COMPUTER-BASED SIMULATOR TRAINING IN THE HOSPITAL

A Structured Program for Surgical Residents

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Abstract: Rapid developments in techniques and new skills requirements have increased the need for surgical training outside the operating room (OR). Simulator training is often seen as a vital part of the surgical resident's education. This paper presents a simulator training program aimed at providing surgical skills training for residents in a hospital. The theoretical background on the subject is considered and initial findings discussed. The results highlight the need to organize the training systematically. Simulator training prior to entering the OR should be mandatory for all residents, even though the study showed the motivation for voluntary participation to be high. The role of the specialist surgeon emerged as an essential element in the simulator training, both as an evaluator and as an instructor.

1 INTRODUCTION

During their university studies, physicians are provided with the basic knowledge and skills of medicine. After graduation, those aiming to become surgical residents have to work in hospitals for another period of 5-6 years to achieve the level of a specialist. The basic university teaching is thoroughly planned, but the six years of learning for specialization may well include no detailed learning or teaching program, and tends to be dependent on local circumstances. In many medical specialities self-study via books or the Internet can compensate for possible defects caused by inadequate training programs. However, surgical skills cannot be achieved by reading. Learning comes from experience in the operating room (OR) or from a simulated learning environment. At least in Finland, hospitals are mainly organized to take care of patients; the training of personnel is a secondary task.

Video-assisted surgery has changed traditional surgery and new skills are needed in the OR. Laparoscopy refers to a surgical technique performed in the abdominal cavity in which the operation is conducted through small incisions, with the surgeon viewing the operating area from a video-screen. Laparoscopic operations have proved to be more difficult than traditional open surgery, for both experienced and novice surgeons (Madan et al., 2004; Soper et al., 1994). Rapid developments in equipment have increased the time needed to learn surgical procedures. There is thus a need to construct teaching protocols (Reznick and McRae, 2006) that are not only more effective in themselves, but also capable of being embedded within fluent, economical and routine organizational processes. Simulator training has been introduced as one solution that can help to solve the problem of reducing the time needed to train residents in acquiring the complex skills in question. Most residents began their residency without any manual skills in laparoscopy, hence one might expect this to be the the best point at which to introduce simulator training. However, there is, overall, a lack of research on guided simulator training in hospitals.

This study discusses a pilot simulator training program and presents initial results on the participation of residents in the program, and on the

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motivation for training. The paper is organized as follows: The theoretical grounds for the training are introduced. A case study and training program in progress is presented. The aim of the study is set out, followed by analyses of the initial results. The results are discussed, with mention of the challenges that emerged in the study. We present brief conclusions concerning the training program in its present state, and make suggestions for the future.

2 THE THEORETICAL BASIS OF SIMULATOR TRAINING

Here we present the main factors that have contributed to the creation of simulators, and some practical ideas for investigating the pedagogical aspects of simulator training.

2.1 Challenges Regarding the Training of Skills

It is important to train novices specifically in laparoscopy, so that they can become automated in instrument manipulation and in discerning the transformation of spatial information (Gallagher and Satava, 2002; Villegas et al., 2003) before entering the OR. Surgical complications occur most frequently during the first ten procedures (Jordan et al., 2000). The technique has certain limitations, including fixed instrument entry points and limited degrees of freedom (Berguer et al., 2000). The risks of the operation are particularly great when one is working with instruments that are 30 cm in length, inside the abdominal area, close to fragile organs, without direct visual contact. The visual-motor tasks of laparoscopy require excellent hand-eye coordination. Problems of perceptual motor control arise when one has to adjust to operating while watching a two-dimensional monitor image, in a situation where the camera is held by someone other than the operating surgeon (Conrad et al., 2006). One of the main difficulties in learning laparoscopic skills lies in developing the ability to estimate the surface roughness of tissues (Brydges et al., 2005). Overall, it is clear that with this new technique the challenges in acquiring surgical skills have increased.

