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Education

DUAL LEARNING IN AN EMERGENCY MEDICINE CLERKSHIP IMPROVES STUDENT PERFORMANCE

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□ Abstract—Background: The emergency department (ED) is an ideal environment to teach learners about the “undifferentiated patient.” Student learning may be inconsistent because of inherent variability in the ED. Previous research has suggested that standardizing the emergency medicine (EM) clerkship by implementing didactics and requiring students to see patients with particular chief complaints improves educational outcomes. **Objective:** To compare knowledge acquisition after a new curriculum to the traditional curriculum. **Methods:** This was a prospective, quasiexperimental study of senior medical students in an EM clerkship. Students were assigned to the dual learning (DL) group or standard learning (SL) groups based on month of rotation. All were required to see patients with 10 specific chief complaints and were lent an EM textbook. The SL group was instructed to read about the required cases. The DL group attended a 2-hour didactic session covering 5 of the 10 required cases. All students completed an identical pre- and postclerkship multiple choice knowledge test. **Results:** Data from 51 medical students

(DL = 27; SL = 24) were analyzed. Mean pretest scores were comparable between groups. A 2 (groups) by 2 (sessions) mixed-design analysis of variance yielded a significant group by session interaction effect ($p < 0.001$). The DL group significantly increased its mean score from 8.7 (standard deviation [SD] = 1.8) pretest to 11.6 (SD = 1.9) posttest; there was no improvement in the SL group (pretest: 9.3 [SD = 1.5], posttest: 10.0 [SD = 2.0]). **Conclusion:** A DL model combining clinical and enhanced didactic requirements for an EM clerkship led to greater knowledge gain than the standard curriculum. This model may suggest ways to improve the educational experience in the EM clerkship. © 2015 Elsevier Inc.

□ Keywords—clerkship; emergency medicine; medical education; medical student; undergraduate medical education

INTRODUCTION

It has been 2 decades since a Josiah Macy Foundation Report recommended that emergency medicine (EM) training be a requirement in medical school (1). The value of training in EM topics and the importance of physicians understanding the management of critically ill, undifferentiated patients is increasingly recognized and now required by the Liaison Committee on Medical Education (2). While most medical schools offer EM as an elective course, a recent study reported that 52% of responding

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U.S. medical schools now have a mandatory EM clerkship (3).

As EM clerkships have become increasingly prevalent, educators have struggled with how to best meet the needs of rotating students in a fast-paced, challenging clinical environment. EM professional societies and task forces have suggested some standardization of curricular elements (i.e., focused history and physical examination, approach to emergent patient presentations, recognition of immediate life-threatening illnesses, teamwork) for these clerkships and potential modes of implementation, such as bedside teaching, self-directed learning, and simulation (4,5). Specific educational resources have also been created (6).

Studies have highlighted the differences in what medical students can experience on an EM clerkship and how they affect learning outcomes (7). One study found a positive correlation between student completion of core practical objective guidelines (such as number of patient encounters) and postrotation examination scores as well as clerkship grades (8). Even though there have been multiple attempts to standardize the curriculum through the use of consensus guidelines, few use an evidence-based approach toward formalizing educational strategies (9,10). These evidence-based approaches have been varied and have included assessing whether education modalities such as simulation, personal digital assistant (PDA) logs, and chief-complaint based requirements are effective educational advances (6,11,12). A study by Lampe et al. showed improved scores on general EM examinations at the end of the clerkship when students were required to see patients with particular chief complaints (13). Approximately 44% of medical school respondents in a recent national survey now require students to see a list of specific patient chief complaints (3).

While Lampe et al. were able to show an improvement in examination scores by adding a clinical requirement of specific chief complaints, there was no guaranteed consistency in clinical education experience. All students may have seen patients with the required case presentations, but the actual clinical instruction they received on these cases may have been quite inconsistent because of variability in instructors, variance in patient presentation of disease, and time constraints during a given day in the ED. We hypothesized that the use of a dual learning (DL) model combining the clinical patient presentation requirement and a formal didactic small-group case conference based on the required presentations would lead to greater standardization of the EM clerkship curriculum and greater knowledge acquisition by students compared to a standard curriculum in which students engage in self-directed study.

METHODS

Study Setting and Participants

All fourth-year medical students enrolled in the Harbor-UCLA emergency medicine clerkship between October 2011 and September 2012 participated in this study. This study was certified as exempt by the Institutional Review Board of the David Geffen School of Medicine at UCLA Office for Protection of Human Subjects.

