

Prosthodontics: A Past with a Future?

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A b s t r a c t

As one of the oldest dental specialties, prosthodontics has a long history of innovation and adaptability. This overview of the field presents landmarks in the development of prosthodontics from mediaeval times to the present and speculates on some future trends. It effectively sets the stage for the other articles in this issue, which explore the many facets of prosthodontic evolution.

MeSH Key Words: *prosthodontics/education; prosthodontics/history; prosthodontics/trends*

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Prosthodontics was second only to oral surgery in its appearance as a dental speciality. Over its long history, it has proven to be a remarkably adaptable and innovative branch of the subject as it has evolved and responded to expanding and ever more sophisticated patient needs and new technologies. It was the first specialty involved in reconstruction, a departure from the ablative approach of early dentistry. Over time, it has changed considerably and it possesses a unique set of characteristics that have shaped much of dentistry.

The articles in this issue explore the many facets of prosthodontic evolution; this paper sets them in historical, contemporaneous and prospective frameworks and highlights some key prosthodontic developments. It draws largely from the European and North American traditions, which developments elsewhere in the world will probably make less dominant in the future.

The Past

The Early Years

The development of agriculture about 8,000 years ago, with the consequent dramatic increase in the efficiency of food production,¹ led to a change from a nomadic to a settled existence and permitted humans to extend into activities other than food production. These changes resulted in increasing urbanization of societies and the development by individuals and groups of a widening range of skills and the necessary systems for acquiring and maintaining them. Some of the surplus capacity was used by societies to underwrite often grandiose projects for religious, military or political reasons; however, much was also directed toward improvements in the quality of life, such as

health care, which included dentistry. Although this was originally a relatively crude process, involving little more than basic oral surgery, with increasing resources and health aspirations, the evolution of research and education and an industrial base, an understanding of oral disease and techniques for its prevention and management expanded almost exponentially.

Mediaeval to Victorian

In mediaeval England, professional provision of health care was strongly influenced by the craft guilds. The 1543 painting by Holbein (Fig. 1) depicting the barber surgeons receiving a charter from Henry VIII clearly demonstrates their status and the nature of the contract between state and profession. This contract included elements of training, self-regulation and protectionism that have been the basis of the health care professions for some 700 years. It is noteworthy that the first book about teeth, *Artzney Buchlein*, had been published 13 years earlier, in 1530, although it



Figure 1: Henry VIII of England presenting a charter to the barber surgeons of London. Photo courtesy of The Worshipful Company of Barbers.

