The oral pathosis caused by systemic disorders in middle-aged and elderly adults has been the focus of many publications in recent years. The intraoral soft and hard tissue changes associated with systemic disorders, medications, chemotherapy, and radiation treatment have been well-investigated and documented. Far less attention has been paid to the role of oral infection as the etiology of systemic disorders. A literature review (1980-1994) is provided here focusing on well-documented cases in which systemic disorders were caused by oral foci of infections. This paper attempts to raise the level of awareness of practitioners in considering possible systemic complications caused by oral infection. It also emphasizes the need for further longitudinal studies in this field involving healthy and medically compromised elderly individuals.

The oral cavity harbors a large and diverse microbial population. The intraoral soft and hard tissues serve as areas for adherence and colonization of these microorganisms. Most people consider the oral flora to be harmless or to have low virulence; however, under suitable conditions, certain types of microorganisms can become pathogenic, leading to oral and nonoral diseases. The microorganisms causing caries, pulpitis, gingivitis, and periodontitis can spread through the periapical tissues and continue throughout the orofacial tissues; they may enter the bloodstream (hematogenous dissemination) and infect tissues distant to the oral cavity; or they may enter the lower airways by aspiration or "microaspiration" and cause aspiration pneumonia.

In the presence of oral disease, it is likely that significant numbers of pathogenic microorganisms exist. Adults in the United States have an average of 10 decayed or filled teeth. Moderate to severe periodontal disease is reported in one-third of the elderly population. The number of edentulous individuals aged 75 years or older has drastically declined from 67.3 in 1958 to 47.3 in 1985. The increasing trend for retention of teeth into older age puts older adults at continued risk for systemic complications of oral origin.

Within the last 15 years, significant numbers of researchers have focused on oral complications of systemic conditions and oral side-effects of systemic medications in middle-aged and elderly individuals. The oral complications associated with endocrine disorders, connective tissue and autoimmune diseases, chemotherapy, radiotherapy, and salivary gland dysfunctions have been well-investigated and well-documented in this age group. In addition, the negative impact of oral complications associated with some of the above-mentioned conditions on the quality of life and the nutritional status of these patients have also been documented. Far less attention has been paid to the role of oral infection as the etiology of systemic complications. The purpose of this paper is to present a review of the more recent literature (approximately the last 15 years), highlighting those intraoral conditions which have been conjectured or documented to have caused systemic complications. In an effort to focus the paper, we will limit our presentation to those publications which specifically listed an oral infection as the cause of disease at sites remote from the oral cavity. The systemic complications associated with salivary gland dysfunction, oral cancer, masticatory impairment, and nutritional deficiencies are reviewed elsewhere and are not included here.

Literature published between January, 1980, and October, 1994, was examined for this review. We focused on those papers relating to the systemic dissemination of oral infections in geriatric subjects (65 years of age or older) and middle-aged subjects (aged 50 to 64). Papers presenting findings of middle-aged subjects were included in this review for several reasons. One is that middle-aged
adults have oral conditions (tooth retention, caries, and periodontal disease) more likely to typify the oral findings found in the newly geriatric patient. Thus, our consideration of the findings of this younger population may provide us with indications of what to expect in future cohorts of elderly. Second, middle-aged adults with family and work responsibilities are more likely to seek and receive health care for symptoms than are older adults. Therefore, it is our expectation that we will find fewer references in the literature (particularly case reports) dealing with oral conditions in the elderly as a result of under-reporting. Third, the clustering of multiple diseases in the elderly makes it more difficult for the primary care physician to determine a causative source definitively or to identify the appropriate health care professional to assist in the diagnostic work-up or subsequent patient management. Such under-detection would limit the number of citations found in the literature.

The review which follows is organized according to the organ/system involved. The signs, symptoms, and management of the systemic complications are discussed in order to familiarize the practitioners with the diverse clinical presentations which may occur as a result of the systemic dissemination of oral infection.