Study Design

This was a prospective, quasiexperimental study. Subjects were assigned to either the DL group or the standard learning (SL) group based on month of rotation, with an equal division of months in the first half of the academic year assigned to each group. On the first day of the rotation, all subjects completed a multiple choice test, piloted on a reference group of learners, to assess baseline knowledge. All students were lent a standard EM textbook at the beginning of the rotation and encouraged to read about patients they encountered in the ED during their clinical shifts (14). They also attended the weekly Department of Emergency Medicine didactic program, consisting of large and small group sessions, simulations, and procedure labs, as well as weekly sessions designed specifically for students. In addition, all students were required to see patients with 10 specific chief complaints designed to cover core topics in EM (i.e., abdominal pain, asthma exacerbation, chest pain, diabetic ketoacidosis, headache, laceration repair, orthopedic injury, pediatric fever, trauma, and vaginal bleeding in a pregnant patient). The SL group was instructed to complete self-directed reading specifically covering the assigned chief complaints. All students received the list of suggested readings in their orientation packets; we emphasized this requirement to the SL group but did not call attention to this list during the DL group's orientation. The DL group attended a 2-hour case-based small group session specifically for medical students covering 5 of the required chief complaints (i.e., abdominal pain, chest pain, asthma exacerbation, pediatric fever, and orthopedic injury) at the end of the second week of the rotation. We deliberately placed the didactic session in the middle of the clerkship so that students were likely to have seen some of the required cases before the session and could bring that knowledge to the discussion. This also enabled students who had met a particular chief complaint requirement but needed more clinical reinforcement to seek out another case after the didactic session. During this faculty-moderated session, students were presented with clinical scenarios and were guided through a discussion of the diagnostic evaluation, management, and

disposition of the cases. The students were expected to have some basic knowledge of the required topics and were the primary drivers of the discussion. Both the control and the test groups were aware of the relative importance of the 10 required patient presentations. At the end of the rotation, all students completed a multiple choice posttest to assess knowledge gain.

Instrument

The knowledge tests consisted of 15 multiple choice items covering the chief complaints of abdominal pain, chest pain, asthma exacerbation, pediatric fever, and orthopedic injury. Pre- and posttests were identical. Test items are available in [Appendix A](#). The tests were created by the clerkship director and assistant director and reviewed by the department's education faculty. Piloting of the instrument was performed with a small group of EM residents shortly after completion of their internship. Known-group validity was determined by comparing residents' scores to pretest student scores; residents scored significantly higher than students (Mann-Whitney U test; $p = 0.010$). The Guttman split-half reliability coefficient was 0.53.

Data Analysis

A 2 (groups) by 2 (sessions) mixed-design analysis of variance was used to compare knowledge gain between the 2 groups. Alpha was set at 0.05, and we calculated η^2 as an effect size measure. Analysis of covariance was used to account for students who intended to go into EM vs. those who were bound for other specialties. We used SPSS software (version 20; IBM, Chicago, IL) for our analyses.

RESULTS

A total of 53 medical students enrolled in the Harbor-UCLA EM clerkship during the study period and participated in the study. Two students were absent during the administration of either the pre- or posttest and so their data were excluded from the analysis. Fifty-one of 53 (96.2%) subjects had complete data (27 in the DL group and 24 in the SL group). Participant characteristics are listed in [Table 1](#). The percentage of students who intended to go into EM was slightly higher in the DL group than in the SL group, but not significantly different (78% vs. 67%, respectively; chi-squared test not significant; $p = 0.53$). Mean pretest scores were similar between groups (9.3 [standard deviation {SD} = 1.5]) and 8.7 (SD = 1.8) for the SL and DL groups, respectively ($p = 0.24$). A 2 (groups) by 2 (sessions) mixed-design analysis of variance yielded a significant group by session

Table 1. Participant Characteristics

	Male (%)	Identified Emergency Medicine as Intended Specialty (%)
Standard learning group (n = 24)	13 (54)	16 (67)
Dual learning group (n = 27)	15 (56)	21 (78)

interaction effect ($p < 0.001$; $\eta^2 = 0.26$). As shown in [Figure 1](#), the DL group significantly increased its mean score from 8.7 (SD = 1.8) pretest to 11.6 (SD = 1.9) posttest ($p < 0.001$); there was no statistically significant improvement in the SL group (pretest: 9.3 [SD = 1.5]; posttest: 10.0 [SD = 2.0]). In addition, we ran an analysis of covariance with "EM bound" vs. "non-EM bound" as a dummy coded covariate. The covariate did not significantly interact with the pre-post repeated measure (Wilks' lambda = 0.96; $p = 0.17$). This result suggests that in the DL group, students who were EM-bound improved as much as students who were not EM-bound; the same was true in the SL group.

