Dental students' ability to locate emergency equipment – Lessons learned from Aviation

[1]Harold M. Pinsky DDS; [2]John M. Le BS; [3]Domenica G. Sweier DDS PhD; [4]Kyriaki Marti DMD MD PhD

[1] Adjunct Clinical Lecturer, Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry

[2]Third year dental student, University of Michigan School of Dentistry

[3] Clinical Associate Professor, Department of Cariology, Restorative Sciences & Endodontics, University of Michigan School of Dentistry

[4]Adjunct Clinical Assistant Professor, Department of Oral and Maxillofacial Surgery/Hospital Dentistry, University of Michigan School of Dentistry

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Author Responsible for Correspondence

Harold M. Pinsky, DDS

Department of Periodontics & Oral Medicine

University of Michigan School of Dentistry

1011 N. University Ave.

Ann Arbor MI 48109

Phone #: 734-615-3210

Email:hmpinsky@umich.edu

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INTRODUCTION

Patient safety is at the very foundation of comprehensive dental care. A necessary part of dental care is the need to be able to manage medical emergencies when they arise. Traditional training in managing medical emergencies in the dental school begins with lecture-based coursework(1). Training then continues with evidence-based instruction on the theory of managing specific emergency situations towards active learning educational methods(2–4). Teaching safety in emergency management can be divided into three building blocks: 1) the location of emergency equipment, 2) the operation of emergency equipment, and 3) the understanding of when and how to properly use a particular piece of equipment. In order to accomplish these three components effectively, proper training of equipment location and operation is best accomplished in an environment that simulates the experience. At the University of Michigan School of Dentistry (UMSoD), students are exposed to medical emergency training once, in lecture format and role-playing simulation rotation and, recurrent training is non-existent and not mandated. Typical lecture-based learning is inefficient to practice emergencies, as demonstrated in other fields such as aviation, first responders, and others, who are constantly honing their skills(5–7).. We identified a gap; at no point in the curriculum were our students taken to the physical location of the medical equipment in the School of Dentistry.

Recently, dentistry has looked to the airline industry and their Crew Resource Management (CRM) for guidance on medical emergencies management(8). CRM is defined as a management system which optimizes use of all resources, specifically equipment, information, and people, to promote safety and efficiency. One component of CRM is to have properly

located equipment and properly trained personnel to use that equipment. In dentistry, the location of emergency equipment and the ability of the students to use them effectively are crucial in managing a medical emergency. The translation of knowledge of emergency treatment to practical application mandates knowledge of emergency equipment location and correct use(9). Furthermore, it is not unrealistic to expect every personnel on a health team, including faculty, staff, and students, to be able to find this equipment in their clinical environment. Specific to managing an aviation emergency, it is well known that the airline industry tends to operate multiple fleets and model types with the potential for a significant difference in interior arrangement and design. Although the interior design of each aircraft model type is unique, flight attendants' training includes operating and managing an emergency in the cabin, based on the standardized location of specific emergency equipment. Consequently, during a simulated emergency training session, while there may be a multitude of possible medical emergency scenarios, it is essential to keep the medical supplies and equipment predictably in a consistent location and space so that a well-trained individual can find it (10).

According to the Committee on Dental Accreditation (CODA), it is an expectation for the graduating dental student in the United States to "be able to manage common medical emergencies."(11) At the same time, when planning to provide pre-clinical medical emergency management training in the dental curriculum, it remains absolutely necessary that these skills be quantitatively assessed for outcomes(12,13). We initiated a newly developed simulation-based medical emergencies course for second year dental students based on Kolb's theory of experiential learning. This course included a quantitative assessment of students' training in medical emergencies recognition and management. Kolb's theory shows that effective learning is accomplished when a person progresses through a cycle of four stages: 1) concrete experience, 2) reflective observation, 3) abstract conceptualization and 4) active experimentation. This is achieved as the learner first has the actual experience, then is given the opportunity to reflect on the experience, learns from the experience and eventually has the opportunity to try out (repeat) the experience again(10).

