Impact of Infrastructure on Graduate Dental Education and Dental Clinic Productivity


Abstract: Using all-inclusive data from 126 U.S. Department of Veterans Affairs health care facilities that provide dental services, this study identified the staffing infrastructure under which the Veterans Health Administration can provide graduate dental education without compromising dental clinic productivity. From regression analyses, we found that teaching residents has a negative impact on staff dentists’ productivity; however, when the dental assistant to provider ratio is greater than or equal to 1.0, dental residents’ workload contribution can offset the negative impact on overall clinic productivity. In the presence of dental residents, the dental assistant, front-desk personnel, and dental treatment room to provider ratios have a positive impact on productivity. The optimal ratios were calculated as 1.5 for dental assistants, 2.1 for dental treatment rooms, and 0.57 for front-desk personnel.

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Key words: productivity, dental assistant, dental treatment room, operatory workload, front-desk personnel, dental resident, graduate dental education

Submitted for publication 8/9/08; accepted 11/5/08

The purpose of this study was to identify the staffing infrastructure needed to provide graduate dental education in the U.S. Department of Veterans Affairs (VA) dental clinics without compromising productivity. The initial intent of the study was to facilitate VA policy and planning regarding staffing dental clinics with residency programs. Since the study used labor paid hours to calculate productivity without involving costs, the data were not subject to any differences in cost accounting methods among various health care settings; therefore, the findings may be used to develop educational infrastructure guidelines for dental training in non-VA settings.

Educating health care professionals is one of the statutory missions of the Department of Veterans Affairs. The VA is the only federal government agency directly involved in the administration and monitoring of health care education programs. Being the largest provider of health care training in the United States, the VA provides training encompassing the entire spectrum of health professions including physicians, dentists, nurses, pharmacists, audiologists, dietitians, social workers, psychologists, physical therapists, optometrists, podiatrists, physician’s assistants, respiratory therapists, dental hygienists, and nurse practitioners. Each year, more than 100,000 health care professional trainees receive all or part of their education at VA facilities. In 2007, the VA funded 354 postgraduate dental resident positions in general practice, oral and maxillofacial surgery, endodontics, periodontics, and prosthodontics.

When studied approximately twenty years ago, VA facilities with hospital-based general practice residency programs were found to be as cost-efficient as non-teaching facilities, and services provided by residents appeared to offset a major part of training costs. The general practice residency training programs were found to have an impact on dentists’ choices to practice in hospital settings, perform more surgical procedures, and become more involved in teaching. In addition to dental residency training, the VA provides clinical training for dental hygienists and dental assistants. VA training programs not only ensure the high quality of medical services delivered to veterans, but also provide a pipeline for the VA
and the nation’s health care workforce. To assess the quality of graduate medical education, the VA Office of Academic Affiliation has conducted the annual VA learners’ perception survey since 2000. This survey has been well validated and covers key domains of resident satisfaction including the learning environment, clinical faculty or preceptors, physical environment, and working environments. In the 2007 learners’ perceptions survey, there were two questions that asked dental trainees about the likelihood of their considering working for the VA before and after their VA clinical training. Twenty-five percent answered “very likely” or “somewhat likely” to the following question: Before this clinical training experience, how likely were you to consider a future employment opportunity at a VA medical facility? This was in contrast to 73 percent answering “very” or “somewhat likely” to the following question: As a result of this clinical training experience, how likely would you be to consider a future employment opportunity at a VA medical facility? The survey results indicated that the residents were 48 percent more likely to consider working for the VA after their VA clinical training experience.

All programs funded by the VA must be accredited by the American Dental Association’s Commission on Dental Accreditation (CODA). Care provided by residents is closely supervised, and the resident supervision is monitored and documented. In addition, the VA conducts annual learners’ perception surveys and sets policies and guidelines for resident education and supervision.

The accreditation standards for general practice residency (GPR) and advanced education in general dentistry (AEGD) programs both specify the requirement of adequate support staff. The program requirements state, “The program should determine the number and participation of allied support and clerical staff to meet the educational and experiential goals and objectives. Allied support may include dental assistants, dental hygienists, dental laboratory technicians, and front-desk personnel as needed.” Furthermore, “students/residents and teaching staff must not regularly perform the tasks of dental assistants, laboratory technicians, or clerical personnel.”

