Dental Research at the National Bureau of Standards

George Colby Paffenbarger was a man of considerable insight. Nearing the end of his life as a result of prostate cancer, he perceived a need to educate the dental profession and the public about the enormous benefits to dentistry and public health that were being wrought through the cooperative research of the American Dental Association (ADA) and the National Bureau of Standards. Tax dollars, allocations from ADA dues, and funding from the National Institute of Dental Research were being used to support this work, and it was important for everyone to know that this investment was yielding benefits which far exceeded costs. Elsewhere, an oversupply of graduating practitioners and a reduced demand for dental care was leading to the closing of some dental schools and an attendant pressure to reduce all sources of funding for dental research. What George Paffenbarger saw, and others did not, was the continued evolution of (then unappreciated) dramatic benefits from dental research, even as the primary emphasis for research began to shift away from treatments for caries (the incidence of which had already declined) to treatments for other oral diseases and conditions. Paffenbarger's solution to this problem was to publish a paper [1] that would place the ADA/NBS dental research program into a clear and succinct context.

Paffenbarger undertook this project in collaboration with John A. Tesk and W. E. Brown at NBS. Together, they documented the development of modern dental materials research, beginning with the inception of a dental research program at NBS in 1919.

The beginning can be traced to a request by the U.S. Army to develop a bid specification for the purchase of dental amalgam. That effort, headed and championed by Dr. Wilmer Souder, focused on the properties of amalgams, including their compositions, dimensional changes on setting, compressive strengths, and flow characteristics [2]. That work led to the collaboration between NBS and the Weinstein Research Laboratory to measure the physical properties of the whole range of materials being used by dentists, for which the literature of the day was rather scant and often controversial [3]. The impact of that eight-year study is credited with the development of the cooperative program of the ADA and NBS, which continues to this day.

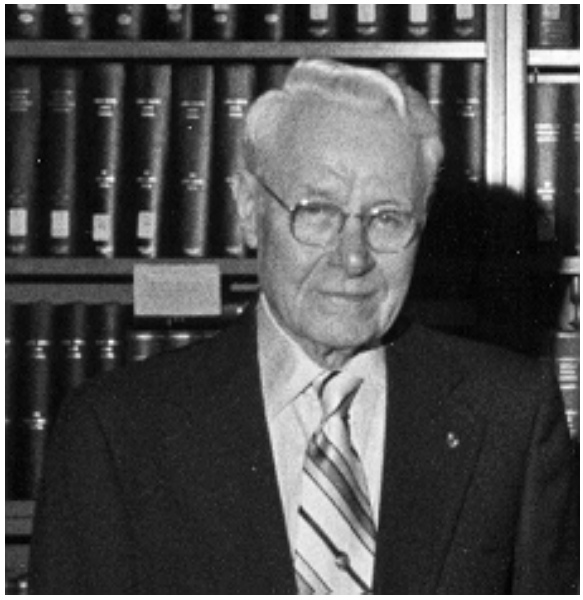

Fig. 1. George C. Paffenbarger.

The review by Paffenbarger, Tesk, and Brown paints a picture of a remarkable and far-reaching program that touches on every aspect of dentistry and, hence, public health. The thrust of the program was not simply the measurement of properties or even the development of standards and certification programs. Dental professionals and the public needed to be informed about the significance of the results, particularly with respect to self-serving promotions of products that had been propagated unchecked early in the century. "Aside from probable deceptive claims (for the exploitation of dental materials) exposed in the individual surveys, reports were published by the Association at NBS showing the fraudulent nature of some of the deceptions." [1]

Dental practices were also an important part of the program. As the ADA/NBS program began to understand more about the physical and chemical properties of amalgams, the influence of impurities and contaminants on the degradation of restorations also began to be understood. In one case, the practice of dentists mulling the amalgam mix in the palms of their hands was found to add moisture and sodium chloride to the mix, which subsequently led to severe corroding of zinc-bearing amalgams [4].