2.2 The Role of Simulators in Training

Simulator training has already given promising results and has taken on a significant role in teaching surgical skills, without putting patients at risk (Cosman et al., 2002; Schjiven et al., 2005; Villegas et al., 2003). In addition, research has confirmed a transfer of skills between the simulator and the OR (Ahlberg et al., 2005 & 2006). For trainees to achieve the required level of skill, simulator training should be integrated within the curriculum, and should rely on the teaching skills of experts (Ahlberg et al., 2005; Ström et al.,2002). Managing simulator training has to be an active process, in order to address the key issue of transferability from the simulated to the real environment (Kneebone, 2003). The advantages of using simulation have been listed by Kneebone (2003):

1. Training can be defined by needs of the learner, not the patient or the teacher.
2. There is permission to fail, and to learn from mistakes and failures, without risk.
3. The simulator provides objective proofs of performance and feedback.

The expectations of simulator training have grown at the same time as simulator technology has evolved. It has been shown that simulator training improves OR performance in laparoscopy. Simulators are regarded as useful tools for introducing equipment and training technical skills (Poulin et al., 2006). Simulators could also be used to assess the readiness of the resident surgeon to proceed to real patient surgery (Feldman 2004).

3 CASE STUDY: A SIMULATOR TRAINING PROGRAM FOR SURGICAL RESIDENTS

The training program was organized in the Central Hospital of Central Finland. This hospital caters for a population of almost 280 000. The program forms part of a multidisciplinary project bringing together knowledge gained from education, cognitive science and surgery. The study was performed in a medical skills learning centre using the interactive Simbionix Lap Mentor II virtual reality trainer. The training program was designed to teach laparoscopic skills to surgical residents, and to further develop existing skills.

3.1 Study Design – Equipment and Environment

The medical skills learning centre is an interactive room containing simulators, cameras and other equipment. The idea was to create a peaceful learning environment where skills could be trained, whenever actual patient care would allow this. The Lap Mentor simulator enables the user to interact with a three-dimensional database in real time, and it offers games designed particularly for laparoscopic skills training, plus a realistic image representation of an organ system. The simulator has real instrument handles attached to the machine through robotic instrument ports; these give the sense of realistic “touch” contact with tissues and organs. Exercises vary from games and partial operation exercises to advanced complete operations, including laparoscopic suturing tasks performed in a simulated abdomen.

3.2 The Training Program and Data Collection

The training program for surgical resident education was launched in March 2008. Prior to resident instruction, the specialists were given time to become familiar with the equipment and exercises. Due to the complexity of the simulator as training equipment, both the specialists and the resident surgeons were offered additional help from the facilitator of the training program. Working independently or in pairs, the residents were instructed by a specialist in using the simulator and going through the exercises. The training program exercises were selected by a specialist surgeon who was experienced in simulator training. Figure 1 presents the structure of the simulator training, including three videotaped training sessions and two self-training periods.

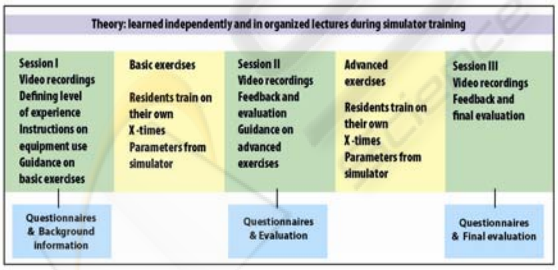

Figure 1: The training program for surgical residents.

The training program has three instruction and evaluation sessions in which both the specialist and the resident surgeon are present. Simulator training is seen as an element in surgical resident training, where the overall aim is to integrate the learning of theory and guided training within both authentic and simulated environments. During independent training, all the residents practise the same exercises until they themselves are satisfied with their performance.

Data was collected from the first part of the training program (Session I), and also when the participants made independent use of the basic skills trainer (Basic Exercises). The research data consists of background information on the surgical specialists and residents, plus information concerning skills training and exercises performed with the simulator. This information was collected via questionnaires. All the simulator exercise parameters were measured automatically. The parameters offer detailed information on the surgeon’s performance, the amount of training, and errors. The research subjects were all surgical residents (N=19) who needed to practise their laparoscopic skills. Three sessions (See Figure 1) in which both specialist and resident surgeons participated were videotaped. The video data was collected with several cameras in order to get detailed information on the events and actions during the exercises.