**Brain abscesses**

In 1981, Gallagher et al. reported on a case of a 54-year-old healthy male who was admitted to the hospital because of headache and involuntary twitching of the left facial and neck muscles. These signs and symptoms developed 14 days after a periodontal abscess surrounding the mandibular left second premolar was deeply curretted and drained. No cultures of the causative organism were performed, nor were antibiotics recommended post-operatively. The patient was diagnosed with a right frontal lobe brain abscess. Organisms cultured from the brain abscess included *Staphylococcus epidermidis, Bacteroides melaninogenicus*, and *Streptococcus* species; *Bacteroides* is a known periodontal pathogen. The patient expired five weeks after being admitted to the hospital, despite massive doses of antibiotics. The authors considered the manipulation of the septal gingivae surrounding the left premolars as the cause for the bacteremia and subsequent formation of the brain abscess.

The next year, Goteiner et al. described a 52-year-old female who experienced a severe frontal headache starting two weeks after she underwent multiple extractions because of advanced periodontal disease. Three weeks post-extraction, she was admitted to the hospital because of being febrile and experiencing severe periorbital pain. The diagnostic work-up was significant for a cystic cerebral abscess containing enterococci, diphtheroids, and streptococci organisms. Despite IV antibiotic therapy, the patient did not improve until all her remaining periodontally involved teeth were removed. Within a week after the extractions, the brain abscess diminished in size, and the patient’s health returned to normal. The authors therefore deduced that it was the initial extractions which seeded the brain abscess. The remaining presence of severe periodontal disease continued to contribute to the abscess formation in spite of the antibiotic treatment.

In 1988, Saal et al. reported on a 51-year-old African-American male who was hospitalized after experiencing a tonic/clonic seizure of approximately five minutes’ duration. His condition was related to a frontoparietal brain abscess which led to progressive deterioration of mental and motor competence. The patient’s oral evaluation was significant for the presence of a periapical radiolucency in the maxillary anterior region. The aspirates from this lesion and the brain abscess contained a common pathogen (*Peptostreptococcus* sp.). The extraction of the infected tooth resulted in the resolution of the patient’s neurological signs and symptoms. The authors concluded that the chronic periapical dental abscess was the cause of the brain abscess.

The case of a 54-year-old male who developed fever and chills after experiencing two episodes of dizzi-ness and nausea was described by Andrews and Farnham in 1990. His condition was diagnosed as a brain abscess of the right parietal lobe, and his blood culture was positive for *Viridans streptococci*. The patient’s oral condition was significant for the presence of multiple endodontically and periodontally involved teeth and oral candidiasis. He responded to antibiotic therapy only after all his remaining teeth were extracted and antifungal therapy was initiated.

Recently, Andersen and Horton described a 70-year-old male physician who developed intracranial pain and swelling three days after he received a routine scaling and root planing from his dental provider. Six days after his dental appointment, he reported numbness and heaviness in his left shoulder, chest, and neck. He was diagnosed with a right parietal lobe brain abscess which cultured positive for *Peptostreptococcus* and *Fusobacterium*. These pathogens are commonly found in periodontal pockets. Unlike the previous patients, this patient was diagnosed as having stable rather than acute periodontal disease. He responded well to antibiotic treatment.

**Meningitis**

Hedström et al. in 1980 discussed the case of a 75-year-old male who presented with a six-month history of intermittent fever, chills, and night sweats. Extensive biochemical, bacteriologic, virologic, serologic, and radiographic studies were inconclusive except for radiographic evidence of two periapical dental infections in the maxillary anterior region. The patient was treated with phenylbuta-zone 0.6 gm/day for two weeks. Then he was placed on 150 mg indomethacin/day for “a few months.” It is not clear how long the patient was kept on this regimen, but the authors reported that when indomethacin was discontinued, the fever recurred. For 1½ years after the onset of the patient’s symptoms, he...
remained afebrile as long as he was taking indomethacin daily. No information was given as to whether the periapical infections were eliminated or if they continued to exist. The authors were highly suspicious of a dental origin for this patient's chronic meningeal symptoms, in spite of the fact that so many of the diagnostic tests were negative. They reasoned that the negativity of the tests was due to the lateness of the testing for the antigen to *Streptococcus milleri* after the onset of the disease (> 6 months). Apparently, the authors previously had been able to recover the antigen from the cerebrospinal fluid of a similar case at six weeks after onset of symptoms but not at a later date. They recommended that investigators should search for *Streptococcus milleri* antigen within 2-5 months after the onset of disease in patients with chronic meningeal inflammation and concomitant dental infection.