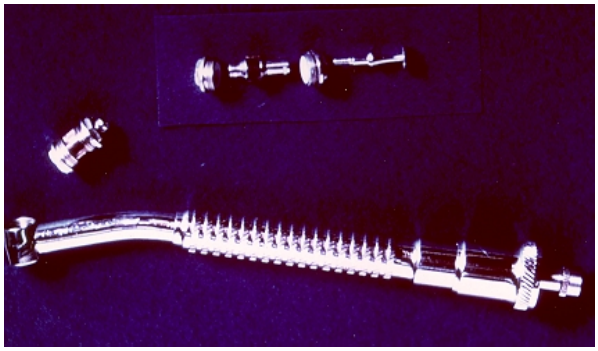

Fig. 2. The contra-angle handpiece, developed in the ADA/NBS program, is used in virtually every modern dental office in the world.

The growth of the ADA/NBS program was breathtaking in itself. Since the 1950s, the program has included research on crystal structures, crystal chemistry of minerals, solubility studies, calcium phosphate cements, topical fluoridation procedures, enamel etching, the formation mechanisms of caries, the *in situ* microanalysis of carious and sound enamel, the characterization of cardiovascular calcifications, and the development of new materials and instruments. Among the most noteworthy developments that sprang from this program are the modern high-speed-turbine, contra-angle handpiece; the panoramic x-ray unit; modern dental composite restoratives and sealants; and the national and international standards programs for dentistry.

With respect to the waning support for dental research in the mid-1980s, this accounting by Paffenbarger et al. was successful in helping to sway the members of the ADA to preserve its support of dental research and to seek alternative methods to help curtail the rise in ADA dues. It was clear that the ADA/NBS program had saved the public and the dental profession billions of dollars over the years, at a cost that seemed insignificant in comparison to the benefit.

George Paffenbarger received the degree of DDS from Ohio State University in 1924 and after a brief time in private practice and teaching, joined the research staff of the ADA at NBS in 1929. During part of his tenure, Paffenbarger served as Director of the ADA research unit at NBS. Among his most recognized research contributions were his investigations into the stability of both dental impression materials and polymer based denture materials, and studies of the retentive mechanisms of dental cements. He also became a staunch champion of the modern tooth-colored composite restoratives that emanated from the research of R. Bowen (another accomplished ADA researcher at NBS). He was also instrumental in the development of dental standards activities throughout the world. Paffenbarger was recognized by numerous academic institutions, including Ohio State (his alma mater), Fairleigh Dickenson, Georgetown, and Nihon (Japan) Universities, through the receipt of honorary degrees. St. Andrews University, Scotland, invited him to be Praelector In Dentistry for the Faculty of Medicine. He was an honorary member of numerous national and international dental societies and organizations, including the ADA, the Japanese Dental Association, the Federation Dentaire Internationale, and French, German, British, Argentine societies. He was also a Fellow of the Washington Academy of Science. He was the recipient of an almost countless number of awards, including the Wilmer Souder award, the highest award for dental materials research bestowed by the International Association for Dental Research (IADR, a society that he also helped to found). During World War II, Paffenbarger served in the United States Navy, with responsibility for procurement and testing of dental supplies. By 1959, when he retired from the United States Naval Reserve, he had risen to the rank of Rear Admiral . When he lectured before domestic dental societies he was known to emphasize the importance of dental research by saying “now this is something that you paid for, but look at what you’ve gotten in return.” He was an unyielding opponent of the drawing of conclusions from poor research and unsubstantiated results, but he was a warm, friendly mentor for those who recognized the need for improvements in their work and who sought his counsel to strive toward the ideals of excellence that embodied his life.

