Continuing Medical Education

Effectiveness of Case-based On-line Learning of Evidence-based Practice Guidelines

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Background: *Traditional continuing medical education (CME) has not been successful in improving physicians' practice. This project evaluated the use of e-mail to deliver evidence-based moderated case discussions to family physicians.* Methods: *In a randomized controlled trial, 58 southwestern Ontario physicians were recruited and randomly assigned to receive two evidence-based cases (type 2 diabetes, prevention) or were put on a waiting list to receive the same. On-line discussions took place about each case. Data were collected using two knowledge questionnaires, charts audits, and standardized patient visits for each of the two cases.* Results: *The two groups were similar except for rural/urban and solo versus group practice. The latter was related to outcomes, and analyses were controlled for this variable. The intervention group showed statistically significant improvements compared to the control group for knowledge and chart-audit scores for one of the two cases.* Conclusions: *Using a randomized control design, this e-mail CME method demonstrated mixed effectiveness.*

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Continuing medical education (CME) is offered in a variety of formats, including "traditional" CME (eg, conferences/lectures), dissemination of educational material (eg, mailed guidelines), educational outreach (eg, facilitator in the office), feedback (eg, audit of prescribing patterns), and problem-based small-group learning (eg, case-based discussions).

Traditional CME has not been particularly successful, however, in influencing clinical practice, even for the small proportion of family physicians that attend CME meetings.[1] Recent innovations in CME use adult learning theory,[2-5] which, among other things, focuses on facilitating learning, rather than instruction and self-directed problem-based learning, usually provided in small-group formats.[6-8] In addition, opportunities are offered by information technology both for distance CME using e-mail and for point-of-care answers to clinicians' specific questions.[9-11] There has, however, been limited formal evaluation of these innovations.[12-14]

In 1996, the Thames Valley Family Practice Research Unit in London, Ontario, conducted a pilot study of 40 volunteer family physicians, in which 10 different cases were discussed using a moderated e-mail-based discussion group. This pilot study showed higher knowledge in the intervention group, compared with a comparison group. Physicians reported that 64.7% had made changes in their practices as a result of the intervention, and they cited convenience and the fact that the interaction occurred with family physician colleagues as the main advantages of this method of CME.[15,16]

The present study assesses a CME intervention delivered in a format that included small-group learning and discussion of cases in a peer-moderated e-mail-based discussion group. This approach can be seen as intermediate between the didactic format of traditional CME on one hand and point-of-care learning on the other. We formally evaluated the presentation and discussion of a set of on-line evidence-based case studies.

The primary research question for this research project was whether an on-line case-based continuing education program for family physicians improves their knowledge, quality of practice, and targeted behaviors.

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We hypothesized that family physicians randomized to a case-based on-line learning (CBOLL) group would exhibit increased knowledge, quality of practice, and targeted behaviors compared to family physicians randomized to a wait-listed control group.

Methods

Eligibility Criteria/Settings and Locations

Participants were comprehensive family physicians in southwestern Ontario with access to and willingness to check their e-mail at least twice per week. Data were collected in the offices of these physicians (via chart audits and observations by standardized patients who visited the practice) as well as through mail-back knowledge questionnaires.

Recruitment and Group Assignment

Based on the Borgeil[17] method of peer recruitment, the study investigators perused a list of physicians from southwestern Ontario (n=1,074) and placed calls to those they knew.[18] A total of 209 physicians were approached. Those physicians who expressed interest in participating in the study were then sent an information package describing the study in greater detail. The packet included a brief demographic profile questionnaire and a consent form that they were asked to complete and return. Of the 209 physicians approached, 58 (28%) agreed to participate.

Method Used to Generate and Implement Random Allocation Sequencing

Once enrolled in the study, family physicians were allocated to the immediate intervention group or wait-list control group in a stratified random fashion. The study coordinator made a series of strata based on the following characteristics that in our previous study[19] have been shown to be related to practice behavior: rural/urban, male/female, less than 15 years in practice/15 or more years in practice, certificant of the College of Family Physicians (CCFP)/not certified by CCFP, and "open"/"closed" practices. Open and closed practices are those accepting or not accepting new patients, respectively.

Family physicians within each stratum were then allocated by the study co-coordinator using a random numbers table to the intervention or control group. However, for pragmatic reasons, if one study physician practiced in a group, then all participant physicians in that group were allocated together to the same arm of the study.