In all of the previously mentioned cases involving the central nervous system, the oral infection spread via a hematogenous route. In all cases except for one, no acute signs of dental infection were present. In most cases, the conclusions arrived at in the reported cases, i.e., the implication of an oral foci as the source of the infections, were based on comprehensive clinical, serologic, microbiologic, and radiographic evaluations.

**Mediastinal abscesses**

In 1991, Garatea-Crelgo and Gay-Escoda described a case of a 64-year-old male who developed Ludwig's angina as a result of infections in the left mandibular molar and premolar teeth. The spread of infection eventually caused mediastinitis and led to the patient's stay in the intensive care unit for 90 days. Cultured material from the neck and chest abscesses revealed streptococci and Gram-negative rods. The patient received massive doses of antibiotics, and the infected teeth were extracted. He was discharged once his medical status became stable. The authors reviewed 25 additional cases of odontogenic mediastinitis, including three individuals aged 51, 52, and 63 years old, and reported a 42.8% mortality rate, with the condition more common in men than in women. Philip in 1991 also discussed the case of a 67-year-old male who developed odontogenic mediastinitis associated with infected mandibular canines. The culture results from the infected oral sites were determined to be positive for *S. milleri*, Viridans streptococci, diphtheroids, and coagulase-negative *Staphylococcus*. In spite of massive antibiotic therapy and removal of the infected teeth, the patient stayed in the intensive care unit for 12 weeks before his condition was stable enough for him to be transferred.

Another mediastinitis case was reported in the same year by Guardia et al., who detailed an episode of fatal necrotizing mediastinitis secondary to descending acute supplicative parotitis in a 67-year-old male. The infection was caused by mixed aerobic and anaerobic bacteria. The authors deduced that the organism associated with the cellulitis had probably arisen from the oral flora which ascended to the parotid gland via Stensen's duct.

**Bacterial endocarditis (BE)**

In 1981, Root et al. published a report of a 69-year-old male with a history of a prosthetic aortic valve who was admitted to the hospital because of a 10-day history of malaise and a two-day history of fever, chills, and sweats. His condition was diagnosed as endocarditis. His oral findings were significant for moderate periodontitis and a mobile left maxillary molar. Blood cultures were positive for a fastidious Gram-negative cocobacillus identified as *Hemophilus aphrophilus*. This organism was also identified from the plaque samples obtained from the patient's dentition. Cultures from gingival tissues were negative. Despite four weeks of antibiotic therapy, the cultures obtained from the dental plaque remained positive, which suggested the persistence of the organism in an avascular focus. Corrective periodontal surgery was performed, and the patient was eventually discharged on antibiotics. The one-month follow-up revealed negative blood cultures and no evidence of recurrence. The authors reviewed other reported cases and cited 11 additional cases of endocarditis in whom extensive periodontal disease and/or recent dental manipulations were reported. They concluded that a deliberate search for a correctable primary oral focus of infection should be included in the management of patients with endocarditis.

It was also in 1981 that Thornton and Alves published the results of their retrospective study of 139 patients with bacterial endocarditis. The patients' average age was 40.5 years (age range, from 1 to 79 years). Thirty-six percent of the patients reviewed were 50 years of age or older. Twenty-two of the 139 cases (16%) of bacterial endocarditis occurred in individuals who had a prior history of dental treatment or oral disease. The interval between dental treatment and the onset of cardiac problems ranged from 4 days to 8 weeks. Only five of the 22 individuals with a history of positive findings of oral disease or dental treatment had been given prophylactic antibiotics. *Viridans streptococci* was the leading organism isolated from blood cultures of these patients. *Viridans streptococci* is the predominant etiologic organism in endocarditis. It is also the most common microorganism of the oral cavity and is frequently isolated from blood cultures after various dental procedures. The authors concluded that dental practitioners should familiarize themselves with those heart conditions which require antibiotic therapy prior to invasive dental procedures.

