Anesthesia machine checkout and room setup: a randomized, single-blind, comparison of two teaching modalities

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Original Article

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Abstract

Background: Novel methods for teaching are needed to enhance the efficiency of academic anesthesia departments as well as provide approaches to learning that are aligned with current trends and advances in technology.

Methods: A video was produced that taught the key elements of anesthesia machine checkout and room set up. Novice learners were randomly assigned to receive either the new video format or traditional lecture-based format for this topic during their regularly scheduled lecture series. Primary outcome was the difference in written examination score before and after teaching between the two groups. Secondary outcome was the satisfaction score of the trainees in the two groups.

Results: Forty-two students assigned to the video group and 36 students assigned to the lecture group completed the study. Students in each group similar interest in anesthesia, pre-test scores, post-test scores, and final exa scores. The median posttest to pretest difference was greater in the video g (3.5 (3.0-5.0) vs 2.5 (2.0-3.0), for video and lecture groups respectively, p 0.002). Despite improved test scores, students reported higher satisfaction the traditional, lecture-based format (22.0 (18.0-24.0) vs 24.0 (20.0-28.0), video and lecture groups respectively, p <0.004).

Conclusions: Higher pre-test to post-test improvements were observed among students in the video-based teaching group, however students rated traditional, live lectures higher than newer video-based teaching.

Key words: Anesthesia education, anesthesia safety, machine checkout.

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Introduction

Trainee education is a core mission of most academic anesthesia departments. Educational paradigms in all areas of medicine are shifting to meet the needs of the current generation of trainees who learn differently than most faculty.[1-3] In order to provide high quality information as well as assimilation and retention of information, the classical methods of teaching (lectures) are being challenged. Current trainees are adept at computerized learning, are visual learners, prefer multimedia content, prefer working in teams, and want full access to educational materials for review later.[4-7] In many cases, preference is given to online versions for portability and immediate retrieval and access.[8] Video-based education may enable standardization of educational content, as well as provide access to material within the duty hour limitations.

In an effort to provide better education for our trainees, we hypothesized that a video-based format that delivered information about machine checkout and room setup would be superior to the traditional lecture-based format in terms of retention of the information and trainee satisfaction. The video would eliminate the variability inherent in live lectures by multiple faculty and would allow trainees open access to content from any internet connection at a time most convenient to them.

We created a sixteen minute video to demonstrate salient points of anesthesia machine checkout and room setup. We compared this web-based instructional video with a traditional, live faculty lecture that used identical graphics and content directly from the video. The two teaching modalities were identical in the core content. The difference between the groups was the format for delivering the information, the mechanism by which trainees could review the content, and a subset of extra material that was included in each teaching modality that served to validate the exam given. Study groups were third and fourth year medical students on their two-week anesthesia rotation. The primary outcome was to evaluate the efficacy of video-based instruction. Our secondary outcome was to determine the satisfaction among subjects with video instruction**.**

Methods

Video Content:

Using the Datex-Ohmeda Anesthesia Delivery Unit, (GE Healthcare, Piscataway, NJ), one faculty filmed the key components of machine checkout and room setup (CMS). We utilized the widely accepted mnemonic, MS. MAIDS, which stands for Machine, Suction, Monitors, Airways, Intravenous Lines, Drugs and Safety. This mnemonic was the outline for the video. Within each of these headings, basic details, common pitfalls, and direct instruction was given. The video was placed on our departmental website and access during the study was restricted to study subjects via password protection. Computers with internet access were made available to study subjects, and they were given as much time as they wanted to view the video. During their rotation, subjects could access the video as often as they wished, from any computer with internet access. We were able to track the number of times each study subject opened the video content. The video is available in Appendix 1.

Video Production:

The video was produced in conjunction with the Applied Media Production Services at the University of Iowa. Professional videographers filmed the video and using Final Cut Pro 6.0 (Apple, Inc, Cuppertino, CA) the video was edited by CMS. After the video imagery was finalized, a voice recording was created in a sound booth. The video was synchronized with the dubbed voice recording and merged. The final production was placed on the department intranet, with password protection. The total cost for the production was $2150 and utilized approximately 120 faculty hours to create and edit.

