Dental Therapists in General Dental Practices: An Economic Evaluation

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Abstract: Dental access disparities are well documented and have been recognized as a national problem. Their major cause is the lack of reasonable Medicaid reimbursement rates for the underserved. Specifically, Medicaid reimbursement rates for children average 40 percent below market rates. In addition, most state Medicaid programs do not cover adults. To address these issues, advocates of better oral health for the underserved are considering support for a new allied provider—a dental therapist—capable of providing services at a lower cost per service and in low-income and rural areas. Using a standard economic analysis, this study estimated the potential cost, price, utilization, and dentist's income effects of dental therapists employed in general dental practices. The analysis is based on national general dental practice data and the broadest scope of responsibility for dental therapists that their advocates have advanced, including the ability to provide restorations and extractions to adults and children, training for three years, and minimum supervision. Assuming dental therapists provide restorative, extraction, and pulpal services to patients of all ages and dental hygienists continue to deliver all hygiene services, the mean reduction in a general practice costs ranges between 1.57 and 2.36 percent. For dental therapists treating children only, the range is 0.31 to 0.47 percent. The effects on price and utilization are even smaller. In addition, the effects on most dentists' gross income, hours of work, and net income are negative. The estimated economic impact of dental therapists in the United States on private dental practice is very limited; therefore, the demand for dental therapists by private practices also would probably be very limited.

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Dental access disparities are well documented and have been recognized as a national problem.[1] The major cause of access disparities is the lack of reasonable Medicaid reimbursement rates for the underserved. Specifically, Medicaid reimbursement rates for children are 30 to 70 percent below market rates, with an average of 40 percent below across the United States.[2] In addition, most state Medicaid programs do not cover adults. Another reason cited for access disparities is a lack of adequate supply of dental services in low-income and rural areas.

Although only 30 percent of Medicaid-enrolled children visit a dentist annually, about 70 percent of Medicaid children receiving care do so in private practices.[3] This is because Federally Qualified Health Centers (FQHCs) and other safety net clinics have limited capacity (an estimated 8 to 9 million patients annually).[4] In contrast, there are about 140,000 general and pediatric practitioners, and some 20 to 30 percent of them accept some Medicaid patients.[2,5] Within the framework of the next ten or more years, any solution intended to provide dental access to a large proportion of the underutilizing, disadvantaged population must engage the private practice system. To address these issues, advocates of better oral health for the underserved are considering support for a new allied provider—referred to as a mid-level dental provider or a dental therapist—capable of providing services at a lower cost per service and in low-income and rural areas.[6]

With this background, three questions arise: What type of dental services could be provided by dental therapists that would address the oral health needs of the underserved and under what organizational delivery structure and level of supervision? What kind and extent of training would be required for dental therapists to provide these services? Could dental therapists increase productivity and efficiency in a general dental practice?

Some dental policymakers suggest that there is plenty of room for an individual who has received

less training than a dentist to contribute to the reduction of access disparities. Once one gets into the economic details, substantial limitations regarding the impact of this claim are encountered. Aside from the details regarding the major characteristics of dental therapists, one should examine carefully the details of the major characteristics of general dental practices.

The overall goal of this study was to evaluate the potential economic effects of employing dental therapists in general practices. Substituting lower paid dental therapists for higher paid dentists should lower the unit cost of delivering dental services to patients of all ages, including children. With lower unit costs, dental practices would be offering more dental services to their patients, including Medicaid patients. To examine these issues, the analyses focus on the impact of dental therapists employed in general practices on dental service costs, prices, utilization, and dentists' incomes. For this analysis, the characteristics of dental therapists are important, and we have adopted the most favorable dental therapist characteristics their advocates have advanced. These include ability to provide a broad scope of dental services, training for three years, and minimum supervision.[6]

Methods

Economic Model

In a market-oriented economy, the demand for and supply of dental services determine the equilibrium price and quantity that prevail in the market. Figure 1 shows these conditions: the demand (D) for and the supply (S) of dental services, as well as the equilibrium price per unit of service (P_0) and the quantity demanded and supplied (Q_0). One special characteristic of dental markets is the presence of dental insurance. This feature affects the demand for dental care and makes it less price-elastic at any price level. For example, Figure 2 shows the price elasticity declining at a given price, say P_0, as insurance coverage increases from 0 percent (D_0) to 50 percent (D_{50}) to 100 percent (D_{100}).

