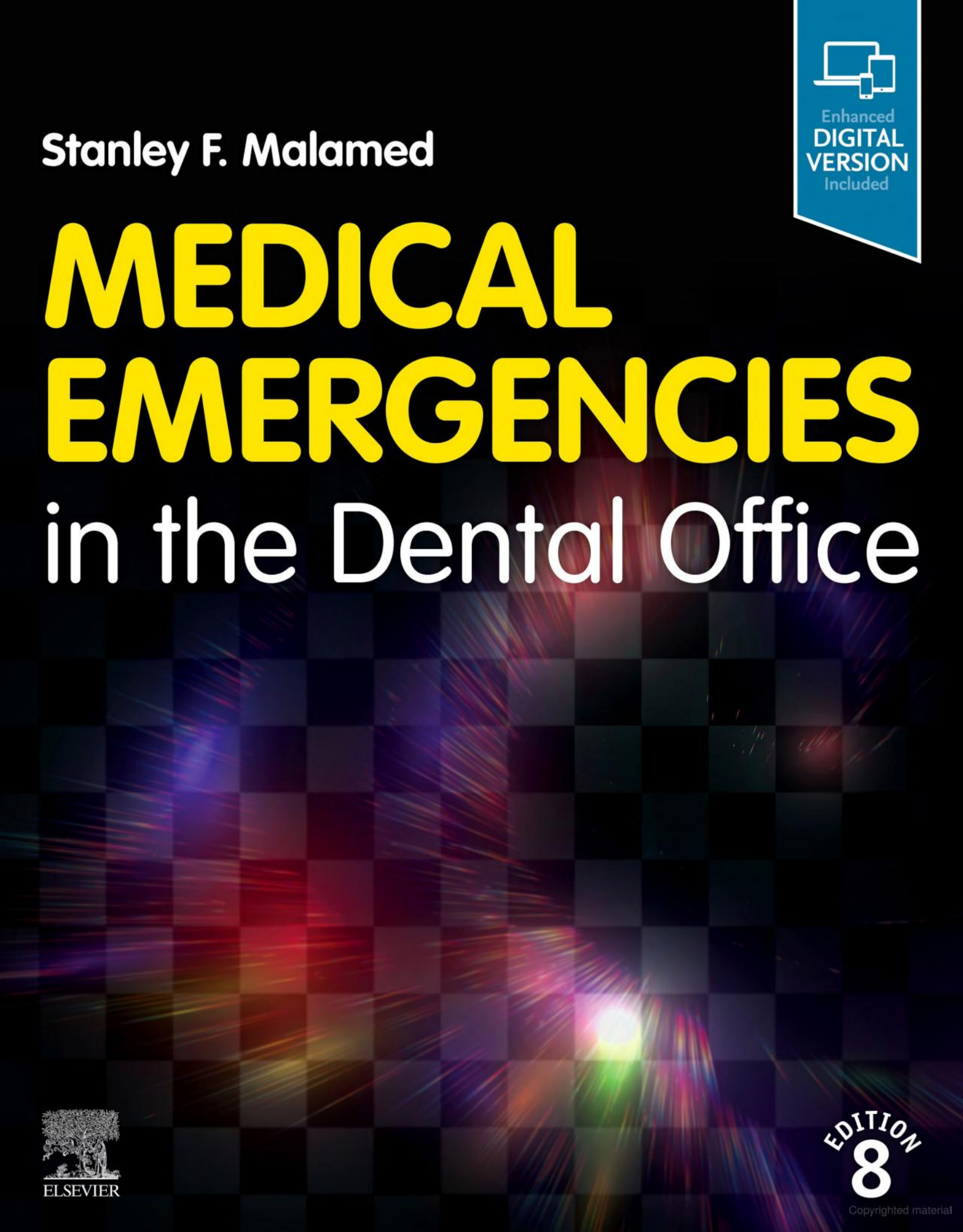
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Medical Emergencies *in the Dental Office*

Eighth Edition

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Foreword to the Sixth Edition (Previously published)

I am very pleased to be invited to offer a foreword to the new sixth edition of *Medical Emergencies in the Dental Office.* In recalling the original publication of 1978, one is impressed with the creative talent and knowledge of the "titans of teaching"—Dr. Frank ("Cap") McCarthy and Dr. Stanley Malamed. They foresaw the need and developed basic logical ways of assessing a patient's physical status when presenting for dental treatment.

Undergraduate dental education often pays limited lip service to our basic concern for the wellbeing of the total patient as it struggles to teach the many manual and technique-oriented procedures. However, we know that the "mouth is really part of the body," and our concerns involve the whole individual, especially one compromised by underlying systemic pathology.

Although a bridge or implant may fail, these are repairable. When a patient sustains a stroke secondary to an unsuspected hypertensive crisis or aspirates a chunk of impression material that blocks breathing, we are faced with a potential tragedy. Learning how to assess the physical and emotional status of each patient provides a hedge against disaster.

I have always believed that the dental undergraduate curriculum should include a better grounding in pathophysiology to provide a basis for practice. The dental profession has moved forward to use blood pressure recording almost routinely, especially in assessing new patients, and has moved to require basic life support (BLS) and advanced cardiac life support (ACLS) education for licensure. Further, monitoring devices are now mandated in most states for those dentists who use sedative and anesthetic agents.

It is impressive to see how these teachings have changed over time; important algorithms that were believed to be like gospel have been discarded as more experience has been gained. The sixth edition of this book reflects these improvements. These changes mandate that we keep current in our knowledge and practices.

Some tragedies are inevitable when dealing with patients, but knowing how and when to anticipate and manage medical emergencies reduces the likelihood that a tragedy will occur. The expense of training the professional and lay public in the recognition and management of emergencies is enormous, but a successful resuscitation, saving the life of a loved one, is worth it.

Norman Trieger, DMD, MD
Chairman Emeritus and Professor, Department of Dentistry, Albert Einstein College of Medicine/ Montefiore Medical Center, Bronx, New York

Preface to Eighth Edition

In December of 1975, I started writing *Medical Emergencies in the Dental Office*. That first edition was published in April of 1978. As I wrote in the preface to that first edition, my primary aim in writing the book was, as it remains today, to stimulate members of my profession—dentists, dental hygienists, dental assistants, and all other office personnel—to improve and maintain their skills in preventing medical emergencies and in recognizing and managing those few medical emergencies that will inevitably occur. This aim is even more focused in my mind as I complete the revision of this, the eighth edition of *Emergencies,* in September 2021.

Multiple surveys have shown that a medical emergency is likely to occur in a dental office every two to four years.

Approximately 75% of medical emergencies seen in the dental environment may be preventable by implementing a system of patient evaluation, treatment modification, and management.

Though most medical emergencies may be prevented, potentially life-threatening situations will still occur.

I continue to receive e-mails and telephone calls about such events. I have met with many doctors and other dental personnel who have had real-life encounters with life-threatening medical problems. Virtually all of these have occurred within the dental office. However, a considerable number happened in the "real world": on family outings, while traveling, in restaurants, or at home.

There is a significant need for increased awareness by dental professionals in the area of emergency medicine. Although dental regulatory bodies in most states and provinces in North America mandate current "certification" in BLS* (cardiopulmonary resuscitation [CPR]) for a doctor to maintain a dental license, not all states and provinces have as yet addressed this important issue. Why they have not is incomprehensible to me.

As someone with a long-term commitment to teaching basic life support (BLS), pediatric advanced life support (PALS), and advanced cardiovascular life support (ACLS), I see the immense value in training all adults in the simple procedures collectively known as *basic life support.* Local and state dental societies, as well as specialty groups, should continue to present courses in BLS or initiate them as soon as possible.

Progress has been made, yet much remains to be done. The awareness of our profession has been elevated, and laudable achievements continue. The American Dental Association has inaugurated an airway management program (2018), "Managing Sedation Complications." A truly excellent emergency medicine app—"Ten Minutes Saves A Life"—from the Anesthesia Research Foundation of the American Dental Society of Anesthesiology, is available—at no cost—from either the App Store (Apple) or Google Play. I highly recommend downloading it. A steadily increasing number of states have mandated the presence of an automated external defibrillator in all dental offices.

Another significant advance in the educational arena was the March 2019 recognition, by the American Dental Association, of "anesthesiology" as the 10th officially recognized dental specialty. Dentist anesthesiologists have become the leaders in providing continuing dental education in the areas of sedation, general anesthesia, physical evaluation, local anesthesia and pain control, emergency medicine, and patient safety.

However, because of the very nature of the problem—a rarity of occurrence—what we in dentistry require is the continued maintenance of a high level of skill in preventing, recognizing, and managing medical emergencies. To do so, we must participate in ongoing programs designed by individual doctors to meet the specific needs of their offices. These programs should include annual attendance at continuing dental education seminars in emergency medicine; access to up-to-date information on this subject (through the internet, journals, and textbooks); semiannual or annual refreshing of BLS, PALS, or ACLS skills; and mandatory in-office practice sessions in emergency procedures attended by the entire office staff. Such a program is discussed more completely in Chapter 3.

