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ORAL HEALTH AND CHRONIC KIDNEY DISEASE: BUILDING A BRIDGE BETWEEN THE DENTAL AND RENAL COMMUNITIES

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Abstract
An estimated 20 million Americans are diagnosed with chronic kidney disease (CKD), and another 20 million may be undiagnosed or at risk for kidney disease. Within this population are approximately 450,000 people in whom the disease has progressed to end stage renal disease (ESRD), requiring dialysis or renal transplantation to maintain essential life functions. Many of these patients living on dialysis are medically and dentally indigent. Although several medical care financial assistance programs are available to patients with the role of oral health in systemic disease is often unrecognized or misunderstood. Patients with kidney disease are not only at an increased risk for infection, but also malnutrition, including vitamin and mineral deficiencies and/or toxicities. The renal diet can be restrictive, which often makes it difficult to obtain adequate vitamins and minerals. Performing a physical assessment including an advanced nutrient assessment by evaluating the skin, eyes, nails, and the oral cavity can identify several nutrient deficiencies. To improve patient outcomes, a collaborative plan between the dental and renal professions must be established to resolve access to care barriers, enhance transdisciplinary communication, implement evidence based practice, and establish favorable nutrition status. The registered dental hygienist and the registered dietitian, with their similar educational backgrounds, are ideal candidates to begin working in unison for the improved health of patients with renal disease.

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Key Words: Chronic kidney disease (CKD), renal disease, nephrology, end stage renal disease (ESRD), prerenal transplantation

Introduction

The kidneys control 3 basic life functions: excretion of nitrogenous waste products; regulation of volume, composition, and acid-base balance of plasma; and synthesis of hormones necessary for erythrocyte production, bone metabolism, and maintaining blood pressure.[1] When the kidneys are functioning correctly, we seldom notice their importance. Even in the early stages of renal disease, there are few noticeable physical symptoms.[2] However, if renal function markedly decreases as a result of primary renal disease or as a secondary disease, systemic health suffers.[3]

The National Kidney Foundation estimates that 1 in 9 Americans (20 million adults) have chronic kidney disease (CKD), and that an additional 20 million Americans are at increased risk.[2] Hypertension and non-insulin dependant diabetes mellitus[4] (complicated by obesity)[5] drive the epidemic of kidney disease (Figure 1). In addition, it is now recognized that mildly increased serum creatinine levels (as measured by standardized laboratory testing) are not a natural part of aging, but rather a red flag indicator for reduced renal function.[2]

Of the 20 million Americans living with kidney disease, approximately 470,000 are living with end stage renal disease (ESRD).[6] Astonishingly, since 1983 this number has almost tripled,[6] and by the year 2030, more than 2 million

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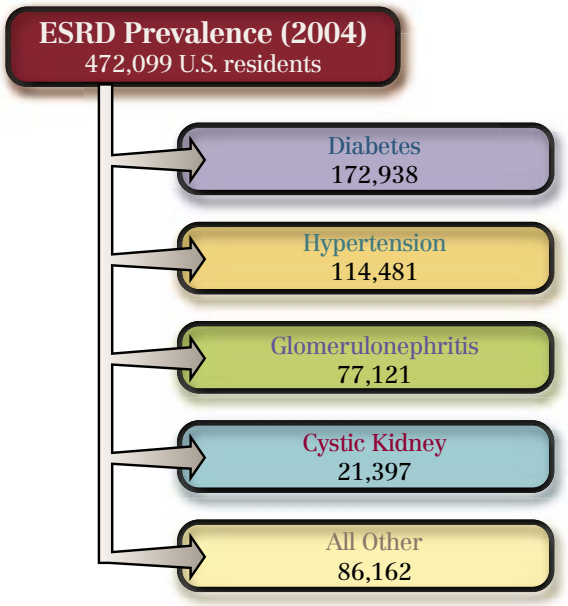
Figure 1: End stage renal disease (ESRD) prevalence in 2004



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people are likely to be receiving treatment for kidney failure.[7] Because the early stages of kidney disease are typically asymptomatic, many patients (unaware of their risk for kidney disease) wait to seek medical care until renal disease has progressed to ESRD.[8] Unfortunately, ESRD is a bilateral, chronic, and progressive disease characterized by irreversible destruction of the renal nephrons.[9] Comorbidities are common with ESRD; systemic complications associated with renal failure include: cardiovascular (hypertension, congestive heart failure, and pericarditis), gastrointestinal (anorexia, nausea, vomiting, generalized gastroenteritis, peptic ulcer disease, stomatitis, and candidiasis), neuromuscular, hematologic, and dermatologic systems.[10] As a result, clinical management of ESRD patients often extends into multiple disciplines of medicine.