Interestingly, this teaching method is being utilized for dental procedures, but is underemphasized regarding emergency training. Furthermore, there has been no attempt to report on the use of medical equipment location in dental schools. Therefore, we aim to alleviate this important deficit by studying the effect of a innovative training program for dental students on their ability to locate emergency equipment in dental clinics. The purpose of this study was to determine if an innovative hands-on training program was effective in supporting dental students as they learned how to locate medical emergency equipment in the clinical setting.

MATERIALS AND METHODS

This study was conducted as part of the medical emergencies course offered in the winter term of the second year of the dental curriculum (2014 and 2015). This study was reviewed and determined exempt by the University of Michigan Institutional Review Board (IRB) (HUM00086587).

Before the simulation session, all 2nd year dental students participated in a traditional lecture-based course, including instruction on the use of medical emergency equipment; visual identification of equipment was done using only photographs, due to the nature of the lecture-based course. Depending on the group, not more than five or six weeks elapsed between the lecture-based and the simulation-based course. To evaluate the students' ability to locate medical emergency equipment, two senior authors (HMP and KM) in this study, generated a list of 9 items (Table 1) that were deemed necessary for proper medical emergency management in a dental environment after consulting the relevant literature and based on a previously published dental checklist by Pinsky et al.(1,8,14–20).

Initially a building floor plan was acquired and the locations of all pre-determined items were marked (Figure 1). During the simulation portion of the medical emergencies course, students were asked to locate the list of equipment (Table 1) in the clinic. To document the students' ability to find the items, students were given a list (Table 1) and asked to independently locate them on the third-floor clinics. As the "scavenger hunt" was performed during the medical emergencies simulation-based course as previously mentioned, we estimated required time to 10-15 minutes preemptively, and we allowed students to complete

their assignment within that timeline. Students were asked to independently mark 1) *Yes*, if they could find the item or 2) *NO*, if they could not find the item. Students were also informed that no grade would be associated with the assignment. No time limit was imposed on the students. The list was then collected anonymously at the end of the exercise and frequency data were recorded by three of the authors (HMP, KM, and DS) (Table 2).

Six months later, a convenience group of eighteen students who had participated in the course were arbitrarily sampled by one of the authors (JML) based on availability of the students' time. This "Novel group" received additional hands-on training, which consisted of physically locating each item under supervision of an experienced facilitator (JML). This second phase occurred in the same clinical setting used in the initial test. Two weeks later, each student in the "Novel group" was assessed individually. This time, each student was followed by the same facilitator who confirmed the ability of the student to locate the equipment and this information was recorded (Table 2). All attempts were made to maximize the student sample in the "Novel" group". Due to their limited time and scheduling conflicts, we were not able to increase the number of participants in this group (as presented in Table 2).

Analyses

To evaluate impact of course on the students' ability to successfully locate equipment/items, differences in frequency counts across training groups (Traditional and Novel) were compared using a Chi-square test of independence. $P \leq 0.05$ was considered statistically significant for two-tailed tests, and frequency rates reported as percent frequency for both trainee groups.

RESULTS

Traditional Group

Of the 138 students tested during the 2014 and 2015 term, the majority could identify the location of the emergency phone (90.58%) and portable oxygen tank (75.36%), while a small percentage of students could locate the ammonium chloride (11.59%). The remainder of the items included: AED (63.77%), red emergency kit (37.6%), eye wash station (53.62%), blood pressure and glucometer (63.77%), emergency shower (64.49%), and emergency elevator for

CODE situation (46.38%) (Table 2). Additionally, 10.14% of the students could locate 7 of the 9 items with only 5.07% students being able to locate all 9 items (Figure 3).