The ultimate goal in the preparation of a dental office for emergencies should be for you, the reader, to be able to put yourself into the position of a victim of a serious medical complication in *your* dental office, and for you to be confident that *your* office staff would be able to react promptly and effectively in recognizing and managing the event.

*The American Heart Association does not "certify" competency in any level of "life support." Cards given upon completion of a BLS, ACLS, or PALS course state that "the above individual has successfully completed the national cognitive and skills evaluations in accordance with the curriculum of the American Heart Association for the BLS (or ACLS, or PALS) program."

Acknowledgments

Stanley F. Malamed, DDS

As with earlier editions of this text, I have been fortunate to have been associated with a number of people who helped to make the job of revision—in all seriousness—quite enjoyable. As I have discovered with each previous edition, it is impossible to mention everyone involved in the production of a book; however, I do want to mention four people from Elsevier, with whom I have been intimately involved since the start of my preparing this 8th edition of *Medical Emergencies in the Dental Office*:

Alex Mortimer (London, UK);
Sara Watkins (St. Louis);
Casey Potter (Philadelphia); and
Thoufiq Mohammed (Chennai, India)

The nature of publishing has changed markedly since the 1st edition of *Medical Emergencies* in 1978. At that time, the entire manuscript was hand-written, typed by my wife, Beverly, and then (snail) mailed to the publisher, CV Mosby, in St. Louis, Missouri. Subsequent communications were usually expedited through overnight delivery.

Times change. The manuscript for this 8th edition has been prepared digitally, with all communication done via the internet. Note the physical locations of the Elsevier editors and project managers I have worked with: the United Kingdom, India, and the United States.

During the trying times of the COVID-19 pandemic (2020–2021), sitting at home contemplating what the future will be like, writing this 8th edition of *Medical Emergencies* became a very important part of my everyday life. Indeed, without the modern conveniences of the internet, providing access to all of the world's published research and literature, this edition would not have been possible.

I need to mention one more person, Ms. Elizabeth Bell, without whom none of my textbooks would have happened.

Back in the day (1975), Ms. Bell, an editor at CV Mosby, came to my office (unannounced) to ask me "what textbook was I using for my course in local anesthesia." I knew that CV Mosby published the very widely used local anesthesia textbook – *Monheim's Local Anesthesia and Pain Control in Dental Practice*. I told Ms. Bell that I had written my own syllabus for the course instead of using the Monheim text. When asked WHY I did not use Monheim, I mentioned that the two most recent editions had not been updated, that the text was, in fact, out-of-date. Ms. Bell then asked if I had ever given thought to writing a textbook, to which I answered "NO." She replied, "Would you consider it?" to which I answered "YES."

I wrote a sample table of contents and chapter on local anesthesia. Ms. Bell came back saying that CV Mosby liked it but that the Monheim textbook was a best-selling title for CV Mosby, and they did not want another book competing with it. "Was there another subject I could write on?" EMERGENCY MEDICINE was the choice.

Happily, the 1st edition of *Medical Emergencies* was successful, being widely adopted in dental schools. CV Mosby then decided to publish my book on local anesthesia (1980). Soon after it replaced the Monheim text, they asked if there was another subject left for me to write about; thus came SEDATION (1985).

Elizabeth Bell – I want to THANK YOU for having started me on a very rewarding path. It likely never would have happened if you had not simply "dropped by" my office that afternoon in 1975.

Contents

1 Introduction

Life-threatening emergencies can occur in dentistry and can happen to anyone—a patient, a doctor, a member of the office staff, or a person merely accompanying a patient. Although life-threatening emergencies are generally infrequent in dental offices, many factors are combined to increase the likelihood of such incidents, including (1) an increasing number of older persons seeking dental care, (2) therapeutic advances in the medical and pharmaceutical professions, (3) a growing trend toward longer dental appointments, and (4) the increasing use and administration of drugs in dentistry.

Fortunately, other factors can minimize the occurrence of life-threatening events, such as a pretreatment physical evaluation of each patient involving a medical history questionnaire, dialog history, and physical examination, with subsequent modifications to dental care to minimize medical risks if necessary.

Morbidity

Despite the most meticulous protocols designed to prevent the development of life-threatening situations, emergencies will still occur. Consider, for example, the sudden and unexpected deaths of young, well-conditioned athletes.[1–5] Such emergencies can occur in any environment. Indeed, the occurrence of such a tragedy at a dental office is not even a surprising event, given the stress that many patients are associated with dental care. In a survey of medical emergencies occurring in dental offices in Scotland, four deaths from cardiac arrest were reported in persons who were listed as "bystanders," that is, persons not scheduled for dental treatment at the office in which they died.[6] This text studies emergency situations that can develop in dental practice. However, dental practitioners must first understand that there is no medical emergency that is unique to dentistry. For instance, local anesthetic overdoses can be seen outside dentistry in patients with cocaine abuse.

Table 1.1 presents the combined findings of two surveys of dentists from the United States, one completed by Fast, Martin, and Ellis[7] in 1985 and the other by Malamed[8] in 1992. A total of 4309 survey respondents from all 50 US states and 7 Canadian provinces reported 30,608 emergencies over 10 years. Of the respondents, 96.6% answered positively to the following question: "In the past ten years, has a medical emergency occurred in your dental office?" (Doctors used their own definitions of what constituted a medical emergency.)

About 50% of these emergencies (15,407) were listed as syncope (i.e., fainting), which is usually a benign occurrence. However, the reader should beware of the word *benign* in any description of an emergency. When improperly managed, any emergency—even a "simple" faint—can turn into a catastrophe. The reader is referred to the addendum in Chapter 6 as an example. On the other hand, a notable proportion (25.35%) of reported emergencies were related to the cardiovascular (3381), respiratory (2718), and central nervous (1663) systems and were thus potentially life threatening.

Table 1.2 summarizes the medical emergencies that occurred at the School of Dentistry clinics at the University of Southern California (now the Herman Ostrow School of Dentistry of USC) from 1973 through mid-2012. Although most of these situations arose while the patient was undergoing treatment, others developed while the patient was not even in the dental chair. For example, some patients experienced episodes of orthostatic (postural) hypotension in the restroom, several experienced convulsive seizures in the waiting room, and one experienced a seizure just outside the clinic entrance. An adult accompanying a patient developed an allergic skin reaction after ingesting aspirin to treat a headache.[9] In two other instances a dental student viewing pictures of acute maxillofacial injuries in a lecture hall and a dentist treating a patient suffered episodes of vasodepressor syncope. Such examples underscore the need for dental practitioners to prepare for emergency situations.

Table 1.3 summarizes the medical emergencies arising at another US dental school over an 8½-year period. Twenty percent (17 of 84) of events occurred in persons who were not patients at the time (e.g., faculty, students, persons accompanying patients).[10]

Previous editions of this text have presented studies on the incidence of medical emergencies in Australia,[11] New Zealand,[12] Fiji,[13] and Brazil.[14]

Tables 1.4 to 1.10 present the results of more recent studies carried out in Germany,[15] Croatia,[16] the Netherlands,[17] United Kingdom,[18] Poland,[19,20] Saudi Arabia,[21] and the United States.[22]

TABLE 1.1 Emergencies in Private-Practice Dentistry

Emergency Situation	Number Reported[a]
Syncope	15,407
Mild allergic reaction	2583
Angina pectoris	2552
Postural hypotension	2475
Seizures	1595
Asthmatic attack (bronchospasm)	1392
Hyperventilation	1326
"Epinephrine reaction"	913
Insulin shock (hypoglycemia)	890
Cardiac arrest	331
Anaphylactic reaction	304
Myocardial infarction	289
Local anesthetic overdose	204
Acute pulmonary edema (heart failure)	141
Diabetic coma	109
Cerebrovascular accident	68
Adrenal insufficiency	25
Thyroid storm	4
TOTAL	**30,608**

[a]N=4309 reporting dentists.

Data were combined from Fast TB, Martin MD, and Ellis TM. Emergency preparedness: a survey of dental practitioners. *J Am Dent Assoc*. 1986;112(4):499-501 and Malamed SF. Managing medical emergencies. *J Am Dent Assoc*. 1993;124(8):40–53.

TABLE 1.2 Emergencies at the University of Southern California School of Dentistry (1973–June 2012)

Emergency Situation	Number Reported
TYPE	
Syncope	65
Hyperventilation	54
Seizures	53
Postural hypotension	30
Hypoglycemia	29
Mild allergic reaction	18
Angina pectoris	18
Acute asthmatic attack	13
Acute myocardial infarction	1
Cardiac arrest	1
VICTIM	
Patient (during treatment)	185
Patient (before or after treatment)	56
Dental personnel	27
Other (bystanders, patient escort, parents, spouses)	14

Although any medical emergency can develop in a dental office, some are seen more frequently than others. Many such situations are stress-related (e.g., pain, fear, and anxiety) or involve preexisting conditions that are exacerbated when a patient is placed in a stressful environment.

