IMPACT OF A PERIODONTAL HONORS COURSE ON EDUCATIONAL EXPERIENCE AND FINANCIAL PRODUCTIVITY

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Abstract

Objective: The objective of this study was to assess the impact of a periodontal honors course on the educational experience and financial productivity of residents enrolled in the Advanced Education Program in Periodontology at the University of Minnesota.

Methods: Data were collected during a semi-annual chart audit process conducted by the program director and appointed staff whereby treatment progress and individual procedures were tabulated for all assigned patients. Demographic data and financial productivity data for the residents was also collected. Data was analyzed for the 15 year period from 1998-2012 and was split in a pre-honors cohort, Cohort 1 (1998-2002, N=14), and two post-honors cohorts, Cohort 2 (2003-2007, N=15) and Cohort 3 (2008-2012, N=16) to examine the immediate and long term effects after introducing this course. Differences in resident performance in non-surgical and surgical periodontal therapy, sedation procedures and financial productivity were studied.

Results: Periodontal residents performed significantly ($p < 0.05$) more non-surgical (scaling and root planing, periodontal maintenance), surgical (exodontia, osseous grafting, implant surgery, soft tissue grafting) and sedation procedures after instituting the periodontal honors course. During this 15 year period there was greater than a 600% increase in financial productivity by the periodontal residents with the most dramatic growth occurring in the first 3 years after instituting the periodontal honors course.

Conclusion: There was an overall statistically significant improvement in the clinical experience and corresponding financial productivity of the residents in the Advanced Education Program in Periodontology after introducing the periodontal honors course.

Implementation of such an honors program by other disciplines and dental schools has a strong potential to improve the quality of specialty education as well as monetarily reward the residency program and the institution as a whole.

Table of Contents

List of Tables

Table

List of Figures

Figure

.

CHAPTER I

INTRODUCTION

The need for reform in dental education with the development of innovative and effective teaching methodologies has been perceived over the last several decades. In 2005, the American Dental Education Association (ADEA) formed the ADEA Commission on Change and Innovation in Dental Education (ADEA CCI) to oversee and guide the educational change efforts of the association (1). The Institute of Medicine published a report entitled *Dental Education at the Crossroads: Challenges and Change* that urged dental schools to develop a plan and timetable for curriculum reform (2). This report pointed out that traditional dental school curricula are crowded with redundant or marginally useful material and students do not have time to consolidate concepts or to develop critical thinking skills. The report concluded that the science base of oral health is not effectively related to clinical practice. To address these issues, the report recommended decreasing the number of lecture hours and increasing time spent in more active learning strategies such as small group discussions (2).

According to Bloom, "health professionals need to be creative, flexible, non-dogmatic, and critical in their thinking to be effective. However, unless the norms of the professional [education and] working environment[s] reflect these same values, curriculum change is futile." (3). Continuous update of any educational program is of fundamental importance to the quality and evolution of the program and is at the heart of accreditation processes (4, 7). The Commission on Dental Accreditation (CODA) in the

United States and its Canadian counterpart, the Commission on Dental Accreditation of Canada (CDAC) establish standards and guidelines by which educational programs in dentistry and advanced dental specialties are accredited in the United States and Canada, respectively (5, 6, 8, 9). Although both CODA and CDAC provide specific guidelines for the content and scope of clinical education in Periodontics offered by their respective accredited educational institutions, specifics such as the various modes of instruction of surgical techniques and the minimum number of procedures required are left entirely to the discretion of individual programs (8, 9). The absence of such specific information precludes any systematic assessment, critique, or improvement of these programs. ADEA has focused on assessing clinical competence as part of a major renewal of dental education (12). There is very limited literature available on the current status of the curriculum for Advanced Education Programs in Periodontology as taught in North American programs (10). Kassebaum et.al. (2004) examined the current format of curricula at North American dental schools in order to establish curriculum evaluation strategies, and identified recently implemented changes as well as planned future innovations (11). Haden et al (2010) conducted a web-based survey of dental school curricula to assess 1) past trends in curricular change from 2003- 2009; 2) current changes under way in dental school curricula; 3) significant challenges to curricular innovation; and 4) projected future trends in curricular change and innovation (12). Respondents reported that priorities for future curriculum modification included creating interdisciplinary curricula that are organized around themes, blending the basic and clinical sciences, provision of some elements of core curricula in an online format,

developing new techniques for assessing competency, and increasing collaborations with other health profession schools (12). Respondents identified training for new faculty members in teaching skills, curriculum design, and assessment methods as the most critical need to support future innovation (12).

Ghiabi et.al. (2010) documented the surgical training curricula offered by North American periodontal graduate programs (10). Traditional teaching methods such as slides, live demonstration, DVD/CD, and animal cadavers were the most common teaching methods used, whereas online courses, computer simulation, and various surgical mannequins were least commonly used (10). The most commonly performed surgical procedures were conventional flaps, periodontal plastic procedures, hard tissue grafts, and implants (10). Furthermore, residents in programs offering a structured preclinical component performed significantly more procedures ($P=0.012$) using lasers than those in programs not offering a structured preclinical program (10). Devising new and innovative teaching methods is a clear avenue for future development in North American periodontal graduate programs (10).

To address the problem of the general decline in the depth and range of clinical skills of recent dental school graduates, particularly in prosthodontics, a predoctoral honors program in prosthodontics was established at New York University College of Dentistry (13). A survey of students conducted in 2004 at New York University College of Dentistry (NYUCD) demonstrated an inadequacy in clinical implant restoration experience by graduation (14). This prompted the development of an extensive dental implant curriculum at NYUCD to meet the needs of their dental students (14). The

authors reported a model for a pre-doctoral implant curriculum that included curriculum planning, curriculum implementation, program management, and post-implementation stages (14). It was advised that by implementing such a model, dental schools can develop implant education for their students that is adapted to their institutional missions, priorities, and resources (14). Thoughtful periodontal curriculum timing, as well as early integration of periodontal psychomotor and didactic elements can allow for the safe, early (D1) entry into clinical patient care in the sophomore recall program (15, 16). Continuous cultivation of D2, D3 and D4 comprehensive periodontal patient management allows oversight of the growth and development of critical thinking and decision making in periodontal diagnosis and treatment planning as well as in the implementation and self-assessment of periodontal care, follow up and referral (15,16). Dental educational specialists can assist in making faculty aware of educational best practices by conducting and publishing the results of well-designed research studies that investigate daily issues faced by dental teachers.

This publication presents the results of one such innovative effort that was initiated in 2003 at the University of Minnesota / School of Dentistry and has been offered annually since then. Active learning techniques including small group discussions, hands-on training and use of surgical mannequins were used throughout this course.

Introduction to the Periodontal Honors course:

A periodontology honors course was initially instituted by the Director of the Advanced Education Program in Periodontology at the University of Minnesota in 2003. The main goals of this course were four-fold:

1. Enhance the pool of most academically and clinically qualified pre-doctoral dental students to apply and enroll in an Advanced Education Program in Periodontology and hence pursue a career in Periodontics.
2. Enhance the preclinical experience of the pre-doctoral dental students in diagnostic, treatment planning, non-surgical and surgical periodontics.
3. Harmonizing the entry skill of incoming residents enrolled in the Advanced Education Program in Periodontology in order to accelerate their clinical training and corresponding financial production of the program.
4. To provide teaching and mentoring experience to the periodontal residents in order to stimulate their interest toward an academic career in Periodontology.

