Examining the Ins and Outs of CME: A Comprehensive Analysis of a Catalog of CME Activities for Venous Thromboembolism Prophylaxis

Stephanie A. Stowell, MPhil,1 Alok A. Khorana, MD,2 Carolyn A. Berry, PhD,3 Liza King, MPH,3 Rachel Bongiorno Karcher, PharmD1

1Med-IQ, Baltimore, Maryland; 2Division of Hematology/Oncology, University of Rochester Medical Center, Rochester, New York; 3New York University Langone School of Medicine, New York, New York, USA

ABSTRACT

Background: The components that produce effective continuing medical education (CME) activities are inadequately defined and poorly understood. In an attempt to provide clarity surrounding the factors that affect the delivery process and the efficacy of educational efforts, we undertook an in-depth study of a catalog of CME activities for venous thromboembolism (VTE) prophylaxis produced between 2007 and 2010.

Methods: Four aspects of CME activities were examined: (1) change in clinician performance, (2) retention of knowledge and confidence over time, (3) impact of platform type, and (4) impact of frequency of exposure to CME activities.

Results: Outcomes information from 27 CME activities was available for 1549 participants who met the study criteria. The results demonstrated that Web-based CME activities were associated with clinician improvements in patient-related processes of care; participants were more likely to prescribe VTE prophylaxis within guideline-recommended timeframes and provide prophylaxis measures to surgical patients at the time of hospital discharge. Postactivity confidence remained significant over the long term, with relatively less retention of gained knowledge. Participants of live meetings had the greatest knowledge gains compared with participants of other platforms. Knowledge gains appeared to increase with up to 4 activity exposures. Although the greatest change in knowledge occurred after 1 activity exposure, knowledge was most affected over time after exposure to 2 interactive activities.

Conclusions: These results offer a clearer picture of the factors necessary for providing effective and behavior-changing CME, which is an essential component of a clinician’s practice.

INTRODUCTION

Medical professionals engage in continuing medical education (CME) activities to enhance knowledge and skills that will ultimately lead to improvements in clinician competence and performance and patient outcomes; however, the effectiveness of CME and the components that provide tangible changes in clinician behaviors that improve patient care are poorly understood [1]. Although previous studies have attempted to determine the overall effectiveness of a variety of educational activities, these studies were limited to literature reviews and meta-analyses that consisted of evaluations of activities with diverse content areas and lacked standardized reporting of results [2-4].

In 2008, the Conjoint Committee on Continuing Medical Education recommended that research in CME be a national priority to create best practices for continuing professional development and maintaining the competence of physicians [5]. Given this recommendation and in an effort to better understand how various activity-specific factors influence a clinician’s confidence, knowledge, and performance, we undertook a comprehensive analysis of a catalog of CME activities for venous thromboembolism (VTE) prophylaxis from a single accredited medical education institution.

VTE has been a predominant focus of CME activities. More than 275,000 new cases of VTE are diagnosed annually, and it is the third-leading cause of hospital mortality in the United States [6-9]. Despite the existence of multiple evidence-based guidelines to prevent VTE, the 2008 Epidemiologic International Day for the Evaluation of Patients at Risk for Venous Thromboembolism in the Acute Hospital...
Care Setting (ENDORSE) study reported that approximately 40% to 60% of patients at risk of VTE fail to receive appropriate guideline-recommended prophylaxis [9-13]. VTE prophylaxis is clearly a necessary topic of medical education, and, because of the time constraints faced by many clinicians, timely and effective educational activities are needed for imparting guideline recommendations. By examining whether participants have integrated educational objectives into clinical practice, whether participants have retained knowledge and confidence gains over time, whether educational platforms vary in effectiveness, and whether exposure to multiple VTE activities correlates with knowledge gains, we hoped to gain a deeper insight into which aspects of CME are the most effective in changing confidence, knowledge, and performance.

**MATERIALS AND METHODS**

We reviewed all CME activities for VTE prophylaxis produced by a single accredited medical education company between 2007 and 2010. All participants with available outcomes information were eligible for study inclusion, except those who met the exclusion criteria noted below. The objectives of the study analysis were to determine whether:

1. Educational objectives are integrated into participants’ clinical practices (ie, performance outcomes),
2. Postactivity knowledge and confidence gains are retained over time (ie, long-term outcomes),
3. Educational platforms vary in effectiveness (ie, platform effect), and
4. The number of VTE activities in which learners participate correlates with their last measured-knowledge data (ie, dosage effect).

