

Comparing PDA- and Paper-based Evaluation of the Clinical Skills of Third-Year Students

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ABSTRACT

Background: The mini-Clinical Evaluation Exercise (mini-CEX) is used to assess medical students' clinical skills during medicine clerkships.

Purpose: To evaluate reliability, feasibility, and user satisfaction of a paper vs PDA-based mini-CEX in a third-year medicine clerkship.

Methods: The mini-CEX was reformatted as a PDA-based rating form for a medicine clerkship over 1 year. Faculty and residents were instructed to use either paper-based or the PDA form to assess clinical skills of students. A 9-point Likert scale was used to assess clinical skills and user satisfaction. Independent *t*-tests were used to assess differences between delivery formats.

Findings: Nearly all (98%) students completed 2 Mini-CEXs, with 275 PDA- and 101 paper-based records performed. Form reliability (Cronbach alpha) exceeded 0.9 for both. Overall resident satisfaction scores with the PDA form (7.2 ± 1.8) were higher ($P = 0.01$) than the paper-based form ($6.6/1.7$). However, faculty satisfaction scores with the PDA form (6.9 ± 1.6) were significantly lower ($P = 0.01$) than the paper form (7.6 ± 1.5). Mean scores for all 7 clinical competencies of PDA format (7.9 ± 0.9) were higher than the paper-based (7.6 ± 1.1) version ($P = .01$). Mean observation (26 min; ± 16) and feedback time (11 min ± 8) were longer (both $P < .05$) with PDA-based form compared to the paper version (22 min ± 14); (8.7 ± 6.3). Student and evaluator satisfaction ratings were not significantly different by form.

Conclusions: Both PDA- and paper-based mini-CEX delivery was acceptable to evaluators and students with both formats demonstrating high reliability. However, because evaluators' satisfaction, observation, and feedback time differed by form, further studies are needed to determine factors influencing rating variability.

BACKGROUND

Personal digital assistants (PDAs) are used with increasing frequency in clinical and medical education.¹⁻⁶ PDAs have been used to gather data on student learning activities, to facilitate documentation that feedback has been provided,⁷⁻⁸ and to

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enhance learning of evidence-based medicine.^{9,10} Direct observation of clinical skills is a crucial learning activity in medical education¹¹⁻¹³ and provides numerous benefits to learners, such as formative evaluation, feedback, and enhancement of problem formulation skills.^{14,15} The mini-Clinical Evaluation Exercise (CEX) originally developed by the American Board of Internal Medicine (ABIM) has been used to assess the clinical skills of internal medicine residents¹⁶⁻¹⁸ and, less frequently, medical students.^{19,20}

Students graduating from medical school must acquire the core skills essential for patient care and must be able to demonstrate competency in performing related clinical tasks.²¹ Although direct observation of medical students' clinical skills is a worthy goal for all clerkships, students report they are directly observed performing a history and physical examination 4 or fewer times throughout medical school training.²² In 2005, only one-fourth of graduating seniors reported that a faculty member observed them

performing a physical examination during their medicine clerkship.²³ Because students' clinical skills are observed so infrequently, faculty and residents often rely heavily on distant recollections of learning activities, whether patient presentations or classroom discussions, that are then generalized to the evaluation of students' actual bedside skills and clinical performance.²⁴ Additionally, the direct observation and clinical assessment of trainees in the midst of real patient care is invaluable and might yield unique information that could fill in gaps of clinical skills that otherwise would go unrecognized or be detected too late.²⁵

A previous study showed that PDA-based mini-CEX can be a reliable and feasible tool to assess students' clinical skills by direct observation.²⁶ However, it is not known whether there are differences in reliability, users' satisfaction, and clinical skills

ratings between use of a PDA vs a paper-based mini-CEX during a medicine clerkship. New approaches to facilitate direct observation and immediate formative evaluation of students' clinical skills must be sought, assessed, and compared. Hence, the objective of our study was to evaluate and compare the 2 mini-CEX forms during a medicine clerkship.

