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Management of oral infections: Part 1

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Management of oral infections: Part 1

Abstract

This two-part course will review acute oral infection management with regard to bacteria, viruses, and other microflora that may be encountered in the dental practice. Part one focuses on the essentials that should be considered when treating dental infections, including microbiology, triage, anatomy, and laboratory testing. Part one also includes information about antibiotic, surgical, and palliative treatment needed in the management of acute dental infections. Part two will focus on the treatment of oral infections due to fungal, viral, and bacterial organisms.

Educational objectives

1. Describe how bacteria may lead to infection and how to manage this with antibiotics
2. Discuss anatomical features that can lead to infection spread in the head and neck
3. Be prepared to treat swelling and manage incision and drainage

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Introduction

Acute dental infections can be challenging to manage.[1] Periapical abscesses are a frequent occurrence in the dental practice, and identification and management are key to preventing spread of infection and potentially life-threatening results that may occur when not treated. A study covering a nine-year period of hospital admissions in the United States showed that more than 61,000 hospitalizations were directly related to dental infection from periapical abscesses.[2] Of the hospitalizations reported in that study, 66 patients died as a result of those dental infections.[3] Another study in 2007 reported 7,886 hospitalizations attributed primarily to periapical abscesses resulting in a total of 23,001 hospitalization days. The total hospital charges attributed to those patients was $105.8 million.[3] Unfortunately, this demonstrates that dental abscesses are often an underestimated disease of the oral cavity.[4]

A study based on a questionnaire found that of those who responded, 95% of practitioners recognized the need for prescribing antibiotics when evidence of infection presented. Interestingly, practitioners were generally not influenced by a patient's expectations of receiving antibiotics (92%), but when the patient pressured them, 30.3% would prescribe an antibiotic. When a definitive diagnosis was not able to be made, 47.3% would write an antibiotic prescription. Yet, if treatment had to be delayed, a majority of dentists (72.5%) would prescribe antibiotics. Amoxicillin was the most frequently prescribed antibiotic, with a wide variety in dosage, frequency, and duration for all the antibiotics used in the treatment of acute dental infections.[5] The global burden during a 10-year period (1990–2010) of periodontal disease, oral cancer, and caries increased markedly by an average of 45.6%. As dentists are typically the first to see patients with early odontogenic infections, it is vital that they be prepared to evaluate and treat these problems before they become severe enough to require hospitalization.[6]

The nature of oral infections

The oral cavity is an environment with large numbers of bacteria, as well as fungal organisms, parasites (protozoa), and viruses that naturally colonize the surfaces. More than 700 bacterial species—both nonpathogenic and pathogenic—have been identified in the oral cavity, of which more than 50% have not been cultivated.[7,8] The mouth is a complex habitat where microbes colonize the hard surfaces of the teeth and the soft tissues of the oral mucosa. When a breakdown of the hard or soft tissue occurs, the microflora can take advantage of the opportunity, which leads to infection. Oral opportunistic pathogens were reported in 13.6% of patients in one study.[9]

Anaerobic gram-negative rods are commonly isolated in primary endodontic infections, with this being dominated by facultative anaerobic gram-positive cocci and *Streptococcus*, *Enterococcus*, *Peptostreptococcus*, and *Actinomyces* rod species.[10] Opportunistic microorganisms such as *Escherichia coli*, *Streptococcus pneumoniae*, *Staphylococcus aureus*, and *Klebsiella pneumoniae* are commonly found in the oral cavity and have been linked to systemic issues via oral biofilm.[11] Additionally, increasing evidence is being reported that *Candida albicans*, a fungus, is frequently isolated from endodontic infections.[12] Practitioners need to be aware that some infections may not be bacteria-related, and treatment needs to be modified when they do not respond to antibiotics normally prescribed for bacterial infections.

Increasing evidence has been presented linking multiple systemic diseases, such as cardiovascular, pulmonary, pancreatic, and kidney diseases, as well as Alzheimer's disease and other conditions, with the microflora present in oral biofilm.[13] Oral biofilm has been identified as more complex than what we had termed "plaque" for many decades. This material houses many species of microflora in a sticky matrix that is found on hard and soft tissues. Biofilms are not unstructured, homogeneous accumulations of cells, but are complex communities of surface-associated bacterial cells enclosed in a polymer matrix.[14]

Bacteria within the biofilm acts differently than bacteria found on surfaces (planktonic). Bacteria in biofilm may boost or suppress metabolic activity, which then may lead to an oral infection. Numerous factors regulate the number and types of bacteria within the biofilm, which includes the microflora complexity, bacterial retention and interspecies interaction, host resistance, and the condition of the soft and hard tissues present in the patient's oral cavity. Diet plays a factor that is often overlooked as carbohydrate-rich diets favor bacteria species such as *Streptococcus mutans*, an organism that causes dental caries that may lead to endodontic infection.