Financial constraints and challenges within the renal population are commonplace; however, financial assistance for medical (but not dental) care is available.[11] According to the American Dental Hygienists Association (ADHA), barriers to oral health care are a critical issue in the United States due to disparities in the healthcare delivery system.[12] In the ADHA 2001 Access to Care position paper (part of the Surgeon General's 2000 report, *Oral Health in America*), untreated poor oral health is described as, "a silent epidemic promoting the onset of life-threatening diseases which are responsible for the deaths of millions of Americans each year."[12] Because the registered dental hygienist and the registered dietitian can identify patients who are at risk for oral disease and malnutrition, they are in an excellent position to refer patients to the appropriate healthcare professional.

Several factors contribute to the need for continuing education in oral-systemic medicine, including the high number of medically indigent CKD patients; marked increases in medically complex ESRD patients; new clinical guidelines (such as the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative [KDOQI][13] and Dialysis Outcomes Practice Patterns Study [DOPPS][14]); and adverse effects of malnutrition. As new guidelines and directives are integrated into medical treatment for renal disease, dental providers should review the impact that may be directly or indirectly influencing dental care (e.g., establishing whether or not antibiotic prophylaxis is indicated for invasive dental treatment, and determining whether the type of dialysis access used creates additional risk for infection). A strategic effort is needed to improve access to dental care, enhance communication, implement evidence-based practice, establish favorable nutrition status, and improve patient outcomes. The registered dental hygienist and the registered dietitian, based on similar educational backgrounds, can begin a process of transdisciplinary communication, working collaboratively toward recognizing and resolving existing voids in patient care.[15]

Enhancing transdisciplinary communication

How can both the dental and renal communities communicate effectively and efficiently to keep up to date on CKD, ESRD, and oral health? A transdisciplinary approach may be the answer. This approach involves an interdisciplinary commitment to patient care, wherein team members share responsibility for total patient care and develop professional relationships that provide specialized learning that should improve patient outcomes.[15]

Dental hygienists and registered dietitians — shared educational background. The registered dental hygienist and the registered dietitian have a similar educational background of basic science courses including general chemistry, anatomy, physiology, biochemistry, microbiology, pathology, nutrition, and pharmacology that will enhance transdisciplinary communication.[16] In addition, preventive care is a major focus of oral and nutritional care.[16] Although the minimal educational requirements to become a registered dental hygienist vary from state to state, the minimal educational requirement to become a registered dietitian is a bachelor's degree, dietetic internship, and completion of a registration examination.[17]

However, the complexity of care for patients with ESRD reinforces the need for a higher level of education for the dental hygienist; such requirements would be met through the ADHA proposed Advanced Dental Hygiene Practitioner designation, whereby competency is established with a Master's Degree.[12] These higher minimal educational requirements would enhance communication between the registered dental hygienist and registered dietitian.

Role of patient participation in transdisciplinary care. It is the opinion of both authors that motivating patients with CKD to increase their own involvement in the healthcare process can result in decreased infections, decreased hospitalizations, and improved outcomes. For example, dental providers can facilitate patient involvement by involving other care team members in development and delivery of pre- and postoperative clinical instructions. This can ameliorate patient frustration due to common neurological side effects such as confusion, paranoia, and apathy, and thus engage patients in the oral hygiene necessary to improve outcomes.[18] These authors strongly believe — based on our personal experience with ESRD and our credentials as allied healthcare providers — that dental and medical providers must also assess patient quality of life issues. Such issues include overall happiness, sense of well-being, ability to continue working or exercising, and the current knowledge, skills, or motivation to prevent comorbidities such as diabetes, hypertension, etc. This assessment, which could be done by the patient's dialysis social worker or during the patient's dental assessment interview, can offer providers valuable insights toward improving patient care. Furthermore, when the patient is invited into the decision-making process, adherence to healthcare recommendations, and therefore patient outcomes, are improved. For these reasons, we believe that patient participation is an essential factor in the success of transdisciplinary care.