Nevertheless, studies to determine the appropriate number of support staff to ensure dental resident educational quality are scarce. The present study was conducted to address this gap in current knowledge. We used productivity measures based upon services in which dental residents actually participated in order to determine the availability of clinical educational opportunities. We used workload measures to calculate the optimal ratio of support staff and dental treatment rooms.

**Methods**

**Study Design**

A cross-sectional study was conducted using data collected from all 126 VA facilities offering dental services for a period of one academic year, from July 2006 to June 2007. The unit of analysis is the “parent” VA facility. In many cases, a VA parent facility manages multiple satellite dental clinics. In those cases, data from satellite clinics were rolled up to the parent level in order to synchronize the payroll and workload data. An explanatory regression model was built to explain the variations in productivity among the 126 dental facilities. Productivity for each parent facility was used as the dependent variable, and the case-mix complexity level of the facilities, staffing patterns for dental assistants, laboratory technicians, hygienists, front-desk personnel, other ancillary staff, and the ratio of dental treatment rooms to providers were used as the independent variables. The productivity was calculated by dividing the total number of relative value units (RVUs) produced during the study year by the total full-time equivalent (FTE) of either faculty dentists or the combination of faculty and resident dentists. One FTE of resident dentist position can be shared by several residents who rotated through the same clinic. The staffing patterns were expressed as a ratio, which was calculated by dividing the total FTE of ancillary staff by the total FTE of faculty and resident dentists.

The VA has dual missions of education and providing services to veterans; ideally, dental education infrastructure should be such that the presence or absence of a dental residency program does not negatively impact the overall productivity of a clinic or a patient’s access to dental care. The analyses were thus separated into two steps. First, we identified factors that impact a dental clinic’s productivity. Then, after controlling for the factors that impact a dental clinic’s productivity, we examined and identified what conditions contributed to avoiding the negative impact in productivity when residents were present in a clinic. Finally, we determined the optimal ratios of dental assistants, front-desk staff, and dental treatment rooms (or “operatories”) to dental providers (attending dentists plus dental residents).
Two linear regression models (OLS) were constructed to answer two research questions: 1) what were the factors affecting the productivity of faculty dentists? and 2) what were the factors affecting the combined productivity of both faculty and resident dentists? The faculty dentist productivity was used as the dependent variable for the first model, and the combined faculty and resident productivity was used to construct the second regression model.

Regression models were constructed by a two-stage process. In the first stage, the outliers with high leverage to the model were removed using a threshold of a leverage value of 2 from the influence diagnostics. The second eliminated the nonsignificant variables when p value was greater than 0.05, and variables with high collinearity using a threshold of condition index >30 from the collinearity diagnostics.

The minimum dental assistant staffing ratio was identified through testing the established regression model with various thresholds of dental assistant ratio to see at what ratio having a dental resident program no longer negatively impacted the model.

The optimal staffing ratio was calculated from the derivative of staffing ratio from the regression model shown below while controlling for the number of residents, staff dentists, and other significant variables:

\[ Y = \beta_0 + \beta_1 A + \beta_2 A^2 \]  
\[ Y = \text{workload output in RVU, } A = \text{staffing ratio} \]

Derivative of \( A = \text{optimal staffing pattern:} \)

\[ 0 = \beta_1 + 2 \beta_2 A \]

\[ A = -\frac{\beta_1}{2 \beta_2} \]

**Data Sources**

This study used the resident-training program reports, payroll, and workload data from 126 VA dental facilities. The data did not include any dental services provided by non-VA providers that were paid on a fee-for-service basis. VA staff salaries are generally fixed for one year and are independent of the workload performed. Workload data were collected in three output units: 1) relative value units (RVUs), 2) number of visits, and 3) number of unique patients served in the clinics. Workload was recorded electronically by CPT codes associated with a provider in the VA Patient Care Encounter and Dental Encounter Information Systems. For each CPT code, the VA Dental Coding Committee in cooperation with VA Decision Support System staff had previously assigned an RVU value based on the dentists’ hands-on time required to perform the procedure. The strength of using the RVU as the output measure is that it reflects the time and complexity of the procedures; however, it does not adjust for the increased efficiency that may result when several procedures are bundled into one visit. In other words, when multiple procedures were performed at one sitting, the RVUs accumulated from all procedures could be somewhat higher than the dentists’ actual hands-on time. Monitoring the number of visits or the number of unique patients served provides disincentives to perform inappropriate dental procedures and unbundling of dental services. Since the VA operates under a global budget system, providing disincentives to inappropriate treatments is important. However, we recognized that simply counting visits and/or unique patients may fail to reflect dentists’ actual procedural time. All three workload measures were used in the analyses with similar findings. Hence, results using RVUs as the output measures are presented in this study.