Systemic disease has an influence on the oral microbial population, with host defense mechanisms being compromised by conditions such as diabetes, heart failure, chronic lung disease, malnutrition, and alcoholism. This immune system compromise may lead to a reduction in phagocytic activity and circulation, allowing the infection to increase related to diminished host response. Immunosuppressant medications used for some medical conditions also hamper host defense mechanisms and increase infection risk. Prolonged systemic antibiotic therapy also reduces normal bacterial flora, allowing resistant flora and/or the emergence of fungal organisms.

Other factors that influence oral infection, including age, behavioral considerations such as drug or alcohol abuse, and the patient's psychological status, play a factor in the incidence and severity of infections that may develop. The areas of the body, including parts of the oral cavity, should be thought of as a chess board with only one organism able to occupy a square at a time. When in a healthy state, nonpathogenic bacteria occupy those squares. But when systemic issues and breakdown of the system or areas of the oral cavity occur, pathogenic microfloras are able to occupy some of those squares, leading to infection.

Microorganism virulence is also a factor in infection potential and severity. Virulence is a harmful quality possessed by microorganisms that can cause disease, which is related to the invasive nature of that particular organism. This relates to the microflora's toxins and their metabolic and enzymatic by-products produced during

the course of the infectious process. Infection revolves around the interactions of the microbial population present, their individual virulence, and the host defenses. Host defenses—the immune system—are an important factor in the prevention of oral and systemic infection. Bacterial colonization is minimized by epithelial cell shedding from the soft-tissue surfaces and the flushing of those surfaces by saliva. But infections that originate in the pulpal tissue or within the bone (periapical abscesses) are, in a sense, an isolated system, allowing infection to progress without the immune system being able to manage the bacteria that is causing the infection. The immune system provides a mechanical protection, but a chemical protection is also present with the production of lymphoid cells producing immunoglobulins.[15] Serum proteins, such as histamine, prostaglandins, and lymphokines, are released as a result of inflammation. These proteins are designed to mediate the actions of the invasive microflora. These are supported by cellular defenses dependent on receptors, phagocytes, and lymphocytes via B and T cells.[16,17]

Infection diagnosis

Acute oral infections are predominantly self-limiting, and management of an infection typically requires minimal intervention. Yet, some oral infections may be associated with greater morbidity and mortality, and recognizing the signs and symptoms of the disease process is essential to providing appropriate triage for the patient. Onset of symptoms and how quickly the swelling presented, as well as where the swelling is spreading, are indicators of the severity of the infection and its potential for increased morbidity. A patient who presents reporting rapidly increasing swelling under the jaw that is spreading into the neck or into the area inferior to the orbit and cheek is indicative of a severe infection, and management needs to be taken seriously. When coupled with other local and systemic symptoms—such as difficulty breathing or swallowing, fever, a thready pulse, increasing pain quality (e.g., change from a mild ache to a severe throb)—there is urgency for referral to an oral surgeon, medical practitioner, or a local emergency room or urgent care center. These clinical signs and symptoms indicate systemic toxicity and possibly a life-threatening situation.

Anatomic considerations

A basic understanding of head and neck anatomy, including the fascial spaces and how those spaces connect, will guide the practitioner in recognizing infection spread and whether urgent referral is needed to manage the situation. As part of the understanding of anatomy and its effect on infection spread, knowing where lymph nodes are located helps during diagnosis as to infection severity. Lymph nodes that present with tenderness, are enlarged, indurated, or fixed suggest the presence of infection that has spread beyond that which is associated only with a tooth abscess. Infection and swelling that presents in the pterygomandibular, parapharyngeal (lateral pharyngeal and retropharyngeal), peritonsillar, cervical, and infratemporal or parotid spaces are considered high risk and necessitate urgent intervention as the situation can quickly become life-threatening.

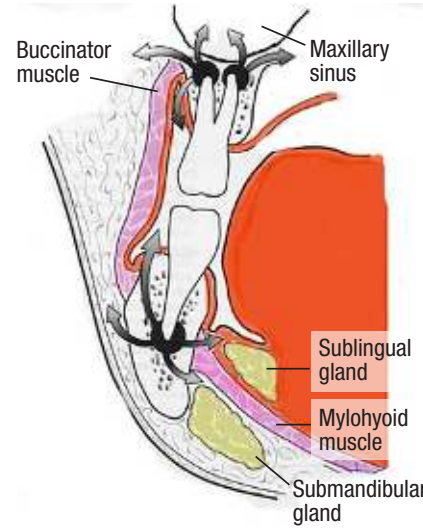


FIGURE 1: Routes of spread of odontogenic infection that can spread from periapical origin