Evidence-based dental management of patients living with CKD/ESRD

Kidney Disease Outcome Quality Initiative (K/DOQI guidelines). Between 1989 and 1999, the incidence and prevalence of ESRD doubled.[19] As a result, in 1999, the National Kidney Foundation's K/DOQI guidelines became an integral part of nephrology practice throughout the U.S.[19] Since its inception, the objective of K/DOQI guidelines has been to improve quality of care and patient outcomes of all patients living with kidney disease by developing clinical practice guidelines for the management of patients in various stages of kidney disease.[19]

The K/DOQI guidelines represent the first comprehensive effort to provide evidence-based guidance for development of strategies that would have a measurable impact on quality of life in patients receiving dialysis.[20] Since 1997, the NKF has released guidelines[13], with topics including vascular access for dialysis treatments, diabetes, hemodialysis and peritoneal dialysis adequacy, anemia, nutrition, dyslipidemia, bone metabolism, hypertension, cardiovascular disease (CVD), and CKD itself. At present, the K/DOQI guidelines do not specifically address oral health or the complications associated with it; however, they do address several aspects of care that indirectly affect oral health. In accordance with new scientific practice evidence through the Dialysis Outcomes Practice Patterns Study[21], the medical and dental clinical recommendations for patients living with ESRD are sure to be altered and interdisciplinary communication will become even more imperative. A comprehensive list of K/DOQI topics can be found at the National Kidney Foundation K/DOQI website at http://www.kidney.org/professionals/kdoqi/guidelines.cfm.

Dialysis Outcomes and Practice Patterns Study (DOPPS). DOPPS is an ongoing global research program studying clinical practice trends and patient outcomes from international hemodialysis studies.[21] Countries participating in DOPPS research include Australia, Belgium, Canada, France, Germany, Italy, Japan, New Zealand, Spain, Sweden, the United Kingdom, and the United States.[22]

DOPPS research is unique in its longitudinal approach, with a focus on the full range of unit practice patterns which may relate to clinically important patient outcomes, and with comorbidity factors adjusted to a greater extent than previously possible.[21] Furthermore, international participation provides an unprecedented comparison of variability in practice patterns and outcomes.[21] This will enhance an understanding of the relationships between various treatment effects and patient outcomes.[21]

The DOPPS hypothesis is that differences in practice patterns correlate with outcome differences, and patient outcomes will improve through better understanding of the associated factors.[21] Based on this hypothesis, there will be a large influx of new information regarding patient care over the next several years. Like the K/DOQI Guidelines, DOPPS research does not include oral healthcare recommendations for patients living on dialysis. However, it does contain a plethora of clinical research that has an indirect association with oral health, i.e., vascular access, CVD, and secondary hyperparathyroidism.[14] Both nephrology and dental professionals will greatly benefit from this emerging evidence-based research. More information about DOPPS is available at http://www.dopps.org/data_request.aspx.

Treatment modalities for patients with CKD and ESRD. Treatment modalities for patients with CKD and ESRD

vary.[19] For patients living with CKD, results can be very favorable if the disease is detected early.[19] With early detection and implementation of angiotensin-converting enzyme inhibitors (ACE inhibitors) or angiotensin receptor blockers (ARBs), loss of renal function can often be prevented or delayed.[23] However, the early stages of renal disease are typically asymptomatic, and treatment is frequently delayed until ESRD.[2] Treatment modalities for ESRD include solid organ transplantation, hemodialysis, and peritoneal dialysis.[24] The United Network for Organ Sharing reports that over 96,000 people are currently solid organ waiting list candidates.[25] Of the candidates listed, an overwhelming number (over 70,000) are patients awaiting renal transplantation.[25] Although current treatment modalities for ESRD are not a "cure" for ESRD, the miracle of organ transplantation offers those living with ESRD a less inhibited lifestyle than would be feasible with hemodialysis or periotoneal dialysis. However, renal transplantation does come with significant risks for cardiovascular disease and infection.[4]

Though the renal transplant community is growing rapidly, it is even more remarkable that over 70% of the estimated 470,000 patients with ESRD are receiving dialysis treatment.[26] Although many patients may favor organ transplantation as a treatment modality, contraindications include various types of neoplastic disease, HIV infection, AIDS, morbid obesity, smoking, some infectious processes, active systemic disease, and irreversible vital organ failure.[24] Furthermore, some patients may be fearful or uninterested in organ transplant therapy. Although dialysis is a lifesaving procedure, current treatment modalities replace only 15% of renal function.[27] Unfortunately, this long-term accumulation of toxic waste and edema routinely leave the patient susceptible to other systemic complications.[28]

With advancing medical expertise in the field of nephrology, the life expectancy of ESRD patients will continue to increase, and the rising population of ESRD patients will require dental care.[27] The dental and nephrology healthcare providers will need to communicate and collaborate in providing quality care to this expanding immuno"complex" population.