The results for all statistical tests were considered significant if they would have occurred by chance less than 5% of the time (ie, \( P < .05 \)). No statistical tests were conducted for activities with fewer than 20 eligible study participants. The following describes the methods specific to each study aim:

**Aim 1: Performance Outcomes**

A performance-based assessment of clinician-provided patient care was conducted with 736 medical doctors (MDs), doctors of osteopathic medicine (DOs), nurse practitioners (NPs), and physician assistants (PAs) who had participated in a didactic Webcast or virtual case study (VCS) and practiced within the United States, but who had not previously initiated a VTE performance-improvement activity. This analysis evaluated whether participation in knowledge and competency activities produces changes in clinician performance in process measures. Data on performance processes related to VTE prophylaxis were collected through retrospective chart reviews with the aid of a standardized collection form. Two data-collection forms and sets of performance measures were used—one for medically ill and oncology patients, and one for orthopedic surgery patients. A subset of the performance measures were the same for all patient types. Participants submitted deidentified information on at least 10 patients, 5 of whom had been seen at least 6 months before the participant’s index activity date and 5 of whom had been seen at least 6 months after this date.

Pearson chi-square tests, Fisher 2-tailed exact tests, and a series of logistic regression analyses were used to assess the sampling of medically ill, oncology, and orthopedic surgery patients. Patient data that were missing or not applicable were excluded from the analysis. Participants were not instructed to submit information on the same or different patients, and no attempts were made to link patient charts.

**Aim 2: Long-term Outcomes**

A total of 851 past participants who were MDs or DOs and who had completed 1 of 4 Webcast activities were eligible to take a posttest at least 6 months after the completion of their respective activities. International participants were excluded, and priority was given to oncology specialists during survey fielding, given their relatively low representation among the participants. The surveys included each activity’s original confidence and knowledge questions. Participants responded to confidence questions on a 4-point Likert scale. Knowledge questions had only a single correct response, and the percentage of correct answers for each survey’s knowledge questions was calculated.

To examine immediate knowledge and confidence gains, retention, and longer-term knowledge retention, we used chi-square and paired Student t tests to compare survey data retrospectively with pre- and posttest data. The representativeness of the survey groups was analyzed by comparing the pre- and posttest responses of all participants who completed the long-term surveys with data from the entire sample of participants who completed only pretest and immediate posttest surveys.

**Aim 3: Platform Effect**

We analyzed knowledge data from 15 VTE activities representing 5 platform types—didactic Webcasts (\( n = 4 \)), case-based Webcasts (\( n = 4 \)), VCSs (\( n = 2 \)), implementation guides (IGs) (\( n = 3 \)), and live meetings (\( n = 2 \)). VCSs consisted of interactive, branching, Web-based case presentations that required the participant to make critical decisions at key points of care, and IGs were electronic publications that focused on providing practical strategies for patient management.

The percentage of correct responses (hereafter referred to as the “percentage correct”) across all knowledge questions was calculated for each participant’s first pretest and posttest. Any other activities subsequently completed by the participants were excluded. Paired t tests were used to compare the overall percentages correct of the pretest and posttest for each platform. One-way analysis of variance (ANOVA), post hoc least significant difference tests, and repeated-measures ANOVA were used to determine whether knowledge gains differed among platform types or changed differentially from pretest to posttest.
Aim 4: Dosage Effect

A chronologic list of VTE activities was produced for participants of all 27 VTE activities. Participants were excluded if their first or only activity did not include a pretest and a posttest, or if they resided outside of the United States. The percentage correct across all knowledge questions was calculated for each participant’s pretest and posttest. For participants who completed only one activity, the pre- and posttest results used were from the same VTE activity. For participants who completed multiple VTE activities, we used the results of their pretest from their first (earliest) VTE activity and the results of the posttest from their last (most recent) activity; however, for cases in which a participant’s last activity did not include a pretest and a posttest, we used the posttest percentage-correct results from their most recent activity that did include a pretest and a posttest.

Repeated-measures ANOVA was used to evaluate differences in the participant’s performance between the pretests and posttests. In addition to a simple count of activities, each type of activity was weighted by relative level of interactivity, which ranged from the least interactive (ie, satellite broadcasts) to the most interactive (ie, performance improvement activities). The impact of the weighted number of courses on participant performance was assessed with repeated-measures analysis of covariance (ANCOVA). Pearson correlations among the untransformed and log-transformed data of the course-exposure variables and knowledge-change scores were determined to further assess the role of course interactivity.