DISCUSSION

The results of this study suggest that a DL model that combines a clinical requirement and a related small group, case-based session can lead to greater knowledge acquisition among medical students when compared with the more traditional approach. Clinical bedside teaching, problem-based learning groups, case conferences,

Knowledge in the Dual Learning Group vs Standard Learning Group

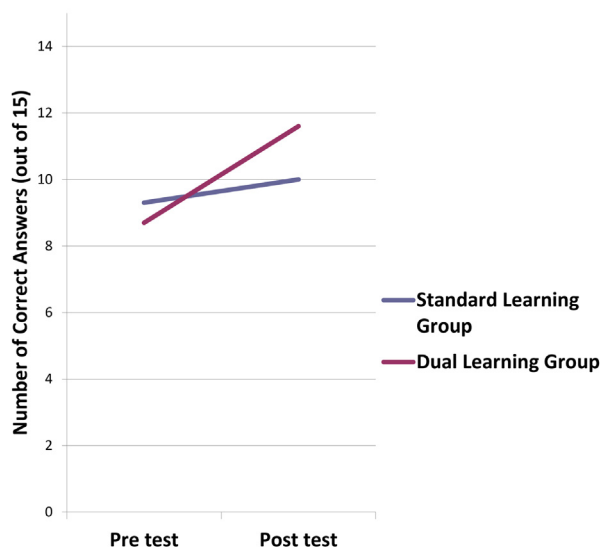


Figure 1. Knowledge gain in the dual learning vs. standard learning groups.

simulation, and self-directed learning have all been cited as suggested settings for education in the EM clerkship, but evidence-based best practices for how to deliver the curricular content of an EM clerkship have yet to be formalized (4,15,16). It is logical to believe that some combination of clinical (actual or simulated) and didactic modalities may be ideal as suggested by previous literature (16,17).

Our results are in line with the work of Debehnke who showed that readings augmented with case conferences improved student knowledge (18). Lampe et al. showed improved outcomes when clinical requirements were added to standard didactics (13). In the current study, we found that combining clinical learning with instructor-moderated case-based conferences improved learning outcomes. Novice learners may have unique needs and may not be able to extrapolate material they have read in a self-directed fashion, despite exposure to similar cases in the clinical setting, even with bedside teaching (19). It may be better to have an expert emphasize and explore content that has been seen in readings and the clinical setting with targeted small group didactics that allow for clarification of core concepts, applied in clinical situations, but without the pressure and interruptions that are inherent in the ED. We believe that the fact that students have had clinical exposure to the topics before the case conference fuels their desire to learn as they work toward independence in the clinical setting.

Case-based education can direct students as they learn complex medical decision-making skills, including how to approach the undifferentiated patient, apply relevant medical knowledge, and create logical management plans. In 1 study, fourth-year medical students reported a need to learn how to formulate treatment plans (20). Using cases derived from patients that students have actually cared for in the clinical setting combines experiential learning with an organized approach in a low stress environment, without adverse effects on patient safety. Small group case conferences, such as the one in our study, may also appeal to learner partialities as clerkship students have reported tutorials and preceptor-assisted learning sessions among their curricular preferences (21). This setting also provides novice learners deliberate access to the thought process of a seasoned clinician expert. In a study by Ilgen et al., novices and experts approached clinical scenarios using different strategies (22).

The increase in test scores seen in the DL group may not only be reflective of increased knowledge but also improved critical thinking skills, which can be taught during problem-based learning sessions (17). In this instance, students bring their individual clinical experiences with similar cases to the table for the case conference. Together with the expert teacher, students shared a variety of presentations of the same clinical entity,

thereby effectively increasing each of their exposures in an efficient learning manner.

Our research supports previous literature that shows the importance of instructing EM clerkship students how to approach emergent patient presentations (5). By combining clinical patient presentations and emphasizing a case-based approach in didactics, students learn to evaluate and manage emergent patient presentations from start to finish. This emphasizes the relevance of the content and allows the students to better assimilate this information with what they have learned during their clinical shifts, leading to a greater knowledge gain. Reinforcing required reading and standard didactics with clinical experience, followed by deliberate practice in a safe setting, is likely to produce practitioners who are able to apply theoretical knowledge to the clinical setting.

