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The efficacy of a computer-assisted preoperative tutorial for clinical clerks

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Objective: To assess the effectiveness of computer-assisted preoperative tutorials on human anatomy in improving the operating-room learning experience for clinical clerks.

Design: Crossover trials with immediate assessment and approximately 1-week delay between trials.

Setting: General surgery operating room of a university teaching hospital.

Subjects: Eight 4th-year clinical clerks on a single 8-week surgical rotation.

Main Outcome Measures: The senior surgeon's assessment of the clerk's knowledge and understanding of the operation, according to a six-item questionnaire, and the clerk's own assessment of the experience in the operating room, according to an eight-item questionnaire.

Results: Surgeons rated the clerks' performances in the operating room as better when they had received the preoperative tutorial (mean [and standard deviation], 3.7 [0.4]) than when they had not received the preoperative tutorial (3.0 [0.3]). The difference (0.7 [0.6]) was statistically significant ($t_7 = 3.3$, $p < 0.01$). Similarly, clerks rated their own experience more positively when they had received the tutorial (4.0 [0.2]) than when they had not (3.1 [0.3]), with the difference (0.9 [0.5]) being statistically significant ($t_7 = 4.9$, $p < 0.001$).

Conclusions: Short, preoperative, computer-assisted tutorials on human anatomy can have a positive impact on the clerk's level of knowledge and confidence in the operating room. Further research is warranted into the extent to which students spontaneously make use of these tutorials.

Objectif : Évaluer dans quelle mesure les tutoriels préopératoires informatisés sur l'anatomie humaine aident les préposés à mieux apprendre en salle d'opération.

Conception : Essais croisés avec évaluation immédiate et écart d'environ une semaine entre les essais.

Contexte : Salle d'opération et de chirurgie générale d'un hôpital d'enseignement universitaire.

Sujets : Huit préposés cliniques de quatrième année effectuant un stage en chirurgie d'une durée de 8 semaines.

Principales mesures des résultats : L'évaluation effectuée par un chirurgien principal des connaissances et de la compréhension de l'intervention chez le préposé clinique, selon un questionnaire à six questions, et l'évaluation effectuée par le préposé même de l'expérience acquise dans la salle d'opération, selon un questionnaire à huit questions.

Résultats : Les chirurgiens ont mieux coté le rendement des préposés à la salle d'opération lorsque ceux-ci avaient reçu la formation préparatoire (moyenne [et écart type], 3,7 [0,4]) que lorsqu'ils ne l'avaient pas reçue (3,0 [0,3]). L'écart (0,7 [0,6]) était significatif sur le plan statistique ($t_7 = 3,3$, $p < 0,01$). De même, les préposés ont mieux coté leur expérience après avoir reçu la formation (4,0 [0,2]) que lorsqu'ils ne l'ont pas reçue (3,1 [0,3]), l'écart (0,9 [0,5]) étant significatif sur le plan statistique ($t_7 = 4,9$, $p < 0,001$).

Conclusions : De brefs tutoriels préopératoires informatisés sur l'anatomie humaine peuvent avoir un effet favorable sur les connaissances des préposés et sur leur confiance à la salle d'opération. Il est justifié de pousser les recherches pour déterminer dans quelle mesure les étudiants utilisent ces tutoriels spontanément.

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Medical school faculty face many difficulties in their efforts to train medical students to become competent physicians. One major difficulty is to educate students from diverse backgrounds efficiently and effectively with little opportunity for individualized attention. Recognizing the need for change in both the substance and style of medical education, the Association of American Medical Colleges suggested that medical schools should take the lead in the application of computer technology.[1] The tremendous progress in computer technology has the potential to make this recommendation a reality.

Computers are playing an increasing role in surgical education, particularly in the instruction of basic science. Human anatomy is also of particular interest to surgeons. Meals and Labo[2] noted that difficulties with traditional methods of anatomy instruction include limited access to a dissection laboratory, insufficient cadaveric specimens and the inability to accurately restore relationships among anatomic elements once disturbed. Computer-assisted instruction (CAI) programs have been developed to overcome these obstacles.