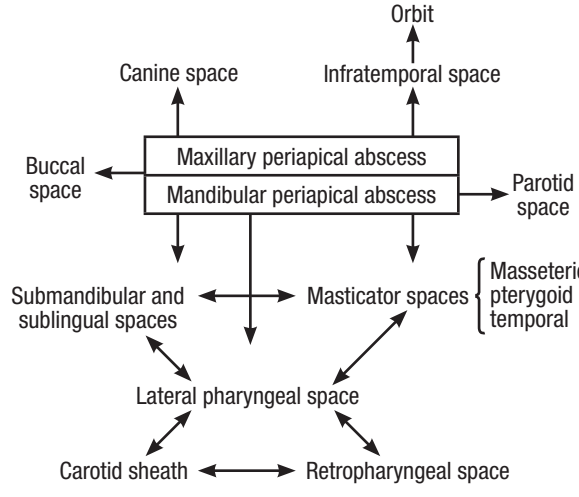


FIGURE 2: Areas of potential infection spread related to fascial spaces

Spread of the infection beyond the periapical area of the tooth through fascial spaces depends on from which jaw the infection originated from **(figure 1)**. Fascial spaces are potential spaces that exist between the fasciae and underlying muscles and other tissues.[18] In health, those spaces do not exist; they are only created by pathology, (e.g., the spread of exudate in an infection). Understanding those factors aids the practitioner in deciding which arch to initially examine radiographically to identify the infection source. When the patient presents with swelling inferior to the orbit, the maxillary anterior teeth are typically the source of the infection related to an abscess.

Infections originating in the maxillary canine or premolars may present with swelling inferior to the zygoma and may be mistaken as originating in the cheek, although infections that originate in the canine space that spread to the area inferior to the zygoma, if left unattended, may move into the cheek (buccal space) as they spread further. Infections originating in the mandibular posterior teeth may also spread to the buccal space, but those will demonstrate more swelling at the inferior aspect of the cheek, whereas infections spreading to the buccal space from the maxillary teeth will present with

greater swelling in the superior aspect of the area **(figure 2)**.

Infections originating in the mandible may spread to more spaces due to the anatomical connections to those teeth. As the bone in the posterior mandible is thinner on the lingual than on the buccal aspect of the jaw, infections may perforate the osseous plate and gain access to spaces, allowing the infection to spread lower anatomically. This has the potential to lead to airway issues as the infection spreads via gravity to the submandibular and sublingual spaces and then to the pharyngeal space **(figure 2)**.

Cellulitis, another potentially life-threatening condition, is a spreading bacterial infection just below the skin surface via the fascial planes. This is frequently caused by *Streptococcus pyogenes* or *Streptococcus aureus*.[19,20]

Ludwig's angina, a cellulitis-causing condition, is a rare infection that occurs under the tongue in the submandibular space. This bacterial infection usually occurs following abscess of a second or third mandibular molar, with spread of the infection to the area under the tongue, and it's more common in adults than children. The submandibular space consists of two compartments in the floor of the mouth, the sublingual space and the submylohyoid **(figure 3)**. Ludwig's angina is an aggressive, rapidly spreading cellulitis without lymphadenopathy and a potential for airway obstruction that can be life-threatening. Usually, when prompt treatment is initiated, full recovery results. When identified, this requires rapid intervention for prevention of asphyxia and aspiration pneumonia. Clinical signs include upward and backward displacement of the tongue and bilateral submandibular swelling extending inferiorly into the anterior neck with extension to the clavicles, resulting in dysphagia.

The infratemporal space is another anatomic area of great importance with potential for a life-threatening infection. Infection originating in the maxillary molars may spread to the infratemporal space with a potential risk of spread to the orbit and ascension to the cavernous sinus via the venous plexus in the ovale and spinosum foramina **(figure 4)**.[21] When left untreated or in a rapidly spreading infection, it may spread from the infratemporal space to the brain, resulting in death.[22]

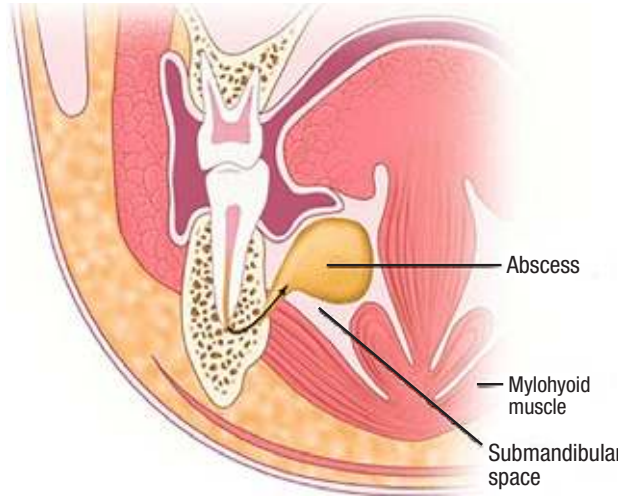


FIGURE 3: Spread of infection originating from endodontic infection of the mandibular posterior teeth leading to Ludwig's angina via communication with the submandibular space