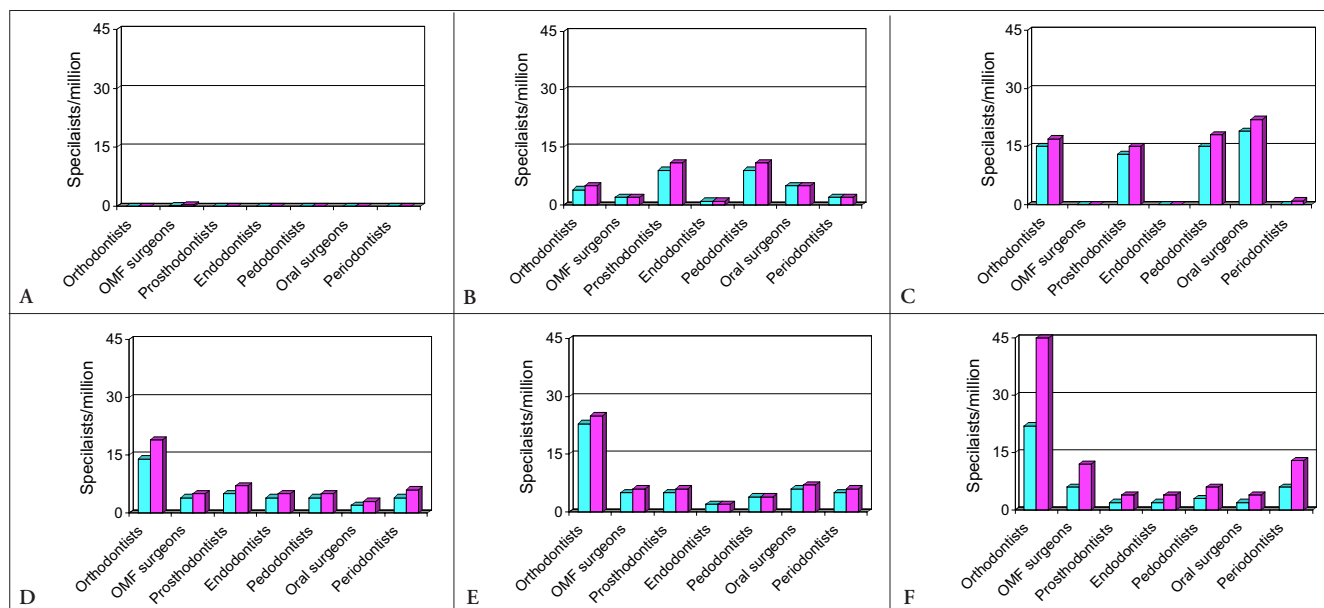


Figure 2: Average number of dental specialists per million population according to per capita gross domestic product (GDP) in 2000. Data taken from URL: http://www.fdiworldental.org/resources/3_0facts.html (accessed March 12, 2004). Numbers for 'Specialists' represent data for all countries, while 'corrected' represents (compensated) data for only those countries that recognize at least one dental specialty. **A.** 17 countries, GDP = USD 90–990 compensated data for 10 countries with specialists. **B.** 16 countries, GDP = USD 1,000–2,990, compensated data for 14 countries with specialists. **C.** 7 countries, GDP = 3,000–5,500, compensated data for 6 countries with specialists. **D.** 11 countries, GDP = 8,000–20,000, compensated data for 8 countries with specialists. **E.** 10 countries, GDP = USD 20,500–28,000, compensated data for 9 countries with specialists. **F.** 6 countries, GDP = USD 29,000–40,000, compensated data for 4 countries with specialists. Specialists; ■ Corrected. ■

was not until 1685 that a dental text appeared in English (Allen C. *The operator for the teeth*).

This period saw a framework of dentistry based largely on tooth extraction. Self-regulation was evident; the profession saw to its own training needs and activities were set within a strongly hierarchical structure. Society was dominated by increasing urbanization, a trend that continued during the Victorian era; during the 19th century, the urban population in England grew from 33% to over 75% of the whole, while the number of cities with a population in excess of 100,000 increased from 1 to 33.²

The increasing resources devoted to education, research and technological development in the Victorian era led to significant advances in dentistry with the establishment of many dental schools as part of universities. Technological developments were accompanied by a more rational, if perhaps mechanistic, approach to the treatment of caries and tooth loss. Among the main inventions were vulcanite denture bases (1851), mechanical devices for tooth preparation and one of the first tooth-coloured restorative materials, the silicate cements (1871). The greatly enlarged knowledge base and expanding skills in dentistry led to the emergence of de facto specialists, as it became increasingly impossible for the generalist to master the necessary knowledge and skills in all aspects of dentistry. Specialization brought in its wake a range of benefits, namely increased public access to advanced skills; enhanced

status for the practitioner; potential access to a niche market; enhanced job satisfaction; a reflection of the desire to learn; and potentially higher income.

It became recognized that for a specialist to function satisfactorily certain criteria needed to be met. These included:

- Adequate access to patients. There had to be sufficient numbers of patients with a need for a specialist form of care; a referral base of generalists and thus a tacit acknowledgement of the relative roles of the specialist and his professional colleagues as well as a symbiotic relationship between the 2; and an appropriate geographic distribution of patients as the provision of specialist services over a thinly spread population is rarely economical.
- Adequate resources within the community to fund such activities and a willingness to make such a purchasing decision collectively or individually.
- A specialist possessing skills that were relevant to a particular requirement — defined, to allow the identification of a specialist as such, and maintained, to remain valid.
- Protection of specialist status in some manner so as to preserve the value of the individual and the collective investment that had been made in acquiring the necessary skills.

Prosthodontic Markers

Prosthodontics was responsible for many of the key developments in dentistry during this period. Among them were:

- development of the understanding of oral function and dysfunction
- evolution of the techniques for replacing missing teeth and restoring those damaged by caries or trauma
- introduction of new materials, such as porcelain, vulcanite and the silicate cements
- development of new technologies for tooth preparation, diagnosis and prosthesis fabrication
- development of teamwork, due to the crucial relation between technician and clinician.

The 20th Century

The 20th century saw significant developments in dentistry in terms of its operational framework, understanding of disease processes and technology. Specialization increased in many countries and **Figs. 2a to 2f** indicate the range of specialists in various countries. These data may be subject to some interpretation in terms of individual specialties, do not include several large countries and may be partly self-defined; nevertheless they indicate the current range of dental specialties and the specialist-to-population ratios. Although national wealth is related to the range and number of dental specialties, this is by no means a clear relationship, and some countries that are relatively wealthy have no officially recognized specialists. Prosthodontics is relatively well provided for on this basis, although the level of commitment to the provision of orthodontic services is noteworthy. The lack of specialists in oral and maxillofacial surgery in the more developed countries probably reflects the status of the subject as a medical rather than a dental specialty.