In a larger retrospective study, Bayliss and colleagues reviewed the available information on 544 cases of infective endocarditis. The patients' ages ranged from 2 to 87 years (mean, 51.6 years). Seventy-four (13.7%) of those cases had undergone some dental procedures within three months of onset of the illness, 67 (90%) without and seven (10%) with prophylactic antibiotic coverage.
Table. Oral and systemic conditions associated with a selected group of common oral microorganisms.

<table>
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<tr>
<th>Pathogen</th>
<th>Oral Findings</th>
<th>Systemic Conditions</th>
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<tr>
<td>Actinomyces</td>
<td>gingivitis</td>
<td>hepatobiliary disease</td>
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<td>necrotic pulp</td>
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<td>Bacteroides</td>
<td>adult periodontitis</td>
<td>brain abscess</td>
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<td>Candida</td>
<td>oral candidiasis</td>
<td>vertebral osteomyelitis</td>
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<td>Fusobacterium</td>
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<td>necrotic pulp</td>
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<td>Lactobacillus</td>
<td>dental caries</td>
<td>aspiration pneumonia</td>
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<td>Peptostreptococcus</td>
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<td>Staphylococcus</td>
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<td>Streptococcus</td>
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<td>periapical abscess</td>
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Thirty-seven (55%) of those who were not given antibiotic prophylaxis had known pre-existing cardiac abnormalities. Forty-eight (8.8%) of 544 cases who had not received dental procedures were reported to have overt dental sepsis. Viridans streptococci was isolated from blood samples of 81.5% of those cases who had received dental treatment and those who had dental sepsis but had not received treatment. Viridans streptococci was also identified in the blood cultures of 176 (32%) of individuals who had not received dental procedures and had no overt dental sepsis. The authors were uncertain about the port of entry in this group but suggested bacteremia associated with the brushing of the teeth and chewing in the presence of mild or unrecognized periodontal infection as a possible explanation. In 42.5% of cases reviewed in this study, the physician, the dentist, and the patient were unaware of the presence of any cardiac abnormalities before the onset of the infective endocarditis. Therefore, the authors recommended that more attention be directed toward encouragement of patients to seek regular dental care and maintain better oral hygiene because of difficulties in identifying individuals with a need for prophylactic antibiotics. In 1984, Siegman-Igra and colleagues reported a case of endocarditis caused by an oral microorganism, Actinobacillus actinomyctecemcomitans, which is a common pathogen in periodontal diseases. They reported a 67-year-old female without any known cardiac disease who was admitted with a history of headache, chest pain, loss of appetite, and difficulty performing everyday activities of one week's duration. The patient was reported to be febrile (38.6°C), extremely anxious, and to have visual and auditory hallucinations at the time of admission. Clinical findings included severe dental caries, systolic murmur, ecchymoses on the lower extremities, and mild right hemiparesis with ptosis of the left upper eyelid. The laboratory studies were significant for normocytic, normochromic anemia, thrombocytopenia, and leukocytosis. The blood cultures became positive for Actinobacillus actinomyctecemcomitans after incubation for seven days. The patient was hospitalized for 45 days. Her anemia was corrected by blood transfusion, and her infection responded to 30 days of antibiotic treatment. She was eventually discharged when her blood cultures reported negative, five days after completion of the antibiotic therapy, and was eventually lost to follow-up.

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The authors reviewed an additional 34 cases of subacute bacterial endocarditis for whom detailed clinical information was available. They reported that 54% of the cases had either dental/periodontal infections or had received dental procedures such as extractions and periodontal treatment. Eighteen (51%) of the reported cases were aged 50 years and older. In all the studies discussed above, the causative microorganisms were identified in blood cultures. No information is available on microbiologic findings from oral specimens such as pulpal or periodontal abscesses in the examined population. The authors associated the endocarditis with the patient's oral conditions or delivered oral care because the causative microorganisms cultured are commonly found in the oral cavity.

