High-Fidelity Simulation: Preparing Dental Hygiene Students for Managing Medical Emergencies

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Abstract: Medical emergencies can occur at any time in the dental office, so being prepared to properly manage the situation can be the difference between life and death. The entire dental team must be properly trained regarding all aspects of emergency management in the dental clinic. The aim of this study was to evaluate a new educational approach using a high-fidelity simulator to prepare dental hygiene students for medical emergencies. This study utilized high-fidelity simulation (HFS) to evaluate the abilities of junior dental hygiene students at Eastern Washington University to handle a medical emergency in the dental hygiene clinic. Students were given a medical emergency scenario requiring them to assess the emergency and implement life-saving protocols in a simulated “real-life” situation using a high-fidelity manikin. Retrospective data were collected for four years from the classes of 2010 through 2013 (N=114). The results indicated that learning with simulation was effective in helping the students identify the medical emergency in a timely manner, implement emergency procedures correctly, locate and correctly utilize contents of the emergency kit, administer appropriate intervention/treatment for a specific patient, and provide the patient with appropriate follow-up instructions. For dental hygiene programs seeking to enhance their curricula in the area of medical emergencies, this study suggests that HFS is an effective tool to prepare students to appropriately handle medical emergencies. Faculty calibration is essential to standardize simulation.

Keywords: allied dental education, dental hygiene, medical emergency, teaching methods

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The life expectancy of the U.S. patient population is increasing, and as the aging population increases, so does the risk of chronic systemic diseases. The Centers for Disease Control and Prevention (CDC) reports that 80% of the older population has one chronic disease, and 50% have two or more chronic diseases. As dental patients present with more complicated medical histories, there is a greater chance that a medical emergency will occur in the dental office. While a medical emergency is a low-occurrence, high-risk event, it is imperative that both dentists and dental hygienists be ready to manage these situations.

Malamed reported that medical emergencies in the dental office are not as rare as once thought, and a survey of 4,309 dentists found that 96.6% had a medical emergency occur in their office over a ten-year period. An eight-and-a-half-year retrospective study conducted at the University of Buffalo School of Dental Medicine reported 164 emergencies per million dental appointments in its dental clinic. Contrary to previous reports that syncope was the most common medical emergency, that study found more occurrences of cardiac events than syncope. Laurent et al. reported that dental students were confident in the management of a cardiac event, but when they asked 22 students to perform cardio-pulmonary resuscitation (CPR) on a manikin, only two performed it correctly. None of those students was able to correctly identify the cardiac event and perform adequate CPR together. Since cardiac events are among the most common medical emergencies, it is imperative that dental and dental hygiene students be prepared to recognize and manage them.

Two previous studies reported a lack of training on medical emergencies in dental curricula. A study using robotic technology in Japan found students were ill prepared to manage medical emergencies in the dental clinic. Another study suggested standardization of medical emergency training in dental education is needed to ensure dental professionals are prepared to handle medical emergencies in the
dental hygiene students feedback on their performance during a simulation of medical emergencies in the dental clinic. The simulation was conducted with four cohorts of dental hygiene students in their third year of a four-year Bachelor of Science program. The simulation was conducted with a Laerdal Medical Corporation 3G manikin known as SimMan 3G, “an advanced patient simulator that can display neurological symptoms as well as physiological.”

Clinical simulation with the use of task trainers, such as dentoforms, has long been recognized as an effective pedagogy in dentistry. HFS is relatively new to dentistry, but has been used by the medical field since the 1960s to improve patient safety.\textsuperscript{11,12} We recognized the need to improve the Eastern Washington University dental hygiene curriculum in the area of medical emergency training and decided to introduce HFS as a safe and effective learning environment for students to build this important skill set. The aim of this study was to evaluate a new educational approach using a high-fidelity simulator to prepare dental hygiene students for medical emergencies.

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**Methods**

This study was declared exempt from review by the Institutional Review Board of Eastern Washington University. A retrospective review was conducted to analyze data collected from grading rubrics used to give Eastern Washington University dental hygiene students feedback on their performance during a simulation of medical emergencies in the dental clinic. The simulation was conducted with four cohorts of dental hygiene students in their third year of a four-year Bachelor of Science program. The simulation was conducted with a Laerdal Medical Corporation 3G manikin known as SimMan 3G, “an advanced patient simulator that can display neurological symptoms as well as physiological.”