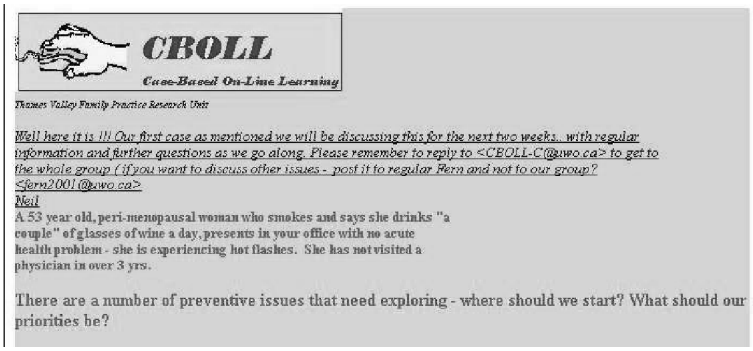
Details of Interventions for Each Group—How and When

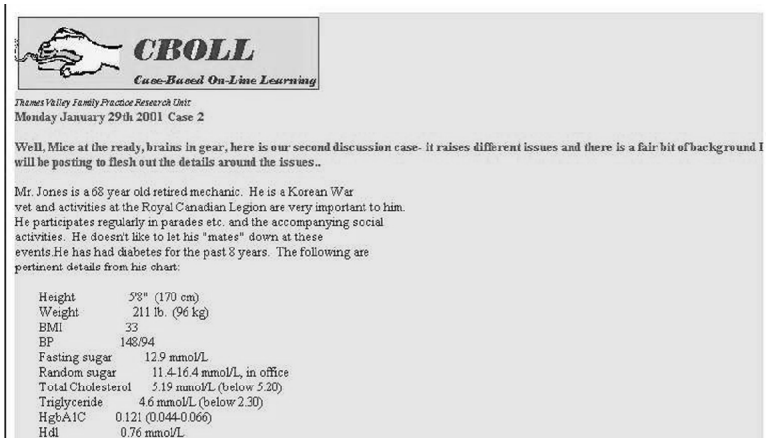
The on-line discussions took place in January 2001 for the intervention group. The intervention was comprised of two case-based on-line learning modules, each lasting 2 weeks. These modules had been pilot tested and found to be effective in terms of physicians' self-reported change in practice.[16] The first module was related to preventive health practices for a perimenopausal female patient, the second to diabetic care for an older male patient (Figure 1). The cases were presented in the same order to both the intervention and control groups. Both cases were based on recent evidence-based guidelines.[20-23]

The moderator, a family physician, began the on-line discussion by presenting a brief case scenario followed by a few clinically relevant questions to prime the ensuing discussion. Every 2 or 3 days, the moderator would add greater detail to the case and pose additional questions. Frequently, Web-based links were included so that participants could "click" on a reference to the latest relevant evidence while taking part in the on-line discussion. Participants were asked to e-mail

Figure 1

E-mail Screens From the First Postings for Each Case





their discussion points to the entire group. At the end of the case-based discussion, the moderator provided a summary of the points discussed in a format that the participants could easily access and to which they could refer during future office visits.

All participants were asked to check their e-mail at least twice per week during each case-based discussion. During the case discussions (the intervention period), the wait-list control group received no intervention.

Outcome Measures

Three outcome measures were used: (1) physician knowledge, measured by questionnaire, (2) quality of practice, measured by chart audit, and (3) physician behaviors, assessed by incognito standardized patients.

(1) Physician Knowledge. Two knowledge questionnaires relating to prevention for a perimenopausal patient (21 items) and type 2 diabetes care (22 items), respectively, were administered at baseline and at 2 and 6 months after the intervention. The same questionnaire was used so that before and after change could be directly measured. The questionnaire content was based on the evidence-based learning points in the intervention, and the items were validated for discrimination (the diabetes items were selected from a questionnaire developed for a previous study[24] and the prevention questionnaire in the pilot phase of this study). Each correctly answered item added 1 point to the knowledge score; theoretically, scores ranged from 0 to 21 for prevention and 0 to 22 for diabetes. However, for comparability, all scores were transformed to a range of 0–100 (100=perfect score).