This course was offered to a select number of senior dental students in the top quartile in their class who demonstrate an interest in Periodontics while all periodontal residents were also required to participate in this course. Typically, the course participants were divided into three groups whereby two dental students were teamed up with a first, second and a third year periodontal resident. Second and third year residents served as direct mentors for the senior dental students and first year residents under the guidance of the program director.

From a broad perspective, the topics covered during the didactic portion of the course included periodontal diagnosis, treatment planning and non-surgical as well as surgical periodontal therapy. Students received hands-on experience in periodontal instrumentation employing ultrasonic scalers and Gracey curettes with a detailed focus on specific instrument positioning, operator position and posture; conventional periodontal

surgical procedures consisting of gingivectomy, modified Widman flap, apically positioned flap, distal wedge, free gingival graft and connective tissue grafts, grafting of infrabony defect via a guided tissue regeneration procedure, and placement of a dental implant on typodont models. The course culminated with a surgical lab exercise whereby students completed six of the proceeding seven surgical procedures on euthanized dogs in conjunction with studies conducted at the College of Veterinary Medicine, University of Minnesota. A high emphasis was placed on the biological rationale for all of the treatments undertaken during the course. The participating dental students were also required to attend weekly treatment plan seminar presentations given by the periodontal residents and/or faculty in order to gain a broader understanding of the scope of periodontal therapy.

After completing the didactic and hands-on portions of the course participants were required to visit a private periodontal practice of one of the adjunct periodontal faculty members in order to expose them to the business side of a periodontal practice. Subsequently, students were given the opportunity to identify at least one patient requiring a conventional periodontal surgical procedure and work with their senior periodontal resident/mentor to perform that surgery. Pre-doctoral students were also encouraged to observe advanced periodontal surgical procedures as performed by the residents and/or faculty. The course was offered during summer semester while the enrolled pre-doctoral students performed their surgical procedures on a selected patient during the fall semester after completing the course.

This article focuses on the impact of a periodontal honors course on the educational experience and corresponding financial productivity of the residents in the Advanced Education Program in Periodontology at the University of Minnesota. We will present the findings of the impact of this periodontal course on the pre-doctoral participants in a separate publication (Manuscript in preparation). To the best of our knowledge, no previous studies have examined the effects of an honors program on the educational experience and financial productivity of the residents who also served as pre-doctoral mentors.

CHAPTERII

MATERIALS AND METHODS

Data was collected semi-annually during the chart audit process by the program director and the appointed staff during which treatment progress of the assigned patients was reviewed for all residents. Additional data for the resident demographics and financial productivity in graduate periodontology clinic was provided by the program director whereby the data was subsequently de-identified by removing the resident names prior to analysis. The data analyzed for the present study spanned over15 years and was split into 3 cohorts with cohort 1 representing the 5 year period from 1998-2002 prior to the inception of the periodontal honors course (Pre-honors 0-5 years, N=14), cohort 2 representing the immediate 5 year period after instituting the honors course from 2003-2007 (Post-honors 0-5 years, N=15) and cohort 3 representing 6-10 year period after the honors course from 2008-2012 (post-honors 6-10 years, N=16). Post-honors course data was analyzed in two separate 5 year cohorts to assess 1) the immediate effects with the introduction of the periodontal honors course and 2) maintenance of such effects over the long term.

Data was tabulated and analyzed for various treatment modalities including both surgical and non-surgical therapy. Non-surgical therapies included scaling and root planing (SRP, per quadrants) and periodontal maintenance procedures (recalls). In instances whereby a limited number of teeth were scaled and root planed, it was considered equivalent to one quadrant of scaling and root planing.

Conventional periodontal surgical procedures included modified Widman flap, apically positioned flaps with or without osseous surgery, open flap debridement, crown lengthening procedures, gingivectomy and distal/proximal wedge procedures. Osseous grafting procedures included guided tissue regeneration(GTR), guided bone regeneration (GBR) including grafting of extraction socket employing autogenous, allogenic and xenograft materials, as well as adjunct biological and synthetic materials including but not limited to resorbable and/or non-resorbable membranes, titanium meshes, enamel matrix derivative, recombinant platelet derived growth factor (rPDGF), bone morphogenic proteins (BMPs), and direct- and indirect-sinus grafting procedures. Tabulation of the implant surgical procedures included only the total number of implants placed by the periodontal residents during either immediate or delayed placement, utilizing one stage or two stage approach, as well as immediate or delayed loading. The second stage surgical procedures were not counted as separate surgical procedures. Soft tissue grafting procedures included Free Gingival Grafts, Connective Tissue Grafts, and Pedicle Grafts.

Intravenous conscious sedation was frequently employed during advanced surgical procedures such as sinus elevation procedures, autogenous block grafting procedures, extensive osseous and soft tissue grafting procedures or complex surgeries involving placement of multiple dental implants. IV conscious sedation was also used for successful management of patients with high dental anxiety. Oral sedation and/or nitrous oxide analgesia were also frequently utilized in this Advanced Education Program in Periodontology. However, this data was not reported in this publication.

A small subset of the data was cross-checked for accuracy by randomly selecting approximately 7-10 patient charts from each resident's file and verifying that the procedures were indeed done to the extent documented during the chart review. The cross-check found all documented data to be 100% accurate. Patient charts were also referred to in cases where a clarification in the procedures performed was deemed necessary, e.g. where data was documented as multiple extractions, the chart was checked to verify the total number of teeth extracted.

A brief overview of the study and the methods were submitted to the Institutional Review Board (IRB) at the University of Minnesota and an IRB exemption was obtained.

Descriptive analysis was used to compare the average age of the resident at entry, gender of the resident, their country of origin and the average experience in years after graduation from the dental school across the three cohorts. Since this program accepts qualified candidates from throughout the world, we compared the number of residents from North America versus the rest of the world. Differences in the total number of non-surgical, surgical and IV sedation procedures performed by the residents in their three respective cohorts (clinical performance) were examined. Enhanced clinical performance as reflected in financial productivity of the residents was evaluated after adjusting for the annual fee increase over these 15years.

Cohorts 2 and 3 also contained residents who had participated in our periodontal honors course (DDS w/Perio Honors, N = 8) during their pre-doctoral training while the other residents had not been previously enrolled in our Periodontal Honors course (Post Honors only, N=23). Clinical performance metrics were compared across these two groups for

the post-honors cohorts. Differences in clinical performance of the residents was analyzed with respect to gender, country of origin (North America vs others), prior experience (0-1 years vs. ≥ 2 years) across cohorts. Multiple linear regression models were used to account for potential cohort differences which might have influenced the analyses. The multiple linear regression models evaluated if the cohort differences hold true when taking into account the differences due to age, gender, country of origin and the prior experience of the residents.

Statistical analyses were performed on the data sets across the three cohorts to evaluate statistically significant changes in various parameters. SAS version for Windows was used to generate descriptive statistics and further analyze data. Non-parametric Kruskal-Wallis test, ANOVA on ranks with Tukey-Kramer adjustment for multiple comparisons, non-parametric Wilcoxon Rank Sum Test and multiple linear regression analysis were conducted.

