Need for Genetics Education in U.S. Dental and Dental Hygiene Programs

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Abstract: The two major afflictions of the oral cavity are dental caries and gingival/periodontal disease. While microorganisms have long been acknowledged as important etiologic factors, the most recent research data demonstrate that both of these pathologic conditions have a strong hereditary base, i.e., even in the presence of putative pathogenic microorganisms, if the host individual is not genetically susceptible, ensuing disease will be mild or even nonexistent. In the face of this evidence for heritability of the two major oral diseases, we evaluated what educational experiences in genetics were provided to students in U.S. dental schools and dental hygiene programs in 2003-04. Our survey of fifty-four dental schools revealed that only one requires a formal genetics course before admission, and only six incorporate a required genetics course within the dental curriculum. Of the 264 dental hygiene programs surveyed, none require a formal genetics course as a prerequisite for admission, and none require a formal genetics course within their curricula. The enormous successes, and future promise, of the Human Genome Project suggest that genetics will soon dominate the future of medicine and dentistry, in prediction of diseases, disease diagnosis, and, eventually, therapy for genetically based disorders. It is therefore incumbent upon dental and dental hygiene education programs to provide genetics education for tomorrow's practitioners.

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Throughout generations, it has been casually noticed that "dental diseases seem to run in families." Non-scientific reports were common in the early 1900s; for example, consider these anecdotal observations cited in Hassell and Harris[1]: "Inheritance plays a massive role in periodontitis. I once saw a mother of eight who had periodontal disease, and so did four of her children"; "We can detect no environmental factor to explain the differences in caries susceptibility between caries-prone and caries-free individuals/parents/siblings. We conclude that genetic factors play an appreciable part in determining individual resistance against dental caries."

Beyond these anecdotal observations, the question of a possible true genetic predisposition toward dental caries was studied in earnest in the first half of the twentieth century by several reputable investigators.[2-4] In an elegant animal model system, Hunt and Hoppert demonstrated in 1944 that dental caries susceptibility is a heritable trait.[5] Klein, in his 1946 study of DMFT in 5,400 individuals from 1,150 different families, concluded that "dental disease in children involves strong familial vectors (*sic*) which . . . have a genetic basis."[6] Comprehensive reviews of the research on heritability of caries were published in 1963[7] and 1972.[8] In 1988, a landmark study was published by Boraas et al.[9] Their six-year retrospective study of a large cohort of fraternal and identical adult twins demonstrated that almost 90 percent of dental parameters investigated were associated with highly significant within-pair resemblance in the identical twins, thus providing new and convincing evidence for a significant genetic component in dental caries experience.

The genetic basis of inflammatory periodontal disorders was less established until quite recently, primarily due to the relative complexity of the disease, continually emerging new knowledge about its pathogenesis, vagueness of clinical diagnosis and statistical quantitation, and the profession's own nomenclature for classifying these diseases, which continues to evolve.[10] During the 1950s, Baer et al. performed an exhaustive series of mouse breeding experiments, using strains that were highly susceptible to alveolar bone loss and other strains that were quite resistant, and concluded that these strains differed at several genetic loci, each of which exerted an effect on periodontal disease susceptibility.[11-13]

In the 1990s, the periodontal research group at the University of Minnesota[14-18] used the large Minnesota Twins Registry[19] to conduct a series of studies to define the magnitude of hereditary control over periodontal disease susceptibility. Their initial reports

indicated that up to 80 percent of the population variances in gingival and periodontal clinical indices could be accounted for by hereditary factors. In a more recent study of another large human twin cohort,[20] hereditary factors accounted for approximately 50 percent of "adult periodontitis," still a dramatic genetic effect. Similar findings were reported by other investigators.[21] In 2000, Michalowicz et al. concluded that "the basis for the heritability of periodontitis appears to be biological and not behavioral in nature."[20] Excellent reviews of the influences of genetics in periodontal diseases have appeared recently.[1,22,23]

Deciphering the mechanisms of such genetic control is difficult. Recent clinical and laboratory investigations have shed light on some mechanisms and spurred increased interest in identifying genetic risk factors for adult periodontitis. Clinical disease incidence and severity have been found to be associated with gene polymorphisms in interleukin (IL)-1a and IL-1b,[24-26] IgG Fcg receptor,[27, 28] and HLA loci.[29] *In vitro* studies using gingival fibroblasts from human twins have demonstrated that the cellular proliferation rate is genetically regulated.[30] Further, responses of periodontal connective tissue cells to the metabolic products of pathogenic oral bacteria have been shown to be under genetic control.[31]

The successes of the Human Genome Project (HGP)[32] promise to solidify genetics as the new cornerstone of medicine and dentistry now and into the future. Enormous strides have already been made in using genomic research to predict disease occurrence (e.g., breast cancer, myocardial infarction, periodontitis, melanoma, Alzheimer's disease, diabetes). With current research targeting new ways to intercept disease processes before they start, "pharmacogenetic" approaches to heritable disorders systemically and in the oral cavity may be implemented in the future.