Several studies[3–5] have shown that CAI is as effective as traditional instructional methods in teaching human anatomy to medical students. Jones, Olafson and Sutin[3] developed a multimedia approach to instructing gross anatomy. Their program included audiovisual material, computer-assisted instruction and tutorials. Students receiving this form of instruction were compared with those receiving the traditional lecture–dissection method of instruction. Through multiple-choice examinations, the authors concluded that students in the CAI group learned anatomy as well as those in the traditional program. Walsh and Bohn[4] provided a computer-assisted anatomy program to 48 1st-year medical students from a class of 151 students. A comparison of test scores on a multiple-choice examination showed no significant difference between the users of the CAI program and the nonusers. Similarly, Guy and Frisby[5] compared interactive-videodisc lessons to the traditional cadaveric demonstration sessions and found no significant difference in learning outcomes between the two groups.

Although these studies show no differences between traditional and CAI-based training techniques, no studies have reported on the efficacy of CAI to teach students anatomy immediately before entering the operating room. It was our opinion that a short tutorial immediately before observing a specific operation could have a positive impact on the clinical clerk's operating-room experience. The following experiment, therefore, was designed to examine the effectiveness of a computer-based tutorial that teaches anatomy in a clinical setting. Specifically, we investigated the efficacy of a preoperative tutorial in helping clinical clerks understand the anatomy of operative procedures in which they were about to participate and the impact of this understanding on their ex-

Table I

Summary of the Operations in Which Clinical Clerks Participated

	Procedure	
Clerk no.	Without tutorial	With tutorial
1	Right hemicolectomy	Laparoscopic cholecystectomy
2	Laparoscopic cholecystectomy	Inguinal hernia repair
3	Laparoscopic cholecystectomy	Mastectomy
4	Inguinal hernia repair	Laparoscopic cholecystectomy
5	Thyroidectomy	Inguinal hernia repair
6	Laparoscopic cholecystectomy	Inguinal hernia repair
7	Lumpectomy	Laparoscopic cholecystectomy
8	Laparoscopic cholecystectomy	Thyroidectomy

Clerks 1 through 4 participated first in the operation without the tutorial followed by the operation with the tutorial, and the clerks 5 through 8 participated first in the operation with the tutorial followed by the operation without the tutorial.

Table II

Eight-Item Questionnaire Completed by Each Clinical Clerk After Participation in an Operation

Item no.	Wording of item
1	I felt confident answering questions regarding anatomy.
2	I felt prepared going into the operating room.
3	I was unable to follow the sequence of the operation.
4	I felt confident in the operating room.
5	I was anxious about going into the operating room.
6	I was looking forward to entering the operating room.
7	Observing the operation did not consolidate my understanding of anatomy.
8	I understood the anatomy of the procedure.

perience in the operating-room encounter.

Methods

Subjects

Eight 4th-year clinical clerks performing their 8-week surgery rotation at the Toronto Hospital during the 1994–1995 academic year made up the study group.

Tutorials

Four tutorials were created to describe the anatomy related to: laparoscopic cholecystectomy, inguinal hernia repair, mastectomy and thyroidectomy. Each tutorial consisted of a prepared 10- to 15-minute oral presentation about the anatomy relevant to the operation (presented to each clerk by the first author [D.H.]). The oral presentation was supplemented by a fixed series of colour images presented on a computer using the A.D.A.M. (Animated Dissection of Anatomy for Medicine) software package (A.D.A.M. Software, Marietta, Ga.). This package is a fully interactive, user-friendly application that lets users identify anatomic structures on the computer screen and contains thousands of individually rendered illustrations. The images can be dissected and scrutinized through dozens of layers from anterior, posterior, medial and lateral perspectives and can be zoomed in or out. Images for use with the tutorials were selected from this database.

Procedure

A repeated-measures experimental design was used. Each clerk was assigned to participate in two different operations (Table I). For the experimental condition, clerks received the relevant tutorial before entering the operating room. For the control condition, clerks did not receive the tutorial before entering the operating room. Efforts were made to ensure that, across clerks, the operations that followed a tutorial were similar to those with no tutorial. The order of the control and experimental conditions was counterbalanced so that half the clerks received the tutorial before the first operation and half before the second operation.