The “Emergencies in the Dental Clinic” simulation was developed to evaluate the abilities of these students to appropriately implement medical emergency procedures in their teaching clinic. Based on Commission on Dental Accreditation (CODA) standards, emergency procedures have been established for dental hygiene students and faculty to follow in the Eastern Washington University Dental Hygiene Clinic (Figure 1). The steps to follow when an emergency occurs with a patient are as follows: notify other clinic staff; make a 911 call; locate the emergency kit; and deliver appropriate treatment and supportive care. The dental hygiene curriculum introduces medical emergencies during the first year; students’ performance is evaluated with an objective structured clinical exam (OSCE). During clinical coursework in the second year, students review medical emergencies and are introduced to a simulated emergency in the clinic.

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![Figure 1. Medical emergency protocol for Eastern Washington University Department of Dental Hygiene clinic](image-url)
Prior to participating in the simulation, the students received an orientation detailing its learning objectives, required readings, patient background, and assigned groups and roles. The medical emergency protocol and implementation for all medical emergencies were also reviewed. Each group consisted of three students who played the roles of clinician, clinician assistant, and recorder. The clinician assumed primary responsibility for the patient; the clinician assistant was responsible for locating the emergency kit and calling for help; and the recorder documented the patient’s vital signs, adherence to emergency procedures, and medical interventions. The students were instructed to prepare for all of the following medical emergencies: myocardial infarction, allergy, stroke, asthma, and hypoglycemia. Their patient’s emergency condition was randomly assigned by the course coordinator, and students were unaware of their assignment in advance. On the day of the simulation, each student group evaluated a simulated patient who was experiencing an emergency and implemented treatment for one of the five emergencies. Following the simulation, each team of students was debriefed in a separate conference room by a trained faculty member.

During the simulation, faculty responsibilities included introducing student groups to their simulated patient, observing the scenario, evaluating group performance with the grading rubric, and facilitating the group debriefing session that occurred immediately after the simulation. Training for faculty facilitators included orientation to simulation scenarios, review of the learning objectives and grading rubric, and observation of a scenario and debriefing conducted by an experienced faculty member to decrease variations in grading.

The faculty members completed a grading rubric for the group with the following content areas: roles and responsibilities, physical assessment, emergency identification, and implementation of emergency procedure. The checklist-style grading rubric for each group varied based on the type of medical emergency (see Table 1 for an example with the allergy scenario). Elements from each grading rubric were transcribed into an Excel spreadsheet. Groups were assigned a unique identifier. Descriptive statistics were used to analyze achievement of learning objectives for the simulation. The data collected included emergency protocol, identification of emergency, treatment of emergency, and reflection on the process during debriefing.

### Results

Data were collected for four years from the classes of 2010 through 2013 (N=114). During this period, a total of 46 groups of students completed the simulation and the debriefing. Due to incomplete data recorded on the grading rubrics, eight groups were excluded from the final analyses. The remaining 38 groups were assigned scenarios focused on emergencies in the following areas: allergy for eight groups, asthma for six groups, hypoglycemia for seven groups, myocardial infarction for seven groups, and stroke for ten groups.

The simulation had five learning objectives (Table 2). Objective one focused on timely identification of the emergency. The time until the emergency was identified was recorded for 20 groups, and the average time until correct identification of the emergency was five and eight-tenths minutes. The correct medical emergency was identified by 36 of the 38 groups (94.7%). Of the two groups that incorrectly identified the emergency, one had the stroke scenario, and one had the hypoglycemia scenario. In the hypoglycemia scenario, the student clinician was unable to differentiate between stroke and hypoglycemia. Inadequate identification in the stroke scenario was thought to be due to suboptimal skills and/or preparation of the student clinician.

Objective two addressed implementation of correct emergency procedures. Students’ achievement of this objective is shown in Figure 2. Placing patients in the supine position was performed incorrectly by 50% of the groups. Oxygen was located and administered correctly by 87% of the groups. In 84% of the scenarios, a student correctly alerted the team about a medical emergency by calling Code Blue. A 911 call was implemented appropriately in 76% of the scenarios. Student groups in the allergy and hypoglycemia scenarios were less likely to place the patient in the supine position (Figure 3). Across all the conditions, students were least likely to implement correct emergency procedures for hypoglycemia.

Objectives three and four evaluated student performance in locating and utilizing the contents of the emergency kit. Of these groups, 97% located the emergency kit, and 95% of the groups administered the medications correctly. Objective five regarding patient follow-up was addressed during the debriefing immediately following the scenario. Results were not
collected for the fifth objective as it was not addressed by the grading rubric.

Discussion

In a dental clinic with actual patients, it is impossible to create a medical emergency. The use of a high-fidelity simulator with emergency scenarios allows dental hygiene students the opportunity to experience an authentic patient emergency. For example, unlike with the use of a standardized patient, HFS allows students to detect abnormal vital signs; observe cyanosis, respiratory distress, and pharyngeal edema; evaluate pupil reactivity; observe tremors; perform CPR; and administer medications. HFS provides students with practice in this life-saving skill set, including problem-solving under stressful situations and integration of clinical content. In addition, teaching with HFS allows faculty members to evaluate the effectiveness of curricular content in this area.

