not however provide very good body functioning feedback. For example they cannot simulate potential tissue damage or the movement of blood flows.

Animal models - Another approach to surgical training is to use a live animal. Trainees in this model practice surgical procedures on an animal like a dog. An advantage of this approach is that the student has body function feedback. Another advantage is that trainees can work together on the surgery (1). A disadvantage is that many individuals and external groups have moral obligations to using animals for surgical training. Another disadvantage is costs. In order to use animals for training organizations must pay the cost for the facilities to maintain the animals (1).

Business & Operational Impact

To seek an understanding to the type of impacts possible, the below categorizes the types of impact that may present while implementing a surgery simulation system.

Impact	High	Significant and will require stakeholder support and preparation in order to achieve success.
	Medium	Moderate and manageable to the stakeholder.
	Low	Minor to the stakeholder.
	None	Stakeholder will be unaffected.

Below are viable alternatives for consideration for Hepatic surgery training.

Alternative	Description
1	Status Quo – Do nothing and continue to training surgeons on Hepatic surgeries using endotrainers, cadavers or animals.
2	Implement simulator for Hepatic surgery.

In consideration of alternatives available and combined with possible impacts, the below is a combined view to help portray the organizational units within the business that may be impacted along with the perceived impact specified.

Impact & Description	Alternative 1	Alternative 2
Business Areas		
Change services offered	None	Low
Change to business processes or work flows such as billing,	None	Medium

marketing, information systems, external integrations, etc.		
Organizational / Operational		
Retraining or recruitment of new staff	None	High
Technical		
Hardware	None	High
Software	None	High
Databases	None	Medium

Project Risk Assessment

The risk management process identifies the risks associated with the implementation hepatic surgery simulations, their likelihood of occurrence, and their potential impact as well as mitigation strategies and accountability for their management. The steps that can be taken to minimize these risks have been outlined in the tables below:

Table 1: Risk Analysis and Evaluation - The guideline in the table below shall be used for analyzing risks, likelihood and consequence.

Likelihood of Occurrence	High	Expected in most circumstances
	Medium	Will probably occur in most circumstances
	Low	May possibly occur at some time
Impact	High	Would stop achievement of functional goals / objectives
	Medium	Would threaten functional goals / objectives
	Low	Would threaten an element of the function/ Lower consequence

Table 2 - Risk Management Plan

Risk Category	**Description**	**Likelihood of Occurrence**	**Impact**	**Mitigation Plan**

Organizational	Cost of technology prohibitive due to budgetary limitations	Medium	Low	Mitigate by developing cost savings plan and seek organizational approval.
	Lack of adequate training on new equipment	High	High	Recruit expert staff with experience or seek training for medical staff desiring to learn new equipment technology
Technical	Selected solution may not be compatible with some legacy collaborative tools.	Medium	Medium	Review current systems environment with project sponsor. Select platform independent solution that adheres to recommended standards
	Technology emerging and immature	High	High	Establish strategy to run new and existing processes in parallel to reduce risk

Benefit Analysis

The goal of surgical simulation is to enable a surgeon to experiment with different surgical procedures in an artificial environment. They help to develop medical skills for real life situations through training and repetition. Surgical simulation techniques have increasing applications in medicine. For example, they can be used to teach anatomy to medical students. Surgeons can also train and develop their skills on virtual models before operating real patients.

According to Dunkin et al (2006), surgical simulation “offers opportunity for the rehearsal of a wide range of skills in a controlled, risk-free environment, allowing for the development of mastery at a pace appropriate to the learner.” Besides, Dunkin et al note that “Simulation provides a means for objective, standardized verification of skills”.

Between September 2006 and June 2007, the Clinical Trial Unit of Copenhagen University conducted a research study to assess the effect of virtual reality training on an actual laparoscopic operation. 32 trainees in gynaecological specialty with no experience of advanced laparoscopy (defined as all laparoscopic procedures involving coordination of more than one instrument) were included in the study, which concluded that skills in laparoscopic surgery can be increased in a clinically relevant manner using proficiency based virtual reality simulator training. The performance level of novices was increased to that of intermediately experienced laparoscopists and operation time was halved. The median total operation time in the simulator trained group and the controlled group were 12 and 24 minutes respectively. Shorter operation time can reduce training cost and ease the pressure on the limited capacity for training in the operating theater (Larsen et al, 2009).

Furthermore, Delingette et al (2005), note that surgical simulators can become provide much greater versatility by offering the ability to learn from mistakes and failures. Dunkin et al also mention that "Surgical simulators can potentially be used to rehearse a complex procedure with the patient-specific data and thus become a natural extension of preoperative planning".

Finally, the patient overall experience is improved with surgical simulation. Patients go through less pain and less stress, faster recovery, and reduced overall illness time (Delingette et al, 2005).

Conclusions and Recommendations

In the future there will be increased emphasis by the Centers for Medicare and Medicaid Services and private third party payers on improving patient outcome and lowering costs. Advanced surgical simulators can help to reduce errors and complications from surgery. Reductions in errors and complications will results in lower costs. Surgical simulators also have many advantages over other surgical training approaches. Advanced surgical simulators can however be very expensive so organizations should carefully review the products offered by vendors.

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