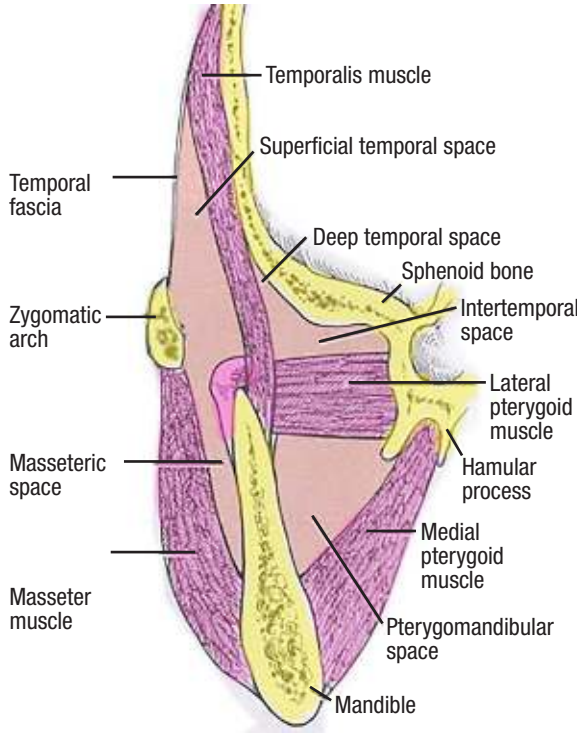


FIGURE 4: Spaces of the infratemporal area that may allow spread of infection of odontogenic origin

Laboratory considerations

The majority of infections encountered in the dental office are minor in nature and can be well managed without the need for culture. But three important considerations are required: origin of the infection, anatomical involvement, and the bacterium most likely involved. Most oral infections are odontogenic in nature and superficial, with the majority of those infections caused by a *Streptococcus* bacteria.[23] Infection by anaerobic bacteria such as *Staphylococcus*, *Neisseria*, and others can also occur, but is less frequent.[24,25]

An infection that does not respond to routine antibiotic therapy requires identification of the microorganism(s) causing the infection via laboratory evaluation. This provides the greatest precision in selecting the appropriate antibiotic to control and eliminate the infection. A culture is recommended when the infection has spread to one or more fascial spaces of the head and neck and initial antibiotic treatment has failed to control the infection, or the patient's underlying health is compromised by other conditions that affect their immune response and the patient demonstrates evidence of systemic toxicity.[26,27]

Gram staining may be the most useful in-office procedure in assessing infectious microorganisms as immediate results are provided, and it allows determination of the type and numbers of species involved.[28]

Techniques for assessing infection (purulent discharge) within an infected tooth may aid in antibiotic selection in those teeth with an endodontic infection that is not responding to antibiotic treatment. When the practitioner is not competent with these in-office techniques, it is best to refer to a specialist for collection, further lab evaluation, and subsequent dental or medical treatment.

Managing dental abscesses

Dental abscesses develop from bacterial contamination and subsequent invasion of the pulp. Ultimately, the infection spreads to the periapical area of the root and surrounding alveolar bone. Subsequent size of the resulting periapical abscess is dependent on several factors, including virulence of the bacteria, how long the infection has been present, and the host's immune system. Intervention is key to prevention of abscess formation, and identification of caries is critical to prevent bacterial communication to the pulpal tissue. Prevention starts with regular dental hygiene visits and examinations to identify dental problems such as caries, periodontal disease, and other issues that—when left unattended—may culminate in dental infections. Patient home care is also a critical factor in infection prevention.

The American Dental Association's (ADA) guideline for antibiotic use for the urgent management of dental pain and intraoral swelling suggests that treatments designed to reduce pulpal symptoms and/or protect the pulpal tissue of the tooth with pulpitis should be utilized.[29] Management of dental abscesses should be considered: nonsurgical approaches (e.g., antibiotics), chemotherapeutic modalities, caries management via dental restorations, endodontic therapy, tooth extraction, and surgery.[29] However, when swelling is noted with any acute infection, purulence must be eliminated via surgical drainage prior to the initiation of an antibiotic to prevent further spread of the infection to other spaces.