Vasodepressor syncope and hyperventilation are typically induced by stress, whereas most acute cardiovascular emergencies, bronchospasm (asthma), and seizures involve preexisting medical conditions that are prone to being exacerbated by stress. Effective management of pain and anxiety in a dental office is therefore essential for the prevention and minimization of potentially catastrophic situations.

Syncope (vasovagal syncope) is the most commonly cited medical emergency in most published studies.[7,8,14–18,20–24]

Drug-related adverse reactions constitute another category of life-threatening situations that occur more often than expected by dentists. Most frequently, these reactions are associated with local anesthetics, the most important and commonly used drug type in dentistry. Psychogenic reactions, drug overdoses (local anesthetic systemic toxicity [LAST]), and drug allergies are just a few of the problems associated with the administration of local anesthetics.

The overwhelming majority of such "drug-related" emergencies are stress-related (psychogenic); however, other reactions (e.g., overdose, allergy) represent responses to the drugs themselves. Most adverse drug responses are preventable. Therefore, thorough knowledge of drug pharmacology and proper administration is critical for the prevention of drug-related complications.

Drug-related emergencies have been demonstrated to be the leading cause of death in dental environments.[25–28]

Matsuura[29] evaluated medical emergency situations in dental offices in Japan (Tables 1.11 and 1.12). Only 1.5% of emergency situations occurred in the waiting room. The greatest percentage of medical emergencies (54.9%) occurred *during* the administration of local anesthetics, which, according to both patients and doctors, was the most stressful procedure performed in the dental office.[30] About 22% of these emergencies developed during dental treatments, whereas 15% occurred within the confines of the dental office following completion of the treatment. Most such emergencies involve orthostatic (postural) hypotension or vasodepressor syncope.

A survey of 1029 dentists in England, Wales, and Scotland demonstrated that most emergencies (36.7%) occurred

TABLE 1.3 Medical Emergencies Occurring in a US Dental School Setting (2000–2008)

Type of Emergency (Suspected or Confirmed)	Dental Patients (Number of Events)	Nonpatients (Number of Events)
Cardiovascular event	15	6
Syncope	12	3
Anesthesia complication	9	0
Diabetic/ hypoglycemic complication	9	0
Aspirated/ swallowed object	4	0
Allergic reaction	3	1
Anxiety	3	
Dizziness/loss of consciousness, no obvious etiology	3	2
Medication-related event	2	1
Fall	2	1
Seizure	2	0
Subcutaneous emphysema	2	0
Substance abuse	1	1
Complication of known disease in employees	n/a	2
TOTAL	**67**	**17**

Data from Anders PL, Comeau RL, Hatton M, Neiders ME. Nature and frequency of medical emergencies among patients in a dental school setting. *J Dent Educ*. 2010;74(4):392–396.

TABLE 1.4 Medical Emergencies Experienced by 620 German Dentists Over a 12-Month Period

	# Dentists who Experienced Emergency (N = 620)	Incidence of Emergency
Vasovagal syncope	358	1,238
Hypertensive crisis	41	72
Seizure	42	46
Hypoglycemia	22	33
Asthma	24	26
Acute coronary syndrome	22	24
Anaphylaxis	7	9
Airway obstruction	5	5
Stroke	4	4
Cardiac arrest	2	2
Other emergencies	18	26
Total		1,485

From Müller MP, Hänsel M, Stehr SN, Weber S, Koch T. A state-wide survey of medical emergency management in dental practices: incidence of emergencies and training experience. *Emerg Med J*. 2008;25(5):296–300.

TABLE 1.5 Incidence of Medical Emergencies in 498 Croatian General Practice Dentists

Emergency Situation	N	%
Vasovagal syncope	286	83.6
Diabetes (hypo/hyperglycemia)	128	37.4
Epileptic seizure	117	34.2
Allergic shock	86	25.1
Other	77	22.5
Emergency situation, but no diagnosis	70	20.5
Cardiac arrest	28	8.2

Data from Čuković-Bagić I, Hrvatin S, Jeličić J, et al. General dentists' awareness of how to cope with medical emergencies in pediatric dental patients. *Int Dent J*. 2017;67(4):238–243.

during dental treatment, while 23.1% occurred before the start of treatment, 20.1% occurred after the administration of a local anesthetic, and 16.4% occurred after completion of the dental procedure.[6]

Approximately 3% of the events in England and Wales and 2.2% of the events in Scotland affected persons who were not undergoing dental treatment. This group included persons who were accompanying patients, passersby, and five members of the dental staff, including a dentist and technician.[6]

The type of dental care provided at the time of an emergency is illuminating. In Matsuura's paper, more than 65% of patients developed an emergency during two types of dental care—tooth extraction (38.9%) and pulp extirpation (26.9%).[29] In the British paper, 52.2% of the events occurred during conservative dental treatment, and 23.5% occurred during dentoalveolar surgery.[6] All types of treatments were implicated, with 1.1% occurring during orthodontic treatment.[6]

Although information regarding the specific cause of an emergency is not always available, those that develop during treatment are most likely to occur when a patient

TABLE 1.6 Incidence of Medical Emergencies in 111 Orthodontic Practices in the Netherlands

	% Who Experienced Event (N=111)	Total Occurrence
Vasovagal collapse	69.5%	219
Hyperventilation	36.2%	83
Allergic reaction	31.4%	163
Hypoglycemia	26.7%	64
Epileptic insult	25.7%	50
Aspiration	20.0%	27
Asthma	4.8%	12
AP/MI	4.8%	5
Cardiac arrest	0.0%	0
Total		573

From Bavandpour MA, Livas C, Jonkman REG. Management of medical emergencies in orthodontic practice. *Prog Orthod*. 2020;21(1):25. doi: 10.1186/s40510-020-00327-3. PMID: 32776156; PMCID: PMC7415467.

TABLE 1.7 Medical Emergencies Occurring Among British Dentists in a 12-Month Period

Emergency Situation	% of Dentists Reporting Emergency	Number of Cases Reported
Vasovagal syncope	63	596
Angina pectoris	12	53
Hypoglycemia	10	54
Epileptic fit (seizure, convulsion)	10	42
Choking	5	27
Asthma	5	20
Cardiac arrest	0.3	1

Data from Jevon P. Updated guidance on medical emergencies and resuscitation in dental practice. *Br Dent J*. 2012;212(1):41–43.

experiences sudden, unexpected pain. In one such instance, a local anesthetic was administered to a patient reporting a sensitive tooth (a mandibular molar), and pain control was successfully achieved (lip and tongue got "numb"). After the treatment began, however, the patient experienced an unexpected spasm of intense pain as the burr approached the pulp chamber. In a similar situation, pain control was thought to have been achieved; however, the patient felt intense pain as extraction of a tooth extraction began. In both cases, sudden pain triggered the release of endogenous catecholamines, epinephrine, and norepinephrine, which, in turn, contributed to the creation of an emergency. Thus, the importance of clinically adequate pain control for safe dental care cannot be overstated.

TABLE 1.8 Medical Emergencies Reported by 419 Polish Dental Practices and 613 Dental Hygiene Practices

	% Dentists Reporting[21]	% Dental Hygienists Reporting[22]
Vasovagal syncope	46.3	17.77
Hypoglycemia	15.99	7.50
Seizures	11.21	8.97
Orthostatic hypotension	8.85	1.79
Hyperventilation crisis	8.61	8.48
Mild allergic rx	6.23	14.19
Angina	6.21	4.89
Asthma	3.10	3.59
Hypertensive crisis	2.15	6.36
Anaphylactic shock	2.14	3.59
Sudden cardiac arrest	1.89	1.31

Data from Gbotolorun OM, Babatunde LB, Osisanya O, Omokhuale E. Preparedness of government owned dental clinics for the management of medical emergencies: a survey of government dental clinics in Lagos. *Nig Q J Hosp Med*. 2012;22(4):263–267; Jevon P. Updated guidance on medical emergencies and resuscitation in the dental practice. *Br Dent J*. 2012;212(1):41–43.

TABLE 1.9 Medical Emergencies Reported by 145 Dentists in the Eastern Province of Saudi Arabia Over a 3-year Period

	% of DDS Reporting Event
Vasovagal syncope	53.1
Hypoglycemia	44.8
Orthostatic hypotension	21.3
Seizures	16.6
Asthmatic attack	11.0
Heart-related problems	8.3
Adverse drug reactions	7.8
Other medical emergencies	7.0
Foreign body aspiration	5.5

Data from Alhamad M, Alnahwi T, Alshayeb H, et al. Medical emergencies encountered in dental clinics: a study in the Eastern Province of Saudi Arabia. *J Family Community Med*. 2015;22(3):175–179.