Case conferences are resource-intensive in terms of creation of materials and faculty instructor time, but our study suggests that the benefits are worth the investment. Despite improved outcomes with a combined clinical requirement, self-study, and passive large group didactics, there is still potential for improved learning. Our study demonstrated a significant gain in learner knowledge and clinical reasoning when an expert guided them in a small group format to solve cases that they had experienced in lecture, reading, and the clinical arena.

Using a multimodal approach also increases the chance that a greater number of learners' needs will be met, because there is no one method that is well suited for everyone. In addition, although students may be required to see 10 standardized chief complaints, their individual presentations could be unique. Furthermore, individual clinician educators may or may not reinforce key teaching points that meet the course objectives based on the chief complaints. Therefore, an added small group didactic session could provide a learning framework that addresses the specific learning objectives related to the 10 chief complaints. We feel that the students' experiential learning of their individual patients provides an anchor upon which to apply the stated objectives that would not have been possible with either method in isolation. Combining a clinical requirement and a targeted small group case-based didactic session, as an augmentation to self-study, will provide a more consistent delivery of information than experiential clinical learning alone and can further standardize the educational curriculum of the clerkship and provide an improved learning experience for students.

Our aim as educators is to create independently thinking and clinically competent practitioners who can logically and safely approach all sorts of case presentations in the ED. We believe our DL method has provided clarity in our teaching of the clinical approach to the

undifferentiated patient by providing a safe venue to refine skills and knowledge gained in traditional didactic sessions and the actual clinical setting. Learners demonstrated improved knowledge about how to manage critically ill, undifferentiated patients who may present to their ED during residency and beyond.

LIMITATIONS

This study took place at a single institution, and the results may therefore be difficult to generalize.

We cannot be absolutely sure that students in the SL group actually did the additional reading assignment that covered the topics of all the required cases, though students do sign an honor code. This limitation is reflective of real life; accurately monitoring self-directed study is challenging. In addition, 1 of the small group leaders was familiar with the test questions. We did not conduct a subanalysis to learn if this session led to higher scores than the remaining sessions. We believe that because of the high degree of student involvement in the sessions, this bias did not alter our results in a significant way. Despite these limitations, we believe this study provides information that can benefit educators involved in EM clerkships.

CONCLUSION

Combining a clinical requirement and a targeted small group, case-based didactic session for an EM clerkship led to greater knowledge gain than a clinical requirement alone and suggests that implementation of a dual learning model can enhance standardization of the educational experience and improve objectively measured learning outcomes.

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ARTICLE SUMMARY

1. Why is this topic important?

Most medical schools offer an emergency medicine clerkship, but inherent variability in the emergency department can lead to inconsistent student learning. It is essential that educators provide sound, evidence-based curricula to their learners.

2. What does this study attempt to show?

This study shows that senior emergency medicine medical students who are required to see patients with specific chief complaints in the clinical setting have improved learning of educational objectives when they participate in an interactive case-based didactic sessions on some of the same topics than students who saw similar patients and relied solely on bedside teaching and self-study.

3. What are the key findings?

This study found that a dual learning model combining targeted small group, instructor-moderated didactics with a clinical requirement led to greater knowledge gain than standard instruction.

4. How is patient care impacted?

Patient care is not directly impacted, but improved education of medical trainees may lead to creation of a workforce that is better able to meet the needs patients in the emergency department.

