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Taking stock: assessing the present-planning the future 'You don't need a weatherman to know which way the wind blows'

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In the past, the dual nature of orthodontics has presented practitioners with unique artistic challenges and scientific opportunities. As a result, orthodontists today are enjoying the 'Platinum Age of Productivity.' However, a disturbing trend that promotes neither art nor science has emerged. Health care reform in the United States has transformed health care from a service to a commodity. Some orthodontists and orthodontic practice management companies have capitalized on this change in thinking and are aggressively promoting orthodontic treatment as a product. This paper examines the impact of this paradigm shift on the future of orthodontics. Particular attention is paid to the interaction of three themes: first, orthodontics as a product, secondly, the current misconception that there is a shortage of orthodontic practitioners in the United States, and thirdly, the difficulty in defining 'excellence' in specialty training in orthodontics. In the near future, the collision of these three concepts will result in an orthodontic 'Perfect Storm'. The ability of our specialty to survive and thrive will be proportional to our professional behavior during these difficult times…*caveat emptor*.

'Orthodontics: the science of the art'

'You don't need a weatherman to know which way the wind blows' (1)

Successful clinical orthodontic treatment requires a blend of science and an art. This duality has been recognized since the inception of the specialty in 1901 and is reflected in similarities found in training for

these two careers. If one aspires to become a painter, then there is a career path that one usually follows. Today, this path begins with art school, while during the renaissance, aspiring artists began by becoming apprenticed to the painters guild. During the first few years of their apprenticeship, the painters learn to mix colors and experiment with watercolor, tempura, and oil media. They study the history of painting, learn the mathematics of single point perspective, and practice techniques for rendering three dimensional objects on two dimensional surfaces. After they have acquired sufficient technical skill, they begin to paint with the master. During these tutorial experiences, the young artists are challenged to 'see what the master sees' and to go beyond technique to create art. We follow a similar pattern when training orthodontists. Young dentists are taught biomechanics, facial growth and development, wire bending and soldering. To these didactic skills we add one-to-one mentorship experiences in the clinic. During this process, students are challenged to look at the whole patient i.e. 'to see what the master sees.' In the clinic, the focus shifts away from cephalometric numbers and wire sequences. Students observe as the master clinician integrates complex concepts to formulate a diagnosis and carry out a treatment plan. The ultimate goal is to have the student 'think like an orthodontist.' At the end of this training, young orthodontists like young artists are ready to begin a career. Those that apply their didactic and practical training are competent journeyman; those that integrate the two are master artisans.

Although we share similarities with artists, we are also scientists. So, what is the nature of science? If we examine two prominent figures in genetics, it will help us understand the nature of scientific inquiry. Gregor Mendel, an Augustinian monk born in Heinzendorf, Austria in 1822, spent his life in the garden working with pea plants. In 1865, he presented a landmark paper that detailed the results of his experimental hybridization of more that 28 000 plants (2, 3). Mendel crossed pure bred pea plants with a variety of unique traits. Some strains had rough pea pods while others were smooth; some plants were tall and others short. By methodically crossing these pure bred types, Mendel was able to mathematically predict how often each trait would appear in the succeeding generation. Mendel's work was a classic example of the reductionist approach to problem solving. Each experiment was based on a single hypothesis and the results of the experiments either confirmed or dispelled the hypothetical argument. Reductionist science asks bipolar questions and methodically tabulates the results. Today Mendel's work forms one of the two pillars of modern genetics.