**Aspiration pneumonia**

Based on a literature review, Limback suggested an association between the presence of teeth and aspiration pneumonia in the elderly residents of chronic care facilities. Noting the lack of documented evidence of such a link, he suggested that one may exist due to the similarity of Gram-negative bacilli found in both periodontal disease and lower
respiratory tract infections.

Recently, Loesche et al.37 evaluated the presence of Gram-negative rods and certain proteolytic organisms (Porphyromonas gingivalis, Prevotella intermedia, Prevotella melaninogenicus, Fusobacterium nucleatum, Rothia dentocariosum) and some aciduric organisms (Streptococcus mutans, lactobacilli, yeast) in the saliva of elderly male patients from outpatient and in-patient VA clinics, and female residents of a retirement home. They reported a significantly higher level of salivary proteolytic and aciduric flora in the older patients. A number of the microorganisms investigated by Loesche and his team have been isolated from infected lung sites of elderly suffering from aspiration pneumonia.

More recently, Loesche et al.39 in a longitudinal study, compared the oral health and salivary microflora of three groups of VA patients. One group had developed aspiration pneumonia, one had pneumonia not aspirational in origin, and the third group had no pneumonia. A higher level of periodontal disease was found in the group with aspiration pneumonia as compared with the other two groups. Periodontally associated pathogens such as F. nucleatum and Capnocytophaga were also reported to be significantly higher in this group. The researchers suggested that saliva containing high levels of F. nucleatum and Capnocytophaga could play a contributory role in the development of pneumonia if the saliva, or food mixed with the saliva, is aspirated.

**Vertebral osteomyelitis**

A 58-year-old man with lower back pain of 4 months' duration which was caused by vertebral osteomyelitis with disc space infection was described by Rubin et al.39 The tissue specimens submitted for culture growth were determined to be positive for Streptococcus sanguis, Fusobacterium species, and Staphylococcus aureus. The oral evaluation of the patient was significant for advanced periodontal disease and poor oral home care. The patient's condition improved with no recurrence when the infected teeth were removed, combined with periodontal care and antibiotic treatment.

Vertebral osteomyelitis is caused by Staphylococcus aureus in 90% of cases. It is unusual to have a mixed bacterial infection associated with this condition. Because of the mixed bacterial growths identified in this case and the fact that all the microorganisms were normal inhabitants of the oral cavity, the authors concluded that the osteomyelitis seen was the result of the patient's poor periodontal health.

Nor are bacterial infections the only possible causative organisms in vertebral osteomyelitis. Hashimoto and Tanioka40 described a 63-year-old man who developed disseminated candidiasis that was followed by pneumonia and lumbar vertebral osteomyelitis after radiation and surgical treatment of squamous cell carcinoma of the floor of the mouth. Since Candida in small amounts can be found as a usual inhabitant in multiple sites of the body, the precise source of infection in this case cannot be confirmed. The authors related the patient's osteomyelitis to the hematogenous spread of the Candida albicans from the oropharyngeal area which may have occurred during or as a result of the intraoral surgical procedure.

**Prosthetic joint infection**

Three patients, ages 66, 67, and 84, who developed infection in their prosthetic joints secondary to severe periodontal disease and poor home care were discussed by Lindqvist and Slätis.41 Two of the three patients had received dental care without prophylactic antibiotics. The third patient had not received any dental care but had an asymptomatic periapical infection in addition to severe periodontitis. The microorganism isolated from the infected joints in all three cases was Viridans streptococci, which is commonly found in the oral cavity. In all three cases, recovery was achieved only after all oral sources of infection were eliminated.

A records review was performed by Powers and colleagues42 on the medical records of 38 elderly patients who had been diagnosed with prosthetic joint infections. Some patients had experienced the infection of the prosthetic joint on more than one occasion. Therefore, a total of 51 episodes of infection was reviewed by the authors. Staphylococcus aureus was the most common organism isolated from the infected prosthetic joint sites in this study. Only one episode (2%) was considered to be possibly caused by an oral source of infection; however, because the distant site (i.e., oral) was not cultured, the authors could not be absolutely sure about this theory.

