A Moderated Journal Club Is More Effective than an Internet Journal Club in Teaching Critical Appraisal Skills: Results of a Multicenter Randomized Controlled Trial

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BACKGROUND: Evidence Based Reviews in Surgery (EBRS) is an Internet journal club that is effective in teaching critical appraisal skills to practicing surgeons. The objective of this randomized controlled trial was to determine whether teaching critical appraisal skills to surgical residents through the Internet is as effective as a moderated in-person journal club.

STUDY DESIGN: Twelve general surgery programs were cluster-randomized to an Internet group (6 programs; 227 residents; 23 to 47 residents/program) or a moderated journal club (6 programs, 216 residents, 21 to 72 residents/program). Each EBRS package includes a clinical and methodological article plus clinical and methodological reviews. Residents in the Internet group were required to complete 8 EBRS packages online plus participate in an online discussion group. Residents in the moderated group were required to attend 8 journal clubs moderated by a faculty member. All residents completed a validated test assessing expertise in critical appraisal.

RESULTS: In the Internet group, only 18% of residents completed at least 1 EBRS package compared with 96% in the moderated group. One hundred and thirty (57.8%) residents in the Internet group completed the test compared with 157 (72.7%) in the moderated group. The residents in the moderated group scored considerably better on the critical appraisal test, with a mean score of 42.1 compared with 37.4 in the Internet group ($p = 0.05$), with a moderate effect size of 0.6 SD.

CONCLUSIONS: A moderated journal club is considerably better in teaching critical appraisal skills to surgical residents. This is likely because of the low participation in the Internet journal club. (J Am Coll Surg 2010;211:769–776. © 2010 by the American College of Surgeons)

Critical appraisal skills are those skills that allow physicians to evaluate the literature.[1] These are necessary skills because surgical knowledge and techniques are changing rapidly and practicing physicians must be able read the surgical literature to determine whether an article is valid and useful. Evidence Based Reviews in Surgery (EBRS) is a program designed to teach critical appraisal skills to both practicing general surgeons and residents and has been shown to be effective in improving these skills in practicing surgeons.[2]

EBRS has been used by general surgery programs in North America in a variety of journal club formats. However, with limited work hours, program directors in surgery have difficulty ensuring that general surgery residents have enough time for educational activities as well as time to develop competency in technical and clinical skills. There are potential benefits in providing teaching through a Web-based platform. This allows residents to study at their own

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convenience and often in a quiet atmosphere when they are fully rested. It is not counted in the work hour requirements. In addition, most residents are used to using the Internet as a major source of information. From the faculty side, the burden of teaching can be onerous and e-teaching has appeal. However, there is currently insufficient evidence that teaching provided electronically is as effective as seminar-type face-to-face teaching. There are no trials comparing the effectiveness of these 2 methods of teaching critical appraisal skills.

The objectives of this trial were to determine if an Internet journal club is as effective as a moderated journal club format in teaching critical appraisal skills to general surgery residents and to compare the acceptance and satisfaction with an Internet journal club with those of a moderated journal club format.

METHODS

Study design: multicenter randomized controlled trial

Study sample

General surgery training programs in the United States were recruited to participate in the trial provided they were not currently using EBRS packages in their journal club and there were at least 10 residents in their program who were agreeable to participating in the trial. As the majority of Canadian programs currently use the program, they were excluded from this trial. Programs were initially invited to participate by an email invitation. Subsequently, all program directors were called to ensure they understood the commitments of the trial and that they had an administrative assistant who could coordinate with the research coordinator of the trial.

Allocation of subjects

Cluster randomization was used to allocate the programs to the Internet or moderated journal club format groups. All residents within the program received the same method of teaching.

Intervention

The trial began in October 2008. Before the start of the trial, information about the program and the residents was collected. This included information about current journal clubs, teaching of critical appraisal in the program, and the number and level of all residents. Names and email addresses of all residents were collected.

There are 8 packages studied each year in EBRS, with each package containing a clinical article that is relevant to general surgery and a methodological article appropriate to the clinical article. The list of topics covered during the trial are listed in Table 1.[3-10] Before starting the trial, all residents were contacted by email to inform them of the trial and the EBRS program.