How will these market conditions be affected with the introduction of dental therapists? As shown in Figure 3, the introduction of dental therapists affects the supply of and not the demand for dental services. For general practitioners to supply more services, the cost per unit of existing care to consum-

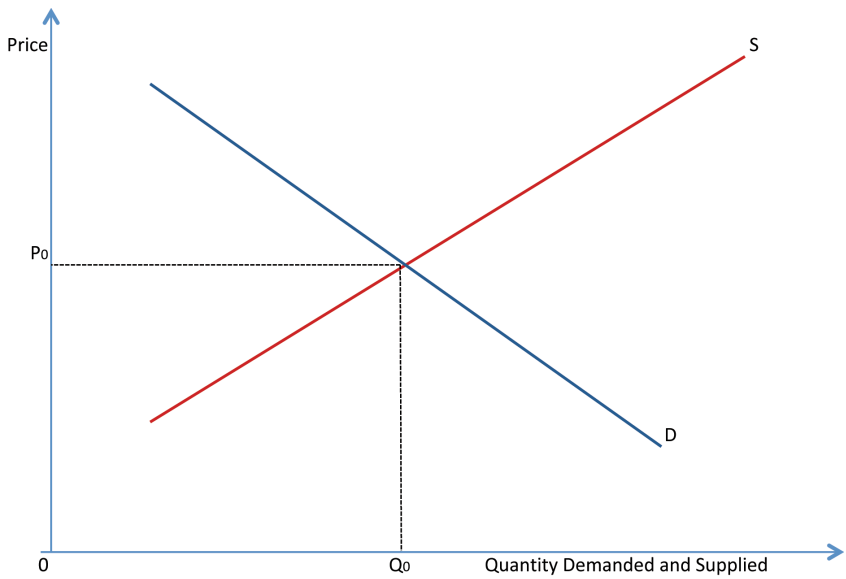

Figure 1. Demand (D) for and supply (S) of dental services

Note: P_0 indicates equilibrium price per unit of service; Q_0 indicates quantity demanded and supplied.

ers must be reduced. Consequently, the employment of dental therapists in general practices is contingent on lowering the cost of dental care—that is, shifting the supply function (S) to the right (S_1), other things being equal. Note that the movement along the demand curve (e.g., from point A to point B in Figure 3) represents a change in the *quantity demanded* and not a change (or shift) in *demand*.

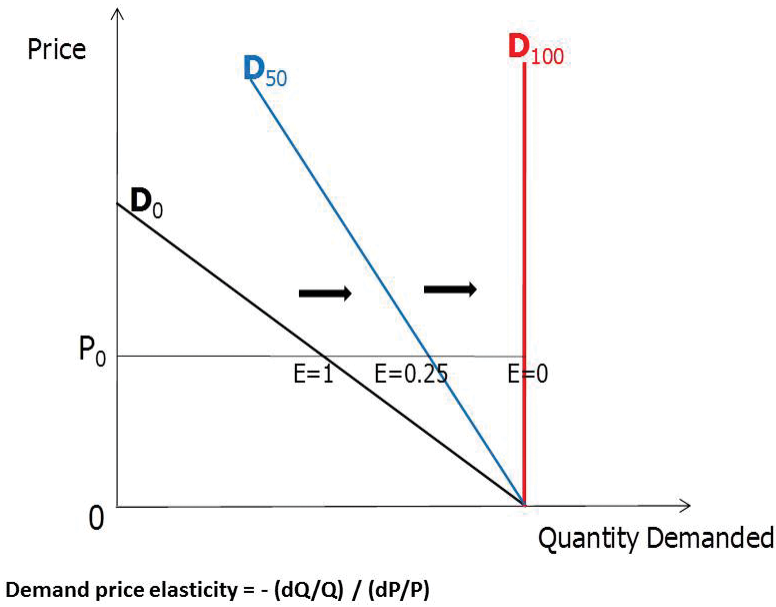

Figure 2. Demand (D) for dental services with 0 percent, 50 percent, and 100 percent insurance coverage