Confidentiality and Exemption from Consent

All CME data of participants were reported in aggregate and deidentified before analysis. Patient data collected during the performance-outcomes aim were deidentified by clinician participants and subsequently provided to researchers. Institutional review board (IRB) approval was not sought for this study aim because the Department of Health and Human Services notes that “if information is recorded by the investigator in such a manner that the subjects cannot be identified directly, or through identifiers linked to the subjects,” then research involving the collection or study of existing data, documents, and records is exempt from review by an IRB [14]. We sought IRB approval for the aim of the long-term outcomes study, and the study aim was determined to be exempt according to the Department of Health and Human Services regulations found at 45 CFR 46.101(b)(2).

RESULTS

Of the 27 CME activities on VTE prophylaxis that were produced, 17 provided both pre- and posttest information. These activities had 1931 participants, 1549 of whom had completed pretests and posttests for at least 1 activity (Table 1). MDs and general practice/ internal medicine specialists represented the largest number of participants. The following describes the results of each study aim:

Aim 1: Performance Outcomes—Are Participants Using the Knowledge Gains from VTE Activities to Adopt Performance Changes That Influence Patient Outcomes?

A total of 736 healthcare professionals were eligible to be included in this analysis because of their previous participation in either a knowledge- and competency-based didactic Webcast or a VCS activity. Any clinicians who had participated in a performance improvement activity were not eligible. Of the eligible clinicians, 34 submitted 348 patient chart reviews (each participant had to submit at least 5 patient charts from office visits that occurred before the participant’s index activity date and 5 patient charts from office visits that occurred after this date). The majority of these participants were MDs.

<table>
<thead>
<tr>
<th>Degree and Specialty of the Study Participants*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree type, n</td>
</tr>
<tr>
<td>MD</td>
</tr>
<tr>
<td>DO</td>
</tr>
<tr>
<td>NP</td>
</tr>
<tr>
<td>PA</td>
</tr>
<tr>
<td>RN</td>
</tr>
<tr>
<td>PharmD/RPh</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Unspecified</td>
</tr>
<tr>
<td>Specialty, n</td>
</tr>
<tr>
<td>General practice/ internal medicine</td>
</tr>
<tr>
<td>Oncology</td>
</tr>
<tr>
<td>Orthopedics</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Unspecified</td>
</tr>
</tbody>
</table>

*MD indicates medical doctor; DO, doctor of osteopathic medicine; NP, nurse practitioner; N/A, not applicable; PA, physician assistant; RN, registered nurse; PharmD/RPh, doctor of pharmacy/registered pharmacist.
Eighteen participants submitted information on medically ill or oncology patients, and 16 participants provided information on orthopedic surgery patients.

A significant improvement was observed in the documentation of VTE risk on admission and in the use of appropriate pharmacologic VTE prophylaxis for medically ill and oncology patients (Figure 1A). When data for medically ill and oncology patients were analyzed as separate groups, a significant change in the performance of patient care processes was maintained for medically ill patients. Statistical significance was not maintained for oncology patients but improved trends in patient care processes were observed. This result was most likely due to the small number of submitted oncology patient charts (preactivity, 29%; postactivity, 32%).

For orthopedic surgery patients, we observed a significant improvement in VTE prophylaxis ordered during admission (Figure 1B). Although improvements in prescribing appropriate (ie, guideline recommended) anticoagulants to patients were observed, this trend was not significant. The frequencies of screening with Doppler ultrasound before patient discharge were equally low in both the pre- and postactivity periods (16% and 18%, respectively; \( P = .833 \)).

Overall, medically ill, oncology, and orthopedic surgery patients were
significantly more likely to receive VTE prophylaxis within 24 hours of hospital admission, intensive care unit admission/transfer, or surgery (Figure 1C). Surgical patients, either oncology or orthopedic, were also prescribed VTE prophylaxis at discharge significantly more often after a participant’s participation in Webcast activities ($P = .005$). No notable changes were observed in the use of mechanical methods of VTE prophylaxis ($P = .230$), and aspirin was prescribed as the sole method of prophylaxis for a small percentage of patients (preactivity, 3%; postactivity, 5%; $P = .385$).