Prosthodontics has not always been easy to define as it involves the management of a wide range of problems and advanced use of techniques employed in general dental practice, rather than the use of a single treatment modality. The American Dental Association defines prosthodontics as “the dental specialty pertaining to the diagnosis, treatment planning, rehabilitation and maintenance of the oral function, comfort, appearance and health of patients with clinical conditions associated with missing or deficient teeth and/or oral and maxillofacial tissues using biocompatible substitutes.”³ The American College of Prosthodontics, on the other hand, simply describes the specialist as being expert in the restoration and replacement of teeth.⁴

The late 20th century was characterized by increasing difficulties in recruiting clinical academic staff in medicine and dentistry in much of the developed world. This reflects

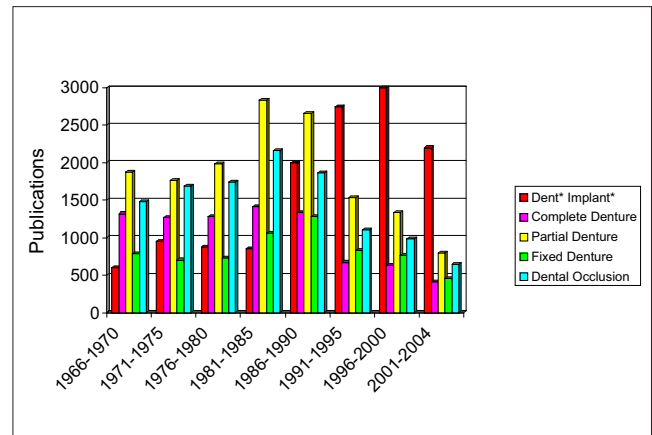


Figure 3: Results of MEDLINE search for publications containing indicated terms for the period 1966–2004.

disillusionment with a perceived increase in bureaucratic interference, a multiplicity of performance targets, lengthened training pathways and a non-competitive remuneration scheme. During this time, there was a significant shift in academic perceptions of the relative importance of the various aspects of prosthodontics as reflected in publications output, although whether this was driven by clinical need, an aspiration to explore new areas or commercial injections of research money may be debatable (**Fig. 3**).

Prosthodontic Markers

Key markers of the evolution of prosthodontics and its contribution to dentistry during this period include:

- recognition of the biological basis of dentistry, especially in Scandinavia, with a reduction in the importance of the mechanistic influence of the late 19th and early 20th centuries
- evolution of the scope of prosthodontics in response to changing treatment needs and new technologies
- the study of occlusion
- increasing use of evidence-based treatment, especially as a result of a number of large Scandinavian studies
- development of adhesive techniques in dentistry
- emergence of dental implantology as a justifiable and effective treatment modality.

In the developed world, during this period patterns of oral disease changed dramatically with significant falls in edentulousness and a large increase in the percentage of the population that was dentate or partly dentate. Changing patterns of life expectancy and birth rates resulted in altered demands and increasing emphasis on maintenance of the natural dentition and improvements in factors such as appearance.

Box 1: Outline of the College of Physicians and Surgeons of Ontario scheme for revalidation of medical professionals

- Step 1 — Screening of all physicians. Multifactorial input.
- Step 2 — Assessment of selected physicians. Peer review.
- Step 3 — Individualized needs assessment.

The Present

The late 20th century saw a significant shift in the long-standing relation between the health care professions and the state, which has shown an increasing tendency to undertake a regulatory role rather than rely on self-regulation by the profession. The government of the United Kingdom has established an overarching body — The Council for Healthcare Regulatory Excellence — to oversee the functions of the various councils and other groups that regulate the health care professions. The split between public and private purchase of health care and the expanding role of the insurance sector in some countries has led to lack of certainty as to who are the profession's primary customers, as each of these groups has different criteria regarding what is considered appropriate to provide, by whom, and at what cost. In the United Kingdom, the government is currently of the view that more power should lie in the hands of the public. In January 2004, Prime Minister Tony Blair stated, "It is only by truly transferring power to the public through choice, through personalising services, that we can create the drivers for continuous improvement in all our services."

Shifts in society have called into question the traditional hierarchical view of the professions, and the assumption that they are always right is increasingly challenged. In the United Kingdom, the health care scandals associated with the Bristol Royal Infirmary⁵ and the activities of Dr. Harold Shipman,⁶ found the medical profession wanting and have resulted in in-depth inquiries that may have long-term implications for all health care professions. It is clear that self-regulation is under threat due to such events, the challenging of the evidence base on which much clinical practice is based (and which has been shown to be often of doubtful or non-existent validity) and a desire on the part of some national legislatures to have greater control over the provision of health care.