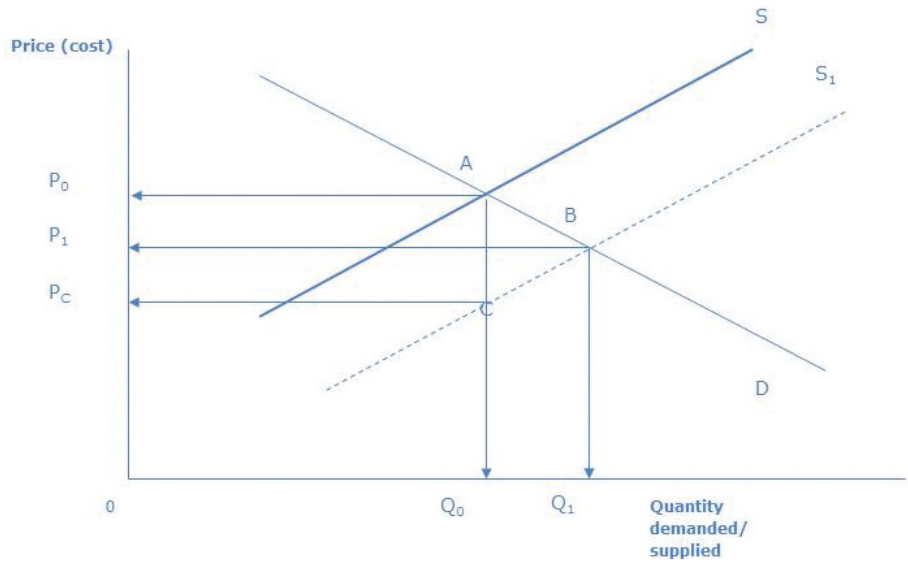

Figure 3. Demand (D) for and supply (S) of dental services—a shift of the supply from S to S1 with introduction of dental therapists

More generally, a change in the quantity of dental services demanded results when fees for dental services increase or decrease due to a change in the supply of dental services. The change in supply could be due to a number of factors, like an increase in the number of dentists or more efficient production of services by the same number of dentists. The thought behind dental therapists is that they would make the production of dental services more efficient; that is, the same number of dentists could provide more services in the same amount of time. The factors that produce the change in the quantity demanded are associated entirely with the supply of services.

The magnitude of the shift in supply represents the potential cost reduction of a subset of services now produced by dental therapists instead of dentists. As the intersection of the demand and supply functions shifts from point A to point B in Figure 3, the new market price per unit of dental services decreases from P_0 to P_1 and the quantity demanded and supplied increases from Q_0 to Q_1. Note that the cost reduction at the original quantity demanded/supplied, Q_0, is from P_0 to P_c or the distance from point A to point C in Figure 3. But the new equilibrium occurs at price P_1—which is higher than P_c—and quantity demanded/supplied of Q_1. Thus, the consumers may get only part (P_0 to P_1) of the total reduction (P_0 to P_c).

In general, how much the price decreases and dental utilization increases depends on the cost reduction per unit of service (i.e., magnitude of shift of the supply curve) and the shape (i.e., price elasticity) of the demand and supply curves. The price elasticity of demand (supply) is defined as the percentage change in quantity demanded (supplied) divided by the percentage change in price $[(Q_1-Q_0)/Q_0]/[P_1-P_0)/P_0]$.