The staffing data originated from the payroll files were downloaded from the Veterans Service Support Center (VSSC) data warehouse, which included the full-time employee equivalent (FTEE) for dentists, dental front-desk support, dental assistants, dental laboratory aids, dental hygienists, and laboratory technicians paid through the dental cost center 8248. Dental resident data were obtained from the VA Office of Academic Affiliations. The resident funding data were recorded as FTEEs. Residents receive payments only when they are on VA grounds for educational activities or when providing patient care. One resident FTEE can be shared by several dental residents who rotate through VA clinics from an affiliated academic institution. The treatment room (“operatory”) data were collected from a survey conducted in 2005.

As eligibility for VA dental care is dependent upon the patients’ service connection for a medical or dental disability or the presentation with a compelling medical need, dental workload and production are affected by the severity of patients’ illnesses. The set-up and patient handling time of patients with severe co-morbid conditions is longer than those with lesser co-morbidities. Since the unit of analysis for this study is the VA parent facility, individual patients’ diagnostic codes were not used. Instead, the hospital complexity level was applied as a proxy measure to reflect case mix and severity of patients’ illnesses.
Results

In the academic year (AY 2006–07: July 1, 2006 through June 30, 2007) examined, there was a total of 181 VA dental clinics in the nation managed by 126 VA parent facilities. Among the 126 parent facilities, sixty-five facilities (51 percent) have dental residency programs with an average of 5.5 residents per teaching facility. The staffing patterns shown in Figure 1 were generated from aggregating individual satellite clinics to the parent facilities, which may enlarge the range of staffing patterns for actual individual dental clinics.

The total workload produced by each facility varied greatly, from 67,890 RVUs per year to 2,148,282 RVUs per year, with an average of 517,898 RVUs per facility and an interquartile range of 454,733 RVUs. To identify factors associated with staff dentists’ productivity, a regression model was explored using staff dentists’ productivity as the dependent variable and the ratios of residents to staff dentists, hygienists to dental providers (staff dentists and residents combined), front-desk personnel to dental providers, laboratory technicians to dental providers, dental assistants to dental providers, dental treatment rooms to dental providers, and the hospital complexity grouping as the independent variables. The results showed that the staff dentists’ productivity was negatively impacted by the resident to staff dentist ratio ($t=-3.7$, $p=0.0004$), but positively associated with the ratio of dental assistants to dental providers (staff dentists plus residents combined) ($t=6.0$, $p<0.0001$) and front-desk personnel to dental providers ($t=4.5$, $p<0.0001$). After controlling for the support staff ratio, the increase of the resident to staff dentist ratio by one could reduce one staff dentist’s yearly workload by 12,666 RVUs. In contrast, increasing the dental assistant to provider ratio by one could increase one staff dentist’s yearly workload by 5,153 RVUs. Similarly, an increase in the front-desk

![Figure 1. Average staffing patterns of teaching and nonteaching clinics](image-url)
personnel to provider ratio by one could increase one staff dentist’s yearly production by $35,112 \text{ RVUs}$ (Table 1). The ratio of hygienists, laboratory technicians, and dental treatment rooms did not significantly impact the staff dentist productivity.

To identify factors that impact the overall productivity of both staff dentists and dental residents (providers), the combined productivity was used as the dependent variable, and the ratios of all types of personnel and the hospital complexity groups were used as the independent variables. When using the combined productivity of staff dentists and residents, the ratio of residents and staff dentists no longer significantly impacted a dental clinic’s productivity, nor did the ratios of hygienists or laboratory technicians to providers and the hospital complexity grouping. Like the staff dentist analysis, the dental assistant to provider and front-desk personnel to provider ratios remained significant; additionally, the dental treatment room to provider ratio significantly impacted productivity (Table 2). Further analyses were focused on identifying the minimum cut-off points for the support staff ratios and the number of dental treatment rooms where the teaching of residents would not have a negative impact on dental clinic productivity.