CHAPTER III

RESULTS

1. **Resident Demographics:**

   The resident demographic data is summarized in Table I. Total number of residents in cohorts 1, 2 and 3 were14, 15 and 16 respectively while their average age was 29.6 (cohort 1), 27.2 (cohort 2) and 28.6 (cohort 3) years. The percentage of male residents in these respective cohorts were 57.1% (cohort 1), 60.0% (cohort 2) and 68.8% (cohort 3) while the percentage of corresponding female residents were 42.9% (cohort 1), 40.0% (cohort 2) and 31.3% (cohort 3). The percentage of residents from North America was 35.7% (cohort 1), 33.3% (cohort 2) and 68.8% (cohort 3), respectively and included residents primarily from US and Canada and one resident from Mexico. On the other hand, the percentage of residents from outside North America was 64.3% (cohort 1), 66.7% (cohort 2) and 31.3% (cohort 3), respectively and included residents from Europe, Asia, Australia and South America. The average experience (in years) of the residents prior to enrolling in the Advanced Education Program in Periodontology was 3.4 (cohort 1), 1.7 (cohort 2) and 1.5 years (cohort 3), respectively.

2. **Number of patients seen:** The average number of total patient visits and unique patient visits for the periodontal residents in their respective cohorts are presented in Figure 1. Unique patient visits reflect those patients seen one or more times during the fiscal year. The average numbers of total patients seen per resident were 119.6 (cohort 1), 227.9 (cohort 2) and 237.0 (cohort 3) while the average of unique patient

visits were 40.4 (cohort 1), 76.7 (cohort 2) and 77.0 (cohort 3). Total patient visits were statistically different between the three cohorts ($p < 0.0001$, ANOVA). Use of the Tukey adjustment for multiple comparisons revealed a significant difference in total patient visits between pre-honors and post-honors cohorts ($p < 0.0001$) while the differences between the post-honors cohorts (Cohort 2 and 3) were not statistically significant ($p = 0.2828$). Similar trends were noted between differences in unique patient visits for the pre- and post-honors cohorts ($p = 0.0002$) but not between the two post-honors cohorts ($p = 0.6604$). The continual increase in the average number of patients seen by residents in their respective 5 year cohorts reflects an enhanced clinical educational experience.

3. **Non-Surgical Periodontal Therapy:** Non-surgical periodontal therapy included scaling and root planing (SRP, per quadrants) and periodontal maintenance procedures (recalls). The average number of scaling and root planing quadrants and the average number of periodontal maintenance procedures performed by the residents in their respective cohorts are given in Figure 2. The average number of scaling and root planing quadrants performed per resident were 194.6 (cohort 1), 275.5 (cohort 2) and 229.3 (cohort 3), respectively while the total numbers of periodontal maintenance procedures performed were 70.0 (cohort 1), 85.2 (cohort 2) and 74.3 (cohort 3). The differences in SRP quadrants between the three cohorts were highly statistically significant ($p = 0.0002$, non-parametric Kruskal Wallis test). Further, pairwise comparisons were made between cohorts using the ANOVA on ranks with Tukey-Kramer adjustment for multiple comparisons. Differences between

cohort 1 (pre-honors 0-5 years) and cohort 2 (post-honors 0-5 years) were the most significant ($p < 0.0001$). However, they were also significant ($p = 0.0276$) between cohort 1 (pre-honors 0-5 years) and cohort 3 (post-honors 6-10 years) and between the post-honors cohorts 2 and 3 ($p = 0.038$). On the other hand, the differences between the periodontal maintenance procedures across all cohorts were not statistically significant ($p = 0.3497$, non-parametric Kruskal Wallis test). The data demonstrates that the periodontal residents performed significantly more quadrants of scaling and root planing after the introduction of periodontal honors course, suggestive of improved non-surgical periodontal therapy experience.

4. **Surgical Therapy:** The surgical therapy was sub-divided into five categories, exodontia (Exo), conventional periodontal surgery (PerioSx), osseous grafting (Oss-Graft), implant surgery (Implants) and soft tissue grafting (STG) procedures. Figure 3 depicts the average total number of teeth extracted, quadrants of periodontal surgery, osseous grafts and implants placed by the periodontal residents in their respective cohorts while Figure 4 illustrates the number of soft tissue grafting procedures performed.

    a. **Exodontia:** The average of total number of teeth extracted per resident were 28.9 (cohort 1), 61.5 (cohort 2) and 158.3 (cohort 3) respectively. The differences in the number of teeth extracted across these three cohorts were highly statistically significant ($p < 0.0001$, non-parametric Kruskal Wallis test). Differences between all cohorts were found to be highly statistically significant when conducting pairwise comparisons with ANOVA on ranks

with Tukey-Kramer adjustment for multiple comparisons ($p = 0.0018$ between cohorts 1 and 2 and $p < 0.0001$ between cohorts 2 and 3 and cohorts 1 and 3). The data demonstrates that the periodontal residents performed significantly more extractions after the introduction of the periodontal honors course, suggestive of improved experience in exodontia.

b. **Conventional periodontal surgery**: The conventional periodontal surgical procedures included modified Widman flap, apically positioned flaps with or without osseous surgery, open flap debridement, crown lengthening procedures, gingivectomy and distal/proximal wedge procedures. The average number of quadrants of conventional periodontal surgical procedures per resident were 70.3 (cohort 1), 60.4 (cohort 2) and 55.8 (cohort 3), respectively. The differences in the total quadrants of conventional periodontal surgical procedures performed by the residents across the three cohorts were not statistically significant ($p = 0.1970$, non-parametric Kruskal-Wallis test). The data demonstrates that the periodontal residents performed similar number of conventional periodontal procedures after the introduction of periodontal honors course. However, there was a trend of a modest decrease which was statistically not significant.

c. **Osseous grafting procedures:** The osseous grafting procedures included guided tissue regeneration (GTR), guided bone regeneration (GBR), grafting of extraction socket employing autogenous, allogenic or xenograft bone, adjunct biological and synthetic materials consisting of but not limited to

resorbable and/or non-resorbable membranes, titanium meshes, enamel matrix derivative , recombinant platelet derived growth factor (rPDGF), bone morphogenic proteins (BMPs), and direct- and indirect-sinus grafting procedures. The average total number of osseous grafting procedures performed per resident was 15.5(cohort 1), 31.9 (cohort 2) and 75.4 (cohort 3) respectively. The differences in the number of osseous grafting procedures performed by the periodontal residents across the three cohorts were highly statistically significant ($p < 0.0001$, non-parametric Kruskal Wallis test). These differences remained statistically significant when pairwise comparisons were made using the ANOVA on ranks with Tukey-Kramer adjustment, $p = 0.0086$ between cohort 1 and 2 and $p < 0.0001$ between cohorts 1 and 3 and cohorts 2 and 3. The data demonstrates that the periodontal residents performed significantly more osseous grafting procedures after the introduction of periodontal honors course, suggestive of improved surgical experience in osseous grafting procedures.

d. **Implant surgery:** The total number of implants placed by the periodontal residents was tabulated without distinctions between immediate verses delayed placement or if a 1-stage verses 2-stage approach was utilized or if an immediate verses delayed loading protocol was followed. The stage 2 surgical procedures were not counted as separate surgical procedures. The average total number of implants placed per resident were 10.8 (cohort 1), 45.7 (cohort 2) and 141.0 (cohort 3). This increase in the number of dental

implants placed was highly statistically significant across the three cohorts ($p < 0.0001$, non-parametric Kruskal Wallis test). When pairwise comparisons were made using the ANOVA on ranks with Tukey-Kramer adjustment, these differences were highly statistically significant ($p < 0.0001$) between all cohorts: 1 and 2, 1 and 3 and 2 and 3. Hence, the data demonstrates that the periodontal residents placed significantly more dental implants after the introduction of periodontal honors course, indicative of improved implant surgical experience.

e. Soft tissue grafting: Soft tissue grafting procedures included free gingival grafts, connective tissue grafts, and pedicle grafts. The average number of soft tissue grafting procedures performed per resident were 5.8 (cohort 1), 7.8 (cohort 2) and 16.9, (cohort 3) respectively. This increase in the number of soft tissue grafting procedures performed by the periodontal residents across the three cohorts was highly statistically significant ($p < 0.0001$, non-parametric Kruskal Wallis test). During the pairwise comparisons between cohorts using the ANOVA on ranks with Tukey-Kramer adjustment, the increase in number of soft tissue grafting procedures were statistically significant between cohorts 1and 3 ($p < 0.0001$) and between cohorts 2 and 3 ($p = 0.0013$) while the differences between cohorts 1 and 2 were not statistically significant ($p = 0.1771$). The data demonstrates that the periodontal residents performed significantly more soft tissue grafting

procedures after the introduction of the periodontal honors course, suggestive of improved surgical experience in soft tissue grafting.