METHODS

Participants

Project participants were 192 third-year medical students at the Medical College of Wisconsin (MCW) who rotated on their required 2-month medicine clerkship during the period September 2006 to June 2007. All third-year medical (M3) students at MCW receive a PDA at the beginning of the academic year and also attend a mandatory 1-hour orientation session on its use.

At MCW, all M3 students complete 1 month of inpatient medicine during their required 2-month medicine clerkship; students can then choose to complete another month of inpatient medicine at a different clinical site or elect to do their second month in an ambulatory setting. Eighty-eight students (46%) chose the 1-month ambulatory medicine option during the project period.

Measurement Instrument

After receiving permission from the ABIM,²⁷ we adapted the ABIM's mini-CEX form to a PDA-based form using Pen Dragon™ software, and a paper form for medical students. The adapted PDA-based mini-CEX form was uploaded onto the PDAs of all M3 students at the beginning of each 2-month medicine clerkship. Consistent with the ABIM's mini-CEX rating form, students were evaluated on 7 clinical competencies. Each competency area was listed on the PDA-based form and was assessed via a 9-point rating scale where 1-3 is unsatisfactory, 4-6 satisfactory, and 7-9 superior. The PDA-based mini-CEX form also captured information about the focus of each clinical encounter and used the aforementioned 9-point scale to record satisfaction scores of the evaluators (faculty member or senior resident) as well as those of the medical students.

Check boxes were used in order to shorten the form, enhance compliance, and reduce completion time. The paper-based mini-CEX was an adapted 1-page form containing exactly the same type and number of items as the PDA-based form, and was provided to students at clerkship orientation.

All student participants were oriented to both the PDA-based and the paper-based mini-CEX form procedure by the clerkship director during orientation. The students also were told they could choose the mini-CEX format and were advised that the clinical ratings recorded on the PDA- or paper-based mini-CEX would not impact their final clerkship grade or

evaluation. All evaluators (faculty and residents) received an orientation packet and e-mail before the start of each 2-month rotation explaining the purpose of the mini-CEX, the key features of both forms, and instructions on how to structure the exercise and complete the form. Detailed guidance on how to deliver feedback at the conclusion of the mini-CEX was not formally discussed with the evaluators.

Data Collection

Students were asked to select a patient of their choosing and complete the mini-CEX while being directly supervised by an evaluator. All students were required to complete 1 mini-CEX each month (2 per clerkship) at their assigned inpatient and/or outpatient site. Students were given the option to select either a senior resident or a faculty member to supervise their clinical encounter and complete either the PDA-based or paper form.

Data Analysis

We calculated the percentage of students who completed the form and determined the overall mean satisfaction ratings for both students and evaluators. A Cronbach alpha was calculated for both forms to assess reliability (internal consistency). Two sample *t*-tests with equal variances were then performed to detect if there were significant differences between the following: mean student satisfaction by evaluator type (resident vs faculty), clinical domain competency ratings by evaluator type (resident vs faculty), and student and evaluator satisfaction scores by setting (inpatient vs outpatient) between the PDA- and paper-based form. To calculate the magnitude of effect size of the differences between means, we used Cohen's *d*. Cohen's rule for effect size considers 0.2 as small, 0.5 as medium, and 0.8 or greater as large.²⁸ All analyses were performed using SPSS (version 15).

Because the use of PDA-based and/or paper-based mini-CEX tools is an integral educational component of the medicine clerkship and part of a formative evaluation process to improve the quality of students' education during the rotation, this project was exempted from Institutional Review Board.

RESULTS

Each M3 student completed 2 mini-CEX forms during their required 2-month medicine clerkship; during the 10-month study period, 376 records were collected and analyzed (98% completion rate). Overall, 73% (275) were PDA-based and 27% (101) were paper-based mini-CEXs, 35% were completed by faculty and 65% were completed by residents. Overall, 69% percent of the mini-CEXs (*n* = 258) were completed in the inpatient setting and 31% (*n* = 118) in the outpatient setting. In the inpatient setting, 69% (177) of mini-CEX were PDA-based and 31% (81) were paper-based. In the outpatient setting, 68% (80) were PDA-based and 32% (38) were paper-based.