CKD risk factors: diabetes, CVD. Patients with diabetes, hypertension, and a family history of renal disease are at highest risk for CKD.[2] (African Americans, Hispanics, Pacific Islanders, Native Americans, and seniors are also at high risk.)[2] Among all new cases of ESRD in 2004, 70% had diabetes, 80% had hypertension[29] and, more than 35% of all new patients starting dialysis are living with diabetes.[27] Regardless of the dialysis treatment modality, patients living with diabetes generally show evidence of wasting and malnutrition.[30] The collective effects of altered cellular response, impaired tissue integrity, and altered collagen metabolism in patients with diabetes undoubtedly play a major role in susceptibility to infection and periodontal disease.[30] Uncontrolled or poorly controlled diabetes has been associated with increased susceptibility and could alter oral flora for years prior to dialysis therapy.[30] Because patients living with diabetes represent one of the largest sectors of the dialysis population, and often present with complex medical histories, clinical management requires skillful communication and understanding of these multifaceted medical issues.

Cardiovascular disease is the major cause of morbidity and mortality in patients with CKD (including renal transplant recipients).[31] Researchers recently confirmed that there is a direct relationship between high serum phosphorus levels and CVD.[32] Cardiovascular complications of CKD include: left ventricular hypertrophy (secondary to anemia and/or hypertension), cardiac failure, hypertension, pericarditis, progressive arteriosclerosis, cardiac arrhythmias (due to hyperkalemia), and calcinosis.[33] Infective endocarditis occurs in 2-9% of patients receiving hemodialysis (a rate which is reported significantly higher than in persons with rheumatic heart disease).[28] With the recent update in antibiotic premedication guidelines for dentistry,[34] medical and dental providers will need to carefully consider infection risk in patients on dialysis. Indeed, with ongoing global research (DOPPS) and the high incidence of comorbidities in the dialysis population, more research is warranted in this area.

Dental management of the patient with CKD/ESRD. As DOPPS research progresses, dental providers will need to stay current with new ESRD treatment strategies. As oral-systemic health research progresses, nephrologists will similarly need to stay current with emerging information that affects patients with ESRD.

The specific oral complications which are commonly observed with ESRD patients include: pallor of the oral mucosa secondary to anemia, diminished salivary flow resulting in chronic dry mouth and parotid infections due to severe fluid restrictions, patients frequently complain of a metallic-like taste, and the saliva often has an ammonia- type odor due to uremia.[10] Also noted are stomatitis, and radiographic evidence of loss of lamina dura, demineralized bone, and localized radiolucent jaw lesions.[10]

Anemia. Oral complications of the dialysis patient include pallor of the oral mucosa due to impaired secretion of the hormone erythropoietin, resulting in anemia.[28] Hematological complications found in the patients with ESRD are anemia (due to low erythropoietin), platelet

Figure 2: Mature/pronounced elbow primary AV fistula

Figure 3: AV graft, which can resemble an AV fistula

dysfunction, and impaired cell-mediated immunity.[35] Dental patients who have CKD or who are receiving dialysis treatments may have new, recurrent, or undiagnosed anemia; therefore, the registered dental hygienist should alert the renal healthcare team if signs of anemia are present during a dental visit.

Uremic stomatitis and xerostomia. Stomatitis and xerostomia are prevalent in patients on dialysis. Stomatitis is characterized by burning red mucosa, and can interfere with vital nutritional intake (e.g., calcium, phosphorus) in patients on dialysis.[30] Xerostomia is common due to strict fluid restrictions and adverse side effects of medications.[28] Other conditions may coexist or contribute to stomatitis and xerostomia.[28] Diagnosis and treatment of oral complications are critical; if untreated, these conditions undoubtedly impair the ability for most patients to obtain adequate nutrition.