(2) Quality of Practice Assessed by Chart Audit. Quality of care for this study was defined as documentation in a clinical chart audit that the physician had followed clinical practice guidelines. The audit of prevention care for a perimenopausal patient was based on the guideline of the Canadian Task Force on Preventive Health synthesis of evidence (Table 1). The audit for diabetes care was based on the Canadian Diabetes Association guidelines (Table 2). Each item, representing a recommended maneuver documented, counted for 1 point, and scores ranged from 0–18 for preventive care and 0–24 for diabetes care. However, for comparability, all scores were transformed to a range of 0–100.

Three chart audits were conducted, prior to the intervention and 2 months and 6 months after the intervention. Using the office day sheets, physicians' office staff identified patients who matched the billing codes and criteria for patient selection within specified time frames. The first two charts chronologically were selected for the specified time for the prevention topic (billing code 917 or 627.10, annual health exam or

Table 1

Chart Audit Items for Preventive Care

1. Blood pressure documented in chart during patient visit?
2. If systolic blood pressure was greater than 140 mmHg diastolic and BP was greater than 90 mmHg, was management discussed/instituted?
3. Is weight documented?
4. Has menopausal counseling been documented?
5. Have alternative therapies for menopause been recommended or discussed?
6. Has a bone density test been ordered or discussed?
7. Did physician perform a breast exam?
8. Has a mammogram been ordered or discussed?
9. Smoking history discussed?
10. For smokers, was smoking cessation discussed?
11. For smokers, was a chest X ray ordered?
12. Was alcohol consumption documented in units/week or equivalent?
13. If alcohol consumption is greater than 10 units per week, was a screening test documented?
14. Was dental care discussed?
15. Has activity/exercise been discussed with patient?
16. Was a cervical cytology performed or discussed?
17. Was a biannual pelvic exam or pelvic exam documented?
18. Has tetanus immunization been reviewed, discussed, or documented as current?

BP—blood pressure

Table 2

Chart Audit Items for Diabetes

1. Has the patient been seen for two or more diabetic visits over the past 6 months?
2. Has family history of diabetes been documented?
3. Was blood pressure recorded?
4. Was systolic blood pressure at or below the target range (130)?
5. Was diastolic blood pressure at or below target range (80)?
6. If blood pressure is not at target, was treatment started or discussed (lifestyle changes)?
7. Is the patient on any medication for type 2 diabetes?
8. Has the doctor completed a fasting lipid profile within the last 6 months?
9. If the low density lipoprotein is not within target range (less than 2.5), has the patient been prescribed lipid-lowering agent?
10. Retinopathy—documentation or referral to either an opthamologist or optometrist been made?
11. Documentation of foot examination?
12. Neuropathy exam—vibration assessment
13. Neuropathy exam—sensitivity with monofilament
14. Neuropathy exam—ankle reflexes
15. Nephropathy—urine albumin/creatinine ratio (A/C ratio)
16. Nephropathy—urine dip or urinalysis for protein performed
17. Nephropathy—24-hour urine test for protein
18. Does either the A/C ratio or the 24-hour urine test show elevated results?
19. If either the A/C ratio or the 24-hour urine test are elevated, has an angiotension-converting enzyme inhibitor been started?
20. Has HbA1C been documented at least one time in past 6 months?
21. If HbA1C is greater than 0.070, has the physician discussed or changed patient management (ie, increase/addition of medications, lifestyle change)?
22. Has the physician discussed lifestyle modifications (increase exercise, cease smoking, alcohol consumption)?
23. Has weight, diet, or referral to dietician or diabetes education counseling been reviewed or discussed?
24. Has self-monitoring with glucometer been reviewed or discussed?

menopause, for the first two female patients between ages 50–55 years), and for the diabetes topic (billing code 250.12, type 2 diabetes, for the first two male patients who were ≥50 years old). Chart audits were conducted by one research assistant with a nursing background, trained by the co-investigator and the project coordinator.

(3) Physician Behaviors Assessed by Standardized Patients. Two standardized patients presented unannounced and incognito to the physicians' offices, representing scenarios of a prevention case and a diabetes case. The standardized patients were trained to complete a checklist of physician behaviors specific to their case, based on the validated method of Hutchison et al.[25] The prevention checklist contained 10 items (Table 3) and the diabetes checklist 16 items (Table 4). To comply with Hutchison's scoring method for prevention, only level A and level B recommendations were included as items on the checklist. Again, the scores were transformed to represent the percent of items done during the visit ranging from 0–100. Standardized patient visits were carried out in physicians' offices subsequent to the intervention prior to the administration of the 2-month knowledge questionnaire.