Overall the most common focus of the encounters was data gathering alone (23%), followed by data gathering/diagnosis/therapy (19%), and data gathering/diagnosis (15%). The most common focus for the clinical encounter for both PDA-based and paper-based was data gathering alone (PDA 23%, paper 22%), data gathering/diagnosis/therapy (PDA 19%, paper 17%), and data gathering/diagnosis (PDA 15%, paper 13%). The overall self-described complexity was moderate in 61%, high in 28.5%, and low in 10.5% of patients.

The most frequently evaluated competencies were humanism (93% PDA-based, 82% paper-based), organization and efficiency (93% PDA-based, 83% paper-based), and overall clinical competence (93% PDA-based, 82% paper-based). Other mean clinical skills ratings by PDA vs paper are shown in Table 1.

Form reliability (Alpha Cronbach reliability coefficient) was similar and exceeded 0.9 for both the PDA- and paper-based versions. Mean scores for overall clinical competencies, regardless of evaluator type, were high for both versions. There was statistically significant difference in mean evaluator ratings for all individual competencies and overall clinical competence between PDA (7.9; SD 0.9) and paper-based mini-CEX (7.6; SD 1.1) ($P = .01$). (Table 1)

Mean satisfaction ratings as well as mean feedback and observation times, by PDA vs paper, are reported in Table 2. Almost half of the paper-based forms included written comments, 48/98 (49%) while less than one-third of the PDA-based mini-CEX 75/275 (27%) had written entries in the comment section.

DISCUSSION

Our findings demonstrate that both PDA- and paper-based mini-CEX delivery was acceptable to evaluators and students, with both formats demonstrating high reliability. Clinical competency scores and observation and feedback times were higher in the PDA-based mini-CEX compared to the paper-based.

Data gathering was still the most common encounter focus, regardless of whether the PDA or paper format was used. Such prominent focus on data gathering is consistent with the Pangaro RIME (Reporter, Interpreter, Manager, Educator)

Table 1. Overall Mean Clinical Skills Ratings for both Paper-based and PDA-based Mini-CEXs

Clinical Skills (domains) ^a	PDA-based mean (SD)	Paper-based mean (SD)	P-value ^b
Medical interviewing	7.9 (1.0)	7.6 (0.9)	<0.01
Physical examination	7.6 (1.0)	7.1 (1.0)	<0.01
Humanistic qualities	8.5 (0.8)	8.2 (0.9)	<0.01
Clinical judgment	7.6 (1.0)	7.2 (1.1)	<0.01
Counseling skills	7.9 (0.9)	7.7 (1.0)	0.04
Organization/efficiency	7.8 (1.0)	7.4 (1.1)	<0.01
Overall clinical competence	7.9 (0.9)	7.6 (1.1)	0.01

^a Clinical skills are indicated as clinical domains of the mini-CEX forms.

^b *t*-test with equal variances (*P*-value) statistically significant

Table 2. Faculty, Residents, Students' Satisfaction Ratings, Mean Overall Clinical Competence, and Observation and Feedback Times of PDA-based vs Paper-based Mini-CEX^a

	PDA-based mean (SD)	Paper-based mean (SD)	P-value ^b (Cohen's d ^c)
Faculty satisfaction	6.9 (1.6)	7.6 (1.5)	<0.01* 0.41
Resident satisfaction	7.2 (1.2)	6.6 (1.7)	<0.01* 0.35
Student satisfaction	7.0 (1.6)	6.8 (1.7)	0.22 0.12
Overall clinical competency	7.9 (0.9)	7.6 (1.1)	0.01* 0.35
Observation time (min)	26 (16)	22 (14)	0.04* 0.26
Feedback time (min)	11 (8.0)	8.7 (6.3)	0.02* 0.32

^a (Range 1-9)

^b *t*-test with equal variances (*P*-value)* statistically significant

^c Cohen's d: 0.20 small, 0.50 medium, 0.80 large

evaluation framework in which students' clinical skills follow a developmental progression from reporter to interpreter to manager and finally to educator.²⁹ The focus on data gathering (reporter) and diagnosis (interpreter) provides evidence that the clinical encounters reinforce crucial and important goals for the development of M3 students.

