A Medical Crisis Management Simulation Activity for Pediatric Dental Residents and Assistants

Gee Mei Tan, M.M.E.D.

Abstract: Dentists are expected to deliver safe and pain-free dental procedures after they graduate from dental school. This includes using local anesthetics and sedative drugs that may be associated with side effects and complications that can lead to crisis situations. This study postulated that teaching medical crisis management to dental residents and assistants using human patient simulation (HPS) would improve their confidence in managing crisis situations in the real world. Four medical crisis scenarios were designed and programmed into a pediatric simulator. The scenarios included anaphylaxis, laryngospasm during procedural sedation, sedative medication overdose, and multiple drug interaction with cardiac arrhythmia. The simulation room was outfitted with an authentic dental operatory and emergency equipment to enhance the realism. One first- or second-year pediatric dentistry resident and a staff dental assistant were assigned as a team to participate in each ten-minute scenario followed by a debriefing session. At the end of the sessions, the participants completed an anonymous survey regarding the simulation experience. There were a total of twenty-four participants, 91.7 percent of whom felt that HPS was a good tool for learning medical crisis and that they would be more confident in managing a similar situation in the dental office after this experience. A majority of the participants felt that using HPS as a tool to teach crisis management is an acceptable and valuable technique to help improve their confidence in managing crisis situations that may occur in dental offices.

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Dentists are expected to deliver safe and pain-free dental procedures when they graduate from dental school. This would not only include competent dentistry skills but also the use of drugs like local anesthetics, ketamine, benzodiazepines, and opioids for sedation and analgesic purposes. These drugs have inherent risks of cardiovascular and respiratory complications, which may be more evident with the current complexity of medical problems in patients at the extremes of age.1-4 Medical emergencies in a dental practice are not common. However, without proper training of dental personnel in appropriate resuscitation and management skills, an emergency situation may have devastating consequences.

Medical crisis management education is a small component of the dental curriculum. Clark et al. surveyed all dental schools in the United States in 1983 and conducted follow-up surveys nine and twenty years later.5-7 They found that, in those three years, schools dedicated means of 17.4 hours, nineteen hours, and twenty-two hours, respectively, to medical emergency training in their dental curricula. They also found that not all schools required a medical emergency training course in their curriculum.

In 2006, the American Academy of Pediatric Dentistry and American Academy of Pediatrics adopted guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures.8 This guideline states that the practitioner responsible for the administration of sedative drugs must be competent to use such techniques and be able to manage the complications of these techniques. It also states that support personnel must be trained in and be capable of providing pediatric basic life support. In pediatric versus adult dental office procedures, there is a higher proportion of patients who are more anxious and less cooperative; hence, there is a greater need for sedation and anxiolysis. This would mean that the dentists and the dental assistants would need to be competent in managing any inadvertent crisis that develops during these procedures.

Simulation has been used extensively in teaching specific technical skills, for example, bronchoscopy9 and fiberoptic intubation.10 It has also been
used to teach and assess performance in medical crisis situations.11,12 The Anesthesiology Department at The Children’s Hospital (TCH) of the University of Colorado Denver is active in medical simulation and, in collaboration with the Dentistry Department, piloted an innovative simulation course as part of the pediatric dental residency curriculum. This study postulated that teaching medical crisis management to dental residents and dental assistants using human patient simulation would improve their confidence in managing crisis situations in the real world.

Materials and Methods

The Colorado Multiple Institutional Review Board approval for the publication of the curriculum and the post simulation experience survey results was obtained for this study. The study had been approved by the hospital’s Institutional Review Board prior to implementing any study-related interventions.

Four pediatric dental faculty members on staff in the Pediatric Dentistry Department of TCH decided among themselves which dental office-based crisis scenarios they would like to simulate, and each dentist was assigned to write one of the four scenarios. These scenarios were then enhanced and programmed into PediaSim Emergency Care Simulator (Medical Education Technologies, Inc., Sarasota, Florida). The PediaSim is an adolescent human simulator that can be manipulated by a computer system to reflect normal and abnormal human anatomy and physiology. It is able to blink, has breath sounds with chest wall movements and heart sounds with central and peripheral pulses, and is able to communicate via a microphone-speaker system controlled by an operator behind the scenes. It can also exhibit physiological reactions to drugs administered including oxygen, epinephrine, atropine, and muscle relaxants.