Table 1. Methodological and Clinical Topics Reviewed in 2008–2009

Month	Methodological topic	Clinical topic
October	Treatment effectiveness	Use of recombinant factor VIIa in severely injured trauma patients[3]
November	Equivalence	Watchful waiting versus surgical repair of inguinal hernia[4]
December	Treatment effectiveness	Adjuvant chemotherapy and surgery versus surgery alone for gastric cancer[5]
January	Meta-analysis	Fast track surgery[6]
February	Decision analysis	Analysis of 4 diagnostic strategies for rectal bleeding[7]
March	Prognosis	Scoring system for acute pancreatitis[8]
April	Quality of life	Quality of life after axillary dissection versus sentinel lymph node biopsy in early breast cancer[9]
May	Use of administrative data	Urban versus rural case-mix differences in the United States[10]

Internet journal club group

For programs randomized to the Internet group, residents received EBRS packages through the Internet only. No other critical appraisal journal club was held. Residents were provided with instructions on how to access the EBRS Web site (http:facs.org/education/ebrs.html) and were able to download all articles and reviews from that site. All participating residents were registered with EBRS. A listserv discussion group was set up for the residents with methodological and clinical experts who facilitated the discussion.

Each month the resident received notice that the articles were available for reading. At the same time, a relevant clinical scenario was posted on the listserv to start the discussion. Reviews are posted at the end of week 1 of a 2-week period and the residents completed an evaluation form and submitted it electronically. Feedback was given to the program directors indicating whether the residents completed the package.

Moderated journal club group

For programs randomized to the moderated journal club format, all residents in the program received EBRS teaching in this way. The 8 EBRS packages, including all articles and reviews, were sent to the program before commence-

ment of the trial. Programs were asked to use them in the specified order. Each program was asked to set up a monthly journal club led by at least one general surgical faculty member. Residents were expected to have read the articles before each journal club and to be prepared to discuss the articles in a seminar situation with prompts by the faculty member. At the end of the journal club, they received the clinical and methodological reviews and completed an evaluation form. Attendance was kept and this was sent monthly to the research coordinator.

Outcomes

Primary outcomes

All participating residents completed a critical appraisal test within 1 month of completion of the EBRS packages. Test packages were sent to the programs. Each program director was asked to set aside a 3-hour time slot during which the residents would complete the examination in a designated examination room. At their completion, they were sent back to the administrative center at the Mount Sinai Hospital.

The critical appraisal test was developed at the University of Toronto.[11] The test initially consisted of 3 articles relevant to the practice of general surgery and highlighted different methodological topics. Examinees read the articles and then complete a series of short-answer questions and 7-point rating scales to assess study quality. It was validated previously in a cohort of 44 general surgery residents at the University of Toronto. It showed good internal consistency (Cronbach's $\alpha = 0.77$) with evidence of face, content, and construct validity. Inter-rater reliability of 2 physicians marking the examination was 0.93. Subsequently, the test was shortened to include 2 articles with minimal impact on either reliability or validity. This same test was used in a previous randomized controlled trial assessing the critical appraisal skills of practicing surgeons who participated in EBRS.[12]

In this trial, the test consisted of 2 articles: an article assessing the effectiveness of a probiotic drink in preventing antibiotic-induced diarrhea[13] and an article assessing the use of abdominal ultrasound in the diagnosis of acute appendicitis.[14] The score for each article was 48, for a total score of 96.

The test was marked by one of the investigators using a standardized marking key that had been developed by consensus by 2 clinical epidemiologists and 1 general surgery resident who was enrolled in a Masters program in clinical epidemiology.

Secondary outcomes

The mean number of packages that each resident completed or journal clubs he or she attended was calculated. In addition, satisfaction with the clinical and methodological topics, reviews, and listserv discussion (Internet group only) were assessed on a Likert scale with scores ranging from 1 to 5 (5 being very satisfied).