**Gastritis and ulcers**

Peptic ulcer disease is another important cause of morbidity and mortality in elderly people. In recent years, increasing attention has been given to isolation of Helicobacter pylori, which has been shown to cause antral gastritis and is suspected of being a contributory factor in duodenal and gastric ulceration. The prevalence of H. pylori infection increases with age.43,44 In one study, its prevalence was found to approach 75% in patients above 65 years of age.45 H. pylori has been detected and isolated in oral specimens.46 Nguyen et al.47 reported the presence of H. pylori in the dental plaque of 38.8% of their total examined patient population (n = 18) with H. pylori gastritis. The authors considered the oral cavity as a possible reservoir of the organism and cause of re-inoculation of the stomach mucosa after topical anti-H. pylori therapies such as bismuth.

**Hepatobiliary diseases**

A 71-year-old male was admitted to the hospital because of a seven-week history of lethargy, night sweats, and anorexia. Edwards et al.48 describe this patient's two-year history of feeling unwell and loss of approximately 40 lbs during that period. Except for smoking 20 cigarettes per day, the patient had no contributory medical history. His oral evaluation was significant for advanced periodontitis and multiple periapical lesions. The
blood culture was negative. Hematologic, serologic, histologic, and ultrasonographic evaluation revealed a diagnosis of hepatobiliary disease of unknown origin. While diagnostic investigations were in progress, all the infected teeth were removed in 3 stages under local anesthesia. Within 48 hours of the second stage of dental treatment, the patient became afebrile without receiving any antimicrobial or anti-inflammatory therapy. Two months after completion of the dental treatment, the patient became asymptomatic, gained 22 pounds, and developed a normal hematologic and serologic profile with no hepatomegaly. He continued to remain asymptomatic during the 12-month follow-up period and added pounds until his usual weight of 176 lbs was reached. The authors considered the etiology of this patient's condition to be bacterial endotoxins and the non-specific effects of fever and malnutrition, all of which were caused by the oral condition, to be responsible for the hepatic damage which occurred.

Two other patients, aged 54 and 69 years, admitted to the hospital because of a 3-4-week history of malaise, were reported by Crippin and Wang. Both patients were immunocompetent and reported no significant past medical conditions. The comprehensive medical work-up led to a diagnosis of multiple hepatic abscesses. The culture of the purulent material from the liver was positive for Fusobacterium nucleatum in both cases. In one case, Viridans streptococci and Actinomyces odontolyticus were also identified in addition to F. nucleatum. Because these microorganisms are often found in the oral cavity, the authors considered the hepatic abscesses to be of dental origin. Oral evaluations of the patients revealed a periapical abscess of the right third molar in one case and advanced periodontitis with a periapical abscess of the left second molar in the other. Cultures from oral abscesses in both cases were positive for F. nucleatum. The patients underwent removal of all infected teeth and antibiotic therapy. Both patients recovered completely and did not experience recurrence during the 18-72-month follow-up period after discharge. The authors compared these two cases with ten cases of liver abscesses in patients with diverticulitis (a benign colonic disease). They reported significantly higher numbers of liver abscesses in the two cases with dental disease than in the patients with diverticulitis. Pyogenic hepatic abscesses were multiple in both cases of patients with dental diseases, whereas all of the abscesses associated with diverticulitis were single. Pyogenic hepatic abscesses are diagnosed by exclusion. In the two cases reported above, no other etiology could be established by a thorough laparotomy. The colonoscopies were negative, and ultrasonographic evaluation of the biliary trees was unremarkable. As a result of the comparative numbers, the microbiologic findings, and the lack of positive test results, the authors concluded that the hepatomegaly caused by hepatic abscesses diagnosed in the 54- and 69-year-old patients were of dental origin. Further, the authors recommended that thorough dental evaluations be included in the diagnostic work-up of all patients suspected of having cryptogenic pyogenic hepatic abscess.