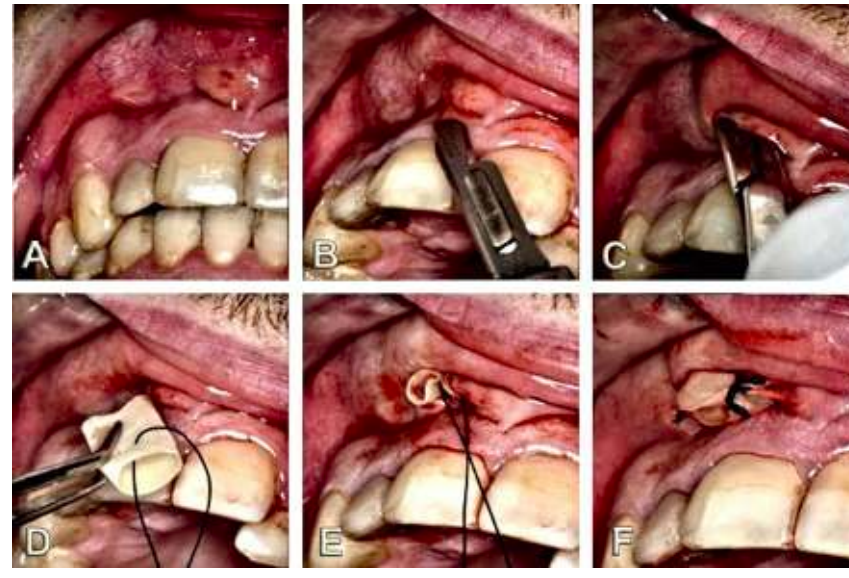
Incision and drainage

Drainage of orofacial purulence can be accomplished through pulpal access, tooth extraction, or surgical incision to achieve drainage. The decision as to which approach depends on the condition of the infected tooth and severity of the infection. When incision and drainage are planned, the soft tissue is incised and spread with a hemostat to allow purulence to drain. This is followed by placement of a rubber drain.[30] In medical procedures, the drain has been referred to as a "Penrose" drain and consists of a rubber tube placed into a surgical incision to allow drainage. Intraorally, a rubber tube may be difficult to place due to the smaller confines, and typically a strip of latex or nonlatex material may be used as an alternative drain. This achieves the same goal as a Penrose drain, keeping the surgically placed wound open to allow drainage and not allow the incision to seal until the drain is removed by the practitioner.

With regard to the typical intraoral swelling that would require incision and drainage, swelling is identified in the vestibule, which may or may not present with a fistula. When the swelling initiates high in the vestibule, a fistula usually does not present **(figure 5a)**. Following administration of local anesthetic to the area, a scalpel is utilized to make an incision from the posterior to anterior at the center of the swelling **(figure 5b)**. A hemostat is inserted into the incision and the instrument expanded to stretch the tissue and allow drainage of the purulence **(figure 5c)**. A blunt-tipped instrument, such as a periosteal elevator or surgical curette, may be placed into the incision and probed to allow drainage from any pockets of exudate that are in the area.

Massaging the area toward the incision will aid in drainage during the surgical procedure, which can be followed by irrigation with sterile saline solution in an irrigation syringe to aid in flushing exudate and its associated bacteria from the area. A nonresorbable suture is placed through the drain, and the drain is inserted deep into the incision **(figure 5d)**, with the end protruding from the incision **(figure 5e)**. The drain is then sutured to the exterior of the incision to retain the drain in the incision and prevent closure of the soft tissue and allow continuous drainage **(figure 5f)**. The drain needs to be long enough to remain in the site, as a short drain can be pushed out of the incision and allow wound closure.

Postoperative instructions include warm salt water rinses several times daily until the patient returns for a postsurgery appointment. Chlorhexidine rinses with a concentration of 0.2% have been advocated to keep bacteria levels down and help prevent oral bacteria from entering the wound during healing.[31,32] The patient is seen three to four days later. If drainage has stopped and swelling is resolved, the drain may be removed. If drainage



FIGURES 5A-5F: Steps to perform incision and drainage intraorally

is still noted and the swelling has been reduced, then the patient should be seen three to four days later to reevaluate healing. Should swelling have increased at the postoperative appointment or drainage continues, switching the antibiotic should be considered as resistant bacteria may be present.

Antibiotics

Bacterial populations associated with oral infections and antibiotic resistance continually evolve, and treatment needs to also evolve as new evidence develops.[33] It has been noted that only about 12% of dentists correctly and adequately prescribe antibiotics, which may demonstrate the need for comprehensive guidelines on antibiotic use.[34] Antibiotics are recommended when pain is associated with a periapical abscess or when swelling is noted with or without accompanying pain. Patients may present with the complaint of recent swelling but indicate no pain or that the pain has disappeared. As pressure is relieved in the area as the purulence spreads into a fascial space, pain may decrease or stop entirely.[24] Presence of a fever is indicative of an active infection and antibiotic prescription is indicated.

