

Transformation of dental services from a governmental model to a revenue-generation model of operation in a tertiary care hospital: a health economics assessment

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BACKGROUND: Healthcare in Saudi Arabia is under transformation from a national free health service to a system paid either by insurance or governmental funds. This change will impact the model of operation including dental services.

OBJECTIVES: Estimate the revenue of the Department of Dentistry based on an insurance-based billing system.

DESIGN: Medical record review

SETTING: An academic tertiary care hospital in Riyadh

PATIENT AND METHODS: Data on outpatient visits for the period 2015-2019 was extracted from the electronic health records. The billing data was categorized by specialty and current procedure terminology (CPT) code. The revenue stream for each CPT code was estimated and compared between the actual cost of service for each CPT code billed price, and average price of the market leaders in private practice.

MAIN OUTCOME MEASURE: Revenue generated by the department.

SAMPLE: 339 421 outpatient visits for 22 056 patients.

RESULTS: Female and males made 179 555 (52.9%) and 159 858 (47.1%) outpatient visits, respectively. Outpatient divided by the age groups: ≤14, 15-65, >65 years were 58 868 (17.3%), 251 552 (74.1%), 29 001 (8.5%), respectively. The visits divided by specialty were as follows: general dentistry 28.1%, pedodontics 12.5%, orthodontics 7.1%, endodontics 7.0%, oral and maxillofacial surgery 6.9%, prosthodontics 4.4% and periodontics 3.3%. Outpatient visits to the nursing clinic and hygienist amounted to 30.7%. The median number of visits per patient per year was 5 (range, 1-63), which increased to 6 (range, 1-110) in 2019. The annual revenue plateaued in 2019 at 13 983 538 SAR (3 728 943 USD) with only a 2.2% of increase from 2018. Out of 292 CPT codes, 44.8% were priced below the actual cost. Moreover, 28.4% showed pricing below actual cost, but higher than the price of the market leaders. There was an annual loss of revenue of 10.1% due to incorrect pricing of CPT codes. Average productivity of the dentist and hygienist amounted to 2263 and 760 visits per year, respectively.

CONCLUSIONS: There is a need for improvement in delivery of care, cost-containment, productivity and amendment of charge description master pricing.

LIMITATIONS: The sample did not include data from the period 2020-2022 due to the restriction of dental services due to the COVID-19 epidemic.

CONFLICT OF INTEREST: None.

Healthcare in Saudi Arabia is undergoing a major transformation.¹ King Faisal Specialist Hospital and Research Centre-Riyadh (KFSHRC-R) will transform its model of operation from a governmental hospital that delivers free service to its patients to a model where the service will be paid either by insurance or a governmental fund. It is hoped that this model of care will improve efficiency and productivity. The Department of Dentistry will consequently bill for its services and it is imperative to assess one's readiness for such a transformation in terms of efficiency, timely delivery of care and sustainable revenue streams.² There is no precedent for this model in Saudi Arabia and KFSHRC-R is the first hospital to undergo such a transformation in the model of operation. The aim of this study was to identify how much the Department of Dentistry would generate in terms of revenue under such a model. Included in objectives are whether there might be any losses and to identify which specialties would incur such losses and the reasons behind such losses.

METHODS

Anonymized data with regard to dental practice at KFSHRC-R were extracted from Cerner Millennium by Cerner, R4 Clinical+ v 4.7.0 by Carestream, Venus Billing System and Revenue Cycle Management System by Data Ocean for the period from January 2015 to December 2019. Visits to the emergency department were excluded from the analysis. The department employed on average 41 dentists as full-time employees and 8.6 hygienists on average as full-time employees. Each dental full-time employee is paid an average of 700000 SAR (186667 USD) per year. All visits for dentists and hygienists were included in the analysis. The demographics of the sample collected in terms of gender and age were analyzed. A descriptive analysis was carried out of the type of outpatient appointments and the category of current procedure terminology (CPT) code. Each CPT code had a billed rate as per the KFSHRC-R billing system. The billing rate was compared to a benchmark cost without profit that was provided through previous consulting work handled through a billing consulting company. If a CPT code was being billed at a rate less than the cost rate, then it was considered a CPT code that was incurring a negative margin of loss. If it was billed at a rate equal or higher than the cost rate then it was a CPT code that was incurring a positive margin of profit. Moreover, the billing rate was compared to an average calculated from three market leaders providing comparable services to that provided by KFSHRC-R to show if the billing rate

was higher or lower than the prevailing market price for that CPT code.