For emergency procedures to be effective, training needs to be conducted in the didactic curriculum and clinical practice. Research in other health professions has reported the development of standardized emergency procedures and training to prepare learners for medical emergencies in their clinics and practices. The use of HFS as the training method in our study allowed integration of standardized emergency procedures with hands-on training in which learners were able to apply clinical skills during a simulated medical emergency. Key aspects for simulation to be successful are faculty members’ providing group feedback and debriefing to address elements such as level of preparation, ability to assess a medically compromised patient, and implementation of specific interventions related to a medical emergency. During the facilitator-guided debriefing, students were able to self-reflect on their individual performance and the performance of their team to provide appropriate care for their patient. Simulation of medical emergencies with facilitator-guided debriefings can serve as a curricular resource to provide students with the necessary training to handle medical emergencies.

Based on our finding that approximately 95% of the groups identified the medical emergency in the dental clinic correctly in a timely manner, the overarching goal of successful training for medical emergencies was achieved, and the learning goal of the simulation was met. Additionally, other findings allowed faculty members to identify potential strengths and weaknesses among the learners and/or the curriculum.

According to the faculty graders, the key practices of oxygen delivery and calling Code Blue were correctly executed by the majority of the student groups. An identified weakness of the student groups was placing the client into the supine position, which is a required step in the protocol. This may be indicative of a problem with the protocol or students’ perception that this point was not important. Based on these findings, the curriculum may need to be revised to include further review of the protocol and improving education regarding the benefit of placing the patient in the supine position during medical emergencies.

A surprising finding was that calling 911 was only correctly utilized in 76% of the scenarios. Incorrect examples included calling 911 too soon or calling when it was not needed. This inappropriate use of 911 indicated the student groups were not using appropriate clinical judgment in a stressful situation like a medical emergency and may indicate either miscommunication between the clinician and support members or students’ thinking the emergency may not progress further. Malamed emphasized that calling 911 is a valuable and necessary part of a medical emergency protocol. The scenario that had the lowest rate of proper 911 utilization was the allergy scenario. This may indicate that students did not feel an allergy can be serious, and they forgot the potential for anaphylaxis exists. In the simulation, the allergy scenario always progressed to the point at which the patient had difficulty breathing. Further education on the decision making process in calling 911 needs to be addressed in the curriculum.

There are identical emergency kits in three areas of the dental hygiene clinic, and the protocol states that students should grab the closest kit available. Although the kit was obtained, the assigned person in four of the 15 student groups did not grab the closest medical emergency kit, but the one most convenient to her regularly assigned clinical chair. Doing that would add unnecessary time in a crisis. Discussion during debriefing was related to whether the protocol was followed and what improvements could be made to increase efficiency. One suggested curriculum improvement would be to demonstrate a medical emergency scenario during students’ orientation to the simulator.

A benefit to this project was discovering areas to improve the dental hygiene curriculum. After all
### Table 1. Elements on which students were evaluated in allergy simulation

<table>
<thead>
<tr>
<th>Essential Elements to Evaluate: All Groups</th>
<th>Key</th>
<th>Notes/Key Objective(s):</th>
</tr>
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</table>
| SimMan etiquette, preparedness, professionalism, and respect | • Followed guidelines during simulation (no drinks, gum, pens, etc.)  
• Practiced appropriate bloodborne pathogen precautions  
• All participated professionally in simulation and debriefing  
• All were respectful to classmates and facilitators | Each group can be graded as a whole:  
• Note below only those students who were deficient in any area  
• Each team member contributed to discussion  
• Difference of opinion was expressed as constructive and professional |

**Patient assessment:** correctly assess patient by identifying emergency in a timely manner.

**Physical assessment:** vital signs, rhythm, patient symptoms

| P/F | Vitals: BP 102/70, HR 108, RR 32; O2 sats 90%  
Appropriate assessment questions asked  
Symptoms noted: itchiness, rash development, swelling, progressing to difficulty breathing and/or wheezing | Vitals and symptoms (question patient about symptoms)  
Allow 6 minutes for assessment questions and taking vitals before moving on |

**Documentation of patient medical history**

All cases: sulfa allergy=rash; bee stings=anaphylaxis

Patient medical history same with all cases: diabetes, hypertension, asthma; PMH includes post-MI and post-stroke, St. Jude’s valve, HX seizures