The four scenarios were anaphylaxis, laryngospasm during procedural sedation, sedative medication overdose, and multiple drug interaction with cardiac arrhythmia. Each scenario was written with different stages starting with a baseline or early stage, followed by deteriorating stages and a recovery stage (see example in Table 1). Each stage consists of patient vital signs and responses with the health professional’s expected actions or reactions to the patient. The simulation room at the Center for Advancing Professional Excellence (CAPE), University of Colorado Denver, was outfitted with an authentic dental operatory and emergency equipment to enhance realism for the participants (Figure 1).

Each of the four faculty members participated in a four-hour faculty development course a month before the simulation curriculum started. None of the four had facilitated a medical crisis simulation before. The objective of the faculty development course was to allow each faculty member to experience being in the hot seat of a simulation scenario and debriefing session. The faculty development course included a one-on-one lecture on adult learning theories and debriefing techniques. This was followed by participation in two of the programmed dental scenarios, with an actor portraying the role of a dental assistant, and a debriefing session for the faculty member. A checklist of expected actions (see example in Figure 2) was also created for each scenario to aid in the facilitation and debriefing of the dental residents and assistants. Each faculty member would only facilitate the learners in the same scenarios they had participated in during the faculty development.

Pediatric dental residents at the University of Colorado Denver are all certified in Pediatric Advanced Life Support (PALS). Any other medical emergency-related education is taught using didactic lectures. In 2008, all dental residents and dental assistants participated in this new curriculum. Each dental resident and assistant participated in four scenarios over two days—that is, two scenarios per day. One dental resident was paired with a dental assistant, and the two worked as a team in each scenario on each day; thus, the team on the second day may be different from that of the first day. A facilitator was assigned to each team. Each team was given a ten-minute acclimation to the simulation room and the manikin. They were oriented to the equipment in the room and the physiology and anatomy of the manikin. This was followed by a preparatory briefing by a facilitator that included the objectives of the event and the storyline of the simulation scenario. The participating team was brought back into the simulation room for a ten-minute scenario experience. During the simulation session, the facilitator would be watching the scenario unfold behind a one-way glass wall. During the session, the participating team would interact with the facilitator via a phone conversation if they needed or called for help. The facilitator would only enter the simulation room at the end of the ten-minute session or earlier if the team successfully completed the crisis scenario. A fifteen-minute debrief session between the team and the facilitator in a separate private room completed the session.
Table 1. Scenario on anaphylaxis in the dental office

Scenario Objectives:
Recognition of crisis situation
Diagnosis of anaphylaxis
Administration of general resuscitation skills, i.e., airway, breathing, circulation, and call for help
Administration of specific management for anaphylaxis

The Patient:
6-year-old boy
20 kg
115 cm tall
Has mild asthma; on albuterol inhaler as needed
Had tonsillectomy and adenoidectomy done at 4 years old
Allergic to iodine and aspirin → hives
Patient lives with mother and older sister in an apartment

Scenario:
Patient has multiple dental cavities and is here for dental restorations. He has been in the dental operatory for approximately 15 minutes. The dentist has successfully administered the local anesthetic (1.8 ml of Lidocaine with 1:100,000 epinephrine), placed the rubber dam, prepared two fillings in the lower left quadrant, and is about to place the matrix band to prepare for filling the cavities.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Vital Signs</th>
<th>Patient’s Response</th>
<th>Required Participant Action</th>
<th>Notes to Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early reaction</td>
<td>BP 104/64 to 107/66 mmHg</td>
<td>Awake</td>
<td>Assess vital signs (VS)</td>
<td>BP, pulse oximetry, and HR shown on screen when asked for and applied. Transition to late reaction in 3 minutes.</td>
</tr>
<tr>
<td></td>
<td>HR 105/min</td>
<td>Hoarse voice</td>
<td>Put on monitors for VS: BP &amp; HR &amp; pulse oximetry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RR 25-27/min</td>
<td>Speaks only a few words</td>
<td>Look for:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saturation 95%</td>
<td>“I can't breathe.”</td>
<td>Extent of rash</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“My throat feels full.”</td>
<td>Extent of intra- and extraoral swelling</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>“I itch a lot.”</td>
<td>Call for help; call 911</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Administer Benadryl sublingually 1 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Late reaction</td>
<td>HR 120 to 140/min in 2 minutes</td>
<td>Swollen tongue</td>
<td>Reassess VS</td>
<td>Patient becomes worse in 3 minutes.</td>
</tr>
<tr>
<td></td>
<td>BP drops to 75/45 mmHg in 2 minutes</td>
<td>Respiratory distress:</td>
<td>Check for ABCs</td>
<td>If epinephrine is given, go to recovery.</td>
</tr>
<tr>
<td></td>
<td>Saturation 88% in 2 minutes</td>
<td>Exaggerated chest movement</td>
<td>Administer oxygen</td>
<td>If epinephrine not given in 4 minutes into state, go to ventricular tachycardia.</td>
</tr>
<tr>
<td></td>
<td>RR 35/min</td>
<td>High pitched stidor</td>
<td>Diagnose anaphylaxis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulse present</td>
<td>Wheezing</td>
<td>If help arrives, give a brief report of situation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wheezing</td>
<td>“I feel itchy.”</td>
<td>Call for crash cart and help</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eyes closed 2 minutes into state.</td>
<td>Administer IM epinephrine 0.2 ml of 1:1,000 solution with EpiPen</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Patient is minimally responsive.</td>
<td>Consider IM hydrocortisone 100mg</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. Scenario on anaphylaxis in the dental office