Aim 2: Long-term Outcomes—To What Extent Are Knowledge and Confidence Gains Retained over the Long Term?

Four surveys of activities after didactic Webcasts were each fielded to 81 participants, with the exception of Webcast A, for which surveys were fielded to 101 participants. Response rates ranged from 32% to 49%. The mean time elapsed since participation was the longest for participants of Webcast A (35.5 months), followed by Webcast B (24.6 months), Webcast C (20.6 months), and Webcast D (14.9 months).

Various aspects of participant confidence were surveyed in 3 of the 4 Webcasts. Over the long term, participants demonstrated significantly higher levels of confidence compared with baseline levels; however, long-term confidence was not as high as levels reported immediately after the individual activities (Figure 2A). All participants demonstrated significant immediate gains in knowledge (pretest versus posttest) after the activity (Figure 2B). Long-term knowledge tended to remain higher than preactivity levels but was less than knowledge levels immediately after the activity levels for 3 of the 4 Webcasts. Only Webcast A participants demonstrated significant long-term retention of knowledge when pretest scores were compared with long-term scores ($P = .03$; Table 2). Further analysis of the survey respondents found this group to be slightly more confident and somewhat more knowledgeable than the larger sample of participants who initially completed the activities (data not shown).

Aim 3: Platform Effect—Do Knowledge Outcomes Vary among Different Platform Types?

Fifteen VTE activities were categorized into different platform types. Table 2 presents the $P$ values for long-term knowledge analyses.
within 5 platform types—didactic Webcasts (n = 4), case-based Webcasts (n = 4), VCSs (n = 2), IGs (n = 3), and live meetings (n = 2)—and 1508 participants completed at least one of these activities as their initial VTE activity. The number of eligible participants for each platform type ranged from 15 (case-based Webcasts) to 1268 (didactic Webcasts). Of note is that case-based Webcasts, VCSs, and IGs were relatively newer platform types, and most of the participants had completed more traditional live-meeting and didactic-Webcast activities as their initial activities.

Statistically significant improvements in knowledge outcomes were observed for 4 of the 5 platform types (Figure 3). A trend in improved knowledge outcomes was observed for case-based Webcasts (pretest, 55%; posttest, 66%); however, tests for statistical significance were not performed because of the small sample size. Additionally, because of the small number of participants in the case-based Webcasts and because only 30-day postactivity outcomes were available for the VCS platform, comparisons among platforms were limited to the didactic Webcasts, IGs, and live meetings. Comparisons among these platforms found significantly lower baseline levels of knowledge for live-meeting participants (P < .001) but showed no significant differences in posttest knowledge outcomes (P = .219). A comparison of the change in knowledge from the pretest to the posttest across 3 platforms demonstrated the main effects of time (P < .001) and platform (P < .001), as well as an interaction effect on knowledge changes (P < .001).

**Aim 4: Dosage Effect—What Effect Does Participating in Multiple VTE Activities Have on Knowledge Gain?**

Eleven VTE activities were the chronologically first and/or last activities completed by 1293 participants. Participants were first analyzed according to the number of courses completed. Statistically significant improvements were observed for all participants, regardless of how many courses were completed (P < .001). A trend for increasing knowledge gains was observed for participants who completed 2, 3, or 4 courses (P < .001; Figure 4). The smallest group of participants (n = 33), those who had completed at least 5 activities, also demonstrated knowledge gains; however, these gains were less than those achieved by the groups who had completed 2 to 4 courses.
Each of the 11 courses was weighted according to its level of interactivity. The weighted number of courses that each participant completed was measured as a continuous variable and used as a covariate in the analysis of knowledge gains from pretest to posttest. Statistically significant effects of time and course exposure, as well interaction between time and course exposures (P < .001), were observed for both the weighted and unweighted counts of courses. Correlation analyses were performed to further distinguish the effects of time and course exposures. The positive relationships between the residualized knowledge-change scores and the natural logarithm of the number of courses (as well as time) of both the weighted and unweighted counts of courses were stronger than those for the untransformed versions of the 2 exposure variables (weighted, 0.224; count of courses, 0.216; P < .001 for both). This finding suggests that the greatest impact on knowledge gain occurred during the initial exposures (ie, between participation in 1 versus 2 courses and participation in 2 versus 3 courses). In addition, the residualized change score was slightly stronger for the weighted course exposure than for the count of courses, which indicated that the relationship between exposure and knowledge gain was enhanced when interactivity was taken into account.

