

Building Partnerships and Interdisciplinary Collaborations in Oral Health Research

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Abstract: Schools of dentistry in large health science centers, while offering excellent education programs, often fail to attain high levels of research for several reasons, including 1) a limited number of faculty who become consumed by the school's teaching mission to the extent that major research is not possible; and 2) faculty often come from the ranks of practitioners and are not necessarily trained for, or have had direct experience in biomedical research. Continuing dental research not only adds to the general knowledge base, but is critical to constant improvement in human oral health. Partnerships among universities, industry, and governmental agencies are increasingly essential for effective translational research. Two models that characterize the organization of research units within universities are discussed: the distributed model, in which individual researchers are assigned throughout the units of the schools, often in various departments, and the localized model, in which most of the researchers are assigned to one unit or department. Furthermore, characteristics of successful oral biology departments are presented in an effort to understand their success, including recruitment of faculty with scientific backgrounds, development of rigorous graduate programs, well-defined responsibility for undergraduate or professional teaching obligations, and the development of a group of sufficient size to allow for interaction and support in research and teaching. Lessons learned from successful oral biology departments in dental schools can likely be applied to comparable units of academic health centers.

The well-known central mission of most universities revolves around teaching, research, and service. In most universities, teaching and research are essential, and service often serves, or is a byproduct of, the teaching and research missions. Large universities with health science centers, which include not only medical schools and university hospitals, but also smaller units such as schools of dentistry, nursing, pharmacy, and health-related professions, often find themselves lacking in research activity in these smaller units. Schools of dentistry, nursing, pharmacy, and health-related professions often offer excellent education programs, but fail to attain high levels of research.

There are many reasons for this difficulty in attaining significant research activity in these small units of university health centers. For example, the teaching mission of the small professional school consumes its limited faculty to the extent that major research by a significant number of these faculty members is not possible. Another factor is that faculty in these small professional schools often come from the ranks of practitioners and, although they are often excellent teach-

ers, they are not necessarily trained for, or have had direct experience in biomedical research.

We have witnessed the closing of several schools of dentistry, and a common feature in most of these recent closings is the lack of active, growing research activities exhibited by these schools. Other reasons are often given for the closing of dental schools, such as lack of sufficient high-quality applicants and the high cost of operations. However, it is clear that lack of significant research programs at a level comparable to or even approaching those seen in medical schools or other units of the university often contributes to the perception that these professional schools are not fully contributing to the central missions of the university. This, coupled with high costs and lack of qualified applicants, makes these smaller units targets for closure, especially during difficult financial times. It is clear that it is important to many universities that all of the health science units contribute significantly to the scholarship and research activities of the university, as well as to teaching and service.

Potential of Oral Health Research to Benefit the Health of the Population

In addition to adding to the general knowledge base, research activities in a dental school also have great potential to have an impact on the oral health of the general population. New discoveries relating to diagnosis, treatment, and prevention of oral diseases have enabled the profession to provide high levels of oral care and will likely continue to do so in the future. Research is the engine that drives the profession of dentistry, as well as all other health professions. Research findings also provide the basis of a constantly renewed and vital curriculum necessary for successful teaching of clinicians able to render effective, up-to-date care and prevention throughout their careers. It is clear then that fundamental and applied research not only drives the profession forward, but also will have great impact on education, and hence is not only essential to the central missions of the university, but is critical to constant improvement in human health.

The Role of Partnerships and Interdisciplinary Collaborations

Partnerships among universities, industry, and governmental agencies are increasingly essential for effective translational research. In an ongoing oral vaccine project in which my colleagues Drs. Ashu Sharma, Howard Kuramitsu, and Todd Evans are participating, there is a partnership with essential participants from several universities, government, and industry. In this project, in fact, six institutions are partners: the State University of New York at Buffalo, Rockefeller University, SIGA (a biotechnology company), the National Institutes of Health, the Food and Drug Administration, and the University of Maryland Vaccine Development Center. The project involved use of a common oral organism, *Streptococcus gordonii*, as a vector for oral vaccines against group A streptococcal disease.