The architect of the second pillar, Charles Darwin, took a different approach to the problem of biological diversity and heritability. From 1831 to 1836 Darwin served as naturalist aboard the *H.M.S. Beagle.* As Darwin sailed around the world he observed and categorized plant and animal life in different climates and habitats. Twenty-three years after he completed the voyage, Darwin wrote his classic text 'The Origin of Species' based on his findings (4). In his text, Darwin presents a logical explanation for the biologic diversity he observed on the planet. Darwin's work is a classic example of scientific synthesis. His theories of gradual change through evolution, natural selection, and specialization best fit his observations. However, the number of variables related to evolution, and the extraordinary length of time involved in the process, prohibit rigorous scientific proof of his theory. Instead, Darwin argues that his theory fits the facts and makes the most sense. In other words, Darwin is either right or God was extremely fond of beetles (5). As orthodontists, we are confronted with complex concepts and in the absence of rigorous scientific proof, we must choose the most logical explanation that is consistent with our observations.

So, which of these scientists made the greatest contribution to modern genetics? Clearly, they were both important! Similarly, orthodontic science needs both reductionists and synthesizers. Because variation in human craniofacial morphology is greater than treatment variation, we must synthesize our observations to develop care plans for patients. This problem was clearly evident when the results of the federally funded randomized clinical trials of functional appliances were analyzed. On the contrary, we can use hypothesis driven research to examine different treatment strategies for specific aspects of malocclusion. Lysle E. Johnston Jr demonstrated the utility of this approach in his classic papers on Class II correction (6–9). The specialty is indebted to educators like Dr Johnston for providing intellectual guidance to a generation of young orthodontists.

Since the turn of the century, the relative emphasis on art and science in orthodontics has vacillated like two

children on a teeter tauter at recess. At times, science has dominated the specialty. During these times it was important for universities to emphasize the artistic aspects of orthodontics. At other times, the artistic aspects of orthodontics dominated clinical practice. During these times the universities stressed the scientific underpinning of the specialty. Thus, the role of the university is to maintain balance and to plan for the future.

In keeping with this role, I have identified three recent trends in orthodontics that have the potential to change the future of orthodontic practice.

Orthodontics as a commodity

Initial efforts toward health insurance reform in the 1990s were directed toward establishing a single payer system for health care in the United States. Such a 'National Health care System' is based on the concept that access to free medical and dental care is a right of every individual in our society. Under this system the government institutes a program designed to provide health care to all citizens and this program is financed through tax dollars. For a variety of complex political and economic reasons the push for National Health Insurance stalled in the late 1990s. Instead, another paradigm emerged. The central dogma of this paradigm was that, since the United States economy is based on free market capitalism, our health care system should be, too. This philosophical shift moves health care from a service to a commodity. Commodities are goods and services whose cost is based on supply and demand. When marketing a product, the provider attempts to identify the price point that maximizes profitability. The consumer tries to find the product conveniently at the lowest price. Value, the intersection of low cost and high quality, is the holy grail of commodity shopping. As the price point is based on supply and demand for the product, prices are lower when supply is great. In the case of health care, demand is rising as the average age of our population increases. This creates an insatiable demand for medical care, and, as demand goes to infinity, costs spiral upward. This is the current state of affairs in health care, cost is rising so rapidly that more and more individuals cannot afford health insurance.

Orthodontics is unique among 'health care products' in that there is no scientific test that can be used to identify malocclusion and there is no recognized cutoff between health and disease. This has long been recognized in the specialty, however, the shift from health care service to health care product has different implications for orthodontics than for other more vital health care needs. Having straight teeth improves the quality of one's life. Therefore, as the public wrestles with rising health care costs, orthodontics is likely to be seen as a product that some can do without. At the very least, it is one health care service that may remain a commodity controlled by market forces. If one strolls around the convention floor at the next American Association of Orthodontists meeting, it is not hard to find evidence of the marketing of orthodontics as a product rather than a health care service. Sales booths display neon and glow-in-the-dark colored elastics and loops. Other vendors tout clear brackets and devices to move teeth without braces. Even the official AAO program uses asterisks to identify scientific speakers (i.e. salesman) who have a financial interest in the topic (i.e. product) they are presenting (i.e. selling). These factors are subjective evidence that orthodontics is becoming a product in the American marketplace.