**DISCUSSION**

Several reviews have examined the results of a variety of studies of individual CME activities [2-4]. We believe, however, that the present study is one of the first in-depth studies to examine a series of CME activities within a single therapeutic topic from a single accredited medical education institution. Notably, the completion of a CME activity was correlated with improved participant performance in the provision of VTE prophylaxis regimens at the time of hospital discharge.

Other significant findings include improvements in participant knowledge after the completion of didactic-Webcast, VCS, IG, and live-meeting activities. Compared with participants of didactic Webcasts and IG, live-meeting participants demonstrated the greatest changes in knowledge. This steeper increase in knowledge outcomes was likely driven primarily by one course within the live-meeting platform, a unique type of live meeting designed for a hospital-specific quality improvement initiative. The course was 5 hours in length, and 64% of the participants were registered nurses. These factors, the activity duration, and the high predominance of nonphysician healthcare professionals, who may have been less familiar with the topic at baseline, likely contributed to the steeper increase in knowledge outcomes.

Using available data, we attempted to explore the influence of activity dosage by comparing participants’ earliest pretest scores with their most recent posttest scores. Owing to the lack of precedent for this type of analysis, a heuristic method was developed. Interestingly, participants demonstrated the greatest change in knowledge after exposure to 2 activities, and knowledge gains continued to increase up to 4 activity exposures. The lack of increased knowledge gains observed after 4 activity exposures was most likely due to the small number of clinicians who participated in 5 or more activities. Despite the unorthodox methodology, our overall results indicate that repeated activity exposures do increase knowledge gains.

A literature review of medical education offerings by Marinopoulos et al concluded that interactivity was key to effective education, and multiple exposures were associated with positive effects on practice behaviors over time [3]. Recently, the American College of Chest Physicians Health and Science Policy Committee determined that multimedia interventions that used a combination of print, video, and audio along with multiple exposures through varying instructional techniques led to more-effective education activities [4]. These conclusions support the findings from the present study and the need for curriculum-based CME series that encourage individuals to complete multiple activities presented through various platform types on a given topic.

Over the long term, participants retained higher levels of confidence in their various abilities to identify and prescribe VTE prophylaxis to appropriate patients. Additionally, participants in 75% of the activities examined showed a trend for retained levels of knowledge gain over time. Others have observed that 68% of CME activities produce improvements in long-term knowledge [3]. Our results are consistent with these findings, despite the lack of significant gains in retained knowledge.

This study had several limitations. The activities included in this study were unique in their individual learning objectives and faculty, and some of the activities were more tailored toward subspecialties (eg, orthopedics and oncology). Given these variables, participants may have performed differently on specific platform types or on activities over time. The length of the individual activities also varied. Most of the activities were certified for 1 CME credit hour; however, live-meeting activities were certified for 2 to 5 credit hours. As previously noted, it is likely that the time-intensive nature of the live meetings contributed to the study findings. In addition, confidence questions may have reflected participant biases. Finally, none of the educational activities included control groups. Therefore, we cannot measure the true effect of these activities on participant performance, confidence retention, and knowledge retention, nor can we measure the differences among platform types and frequency of activity exposure.

CME is an essential component of a clinician’s career. Forty-four states require physicians to complete 12 to 50 CME credit hours each year, and the Accreditation Council for Continuing Medical Education accordingly requires accredited providers to
actively demonstrate the change in competence and performance of clinician participants after completing CME activities [15,16]. The Conjoint Committee on Continuing Education and others, however, have questioned the effectiveness of CME [1,4,5]. This comprehensive study provides evidence that CME activities are effectively shaping clinician knowledge and improving care at the patient level. Furthermore, these results offer a clearer picture of the factors necessary for successful education and can be used to model future activities.

ACKNOWLEDGMENTS

This work was supported by an educational grant from Sanofi-aventis U.S. Inc., A SANOFI COMPANY. The authors thank Alison Bennett for project management; LaWanda Abernathy and Catherine Mullaney for participant recruitment; Amy Sison and Kristin Hartman for outcomes management; Sharon Howard for data entry and concierge services; Kenny Khoo for data management; Stephanie Albert and Kieran Hartsough for assistance in data analysis; Rebecca Julian and Brenda Milot for editorial assistance; and Sara Metzger for production assistance.

REFERENCES