There was a wide distribution of the ratios of dental assistants to providers (staff dentists and residents combined) ranging from 0.3 to 2.0 with a national average of 1.0. The national average was used to test the cut-off point of a staffing pattern wherein the teaching of residents may significantly impact a clinic’s productivity. When facilities had a dental assistant to dental provider (staff dentists plus residents) ratio greater than or equal to 1.0 ($N=66$), the ratio of dental residents to staff dentists no longer impacted the combined productivity (Figure 2). Only the dental treatment room to provider ratio and the front-desk personnel to provider ratio affected the workload. When facilities had a dental assistant to provider ratio less than 1.0 ($N=60$), the ratio of residents to staff dentists showed a negative impact on combined productivity (parameter estimate=-5.293, $p=0.006$). The same approach was used to identify the cut-off points for staffing the front-desk personnel and to provide the number of dental treatment rooms, but with no significant finding.

The optimal ratio of dental assistants to providers (staff dentists plus residents) was calculated from a regression model using the combined workload as the dependent variable and the dental assistant to provider ratio and the ratio square as the independent variables while controlling for the number of staff dentists and residents. This same approach was used to calculate the optimal dental treatment room to provider ratio and the ratio of front-desk personnel to provider ratio by one could increase one staff dentist’s yearly production by $35,112 \text{ RVUs}$ (Table 1). The ratio of hygienists, laboratory technicians, and dental treatment rooms did not significantly impact the staff dentist productivity.

| Table 1. Factors impacting the productivity of staff dentists (linear regression model) |
|---------------------------------|----------------|----------|--------|-----------|
| Parameter                      | Estimate      | Standard Error | t value | p value   |
| Intercept                      | 31,535        | 7,170       | 4.4    | <0.0001   |
| Resident to staff dentist ratio| -12,468       | 3,416       | -3.7   | 0.0004    |
| Dental assistant to provider ratio† | 35,153    | 5,827       | 6.0    | <0.0001   |
| Front-desk personnel to provider ratio | 35,112    | 7,842       | 4.5    | <0.0001   |

R-Square=0.59, $F=57$, $p<0.0001$
†Provider=staff dentists plus dental residents

| Table 2. Factors impacting the combined productivity of dental providers (linear regression model) |
|---------------------------------|----------------|----------|--------|-----------|
| Parameter                      | Estimate      | Standard Error | t value | p value   |
| Intercept                      | -17,412       | 4,350     | -4.0   | 0.0001    |
| Dental assistant to provider ratio† | 15,817    | 4,912       | 3.2    | 0.0017    |
| Dental treatment room to provider ratio | 10,158    | 1,697       | 5.9    | <0.0001   |
| Front-desk personnel to provider ratio | 15,903    | 7,319       | 2.2    | 0.0318    |

R-Square=0.52, $F=43$, $p<0.0001$
†Provider=staff dentists plus dental residents
nel. The optimal ratio of dental assistants to provider was calculated as 1.5; the optimal dental treatment room to provider was 2.1; and the optimal front-desk personnel to provider was 0.57 (Figure 3).

**Discussion**

From the perspective of dental residents, the value of postgraduate training includes knowledge enhancement, increased efficiency, and gaining a higher competence or proficiency level from the experience of performing more complex procedures. The major drawback for extending the education for one more year is the financial loss. Previous studies have noted that inefficient learning environments can hinder residents’ opportunities to develop clinical competence. In one study, residents who completed one-year postgraduate training programs reported having a lower perceived level of competence than at the time of their dental school graduation. Excessive amounts of non-educational activities, inconsistent feedback from faculty, and limited access to faculty were listed as concerns from 655 junior, senior, and graduate dental students regarding their clinical education. Accordingly, the goal of our study was to identify the appropriate staffing support for dental education to prevent dental residents from performing non-educational activities and to ensure a meaningful clinical experience. Adequate clinic productivity is necessary for a good clinical experience.

We found that providing teaching and supervision for dental residents was negatively associated with the staff dentists’ workload. In other words, teaching activities slowed down or interfered with the productivity of dental faculty. The findings indicated that having one dental resident can negatively impact a staff dentist’s total workload by 27,218 RVUs per year; however, one dental resident can also produce 36,917 RVUs in a year. Thus, the workload generated by dental residents can offset the workload lost by staff dentists due to teaching activities. When the production of residents was attributed to the supervising dental faculty, as is the case with medical resi-
dents, production increased to an average of 99,153 RVUs, compared to 87,531 RVUs for non-teaching staff dentists. Our data suggest that the cost associated with dental education is most likely associated with the lower productivity of the staff dentists due to teaching, but also appears to be a function of the availability of dental assistants, front-desk personnel, and the number of dental treatment rooms.