In addition to this subjective evidence, there is objective evidence that orthodontic treatment is becoming a product. We recently published a study of orthodontic utilization among tenth graders in Cuyahoga, Ohio county schools. Overall, 37% of suburban school children had received or were undergoing orthodontic treatment. The two factors that influenced utilization rates were the dentist's recommendation and family income. Surprisingly, we also found that at some affluent suburban schools, the utilization rate for orthodontic services approached 80% (10). With estimates for the prevalence of malocclusion among US teenagers at 40%, one would have to assume that at least some of these tenth graders had very mild malocclusions. In addition, it is hard to imagine that market penetration could go beyond the 80% level even if the cost of the product was minimal. A study by Clarence Red compared three groups of 100 consecutively treated cases treated 5 years apart (11). He used the Peer Assessment Rating (PAR) and showed that, although the outcome of treatment was similar, the initial malocclusions being treated were less severe over time. He found that the average pre-treatment PAR score for the first group was 28, for middle group

23, and for the most recently treated group, 19.8. His results were confirmed by Nyugen who examined 100 consecutive pre-treatment models from five orthodontists and five general practitioners (12). Nyugen showed that the average pre-treatment PAR score of patients treated by both specialists and general practitioners averaged 20.1. These objective studies of orthodontic practice demonstrate that orthodontic services are being provided to more and more teenagers who have less and less malocclusion. In fact, it could be argued that, at least for some of these patients, orthodontics is a cosmetic product and not a health service. Clearly, portrayal of orthodontics as product is a problem area for the specialty in the future. Unfortunately, it is not the only one.

The shortage of orthodontists in the United States

There is a common belief among orthodontic leaders that there are not enough orthodontists graduating to take care of the patients who need treatment. The reason most often cited in support this belief is that orthodontists who are retiring cannot find a buyer for their practice. Although I can see how this situation causes personal financial concern for retiring orthodontists, I do not see how it relates to unmet orthodontic treatment need. In fact, I contend that it is more likely that we already have too many orthodontists. My argument is based on three assumptions. First, that our current capacity to treat patients is higher than most expect. Secondly, that advances in technology will continue to make orthodontists more efficient, and thirdly, that the orthodontic patient population in the United States will decrease in the future.

First, advances in materials and adhesives allow one orthodontist today to treat many more patients than ever before. According to the 2001 JCO practice study, each orthodontist treats an average of 240 new patients per year (13). The precise number of orthodontic providers in the United States is difficult to determine because orthodontic services are provided by general dentists, pediatric dentists and orthodontists. However, it is probably safe to assume that the vast majority of orthodontic services are provided by specialists in orthodontics (7). The largest specialty organization of orthodontists, the American Association of Orthodontists, has about 14 600 members. If we assume that 10% do not treat patients for a variety of reasons (i.e. retired, disabled) then there are about 13 000 orthodontists treating patients in the United States. Using these numbers to estimate our current treatment capacity, the orthodontic community can treat about 3.12 million new patients each year (13 000 times 240). The US census bureau estimates the population of the United States, as of July 1, 2001, at about 285 million with about 20 million between the ages of 10 and 14. Assuming equal distribution among these ages, then there are about 4 million children at each age. If 40% have a malocclusion, then about 1.6 million potential orthodontic patients exist at each age. If we assume that 25% of our 3.12 million patients would be adults and another 25% would be Phase 1 cases, then the 1.6 million 12-year olds with malocclusions would comprise the other 50%. Using these numbers, current orthodontic provider capacity is fairly close to the estimated need. As the census bureau also estimated that in 2001 there were 4 million births, we should continue to have about 1.6 million new patients each year (14). Therefore, as long as the number of orthodontists remains constant and the number of patients treated by each orthodontist is roughly the same, orthodontic supply and demand seem fairly well matched both now and in the future. However, this is not likely to be the case.