Masking

Standardized patients and chart auditors were masked to the randomization. Standardized patients entered physicians' offices incognito, posing as real patients presenting in such a fashion that the implementation of the guidelines would be relevant. Since many of the practices were "closed" (not accepting new patients), a substantial amount of work was required to create realistic scenarios specific to the culture of each practice. This scenario development was created with the assistance of the physicians' staff and with the physicians' consent. Physicians participating in the study were requested to inform the research office if they had detected a standardized patient so as not to compromise patient care. During the data collection only 12% of the incognito standardized patients in both the intervention and control groups were detected by the physicians.

Sample Size

Based on data of similar standardized patient measures on prevention developed in prior research, the standard deviation of the practice scores was 11.7, and a meaningful difference was 8.2 for a standardized effect size of 0.7.[25] With an α=0.05 and a power of 0.80, the apriori sample size estimate was set to 32 per group.[25,26]

Statistical Methods

Differences between the control and intervention groups on the knowledge questionnaires at 2 months and 6 months were assessed using unpaired *t* tests. Multiple regression analysis controlled both for baseline levels of knowledge and for solo versus group practice, the only confounding variable. Similarly, for the 2-month and 6-month quality of practice assessed by chart audit, differences between the control and intervention groups were tested using multiple regression analysis controlling both for baseline levels of quality of practice and for solo versus group practice. In exploratory post-hoc analysis, we added 2-month knowledge to this regression model. Standardized patients only assessed the physician behaviors at 2 months; therefore, the differences between control and intervention groups were tested using multiple regression analysis controlling only for solo versus group practice.

Qualitative Analysis

Two investigators independently reviewed the e-mails transmitted during the discussions of the on-line cases. Together they identified themes and trends of the on-line discussions.

Table 3

Prevention Items—Standardized Patient

1. Estrogen replacement therapy
2. Blood pressure measurement
3. Specific alcohol use
4. Mammogram
5. Breast examination
6. Tetanus vaccination
7. Cervical cytology
8. Exercise in general
9. Fasting blood glucose
10. Smoking

Table 4

Diabetes Items—Standardized Patient

1. Regular retinopathy screen (ie, optometrist/opthamologist)
2. Order HbA1C
3. Order fasting sugar
4. Order fasting lipids
5. Order urine creatinine/albumin ratio
6. Look at feet
7. Weight check
8. Blood pressure
9. Diet discussion/referral for diabetes education
10. Background history of diabetes (and family history)
11. Medication discussion
12. Management plan
13. Blood glucose monitoring
14. Exercise
15. Electrocardiogram
16. Smoking

Results

There were 27 participants randomized into the intervention group and 31 into the control group. Table 5 shows that the intervention and control group family physicians were similar in terms of gender, years since graduation, certificant status, and open/closed practice. However, there were substantial differences between the groups based on rural/urban practice location and solo/group practice structure. Because the latter was related to outcomes, we conducted all analyses controlling for solo/group status. In a different comparison not shown in Table 5, the 1,027 family physicians from which the participants were identified were similar in years since graduation (20 years) and proportion in group practice (63%) but were much less likely to be certificants of the College of Family Physicians of Canada (65%) than the participants.

Table 5

Demographic Characteristics: Comparison Between the Intervention and Control Group Physicians

	Intervention Group n=27	*Control Group n=31*
Gender		
% male	63.0	71.0
Years since graduation		
Mean	17.9	18.6
Certificant of College of Family Physicians of Canada		
% yes	96.3	87.1
Open/closed practice		
% closed	85.2	80.6
Location of practice		
% rural	63.0	51.6
Solo/group practice		
% group	66.6	77.3

Knowledge Test

The intervention was associated with increased knowledge (Table 6). Knowledge scores among the intervention group family physicians were higher than among control group family physicians on the prevention topic, at both 2 months and 6 months. The difference for the diabetes topic was in the expected direction but was not significant. There was no consistent relationship of knowledge scores to solo versus group practice setting.