Model Specification

The level of training, scope of services, degree of supervision, and wages of dental therapists are the dimensions that will determine the changes in the cost of dental care. These dimensions are interdependent and related to the productivity and efficiency of dental practices employing dental therapists. In general, there is a positive relationship among the level of training (formal education or on-the-job), years of experience, and earnings. This relationship was formalized several years ago by economist Jacob Mincer. It is based on solid economic theory and "fits the data remarkably well in most contexts."[7] That is why, on average, persons who have extensive education earn more than those persons with more limited formal training. Also, dentists in their forties or fifties have higher incomes than dentists just out of dental school.

General dentists are trained for more years than dental therapists will be; dental therapists will be trained for more years than dental hygienists; and dental hygienists are trained for more years than dental assistants. As a result, the wage rate of a dentist (W_D) is expected to exceed that of a dental therapist (W_{DT}) and so on. In other words, the following condition is expected to prevail: $W_D > W_{DT} > W_H > W_{DA}$.

For a general dental practice to perform efficiently, each and all its resources (inputs) must be employed efficiently. This requires that the incremental value generated by an input be equal to its remuneration (wage rate). Consider a dental service (e.g., an X-ray) that takes the same amount of time to be performed by dentists, dental therapists, hygienists, or assistants. Efficient use of resources in a dental practice requires that the input employed for this service is the least costly. Specifically, dental assistants should take X-rays rather than dentists, dental therapists, or hygienists. Similarly, economic efficiency requires that dental hygienists rather than dental therapists or dentists provide prophylaxes. Therefore, employing a new allied provider to produce what dental assistants (e.g., x-rays) or hygienists (e.g., prophylaxes) are producing currently would increase the cost of existing services rather than reduce it. In other words, it would be economically irrational and inefficient to employ dental therapists to perform dental procedures currently performed by lesser trained allied dental personnel. As a result, dental procedures in a dental therapist's scope of services, currently performed by dental assistants or dental hygienists, are excluded from the analysis that follows.

However, there is a subset of dental services currently produced by dentists that dental therapists could produce. These are listed in Table 1. To estimate the resulting cost reductions of these services being performed by dental therapists (instead of the dentists), one would have to a) estimate the dentist's share in the cost of those services and b) apply to that portion the wage differential between dentists and dental therapists.

Equation 1 shows the potential cost reduction of employing a dental therapist, and equation 2 shows the percent cost reduction in total gross billings of a general dental practice:

(1) Potential Cost Reduction =
$X * s * (W_D - W_{DT})/W_D$.

(2) Percent Cost Reduction = $(X / Y) * s * (W_D - W_{DT})/W_D$.

In these equations, X is the market value of a subset of dental services currently produced by dentists that could be produced by allied providers; s is the dentist's share in the cost of these services; W_D is the wage rate of the dentist; W_{DT} is the wage rate of the dental therapist; and Y is the gross billings (market value) of dental services produced by a general dental practice.

Data Sources, Definitions, and Measures

The X/Y ratio (equation 2) was calculated using data from the American Dental Association (ADA) 2005–06 Survey of Dental Services Rendered and 2009 Survey of Dental Fees.[8,9] These surveys provide national estimates of the frequency and average fees for specific dental services provided by general practitioners. To estimate the range of the X/Y ratio, data were available from eighty general dental practices located in Colorado.[10] From previous studies, the dentist's share in dental services cost (s) is between 20 percent and 30 percent, depending on the configuration of a dental practice.[10,11] These estimates measure the contribution of a dentist as a producer of dental procedures; they do not include a dentist's contribution as an entrepreneur-investor-manager in a general dental practice. The initial value of a general dentist's wage rate (W_D) was set at $80. This is a higher value than the salary reported for employed dentists.[12] Finally, for dental therapists' wage rate (W_{DT}) the wage rate of a dental hygienist was used ($40) as an initial conservative value. Data on the characteristics of independent and solo general practitioners were obtained from surveys conducted by the ADA.[12]

Assumptions

It is important to note that several assumptions and caveats are associated with our analyses and estimates:

- First, we have assumed that a dental therapist can be seamlessly integrated into a general practice with no training costs and will be delegated to provide a specific set of services (Table 1).
- Second, we have assumed that dental therapists would be perfect substitutes for general dentists whose formal training is several years longer.
- Third, we have assumed that dentists are willing to delegate a broad scope of services and reduce their own chair-side hours of work.
- Fourth, we have assumed that the estimated cost reductions do not include costs associated with the dentist's supervision of dental therapists.
- Fifth, we have assumed that dental therapists would not be performing any of the tasks or procedures currently performed by dental assistants and dental hygienists.
- Sixth, we have assumed that the employed part-time new dental therapist will not create issues associated with patient scheduling and inefficiencies in the production of dental services.

Table 1. Procedures dental therapists could perform in all general dental practices and on patients of all ages

Procedure Code	Dental Procedure	% Number	% Value
2140	Amalgam, one-surface	0.96%	1.25%
2150	Amalgam, two-surfaces	1.30%	2.13%
2330	Composite, one-surface anterior	1.15%	1.78%
2331	Composite, two-surface anterior	0.89%	1.70%
2391	Composite, one-surface posterior	1.94%	3.29%
2392	Composite, two-surface posterior	1.65%	3.61%
2930	Stainless steel crown, primary	0.16%	0.13%
3110 & 3120	Pulp cap, direct and indirect	0.10%	0.08%
3220	Pulpotomy	0.15%	0.27%
7140	Extraction, elevation/forceps removal	1.53%	2.37%
Sum of above subset of dental procedures		9.83%	16.61%
All procedures in general dental practices		100.00%	100.00%

Sources: American Dental Association, Survey Center. 2005-06 survey of dental services rendered. Chicago: American Dental Association, 2007; and American Dental Association. 2009 survey of dental fees. Chicago: American Dental Association, 2009.

- Finally, we have assumed that states would allow new allied providers with three years of training to perform a wide range of irreversible dental procedures to patients of all ages.

These implicit assumptions are intended to provide an upper boundary estimate of the impact of dental therapists on general dental practice finances.

Results

Characteristics of General Dental Practices

As of 2008, there were 174,204 active private practitioners in the United States; of those, 134,492 were general practitioners, 5,114 were pediatric dentists, and 34,598 were in other specialties.[5] During the same year, dental hygienists and dental assistants held 174,100 and 295,300 jobs, respectively; 96 percent and 93 percent, respectively, of those were in offices of dentists.[13] In addition, according to our estimates based on the ADA 2005–06 Survey of Dental Services Rendered,[8] these existing allied health personnel are capable of producing over 70 percent of the services in general and dental pediatric practices.

Table 2 shows the percentage of independent general dentists in one-dentist, two-dentist, and three-or-more-dentist primary private practices. Among independent general practitioners, the majority (84.8 percent) were in one-dentist practices.[12] Selected characteristics of independent (i.e., owner) and solo general practitioners are shown in Table 3.[12,14] In 2008, the mean net income of independent general practitioners was $207,210. Among solo general practitioners, the mean net income was $194,320. The mean number of operatories was similar among independent and solo general practitioners: 4.0 and 3.7, respectively. The mean number of dental hygienists was the same for both groups at 1.4.

Cost Reduction

Table 1 shows a list of dental procedures that dental therapists could carry out. Overall, these procedures constitute 9.83 percent of all services and 16.61 percent of the value provided to patients of all ages. In general dental practices, children account for less than 20 percent of all patients.[15] Preventive and diagnostic services are not included in this subset because they could be produced more efficiently by dental hygienists or dental assistants. Using data from eighty Colorado general dental practices, the X/Y ratio ranged from 5.3 percent to 37.4 percent with a mean of 15.7 percent. Using the national estimates of gross billings per owner for independent general practitioners (Table 3), these percentages imply that the value of X may vary between $37,613 and $265,417 with a mean of $111,419.