**Chronic urticaria**

In 1982, Thyagarajan and Kamalam published a paper describing a 73-year-old female with a history of chronic urticaria of 3 years' duration. The patient had apparently been symptomatically treated with antihistamines during that time. An extensive medical work-up was non-significant for any possible causative factors. The oral evaluation revealed multiple infected teeth and dental abscesses. Extractions of 10 teeth and drainage of the abscesses resulted in complete recovery from the chronic urticaria. The patient was followed for 12 months, during which time she remained asymptomatic. The authors emphasized the importance of searching for intraoral foci of sepsis in the management of chronic urticaria.

**Fever of unknown origin (FUO)**

A retrospective study of 35 patients with FUO was completed by Naschitz and Yeshurun in 1985. Two of their cases were male and were within the age grouping of interest to us, i.e., one was 61 years of age and the other was 72 years old. The physical evaluation, including oral findings, was non-significant in both cases. However, radiographic evaluation in one case revealed an asymptomatic periapical infection of two mandibular premolars, and the other case revealed moderate alveolar bone loss. In both cases, removal of the involved teeth led to complete recovery. The authors proposed that careful clinical and radiographic examination of the dental and periodontal status be included in the initial phases of investigation and evaluation of FUO.

Two years later, Shinoda et al. made a similar recommendation, describing a 53-year-old man with FUO which necessitated hospitalization for more than 50 days. Medical examinations failed to discern a cause, but the fever abated after the patient's periodontally involved teeth were extracted.

**Tetanus**

Babajews and Nicholls in 1983 published a case report of a 71-year-old female who was admitted to the hospital because of trismus and dysphagia. She had a history of biting her tongue one week prior to her hospitalization. Three days after the incident, she noted difficulty in mouth-opening. She eventually became ataxic and fell, which resulted in her admission to the hospital. The patient's physical evaluation revealed evidence of supraventricular tachycardia (pulse rate, 170), elevated blood pressure (BP 120/100), severely limited mouth-opening (15 mm), cariously involved teeth, and severe periodontitis based on a clinical evaluation and panoramic radiograph. The trismus was believed to have been caused by the septic denti-
tion. The day after her hospital admission, the patient developed a left femoral embolism followed by unexplained extension spasms brought on by extraneous noises. She experienced more generalized spasms involving the jaws, neck, and back muscles. The patient also became short of breath and cyanosed during spastic attacks, which led to a diagnosis of tetanus. The patient was transferred to the intensive care unit and was given antibiotics, human antitetanic globulin, and muscle relaxants. In spite of the initiated therapy, the patient’s muscle rigidity increased and her condition deteriorated rapidly. A tracheostomy was performed, and her ventilation was monitored continuously for three weeks until her medical status became stable. The authors concluded that tetanus resulted from the tongue being lacerated by a septic tooth. No information was provided on the microbiologic evaluation in this case to ascertain the cause-effect relationship.

Gangrene of the tongue
More recently, King and Barrett described a 69-year-old man who was admitted to the hospital because of increasing dysphagia and a painful mouth. His medical history was significant for Parkinson’s disease. The patient had complained of swallowing difficulties for six months. The patient’s pulmonary and cardiac evaluations were normal, but his physical evaluation was significant for a swollen tongue with desquamative changes and grey discoloration in the right anterior two-thirds. All laboratory tests were normal except for an elevated erythrocyte sedimentation rate (ESR) and low hemoglobin. The patient’s dentition was worn down, having sharp edges. The periodontal condition was labeled as “severe pyorrhoea.”

This patient’s tongue was biopsied, and the histologic findings were compatible with necrotic skeletal muscle with evidence of fungal spores and Gram-positive rods. The patient’s ESR values and dysphagia improved after surgical desloughing of the tongue and removal of the causative factors. The authors considered the infarction of the tongue to have been caused by direct injury from the patient’s eroded, sharp, and infected teeth.

Acute infarction of the tongue is rare because of the richness of its blood supply. In the case presented above, no other contributory factor (e.g., vascular disease) could be identified by the authors.