Novel group (N = 18)

Eighteen (18) students participated in the novel curriculum that targeted hands-on training. After two weeks, the 18 students were tested and 100% of them could locate 7 of the 9 following items: oxygen tank, emergency phone, ammonium chloride, red emergency kit, eye wash, blood pressure cuff, stethoscope and glucometer, AED, emergency shower and elevator location for CODE situation. Most the students (94.44%) could locate the portable oxygen tank and masks, red emergency kit, and AED. Finally, the emergency phone and emergency shower had the lowest finding rate (88.89%) (Table 2). Interestingly, all 100% students could locate at least 7 of the 9 items, including 72.22% students who could locate all 9 items. (Figure 4).

Frequency rates of locating items

Regardless of training modality, the most commonly found item was Emergency Phone (90.58% and 88.89%, for Traditional and Novel curricula, respectively), followed by Portable oxygen tank and mask (75.36%, and 94.44% for Traditional and Novel curricula, respectively).

Comparison of frequency rates indicated that for every item in the Novel curriculum, where faculty showed the students where each item was located, there was a higher frequency of successfully finding each item. Statistical differences in frequency rates of successfully finding equipment were identified across training modalities for all but 2 items — Portable oxygen tank and mask, and Emergency Phone (Table 2).

DISCUSSION

No previous studies have looked at the dental students' ability to locate medical emergency equipment. In a paper discussing availability of emergency equipment, Al-Sebaei et al. evaluated the preparedness of private dental offices and polyclinics in Western Saudi Arabia, and discovered a highly significant deficiency in the availability of emergency drugs and equipment(21). Although the study reported the mean level of preparedness of dental office personnel at 55%, the availability of drugs and supplies were only 35% and 19%, respectively.

Of the 70 offices surveyed, only 7 reported having at least one type of supplemental oxygen delivery device. Additionally, only 7 of the 70 offices had an automated external defibrillator (AED) and bag-valve mask (BVM)(21). Moreover, a cross-sectional study conducted in 2014, surveyed 250 dental graduates in dental offices in different areas of India and showed that emergency kits were only available at 24% of the offices(22). In summary, there are several documented studies reporting the availability of emergency equipment in dental settings, and a few discoverable studies that surveyed the preparedness of dental office personnel(23–28). However, to the authors' knowledge, this current study is the first to directly evaluate dental students' ability to physically locate emergency equipment in their dental school clinics.

In dental schools, instruction on the use of emergency equipment in lecture formats has been well-documented(18,29,30). However, as part of one study at the same institution, Le et al., reported the ability of the students to locate portable oxygen tanks in simulated exercises(13). In that study, Le et al. found that only 68% of UMSoD third and fourth year dental students could correctly locate oxygen tanks when asked to do so as part of a simulated medical emergency. After the Le et al. study, the ability of students to locate the portable oxygen tanks remains 75% in our study, despite the initiation of clear identification signage of the position of the oxygen in the clinical setting, initiated because of the Le et al. paper.

The UMSoD curriculum is replete with examples of instruction and skill acquisition using the Miller's Pyramid: "knows, knows how, shows how, and does"(31). Examples include technical dental procedures such as fabrication of dentures or tooth preparation for a crown. First, the students are provided didactic instruction; they then practice the skills in a simulated pre-clinical setting; and only then do they provide the treatment in supervised patient care(2). Similarly, the ability to successfully locate emergency medical equipment is an acquired skill. This skill had previously only been taught using didactic instruction, the "tell" part of "tell, show, and do."(32) Using a "scavenger hunt" methodology, this study demonstrated a gap in the knowledge and that only using "knows" is not sufficient, we have interpreted the "knows how" part of the pyramid, as the " of being functionally adequate , or of having sufficient knowledge, judgement , skill or strength for a particular duty" as described by Miller (31) By

incorporating the “shows how” and “does”, we clearly demonstrated that students could correctly locate medical emergency equipment after hands-on training(33).

The present study demonstrates that hands-on training on the physical location of medical emergency equipment is essential. Because of this study, a modification in the University of Michigan School of Dentistry curriculum has been approved. A module has been added to the simulated medical emergency course for second year dental students. This module specifically provides hands-on instruction on the location of medical emergency equipment to correct the gap in knowledge that we have identified.