P/F

| Vitals: BP 102/70, HR 108, RR 32; O2 sats 90%  
Appropriate assessment questions asked  
Symptoms noted: itchiness, rash development, swelling, progressing to difficulty breathing and/or wheezing  
Changes in health status assessed  
Allergies assessed (allergic to sulfa)  
Type of allergic reaction assessed (rash)  
Home medications reviewed/assessed, plus today (amoxicillin today)  
Others?  
Did not omit relevant information | Students should assess for changes in health status, allergies, home medications, and any medications that the patient has taken prior to arrival. (Allergies should be assessed prior to any medications being given.)  
Mr. Adams has taken today: Humalog insulin and metformin, lovastatin, warfarin, lisinopril, and amoxicillin prior to appointment |

**Scenario 2: Allergy**

| Yes  
No  
Time frame: __________ | Scenario 2: Allergy—patient will exhibit itching and rash or hives and swelling. Progressing to an anaphylaxis, patient will experience a fall in BP, respiratory wheezing, choking, cyanosis, hoarseness, dilation of pupils, and eventual loss of consciousness. |
Implement emergency procedure correctly.  
Locate and correctly utilize contents of clinic emergency kit.  
Administer appropriate intervention/treatment for specific patient.

<table>
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<tr>
<th>Student dental hygienists expected to correctly implement clinic emergency protocol.</th>
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| • Stop procedure  
• Place patient in supine position  
• Locate and open clinic emergency kit  
• Tell closest student “Code Blue”  
• Call 911 if appropriate  
• Fill out correct paperwork |
| Scenario 2: Allergy—patient will exhibit itching and rash or hives and swelling. Progressing to an anaphylaxis, patient will experience a fall in BP, respiratory wheezing, choking, cyanosis, hoarseness, dilation of pupils, and eventual loss of consciousness. |
| **Appropriate doses are:**  
O2 via oxygen tank  
Diphenhydramine: 25-50mg PO, or 50mg injectable q 6 hours  
Epipen: 0.3-0.5 mg SC or IM; may be repeated q 10-15 minutes. |
| **Scenario 2: Allergy**—patient will exhibit itching and rash or hives and swelling. Progressing to an anaphylaxis, patient will experience a fall in BP, respiratory wheezing, choking, cyanosis, hoarseness, dilation of pupils, and eventual loss of consciousness.  
**Appropriate doses are:**  
O2 via oxygen tank  
Diphenhydramine: 25-50mg PO, or 50mg injectable q 6 hours  
Epipen: 0.3-0.5 mg SC or IM; may be repeated q 10-15 minutes. |
| **Oxygen:** help resolve oxygen demand/oxygen supply imbalance  
**Diphenhydramine:** antihistamine; block histamine out of receptors to block allergic response  
**Epinephrine:** alpha agonist; bronchodilator  
**Nitrous oxygen not indicated** |
| **Progress to basic life support if necessary** |

**Provide patient with appropriate follow-up instructions.**

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<th>Follow-up instructions and patient education P/F</th>
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| • Medical referral (if indicated)  
• Instructions for medications  
• Implications for future treatment |
Table 2. Learning objectives for medical emergency simulation in the dental hygiene clinic

Learning objectives

1. Correctly assess patient by identifying emergency in a timely manner.
2. Implement emergency procedure correctly.
3. Locate and correctly utilize contents of clinic emergency kit.
4. Administer appropriate intervention/treatment for specific patient.
5. Provide patient with appropriate follow-up instructions.

The student groups finished debriefing, it became apparent that more training was needed to ensure interrater reliability on the grading rubric. The four facilitators approached grading differently. The grading rubrics themselves did not allow for student individuality, an action that may not have been indicated on the rubric but either improved the outcome or did not negatively affect the outcome. The rubric could be redesigned to allow for critical thinking and become less of a checklist. Allowing for more creativity in a scenario would make it more difficult...
for facilitators to grade. The simulation could become a non-graded assignment for formative feedback. Some barriers to implementing HFS include the cost of the equipment and training involved to maintain and operate the manikin.

Future research should include student perceptions of HFS and curricular outcome evaluation. Student perceptions of learning medical emergencies through HFS could be measured using surveys and systematically documenting comments during debrief sessions. Comparison of HFS to a standard educational approach for teaching medical emergencies would allow for evaluation of curricular outcomes. Interprofessional medical emergency simulation experiences would also be beneficial to improve the curriculum.

**Conclusion**

This study utilized HFS to provide dental hygiene students with a realistic scenario to practice the skills necessary to identify, assess, and treat a medical emergency in the dental office. The results suggested that HFS is an effective educational method to prepare students to face medical emergencies. This medical emergency simulation has continued in the dental hygiene program and has enhanced the curriculum not just in the area of medical emergency preparedness but also in team performance for patient safety.

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**REFERENCES**