Scientists of the University at Buffalo and Rockefeller University have genetically engineered these innocuous bacteria to deliver antigens of the pathogenic streptococci. The staff of SIGA has prepared lots of this genetically engineered organism under special sterile conditions required for their use in humans. These vaccines are then tested in animals and in hu-

mans to determine if they colonize and produce the desired antigen and can stimulate an immune response. Scientists at the University of Maryland, supported by grants and contracts from the NIH, are carrying out an FDA-approved Phase I trial of the oral vaccine in humans to determine safety and to develop conditions for the administration of the vaccine for eventual efficacy testing in FDA-approved, large-scale pivotal clinical trials. This complex set of partnerships is common in clinical research and is necessary for effective translation of university-based fundamental research to useful products.

Another example of multidisciplinary dental research involves those studies linking oral health to systemic disease. Periodontal diseases are chronic infections whose initiation and progression are markedly affected by systemic diseases such as diabetes and osteoporosis. Hence, for full understanding of periodontal diseases, multidisciplinary teams of investigators including those with expertise in oral infections, diabetes, and osteoporosis are often necessary for a complete approach to study of these interactions.

Periodontal infections may also influence systemic conditions. For example, periodontal infections appear to increase the risk for cardiovascular disease, including acute myocardial infarction. Periodontal infections also appear to increase the risk for adverse pregnancy outcomes in pregnant women and to decrease glycemic control in diabetics. Recently, periodontal infections have been implicated in infections at other sites in the body, such as those occurring in the respiratory tract. Study of each of these interactions requires teams of investigators with diverse expertise. For example, research to determine the mechanisms by which periodontal infections contribute to atheromatous plaques in coronary arteries requires interaction of scientists from many disciplines including biochemists, pathologists, microbiologists, and molecular biologists.

Multidisciplinary teams have been formed at several universities to study the structures on oral organisms that cause blood platelets to aggregate and contribute to thrombotic changes in the heart. The next phase of this research will likely involve other teams of investigators to develop drugs to inhibit this oral bacteria-induced platelet aggregation. These teams will likely include medicinal chemists, toxicologists, cardiologists, and hematologists who will possibly partner with industry for drug development.

Similarly, unraveling the mechanism by which oral and other infections reduce the control of blood sugar in diabetics and enhance diabetic complications

requires interactions among biochemists, chemists, molecular biologists, microbiologists, and pathologists. Once these mechanisms are known, teams of medicinal chemists and toxicologists, as well as clinical researchers, then are required to develop new approaches to intercept these pathologic changes to modify and prevent infection-mediated loss of glycemic control in diabetics. New candidate drug development then requires interaction with industry. Once the drugs are shown to be effective and safe, they are submitted to federal regulatory agencies such as the FDA for approval, a process often involving scientists from universities as well as industry who have carried out the toxicity studies and clinical trials.

Interdisciplinary collaboration is strong in the study of the interaction of periodontal infections with general health. However, this is only one of the many examples of such interactions necessary for full development of translational research potential in oral health research in dental schools. Much of the dental research in the United States is supported by the National Institutes of Health and industry and to a lesser extent by state funding and foundations. Funding agencies are generally supportive of multidisciplinary, inter-institutional collaborations to investigate many oral health problems.

Models of Health Research in Small- to Medium-Sized Research Units

There are several effective models of organized health research in a biomedical research unit. I will focus on those unique aspects of health research as carried out in units the size of a school of dentistry. Two models characterize the organization of research units within universities: the distributed model and the localized model.

In the distributed model, individual researchers are assigned throughout the units of the schools, often in various departments. As most dental school departments are rather small (five to ten members), this distribution would result in possibly one or a few qualified researchers in each of eight or ten departments.

In the localized research model, most of the researchers are assigned to one unit or department. Such departments of researchers are common in dental schools and are often called departments of oral biology or dental basic science departments. There are ex-

amples of schools in which a combination of the two models exist with concentrations of researchers in a few departments and individual researchers in several other departments.