There are limitations to consider in this study. First, the initial study data were self-reported leaving the possibility of students over-reporting, “yes” marks. But, examination of data showed that only two students reported finding all 9 items prior to any training. Therefore, if over-reporting were true, then it only occurred in a very small percentage of the sample (Figure 3). Second, even though the students were instructed by the facilitators to complete the “scavenger hunt” independently without consulting other colleagues and staff on the clinic floor, they were not individually monitored during this exercise. Our study design did not have a method to restrict students from communicating with each other during the session. Additionally, the scavenger hunt was broken into multiple sessions on different dates. Thus, students who had completed their session, may have had communicated their experiences to colleagues who had not experienced the exercise. Third, the “Novel” group was a subset sample selected based on availability and further efforts to increase their number was not feasible due to time constraints even though our original plan was to test all students. Fourth was that we only tested 18 students at two or more weeks for knowledge retention of medical equipment location, and the resultant statistical analysis should be viewed with that in mind.

We have initiated mandatory hands-on training on all items. A dedicated physical tour of the facility emphasizing the actual location of medical emergency equipment has been instituted for the following year. Based on our findings, and the subsequent preparation for Accreditation in our school, a complete building standardization of location of emergency equipment was accomplished. Furthermore, we are also considering implementing this recurrent training on an annual basis like the airline pilot best practices. The literature,

although limited to nursing and to skills associated with ACLS (Advanced Cardiac Life Support) training, supports a recurrent training 6 months and 1 year after initial training(34,35) .

Like the mandated recurrent training required by the FAA (Federal Aviation Administration) for airline pilots, our plan is to institute refresher training for dental students every 6 months to one year. For acquisition of long-term data, we propose further reassessment of students at least two-three years' post-intervention. With the knowledge provided through this training, the students will be better prepared to locate medical emergency equipment. Due to this newly identified gap, we are expanding our findings to include training for dental hygiene students. Additional options for improvement in students' competencies in locating emergency equipment include identifying opportunities for recurrent training for our learners. Additional opportunities exist for assessment of retention of previous training within preexisting courses in the curriculum, such as orientation sessions occurring at least annually. Furthermore, based on our observations, it is logical to infer that additional training of faculty and staff may also be beneficial.

CONCLUSION

In conclusion, our results support the incorporation of targeted hands-on training for dental students in the pre-doctoral curriculum on the location of medical emergency equipment in a clinical setting. As previously described, of the 138 students tested, only 10.14% of the students could locate 7 of the 9 items when compared to 100% in the novel group. Only 5.07% of students in the traditional group could locate all items initially, compared to 72.22% students in the novel group. Therefore, it is evident that the physical hands-on training is an effective educational tool.

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TABLES

Medical Equipment/Item
1 - Portable oxygen tanks and masks
2 - Emergency phone location with information card containing emergency phone numbers
3 - Ammonium Chloride
4 - Red Emergency Kit
5 - Automated External Defibrillator (AED)
6 - Eye wash
7- Blood pressure cuff and stethoscope, and glucometer
8 - Emergency Shower
9 - Elevator location for Emergency Medical Team/CODE situation

Table 1. List of nine medical equipment the students needed to find.

Equipment/Item	Traditional (N=138) N (%)	Novel (n = 18) n (%)	*P* value
Portable oxygen tank and mask	104 (75.36%)	17 (94.44%)	.059
Emergency Phone	125 (90.58%)	16 (88.89%)	.810
Ammonium Chloride	16 (11.59%)	18 (100.00%)	.001
Red Emergency Kit	52 (37.68%)	17 (94.44%)	.001
Automated External Defibrillator (AED)	88 (63.77%)	17 (94.44%)	.009
Eye Wash Station	74 (53.62%)	18 (100%)	.001
Blood Pressure cuff and stethoscope and glucometer	88 (63.77%)	18 (100.00%)	.002
Emergency shower	89 (64.49%)	16 (88.89%)	.038
Emergency Elevator	64 (46.38%)	18 (100.00%)	.001

Table 2: Comparison of dental students' ability to find 9 item across training programs using chi-squared test of independence.