Among all types of dental support staff, only dental assistants and front-desk personnel were found to significantly impact the productivity of providers. In a dental clinic, dental assistants’ functions include setting up instruments, assisting dentists with dental procedures, taking X-rays, removing sutures, applying medication, sterilizing equipment and instruments, controlling inventory, billing insurance, excess filling, and making dental impressions and teeth casts. Dental assistants’ functions are essential for a dental clinic but do not enhance residents’ knowledge, although they may provide the support necessary to allow dental residents to acquire a greater procedural experience. Front-desk personnel functions include intake of patients, answering the telephone, and making clinic appointments.

To further explore the impact of the dental assistant to dental provider ratio on resident education, we separated the facilities into two groups—the first with a ratio of 1.0 and above, the second with a ratio of less than 1.0. Regression models were constructed for each group. When the dental assistant to staff dentist ratio was equal to or above 1.0 (N=64), the resident teaching burden reflected by the resident to staff dentist ratio did not impact the productivity of the clinic. The only factors that impacted workload were the dental treatment room to provider ratio and front-desk personnel to provider ratio. When the dental assistant to provider ratio was below 1.0 (N=60), the teaching burden (resident to staff dentist ratio) showed a negative impact on productivity, while the dental assistant to provider ratio and dental treatment

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**Figure 3. Average combined productivity of attendings and residents relative to optimized ratios**

Optimal dental assistant to provider ratio: $-631872/2 \times (-214399) = 1.47$

Optimal front-desk personnel to provider ratio: $-357431/2 \times (-312561) = 0.57$

Optimal dental treatment room to provider ratio: $-42621/2 \times (-10086) = 2.11$
room to provider ratio showed a positive impact. Changing the ratio for dental treatment room and front-desk personnel ratios did not demonstrate an effect similar to the dental assistant ratio; therefore, the staffing ratio of the dental assistants seemed to be the most important factor that impacts a dental clinic’s productivity. When the staffing ratio (dental assistant to dental provider) is less than 1.0, the resident teaching burden had a negative impact on clinic productivity regardless of the contribution of residents to overall workload. With or without a dental residency program, the front-desk personnel support had a positive effect on dental clinic productivity. With a dental residency program, the dental treatment room ratio also demonstrated a significant positive effect. In other words, to avoid a dental residency program having a negative impact on the productivity in a clinic, a minimum dental assistant to provider ratio of 1.0 is essential. The minimum number of dental treatment rooms and front-desk support was inconclusive; however, the optimal ratio for dental assistant to provider was calculated as 1.5. The optimal ratio of dental treatment room to provider was calculated as 2.1, and the optimal ratio of front-desk personnel was 0.57.

Conclusion

The purpose of this study was to identify the appropriate teaching infrastructure for graduate dental education to balance the VA’s dual missions of education and providing services to veterans. Our findings indicate that the staffing ratios of hygienists and laboratory technicians do not impact the productivity of a dental clinic. The types of staff that impact productivity are dental assistants and front-desk personnel. Teaching residents has a negative impact on staff attending dentists’ productivity; however, the workload contributed by residents offsets the teaching burden and neutralizes the negative impact on overall clinic productivity. This offset only occurs when the dental assistant to provider ratio is greater than or equal to 1.0. When the dental assistant ratio falls below 1.0, the resident teaching burden has a negative impact on a dental clinic’s overall productivity. With or without a residency program, adequate front-desk support had a positive impact on dental clinic productivity. With a residency program, the ratio of dental treatment rooms to provider impacts productivity positively.

Thus, the findings of this study indicate that a minimum ratio of one dental assistant to provider is needed to appropriately support a dental residency program. To reach the optimal efficiency of a dental clinic, the findings support the dental assistant to provider ratio of 1.5, the front-desk personnel to provider ratio of 0.57, and the dental treatment room to provider ratio of 2.1.

Acknowledgments

The authors thank Dr. Theodore Stefos, economist for the Office of Productivity, Efficiency, and Staffing, Department of Veterans Affairs, Veterans Health Administration Central Office, for his support and guidance on research methodology.

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6. Data generated from the database of the Office of Academic Affiliations, Department of Veterans Affairs, as provided by Dr. Barbara Chang, Director of Medical and Dental Graduate Education (March 2008).