As the infection spreads beyond the periapical area of the root, the bacteria involved in the infection include a combination of aerobic and anaerobic microorganisms. This shift in microflora composition can significantly increase the virulence of the infection and thus complicate antibiotic selection. Microbial resistance is an important consideration when selecting an antibiotic. A recent study reported a 47.8% penicillin-resistant *Streptococci* incidence.[35] Similar studies have reported resistance to penicillin with *Staphylococcus* species and it may be time to reconsider use of penicillin itself as an antibiotic for treatment of oral infections and use broader-spectrum antibiotics.[36] Antibiotic choices are dependent on how long the infection has been present and if a medication allergy is present (table 1). Dosage and duration are also factors in the antibiotic selected (table 2). Too low a dose or duration of use may allow bacteria that are minimally resistant to flourish as the susceptible bacteria are killed, creating a more resistant infection.

Antibiotic choice is largely empirical as the science supporting the efficacy of one antibiotic over another is not definitive due to conflicting published research.[37] Penicillin in general is often the first drug of choice for treatment of oral infections. Olsen and van Winkelhoff stated that acute oral infections can spread extraorally, and recommended penicillin when suspicion of methicillin-resistant *Staphylococcus aureus* involvement is low.[38] Appropriate and correct use of antibiotics is essential to ensure that effective and safe treatment is available and that practices that may enhance microbial resistance are avoided.[39]

Amoxicillin is favored as the drug of first choice over penicillin due to its broader spectrum of action against gram-positive and -negative bacteria.[40] If the patient has a history of antimicrobial resistance to penicillin, then metronidazole may be used to supplement that drug to aid in overcoming the antibiotic resistance by the flora present in the infection.[41,42] An alternative that is available in a single pill is Augmentin, a combination of amoxicillin and clavulanic acid, which should be considered when the patient has a history of penicillin ineffectiveness and no allergy issues to penicillin-type drugs. For individuals allergic to the penicillin-based antibiotics, Clindamycin can be prescribed.[43] Clindamycin has been reported to be effective against both aerobic and anaerobic bacteria with rapid osseous penetration.

Penicillin: Penicillin, as mentioned, tends to be the first line of treatment for oral infections. It inhibits bacterial cell wall cross-linking and is thus bactericidal. Although it has a fairly narrow antimicrobial spectrum, it affects most bacteria associated with oral infections. Penicillin resistance has been reported, occurring primarily through the production of beta-lactamase.[44] Recent evidence suggests a high penicillin resistance incidence among patients previously treated with beta-lactamase antibiotics (penicillin and cephalosporin).[45] In culture and sensitivity testing of odontogenic abscesses, penicillin was reported to be the least effective antibiotic for eradicating bacterial isolates.[46] Amoxicillin has a broader spectrum of activity than penicillin and should be considered as an alternative to penicillin for routine treatment of oral infections.

Cephalosporin: Cephalosporin's mechanism of action is similar to that of penicillin. Cephalosporins have increasing activity from the first to the fourth generation with their spectrum of antibacterial coverage, specifically against gram-negative bacteria. There is a reported 7%–18% incidence of cross-reactivity with penicillin, which should be considered when a patient reports an allergy to penicillin.[47] Cephalexin (Keflex) is a common cephalosporin drug used in dentistry. Cephalosporins are not a first-line treatment in the management of oral infections and are more commonly used for sinus communications/infections and for antibiotic prophylaxis in patients with prosthetic joints.

Metronidazole: Metronidazole, a synthetic antibiotic, is effective against anaerobic bacteria by disruption of the bacterial DNA, inhibiting nucleic acid synthesis. It provides excellent anaerobic coverage and should be used in conjunction with penicillin or amoxicillin. With regard to oral infections, it is not prescribed alone.

Clindamycin: Clindamycin (Cleocin) inhibits bacterial protein synthesis, and at high dosages is bactericidal. Use has increased in recent years due to increasing concern over penicillin resistance. It has replaced penicillin as the recommended antibiotic for the management of oral infections in the *Sanford Guide to Antimicrobial Therapy*.[48] Clindamycin has excellent coverage of gram-positive cocci and anaerobic bacteria. Clindamycin should be considered the antibiotic of choice for the penicillin-allergic patient. Clindamycin alone and a combination of penicillin with metronidazole are both effective pharmaceutical regimens.[49]

Macrolides: Erythromycin is the most commonly used macrolide in dentistry, with a spectrum of activity similar to that of penicillin. Resistance to erythromycin, like penicillin resistance, has become a clinical concern. Kuriyama et al. reported that erythromycin was ineffective against *Streptococcus viridans* and most *Fusobacterium* species.[43] Therefore, erythromycin

TABLE 1: Antibiotic recommendations based on onset of infection and penicillin allergy