4 THE AIM OF THE STUDY AND THE RESEARCH QUESTIONS

The study focuses on the first part of the training program, and the initial results of the residents’ training. We formulated the following research questions:

1. What were the expectations of the residents at the start of the training?
2. What is the relationship between motivation and active participation in the training?
3. What is the relationship between one’s own self-assessed skills and active participation in the training?
4. What kind of constraints emerged regarding participation?

5 RESULTS

The study investigated the main aspects of the training in its early stage. These aspects include the expectations and motivation of the participants, and the resources they allocated to the training program. An interesting aspect of the research was the self-evaluated skills of the participants, and the amount of practice that the participants put in.

5.1 The Expectations and Motivation of the Residents

The trainees were divided into three groups according to their level of experience. The beginners (Group A) had just started their surgical resident training in the hospital and were at an early stage in their basic three-year training period. The advanced trainees (Group B1) had done more than one year of basic training. The more advanced trainees (Group B2) had already completed three years basic of training out of the total of six years resident training.

The expectations (N=17) of the residents regarding the simulator training were obtained from the questionnaire data. The less experienced residents mostly expected to become better acquainted with laparoscopic techniques and instrument handling, and to adapt to the new surgical technique. They also expected to be able to comprehend a two-dimensional video picture while they were operating. The more experienced trainees mostly expected to achieve better dexterity and more efficient hand-eye coordination. They further expected to develop a routine in the procedure, and to learn new procedures. Seventeen out of the total of eighteen residents who answered agreed that simulator training would be useful for them.

Table 1: Motivation to participate in training.

Group	Motivated	Quite motivated	Quite non motivated	Total
A beginners	6	1	1	8
B1 advanced	4	1	1	6
B2 more advanced	1	3	0	4
Total	11	5	2	18

There were motivated trainees (see Table 1) in each group. The majority (10/18) of the residents rated as a demotivating factor future difficulty in finding the time to practise with the simulator. However, there was also a high rating (13/18) regarding the possibility to practise with the simulator outside normal working hours.

5.2 Levels of Participation and Constraints

The findings regarding the training program were based on the researcher's experiences of the activity of participants as well as on the questionnaires. Table 2 summarizes the levels of active participation.

Non-active training means that the resident

Table 2: Participation.

Group	Non active training	Actively training Basic exercises	Participation Session 2 within 3 months	Participation Session 2 within 8 months	Completed Basic skills, not advancing	Total Participation
A	2	1	1	3	1	8
B1	2	0	2	3	1	8
B2	1	0	2	0	0	3
Total	5	1	5	6	2	19

participated in Session 1, but thereafter did not engage in independent practice with the simulator. Participation problems were reported especially by residents in Groups B1 and B2. The reasons for cancellations and involvement problems were listed by the researcher during the training, as follows: (1) time problems; (2) problems (for both specialists and residents) in sharing time for guidance sessions; (3) a lack of motivation for participation among more experienced residents. The reasons for cancelling scheduled sessions were usually related to extra workload situations in the clinic.

5.3 Skill Levels and Time Devoted to the Training

Residents were given the freedom to train their skills on the simulator without any upper or minimum limit on their training times. They were only told to practise until they felt confident and skilful in performing the task. There were a total of five different exercises within the Basic Exercises (see Table 3). Table 3 shows the mean amount of time (hours) spent by residents on each exercise. It also shows the mean level of self-assessed laparoscopy skill for each group, prior to starting the program.

Table 3: Residents skill level and practising times.

Groups	Skill level mean	Mean practice time Exercise 1	Mean practice time Exercise 1	Mean practice time Exercise 1	Mean practice time Exercise 1	Mean practice time Exercise 1	Total practice time
A	0.6	9.5	10.2	7.9	6.0	6.8	31.4
B1	1.6	9.4	6.8	8.0	6.8	7.4	38.4
B2	2.8	8.6	9.5	7.6	7.6	8.3	41.6
Total mean	1.6	9.2	8.8	7.8	6.8	7.5	8.02

The most active trainees seemed to be the experienced trainees from group B2. This group also spent an almost equal amount of time on each exercise. The residents from group A had less participation in the more difficult exercises.