Study design:

The Institutional Review Board at The University of Iowa approved the study and requirement of written, informed consent was waived by the IRB. The topic "Machine Checkout and Room Setup" was added to the medical student curriculum. Medical students who rotated through our department were randomly assigned by random block design en bloc to one of two teaching modalities: self-study web-based video (video group); or classical didactic lecture (25 to 35 minutes, lecture group). This randomization schema resulted in distinct treatments because each rotation of 6 to 8 students either saw the video or received a lecture. There is an inherent risk of students discussing educational content while on a rotation. In an effort to reduce cross-communication between students during the rotation, we chose to keep all students coming on to the rotation in one teaching modality, as opposed to randomizing individual students within the two week cycle.

The lecture was scripted and based upon the video content, with screen captured images from the video used in each Microsoft® Office PowerPoint® slide (see Appendix 2). The same faculty (RPF) gave all lectures and students were allowed to ask questions during and after the lecture. Students in the lecture group were also given an outline handout during the lecture to take notes on (see Appendix 3). Students from both groups were free to talk to residents, faculty and each other about the topic after the presentations and during the rotation. No effort was made to control their access to other information about this topic.

Students completed a questionnaire regarding previous experience with anesthesia machines. Those with prior experience (anesthesia externs, n=7), those who failed to complete one or more testing metric (n=8), or those who were visiting international students (n=2) were excluded from the data analysis. Basic information about machine checkout was taught to both groups. However, each group also received additional specific facts about machine checkout and room setup, which were not taught to the other group. Questions regarding these specific facts were included in the post test and the final exam to assess their retention of the information and to validate the exam and identify crossover learning. Students and faculty were not told that a study was in progress, thus faculty evaluators were blinded to the teaching modality that students received. Only one investigator (RPF) and the study coordinator knew which teaching modality students received and neither participated in student evaluations.

There were four performance measures for this study. First, a written pre-test of machine check-out and room set-up knowledge was given to all the students on the first day of the rotation (14 questions, see Appendix 4). Second, a written post-test was given to all students one day after participating in either the video instruction or didactic lecture (the same 14 questions as the pre-test, plus 8 questions specific to the video and 8 questions specific to the lecture-30 questions total, see Appendix 5). Third, a written

final exam on the last day of the rotation (50 questions) that included six questions specific to machine checkout and room setup that had been taught to both groups (see Appendix 6). Lastly, faculty members that supervised the students in the operating room were asked to evaluate student participation and performance during the rotation. These performance measures were used to determine if each group was composed of students with similar interest and academic achievement (0 to 45 possible points). Questions were validated and difficulty and discrimination values for all test questions were obtained from the Exam Service in conjunction with the Office of Consultation in Research in Medical Education at the University of Iowa.

There were three satisfaction measures for this study. All students were asked to grade their overall training for the rotation (6 questions; 0 to 30 possible points) and the overall teaching for the rotation (11 questions; 11 to 55 possible points). In addition, students in the video group were asked to appraise the video (5 questions; 0 to 25 possible points); while students in the lecture group were asked to evaluate the instructor (9 questions; 0 to 45 possible points) These evaluations are available in Appendix 7 & 8.

Data analysis:

Prospective power analysis revealed that 90% power could be obtained with 34 students in each group comparing post-test to pre-test difference scores between video and lecture groups for 20% increase in video group scores assuming a standard deviation of 0.25 on the two-sided type I error rate of 0.05. Data were tested for normality by Shaphiro-Wilk test. Non-parametric Wilcoxon Rank Sum or Wilcoxon Signed-Rank tests were used (SAS version 9.2, XP PRO, Cary, NC). Data are presented as median and interquartile range. Significance was set at $p < 0.05$.