5. **IV Sedation:** Intravenous conscious sedation was frequently employed during advanced surgical procedures especially sinus elevation procedures, autogenous block grafting procedures, extensive osseous and soft tissue grafting procedures or complex surgeries involving placement of multiple dental implants. IV conscious sedation was also used for successful management of patients with high dental anxiety. The average number of intravenous conscious sedations performed per resident was 7.1 (cohort 1), 23.7 (cohort 2) and 28.4 (cohort 3) respectively. The increase in the number of IV conscious sedation procedures performed by the periodontal residents across the three cohorts was highly statistically significant, ($p < 0.0001$, non-parametric Kruskal Wallis test). When pairwise comparisons were made between cohorts using ANOVA on ranks with Tukey-Kramer adjustment, the increase in IV conscious sedation procedures was highly statistically significant ($p < 0.0001$) between cohorts 1 and 2 and cohorts 1 and 3. However, the increase observed between cohorts 2 and 3 was not statistically significant ($p = 0.1278$). There was a statistically significant increase in the number of these procedures after the periodontal honors course reflecting a more favorable resident experience. The data demonstrates that the periodontal residents performed significantly more intravenous conscious sedation procedures after the introduction of the periodontal honors course, suggestive of improved sedation experience.

6. **Resident Financial Productivity:** The financial productivity data for the periodontal residents is presented in Figures 6 and 7. The annual growth (percentage change) in the residents' production including the average annual fee increase is shown in figure 6. The first year of this study was 1998 and serves as the baseline for the cumulative 15-year comparison. The data demonstrated a dramatic increase (44.2% to 55.5%) in the financial productivity during the first three years after instituting the periodontal honors course (years 2003-2005). This increase in financial production was maintained in the following years by exhibiting an annual increase ranging from 5.3% to 12.9%. Differences in financial productivity between the three cohorts were statistically significant ($p < 0.0001$, ANOVA). Use of Tukey adjustment for multiple comparisons revealed statistically significant differences in financial productivity between cohorts 1 and 2 ($p = 0.0012$), cohorts 1 and 3 ($p < 0.0001$) and cohorts 2 and 3 ($p = 0.0011$). The cumulative percentage change in financial productivity by the residents over the 15 years was > 600% as shown in Figure 7. The most profound increase in financial production occurred during the initial three years after the periodontal honors course was instituted.

7. **Potential Confounding Variables:**

   Table II depicts differences in clinical performance of the periodontal residents with respect to their gender, country of origin (North America vs others), prior experience (0-1 years vs. ≥ 2 years) and participation in this periodontal honors course during their pre-doctoral dental training. The multiple linear regression analysis for the proceeding variables is shown in Table III.

a. **Country of Origin:** Qualified international applicants who are accepted into this program may bring differences in their pre-doctoral training background, cultures, belief-systems and treatment philosophies that can potentially affect the resident's clinical performance. Table II uses non-parametric Wilcoxon Rank Sum Test to compare variation in clinical performance for residents from North America against those from the rest of the world across. Parameters that were statistically significant different between these two groups were exodontia ($p = 0.0012$), osseous grafting procedures ($p = 0.0104$), implant surgery ($p = 0.0394$) and soft tissue grafting procedures ($p = 0.0457$). However, after adjusting for cohort differences by using a multiple linear regression analysis (Table III), the only statistically significant difference was for exodontia ($p = 0.0025$). Consequently, irrespective of the resident's country of origin they all gained similar clinical experience except for the North American residents who extracted more teeth than the residents from the rest of the world.

b. **Gender:** Table II reveals that gender did not statistically significant ($p > 0.05$) affect clinical performance of the residents across any of the performance categories. The results remained the same even after adjusting for the cohort differences in the multiple linear regression analysis, shown in Table III. Consequently, both the male and female residents received similar clinical experience in this Advanced Education Program in Periodontology.

c. **Prior Experience:** Incoming residents' prior experience in private practice and/or formal education ranged from 0-14 years (Table I). Many residents had additional post-graduate training such as advanced education in general dentistry (AEGD), general practice residency (GPR), specialty training in oral and maxillofacial surgery or prosthodontics.

Residents were stratified into two cohorts consisting of 0-1 years and 2 years or greater of prior experience in order to evaluate the effect of a resident's prior experience on clinical productivity. Non-parametric Wilcoxon Rank Sum Test revealed the only parameter that was statistically significant regarding prior experience was exodontia ($p = 0.0386$). However, after adjusting for cohort differences by using a multiple linear regression analysis (Table III), there weren't any statistically significant differences between these two groups. Hence, our data shows that all residents gained equivalent clinical experience regardless of their prior experience.

d. **Prior participation in the periodontal honors course:** Among the 15 year data were eight residents who had participated in the Periodontal Honors course during their pre-doctoral training. All periodontal residents are required to participate each summer and help teach the Periodontal Honors course throughout their 3-year residency. Consequently, eight residents attended the periodontal honors course as a pre-doctoral student plus three summer semesters as a resident (total 4 times) while the other residents participated and subsequently helped teach the course only during three

summer semesters of their residency. Non-parametric Wilcoxon Rank Sum Test (Table II) was used to compare differences in clinical performance of those residents who attended the Periodontal Honors course as pre-doctoral students plus the three summer semester during their periodontal residency verses residents who only attended and participated in the course during the three summer semester of their residency. IV sedation was found to be the only parameter statistically significant ($p = 0.0136$) influenced by participating in the Periodontal Honors course as a pre-doctoral student. Consequently, residents who participated in the periodontal honors course during their periodontal training had similar clinical experience to the residents who had also participated in the honors course during their pre-doctoral dental training except that those residents performed more IV sedation procedures.

8. **Multiple Linear Regression Models:** A multiple linear regression analysis model was utilized to evaluate clinical experience and corresponding financial productivity among pre-honors and post-honors cohorts while accounting for difference due to age, gender, country of origin and prior experience of the residents (Table III). Differences between all three cohorts were still found to be valid after accounting for differences due to various demographic variables. Differences in clinical performance metrics between the pre-honors and post-honors cohorts were statistically significant except for conventional periodontal surgery and periodontal maintenance procedures. Hence, there was an overall statistically significant

improvement in the clinical experience of the residents after the introduction of the periodontal honors course while experience in conventional periodontal surgery and periodontal maintenance procedures remained consistent with those prior to instituting the Periodontal Honors course.