Data was collected from 835 individual data entries from 660 different CPT codes. Of these, 474 entries from 352 CPT codes had no volume in the year and thus were excluded from the analysis. In total 361 individual entries from 292 CPT codes were included for analysis. Data was collected detailing revenue for different types of dental work for a one-year period. The aim of the analysis was to detail the revenue for each type of work, and to categorize the amount of revenue in work with different profit levels. Revenue for each type of dental work was collected, with each type of work categorized into CPT codes. Most CPT codes consisted of one type of work only, but some codes had more than one individual type of work associated with them. For the purposes of analysis, one observation per CPT code was included in the analysis. Where there was more than one set of values per CPT code, the total revenue for the code as a whole was calculated. Where the margin and the difference with the benchmark price varied within a CPT code, a single value per CPT was calculated by weighting the results for each type of work by the revenue of the work.

All analyses were descriptive in nature using the Dental Health Record C4, Kodak Dental Systems version 3.1.8 and analysis with IBM SPSS Statistics 29. Categorical variables were summarized by the number and percentage in each category. Continuous variables were summarized by the mean and standard deviation or median and data range. The main outcomes of interest were total revenue, and the percentage of all revenue for each type of work, or groups of work. Each type of work was categorized in three main ways: 1) based on whether the price of work was higher or lower than the 'benchmark' price, 2) whether there was a positive margin (profit) or a negative margin (loss), and 3) the speciality of the work. Summaries of revenue in each of these categories, or combinations of categories were quantified.

RESULTS

During the period of the study from 2015 to 2019, 11214 (50.8%) and 10840 (49.2%) female and male were treated, respectively (**Table 1**). They paid 179554 (52.9%) and 159858 (47.1%) outpatient visits, respectively, with an average 16 visits per female patient and 14.7 visits per male patient. Saudis constituted 89.4% of the patients and 93.7% of the visits. The number of patients treated and number of patients visits increased from 7294 and 51505 to 9722 and 80319 with an average annual increase of 486

(6.7%) and 5763 (11.2%), respectively, with a median number of visits per patient of 5 in 2015 to 6 in 2019, which equates to care delivered by fewer visits per patient since the number of patients increased from 2015 to 2019 (**Table 2**). Patients younger than 14 years of age and seniors older than 65 years comprised only 17.3% and 8.5% of all the visits and 18.6% and 8.95% of all the patients treated during the period 2015-2019, respectively. (**Table 1**).

Distribution of visits showed that dental nursing clinic and hygienist clinic appointments constituted 23.5% and 7.2% of the total visits for the whole period of 2015-2019, respectively. During the same period, general dentistry, pedodontics, orthodontics, endodontics, oral and maxillofacial, prosthodontics, periodontics made up 28.1%, 12.5%, 7.1%, 7.0%, 6.9%, 4.4% and 3.3%, respectively, of the total number of visits (**Table 1**). On average each dentist and hygienist saw 2263 and 760 visits per year.

The most common charge description master (CDM) codes are shown in **Table 3** for each year. Most were for x-rays or oral hygiene instructions. The revenue for all dental specialties for the period of the study was 51 922 240 Saudi Arabian Riyals (SAR) (13 864 597 USD) (**Figure 1**). The revenue for the nursing and hygienist clinics was 7 167 530 SAR (1 911 341 USD). Thus, the total revenue for all the appointments was 59 089 770 SAR (15 757 272 USD). **Figure 2** shows the revenue per year of study.

Approximately 131 (44.9%) CPT codes incurred a negative margin of loss when compared to the benchmark cost of the CPT code while 161 (55.1%) incurred a positive margin compared to the benchmark cost of the CPT code. Eighty CPT codes (27.4%) incurred a positive profit margin and were higher in price than the average of the market leaders. Eighty-one (27.7%) CPT codes incurred a positive profit margin, but were lower in price than the average of the market leaders. On the other hand, 83 (28.4%) CPT codes incurred a negative margin of loss, but were higher in price than the average of the market leaders. Forty-eight (16.4%) CPT codes incurred a negative margin of loss and at the same time were lower in price than the average of the market leaders. **Table 4** shows the distribution of the CPT codes that incurred a negative margin of loss whether higher or lower than the average price of the market leaders among the different specialties. The estimated loss of revenue due to pricing that was lower than the actual cost was estimated at 29 922 900 SAR (7 979 440 USD).

Table 1. Numbers of visits and patients.