Bone and mineral metabolism. Mitch and Klahr[36] describe the following metabolic process. As kidney function declines, calcitriol production and phosphorus excretion decrease, which results in phosphorus retention and contributes to the development of hyperparathyroidism. Parathyroid hormone (PTH) and 1,25-dihydroxycholecalciferol (calcitriol), the active form of vitamin D, regulate calcium and maintain phosphorus levels. PTH is mostly responsible for monitoring mineral balance, while calcitriol regulates intestinal calcium absorption. PTH also controls the renal excretion of phosphorus, increases serum calcium by releasing calcium from bone and increasing calcium reabsorption by the kidney. Calcitriol synthesis is also increased by PTH.

Both radiography and laboratory testing of intact PTH hormone are very important in the investigation and diagnosis of secondary hyperparathyroidism.[37] Although Brown tumors (osteoclastomas, i.e., radiolucent cysts associated with renal osteodystrophy) had been more commonly associated with primary hyperparathyroidism, they are increasingly being seen with renal osteodystrophy in patients with ESRD, and may be evident on panoramic and periapical radiographs.[37] Extraosseous calcifications are more common in secondary hyperparathyroidism than primary hyperparathyroidism, and can manifest as tumoral calcification associated with bone erosions, chondrocalcinosis, vascular calcification, calcified pulmonary nodules, cerebral subcortical calcification, calcification within the eyes, layering of soft-tissue calcification, cardiac calcifications, renal calcification, and hepatic calcification.[37] Because secondary hyperparathyroidism is radiographically evident (radiolucent Brown tumors, radio opaque carotid calcifications, and radio opaque calcifications found in soft tissues), dental professionals can help screen patients with ESRD for subtle and extreme manifestations of secondary hyperparathyroidism, through routine dental intraoral and extraoral radiographs.

Vascular access in patients receiving dialysis: impact on dental care

Patients receiving dialysis treatments (for photographs of a dialyzer and hemodialysis delivery system, see the *Collateral Items* section at www.thesystemiclink.com) have different access options for the site at which blood will be removed and returned during dialysis, including:[38]

- **Arteriovenous (AV) fistula —** a surgical procedure that connects an artery and vein together through anastomosis, which matures and/or develops providing a permanent dialysis access site.
- **AV graft —** a synthetic tube implanted under the skin in the arm; this is an artificial vein used for the dialysis access
- **Central venous catheter —** a plastic catheter with 2 lumens is inserted into a vein in either the neck, chest, or leg near the groin; used as a temporary access when other access sites fail, or advance planning for dialysis is not possible.

Infection of the dialysis access area (regardless of type of access) is an ongoing concern, and can result in septicemia, septic emboli, infective endarteritis, and infective endocarditis.[28] It is critical that dental providers understand the rate of infection for each type of access when deciding if antibiotic premedication is appropriate. Furthermore, blood pressure should not be taken in the arm used for dialysis access, and the patient should not be positioned in a way that increases pressure on the arm with the dialysis access. However, dental providers are generally unable to visually differentiate between the different types of access (Figures 2 and 3). Therefore, it is important for dental providers to have a comprehensive understanding of the various areas for vascular access in their patients who are undergoing dialysis treatments, to facilitate optimal patient outcomes.

Table 1 - Oral symptoms of common vitamin and mineral deficiencies in patients on dialysis

Vitamin	Function	Oral Symptoms of Deficiency
B Vitamins	Part of metabolic pathways involved in energy production, nucleic (DNA and RNA) synthesis, some neural processes[46]	Cheilosis of the lips, angular cheilitis (can also result from poorly fitting dentures), filiform atrophy, bald tongue[47] •**Thiamin (B1):** Apthous ulcers on the tongue[47] •**Riboflavin (B2):** Magenta colored tongue[47] •**Niacin (B3):** Scarlet glossitis, filiform papillae progressing to complete atrophy[47] •**Pyridoxine (B6):** Filiform papillary hypertrophy, glossodynia[47] •**Cobalamin (B12):** Filiform papillary atrophy, glossitis, glossodynia, pale or scarlet tongue, aphthous ulcers[47] •**Folic acid:** Pale lips, pale tongue, aphthous ulcers[47]
Vitamin C	Antioxidant, aids in iron absorption, participates in collagen synthesis, neurotransmitter synthesis, reduces inflammation due to its role in prostaglandin synthesis[48]	Bleeding gums, tooth loss, gingivitis[47]
Iron	Energy production, part of hemoglobin that helps carry oxygen throughout the body[46]	Pale lips/tongue, filiform atrophy, bald tongue, scarlet tongue, atrophied tongue[47]
Zinc	Assists in immune function, growth and development, influences behavior and learning performance, wound healing, taste perception[46]	Extraoral dermatitis, lichenification around the mouth, peeling of lips, angular cheilitis,[47] poor taste acuity[43]