Death or Permanent Brain Damage

Most emergency situations that occur during dental practice are considered *potentially* life-threatening. Only on rare occasions does a patient die in a dental office (Fig. 1.1).

TABLE 1.10 2018 Center for Dental Practice Survey on Preparedness for Medical Emergencies in Dental Practices (N=529)

Emergency Situation	% Seen Over 12-month Period
Syncope (fainting)	39.77
Epinephrine reaction	37.43
Postural hypotension	33.92
Allergy-mild or moderate reaction	15.79
Physical injury requiring First Aid	15.20
Hyperventilation	11.70
Seizures	11.11
Other, please specify	5.85
Insulin shock (hypoglycemia)	2.92
Asthmatic attack (bronchospasm)	1.75
Local anesthetic overdose	1.17
Angina pectoris	1.17
Anaphylactic reaction	0.58
Cardiac arrest	0.58

Modified from the Center for Dental Practice Council on Dental Practice Survey on Preparedness for Medical Emergencies in Dental Practice. February–March 2018. American Dental Association, Chicago IL, August 2018.

TABLE 1.11 Occurrence of Systemic Complications

Timing of Complication	% of Total
In waiting room	1.5
During or immediately following administration of local anesthesia	54.9
During treatment	22.0
After treatment (in office)	15.2
After leaving dental office	5.5

Data from Matsuura H. Analysis of systemic complications and deaths during treatment in Japan. *Anesth Prog*. 1989;36(4-5):223–225.

A 2020 search of PubMed/Medline, Scopus, and Internet archives by Minoli et al. identified 36 fatal events in dental offices in Italy between 1990 and 2019. Interestingly, all were reported in national or regional newspapers, and none were reported in scientific databases.[31] Tooth extraction was the most common treatment being performed when the fatal event occurred (39%), followed by treatment of a tooth abscess (11%). Myocardial infarction and cardiac arrest were the two most common causes of death (28% and 25%, respectively), with the third being allergies (11%), followed by infections (8%). Four deaths occurred before treatment, 10 occurred perioperatively, and 21 occurred

TABLE 1.12 Treatment Being Performed at the Time of an Emergency Situation

Treatment	% of Total
Tooth extraction	38.9
Pulp extirpation	26.9
Unknown	12.3
Other treatment	9.0
Preparation	7.3
Filling	2.3
Incision	1.7
Apicoectomy	0.7
Removal of fillings	0.7
Alveolar plastics	0.3

Data from Matsuura H. Analysis of systemic complications and deaths during dental treatment in Japan. *Anesth Prog*. 1989;36(4-5):223–225.


Part II / Sunday, August 6, 2006

Patient Has Heart Attack, Dies; Dentist Also Stricken

• **Figure 1.1** A dentist and a patient are both stricken with heart attacks.

postoperatively. Of the nine patients with myocardial infarctions who had fatal outcomes, three occurred preoperatively, three occurred perioperatively, and three occurred postoperatively. In 17 cases, there was a temporal relationship between the administration of either a local anesthetic or a sedative drug, with seven of the eight cardiac arrests having a close temporal relationship with the injection of a local anesthetic and one following the administration of sedative drugs. There were four deaths due to allergies, two of which followed the administration of antibiotics.

Reuter et al. reviewed 148 fatalities occurring within 90 days of a patient receiving dental care.[25] The leading cause of death was an anesthesia/sedation medication–related complication (n =70), followed by a cardiovascular event (n =31), infection (n =19), airway-respiratory complication (n =18), bleeding (n =5), and others (n =5).

In a 2012 review of adverse events during pediatric dental anesthesia and sedation, Chicka et al. found 17 adverse events related to anesthesia, with 13 involving sedation, 3 involving local anesthesia alone, and 1 involving general anesthesia.[26] In that study, the average age was 3.6 years old, and 53% of the associated claims involved patient death or permanent brain damage. An overdose of local anesthetics was observed in 41% of the claims. Of the 13 claims involving sedation, only in one instance was patient physiologic monitoring (e.g., pulse oximetry) in use.

Gaiser et al. searched for dental office fatalities reported both in the scientific literature and lay press.[28] A total of

18 deaths were found in Germany, 2 in Austria, 120 in the United States, 15 in the United Kingdom, and 1 in France. No deaths were reported in Switzerland. Twenty-eight deaths were excluded from the review for various reasons.

Most deaths were attributed to *anesthesia, medication, or sedation*, followed by *infection* and the *cardiovascular system*. In the United States, more deaths occurred under sedation (46%, 44/96) than in other countries, including Germany and Austria (6%, 1/17) and the United Kingdom (7%, 1/14).

In the Germany-Austria group, 13 of the 17 fatalities were treated under general anesthesia prior to death. Within the UK group, 6 of the 14 patients received general anesthesia, 1 received sedation, and 5 received local anesthesia alone. Two patients did not undergo anesthesia. Of the 61 deaths assigned to the *anesthesia, medication*, or *sedation* category of the 96 US fatalities, 10 were attributed to a medication administered either prior to or after treatment (antibiotics and analgesics). Table 1.13 summarizes the 128 reported fatalities associated with dental treatment.

In a 2013 paper, Lee et al. reviewed 44 deaths associated with pediatric dental sedation and general anesthesia.[32] Twenty-one deaths (47.7%) were in the 2–5-year age group, 8 (18.2%) were in the 6–12-year age group, and 13 (29.6%) were in the 13–21-year age group. Fillings/crowns and extractions accounted for 32 deaths (72.7%). Four patients received only local anesthesia (9.1%), while 20 (45.5%) received moderate sedation, either orally or intravenously. General anesthesia was involved in 10 incidents (22.7%). In 56% of these cases (25/44), the anesthesia provider was a general or pediatric dentist, whereas an oral surgeon was the provider in 18% of cases, and an anesthesiologist (MD or DDS) was the provider in 15.9%. The facility where the event occurred was a private dental office in 70.5% of cases, while 13.6% occurred in a surgery center or hospital.

In a 1999 British paper, Atherton et al. reported on the circumstances of 10 deaths reported in England and Wales and 10 reported in Scotland[6] (Table 1.14). Fourteen of these deaths were listed as cardiac arrests, four as myocardial infarctions, and two as cerebrovascular accidents. Four of the deaths listed in Scotland occurred in passersby, but none in patients. Taking these numbers into account, fatalities resulted from approximately 0.7% of the emergencies reported in England, Wales, and Scotland.[6]

An adequate pretreatment physical evaluation combined with the proper use of the many techniques for pain and anxiety control can help to prevent emergencies and deaths in dental settings. It is the author's firm belief that all dental practitioners must pursue prevention vigorously. Chapter 2 of this text is devoted to this goal, as are other excellent textbooks.[33]

However, medical emergencies occur. Vaughan[24] reported that more than half of all dentists are required to perform emergency management during their careers. In Belgium, Marks et al. reported a 43.6% occurrence of emergencies,[34] while in India, 58.1% of 105 dental interns experienced at least one medical emergency.[17] Sixty-seven percent of 145 dentists surveyed in Saudi Arabia[23] and 67.7% of

TABLE 1.13 Summary of 120 Dentistry-Related Fatalities

	# of Fatalities Reviewed	Mean Age (Years)	Age Group (Years)	Cause of Death Category
Germany & Austria	17	19.6	0–5: 8/17, 47% 6–17: 2/17, 12% 18–30: 3/17, 18% 31–55: 3/17, 18% 56–70: 0/17, 0% >70: 1/17, 6%	A,M,S[a] (82%) Bleeding (12%) Infection (6%)
United Kingdom	14	30.5	0–5: 2/14, 14% 6–17: 4/14, 29% 18–30: 1/14, 17% 31–55: 4/14, 29% 56–70: 3/14, 21% >70: 0/14, 0%	A,M,S[a] (64%) Bleeding (21%) Infection (17%)
United States	96	22.6	0–5: 25/96, 26% 6–17: 29/96, 30% 18–30: 18/96, 19% 31–55: 12/96, 13% 56–70: 7/96, 7% >70: 5/96, 5%	A,M,S[a] (64%) Airway, respiratory (16%) Infection (9%) Cardiovascular (8%) Bleeding (1%)
France	1	7	6–17: 1/1, 100%	Airway, respiratory (100%) (choked on x-ray film cover)

[a]A,M,S, Anesthesia, medications, sedation.

From Gaiser M, Kirsch J, Mutzbauer TS. Using non-expert online reports to enhance expert knowledge about causes of death in dental offices reported in scientific publications: qualitative and quantitative content analysis and search engine analysis. *J Med Internet Res*. 2020;22(4):e15304. doi: 10.2196/15304. PMID: 32038029; PMCID: PMC7195661. Reference #28.