Sample size estimation

Sample size was determined for a 2-arm clinical trial to demonstrate noninferiority (ie, the online course is at least equivalent to the in-person moderated seminar series). In calculating the sample size, the following assumptions were made: continuous outcomes variable, power = 0.80, $\alpha = 0.05$, SD = 8 units within each group (derived from our previous trial[12]) and equal group sizes. Multiple residents would be recruited from each program. Programs were to be randomized to receive either the online or moderated version of the course. As a result, to control for within-program correlation, it was assumed that approximately 10 residents would be recruited per program, and the intra-class correlation within programs would be 0.05, resulting in a moderate design effect of 1.45. Therefore, traditional sample size calculations were increased by a factor of 1.45 to account for this correlation.

Based on these assumptions, a sample size of 96 residents per group would have sufficient power to consider a maximum difference of 3.5 points on the critical appraisal test (7.3 percentage points) as equivalent.

Data analysis

All data are expressed as proportions and means depending on whether the data are continuous or dichotomous. One-sided equivalence tests were performed to determine if the Internet journal club is statistically equivalent or superior to the moderated journal club. The p values from the equivalence test were adjusted by the design effect to account for the intra-class correlation. In addition, mean critical appraisal test scores of the 2 groups were compared using a mixed modeling approach to test for significant differences if equivalence testing could not reject a difference. Mixed models are a powerful class of regression models that can account for the correlation within residency programs. In addition, these models allow for the control of putative confounders that might not be addressed in randomization, such as the residency year, age, and training of participants. Data from the evaluation questionnaire were analyzed to assess differences in satisfaction with the teaching format between the 2 groups using design-based *t*-tests to account for the correlation within residency program.

Ethical considerations

The study was approved by the Ethics Review Committee at Mount Sinai Hospital as well as the Institutional Review

Table 2. Program and Resident Information

Center no.	No. of residents	Previous journal club	Currently teaching critical appraisal skills	Faculty with clinical epidemiology training
Internet journal club				
1	45	No	Yes	No
2	25	Yes	Yes	No
3	47	Yes	Yes	No
4	39	Yes	Yes	No
5	23	Yes	No	No
6	46	No	Yes	Yes
Moderated journal club				
1	72	No	Yes	Yes
2	27	Yes	No	No
3	21	Yes	No	No
4	28	No	Yes	No
5	27	Yes	Yes	No
6	41	Yes	Yes	Yes

Boards at all of the participating institutions. All residents signed an informed consent form agreeing to take the critical appraisal examination. The trial was registered with clinicaltrials.gov. Trial registration number is ISRCTN91247307.

RESULTS

Thirteen general surgery programs agreed to participate in the trial and were randomized to the 2 groups. However, before starting the trial, there was a change in program director at 1 program, so this site dropped out, leaving 12 programs that were randomized equally to the 2 groups. There were 225 residents in the Internet journal club and 216 residents in the moderated group. As shown in Table 2, four programs in each group reported that they had some type of journal club and taught critical appraisal skills previously, but only 3 programs reported that there were surgeons with clinical epidemiology training on their faculty.

In the moderated group, 96% of residents completed at least 1 package, and in the Internet group, only 18% of all of the residents participated and completed any package. In the moderated group, the mean resident attendance at each journal club ranged from 33% to 80.1%. The mean number of packages completed by each resident was 5.3 (range 0 to 8), and the mean number of packages completed by residents in the Internet group was 0.66 (range 0 to 8). Data for individual centers in the moderated group are shown in Table 3. Mean number of evaluations returned for each journal club was 18.8 in the Internet group compared with 143 in the moderated group ($p < 0.001$). Interestingly, although participation rates were considerably lower in the Internet group, mean satisfaction scores were not substantially different between the 2 groups (Table 4).