FIGURES

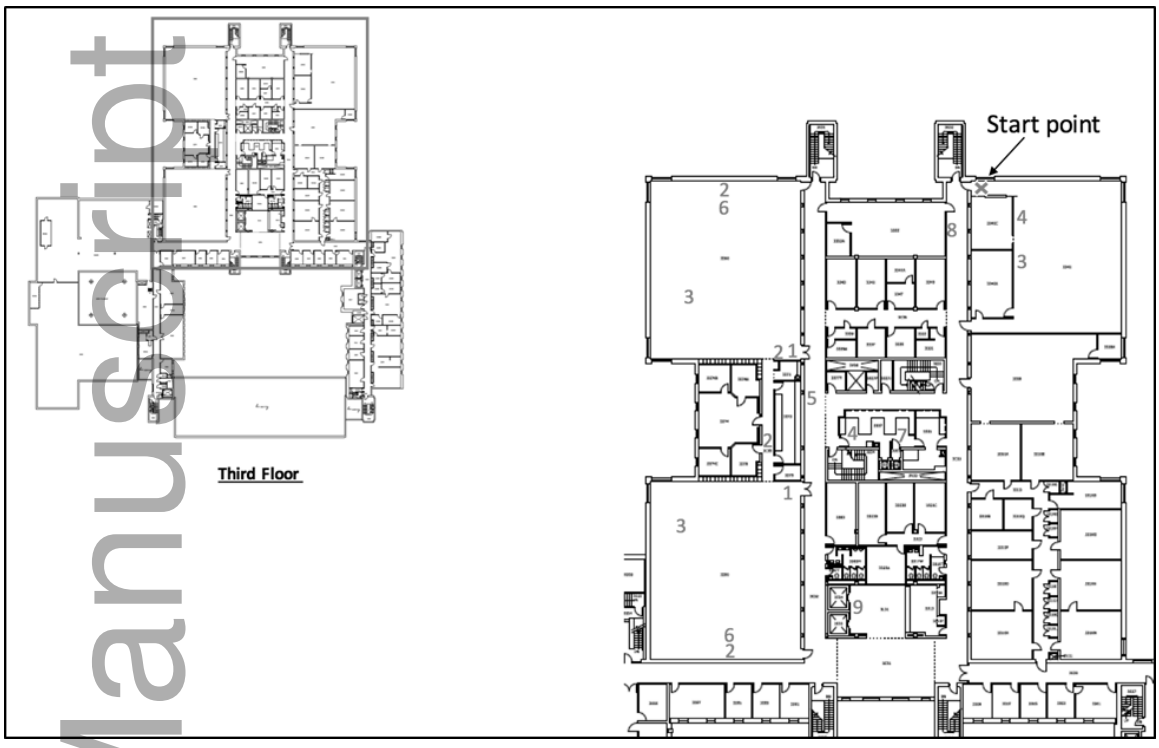

Figure 1: Floor layout of the third floor, with start point marked X. The location of each of the listed items is marked on the floor plan. Although the ammonium chloride (item 3) is only indicated once in each of the 3 clinics, it is actually located in each cubicle drawer in the student clinics (35 of cubes per clinic). (See reference 13).