CHAPTER IV

CONCLUSIONS

Our data demonstrates that the periodontal residents performed significantly ($p < 0.05$) more non-surgical (scaling and root planing, periodontal maintenance), surgical (exodontia, osseous grafting, implant surgery, soft tissue grafting) and sedation procedures after instituting our periodontal honors course. Over the past 15 years there has been greater than a 600% increase in the financial productivity by the periodontal residents with the most dramatic increase occurring in the first three years after instituting the periodontal honors course. The residents received equivalent clinical experience regardless of their country of origin, gender, prior experience or participation in this periodontal honors course during their pre-doctoral training. Hence, there was an overall statistically significant improvement in the clinical experience and the corresponding financial productivity of the residents after introducing our periodontal honors course. Implementing a similar honors course by other disciplines and dental schools has a strong potential to improve the quality of specialty education as well as monetarily reward the residency program and the institution as a whole.

CHAPTER V

DISCUSSION

Ghiabi et. al. (2010) surveyed the surgical training offered by North American graduate periodontics programs in order to set the stage for a systematic inquiry into how the learning experience in periodontics can be optimized (10). The authors also assessed if the clinical experience of the residents would be different in programs that offered a structured preclinical component, as compared to those programs lacking such a component. The only significant difference found was that residents in programs offering a structured preclinical component performed significantly more procedures (P=0.012) using lasers than residents in programs not offering a structured preclinical program. However, they did not explore the extent and/ or the structure of this preclinical component.

Secomb et.al. (2008) performed a systematic review to provide a framework for peer teaching and learning in the clinical education of undergraduate health science students in clinical practice settings and examined the positive and negative aspects of peer teaching (17). This review reported mostly positive outcomes on the effectiveness of peer teaching and learning whereby it can increase student confidence in clinical practice and improve learning in the psychomotor and cognitive domains. Negative aspects identified were poor student learning, if personalities or learning styles were not compatible and students were spending less individualized time with the clinical instructor.

Pileggi et.al. (2008) used a team-based learning (TBL) approach to facilitate student learning and performance in a sophomore preclinical endodontic course (18). TBL is

based upon the division of a class into small groups of students using a problem-based learning approach. Students' performance on the post-test (63.4 percent) showed improved results when compared to the pretest (36.9 percent). Students also exhibited improved diagnostic skills on the final examination. The results of the students' attitudinal survey indicated an 80 percent agreement that TBL enhanced the resident's/student's powers of critical analysis.

The medical literature suggests that surgical simulators can be effectively used to teach basic surgical procedures in a laboratory setting away from the pressures of working on a live patient in the operating room (18-21). A recent report in the dental education literature corroborates the conclusions made in medicine (22).

There is a perceived need among dental educators for curricular reform and implementation of innovative and effective teaching techniques. A periodontal honors course was designed to enhance the quality of educational experience for pre-doctoral dental students and periodontal residents as well as to enhance the pool of qualified and potentially interested applicants to a periodontal residency. All periodontal residents participated in the course first as a student and eventually as a mentor that enabled them to incorporate these same skills throughout the bulk of their residency. Multiple active learning strategies were utilized throughout the course including small group discussions, video demonstrations, use of surgical mannequins and euthanized animals as well as live patients. Problem-based learning is incorporated into the periodontal honors course via a treatment plan seminar whereby residents discuss their own specific cases while citing non-surgical and surgical care references to support their biological rationale for

treatment thereby integrates evidence-based learning. Residents evolved from a student to become a mentor over the course of their 3-year residency. We believe our periodontal honors course plays a significant role in developing a strong foundation in Periodontics for both pre-doctoral dental students and residents at the start of their graduate studies as well as helping to harmonize the entry skill level of the residents. Consequently, all residents work together to mutually improve their clinical training experience.

This unique study examined the long-term effects of instituting a periodontal honors program on our periodontal residents' educational experience and financial productivity while they served as mentors for the pre-doctoral dental students. Implications of long-term observational studies must be interpreted with caution if significant transitions occurred in supervising faculty (program director), personnel (residents), dental assistants, administrative staff (receptionist), etc. However, within this particular residency the tenure of the program director was 26 years, dental assistants ranged from 2 to 27 years while the receptionist was 12 years. Multiple sensitivity analyses were conducted in order to account for differences in clinical performance due to the resident's age, gender, country of origin and prior experience but did not find any significant effect on the outcomes. Sensitivity analyses removing the outliers also did not affect the study outcome. Throughout 15 years of this study the most profound change in residents' educational experience and financial productivity occurred during the first 3 years after the introduction of a periodontal honors course. Consequently, the magnitude of these observed changes and their close proximity to the introduction of the periodontal honors

course suggest a very strong association with the residents' educational experience and financial productivity.

This periodontal honors course already employs recognized effective and innovative teaching methods. The presented data assessing the changes in the educational experience of the residents over a decade after the inception of this course and provides strong evidence for the success of this program.