Variable	Individual visits	Patients
Total	339 421	22 056
Year ^a		
2015 ^b	51 505 (15.2)	7 294 (17.6)
2016	60 946 (18.0)	8 655 (19.3)
2017	68 032 (20.0)	9 064 (20.2)
2018	78 619 (23.2)	9 565 (21.3)
2019	80 319 (23.7)	9 722 (21.6)
Age group		
≤14	58 868 (17.3)	4 095 (18.6)
15-65	251 355 (74.1)	15 996 (72.5)
>65	29 001 (8.5)	1 965 (8.9)
Gender		
Female	179 554 (52.9)	11 214 (50.8)
Male	159 858 (47.1)	10 840 (49.2)
Nationality		
Saudi Arabia	317 686 (93.7)	19 687 (89.4)
Middle East	7 289 (2.2)	608 (2.8)
Asia	4 827 (1.4)	851 (3.9)
Africa	4 600 (1.4)	459 (2.1)
Europe	1 919 (0.6)	189 (0.9)
North America	2 421 (0.7)	210 (1.0)
Other	247 (0.1)	26 (0.1)
Speciality		
Endodontics	22 032 (7.0)	
General dentistry	88 909 (28.1)	
Hygiene	22 800 (7.2)	
Oral and maxillofacial	21 670 (6.9)	
Orthodontics	22 568 (7.1)	
Pedodontics	39 616 (12.5)	
Periodontics	10 273 (3.3)	
Prosthodontics	13 802 (4.4)	
Nurse	74 172 (23.5)	
Other	402 (0.1)	

Data are n (%). ^aThe same patients may be counted in different years and thus the patient count is not unique for each year. ^bData collection started on 22 January 2015.

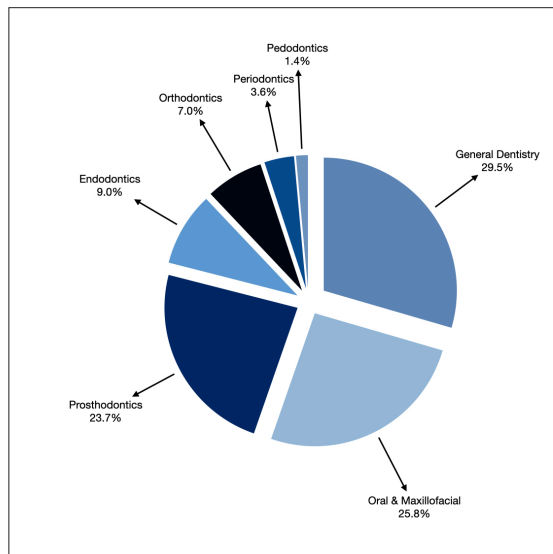


Figure 1. Revenue per dental specialty over the period 2015-2019.

DISCUSSION

There is a debate worldwide about who should cover dental care: the patient alone, the government alone, or by the patient with subsidization from the government.³⁻⁶ This debate is ongoing in Saudi Arabia, which currently has a national health service covered by the government. Other countries have already started to reform.⁷ This research attempted to quantify the cost of care and the expected revenue along with suggestions to improve efficiency of dental services in an academic tertiary care hospital.

During a period of 5 years, each patient paid 11 visits excluding hygienists and nursing appointments. However, the number increased from a median of 5 visits in 2015 to 6 visits in 2019 (**Table 2**). The study could not be extended to encompass the period 2020-2021 due to the reduction in delivery of dental services because of the COVID-19 pandemic. During that period, only emergency and necessary care was provided). The high number of visits probably reflects the nature of patients, many of whom were being treated for tertiary complex conditions like cancer and organ transplantation that required complex medical consultations prior to any dental intervention. But, more importantly, the increasing number of visits (27.7% in number of visits per patient per year), would have also meant a delay in execution of care, which would reduce patient satisfaction in a private model of operation. The average number of patient visits per year per dentist in the US was reported at 3566.4 in 2018 and has remained stable over the period 2015-2018 in a national study of private dental clinics.⁸ The average benchmark in the US fluctuates between 1600 and 2300 patient visits per year per dentist in contracted salary-based practice.⁹ The average number of outpatient visits per year per dentist at KFSHRC-R was 1256 in 2015 and reached 1959 in 2019 which is comparable to the benchmarks for a salary-based practice. This indicates that dentists at KFSHRC-R are performing on par with their colleagues in the US, but are underperforming by 45% in comparison to those performing in a fee-for-service practice. The benchmark from the US for the hygienist should be 7.5-8.5 patients per an 8-hour day.⁴ This amounts to 1600 visits per year.⁹ Hygienists at KFSHRC-R see only 530 per year which means they are underperforming by 67%. As expected, nursing clinic and general dentistry clinic visits comprised 51.6% of the visits. The initial encounter for any patient is