Impact of oral biofilms and pneumonia in patients with ESRD

Due to uremia, there is a low incidence of decay in people living with ESRD.[28] Therefore, the current oral health focus should now shift to oral biofilms and its systemic ramifications. ESRD patients are at high risk for pneumonia;[40] therefore, education should be focused toward its prevention. Other respiratory complications of the ESRD patient include: infection, hyperventilation (Kusmaul's respiration — secondary to acidosis), and pulmonary edema (secondary to left-sided cardiac failure).[41]

A strong relationship has been established between

Table 2 - Food sources high in vitamins B and C, and trace minerals iron and zinc

Vitamin	Food Sources
Thiamin (B1)	Ham, legumes, liver, nuts, pork, whole-grain or enriched breads and cereals[46]
Riboflavin (B2)	Cottage cheese, leafy green vegetables, meat, milk, yogurt, whole-grain or enriched bread and cereals[46]
Niacin (B3)	Beef, brewer's yeast, Cornish game hen, highly fortified break fast cereal, poultry, swordfish, trout, tuna, veal[47]
Pyridoxine (B6)	Beef, fortified oatmeal, highly fortified ready-to-eat cereals, pasta, rice, soy-based meat substitutes[47]
Cobalamin (B12)	Beef, clams, crab, herring, highly fortified ready-to-eat cereals, milk, organ meats, oysters, salmon, shellfish, trout, tuna[47]
Folic Acid	Leafy green vegetables, legumes, liver, seeds[46]
Vitamin C	Citrus fruits, potatoes, tomatoes, tomato juice[47]
Iron	Beef, iron fortified breads or cereals, lamb, veal[47]
Zinc	Beef, bran cereal, bread, eggs, liver, milk, pork, wheat germ[47]

periodontal disease and bacterial pneumonia.[42] The personal experience of the author (Thomas) is that few adjunct nephrology providers are aware of current oral/systemic research. In addition, education about medical complexities in the ESRD population is underemphasized in the oral health profession. Therefore, in the authors' opinion, a synergistic effort between the registered dental hygienist and the registered dietitian could result in a reduced incidence of bacterial pneumonia in the ESRD population and improved patient outcomes.

Impact of nutritional deficiencies on oral-systemic health in patients with CKD/ESRD

Nutrition is a vital part of care for patients with CKD or ESRD. Diet modifications for these patients can include, but are not limited to, adjustments in protein, potassium, phosphorus, calcium, vitamins, and mineral intake.[43] Recommendations generally include increasing high value protein (animal sources) intake, lowering phosphorus intake, restricting potassium (depending on dialysis modality and residual renal function), and restricting fluids to maintain fluid status.[43]

Maintaining adequate protein stores improves the healing process, maintains oncotic pressure, and decreases morbidity and mortality.[36,43] As mentioned earlier calcium and phosphorus balance is important. Calcium imbalances can lead to neural and/or muscular problems,[44] and in combination with phosphorus imbalances, can result in secondary hyperparathyroidism and calcium deposits in the blood vessels.[43] Potassium imbalances can lead to cardiac arrhythmia and muscle weakness, which can result in cardiac arrest.[43] Many vitamin and mineral imbalances can occur in patients on dialysis. These imbalances can result from poor appetite, depression, gastrointestinal symptoms, difficulty chewing and/or swallowing, and difficulty with grocery shopping and cooking;[45] or, due to the dialysis process, dietary restrictions, excretion alterations to maintain homeostasis, dialysate contamination.[36] If patients on dialysis are nutrient deficient, the deficiency tends to be in water soluble vitamins (B and C) more than the fat soluble vitamins, usually due to the dialysis process;[43] and, in the trace minerals iron and zinc.[36,46] Certain vitamin and mineral imbalances can be identified within the oral cavity of the patient on dialysis (Table 1).[47]