TABLE 1.14 Circumstances of Deaths Reported in Surveys

Event (Number)	Location	Stage of Treatment	Procedure
ENGLAND AND WALES			
Cardiac arrest (1)	Waiting room	Before	Dentures
Cardiac arrest (1)	Surgery	During	Dentures
Cardiac arrest (1)	Waiting room	Before	Scaling
Cardiac arrest (1)	Waiting room	Before	Not stated
Stroke (1)	Waiting room	Before	None
Stroke (1)	Surgery	During	Scaling
Myocardial infarct (2)	Waiting room	Before	Not stated
Myocardial infarct (1)	Outside surgery	Before	None
SCOTLAND			
Cardiac arrest (1)	Waiting room	Before	Impression
Cardiac arrest (1)	Waiting room	Before	None
Cardiac arrest (1)	Waiting room	Before	Not stated
Cardiac arrest (3)	Waiting room	After	Not stated
Myocardial infarct (1)	Passer-by		

From Atherton J, McCaul JA, Williams SA. Medical emergencies in general dental practice in Great Britain. Part 1: their prevalence over a 10-year period. *Br Dent J*. 1999;186(2):72–79.

498 dentists surveyed in Croatia had experienced a medical emergency, and there was a 75% occurrence of at least one medical emergency in a dental office in France.[35]

In Poland, Smereka et al.[21] reported that, although 80.66% of dentists (N=419) had not activated emergency medical services (EMS) in the past 12 months, 12.65% had done so once, 4.53% twice, 1.2% on three occasions, and 0.48% four times. In a survey of orthodontic practices in the Netherlands, 15.7% of 111 respondents required EMS assistance.[18]

Unfortunately, even the most stringent precautions and preparations cannot always prevent death. Each year in the United States, 10% of all nonaccidental deaths occur suddenly and unexpectedly in relatively young persons believed to be in good health—thus the term "sudden, unexpected" cardiac arrest. In these cases the most common cause of death is, fatal cardiac dysrhythmia, usually ventricular fibrillation, is the most common cause of death. Since preventive measures cannot entirely eliminate the possibility of such events, we must prepare the dental profession to handle these situations. Successful outcomes are possible when a dental "team" acts quickly to recognize and manage the situation. Indeed, the survival rate in cases of "CPR emergencies" in Australia was reported to be 75%, and an additional three patients with cardiac arrest secondary to anaphylaxis survived.[8]

However, not all deaths occur within the confines of dental offices. The stress associated with dental treatment can potentially trigger events that result in a patient's demise days after treatment. In a survey conducted by the Southern California Society of Oral and Maxillofacial Surgeons, 10 such incidents were reported.[36] Of particular interest were three deaths secondary to myocardial infarction and one secondary to a cerebrovascular accident. Another death was reportedly related to an allergic reaction to propoxyphene hydrochloride, which the dentist had prescribed for postoperative pain relief. In Matsuura's study in Japan, 5.5% of all medical emergencies developed "after [the patient had left] the dental office."[29]

The State of Preparation for the Recognition and Management of Medical Emergencies in Dental Offices

Worldwide, the state of preparation for medical emergencies in dental offices and the level of education for both dental students and practicing dentists vary considerably.

In a 2018 American Dental Association (ADA) survey on emergency preparedness[22] in the United States, 86.43% of the 529 respondents stated that they had trained for medical emergencies with their staff members, with completion of CPR training by 99.45% of dentists, 84.76% of dental assistants, 76.73% of dental hygienists, and 70.91% of office managers. Emergency 'medical kits' were available in 93.39% of offices, oxygen was available in 94.96% of offices, and an automated external defibrillator (AED) was located on site in 75.73% of offices.

In a 2016 survey, Breuer et al. reported that 97% of German dental students were unable to administer oxygen, 48% were unable to perform adequate CPR, and 47% did not use an AED when necessary.[37] Muller et al. surveyed practicing German dentists (n = 620), reporting that 77%

of respondents expressed an interest in emergency management, and 84% stated that they owned an emergency bag. Over the 12-month study period, 57% of the dentists reported up to three emergencies, and 36% of the dentists reported up to 10 emergencies. A total of 567 dentists (92%) took part in emergency training following graduation, with 23% participating once and 68% more than once.[15]

In another study, 1/3 of Japanese dental students were unable to locate the radial pulse, and 22% could not properly use a pulse oximeter.[38]

In a Polish survey, as many as 41.29% of participants did not feel competent in managing sudden cardiac arrest, 74.47% in managing hypertensive crisis, 55.61% in managing asthma, 55.13% in managing anaphylactic shock, and 52.99% in managing seizures.[21]

Eighty-one percent of Croatian dentists reported never having been trained in CPR while in dental school, with the percentage rising to 86.1% of general practitioners (GPs) after graduation.

Khami et al. reported that less than 60% of Iranian dentists were knowledgeable about the signs and symptoms of hypoglycemia, chest pain of cardiac origin, or the technique for CPR. In a more recent survey of 105 Iranian dentists with at least 5 years of clinical experience, 51% reported that their training in medical emergency recognition and management was inadequate.[39,40]

Among Indian dentists, Gupta et al. reported that 18.5% of dental undergraduate students had received CPR training in dental schools, with 25% of advanced post-graduates receiving CPR training. Forty-two percent had received training in emergency medicine in dental schools.[42]

Several papers on the emergency medicine preparedness of Saudi Arabian dentists reported that most demonstrated a lack of knowledge of basic life support (CPR), as well as an inability to manage a choking victim.[23,42,43] Surveying 100 dental practices in Jazan Province, Saudi Arabia, Al-Iryani et al. reported that 22% of dental clinics had no emergency equipment available on site. Although 95% of the responding dentists had been trained in CPR, only 38% reported feeling confident actually performing CPR, and 18% stated that they had no confidence in managing any medical emergency. On a 20-question multiple-choice quiz related to emergency medicine, the average score was only 54.35%.[44]

In government-owned dental clinics in Nigeria, 204 of the 224 respondents (91.1%) stated that they had no emergency kits in their dental clinics. The most common emergency reported was syncope (104 respondents, 33.8%). Interestingly, 161 respondents (71.9%) claimed that they would be able to manage a medical emergency encountered in their dental practice if kits and drugs were available.[45] In a survey of dental surgeons at a Nigerian teaching hospital conducted by Adewole et al., 20 (26.6%) were consultants, 40 (53.3%) were registrars, and 35 (46.6%) were house officers. Thirty-five (43.7%) had previous knowledge of basic life support (BLS) training, while 45 (56.2%) denied such knowledge. Seventy-three percent of the respondents felt inadequate in the management of cardiovascular emergencies, while only 15.4% felt adequately prepared. There were similar ratings for respiratory emergencies (63.1%, 16.9%, and 3.3%, respectively). The availability of oxygen extension tubing and bag-valve mask devices was nil in all departments. Emergency drugs were claimed to be present by 28.5% of oral surgery respondents and 34.7% of pediatric dental health respondents. Most respondents felt that their clinics were not adequately prepared to deal with medical emergencies.[46]

In the United Kingdom, a survey of 1500 general dental practitioners (1000 in England and Wales, 500 in Scotland) demonstrated that aspirators, airways, oxygen, adrenaline, and injectable steroids were possessed by about 90% of respondents, and glucose, glyceryl trinitrate, and salbutamol inhalers accounted for about 80%.[47] In 74% of the respondents (N=1100), 75% had received training in the management of medical emergencies as undergraduates, and 95% had subsequently received training. The proportion considering themselves 'well' or 'fairly well' prepared to manage emergencies rose from 30% at graduation to 80% at the time of the survey. The 20% who felt themselves 'not very well' or 'not at all,. prepared to manage emergencies were less likely to possess the drugs and equipment to manage an emergency. Nevertheless, a need for further training was expressed by 96%, with only 3% feeling no need.[48]

In New Zealand, Broadbent et al. stated that up to 20% of dentists reported feeling inadequately prepared for medical emergencies and that most were receptive to the idea of receiving further medical emergency–related training. In a survey of 199 general dentists, medical emergencies occurred in 129 practices (65.2%) within the previous 10 years. More than half of the respondents were dissatisfied with the training they had received for medical emergencies as undergraduate students, and 28 (14.1%) currently felt inadequately prepared for an emergency in practice. When asked how their preparedness could be improved, 165 (83.3%) opted for hands-on courses, 15 (7.5%) opted for lectures alone, and 5 (2.5%) opted for other courses alone. One in 20 felt no need for further training. The authors concluded that further training in the management of medical emergencies should be made available to New Zealand dentists.[12]

It is evident from the above studies that the level of training of dentists in medical emergencies varies considerably worldwide, both in basic didactic knowledge related to emergency medicine and in the clinical preparedness to recognize and manage emergencies that might occur.