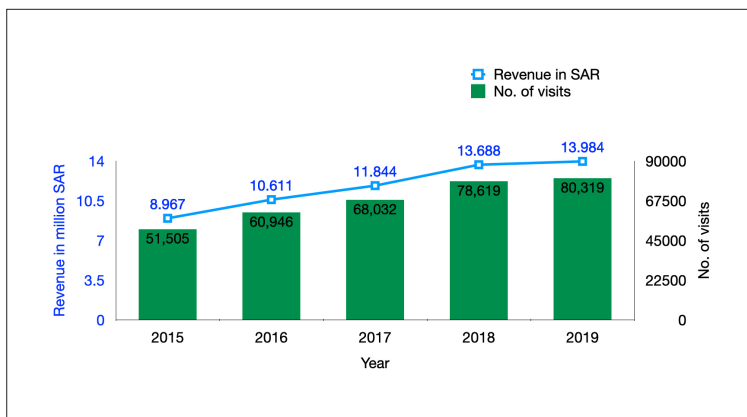


Figure 2. Revenue and number of visits over the period 2015-2019.

Table 2. Number of visits per patient per year.

Year	Number of visits	
	Median (IQR)	Range
All years	12.00 (21.0)	1-196
2015 ^a	5.0 (7.0)	1-63
2016	5.0 (8.0)	1-66
2017	5.0 (8.0)	1-110
2018	6.0 (9.0)	1-101
2019	6.0 (9.0)	1-110

^aData collection started on 22 January 2015.

Table 3. Most commonly occurring charge description master/treatment codes.

Year	Rank	Treatment	Number
2015 ^a	1	Panoramic Film	4338
	2	Oral Hygiene Instructions	3825
	3	Intraoral - Periapical - First Film	3595
	4	Prophylaxis - Adult	3046
	5	Re-Evaluation - Limited Problem Focused	2907
	6	Comprehensive Oral Evaluation	2432
	7	Bitewings - Four Films	2297
	8	Intraoral - Periapical - Each Additional Film	2239
	9	Resin - One Surface Anterior	2169
	10	Resin - Two Surfaces Anterior	2008
2016	1	Panoramic Film	5072
	2	Oral Hygiene Instructions	4358
	3	Intraoral - Periapical - First Film	4108
	4	Prophylaxis - Adult	3840
	5	Re-Evaluation - Limited Problem Focused	3681
	6	Bitewings - Four Films	2954
	7	Resin - One Surface Anterior	2744
	8	Resin - Two Surfaces Anterior	2662
	9	Intraoral - Periapical - Each Additional Film	2490
	10	Comprehensive Oral Evaluation	2453

Table 3 (cont.). Most commonly occurring charge description master/treatment codes.

Year	Rank	Treatment	Number
2017	1	Oral Hygiene Instructions	5337
	2	Panoramic Film	5218
	3	Re-Evaluation - Limited Problem Focused	4587
	4	Intraoral - Periapical - First Film	4237
	5	Prophylaxis - Adult	4224
	6	Intraoral - Periapical - Each Additional Film	3067
	7	Comprehensive Oral Evaluation	2919
	8	Resin - One Surface Anterior	2915
	9	Bitewings - Four Films	2709
	10	Resin - Two Surfaces Anterior	2649
2018	1	Oral Hygiene Instructions	6726
	2	Re-Evaluation - Limited Problem Focused	5929
	3	Panoramic Film	5717
	4	Prophylaxis - Adult	4553
	5	Intraoral - Periapical - First Film	4550
	6	Comprehensive Oral Evaluation	3645
	7	Intraoral - Periapical - Each Additional Film	3608
	8	Resin - One Surface Anterior	2886
	9	Bitewings - Four Films	2843
	10	Extraction Permanent Tooth	2627

Table 3 (cont.). Most commonly occurring charge description master/treatment codes.