Results

Ninety-seven students participated in the study; 17 did not complete one or more of the testing metrics or had previous experience related to anesthesia machines and were excluded. There were 42 students in the video group and 36 students in the lecture group. Interest in anesthesia was similar between groups; 5.0 (3.0-6.0) in the video group *vs.* 5.0 (4.0-6.0) for the lecture group, $P = 0.32$. All students viewed the video once during their orientation, five opened the video twice immediately and eight opened the video at another time during their rotation. We are unable to ascertain if they watched the video or merely logged in and opened it.

The median pre-test scores were not different between the video and lecture groups; 7.0 (6.0-8.0) and 8.0 (6.0-9.0), respectively, $P = 0.07$. The median post-test scores for those 14 common questions were also not different 11.0 (10.0-12.0) and 10.0 (9.0-11.0), $P = 0.16$ for the video and lecture groups, respectively. However, students in the video group (compared with students in the lecture group) had higher median test scores on the final exam. The final exam included the 14 pre-test questions common to both groups plus 16 questions for validation specifically taught to each group (8 taught only to the video group and 8 taught only to the lecture group, $P = 0.0052$). To discern whether there was a difference between the two learning modalities, we compared the difference between post-test scores to pre-test scores for each group using the questions common to both groups. The video group improved more than the lecture group: 3.50 points (3.0 to 5.0) for the video group and 2.50 points (2.0 to 3.0) for the lecture group, $P = 0.002$, (see Table 1).

In an effort to ascertain the validity of the exam and determine whether there was crossover learning between groups, we incorporated specific content into each teaching modality. This content was part of the post-test, and matched with the expected correct responses on the exam. For example, 8 questions which assessed knowledge about facts given only to the lecture group were answered correctly by students from the lecture group and students from the video group scored lower on these same 8 questions; 6.0 (5.0-6.0) vs. 4.0 (4.0-5.0) for the lecture and video groups respectively, $P < 0.0001$. Conversely, 8 questions which assessed knowledge about facts given only to the video group were answered correctly on the exam by students in the video group, while students in the lecture group scored lower on these 8 questions; 6.5 (5.0-7.0) vs. 4.0 (3.0-4.0) for the video and lecture group, respectively, $P < 0.0001$.

For the 14 common test questions, quality of the test questions was validated by the median discrimination and difficulty. Test question difficulty indicates the percentage of students who answer any given question correctly. Discrimination indicates how the questions differentiate the students who know the material from those who do not. We found that difficulty was 0.87 (0.52 to 1.0) *vs.* 0.74 (0.42 to 0.94) and discrimination was 0.12 (0.0 to 0.23) *vs.* 0.30 (0.01 to 0.36) for the video group *vs*. lecture group, respectively. The difference (lecture-video) was -0.01 and 0.12, respectively and was not statistically different, $P = 0.31$ and $P = 0.12$**.**

On the last day of the rotation, all students took a final exam consisting of 50 questions that assessed all aspects of anesthesia care. There was no difference in scores between the two groups; they were 38.5 (35.0-40.0) and 39.0 (38.0-40.5), $P = 0.18$, video group vs. lecture group, respectively. The final exam contained 6 questions specific to machine checkout and room set up. There was no difference between the video group and lecture group on these six questions ($P = 0.14$).

We utilized standardized evaluation forms (SPOT = Student Perception Of Teaching) to determine how satisfied each group was with their instruction. Students' satisfaction with their overall training was higher in the lecture group; they were 24.0 (20.0-28.0) *vs.* 22.0 (18.0-24.0) for the lecture group vs. video group, respectively, $P = 0.004$. Generally, students who were taught with standard, lecture-based teaching felt that topics on machine checkout and room setup were covered in greater depth compared with the students in the video-based teaching group. This perception existed despite both groups receiving nearly identical information, albeit in different formats. For the lecture group, student evaluation of the instructor (RPF) was 39.48 ± 5.67 out of 45 possible total points.