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APPENDIX A

FIGURES

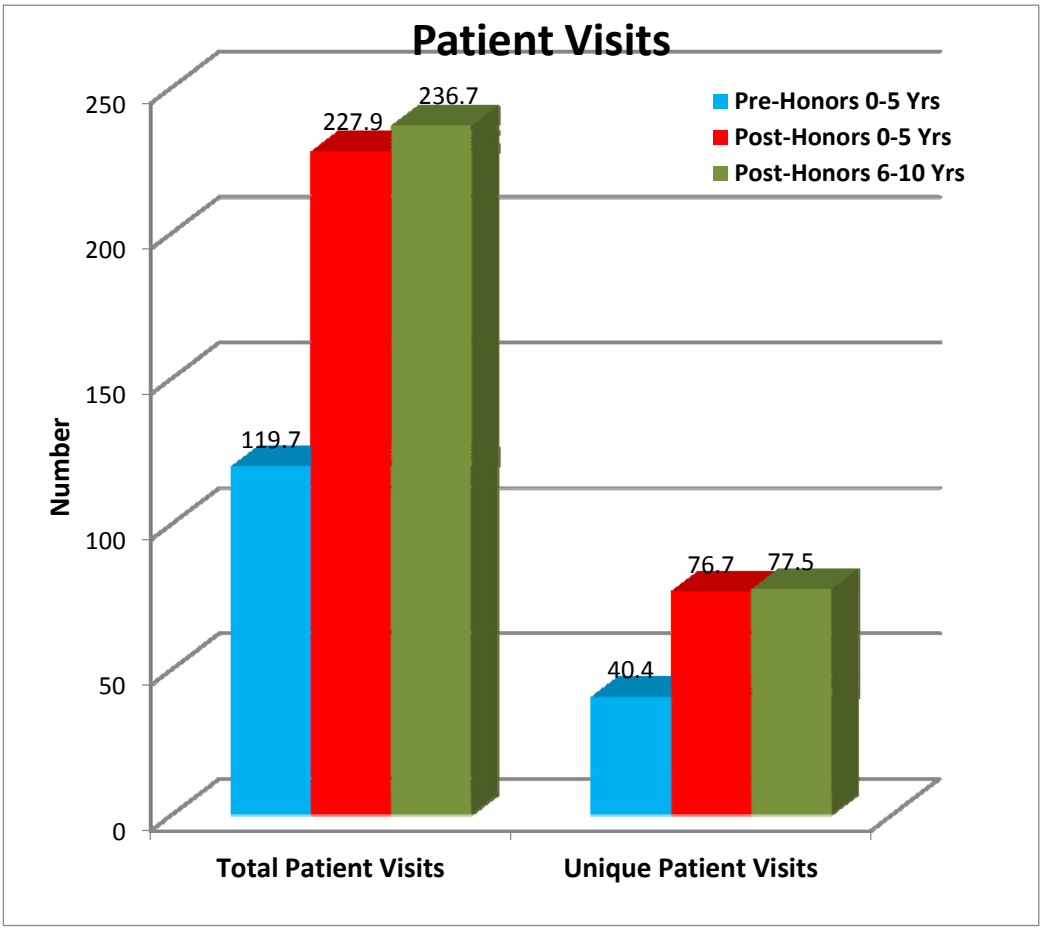

Figure 1 – Mean total and unique patient visits per resident

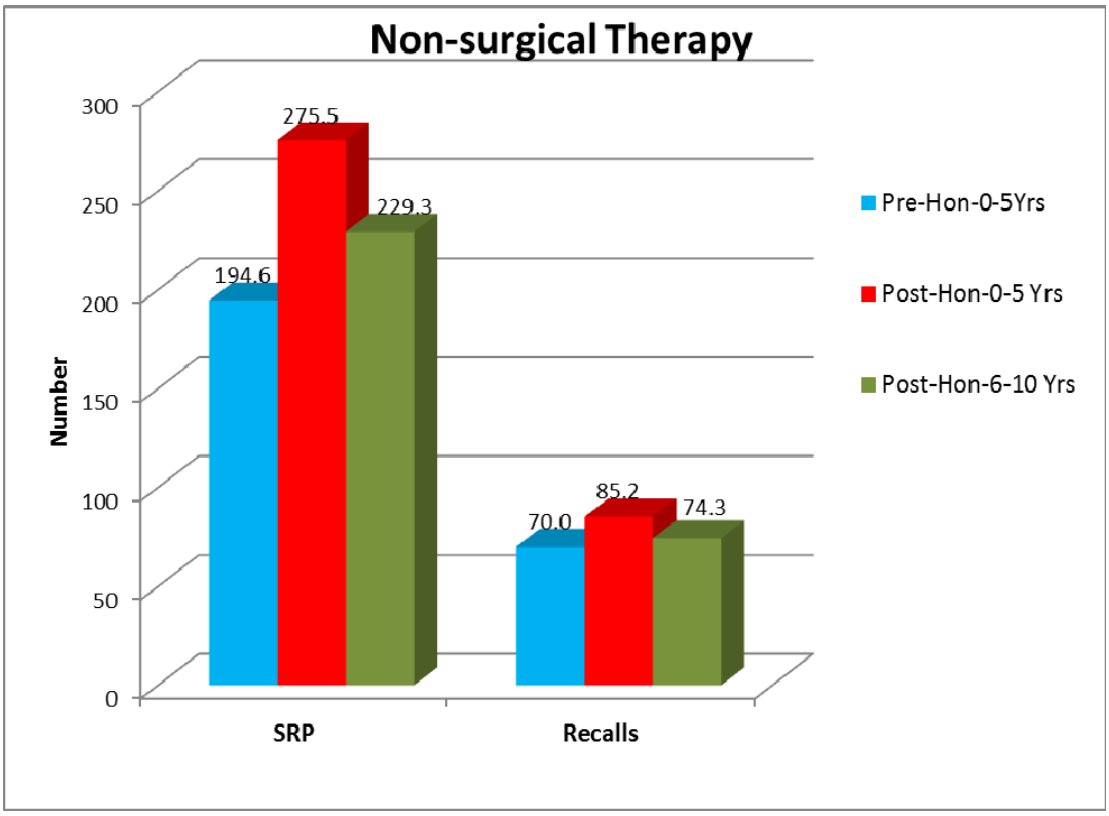

Figure 2 – Resident Performance: Non-surgical therapy- Mean of the total number of scaling and root planing quadrants (SRP) and the periodontal maintenance procedures per resident

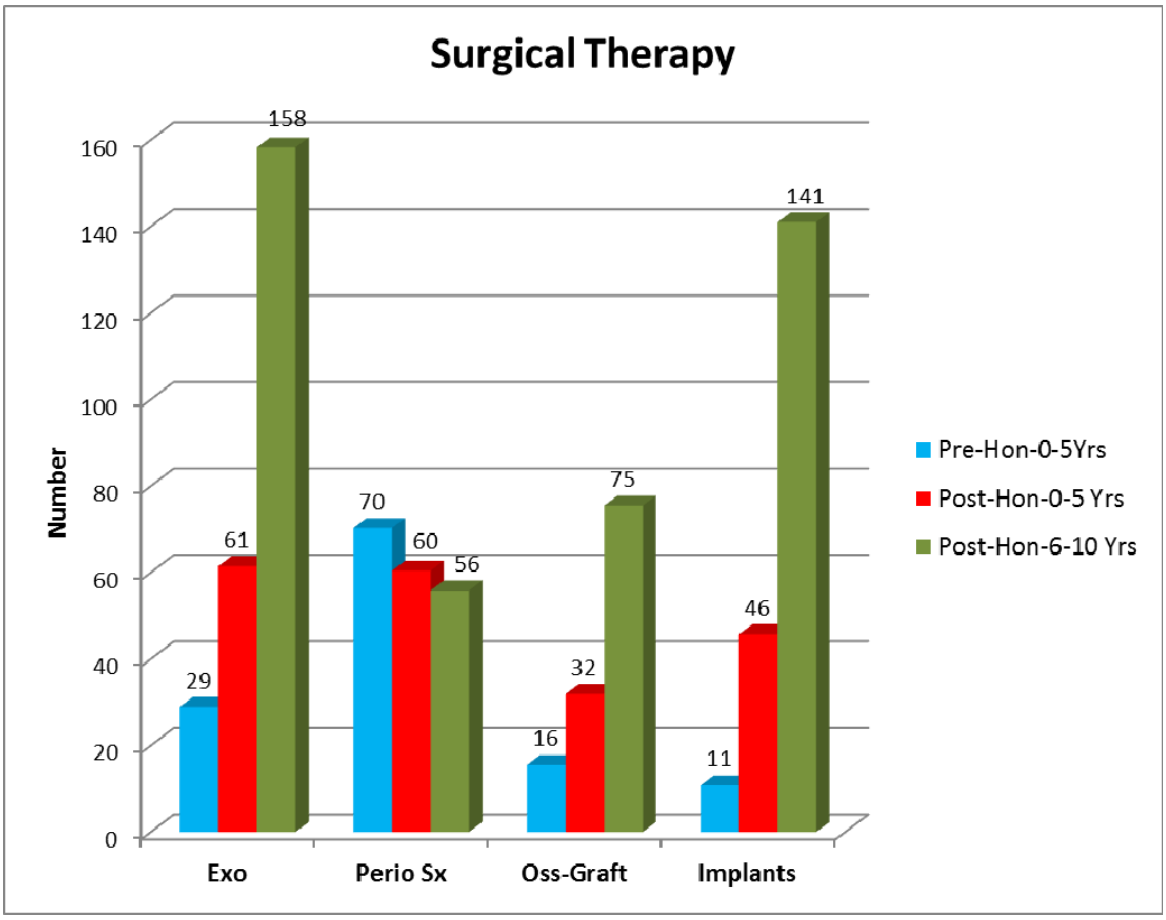

Figure 3 – Resident Performance: Surgical therapy- Mean of the total number of teeth extracted (Exo), conventional periodontal surgery (Perio Sx), osseous grafting surgery (Oss-Graft) and dental implants placed (Implants) per resident