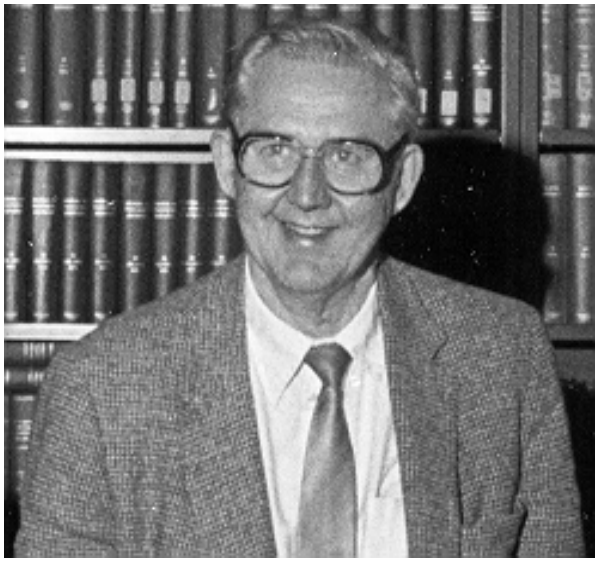

Fig. 3. Walter E. Brown.

Walter Brown received his Ph.D. degree from Harvard University in 1949. From 1948 to 1962 he conducted research on the crystallography and chemistry of calcium phosphates for the Tennessee Valley Authority. In 1962 he joined the ADA research unit at NBS, where he directed research on the solubility and crystal chemistry of mineralized tissues, including tooth calculus. He became director of the ADA unit in 1967 and served in that capacity until his retirement in 1983, after which he continued as a research associate until his death, from Parkinson's disease, in 1993. Brown, like Paffenbarger, received numerous honors and awards. He was recognized universally for his contributions to the crystallography, chemistry, and biochemistry of calcium phosphate compounds. His theories are among the main underpinnings of modern calcium phosphate chemistry. His pioneering studies of the physicochemical properties of mineralized tissues, such as teeth and bone, provided the foundation for much of the modern research on diseases such as dental caries, osteoporosis and arteriosclerosis, and in the development of topical fluoride treatments for teeth. His work also lay at the heart of modern calcium biomaterials. During his life it was said that he was known "from biomineralization to fertilizer" and he delighted in both the truth and the humor of that statement. Among his awards were the Mineralized Tissue Research award of the IADR, the highest award of its kind; an NBS citation for "Outstanding Leadership of the ADA Research Group at NIST," and the Rudjer Institute (Zagreb, Yugoslavia) Founder's Plaque for "contributions to scientific exchange"; he was also an honorary member of the ADA. He followed Paffenbarger as Director of the ADA research unit at NIST.

John Tesk received his Ph.D. degree from Northwestern University in 1963. Prior to his NBS experience, which began in 1978, his career encompassed employment as: Engineer-in-Training with a company in the natural gas industry; Assistant Professor of Materials Engineering at the University of Illinois, Chicago; consultant to Argonne National Laboratory on low temperature neutron damage in metals and, later, Assistant Metallurgist with Argonne on the development of the breeder reactor; Director of Research with a dental company; and Director of Education Services, with the Institute of Gas Technology, for training of engineers and technicians in Algeria. As an employee of NBS, he served as Leader of the Dental and Medical Materials Research group, which included the ADA researchers, from 1983 to 1994. In 1994 he was given the assignment of searching for other health-related needs toward which NIST expertise might be applied. In 1995, along with Stephen Hsu (a renowned tribologist in the Ceramics Division) and six of the world's largest orthopedic companies, he formed the first orthopedic Cooperative Research and Development consortium in the Materials Science and Engineering Laboratory. The consortium's goal was to develop a reliable, accelerated screening test for orthopedic implant joint bearing materials (wear being a primary cause necessitating the removal of these joint implants). Because of the variety of both his experiences and the topics of his publications, John often joked that he was "*known well* for not being *well known*." His honors include the Bronze Medal from NBS and awards from the ADA and the American Society for Testing and Materials for work in national and international standards. In 1998, for contributions made in collaboration with many Japanese dental researchers (including a best paper award, co-author, Professor Kenzo Asaoka) he became the third foreigner elected to honorary membership in the Japanese Society for Dental Materials.

Fig. 4. John A. Tesk.

Prepared by John Tesk and Ronald Munro.

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