One hundred and thirty residents (57.8%) in the Internet group compared with one hundred and fifty-seven (72.7%) in the moderated group completed the critical appraisal examination. Using a design-adjusted equivalence test, total critical appraisal score for the Internet group was not statistically equivalent or superior to the moderated group scores ($T_{278} = 0.85$, $p = 0.198$). Scores were then examined to see if the observed differences could be considered statistically significant. The moderated group scored significantly better on the test, with a mean

Table 3. Format and Attendance of In-Person Moderated Journal Club

Program	No. journal clubs	Mean faculty attendance/session	Resident attendance/session		Mean no. of journal clubs attended/resident
			Mean	%	
1	8	2	58/72	80.1	6.3
2	8	2.5	9/27	33.0	2.6
3	8	2.3	15.9/21	75.7	6.0
4	8	1.1	19.1/28	68.2	5.4
5	8	2.3	18.5/27	68.5	5.5
6	8	1.3	23.4/41	57.1	4.5

Table 4. Satisfaction with the Topics, Reviews, and Listserv Discussion

	Overall, mean (95% CI)	Internet group, mean (95% CI)	Moderated group, mean (95% CI)	p Value for difference between groups
Mean no. evaluations returned/package	80.9 (46.1−115.8)	18.8 (12.7−25.1)	143.0 (128.2−157.8)	<0.001
Satisfaction with clinical topic*	4.01 (3.94−4.07)	3.99 (3.93−4.04)	4.01 (3.93−4.08)	0.560
Satisfaction with methodological topic*	3.79 (3.70−3.89)	3.83 (3.56−4.09)	3.79 (3.69−3.89)	0.764
Satisfaction with clinical reviews*	3.80 (3.73−3.86)	3.86 (3.82−3.91)	3.79 (3.72−3.86)	0.075
Satisfaction with methodological reviews*	3.63 (3.57−3.69)	3.71 (3.53−3.88)	3.62 (3.57−3.68)	0.324
Satisfaction with listserv*	3.20 (2.96−3.44)	3.20 (2.96−3.44)	NA	—

*Evaluated on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

score of 43.8% compared with 39.0% in the Internet group (p = 0.05) with a moderate effect size of 0.6 SD.

Mean scores for each of the 2 articles are shown in Table 5. Mean score for the first article was significantly higher in the moderated group compared with that in the Internet group (53.0% versus 45.9%; p = 0.05).

DISCUSSION

EBRS is a program designed to teach general surgeons and residents critical appraisal skills. It is available online to members of the Canadian Association of General Surgeons and the American College of Surgeons. Surgeons are able to access journal articles and reviews electronically and discuss the articles with colleagues and experts through a listserv discussion group. Participation has been good and feedback about the electronic format has been positive. In addition, EBRS has been made available to general surgery training programs in Canada and the United States for use in journal clubs. EBRS can be used to teach critical appraisal skills, which are a mandated part of residency training curricula. They are also essential skills for ongoing learning, to keep abreast of new knowledge, and to practice evidence-based surgery.

Our group has previously shown that EBRS is effective in teaching critical appraisal skills to practicing general surgeons.[12] Eighty-two general surgeons who were members of the Canadian Association of General Surgeons were randomized to either a control or intervention group. At the end of the trial, participants in both groups completed the same examination administered in this trial. Overall, 70% of the participants completed the trial. Those in the intervention group performed significantly better than those in the control group (mean 58% versus mean 53.7%; p = 0.0001), with the size of the difference between the 2 groups being 1.06 SD units (where 0.8 units is generally considered a large effect size).

In recent years, there have been restrictions in resident work hours in both Canada and the United States. Teaching activities such as rounds and conferences, didactic lecture-based activities, and acquisition of new skills in surgical skills laboratories must be done in this compressed time frame. In addition, as a result of the restricted work hours, some residents are unavailable for teaching activities if they are post-call. The clinical demands of those who are in hospital can restrict them from attending these educational activities. As a result of this, there is growing interest among program directors to provide teaching, and EBRS in particular, electronically to allow residents to complete the packages on their own time. There are several potential advantages to an electronic journal club in addition to resident availability. These include the format being standardized for all residents, the depth of reading done by each resident might be more uniform and complete; and there is a permanent record that can be reviewed at a later time by students and program directors. However, although there are many theoretical advantages to this form of teaching, there is uncertainty about whether this form of teaching is as effective as face-to-face seminar-type teaching.