Most countries operate a system of central control of the professions that may be national or at the state level, depending on the political structure of the country concerned. Recent developments have underlined the need for skills to be current, and many professions have now established a system of continuing professional development (CPD). Evidence for the benefits of this is not robust, and there is debate as to how much education should be

required. In particular, should the specialist have more or different CPD? In the United Kingdom, specialists are expected to undertake more CPD than generalists, but this is not enshrined in General Dental Council (GDC) regulations at present. An extension of this issue is the introduction of revalidation into medicine in some legislatures.

Revalidation is a process intended to satisfy the public that health care professionals are maintaining their skills at an appropriate level — a process familiar in the airline industry where pilots are regularly retested. Revalidation can occur in a wide variety of forms and there has inevitably been debate as to its aims and cost effectiveness. In the United Kingdom, a proposed system for medicine is currently being considered, and one is under development for dentistry, where the GDC has been keen to engage the profession and specialist societies in shaping its proposals. Similar schemes have been described in Canada, where the Federation of Medical Licensing Authorities of Canada has proposed the Maintenance and Enhancement of Professional Performance (MEPP) program. MEPP uses a graded approach (Box 1) and is intended to be efficient and of value to all participants, rather than identifying only the weakest members of the profession. A comparable scheme has been developed in the United States.

Similar programs will undoubtedly emerge in dentistry and present an opportunity for the specialties to shape developments with their long experience of further training and peer review.

Perhaps making it unique among the dental specialties, prosthodontics can only be carried out with technical support and it has, thus, been responsible for many of the initiatives in the development of the dental team. This is a growing area, as it has been recognized that the delivery of dental care can be made more effective by expansion of the team to include various professionals complementary to dentistry (PCDs). These are increasingly being given formal status and professional responsibilities. The United Kingdom, which had long resisted the introduction of denturists, has embraced the use of a greatly enlarged range of PCDs and has in place or is introducing regulations that will see many of these groups controlled in the same manner as dentists are at present. They will include dental nurses, hygienists, therapists (who carry out a range of simpler dental procedures) and technicians, and clinical dental technicians (denturists). All will require recognized training, will have to undertake CPD and will be subject to the GDC's disciplinary procedures. Involvement in such processes will be important for the prosthodontist, who will have a key role in coordinating such groups in a uniquely collaborative environment.

The value of an experienced team has been underlined by such studies as the investigation into the provision of cleft palate services in Europe.⁷

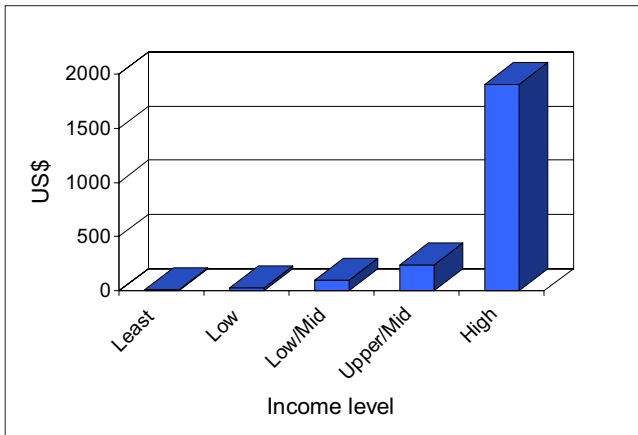


Figure 4: World disparities in health care spending (1977), per capita United States dollars. Income levels classified as least developed countries, other low-income countries, lower-middle-income countries, upper-middle-income countries and high-income countries.¹²