Water-soluble vitamins are absorbed directly into the blood and easily travel throughout the body. Healthy kidneys manage these vitamins and excrete them as needed. These vitamins are usually found in the liquid compartments of food. On the other hand, fat-soluble vitamins are found in fats and oils of food. Fat-soluble vitamins must enter the lymph before entering the blood and they require protein carriers in order to move throughout the body. Since these vitamins tend to become trapped in fat-associated cells, and the kidneys are not aware of the fat-soluble vitamins, the excess is not excreted. Overall, fat-soluble vitamins can be ingested occasionally to maintain adequate levels, however most water-soluble vitamins do not remain in the body, so they must be consumed more often.[46]

Deficiency in fat-soluble vitamins (D, E, A, and K) is not as common as water soluble vitamin deficiency in patients with renal disease; however, toxicities can occur.[43] Vitamin A or E supplementation is not recommended.[43] The dialysis process does not remove vitamin A and renal excretion

is diminished to almost none.[43] High levels of vitamin A may be related to anemia, atherosclerosis, problems of the retina, hypercalcemia,[43] and dark margination of alveolar ridge.[47] Vitamin E supplementation is not recommended, as more research is needed in this area.[43] However, vitamin E deficiency can cause aphthous ulcers of the tongue.[47] Supplementation of vitamin K is not recommended due to its involvement in clot formation or patients on anticoagulant therapy.[43] Lastly, active vitamin D analogues are used as a treatment for suppressing the parathyroid gland,[43] and inactive vitamin D supplements are being used more in the kidney setting; however, more research is needed in this area.[49,50]

Managing nutritional deficiencies in patients with CKD/ESRD. In order to correct some of the nutrient deficiencies, most patients on dialysis take a renal vitamin consisting primarily of a B-vitamin complex with some vitamin C. It is important that patients refrain from taking the vitamin before treatment, since most of the vitamin will be lost due to the dialysis process.[43] A patient can also focus on foods (within in the patient's renal diet) high in certain vitamins and minerals (Table 2). Through improved screening, education, and consultation/referral, registered dental hygienists and registered dietitians can work together to improve the oral-systemic health of patients with CKD/ESRD (Table 3).

Conclusion

The patient receiving hemodialysis treatment for ESRD often presents with comorbidities and a complex medical history. As the prevalence of ESRD continues to escalate in the U.S., dental professionals will see an unprecedented number of patients with CKD and ESRD. Although organ transplantation is often the favored treatment modality for ESRD, an overwhelming number of patients are currently awaiting organ donation for renal transplantation, and many patients do not qualify. Some patients refuse renal transplantation. As evidence-based practice evolves in nephrology and dentistry, a structured means of communication and education must be established between these two disciplines. Without such collaboration, dental treatment could result in injury or infection to the dialysis access (or sepsis), and medical care may be complicated by systemic conditions resulting from dental infection and oral biofilms (e.g., diabetes and pneumonia). Successful long-term outcomes, for patients on dialysis or awaiting renal transplant, will depend on this collaboration. The transdisciplinary care team would benefit from contributions by the registered dental hygienist and registered dietitian, who share a similar educational background, and offer professional expertise that can minimize access to care barriers, enhance transdisciplinary communication, implement evidence-based practice, establish favorable nutritional status, and, ultimately, improve patient outcomes.

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Table 3 - Strategies to achieve effective integration of oral health and nutrition services for patients with CKD/ESRD

	Strategies for the...	
Level of Care	**Registered Dental Hygienist (RDH)**	**Registered Dietitian (RD)**
Screening	Include diet screening, education, and referral for oral infectious disease prevention/control, optimal masticatory function and management of other oral diseases as a component of comprehensive dental care	Include oral health screening in nutrition assessment protocols
Education	Provide diet and nutrition education consistent with the Dietary Guidelines for Americans (http://www.health.gov/dietaryguidelines)	Recognize oral manifestations of systemic diseases and provide patients with dietary guidance to maximize oral intake
Consultation/ Referral	Consult with and refer patients to registered dietitians for management of nutrition risk due to compromised oral health (e.g., ESRD, xerostomia, diabetes)	Confer with and refer patients to dental professionals for management of oral diseases and/or risk factors for oral diseases

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