Risk Factors

Increased Numbers of Older Patients

The life expectancy of persons born in the United States has been steadily increasing. In 1900, the life expectancy was 46.6 years for White males and 48.7 years for White females. In 2017, these figures had changed to 78.6 years overall, 81.1 years for females, 76.1 years for males, 76.4 years for White males, 81.2 years for White females, 71.9 years for Black males, and 78.5 years for Black females. For

TABLE 1.15 Estimated Life Expectancy at Birth, in Years, in the United States

	All Races[a]		White		Black[b]		Hispanic Origin	
Year	Male	Female	Male	Female	Male	Female	Male	Female
2017	76.1	81.1	76.4	81.2	71.9	78.5	79.1	84.3
2009	76.0	80.9	76.4	81.2	71.1	77.6	76.0[a]	80.9 [a]
2005	74.9	79.9	75.4	80.4	69.3	76.1	74.9[a]	79.9[a]
2000	74.1	79.3	74.7	79.9	68.2	75.1	74.1[a]	79.3[a]
1980	70.9	77.4	70.7	78.1	63.8	72.5	70.9[a]	77.4[a]
1960	66.6	73.1	67.4	74.1	61.1[b]	66.3[b]	66.6[a]	73.1[a]
1940	60.8	65.2	62.1	66.6	51.5[b]	54.9[b]	60.8[a]	65.2[a]
1920	53.6	54.6	54.4	55.6	45.5[b]	45.2[b]	53.6[a]	54.6[a]
1900	46.3	48.3	46.6	48.7	32.5[b]	33.5[b]	46.3[a]	48.3[a]

[a]Prior to 2017, statistics for the Hispanic population are included in "All races" but are not available for specific years, as for "White" and "Black".

[b]Prior to 1970, data for the Black population were not available. Data from 1900 to 1969 are for the "nonwhite" population.

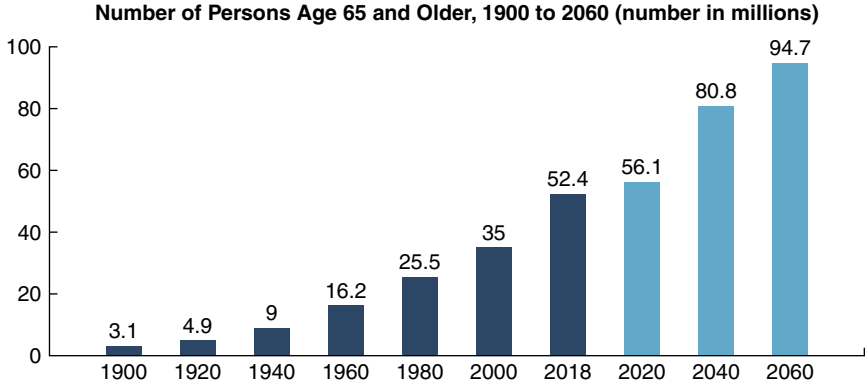
Data from *National Vital Statistics Reports* 68, no. 7. Hyattsville, MD: Centers for Disease Control and Prevention, US Department of Health & Human Services, June 2019.

Hispanics, the overall life expectancy was 81.8 years, with 84.3 years for Hispanic females and 79.1 years for Hispanic males (Table 1.15).[49]

The large number of post–World War II baby boomers have turned the most rapidly growing segment of the US population into those 65 years of age or older (Fig. 1.2). In 2018 (the most recent year for which data are available), 52.4 million Americans were 65 years of age or older,[50] and it is estimated that this number will increase to 80.8 million by 2040 and 94.7 million by 2060.[50]

Although many older patients appear to be in good health, dental practitioners must always look for significant subclinical diseases. All major organ systems (cardiovascular, hepatic, renal, pulmonary, endocrine, and central nervous systems) must be evaluated in older patients, with the cardiovascular and respiratory systems of particular importance. Cardiovascular and respiratory function and efficiency decrease as part of the normal aging process. In some instances, a decreased efficiency manifests itself as heart failure or angina pectoris; however, overt signs are not always apparent. When subjected to stress (pain, fear, anxiety, high humidity, extreme heat or cold), the cardiovascular and respiratory systems of an older person may not be able to meet the body's demands for increased oxygen and nutrients, a deficit of which may lead to acute cardiovascular complications such as life-threatening dysrhythmias and anginal pain or respiratory problems such as acute pulmonary edema.

Cardiovascular disease remains the leading cause of death in persons over 65 years of age in the United States (Table 1.16).[51] Situations that might have been innocuous for a person at a younger age may well prove to be harmful 20 years later. A survey of the effects of age on fatally injured automobile drivers demonstrated the relative inability of



• **Figure 1.2** The most rapidly growing segment of the US population is the group 65 years of age and older because of the large number of post–World War II baby boomers. From the Administration for Community Living 2019 Profile of Older Americans. https://acl.gov/aging-and-disability-in-america/data-and-research/profile-older-americans.

TABLE 1.16 **Ten Leading Causes of Death by Age Group, United States – 2017**

Rank	<1	1–4	5–9	10–14	15–24	25–34	35–44	45–54	55–64	65+	Total
1	Congenital Anomalies 4580	Unintentional Injury 1267	Unintentional Injury 718	Unintentional Injury 860	Unintentional Injury 13,441	Unintentional Injury 25,669	Unintentional Injury 22,828	Malignant Neoplasms 39,266	Malignant Neoplasms 114,810	Heart Disease 519,052	Heart Disease 647,457
2	Short Gestation 3749	Congenital Anomalies 424	Malignant Neoplasms 418	Suicide 517	Suicide 6252	Suicide 7948	Malignant Neoplasms 10,900	Heart Disease 32,658	Heart Disease 80,102	Malignant Neoplasms 427,896	Malignant Neoplasms 599,108
3	Maternal Pregnancy Complications 1432	Malignant Neoplasms 325	Congenital Anomalies 188	Malignant Neoplasms 437	Homicide 4905	Homicide 5488	Heart Disease 10,401	Unintentional Injury 24,461	Unintentional Injury 23,408	Chronic Low. Respiratory Disease 136,139	Unintentional Injury 169,936
4	SIDS 1363	Homicide 303	Homicide 154	Congenital Anomalies 191	Malignant Neoplasms 1374	Heart Disease 3681	Suicide 7335	Suicide 8561	Chronic Low. Respiratory Disease 18,667	Cerebrovascular 125,653	Chronic Low. Respiratory Disease 160,201
5	Unintentional Injury 1317	Heart Disease 127	Heart Disease 75	Homicide 178	Heart Disease 913	Malignant Neoplasms 3616	Homicide 3351	Liver Disease 8312	Diabetes Mellitus 14,904	Alzheimer's Disease 120,107	Cerebrovascular 146,383
6	Placenta Cord Membranes 843	Influenza & Pneumonia 104	Influenza & Pneumonia 62	Heart Disease 104	Congenital Anomalies 355	Liver Disease 918	Liver Disease 3000	Diabetes Mellitus 6409	Liver Disease 13,737	Diabetes Mellitus 59,020	Alzheimer's Disease 121,404
7	Bacterial Sepsis 592	Cerebrovascular 66	Chronic Low. Respiratory Disease 59	Chronic Low. Respiratory Disease 75	Diabetes Mellitus 248	Diabetes Mellitus 823	Diabetes Mellitus 2118	Cerebrovascular 5198	Cerebrovascular 12,708	Unintentional Injury 55,951	Diabetes Mellitus 83,564
8	Circulatory System Disease 449	Septicemia 48	Cerebrovascular 41	Cerebrovascular 56	Influenza & Pneumonia 190	Cerebrovascular 593	Cerebrovascular 1811	Chronic Low. Respiratory Disease 3975	Suicide7982	Influenza & Pneumonia 46,862	Influenza & Pneumonia 55,672
9	Respiratory Distress 440	Benign Neoplasms 44	Septicemia 33	Influenza & Pneumonia 51	Chronic Low. Respiratory Disease 188	HIV 513	Septicemia 854	Septicemia 2441	Septicemia 5838	Nephritis 41,670	Nephritis 50,633
10	Neonatal Hemorrhage 379	Perinatal Period 42	Benign Neoplasms 31	Benign Neoplasms 31	Complicated Pregnancy 168	Complicated Pregnancy 512	HIV 831	Homicide 2275	Nephritis 5671	Parkinson's Disease 31,177	Suicide 47,173

Data Source: National Vital Statistics System, National Center for Health Statistics, Centers for Disease Control (CDC).

Produced by: National Center for Injury Prevention and Control, CDC using Web-based Injury Statistics Query and Reporting System.

older persons to tolerate undue stress. Baker and Spitz[52] found that the proportion of drivers aged 60 years or older who were killed in multivehicle crashes was five times higher than the proportion of younger drivers. Many drivers aged 60 years and over died after crashes that did not prove fatal to younger drivers. The correlation between age and the length of survival suggests that, whereas younger drivers can recover from injuries, many older drivers die of complications.[52,53] The aging process involves both physiologic and pathologic changes that may alter a patient's ability to successfully adapt to stress.

Box 1.1 lists some of the physiological changes that older patients frequently encounter. A decrease in tissue elasticity is a major physiological change that has significant effects on the organs of the body. For example, in a 75-year-old individual, cerebral blood flow was 80%, cardiac output was 65%, and renal blood flow was 45% of that of a 30-year-old individual. These changes in renal blood flow can affect the actions of certain drugs, primarily those that rely principally on urinary excretion for removal of the drug and its metabolites from the body. Penicillin, tetracycline, and digoxin, for example, exhibit increased elimination half-lives in older patients.