Discussion

The primary finding of our study was that video-based teaching was as effective as live instructor lecture-based teaching. In our small study, students learned and retained the information regardless of teaching modality. There was a slight increase in overall learning in the group that received video teaching, which did not affect the final exam grade. This suggests that immediate learning might be better after video education. Faculty evaluation of the students, which included more than knowledge, was slightly higher in the lecture group, although both groups were scored highly. Students rated the education from the live lecture slightly higher than the video. This was surprising as we hypothesized that students would prefer the video format because of the portability and immediate access. Our findings agree with reports from others that have shown most students still prefer live, interactive learning.[9] The challenge for anesthesia educators is to incorporate technologies that students find useful

and retain an interactive learning environment with expert faculty. Nevertheless, our study demonstrated that video-based teaching formats are an efficacious alternative to traditional live lectures.

Use of computer-based teaching has several advantages to busy academic anesthesia departments. Total faculty hours devoted to teaching may be reduced with video-based teaching once the video is made. In our institution, it would require 26 faculty-lecture-hours per year to deliver this one educational topic, as we have medical students who rotate every 2 weeks. It is impossible to know how many faculty hours are devoted to the preparation of lectures before delivery of the content. Video instruction provides consistency in the material presented, and some trainees may be more comfortable with this method of teaching, although in our study they preferred the live lecturer. Some anesthesia training programs use multiple clinical sites, and video-based teaching modules may allow educational content to reach a wider audience.

There are benefits to the trainee as well. Trainees can access the information in real time when they are setting up their room as most operating rooms have computers with internet access. Trainees have the opportunity to review information at their own pace, as much as they want. It would be interesting for future research, to determine if unlimited access to teaching materials could reduce the perceived stress by novice trainees. Watching a video before attending a live lecture can result in "priming" for learners, and may result in greater retention of factual information.[10] Video-based education with myriad distance-based follow-up methods (Blackboard, web chat, etc) may allow for better inclusion of trainees who are on away rotations.

There are limitations to using video-based education as the only method of teaching trainees. Trainees without access to instructors are unable to ask clarifying questions—a possible source of frustration for the trainee, and something that we did not try to specifically assess. As evidenced in the present study, trainees were less satisfied with video-based instruction compared with lecture-based formats despite similar learning. These results are consistent with reports by others.[11,12] In our small study, the two point difference in the learner satisfaction scale is difficult to interpret, and may or may not translate into a meaningful difference in learning outcomes.

Interpersonal interaction between faculty and trainees is absent in video formats, and students may feel their education has a lower priority. However, using videos to teach standard information, and coupling these with round table question and answer sessions or problem-based learning discussions may be an attractive alternative for many busy academic departments. Our study design excluded students with a. number of attributes, potentially limiting the study's generalizability. While the two groups were similar with regard to their interest in anesthesia, we did not assess for other potential factors associated with testing success; it is therefore conceivable that unknown confounders might have influenced testing outcome. Another limitation of our study was that we did not assess whether use of video-based learning prevented mistakes in machine checkout or affected patient safety.

A perfectly functioning anesthesia machine is essential for quality patient care. Human error and insufficient pre-anesthetic machine checkout are common reasons for anesthesia mishaps.[13-15] This is not just a problem for anesthesia trainees. In one study, extensive experience with anesthesia machines was not associated with better detection of machine faults.[16] Video-based teaching may be an attractive supplement to Maintenance of Certification in Anesthesia (MOCA) modules.

Novice anesthesia trainees are subjected to large amounts of information at the beginning of their anesthesia training, including information about anesthesia machines and room setup. Despite lengthy orientation and apprenticeship methods, details can be easily forgotten. Understanding whether various teaching modalities translate into long term retention of material and eventually better patient care is currently unknown.

LEGENDS:
Table 1: Data are median (interquartile range) with P values. Number of possible points for each topic: Interest in anesthesia (9 points), pre and post-tests (14 points for the common questions and 16 points for the group-specific questions), final exam (50 points), student perception of teaching (30 points).

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Appendix Materials:

1. Video
2. Lecture Power®Point File
3. Lecture Handout
4. Pretest
5. Posttest
6. Final Exam
7. Student Perception of Teaching for lecture
8. Student Perception of Teaching for video