Table 2. Percent distribution of dentists in the primary private practice of independent dentists, 2008

Number of Dentists	General Practitioners	Specialists	All Independent
One	84.8%	80.4%	84.1%
Two	11.3%	13.2%	11.6%
Three or more	3.9%	6.4%	4.3%

Source: American Dental Association, Survey Center. 2009 survey of dental practice. Chicago: American Dental Association, 2010.

Table 3. Selected characteristics of independent (i.e., owner) and solo general practitioners, 2008

	Independent General Practitioners	Solo General Practitioners
Mean net income	$207,210	$194,320
Mean practice gross billings	$862,750	$633,380
Mean practice gross billings per owner	$709,670	N/A
Mean number of annual hours in the dental office	1,693.8	1,703.9
Mean number of operatories	4.0	3.7
Mean number of dental hygienists	1.4	1.4
Mean number of dental assistants	1.5	1.6

Source: American Dental Association, Survey Center. 2009 survey of dental practice. Chicago: American Dental Association, 2010.

Table 4 presents the percent cost reduction when the ratio X/Y takes the minimum, maximum, and mean values; the dentist and dental therapist wage differential [$(W_D - W_{DT})/W_D$] is 50 percent; and the dentist's shares in the cost of services are 20 percent, 25 percent, and 30 percent. The upper boundary cost reduction in a general dental practice ranged between 0.53 percent and 5.61 percent; the cost reduction per dentist in dollars ranged between $3,761 and $39,812 with a mean $13,910. It should be noted that these estimates refer to patients of all ages. The estimated cost reduction for services provided only to children ranged between 0.11 percent and 1.11 percent, while the absolute value ranged between $752.20 and $7,962.40 with a mean of $2,782.

Impact on Prices

The estimated cost reductions presented above are based on the current level of dental care (Q_0 in Figure 3). These cost reductions may become price reductions if and only if the supply of dental care is perfectly elastic. Perfectly elastic supply curves are show in Figure 4 as S and S_1. These curves are horizontal (not sloped), which means that the supply of dental services would and could expand to any capacity to accommodate a change (shift) in demand. Thus, a small change in dental fees due to increased demand would stimulate enough change in the supply of dental services to keep fees at their original level. This is not a realistic supply response for short time periods. It may happen over a long period of time in a sector of the economy in which individuals can enter

Table 4. Potential percent cost reduction in general dental practices

	If dentist share in cost of services is:		
	20%	25%	30%
Value of ratio X/Y is at:	Percent Cost Reduction		
Minimum (5.3%)	0.53%	0.66%	0.80%
Maximum (37.4%)	3.74%	4.68%	5.61%
Mean (15.7%)	1.57%	1.96%	2.36%

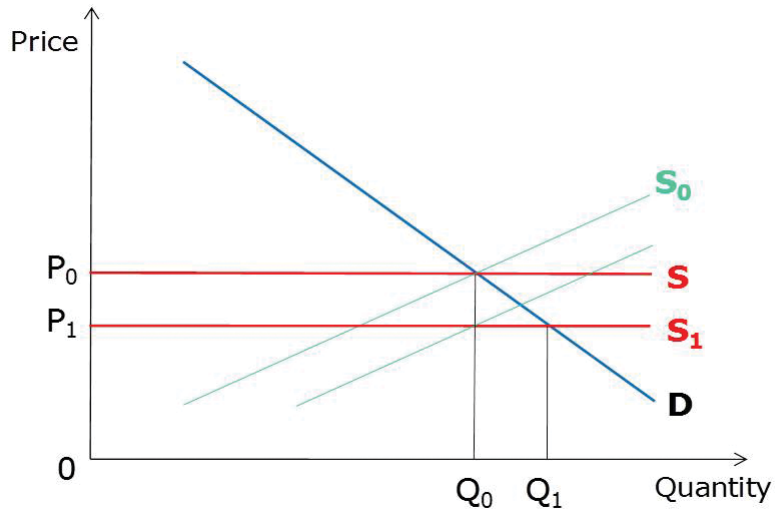

Figure 4. Effects of supply (S) on price and utilization

the supply side of the market without any limitations on entry, but this is definitely not a realistic assumption for the dental sector.