The experience of the last thirty years in U.S. dental schools suggests that the localized model can be successful. I will describe one such example at the State University of New York at Buffalo School of Dental Medicine.

In 1960, the University of Buffalo, a private university, became part of the large State University of New York system. This resulted in a large infusion of funds into the School of Dental Medicine for faculty, staff, and operations. At that time, Dean James English decided to place fifteen of the new faculty positions into the newly formed department called the Department of Oral Biology. The main mission of this department was to be research and graduate teaching. Service was to be carried out only as much as necessary to fulfill the main missions of research and graduate teaching of the department.

Dr. Solon Ellison, a respected and established dental scientist, was recruited to chair this department, and he, in turn, recruited many scientists with Ph.D. degrees and some that also held dental degrees. He also established a university-based Ph.D. program tailored to the needs of dentists who wanted to pursue academic research careers. This department has been fortunate to have been well funded for more than thirty years, being in the top five or six dental school departments in the United States with respect to the amount of NIH grant and contract support received.

In the last ten years, there has been a steady increase also in industrial and foundation funding for the research and teaching programs of the oral biology department. These quantitative measure of success are also supported by the many successful research projects and programs the faculty have carried out which have likely contributed to better oral health of the population.

Several characteristics of this and other successful oral biology departments may be instructive in understanding their success. First, the faculty is hired mainly because of their scientific background, experience, and potential. These faculty are often dentists with Ph.D. training in scientific areas. Also, several non-dentist Ph.D. science faculty have been hired. The guiding principle in hiring faculty has been that they are excellent scientists dedicated to oral health and related research and also good teachers, especially at the graduate level.

The second characteristic of these departments is the development and support of rigorous contemporary, university-based graduate programs. The graduate programs at the master's and Ph.D. levels appear to be important to the vitality of the research department. In a dental school, well-established graduate programs can often attract dentists who combine residency training with the M.S. or Ph.D. training or students who combine the D.D.S. degree with a Ph.D.

The third characteristic of these successful research departments in dental schools is that there is well-defined responsibility for undergraduate or professional teaching obligation. The basic sciences, for example, are often taught primarily by the basic science departments of the medical school. Many oral biology faculty do indeed teach in the basic sciences and serve important functions in relating the basic sciences to dentistry.

The fourth characteristic is the development of a group of sufficient size to allow colleagues to interact and support each other in research and teaching. Sufficient size of the faculty in these units is also important to support an infrastructure of staff, services, and facilities that is ongoing and necessary for optimal research. This infrastructure includes information services, support of laboratory and administrative staff, common laboratory support for services such as sterilization, and shared large equipment.

Finally, it is clear that the leadership of the research group, the school, and university administration must openly and strongly support the research mission of these units for them to be successful. Otherwise, during difficult times, a research unit tends to be considered expendable when compared to the necessity of providing a professional education.

It is not clear which of these characteristics, or perhaps others, contribute most to the success of a re-

search department. It is likely, however, that this combination of critical mass focus of scientists in one department or unit, the infrastructure, the leadership, and the emphasis on graduate training all likely contribute to a very viable, dynamic research organization within a dental school. This localized model also appears to have been successful in a number of other professional schools, including the schools of pharmacy, nursing and health-related professionals at the University at Buffalo.

The distributed model of research in dental schools with scientists in many small groups in several departments may also work, but there are few examples of success with this model in dental schools or in other small units of medical centers such as nursing schools or schools of health-related professions. Most dental schools with vital research activities have one or a few departments where there is a focus of research activity.

Oral health research is vital for the health of the profession as it contributes to advances in prevention and treatment of oral diseases. Furthermore, a viable, dynamic research effort is a necessary component of a school of dentistry as it contributes to the central mission of the parent university. The localized model in which most of the scientific talent in a dental school resides in one of few departments is likely to be successful. Distributed models in which scientists are dispersed throughout the many departments of a dental school have not always been successful, likely since they fail to provide support, infrastructure, and a critical mass for graduate education essential to a viable research unit. The lessons learned from dental schools in which successful contributions of scientists in oral biology departments or their counterparts can likely be applied to comparable units of academic health centers.