Over the last 100 years, advances in technology have dramatically increased the number of patients one orthodontist can treat effectively. Beginning with Edward Hartley Angle, in 1900, a single orthodontist was able to treat about 25 active patients (15). Although Angle used his edgewise appliance system, the materials he used were far different from those in use today. Bands were all handmade out of gold alloy with gold brackets hand soldered to the band. In addition, large diameter gold wires were the primary means of force application. Each appointment took more than an hour of the doctor's time. By the time of B. Holly Broadbent, Sr. in 1930, the edgewise appliance system had evolved and each orthodontist could treat about 50 active patients (estimate, based on personal communication with B. Holly Broadbent, Jr August 2003). However, a great deal of the orthodontist's time was still spent manufacturing and manipulating the components (band, brackets, wires, eyelets, etc.) of the appliance

system. By 1950, Charles Tweed had stainless steel archwires and preformed bands available. These advances allowed each orthodontist to treat about 100 active patients (16). However, each wire was still custom made by the orthodontist and wire bending still dominated the orthodontist's time. With the advent of direct bonding in the 1970s and the introduction of the pre-torqued–pre-angulated appliance, the orthodontist was freed from the tedious tasks of appliance construction. A single orthodontist was now able to treat 200 active patients (17). Between 1990 and 2000, there were advances in direct bonding adhesives, improvements in bracket design, and new wire alloys. These changes allow an average practitioner today to treat almost 500 active patients or about 240 new cases each year (18). Therefore, the last century saw a 10-fold increase in the number of patients treated by a single orthodontist. These increases were not because of increases in the number of days worked per week, or the number of hours of work per day, rather, the engine for change was technology. And, technology is a beast with an insatiable appetite.

Averaging the change in orthodontic capacity over the last 100 years results in an arithmetic increase of about two patients per year. However, the rate of change was not linear but logarithmic. Since technology and not biology was driving these changes, one can assume that the orthodontist of the future will be able to treat more patients than they can today. During the next 10 years it is likely that computer aided design and custom manufacturing will change the way we practice orthodontics today. What if future orthodontic patients went to the orthodontic office and had a three dimensional scan of the head and teeth? And then this three dimensional image of the teeth was used to generate customized braces or a series of suck down retainers, each one with the teeth a little straighter. Then, a single orthodontist might be able to treat 1000 new patients per year. Today's 13 000 practitioners could treat 13 000 000 new patients per year. If we treat 3.2 million today we will need about 10 million more patients in 2010. Looking at the data another way, in 2012, when the 4 million children born in 2000 are ready for braces, they can be treated by 4000 orthodontists. Given these statistics, we would need to have 9000 orthodontists retire during the next 12 years to maintain the same level of activity in our practices. This may be a problem.

Maximum flexibility in accreditation standards

The third issue that will impact orthodontics in the future is the manner in which postgraduate training programs in orthodontics are accredited. The accreditation guidelines established by the ADA cover the following areas:

1. Institutional commitment/program effectiveness/affiliations.
2. Program director and teaching staff.
3. Facilities and resources.
4. Curriculum and program duration.
5. Advanced education students eligibility and selection/evaluation/due process/rights and responsibilities.
6. Research (19).

Although the guidelines do cover all aspects of the training programs, they do not have objective criteria that must be met in each area. For example, the explanation of standard 1 reads as follows:

> ''The program must develop clearly stated goals and objectives appropriate to advanced specialty education, addressing education, patient care, research and service. Planning for evaluation of and improvement of educational quality for the program must be broad-based, systematic, continuous and designed to promote achievement of program goals related to education, patient care, research and service. The program must document its effectiveness, using a formal and ongoing outcomes assessment process to include measures of advanced education student achievement (14).''

Note that there are no minimum standards for the number of patients treated by each resident during their training and that each program is able to develop their own goals as long as they are appropriate. Similar flexibility exists with regard to faculty.