Scenario Objectives:
- Recognition of crisis situation
- Diagnosis of anaphylaxis
- Administration of specific management for anaphylaxis

6-year-old boy
- 20 kg
- 115 cm tall
- Has mild asthma; on albuterol inhaler as needed
- Had tonsillectomy and adenoidectomy done at 4 years old
- Allergic to iodine and aspirin
- Patient lives with mother and older sister in an apartment

Scenario:
- Administered the local anesthetic (1.8 ml of Lidocaine with 1:100,000 epinephrine), placed the rubber dam, prepared two fillings in the lower left quadrant, and is about to place the matrix band to prepare for filling the cavities.

Stage

Early reaction
- Awake
- Assess vital signs (VS) (BP, pulse oximetry, and HR shown on screen when asked for and applied.)
- HR 105/min
- Put on monitors for VS: BP & HR & pulse oximetry
- Transition to late reaction in 3 minutes.

Late reaction
- Swollen tongue
- Reassess VS
- Patient becomes worse in 3 minutes.
- Respiratory distress: Check for ABCs
- If epinephrine is given, go to recovery.
- BP drops to 75/45 mmHg
- Exaggerated chest movement
- Administer oxygen
- If epinephrine not given in 4 minutes in 2 minutes
- High pitched stridor into state, go to ventricular tachycardia.
- Wheezing
- Diagnose anaphylaxis
- Saturation 88% in 2 minutes
- Bronchospasm
- If help arrives, give a brief report of situation
- RR 35/min
- “I feel itchy.”
- Call for crash cart and help
- Pulse present
- Eyes closed 2 minutes into state.
- Administer IM epinephrine 0.2 ml of 1:1,000 solution with Epipen
- Patient is minimally responsive.
- Ventricular tachycardia
- Unresponsive
- Go to recovery if: epinephrine given and defibrillated and
- Start CPR
- End scenario.

Recovery
- Patient is exhausted and crying
- RR 20-25/min
- Eyes open
- Normal breath sounds (no wheezing, no stridor)
- Recovery

At the end of the sessions, each participant was asked to complete a voluntary anonymous survey (see survey questions in Figure 3) on a website (www.zoomerang.com) about their simulation experience. There was a post-simulation session held at the end of each day among the facilitators and this investigator to discuss the lessons learned from that day.

Results

There were a total of twenty-four participants in the study: six first-year dental residents, six second-year dental residents, and twelve dental assistants. The results were obtained from the voluntary anonymous survey after all teams finished all four scenarios. However, not all twenty-four participants completed all the survey questions: some questions had twenty-two responses, while others had twenty-four responses. The participants had a wide range of clinical dentistry experience (range one to twenty years; median four years; average 4.85 years). Only 29 percent of the survey respondents had been involved in a real-life medical crisis before the simulation experience.

Of the participants 91.7 percent felt that human patient simulation (HPS) was a good tool for learning about medical crises and that they would be more confident in managing a similar situation in the dental office after this experience. In addition, 79.2 percent agreed that this program should be an integral part of the dental curriculum, and 87.5 percent felt that they would benefit from more simulation experience. The results of questions pertaining to each crisis scenario are shown in Table 2. About 80 percent of the respondents felt that the scenarios were realistic and that they had adequate time and equipment for the management of the crises. Not all respondents (approximately 80 percent) felt that they were clinically prepared for the various crisis scenarios. The post-simulation debriefing session with the facilitators revealed that a majority of the dental residents and assistants felt that they were unfamiliar with and had difficulty using the equipment (oxygen tank, bag and mask, defibrillator, syringes, and needles) in the room and that they were not familiar with the drug box or the drugs.