Quality (Chart Audit)

Participation in the intervention was associated with quality of practice on the prevention topic (Table 7); the mean quality of practice score at 6 months for the intervention group was significantly greater than for the control group. However, there were no differences on the diabetes topic. The scores for quality of practice for both topics were approximately half the maximum possible score.

While we observed that the association of the intervention with quality scores was stronger at 6 months than at 2 months, we decided to test if knowledge was

Table 6

Physician Knowledge Scores Comparing Intervention and Control Groups Before and After the Intervention

KNOWLEDGE QUESTIONNAIRE	*INTERVENTION GROUP (n=27)*			*CONTROL GROUP (n=31)*		
	Before n=27 X (SD)	*2 Months After n=27 X (SD)*	*6 Months After n=17 X (SD)*	*Before n=31 X (SD)*	*2 Months After n=31 X (SD)*	*6 Months After n=24 X (SD)*
Prevention topic	53.8 (12.8)	63.8 (17.6)*[a]	65.7 (15.2)*[b]	51.9 (9.5)	50.5 (13.8)*[a]	53.3 (10.5)*[b]
Diabetes topic	66.8 (14.1)	72.7 (14.1)[c]	73.2 (7.7)[d]	68.6 (10.4)	67.7 (16.8)[c]	68.6 (11.4)[d]

SD—standard deviation

* $P<.05$

a—Multiple regression: dependent variable 2-month knowledge; independent variables: group (b=2.6, P=.002), controlling for solo/group, and baseline knowledge

b—Multiple regression: dependent variable 6-month knowledge; independent variables: group (b=2.3, P=.004), controlling for solo/group, and baseline knowledge

c—Multiple regression: dependent variable 2-month knowledge; independent variables: group (b=1.42, P=0.57), controlling for solo/group, and baseline knowledge

d—Multiple regression: dependent variable 6-month knowledge; independent variables: group (b=0.86, P=.137), controlling for solo/group, and baseline knowledge

Table 7

Quality of Practice (Chart Audit) Comparing Intervention and Control Groups Before and After Chart Audit

CHART AUDIT	*INTERVENTION GROUP (n=27)*			*CONTROL GROUP (n=31)*		
	Before n=27 X (SD)	*2 Months After n=27 X (SD)*	*6 Months After n=17 X (SD)*	*Before n=31 X (SD)*	*2 Months After n=31 X (SD)*	*6 Months After n=24 X (SD)*
Prevention topic	52.2 (11.1)	52.2 (11.7)[a]	55.0 (10.0)*[b]	51.1 (14.4)	47.7 (13.8)[a]	50.0 (14.4)*[b]
Diabetes topic	53.8 (12.5)	51.7 (12.9)[c]	47.1 (9.2)[d]	51.2 (11.6)	51.6 (9.5)[c]	50.8 (9.1)[d]

SD—standard deviation

* $P<.05$

a—Multiple regression: dependent variable 2-month chart score; independent variables: group (b=0.84, $P=.113$), controlling for solo/group, and baseline chart score
b—Multiple regression: dependent variable 6-month chart score; independent variables: group (b=1.01, $P=.029$), controlling for solo/group, and baseline chart score
c—Multiple regression: dependent variable 2-month chart score; independent variables: group (b=-0.09, $P=.895$), controlling for solo/group, and baseline chart score
d—Multiple regression: dependent variable 6-month chart score; independent variables: group (b=-1.12, $P=.138$), controlling for solo/group, and baseline chart score

a necessary prerequisite for change in practice. In a multiple regression analysis assessing the relationship of the intervention on quality of practice at 2 months and 6 months, taking knowledge into account, we found that after controlling for 2-month knowledge (as well as solo/group and baseline knoweldge), the quality of practice on the prevention topic was significantly better in the intervention group than in the control group at both 2 months (b=1.27, $P=.028$) and 6 months (b=1.25, $P=.016$).

Behavior (Standardized Patients)

Scores on the standardized patient checklist were not significantly different in the intervention group than in the control group (Table 8). The physician behavior scores were high overall, approximately two-thirds of the maximum 100%.