6 DISCUSSION

Simulator training is intended to aid surgical residents in the efficient acquisition of good operating skills. Since resident education tends not to be very systematically organized in hospitals, new training methods need to be adopted alongside traditional ones. In this study simulator training had a supplementary role within residents' traditional work-place learning; hence issues such as participation and motivation were regarded as crucial. Training with the simulator was a new and for the most part unknown issue, for both the specialist surgeons and the residents. The residents' expectations were in line with studies mentioned above, in which it was found that the simulator seems to provide efficient training in aspects such as depth perception and instrument control.

The motivation of the trainees was expected to be lower when their experience level was higher. Previous studies have recommended that simulator training should be used at the novice stage of training, due to anticipated higher motivation at this stage, prior to the development of "negative stereotypes" and incorrect practices (Ström et al., 2002). The presumption was that groups B1 and B2 would be on the whole less motivated. One unexpected finding in the present study was the extent to which motivated trainees were present in every group. There did seem to be more time available for training at the early stage of residency. Notwithstanding this, the motivation to train and participate was not strictly dependent on the level of the resident. Unmotivated residents did not take part in the training at all, whereas those who participated seemed to be committed to the training.

It had been anticipated that the residents would actively participate in the guided training sessions, and that they would also be willing to engage in independent training within the times scheduled for this. In fact, the levels of active participation of the trainees emerged as roughly similar for each group, with no decrease among residents with higher skill levels. Almost all the participants seemed to be loyal to the training program, and breaks in the training were taken only for clearly valid reasons such as maternity leave or transfer to another workplace.

The skills evaluations were consistent with the level of experience of the trainees. The residents evaluated their skills critically. Even if they had performed operations independently on several occasions, the skills were evaluated at no more than 4 in a scale of 1-10. The other hypothesis was that self-assessment of the skill level would correspond to the time spent on the simulator, and to the number of training exercises carried out. In fact, what we found was that the total hours of practice were highest in group B2, i.e. among those residents who already had the highest skill level; hence the causal relationship between skills self-assessment and time spent on the simulator could not be estimated directly. One interesting observation concerned the relationship between the times spent on training and the difficulty level of the exercises (which increased from Exercise 1 to Exercise 5). Group A (novices) did less training on the more challenging tasks than either group B1 or B2, who spent almost the same time on all the exercises.

The differences between the times spent on the tasks in each group could be explained according to the likelihood that the more difficult tasks would require more support and guidance in order to succeed. Without such guidance, the less experienced residents might well be deterred from working through the more difficult exercises. Whatever the reasons, the results do suggest that self-training – without control of the amount of training – may lead novice trainees to do merely the same amount of practice, or even less, than more experienced trainees. For this reason, the role of the specialist surgeon (as both evaluator and instructor) should be taken into account, as an essential element in the training – even if residents can arrive at a fairly objective evaluation of their own skills. Previous studies, too (Kneebone, 2003), have highlighted the importance of the teaching skills of senior surgeons as part of simulator training. In our study, no clear relationship was found between motivation and active participation, however the groups that trained most actively seemed to be slightly more motivated, if we consider that in Group B2 no participants fell into the "fairly non-motivated" category.

Surgical training seems to be approaching its outer limits, bearing in mind that no one knows what the alternative to traditional education might be. Over many decades, traditional training has become incorporated within the everyday routines of hospitals. Incorporating surgical simulator training within normal hospital protocols is a demanding and complex matter. It needs much more basic, longitudinal research, since the innovations in training methods that are clearly needed should be based on real knowledge. There seems little doubt that simulation has its place as a component in the training of surgeons, provided that it supports and is supported by research, technology, clinical practice, professionalism and education.

7 CONCLUSIONS

The study shows that it is possible to run a guided and structured simulator training program in a hospital where the primary task is patient care. The surgical residents feel positive about simulator training and wish to intensify and improve their skills with it. Those who start the training program seem to remain loyal to it. However, the study suggests that simulator training needs to be fully structured – and even mandatory – in order to get all the residents involved in the training. An effective and motivating training program necessitates intense commitment from all the participants, including the supervisors. Further study is required concerning problematic features such as time allocation and the commitment of residents, and the factors involved in providing adequate supervision and support. The next logical step would be the analysis of video-recorded training sessions. The main challenges seem to involve adapting new methods into hospital routines, and creating a new learning/teaching culture within the hospital setting.

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