Residents showed a higher satisfaction with the use of a PDA-based mini-CEX compared to a paper-based. Previous research has shown a high rate of PDA use by residents who perceive PDAs as a valuable resource at the point of patient care.^{30,31} Whether this was related to a user preference of residents toward technology-based tools is still unclear, though there is evidence of high use of PDAs by medical residents³² and research showing that residents and young physicians are more likely to use PDAs compared to attending physicians for patient care in hospital settings.³³ On the other hand, faculty members indicated a higher level of satisfaction with the paper-based version. Such differences may suggest that a mixed use of electronic and paper-based mini-CEX formats within a clerkship, based on whether the evaluator is a faculty or a resident, may be most appropriate to meet the needs and preferences of instructors and learners.

Residents' overall ratings of students in our study was higher than faculty for both PDA- and paper-based mini-CEX. This

is consistent with findings of previous research where either PDA-based²⁶ or paper-based mini-CEX formats were used,³⁴⁻³⁵ hence minimizing concerns that PDA-based delivery significantly impacts mini-CEX clinical skills rating scores.

Our study also indicated a difference in observation and feedback time between the 2 formats, suggesting perhaps that the use of an electronic-based device may result in a gain of clinical skills observation time and feedback delivery. Although differences between the 2 forms were detected in our report, it is difficult to establish whether a PDA or portable electronic device-based mini-CEX is superior to that of a paper-based one, especially if you also take into consideration a small to medium magnitude of the effect size for the differences detected (Cohen's *d* ranging from 0.26 to 0.42).

There are advantages in using a PDA-based mini-CEX. First, it allows evaluators to document and record direct observation of students' clinical skills in a timely and efficient manner, saving the time and effort typically associated with data gathering and data entry, an important consideration in the venue of a multi-site clerkship. Second, the ease of an electronic data collection and analysis supports its use for formative and longitudinal learner assessment, thus allowing clerkship directors to provide additional individualized feedback and/or remediation to students during the clerkship. However, a paper-based form also has certain advantages. Using paper would avoid the start-up cost for the electronic device, as well as cost related to the development and maintenance of the database needed to store and access the data. The paper-based form also may facilitate or encourage evaluators to write more comments, thus helping with the documentation of specific and immediate feedback given to students. However, the rising popularity of new portable devices with multimedia capabilities coupled with the more affordable prices of today's portable electronic devices may provide new educational opportunities and ultimately not constitute a significant barrier to their use.³⁶⁻³⁸

Several limitations of this study should be noted. Due to resource limitations and time constraints, no direct observation of the mini-CEX was conducted by any of the study investigators to confirm the content of each clinical encounter or to validate the type and quality of feedback received by students. Although the study cohort consisted exclusively of M3 students from 1 institution, our medical students are demographically similar to those of other medical schools with respect to gender, undergraduate grade-point average, and United States Medical Licensing Exam Step 1 scores. While M3 students were formally oriented to the PDA-based mini-CEX, evaluators did not receive formal and experiential training with either the PDA-based or the paper-based mini-CEX. However, most evaluators were familiar with the mini-CEX form and process due to its use in the residency-training program and from when

PDA-based mini-CEXs were first introduced in the medicine clerkship at MCW in 2004. Finally, a qualitative analysis of the written mini-CEX comments was not performed because it was not within the scope of this paper; however, it may represent inquiry for future research. Finally, students were asked to perform a limited number of mini-CEXs (2 mini-CEXs per 2-month medicine rotation), which may have facilitated compliance. Our findings demonstrate that both PDA-based and paper-based mini-CEXs represent feasible methods to record direct observations of students' clinical skills in both inpatient and outpatient settings.

Additional studies are needed to further explore differences, advantages, and disadvantages among formats in relation to users, students' learning, clinical context, and possible impact on patient care and patient satisfaction.

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