Type of infection	Recommended antibiotic
Early (first 3 days of infection)	Penicillin, amoxicillin, Clindamycin, cephalexin, or first-generation cephalosporin
Nonimprovement within 24-36 hours	Beta-lactamase-stable antibiotic such as Augmentin (amoxicillin/clavulanic acid)
Late (present more than 3 days)	Clindamycin, cephalexin (if penicillin allergy is anaphylactoid type) or clanthromycin (Biaxin)

TABLE 2: Antibiotics commonly prescribed for oral infections and their dosage for adult and pediatric patients

Antibiotic	Adult dosage	Pediatric dosage
Penicillin	600 mg every 6 hrs	25-50 mg/kg/day divided into 4 doses
Amoxicillin	500 mg every 8 hrs	25-50 mg/kg/day divided into 4 doses
Augmentin	500 mg every 12 hrs (mild) 875 mg every 12 hrs (severe)	25 mg/kg/day divided into 2 doses (mild) 50 mg/kg/day divided into 2 doses (severe)
Metronidazole	500 mg every 12 hrs	15-30 mg/kg/day divided into 3 doses
Cephalexin	500 mg every 6 hrs	25-50 mg/kg/day divided into 4 doses
Erythromycin	500 mg every 8 hrs 333 mg every 6 hrs	30-50 mg/kg/day divided into 2-4 doses
Clindamycin (Cleocin)	300-450 mg every 6 hrs	10-30 mg/kg/day divided into 3-4 doses

should be considered a historical antibiotic in the management of oral infections.

Augmentin: Augmentin is a combination of amoxicillin and clavulanic acid (clavulanate). Clavulanate, a beta-lactamase blocker, stops the enzymes that bacteria produce to make themselves more resistant to antibiotics. Augmentin can treat some strains of bacteria that may be resistant to traditional antibiotics when the patient does not have a penicillin allergy. As a result, the drug may be more effective in treating infections caused by antibiotic-resistant bacteria.[50]

Palliative care

Management of acute dental infections should also include management of discomfort related to the oral infection. When incision and drainage has been performed, or a draining fistula is present, rinsing with warm salt water or oral rinses such as chlorhexidine or chlorine dioxide will help keep bacteria levels down on tissue surfaces and limit potential for bacterial contribution to the infection. Pain management, when necessary, should include over-the-counter pain medications as well as prescriptions that include NSAIDs and opioid analgesics in certain cases. Evidence has been reported that use of a combination of acetaminophen and ibuprofen is more effective than either drug alone.[51,52] Additionally, recent studies have reported that this combination is as effective as narcotic pain medications typically prescribed for orofacial pain without the abuse potential found with narcotics.[53-55] It is an effective analgesic in acute postoperative, moderate-to-severe pain in adults.

Conclusion

Dentists may encounter patients presenting for an emergency with an orofacial infection. Having an understanding of oral microbiology, head and neck anatomy, as well as management of those infections is critical to prevent potential serious complications. Antibiotics are part of infection treatment when swelling is present, or a large periapical area presents radiographically. Selection of the appropriate antibiotic is based on patient allergies to penicillin or the presence of resistant bacteria.

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QUESTIONS

1. Periapical abscesses are:
   A. A frequent occurrence in the dental practice
   B. Infrequently encountered in the dental practice
   C. Not associated with fascial plane swelling
   D. A minor concern when they do occur

2. How many hospitalizations were directly related to dental infection in a study covering a nine-year period of hospital admissions in the United States?
   A. 31,000
   B. 41,000
   C. 51,000
   D. 61,000

3. A 2007 study reported how many hospitalizations attributed to periapical abscess?
   A. 6,886
   B. 7,886
   C. 8,886
   D. 9,886

4. A study questionnaire reported what percentage of practitioners recognized the need for prescribing antibiotics when evidence of infection presented?
   A. 90%
   B. 93%
   C. 95%
   D. 98%

5. When pressured by the patient, what percent of dentists would prescribe an antibiotic?
   A. 25.2%
   B. 30.3%
   C. 34.7%
   D. 41.6%

6. When a definitive diagnosis was not able to be made, what percentage of dentists would write an antibiotic prescription?
   A. 30.3%
   B. 47.3%
   C. 49.2%
   D. 53.5%

7. Between 1990 and 2010, the global burden of periodontal disease, oral cancer, and caries increased by an average of:
   A. 28.7%
   B. 38.2%
   C. 45.6%
   D. 52.3%

8. How many bacterial species, both nonpathogenic and pathogenic, have been identified in the oral cavity?
   A. 600
   B. 650
   C. 700
   D. 750