Specifically, if dental therapists were to produce 15.7 percent of the gross billings of general practices and the dentist's share of the cost is 25 percent, then the percent cost reduction would be 1.96 percent (Table 4) and the percent price reduction would also be 1.96 percent. This value, 1.96 percent, should be considered as the upper bound (largest possible) price reduction. The most plausible scenario is that, at the new equilibrium Q_1 (Figure 3), the potential cost and price reductions would be even lower, say 1.5 percent. In absolute terms, if an average bundle of dental services purchased by an individual consumer was \$500 (P_0), the new price (P_1) would be \$492.50. Moreover, the new equilibrium Q_1 could take a long time to reach. Again, the above estimates refer to patients of all ages. If dental therapists were restricted to providing dental services only to children, this estimated reduction in prices would be less than 0.3 percent.

Impact on Utilization and Gross Billings of General Practices

The effect of introducing dental therapists in general practices on utilization depends on the percent change in cost reduction, the price elasticity of the demand (E_D), and the price elasticity of the supply (E_S). The price elasticity of demand for dental services has been estimated to be less than 0.5.[16] There are no available estimates of the price elasticity of supply.

As mentioned above, the greatest increase in utilization occurs when the supply is perfectly elastic, which we have already stated is not realistic. In this case, the cost reduction is equal to the price reduction. As a result, the percent increase in utilization would be equal to the percent change in price (cost) times the price elasticity of demand for dental services (0.5). For example, a 10 percent reduction in price (cost) would generate a 5 percent increase in utilization. With an estimated average reduction in costs of 1.96 percent, the expected increase in utilization would be about 1 percent. However, if the supply price elasticity is not perfect—i.e., the supply curve is not horizontal—utilization would increase by less than 1 percent.

If the price of dental care decreased by 1.5 percent and utilization increased by, say, 0.7 percent, total dental expenditures would decline [$(P_0 * Q_0) > (P_1 * Q_1)$]. Dividing total dental expenditures by the number of practices would yield gross billings per practice. Thus, if the number of practices remains constant, the gross billings for independent general practices would decline from \$709,670 to \$703,918, or by 0.8 percent. This means a reduction in gross billings. The impact of dental therapists on children's dental utilization would be about 0.15 (=0.3 times 0.5) percent.

Dentists' and Dental Therapists' Hours of Work

In solo dental practices, a dentist's chair-side hours of work would be divided between the dentist and dental therapist. At the current level of output (Q_0), assuming perfect substitutability, the dentist's hours would be reduced by exactly the same number of hours the dental therapist is employed. At the new equilibrium output of Q_1, the sum of the dentist's and the dental therapist's hours worked would increase (by less than 1 percent) but not sufficiently to keep the dentist fully employed. As a result, both the dentist and dental therapist would be partially employed. Specifically, if the price were to decline by 1.5 percent, at the new equilibrium, output (Q_1) would increase by 0.7 percent. This implies that the sum of the dentist's and dental therapist's hours of work would increase by about the same amount. In 2008, solo general practitioners worked an average of 1,704 hours.[7] An increase of 0.7 percent in average hours worked would yield 1,716 hours. Based on the mean X/Y value (15.7 percent) to allocate the total hours, the dentist works 1,447 hours and the dental therapist 269 hours.

Effects on Dentist Income

The net income of solo general practice would decline by about the same percentage as gross income—that is, by 0.8 percent. As a result, at the new price P_1 and utilization Q_1 the net income of solo general practices would be \$192,745. This reflects the 1.5 percent decline in price and 0.7 percent increase in utilization. However, the \$192,745 net income of the solo general practice has to be divided between the dentist and the part-time dental therapist. For example, at an hourly rate of \$40, the annual income of a dental therapist employed for 269 hours is \$10,760. As a result, the annual net income of a solo general practitioner would decrease by 6.4 percent to \$181,895 (\$192,745 minus \$10,760). This decline in net income of dentists would be entirely

due to reduced busyness or fewer hours worked. The hourly wage rate of the solo dentist would actually increase from $114 (=$194,320/1704) to $126 (=$181,895/1447). The employment of dental therapists would be part-time, and as noted they would be making only a small income, less than $11,000.