APPENDIX A: TEST ITEMS

1. What is the most common cause of small bowel obstruction in the US?
 - a. Adhesions
 - b. Hernia
 - c. Malignancy
 - d. Pelvic inflammatory disease
 - e. Sigmoid volvulus
2. A 58 year old female presents with nausea, vomiting, and abdominal pain x 2 days. She denies fevers. She has been unable to tolerate solid foods or liquids for 24 hours. Vitals are temp 98.5 BP 110/75 HR 110 RR 18 O₂sat 97% on RA. An acute abdominal x-ray series reveals distended bowel with air fluid levels. In addition to IV fluids, which of the following is the best way to manage the patient?
 - a. Antibiotics, admission to hospital
 - b. CT scan with po and IV contrast
 - c. Maalox, laxative, discharge home
 - d. Nasogastric tube placement, surgical consult
 - e. Pain medication, anti-emetics, discharge home
3. Which of the following abdominal x-ray findings is indicative of intestinal obstruction?
 - a. Air under the diaphragm
 - b. Fat stranding in the right lower quadrant
 - c. Large bowel diameter of 50 mm
 - d. Small bowel diameter of 25 mm
 - e. String of pearls sign
4. Which of the following is **NOT** part of the “Low risk Criteria” for febrile infants
 - a. Enhanced Urine analysis WBC count <10
 - b. Patient is well appearing
 - c. Patient was born at full term
 - d. Patient received antibiotics in the last 7 days
 - e. WBC count greater than 5000 but less than 15000
5. Which of the following is the best empiric antibiotic regimen for a 15-day-old girl or boy with a rectal temperature of 39°C?
 - a. Ampicillin + cefotaxime
 - b. Ampicillin + ceftriaxone
 - c. Ampicillin + vancomycin
 - d. Ceftriaxone + flagyl
 - e. Ceftriaxone + gentamicin
6. Which of the following pathogens is most likely to cause sepsis in a neonate (age 0–28 days)?
 - a. B. pertussis
 - b. E. coli
 - c. H. influenzae
 - d. N. meningitidis
 - e. S. pneumoniae
7. Which of the following is a risk factor for asthma related mortality in all age groups?
 - a. History of prior ICU admission for asthma
 - b. Higher socioeconomic status
 - c. Initial diagnosis of asthma at age <3 months
 - d. Use of 1 inhaled beta agonist canister/month
 - e. Use of inhaled steroids
8. Which of the following is the most appropriate epinephrine order for a 19 year old male in status asthmaticus?
 - a. 0.3 mg epinephrine 1:1000 IM
 - b. 0.3 mg epinephrine 1:10000 IM
 - c. 0.3 mg epinephrine 1:100000 IM
 - d. 0.3 mg epinephrine 1:1000 IV
 - e. inhaled racemic epinephrine
9. A patient presents with severe asthma exacerbation. When is the optimal timing of oral or intravenous corticosteroid administration?
 - a. 4 hours after presentation to the ED
 - b. After the first albuterol/atrovent treatment
 - c. As soon as possible
 - d. Just prior to admission
 - e. Steroids are contraindicated in asthma exacerbation
10. Which of the following is a contraindication for administering nitroglycerin to a patient with an acute MI?
 - a. Anterior infarction
 - b. History of stroke
 - c. Right ventricular infarct
 - d. Severe hypertension
 - e. Use of sildenafil (Viagra) 3 days ago
11. A 56-year-old old man presents with complaints of severe chest pain that began 20 minutes ago. He is diaphoretic and in moderate distress. His lungs are clear to auscultation. Vital signs are: HR 115, BP 88/54, RR 20, O₂ sat 92% on room air. EKG shows ST elevation in leads V2-V4. He received aspirin by paramedics prior to arrival. Which of the following will best manage his condition?
 - a. 1 liter normal saline bolus
 - b. Dopamine infusion
 - c. Eptifibatide (Integrilin) infusion
 - d. Metoprolol 5 mg IV
 - e. Nitroglycerin sublingual
12. Which of the following is part of the Sgarbossa criteria?
 - a. Concordant ST elevation greater than or equal to 1 mm in any lead

-
- b. Discordant ST elevation greater than 3 mm in leads V1-V3
 - c. Right bundle branch block with ST elevation in leads V1-V2
 - d. ST depression in lateral leads
 - e. ST elevation greater than 2 mm in 2 contiguous leads
13. A 28 year old male presents after a fall on his right arm. He complains of pain in his right wrist. Exam reveals intact motor and sensation and tenderness over the anatomic snuffbox. Xrays of the forearm, wrist, and hand are all negative. What is the appropriate management?
- a. Ace wrap and discharge home with return precautions
 - b. Apply long arm cast from elbow to MCP joints
 - c. Emergent orthopedic consultation
 - d. Reassure patient and discharge home with return precautions
 - e. Thumb spica splint, discharge home, orthopedic referral
14. What is the most common carpal bone fractured?
- a. Hamate
 - b. Lunate
 - c. Pisiform
 - d. Scaphoid
 - e. Triquetrium
15. What increases the risk of avascular necrosis of the scaphoid?
- a. Age less than 16 years
 - b. Associated lunate dislocation
 - c. Distal fracture
 - d. Prolonged immobilization
 - e. Proximal fracture