• BOX 1.1 Changes in Geriatric Patients

Central Nervous System

Decreased number of brain cells
Cerebral arteriosclerosis
Cerebrovascular accident
Decreased memory
Emotional changes
Parkinsonism

Cardiovascular System

Coronary artery disease:
- Angina pectoris
- Myocardial infarction
- Dysrhythmias
- Decreased contractility

High blood pressure:
- Renovascular disease
- Cerebrovascular disease
- Cardiac disease

Respiratory System

Senile emphysema
Arthritic changes in thorax
Pulmonary problems related to pollutants
Interstitial fibrosis

Genitourinary System

Decreased renal blood flow
Decreased number of functioning glomeruli
Decreased tubular reabsorption
Benign prostatic hypertrophy

Endocrine System

Decreased response to stress
Type 2 (adult-onset) diabetes mellitus

Modified from Lichtiger M, Moya F. *Curr Rev Nurse Anesth.* 1:1, 1978.

TABLE 1.17 Pulmonary Changes in Patients 65 Years and Older

Function	Percentage Compared With Capacity at Age 30
Total lung capacity	100
Vital capacity	58
O_2 uptake during exercise	50
Maximum breathing capacity	55

Data from Lichtiger M, Moya F. *CurrRev Nurse Anesth.* 1:1, 1978.

Decreased tissue elasticity also affects the lungs. Pulmonary compliance decreases with age and can progress to senile emphysema. Long-term exposure to smoke, dust, and pollutants can decrease respiratory function in older patients, producing disorders such as asthma and chronic bronchitis. Pulmonary function in older patients is considerably diminished compared with that in younger patients (Table 1.17).[52]

However, within the past three decades, dental practitioners have begun treating patients older than 60 years of age who have retained most of their natural dentition. These patients require a full range of dental care, including periodontics, endodontics, crowns, bridges, restorative work, oral surgery, and implants. Because of their age and the possibility of preexisting physical disabilities, many of these patients are less able to handle the stress normally associated with dental treatments. This reduced stress tolerance should forewarn dental practitioners that older patients are at greater risk during dental treatments, even in the absence of clinically evident disease (Box 1.2). In addition, the dental practitioner must take every step to minimize this risk (see stress-reduction protocols[54] in Chapter 2).

Medical Advances

The incidence of many diseases increases with age. Diabetic patients and patients with cardiovascular disease (heart failure, arteriosclerosis) have significantly longer life expectancies than those 25 or 35 years ago. Many patients who were

• BOX 1.2 Factors Increasing Risk During Dental Treatment

Increased number of older patients
Medical advances in surgery and drug therapy
Increased number of surgical procedures (e.g., implants)
Longer appointments
Increased drug use
- Local anesthetics
- Sedatives
- Analgesics
- Antibiotics

Modified from Lichtiger M, Moya F. *Curr Rev Nurse Anesth.* 1:1, 1978.

previously confined to their homes or reliant on wheelchairs and who were unable to work and were unlikely to seek dental care can now live relatively normal lives because of advances in drug therapy and surgical techniques. Radiation and chemotherapy enable many patients with cancer to live longer. Surgical procedures such as coronary artery bypass grafts and heart valve replacements have become more common, permitting previously incapacitated patients to pursue active lifestyles. Single- and multiple-organ transplants have higher success rates and have been performed at a greater frequency than in the past years. Newer and more effective drug therapies are available for the management of chronic disorders such as hypertension, diabetes, and human immunodeficiency virus infection.

These medical advances are significant. They also mean that dental practitioners must manage the oral health needs of more at-risk patients, many of whom have chronic disorders that are merely being controlled or managed but not cured. McCarthy termed these persons "the walking wounded, accidents looking for a place to happen."[55]

Longer Appointments

The length of dental appointments has increased steadily. According to a survey by the ADA, the average treatment time was 50.7 min in a general dentistry office and 40 min in a specialty practice.[56] Between 1990 and 2009, the average length of a dental appointment increased by 7 min, with an annual increase. In addition, more patients are seen for 1- to 3-hour treatments (e.g., endodontics and implant surgery). Dental care can be stressful for patients, doctors, and staff members, and longer appointments naturally create more stress. Medically compromised patients are more likely to react adversely under these conditions than healthy individuals; however, even healthy patients can suffer from stress, which can lead to unforeseen complications. Stress reduction has become an important concept for the prevention of medical emergencies.

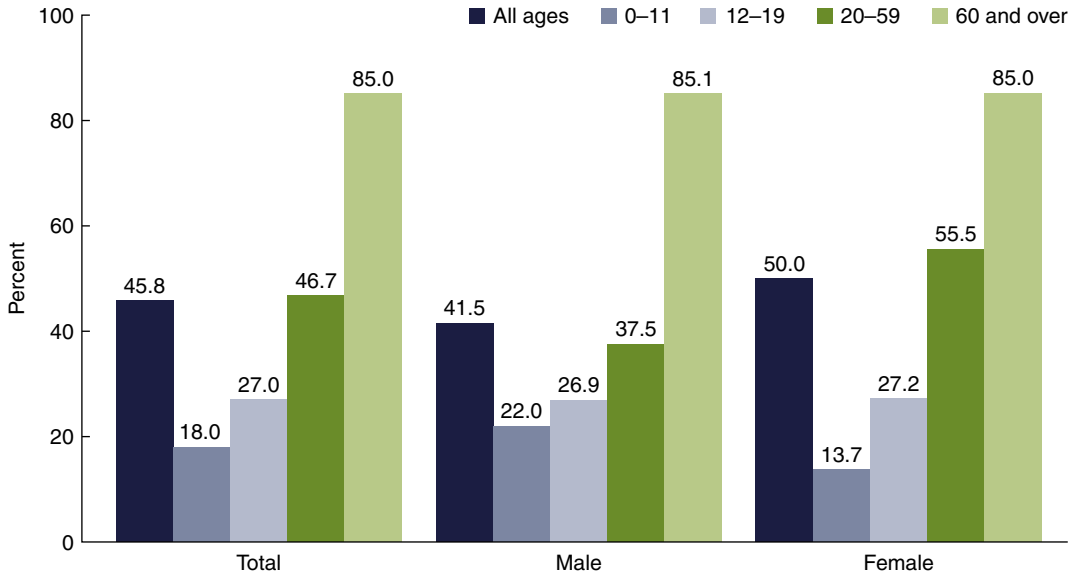
Increased Drug Usage

Drugs play an integral role in contemporary dental practice. Drugs for preventing preoperative, perioperative, and postoperative pain and for managing fear and treating infections are important components of every doctor's armamentarium. However, all drugs exert multiple actions, and no drug is absolutely free of risk. Knowledge of the pharmacologic actions of a drug and the proper technique for drug delivery are needed to decrease the occurrence of drug-related emergencies.

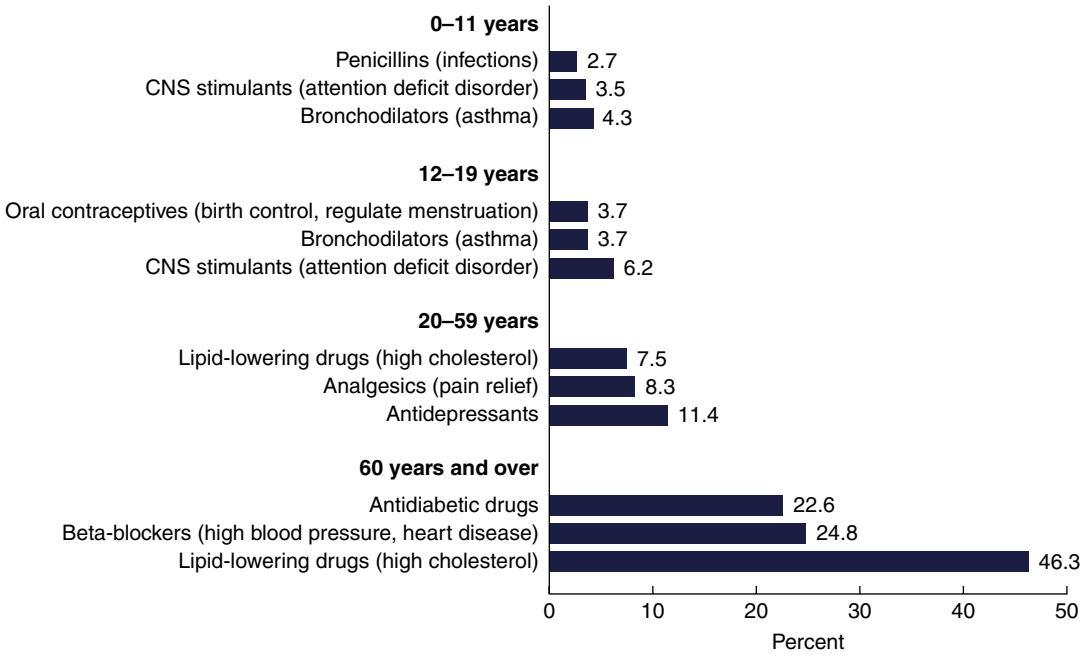
In 2015–2016, 45.8% of the US population had used one or more prescription drugs in the past 30 days (Fig. 1.3). This prescription drug use increased with age in both males and females. Overall, 18.0% of children aged 0–11 years, 27.0% of adolescents aged 12–19 years, 46.7% of adults aged 20–59 years, and 85.0% of adults aged 60 years and over had used prescription drugs during the past 30 days.[57]

Dental practitioners must take special care to anticipate and recognize complications related to either the pharmacologic actions of a drug or potential drug-drug interactions between commonly used dental drugs and other medications. For example, orthostatic hypotension is associated with many drugs used for the management of high blood pressure.