Figure 2: Location and signage of the 9 items

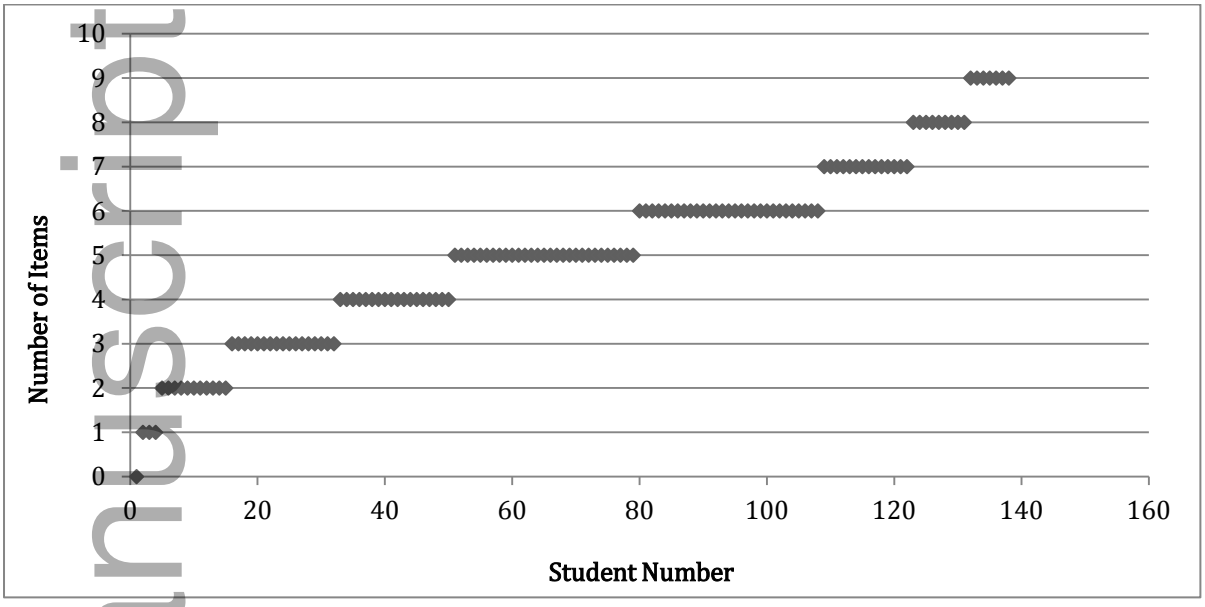

Figure 3: Graph of 2014-2015 cohort of 138 students demonstrating each student's ability to find the number of items on the list (Rotation Groups).

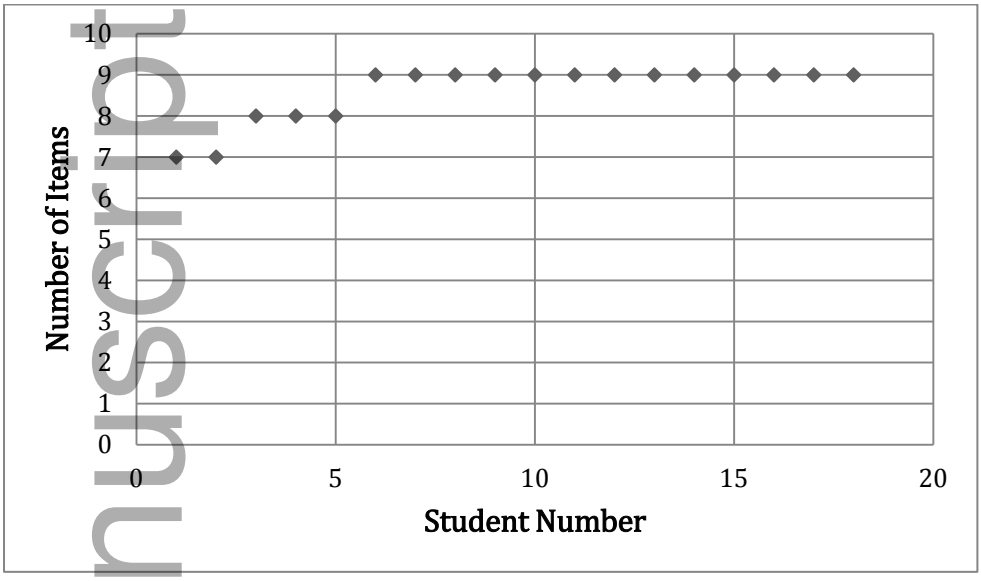

Figure 4: Graph of Intervention Group of 18 students demonstrates each student's ability to find the total number of items on the list (Intervention Group).