Discussion

Medical emergencies in the dental office may not be common, but they are definitely not rare. It has
been found that the prevalence of emergency events (excluding syncope) range from 0.22–0.28/year to 1.8/year in United Kingdom general dental practices and dental teaching hospitals, respectively. These events include but are not limited to seizures, accidental foreign body ingestion, diabetic events (hypoglycemia), chest pain, and drug reactions. The American Dental Association (ADA) recognizes the importance of medical emergencies. The ADA’s accreditation standards for dental education and advanced specialty education programs in pediatric dentistry state that “all students, faculty, and support staff involved in the direct provision of patient care . . . must be able to manage common medical emergencies” and requires that “the student/resident learns to prevent, recognize, and manage common medical emergencies for infants and children through adolescence.” The need for more intensive education in medical emergencies and the strong desire to obtain the knowledge was reiterated by Brazilian dental students. In a survey by Atherton et al., approximately 75 percent of the dentists responding reported that they received medical emergency training in their predoctoral dental training; however, less
than 30 percent of them felt that they were “well” or “fairly well” prepared to handle an emergency situation at graduation. More than 90 percent of these dentists had sought extra medical emergency training after they graduated, but only 75 percent of them felt that they were “well” or “fairly well” prepared at the time of survey.

A recent study by Le et al. found that when faced with a patient with a history of angina pectoris complaining of burning and pressing sensation over the chest, only 68 percent of a group of forty third- and fourth-year dental students identified the need to administer supplemental oxygen to the patient. Of these, only 50 percent successfully administered the oxygen. In their study, Laurent et al. suggested that although more than half of the final-year dental students surveyed felt that they were totally or sufficiently capable of performing cardiopulmonary resuscitation, none of them were capable of competently managing a cardiac arrest when a random sample of these students were put into a simulated scenario. These findings suggest that learning man-
agement of medical emergencies via didactic lectures and isolated cardiac life support courses may not be sufficient to translate knowledge into real-life skills. We must find an educational technique to help in this skill acquisition process. Perhaps immersive medical simulation may be the first stepping stone to the path of success. To this end, the Liverpool University Dental Hospital in the United Kingdom has started a comprehensive undergraduate course for the management of medical emergencies, which includes both theoretical and simulation scenario-based components.20

The responses to this survey of a pilot medical crisis simulation curriculum were very positive. Even though its participants had a wide range of clinical dentistry experience, a majority of the learners agreed that the scenarios portrayed during the simulations were realistic and that the time span of each scenario was adequate and realistic. They also felt that they had adequate drugs and equipment.

Table 1

<table>
<thead>
<tr>
<th>Question</th>
<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many years of clinical dentistry experience do you have?</td>
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<tr>
<td>Have you been involved in a real life medical crisis before?</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
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<tr>
<td>If yes, please elaborate.</td>
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</table>

Indicate the best answer to the following questions using the legends below:

**SD**=Strongly Disagree; **D**=Disagree; **A**=Agree; **SA**=Strongly Agree

<table>
<thead>
<tr>
<th>Question</th>
<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>The event was well organized.</td>
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<tr>
<td>The simulation facility was suitable for the needs of the event.</td>
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<tr>
<td>Human patient simulation is an excellent teaching tool for learning medical crisis scenarios.</td>
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<tr>
<td>I feel more confident in managing a medical crisis in the dental office after this simulation educational experience.</td>
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<tr>
<td>I would benefit from having more simulation experiences.</td>
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<tr>
<td>The simulation program should be an integral part of the curriculum of the pediatric dental program at TCH.</td>
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</table>

For each scenario, please answer the following questions:

<table>
<thead>
<tr>
<th>Question</th>
<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>This simulation experience was realistic: “I felt like I was experiencing the event.”</td>
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<tr>
<td>I had all the equipment and drugs required for the scenario.</td>
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<tr>
<td>The time span of the scenario was adequate.</td>
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<tr>
<td>I felt clinically prepared for the educational experience.</td>
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</table>

Please explain any disagreements with the above questions.

List three limitations of this program that would benefit from modification. Please make recommendations for these improvements.

Name one thing that you will take away from this simulation experience.

Please provide any comment you wish in the space below.

Figure 3. Post-simulation experience survey for the dental residents and assistants
available to manage the scenarios. Although only about a quarter of the learners felt that they were not clinically prepared for these simulation scenarios, a majority (91.7 percent) of them felt that Human Patient Simulation would be a good tool for enhancing their clinical skills for managing crisis situation in their real work-life.