Effects on Non-Solo Dentists

The direction of these results would be the same even in non-solo dental practices as long as the dentists are partners or co-owners. However, there is a subset of non-solo dental practices with employed dentists (i.e., dentists on a salary, commission, percentage, or associate basis).[2] Employed dentists are 11.1 percent of all dentists in private practice. For practices with employee/non-owner dentists, the impact of introducing dental therapists would be different in one respect: the net income of the owners of non-solo practices with employed dentists could increase. Specifically, the owner dentist could substitute some of an employed dentist's hours with that of a dental therapist's hours. As a result, the supply of dental services in non-solo practices would increase.

Discussion

The framework of this evaluation is based on very good data regarding private dental practices and hypothetical data regarding dental therapists. The assumed dental therapist dimensions are generous in terms of training and employment outcomes. Specifically, the dentist's wage rate and share in the cost of dental services were assumed to be higher than actual rates. At the same time, the training and wage rate of dental therapists were set at conservative levels. In addition, there were no costs assigned for supervising dental therapists. These costs could be substantial, especially if direct or indirect dentist supervision is required by state laws. Furthermore, it was assumed all general dental practices that could benefit by dental therapists would employ them. Finally, dental therapists were assumed to provide their services to patients of all ages. Even with these advantages, the estimated gains in efficiency are small. Indeed, the economic impact on most general dental practices was negative. The analyses showed that dental therapists may provide a financial advantage only in general practices with employed dentists and practices in which owner dentists want to cut down their chair-side hours of work. Medicaid reimbursement rates are 30 to 70 percent below market fees across most states, and coverage for poor adults is meager. Consequently, the estimated small reduction in price and increased utilization of dental services are not very promising to these populations, especially children.

It is noteworthy that our study's findings agree with two reports from the United Kingdom (UK).[17,18] That is, private general practitioners there have difficulty covering the overhead of dental therapists and mainly employ them part-time. Evidently, in the UK private dental care system, dental therapists do not generate surplus practice income, and they cannot be kept busy full-time. This study and the international literature conflict with a theoretical investigation of the financial impact of a dually qualified dental hygienist-dental therapist in U.S. private general practices.[6] Its investigators claimed a 50 percent increase in net practice income.

The likelihood that dental therapists will be employed in large numbers in private practices in the United States seems to be small. The basic problem of dental therapists in the United States is that their training and potential services overlap significantly with two other allied health professionals: dental assistants and dental hygienists. The latter professionals are established, are numerous, and produce most of the services dental therapists are intended to produce at a lower cost. Based on our estimates (269 hours per FTE general dentist), the upper bound estimate for dental therapists engaged in private general practices is 1,931 (11.1 percent times 134,492 times 269/2080). If dental therapists are restricted to treating only children, the upper bound estimate for FTE dental therapists employed in general practices is 386.

Conclusions

Improvements in efficiency of the dental delivery system are always desirable regardless of their magnitude. Some believe that the introduction of dental therapists in the U.S. dental care delivery system would be a game changer to address access disparities. The economic analysis presented in this article suggests that the potential impact of dental therapists in private general practices would be negligible. Indeed, it found that dental therapists would have a negative impact on most dentists' hours of work, gross income, and net income.

The U.S. dental care delivery system has evolved over time toward the use of more equipment, dental assistants, and dental hygienists compared

to most other countries in the world. Today in the United States, a *dentist* is not synonymous with a *dental practice:* rather, a dental practice consists of a dental team. A dental therapist may be the answer in some isolated areas where a full-time dental practice cannot be fully utilized. In addition, dental therapists may be employed (as a less expensive input for a subset of dental procedures, part-time or full-time) by dentists who want to reduce their work hours or dental practices that employ associate dentists.

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