Year	Rank	Treatment	Number
2019	1	Oral Hygiene Instructions	7189
	2	Re-Evaluation - Limited Problem Focused	6451
	3	Panoramic Film	5384
	4	Intraoral - Periapical - First Film	4596
	5	Prophylaxis - Adult	4525
	6	Comprehensive Oral Evaluation	3767
	7	Intraoral - Periapical - Each Additional Film	3668
	8	Bitewings - Four Films	3002
	9	Resin - One Surface Anterior	2605
	10	Resin - Two Surfaces Anterior	2188

*Data collection started on 22 January 2015.

usually through these clinics, where any need for more specialized dental care is determined. Pedodontic visits comprised only 17.3% of all visits, which is comparable to a national study from Canada where pedodontic visits reached 18% of all visits.¹⁰

Total revenue for all the clinic appointments was 59 089 770 SAR (15 757 272 USD). There was an average increase in revenue of more than 10% each year, but it dropped to only around 2% in 2019. That drop coincided with a plateau in the number of visits in the same year at 80 319. This indicated a limited capacity to expand in terms of appointments and may be related to issues pertaining to infrastructure like the lack of more dental chairs and probably longer turnaround times between patients. The average salary for a dentist in the department was 700 000 SAR (186 667 USD) per year. The sum of salaries for the same period 2015-2019 was 143 500 000 SAR (38 266 667 USD). The revenue generated was only 36.2% of the salaries paid (51 922 240 SAR; 13 845 931 USD), which means that the dentists were underperforming in relation to salaries paid. Productivity should be increased to reach a sustainable budget in the long run. It was not possible to identify the risks for low productivity in a statistical analysis, but a trend was noticed in the data: the sections with the lowest productivity had a higher portion of dentists who worked in private practice, were within 5 years of the retirement age of 60 years, have been in practice more than 20 years, were administrative leaders or past leaders or were not North American board certified. This indicated a few things: local board training probably led to less experienced dentists who tended to have difficulty in delivering care in a timely fashion. Dentists near retirement or who had been in practice for 20 years or more were probably less motivated to engage in higher output due to their high salaries. Those working in private practice were probably accruing more income than their salaries, and were thus less inclined to increase productivity. Individuals in administrative positions spent more time than required on administrative duties. A solution to the low productivity could be a movement to a fee-for-service model, for dentists in practice for 20 years or

Table 4. Current procedure terminology (CPT) codes that incurred a negative margin of loss distributed by specialty.

Specialty	No. of CPT with negative margin of loss	
	Lower than average price of market leaders	Higher than average price of market leaders
General dentistry	14	1
Endodontics	11	0
Orthodontics	10	1
Periodontics	10	0
Pediatrics	1	0
Prosthodontics	1	47
Oral and maxillofacial	0	33

more or near retirement. A downside of a fee-for-service model is the possibility of providing unwarranted care and overbilling, a practice that should be monitored and discouraged.¹¹

The pricing of the CPT codes showed that 131 codes (44.9%) were incurring a negative margin of loss compared to the calculated cost of the CPT code. In fact out of these 48 CPT codes (16.4%) were priced even lower than the average of the market leaders. This indicated two things. First, the CPT codes at KFSHRC-R must be re-priced as the current prices will create a huge loss for the hospital when it moves into a private sector type of billing for services. Second, 83 CPT codes (28.4%) were incurring a negative margin of loss, but were higher than the average price of the market leaders, indicating a huge gap for improvement in terms of cost efficiency with regard to these CPT codes. The hospital must revisit the practice of the dentists to see if there was wastage in terms of materials used in the treatment plan or overutilization of laboratory tests and x-rays. Incorrect use of CPT codes does not explain the negative margin of loss as this analysis compared the registered billing price of the CPT code and the actual cost of that code and the average price of the market leaders regardless of what was actually delivered to the patient. Therefore, additional training about CPT codes would probably not resolve this problem but may still be useful. The three specialties that really needed to revise the prices of their CPT codes were general

dentistry, endodontics and orthodontics. The two specialties that needed to look into their practice and improve efficiency and show more cost containment were prosthodontics and oral and maxillofacial surgery. This cost-containment can be approached through a reduction in total number of visits to deliver the care and also by a more judicious use of supplies. The loss of revenue due to the use of a billing price lower than the actual cost was estimated at 13315970 SAR (3550925 USD), which amounted to an annual loss of revenue of 10.1%. A market concentrated with dental providers will likely lead to less reimbursement in the insurance market as evidenced from a national study from US.¹² Saudi Arabia is in a similar situation and this will compound the loss for revenue for KFSHRC-R.

In conclusion, the analysis identified some delay in delivery of treatment, which might be expected due to treating complex tertiary conditions. Moreover, there was limited capacity to expand and meet the demand as shown by the plateau in the number of appointments. The productivity was low as might be expected, from a salaried model of practice, which could be improved by switching to a fee-for-service model. There was underproductivity among the hygienists. Furthermore, certain specialties must revisit their practice and improve cost-containment through a reduction in number of visits and judicious use of supplies. Last, the CDM price list needs revision to cover the cost of the services delivered.

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