New knowledge emerging from the HGP is creating an educational dental/medical paradigm shift. Therefore, we wished to ascertain the current state of genetics education in U.S. dental schools and dental hygiene programs.

Methods

This survey was conducted during December 2003 and January 2004, at which time there were fifty-six U.S. dental schools. Two of these had only recently opened and were not surveyed. There are 264 U.S. dental hygiene education and training programs.

Our approach was twofold. First, we used the Internet to access curricular components of all 318 D.D.S. and R.D.H. programs from their websites. Then, after examining and collating all information from the websites, telephone interviews were conducted with either the director of admissions or the chair of the curriculum committee at the U.S. dental schools to confirm our initial assessments from the web data. Similar telephone interviews were conducted with appropriate administrative individuals at 185 of the 264 dental hygiene programs. These 185 programs were chosen for telephone interviews because of inconsistencies, vagueness, or omissions in their web-based curricular listings.

Our approach was the same in each telephone interview. We sought answers to three basic questions:

- Is a formal genetics course required for entry into your program of study?
- Is a formal genetics course required as part of your professional curriculum?
- If the answer to either question is yes:
  - Is the genetics course taught by one of your own faculty?
  - Is the genetics course taught by faculty from a medical school or elsewhere?

Results

Of the 264 dental hygiene programs in the United States, not one currently requires a genetics course for entry into the program, and not one has a required genetics course within the professional curriculum itself. Several programs reported that they "suggested" to applicants that a genetics course would be valuable or otherwise "helpful" for entry into the program.

Of the fifty-four dental schools in the United States that we surveyed via website and telephone interview, only one (University of Florida College of Dentistry, Gainesville, FL) currently requires a genetics course before entry into the program of study. As of December 2003, the core curricula of the following six U.S. dental schools contain a formal, required course in genetics:

- Harvard School of Dental Medicine, Boston, MA
- University of Detroit Mercy, Detroit, MI
- University of Minnesota, Minneapolis, MN

- State University of New York, Stony Brook, NY
- Medical University of South Carolina, Charleston, SC
- Medical College of Virginia, Virginia Commonwealth University, Richmond, VA

Four of the genetics courses required in U.S. dental schools are taught by faculty members from collocated medical schools, with, in some cases, guest lectures by dental school faculty members. Two courses are taught by dental school faculty members.

Discussion

Clearly, U.S. dental and dental hygiene programs are already far behind in terms of educating tomorrow's practitioners in genetics and its implications on clinical practice.

Our survey results need not necessarily be viewed as critical of those schools and programs not currently requiring formal genetics education because it is possible, and likely, that some aspects of genetics are included in other courses such as developmental biology, pathology, or molecular biology. Our survey did not address these possibilities, but Dudlicek et al.[33] reported in detail about this aspect of dental education (but not dental hygiene education). Further, Dudlicek et al. report survey data that were collected in 2001, while our study was conducted during the 2003-04 academic year. Dudlicek et al. report that eight dental schools require a formal genetics course, while our survey found only six. We have ascertained now that two dental schools dropped their genetics requirement since 2001. This finding demonstrates that few U.S. dental schools are emphasizing genetics in their curricula in a formal manner; indeed, the trend appears to be toward reducing courses in genetics.

In summary, genetics *is* the future of dentistry and medicine. Institutions offering professional health care education in the United States must quickly come to accept this fact and move to incorporate formal study of genetics, and its implications, into the prerequisite array of coursework and into the body of study within professional education. In 1997, even three years before the DNA code was finally deciphered, the scientific director of the Human Genome Project, Dr. Francis Collins, published a prescient paper in the *Journal of the American Medical Association* entitled "Preparing Health Professionals for the Genetic Revolution."[34] A *Journal of Dental Education* article by former NIDCR Director Slavkin in 2001[35] implored educators to access and evaluate the recommendations put forth by a Blue Ribbon Panel on the Future of Education and Training in Dental and Craniofacial Sciences (see www/nidcr.nih.gov). Both Collins and Slavkin advocated increased curricular emphasis on genetics education. In the words of Slavkin, "change" and "revision" are the operative terms for the coming decades of the twenty-first century.

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