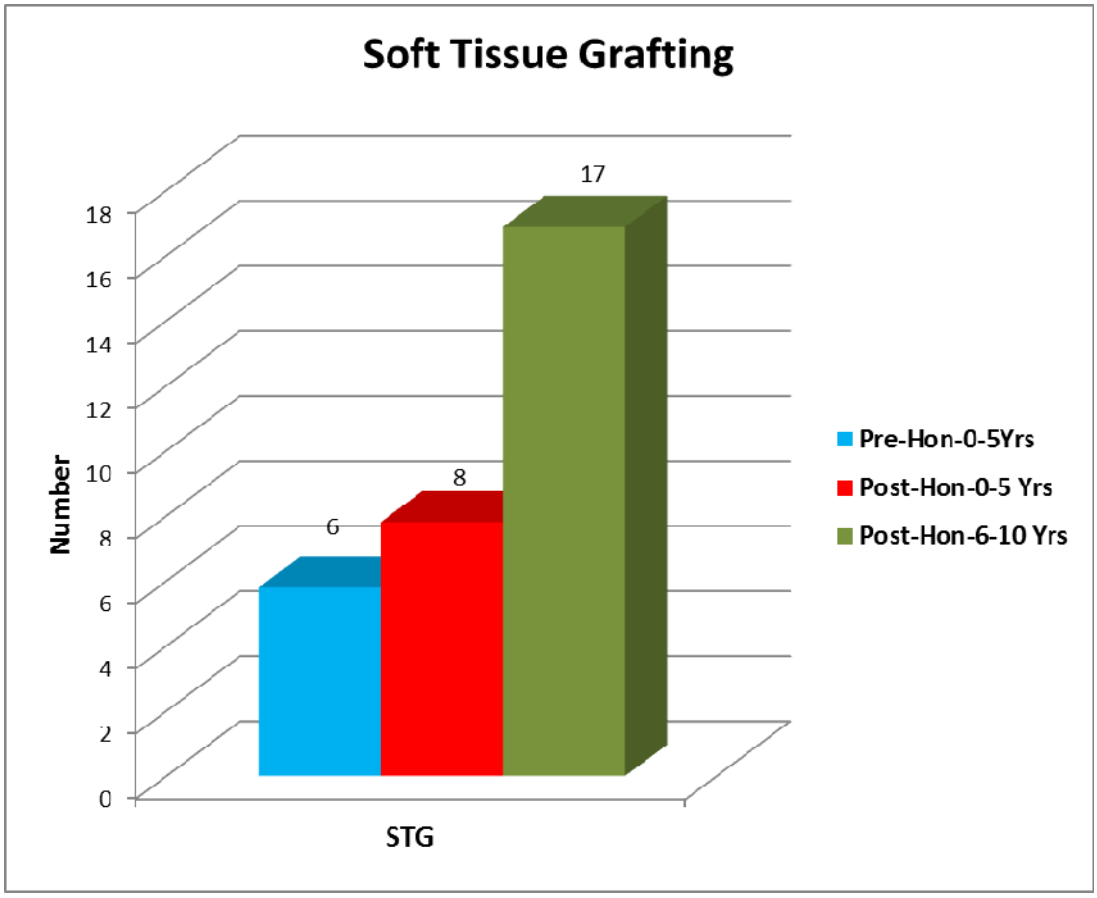

Figure 4 – Resident Performance: Surgical therapy-Mean of the total number of soft tissue grafting procedures (STG) per resident

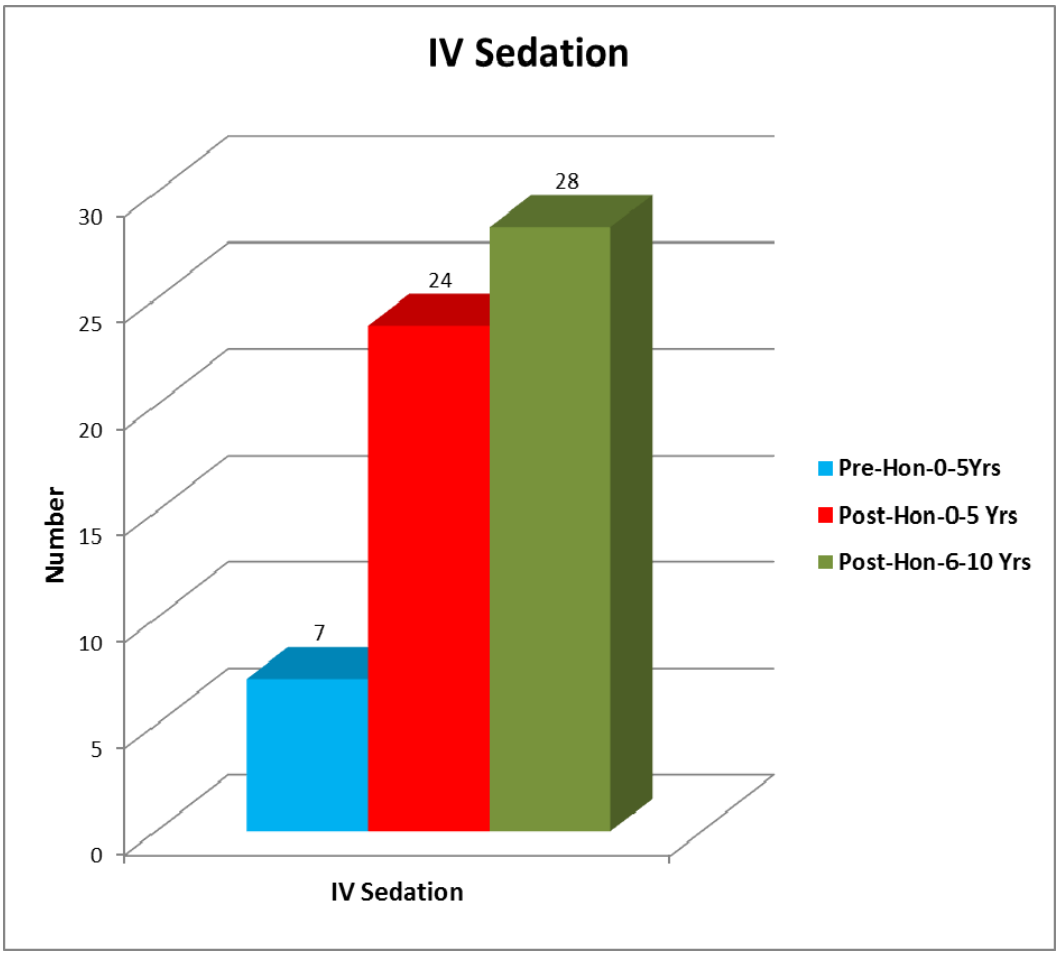

Figure 5 – Resident Performance: IV Sedation-Mean of the total number of intravenous conscious sedation procedures performed per resident