9. Which type of bacteria is commonly isolated in primary endodontic infections?
   A. Anaerobic gram-negative rods
   B. Anaerobic gram-positive rods
   C. Aerobic gram-negative rods
   D. Aerobic gram-positive rods

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QUESTIONS

10. Which of the following is frequently isolated from endodontic infections?
    A. Entamoeba gingivalis
    B. Klebsiella pneumoniae
    C. Candida albicans
    D. Epidermophyton

11. The microflora in oral biofilm has been connected to:
    A. Cardiovascular disease
    B. Pancreatic disease
    C. Alzheimer's disease
    D. All of the above

12. What organism that causes dental caries may lead to endodontic infection?
    A. *Streptococcus mutans*
    B. *Escherichia coli*
    C. *Streptococcus pneumoniae*
    D. *Staphylococcus aureus*

13. Factors that may influence oral infection include all except:
    A. Age
    B. Drug or alcohol abuse
    C. The patient's psychological status
    D. Patient's weight

14. Infections in the pulpal tissue:
    A. Are, in a sense, isolated, allowing infection to progress without the immune system acting on them
    B. Allow the immune system to isolate them
    C. Are more easily managed than periodontal infections
    D. Are infrequent contributors to oral infections

15. Acute oral infections:
    A. Are predominantly self-limiting
    B. Spread rapidly
    C. Require extensive intervention
    D. Do not require any intervention

16. Infections in the head and neck may spread via:
    A. Muscles
    B. Blood vessels
    C. Nerves
    D. Fascial planes

17. Infections and swelling in the head and neck:
    A. Are high risk
    B. Are low risk
    C. Require urgent intervention
    D. A and C

18. An infection in the maxillary canine space may spread to the:
    A. Zygoma
    B. Parotid space
    C. Masticator space
    D. Pharyngeal space

19. An infection in the mandibular posterior may spread to all except the:
    A. Infratemporal space
    B. Submandibular space
    C. Sublingual space
    D. Buccal space

20. Cellulitis, a potentially life-threatening spreading bacterial infection, is often associated with:
    A. *Streptococcus mutans*
    B. *Streptococcus aureus*
    C. *Escherichia coli*
    D. *Streptococcus pneumoniae*

21. Ludwig's angina is associated with infections in the:
    A. Masticator space
    B. Buccal space
    C. Sublingual space
    D. Submandibular space

22. What may be the most useful in-office procedure in assessing infectious microorganisms?
    A. Gram staining
    B. Culturing
    C. Microscopic analysis
    D. Fluorescence

23. Which suggests that treatments designed to reduce pulpal symptoms and/or protect the pulpal tissue of the tooth with pulpitis should be utilized?
    A. ADA's Infection Management Guidelines
    B. ADA's Antibiotic Use for the Urgent Management of Dental Pain and Intra-oral Swelling Clinical Practice Guideline
    C. AAE's Infection Management Guidelines
    D. AAE's Dental Practice Parameters

24. During an incision and drainage procedure, the purpose of the drain is to:
    A. Act as a radiographic marker to determine the depth of the wound
    B. Permit identification of where the incision was made after initial healing
    C. Allow the patient to insert an irrigation syringe in the wound to flush it
    D. Prevent closure of the incision and allow drainage

25. When a periapical abscess is present, antibiotics are recommended when:
    A. Pain is present
    B. Swelling is noted with accompanying pain
    C. Swelling is noted without accompanying pain
    D. All of the above

26. Which antibiotic is favored as the drug of first choice due to its broader spectrum?
    A. Penicillin
    B. Amoxicillin
    C. Metronidazole
    D. Erythromycin

27. According to the *Sanford Guide to Antimicrobial Therapy*, which antibiotic has replaced penicillin as the recommended antibiotic for the management of oral infections?
    A. Macrolides
    B. Cephalosporins
    C. Clindamycin
    D. Augmentin

28. Keflex is what type of antibiotic?
    A. Penicillin
    B. Aminoglycoside
    C. Macrolide
    D. Cephalosporin

29. Cephalosporins have what percent of cross-reactivity with penicillin-type drugs?
    A. No cross-reactivity has been reported
    B. 5%–10%
    C. 7%–18%
    D. 10%–16%

30. What pain medication combination has been shown to be as effective for dental pain as an opioid analgesic?
    A. Diflunisal and ibuprofen
    B. Acetaminophen and ibuprofen
    C. Naloxone and ibuprofen
    D. Acetaminophen and celecoxib

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Management of oral infections: Part 1

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1. Describe how bacteria may lead to infection and how to manage this with antibiotics
2. Discuss anatomical features that can lead to infection spread in the head and neck
3. Be prepared to treat swelling and manage incision and drainage

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1. Were the individual course objectives met?

   Objective #1: Yes No Objective #2: Yes No Objective #3: Yes No

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    _____

    _____

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4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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