> ''Area 2, Item 7 The number and time commitment of faculty must be sufficient to provide full supervision of the clinical portion of the program (19).''

There are no minimum standards for the number of full time orthodontic faculty per resident in training. Given the importance of the one-to-one mentorship training that is necessary to effectively learn complex skills such as orthodontics, the lack of a minimum standard for

mentor–student ratio is surprising. In spite of this flexibility, or maybe because of this flexibility, these guidelines have served our specialty well over the last 100 years. The way the guidelines are written allows our specialty freedom to create training programs that meet individual hospital and university needs.

These guidelines, however, were based on the 20th century view of health care as a service not as a commodity. As orthodontic treatment becomes a commodity, for profit companies might try to increase the supply of orthodontic providers to reduce the cost of the product. Increasing the number of providers is surprisingly easy under our present accreditation system. In fact all you have to do is:

1. Find willing dentists who would like to be orthodontists.
2. Find a university that grants degrees.
3. Build an orthodontic clinic.
4. Hire a program director.

Item number one is not a problem because there are hundreds of orthodontic applicants that do not match with training programs each year. For items 2, 3, and 4, just add money.

'The Perfect Storm'

Just as 'The Perfect Storm' resulted from the convergence of three weather systems in the Atlantic Ocean, I contend that if the three themes I have outlined here collide, there will be a storm. Any one of these three issues could change the future of orthodontics. But if all three continue unchecked, their combined impact will dramatically change the specialty. The 'Platinum Age' of orthodontics will become the 'Corporate Age' and orthodontists will no longer be self employed professionals providing a health care service; they will be discount commodity brokers selling a product to their customers.

> 'Before I draw nearer to that stone to which you point,' said Scrooge, 'answer me one question. Are these the shadows of the things that Will be, or are they shadows of things that May be, only?' (20)

If we, as a specialty group, would like to minimize the impact of the coming storm, we must work together to minimize the negative impact of each of these three individual issues on our specialty. How can we do this?

To minimize the impact of 'orthodontics as a commodity,' we need to emphasize that orthodontic treatment requires the hands of an artisan and the mind of a scientist. Orthodontic results cannot be mass produced. Computerized bracket placement devices or computer manufactured acrylic appliances are tools that assist the orthodontist, but do not replace the orthodontist. To the extent that orthodontics is a science, we can engage in evidence-based practice. However, each patient presents unique challenges to the practitioner, and in the end, each finished case is a 'work of art.'

To minimize the impact of technology on the capacity of orthodontists to treat patients, we must emphasize quality of care and quality of life. Just because an orthodontist can treat 1000 new patients each year does not mean they should. Quality results take time and attention to detail. Each tooth must have the correct tip and torque, including the second molars. We need to place importance on outcome measures, which means taking before and after study casts. We cannot assume that all outcomes in orthodontics are good, we must have the records to prove it. The new emphasis by the American Board of Orthodontics on measuring the outcome of orthodontic treatment is a step in this direction. The ABO must be embraced by the specialty and certification pursued with increased zeal.

To minimize the impact of a declining patient pool, we need to resist the temptation to train more orthodontists just because the applicant pool is larger than the number of residency spaces available. Orthodontists, who are retiring, may have to consider giving their practice away or transferring all their patients to the other orthodontists in their area. Educators must give up some of our flexibility in designing residency programs and establish basic minimum requirements for training. For example, it would be easy to set numerical standards for faculty-to-resident ratio, case starts and case finishes. Compliance with these requirements could be documented quite easily. It might also be necessary to document the quality of treatment provided. Existing occlusal indices designed to measure quality of dental alignment could be used. Establishing minimums might place some existing programs at risk, but closing weaker programs may be preferable to

allowing corporate sponsored programs to produce more orthodontists than we really need.

In summary, orthodontics faces a day of reckoning in the near future. It is up to the leadership and the membership to recognize the risks and respond. The time to plan for our future is now when the sea is calm and we can see the horizon.

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