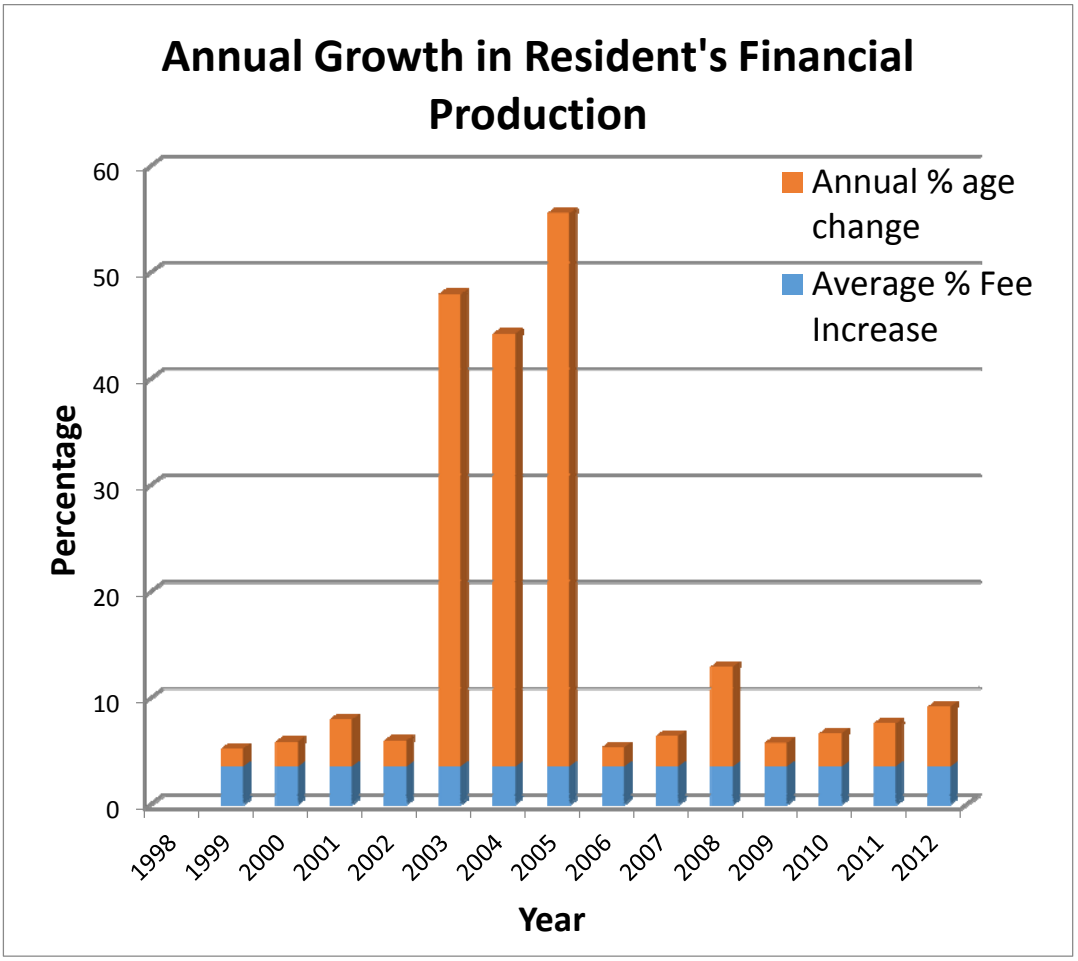

Figure 6 – Resident Performance: Clinical Productivity-Annual growth (percentage) in residents' financial production

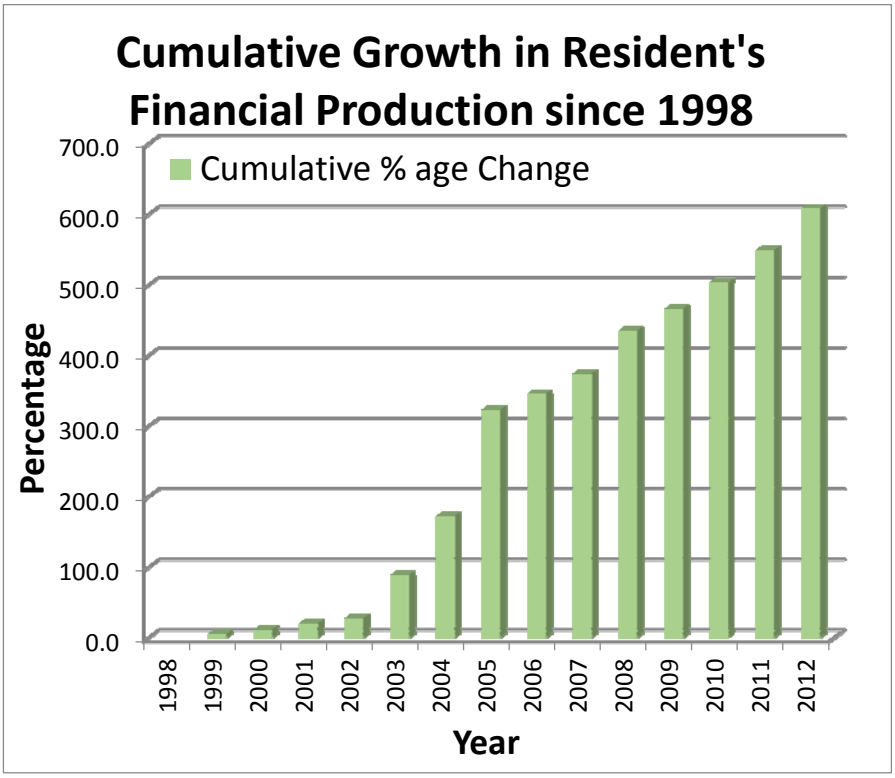

Figure 7 – Resident Performance– Clinical Productivity- Cumulative growth (percentage) in residents' financial production since 1998

APPENDIX B

TABLES

Characteristic	Pre-Honors	Post Honors (0-5 yrs)	Post Honors (6-10 yrs)
	N=14	N=15	N=16
Age, years			
Mean (SD)	29.6 (5.3)	27.2 (2.4)	28.6 (2.6)
Min-Max	25-41	24-33	25-35
Gender			
Female, n (%)	6 (43)	6 (40)	5 (31)
Male, n (%)	8 (57)	9 (60)	11 (69)
Country			
North America, n (%)	5 (35.7)	5 (33.3)	11 (68.8)
Rest of the World, n (%)	9 (64.3)	10 (66.7)	5 (31.3)
Prior Experience, years			
Mean (SD)	3.4 (3.7)	1.7 (1.7)	1.5 (2.1)
Min-Max	1-14	0-5	0-8

Table I – Resident Demographics

Outcome	Males vs Females (all cohorts)	North America vs Other (all cohorts)	Prior Experience 0-1 yrs vs ≥2 yrs	DDS w/ Perio Honors vs. others (Post-Honors Only)
	P-value*	**P-value***	**P-value***	**P-value***
Exo	0.2279	0.0012	0.0386	0.061
SRP	0.5769	0.9184	0.3639	0.7519
Recalls	0.4897	0.776	0.1862	0.0992
PerioSx	0.4258	0.5091	0.2647	1
Oss Graft	0.3428	0.0104	0.154	0.1247
Implants	0.5901	0.0394	0.2552	0.2589
STG	0.3237	0.0457	0.7908	0.1181
IV Sedation	0.8697	0.0619	0.4758	0.0136

*non-parametric Wilcoxon Rank Sum Test (alternative to the two sample t-test)

Table II – Potential confounding variables

Outcome	Cohort	Age	Gender	Country of Origin	Prior Experience
	p-value*	**p-value***	**p-value***	**p-value***	**p-value***
Exo	**<0.0001**	0.4411	0.8213	**0.0025**	0.3583
SRP	**0.001**	0.7031	0.4965	0.8578	0.7324
Recalls	0.5985	0.6866	0.4485	0.6539	0.0589
PerioSx	0.4002	0.3212	0.2063	0.9411	0.6384
Oss Graft	**<0.0001**	0.4434	0.3925	0.1087	0.554
Implants	**<0.0001**	0.2255	0.554	0.083	0.1371
STG	**0.0008**	0.4591	0.2223	0.9814	0.4171
IV Sedation	**<0.0001**	0.9876	0.4059	0.4977	0.7057

*Table contains p-values from a multiple linear regression model

Table III – Multiple linear regression model