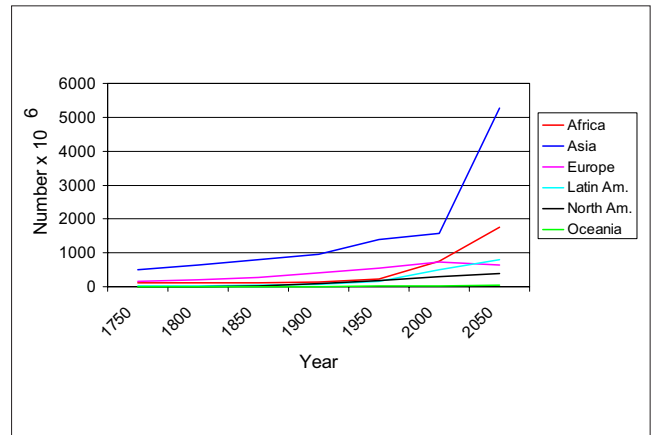


Figure 5: World population trends 1750–2050.¹⁰

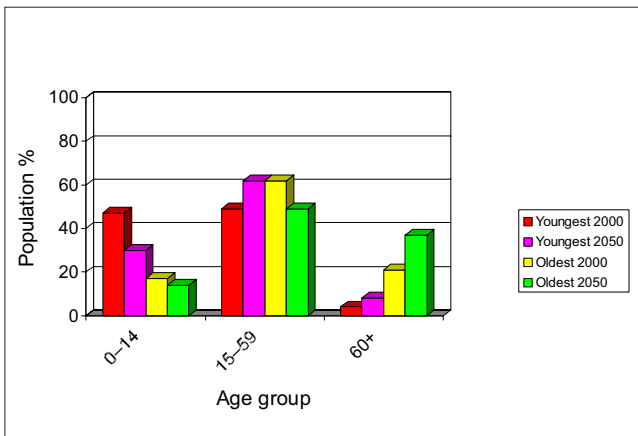


Figure 6: Population age distribution for countries with youngest and oldest populations in 2000 and projected values for 2050.¹¹ (Youngest predominantly Africa, oldest predominantly Europe).

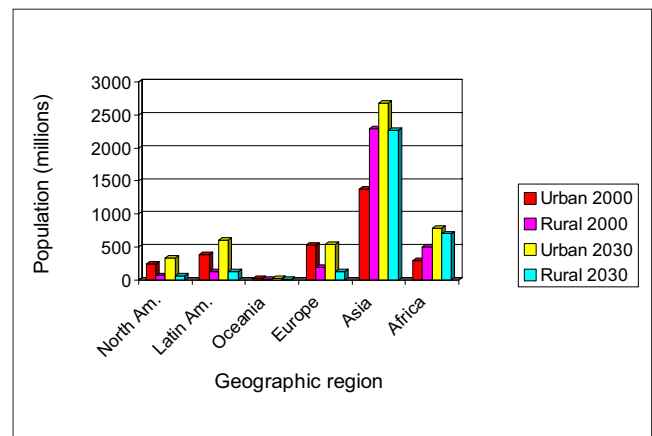


Figure 7: Urbanization in 2000 and projected figures for 2030.¹³

The Future

Forecasting the future is notoriously unreliable; however, a number of key factors are likely to affect prosthodontics: digital computing, globalization and urbanization.

The pervasive influence of digital computing technology has already had a great influence on dentistry and is likely to affect prosthodontics particularly, as the specialty has always been at the forefront of technological innovation.

The widespread availability of data has resulted in greater patient awareness of treatment opportunities and many organizations now provide health care information through the Internet (e.g., the United States Department of Health and Human Services and the United Kingdom's National Institute for Biological Standards Control). The widespread collection of data has also emphasized the value of meta-analysis as a research tool and reinforced the value

of evidence-based treatment. In the United Kingdom, the National Institute for Clinical Excellence lays down standards for therapeutic interventions and has questioned some traditional approaches. Recent legal decisions have begun to challenge the value of peer opinion as a basis for clinical decisions, a trend likely to continue. The GDC is currently examining training for dental implantology, based partly on expectations in some quarters of the skill base that may be acquired during a short course.

The second area where digital techniques are likely to expand is that of image generation and manipulation. Software for treatment planning in dental implantology is commercially available and techniques for fabricating surgical jigs have been developed, leading to expectations that much of the process from recording impressions digitally, to implant placement and superstructure fabrication

may take place in a digitized environment. Computerized fabrication of artefacts is becoming a feasible option.

A logical extension of this process is robotic surgery, which has received little attention in prosthodontics, but is likely to do so in the future, as it is already being tested extensively in medicine.^{8,9}

Population growth and urbanization are areas where the future is more certain, and predictions indicate dramatic changes in the populations of various areas of the world that will have profound effects on the practice of prosthodontics (Figs. 4 to 7). The size and age mix of various societies and their relative wealth will lead to different health care needs and problems with the export of jobs. In Europe, it is not uncommon for technical work to be carried out in another low-wage state, a phenomenon already known in other fields.

It remains questionable as to how long prosthodontics in the developed world can remain isolated from the needs of countries with few resources, an area currently under debate in several developed countries.

Prosthodontics, perhaps more than any other dental specialty, has shown itself capable of evolution in response to changing needs and will probably continue to change.

Future societies will be increasingly urbanized and informed and will have more resources and greater aspirations than their parents. History will be the only home of the specialty that fails to evolve in response to these challenges and opportunities. ♦



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