Discussion
This review of the literature provides evidence concerning the significance of dental infection in the onset of some systemic disorders. It is not an exhaustive review, since we purposefully focused on including those cases in which the systemic sequelae of the oral infections were documented based on comprehensive diagnostic work-ups. We also limited our examination to those individuals 50 years of age and older. Our review does demonstrate that a wide variety of organisms has been determined or conjectured to be the putative cause of disseminated infections from the oral cavity. We have summarized the oral and systemic conditions associated with a selected group of the most common oral microorganisms and presented this information in the Table. The systemic conditions are based on the reported cases summarized in this manuscript. The oral conditions were summarized by others.

Based on the multiple cases presented here, it is evident that there are associations between oral infection and the general health status of an individual. The material reviewed for this publication identified oral infection as the cause of disorders involving the skin, central nervous system, gastrointestinal tract, and musculoskeletal, pulmonary, and cardiac systems. The onset of the disorders varied from a few days to a few months after dental manipulations. Some were caused by acute dental infections, and others were related to chronic asymptomatic oral infections. Still others were a result of typical commensals of the oral cavity becoming pathologic to the host when dispersed to a non-oral site.

The severity and presenting signs and symptoms varied among individuals affected by the same disorder. The majority of the cases reported here were of conditions which occurred in people who were in reasonably good health with no evidence of immunosuppression. Yet these individuals experienced systemic disorders caused by their oral conditions despite their intact medical status.

In contrast, it is important to recall that elders experience age-related declines in the immune system, including both cell-mediated immunity and antibody response to antigens. The elderly may also experience an absent or blunted febrile response to infection because of their altered immune system. Malnutrition, systemic disorders such as diabetes mellitus, connective tissue disorders, polypharmacy, and chemotherapeutic drugs, in addition to the direct impact of aging on the immune system, can increase the susceptibility of this age group to infection. The most common cause of hospital admission in elderly individuals is infection. Bacteremia or bloodstream infection is an important etiologic factor for morbidity in elderly patients and is associated with a higher mortality rate in this population than in a younger population.

The frail of our senior citizenry, the nursing home resident, has, on an average, three or four systemic conditions which increase his/her susceptibility to infection. One can therefore appreciate the potential risk of further systemic maladies which may be faced by the institutionalized elderly with poor oral health.

Many questions remain to be answered regarding the exact role of oral flora in the onset and progression of systemic disorders. Most of the associations which have thus far been described in the literature are based on case reports. The few investigations which have been mounted...
have relied on weaker research design methodologies, including retrospective chart reviews. A higher prevalence of dental morbidity has been reported in elderly institutionalized residents when compared with those of similar age who are seen in out-patient clinics. However, a majority of these investigations are cross-sectional, and because they focus on a very specific population group, the findings cannot be generalized to the larger geriatric population. More longitudinal studies involving a more representative segment of elderly people, independent-living and institutionalized, are needed to confirm the associations found between the oral cavity and general conditions. Recent investigations involving aspiration pneumonia and Helicobacter pylori are good examples of prospective research models and could be used as prototypes for future documentation of the association between the oral cavity and systemic conditions. The availability of advanced diagnostic aids—such as MRI, CAT scan, sonography, PCR, and DNA probes—makes the documentation of the associations much easier than in previous decades.

Given the retention of more teeth by the elderly, the increasing findings of oral diseases in this population, and the decline in immune function, a higher index of suspicion must be operational in the treatment of geriatric patients. Better diagnostic tools and procedures must be paired with a more discriminating diagnostic ability in order to protect the patient from the potential significant morbidity and mortality which can occur as a result of the systemic dissemination of an oral infection.

This paper attempts to raise the level of awareness of practitioners in considering possible systemic complications caused by oral infection. Prompt recognition and elimination of oral foci of infections are essential to minimize secondary morbidity and mortality. Based on the literature reviewed here, it is evident that this topic deserves more attention and investigation. The incidence and prevalence of systemic complications caused by oral foci of infection need to be further studied in healthy and medically compromised elderly individuals.

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27. Andersen WC, Horton HL. Parietal lobe