Upon completion of each operation, the clerks filled out an eight-item questionnaire (Table II) regarding their understanding of the procedure and their confidence during the operation. Similarly, the most senior surgeon present throughout each operation filled out a six-item questionnaire (Table III) regarding the clerk's understanding of the operative procedure, performance in answering anatomic questions relevant to the operation and confidence in the operating room. The use of questions regarding confidence or anxiety in the operating room was based on the assumption that if students understood the operation and were prepared for questions about the anatomy of the operation, they would feel more confident and enthusiastic and less anxious about the situation. All members of the operating-room staff (with the exception of the clerk) were blinded as to whether the clerk had received a tutorial.

Each statement on the questionnaire was answered according to a five-point Likert scale (5 = strongly agree and 1 = strongly disagree).[6] Because some questions were worded negatively (e.g., "I was unable to fol-

Table III

Six-Item Questionnaire Completed by the Senior Attending Surgeon After Each Operation

Item no.	Wording of item
1	The student took an active role in the operation.
2	The student did not demonstrate an understanding of anatomy.
3	The student was sensitive to critical points in the operation.
4	The student asked relevant questions.
5	The student was not confident in the operating room.
6	The student was prepared.

Table IV

Means and Standard Deviations (SD) of Clerks' and Surgeons' Scores on Questionnaires for Operations With and Without Preoperative Tutorials

Questionnaire	Without tutorial	With tutorial	Difference	t_7 value
Clerks				
Mean	3.1	4.0	0.9	4.9*
SD	0.3	0.2	0.5	
Surgeons				
Mean	3.0	3.7	0.7	3.3†
SD	0.3	0.4	0.6	

*$p < 0.001$
†$p < 0.01$

low the sequence of the operation."), an indication of strong agreement would result in a large value for a negative experience. Scoring on these questions was reversed so that a large number indicated a positive outcome for all questions. Scores from the clerks' and the surgeons' questionnaires were analysed separately. For each set of data the scores for operations with tutorials were compared, by the paired *t*-test, with the scores for operations with no tutorials. A one-tailed *t*-test was used with the type I error set at 0.05.

Results

The scores from clerks' and surgeons' questionnaires for operations with and without presentation of the tutorials are shown in Table IV. Both the clerks and surgeons demonstrated a significant improvement in scores for operations that were preceded by a tutorial.

Discussion

Data from the surgeons' questionnaires suggest that a preoperative tutorial consisting of a short oral presentation complemented by a computer-based graphic presentation was an effective method for improving students' awareness of surgical operations in which they were about to participate. Consistent with this conclusion, data from the clerks' questionnaires suggested that students were more confident and prepared concerning the anatomy of an operation after receiving the tutorial and that after the preoperative tutorial, the operation itself was a better learning experience.

It may not be particularly surprising that students who receive some form of direct, operation-specific instruction before entering the operating room will outperform students who receive no such instruction. However, two implications important to surgical education arise from this study. First, the operating room is not being fully exploited as an arena for surgical education. Traditionally, clinical clerks receive no formal instruction about the operation in which they are about to participate (the equivalent of our control condition). Our study suggests that a preoperative tutorial can be of benefit to the clinical clerk both in direct learning and indirect operating-room experience. Second, the potential for a new instructional medium in surgical education is important. With increasing pressure to find new, innovative methods of instruction, medical educators have identified computers as an important new instructional mode. In fact, several investigators[3–5] have used CAI as an integral part of their anatomy curriculum.

This is clearly a phase 1 study with a small number of subjects, which limits the potential scope of our conclusions. However, given the findings in the literature and our results in this study, adequate evidence exists for us to proceed further. Our next effort will be to transfer the oral presentation to the computer, thereby creating a stand-alone version of the tutorials, which will be accessible in the operating-room setting for the student's convenience. If a controlled experiment indicates equal success for the computer-based tutorial, then efforts will be made to determine whether students make use of these tutorials spontaneously. Ultimately, our goal is to provide medical students with an instructional infrastructure that will make the operating room a more positive educational experience.

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