There are several important findings in the present study. First of all, the participation of residents in the moderated journal club format was generally excellent. Attendance was high in most programs and resident feedback was positive. On the other hand, participation in the Internet group was exceedingly poor. Multiple initiatives were undertaken during the year to improve participation but, for the most part, they failed. First, residents were told by

Table 5. Mean Test Scores

Article questions	Overall score (%), mean (95% CI)	Moderated group (%), mean (95% CI)	Internet group (%), mean (95% CI)	p Value
Test score I	49.8 (45.4−54.2)	53.0 (48.4−57.6)	45.9 (40.6−51.2)	0.05
Test score II	33.5 (31.4−35.7)	34.7 (31.7−37.8)	32.0 (30.3−33.7)	0.12
Total test score	41.7 (38.5−44.8)	43.8 (40.2−47.5)	39.0 (35.8−42.2)	0.05

their program directors that completion of the EBRS packages was a mandatory part of the curriculum. The investigators provided feedback on which residents had completed the packages to the program directors on a monthly basis. The program directors were asked to remind residents that their participation was expected. However, there were no repercussions if the resident failed to complete the package. Secondly, the listserv discussion is organized so that a clinical scenario that is relevant to the clinical article is posted each month. It is hoped that there will be a discussion among participants with the clinical and methodological experts joining in during the second week. This has occurred on the listserv discussion group for practicing surgeons, but did not occur on the resident listserv discussion group during the trial. To encourage participation in the resident listserv discussion group, several initiatives were attempted, including posting of queries to stimulate the discussion; posting of comments by experts; and posting of comments that had been posted on the general surgeons' listserv. Third, emails were sent directly from the administrative assistant of EBRS to encourage resident participation. Lastly, the principal investigator tried to contact a random sample of residents directly by email to try to understand why participation was low and if changes could be made to improve participation. However, all of these initiatives failed.

In this study, we were able to show that there was a significant difference in the mean scores on the critical appraisal examination of the 2 groups. However, the difference was only moderate, with an effect size of 0.6 SD. It was disappointing that this was not a larger difference, given the poor participation in the Internet group. There might be several explanations for this. First, the critical appraisal test asked the residents to read and critically appraise 2 articles: 1 was an article on treatment effectiveness and the other was an article on evaluation of a diagnostic test. The EBRS methodological topics vary from year to year and during the 2008-2009 year, there was no package on the topic of diagnostic tests. It is presumed that critical appraisal skills that are learned in EBRS can be used to assess different methodological topics but, in retrospect, the second topic on the critical appraisal test should have been changed to one that had been covered during the year. A substantial difference was observed in the mean scores assessing the article on treatment effectiveness but not on the one assessing a diagnostic test. It is quite likely that a larger difference in the overall mean scores might have been observed if both topics in the critical appraisal test had been topics covered during the year. It is encouraging, however, that the residents in the moderated group scored considerably better than those in the Internet group on the article assessing treatment effectiveness. This topic had been covered 6 months before the critical appraisal test was administered, so it suggests that there was some retention of learning. In addition, of all the methodological topics that physicians and trainees require to evaluate the literature, most tend to have some knowledge of evaluating articles dealing with treatment effectiveness, even without formal critical appraisal training. Despite this, we were able to show a substantial difference in the mean scores of the 2 groups on this question.

In this trial, we chose to use cluster randomization of participants, which is we randomized the programs rather than the residents themselves. This was the only feasible way to perform the trial. In addition, if we had randomized residents individually, then residents from the same program would have been randomized to both groups, and the risk of contamination would have been high. However, there are some limitations of cluster randomization. Individuals in the same cluster (program in this case) tend to share similar characteristics and the effective sample size is decreased. To compensate for this, the proposed sample size in this study was adjusted by a factor of 1.45 as discussed in the Methods section. A mixed modeling approach was used to analyze the data to account for correlation within programs, and incorporate random error at the level of the program. Lastly, because study subjects are randomized in groups, it is possible that the groups are not similar and inferences about the effectiveness of the treatment can be biased. To minimize this risk, we included only general surgery programs in the United States in the study. Baseline characteristics of the programs as shown in Table 2 were similar.