Other examples include potentially significant interactions between monoamine oxidase inhibitors and opioids (e.g., meperidine and fentanyl) and between epinephrine and noncardiospecific β-adrenergic blockers. Patients, both male and female, using phosphodiesterase



• **Figure 1.3** Use of one or more prescription drugs in the past 30 days by age (years) and sex: United States, 2015–2016.



• **Figure 1.4** Use of the most commonly used prescription drug types in the past 30 days by age group: United States, 2015–2016. Notes: The primary indications for the use of the drug type are given in parentheses. Other drug types may also be used for the same indications. (From Martin CB, Hales CM, Gu Q, Ogden CL. Prescription drug use in the United States, 2015–2016. *NCHS Data Brief*. 2019;334:1-8. Available at: https://www.cdc.gov/nchs/products/databriefs/db334.htm.
CNS, Central nervous system.
Source: NCHS. National Health and Nutrition Examination Survey, 2015–2016.

inhibitors (Viagra, Cialis, Levitra) are at risk of developing significant hypotension in the event of an acute anginal episode requiring administration of nitroglycerin.[58] Fig. 1.4 presents the three most commonly prescribed drug types by age group.[57]

This text aims, in part, to increase dental practitioners' recognition of potentially high-risk patients so that appropriate modifications may be incorporated into their planned treatments. A second aim is to increase the prompt recognition and effective management of such situations, which are inevitable despite the most stringent preventative efforts.

Goldberger[59] wrote, "When you prepare for an emergency, the emergency ceases to exist." The ultimate aim in the management of any emergency is the preservation of life. The primary goal is to hold each section of this text together.

Classification of Life-Threatening Situations

Several methods are available for the classification of medical emergencies. The traditional approach is a *systems-oriented classification,* which lists major organ systems and discusses life-threatening situations associated with each of these systems (Box 1.3).

Although a systems approach is often considered suitable for educational purposes, it is lacking from a clinical perspective. A second classification method divides emergency situations into two broad categories: *cardiovascular* and *noncardiovascular emergencies,* both of which can be broken down further into *stress-related* and *nonstress-related emergencies*. This system offers a very general breakdown of life-threatening emergencies that can be particularly useful for doctors.* Combining these systems provides two divisions from which to work: cardiovascular versus noncardiovascular and stress-related versus nonstress-related emergencies (Table 1.18).

This classification system can assist doctors in designing a workable treatment protocol for the prevention of such situations. The risk of developing a stress-related emergency may be reduced by incorporating several stress-reducing modifications into dental care. Such factors include the use of sedative techniques, effective pain control, and limits on the length of dental treatments. The stress reduction protocol is discussed in section 2.

Although the cardiovascular-based classification system is useful for emergency prevention, doctors need a method

*The term *doctor* is applied generically throughout this text, be they a physician or a dentist. The term describes an individual charged with the direction and management of emergency situations, often a dentist for the purposes of this text.

BOX 1.3 Systems-Oriented Classification System of Medical Emergencies

Infectious Diseases

Immune system
- Allergies
- Angioneurotic edema
- Contact dermatitis
- Anaphylaxis

Skin and Appendages

Eyes

Ears, Nose, and Throat

Respiratory Tract

Cardiovascular System

Arteriosclerotic heart disease
Angina pectoris
Myocardial infarction
Heart failure
Blood

Gastrointestinal Tract and Liver

Obstetrics and Gynecology

Nervous System

Unconsciousness
- Vasodepressor syncope
- Orthostatic hypotension

Convulsive disorders
- Epilepsy

Drug overdose reactions
Cerebrovascular accident
- Endocrine disorders

Diabetes mellitus
- Hyperglycemia
- Hypoglycemia

Thyroid gland
- Hyperthyroidism
- Hypothyroidism

Adrenal gland
- Acute adrenal insufficiency

TABLE 1.18 Cardiac-Oriented Classification System of Emergency Situations

	Noncardiovascular	Cardiovascular
Stress-related	Vasodepressor syncope Hyperventilation Seizure Acute adrenal insufficiency Thyroid storm Asthma (bronchospasm)	Angina pectoris Acute myocardial infarction Cerebral ischemia and infarction Pulmonary edema (acute heart failure) Sudden cardiac arrest
Nonstress-related	Orthostatic (postural) hypotension Overdose (toxic) reaction Hypoglycemia Hyperglycemia Allergy	Acute myocardial infarction Sudden cardiac arrest

that can help them more easily recognize and manage such situations in real time. Therefore, classifications based on organ systems are sometimes abandoned. In most real-life clinical situations, doctors may be unaware of their patients' underlying pathological conditions. The doctor needs to be able to recognize and initiate the management of potentially life-threatening situations using only the most obvious clinical signs and symptoms as guides. For this reason, a classification of medical emergencies based on *clinical signs and symptoms* has proven useful since the first publication of this book in 1978.

Of necessity, a doctor will base the initial management of most emergency situations on clinical clues until a more definitive diagnosis can be discerned. Commonly seen signs and symptoms include alterations in consciousness (unconsciousness, impaired or altered consciousness), respiratory distress, seizures, emergencies related temporally with the administration of drugs, and chest pain. In each situation, a successful outcome depends on the doctor's adherence to a defined treatment protocol. Once these steps have been successfully employed, additional (secondary) steps can direct the doctor toward a more definitive diagnosis, which can help correct the problem.

This text is organized around the use of defined protocols and management steps. Each major section is devoted to a common symptom complex, with a list of the most common manifestations of this symptom complex. Basic management procedures for the problem are then discussed, followed by a detailed review of the category's most common emergencies (Box 1.4). Each section closes a differential diagnosis.

These classifications are designed to place each life-threatening situation in the category that most closely represents the usual clinical manifestation of the problem. Several emergency situations could also be included in a classification other than that in which they were placed. For example, an acute myocardial infarction and a cerebrovascular accident are both possible causes of unconsciousness; however, full discussions of these emergencies are found in their more commonly encountered clinical manifestations, chest pain for myocardial infarction, and altered consciousness for cerebrovascular accident.

Outline of Specific Emergency Situations

In the discussion of each emergency situation, various factors were presented. The headings and aims of each include the following:

1. **General considerations:** An introductory section presents general information about the situation. Definitions and synonyms are included when relevant.
2. **Predisposing factors:** This section focuses on the incidence and cause of the disorder and the factors that can predispose a patient to experience a life-threatening situation.

• BOX 1.4 Common Medical Emergencies in the Dental Office

Unconsciousness

Vasodepressor syncope
Orthostatic hypotension
Acute adrenal insufficiency

Respiratory Distress

Airway obstruction
Hyperventilation
Asthma (bronchospasm)
Heart failure and acute pulmonary edema

Altered Consciousness

Diabetes mellitus (hyperglycemia and hypoglycemia)
Thyroid gland dysfunction (hyperthyroidism and hypothyroidism)
Cerebrovascular accident

Seizures

Drug-Related Emergencies

Drug overdose reactions
Allergy

Chest Pain

Angina pectoris
Acute myocardial infarction

Sudden Cardiac Arrest

3. **Prevention:** This section builds on the previous sections to minimize the occurrence of acute exacerbation of the disorder. The medical history questionnaire, vital signs, and dialogue history are used to determine a risk category for each patient based on the system developed by the American Society of Anesthesiologists[60,61] and later modified for use in dentistry. Suggestions for specific dental treatment modifications complete the discussion.
4. **Clinical manifestations:** This section focuses on clinically evident signs and symptoms that foster recognition of the disorder.
5. **Pathophysiology:** This section focuses on the pathological processes underlying the clinical signs and symptoms. A fuller understanding of the cause of a problem can better enable a doctor to manage the situation.
6. **Management:** The step-by-step management of clinical signs and symptoms is the aim of this section.
7. **Differential diagnosis:** Each section closes with a chapter devoted to helping the doctor identify the most probable cause of a patient's emergency.

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