Analysis of E-mail Postings

There were differences in the number of e-mail postings physicians made. Physicians in the intervention group as a group, posted e-mail an average of 49 times for the prevention case (presented as the first case during the intervention) and 36 times for the diabetes case (the second case). The control group physicians posted 32 times for the first case and 27 times for the second case. On average there were two postings per case per participant (range of one–six postings per case). Eighty percent of participants posted their e-mails outside of office hours (early morning, evening, or weekends).

After analysis the postings broke down into several categories: answers to questions posed by participants or the moderator, giving information on electronic links relevant to the case, questions posed to the group or the moderators, opinions about postings, and agreement or disagreement with postings.

Table 8

Physician Behaviors Assessed by Standardized Patients Comparing Intervention and Control Groups After the Intervention*

SP Checklist—Practice Score From Visits		*INTERVENTION GROUP (n=27)*	*CONTROL GROUP (n=31)*
Practice Score	Prevention case[a] (range=0–100)	67.0 (17.5)	62.3 (19.1)
	Diabetes case[b] (range=0–100)	72.5 (16.5)	68.4 (17.9)

* Unadjusted means, standard deviations

a—Multiple regression: dependent variable 2-month physician behavior score (chart audit) regarding the prevention case; independent variables: group (b=4.48, $P=.363$), controlling for solo/group.

b—Multiple regression: dependent variable 2-month physician behavior score (chart audit) regarding the diabetes case; independent variables: group (b=4.24, $P=.361$), controlling for solo/group.

Discussion

The case-based on-line discussion demonstrated a mixed effect, with significant differences on only one of two cases and for only two of the three outcomes (family physicians' knowledge and quality of practice). Nonetheless, this is a promising finding for continuing medical education, a field in which most programs fail to demonstrate an effect.

Over the previous decade the Cochrane reviews have systematically analyzed a number of strategies, other than traditional CME, intended to improve practice.[27-30] The promising elements in our case-based on-line learning may have been convenience for the family physicians who stay in their own setting, small-group interaction and peer support for problem solving, and well-organized moderating by a peer family physician.[15,16] Organizational learning (review and develop systems and quality improvement[2]) was not addressed by our CME model, which may be an important reason why we did not get consistent effects with our two cases. Research is, therefore, needed into the effectiveness of using adult learning models in a group setting and simultaneously facilitating change in the organization of how physicians practice.

Differences Between Cases

The results for the two cases were different, with the prevention case showing an association with knowledge and quality of practice, while the diabetes case did not. One reason for the difference might be an order effect. Our first case chronologically (the prevention case) had more e-mail postings, with the lower number for the second case perhaps indicating fatigue. However, in our pilot study, we noticed different levels of engagement by physicians with different types of cases not related to order, suggesting that different topics might show differences in effect.

A second reason for the difference between the two cases may be that any learning may have been dependent on baseline knowledge level. Knowledge about diabetes was high at baseline, and this ceiling effect may have negated the need for learning, while baseline knowledge was lower for the prevention case, making it easier for knowledge scores to increase. Further educational research is required to test the above interpretations.

Outcome Measurement

Our initial hypothesis was that the incognito standardized patient measure would be the most sensitive measure of physicians changing behavior. However, the study found that the most sensitive measure was actually the chart audit. In spite of the extensive training and the expense, the standardized patient measure showed only a nonsignificant trend in favor of the intervention group. The group means were approximately the same as expected from Hutchison's study[25] (which increases confidence in the standardized patient measure), but a large standard deviation was observed in the current study (almost twice the size as in Hutchison's study, 18.4 versus 11.7). The mean differences between the intervention and control groups on the prevention topic chart audit measure were approximately the same as for the standardized patient measure, and the standard deviations were smaller.

However, the chart audit measure, too, has its limitations. Perhaps the different result for the two cases was due to differences in charting for prevention (where several distinct issues are handled) compared to diabetes (which a physician often considers just one problem). An alternate interpretation is that physicians changed only their charting and not their practice behavior.

Limitations

Several limitations should be considered when interpreting our study results. First, we had a small sample size. This limited our ability to detect significant differences, especially given the wider standard deviations than expected on our measures. Second, there is a possibility of bias in subject enrollment given the nonrandom sampling of participants. Finally, our study used one experienced moderator of on-line education, so our results cannot necessarily be generalized to other settings.

Conclusions

The study identified a promising continuing education format (case-based, on-line learning), as well as questions for future research regarding the content and order of cases presented in on-line education.

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