There were several limitations in the survey results. The sample size for the survey was small (n=22 to 24) and may not be generalizable to all dental residency programs. The results could not be distinguished according to the different roles (residents versus assistants) or years of clinical experience of the learners. Thus, the distribution of these results is unknown. This is a limitation of the study, and we are looking into improving future post-simulation surveys to include a question that will enable us to distinguish the results between dental residents and assistants. However, since more than 70 percent of the results were positive, it can be postulated that this simulation program was well received by both the dental residents and assistants. The scenario checklists were not used as an evaluation tool and thus do not offer any objective results regarding the participants’ knowledge and performance during the simulations. This is therefore only a descriptive report of the curriculum and cannot be used to relate clinical performance by the dental residents or assistants. The post-simulation survey was designed to be anonymous and voluntary in order to obtain unbiased and uncoerced opinions about the program from the participants. However, this led to incomplete data collection due to participants who chose to skip some questions.

From the organization and execution of the simulation together with the feedback during the debriefing sessions and the survey, several important lessons emerged. First, despite being PALS certified, dental residents are still apprehensive at using resuscitation algorithms, drawing up drugs, and “firing” up and using the defibrillator. However, since the dental offices at TCH have Automated Electronic Defibrillators (AEDs), the dental residents and assistants felt that it may be less of a stumbling block to use an AED instead of a traditional defibrillator. Second, neither the dental residents or assistants are familiar with the resuscitation bag and mask equipment (hyperinflation bag with manometer by Ventlab) or the oxygen tank, and they are not able to use it effectively during the simulated resuscitation despite having the exact same equipment available at the dental offices. Third, dental residents are not familiar with drawing up drug dosages using syringes and needles out of drug ampoules/bottles. They have all been taught this via didactic lessons regarding the indications and dosages of the drugs, but not many have had the opportunity to physically perform the task. This simulation was the first time many of them had a hands-on experience with using this equipment and hence realized their lack of these technical skills.

With the experience and lessons learned from this pilot simulation event, the TCH Dentistry Department changed some of its procedures/equipment to enhance patient safety at the dental offices. Another in-service for the use of the oxygen delivery system and AED was planned for all the staff of the Dentist Office. A separate resuscitation drug box was assembled and placed in each of the dental operatories where sedation cases are managed. This box contains syringes and needles and the following drugs: succinylcholine, epinephrine pens, atropine, diphenhydramine, albuterol inhaler, flumazenil, naloxone, and hydrocortisone. Even though these drugs are also available in the crash cart outside the Dental Operatory within the dental office, the crash cart is usually locked and would have a bigger financial impact each time it was opened. It is therefore more feasible to have the drug box in the room and handy at all

<table>
<thead>
<tr>
<th>Table 2. Survey results for each scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaphylaxis Responses (%)</td>
</tr>
<tr>
<td>The simulation scenario was realistic.</td>
</tr>
<tr>
<td>I had all the drugs and equipment available for the scenario.</td>
</tr>
<tr>
<td>The time span for the scenario was adequate and realistic.</td>
</tr>
<tr>
<td>I felt clinically prepared for this experience.</td>
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</tbody>
</table>
times. The simulation program was so well received by the participants that the department decided to fully implement it into its residency curriculum and continue it for subsequent years. The AED was also incorporated into the simulation scenarios instead of the traditional defibrillator in the following years.

Although crisis management simulation activities have been very popular in the medical world, they are still in their infancy in the world of dentistry. This qualitative study described the innovative use of a medical simulation to teach medical crisis management to dental residents and assistants. Future qualitative studies that include pre- and post-intervention tests and correlation to real-life events would be needed to promote its use in dentistry.

Conclusions

The feedback to this pilot simulation shows that a majority of the participants felt that using Human Patient Simulation as a tool to teach crisis management is an acceptable and valuable technique to help improve dental provider and assistant confidence in managing crisis situations that may occur in dental offices. Some participants agreed that this simulation should be incorporated into the pediatric dental residency program.

Acknowledgments

I would like to thank the pediatric dentistry faculty members—Dr. Ulrich Klein, Dr. Irwin Cohen, Dr. Mark Koch, and Dr. Linda Murzyn—for their permission to use the data collected from the residency program. I would also like to thank the Center for Advancing Professional Excellence, School of Medicine Colorado, especially Mr. Joey Failma, for their help and expertise in the simulation.

REFERENCES