These results add to the limited body of knowledge about teaching critical appraisal skills. Taylor and colleagues identified 10 studies in a systematic review of studies evaluating the effectiveness of programs aimed at teaching critical appraisal skills.[15] Only one was a randomized controlled trial. Most were prospective cohort studies with pre- and post-intervention assessments. All of the studies were of poor quality. Six studies included medical students and 4 included residents. The teaching was delivered during 1 week to 1 year and the amount of teaching ranged from 3 to 16 hours. The interventions varied but most included some didactic teaching as well as practical sessions where participants reviewed articles. Twenty-two outcomes were measured and 15 (68%) of these were positive. The studies generally showed an improvement in knowledge. Only 4 studies assessed the critical appraisal skills of participants and only 1 was able to show an improvement in these skills. None of the studies evaluated Web-based teaching of critical appraisal skills.

Despite the enthusiasm for Web-based teaching as an alternative to classroom teaching, there are only a few studies assessing the effectiveness of this teaching method in surgery. No study has directly compared educational programs identical in content, but given in person or through a Web-based platform. The Thoracic Surgery Directors Association developed a Web-based teaching curriculum for residents accepted into thoracic surgery training programs.[16] The curriculum consists of 75 learning modules organized into 13 sections. Residents entering the program between 2001 and 2004 were randomly allocated to receive the curriculum or not receive the curriculum before starting their residency to determine whether this would improve their performance while in the training program. Although the satisfaction with the curriculum and the method of teaching were rated highly by most residents and faculty, in training examination scores were not higher in the group of resident receiving this training.

Hammond and Whalen reported on their experience with the development of an electronic journal club to supplant a conventional journal club in their general surgery training program.[17] They tried to incorporate adult learning principles such as self-direction to a specific task and interaction with respected opinion leaders. The electronic journal club was organized by a core group of 5 individuals who chose the articles. A PDF copy of the article was available for downloading and a simple email chain was used to discuss the article. Faculty facilitators and guidelines for steering the discussion were made available to the residents. Participation was voluntary. The authors reported the results of 26 sessions held during 2½ years. The number of monthly submissions by residents on the email discussion ranged from 0 to 22, with a mean of 5.74 per month. Faculty posted an average of 6.4 submissions. A survey was sent to all residents in the program who were at the PGY2 level or higher. Generally, residents were positive in their evaluations. They believed that the journal club added value to the educational program (mean score 2.2 on a scale of 1 to 5) and that the journal club allowed them to do it when they were not tired (mean score 2.4). The residents generally disagreed with the statements that they participated only because they were monitored (mean score 3.36); that they were too tired to think during a conventional journal club (mean score 3.9); that journal clubs are overrated (mean score 3.63), and that they did not have enough time for reading (mean score 3.6). However, this cohort was not asked directly which journal club format they preferred nor was the study designed for a head-to-head comparison.

The present study provides more evidence that EBRS is an effective method of teaching critical appraisal skills to both practicing surgeons and residents. For resident teaching, the moderated journal club format appears to be superior because of the increased participation of residents and general satisfaction with this format. The question that is left unanswered in this trial is how to make the Internet format equally as acceptable so participation of residents would be increased. This is increasingly important as program directors struggle to provide resident teaching in the era of work hour restrictions. The results of this study suggest that program directors should not assume that uptake of educational programs delivered electronically will be high. More studies are needed to determine what strategies and what types of programs are effective before there is adoption of e-learning by general surgery programs.

CONCLUSIONS

This study suggests that a moderated journal club is substantially better in teaching critical appraisal skills than one completed through the Internet. However, this is likely because of low participation in the Internet education program. Further research is required to understand what aspects of an Internet curriculum are necessary in order to increase satisfaction and participation of residents.

Author Contributions

Study conception and design: McLeod, MacRae, Brasel
Acquisition of data: McLeod, MacRae, McKenzie
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