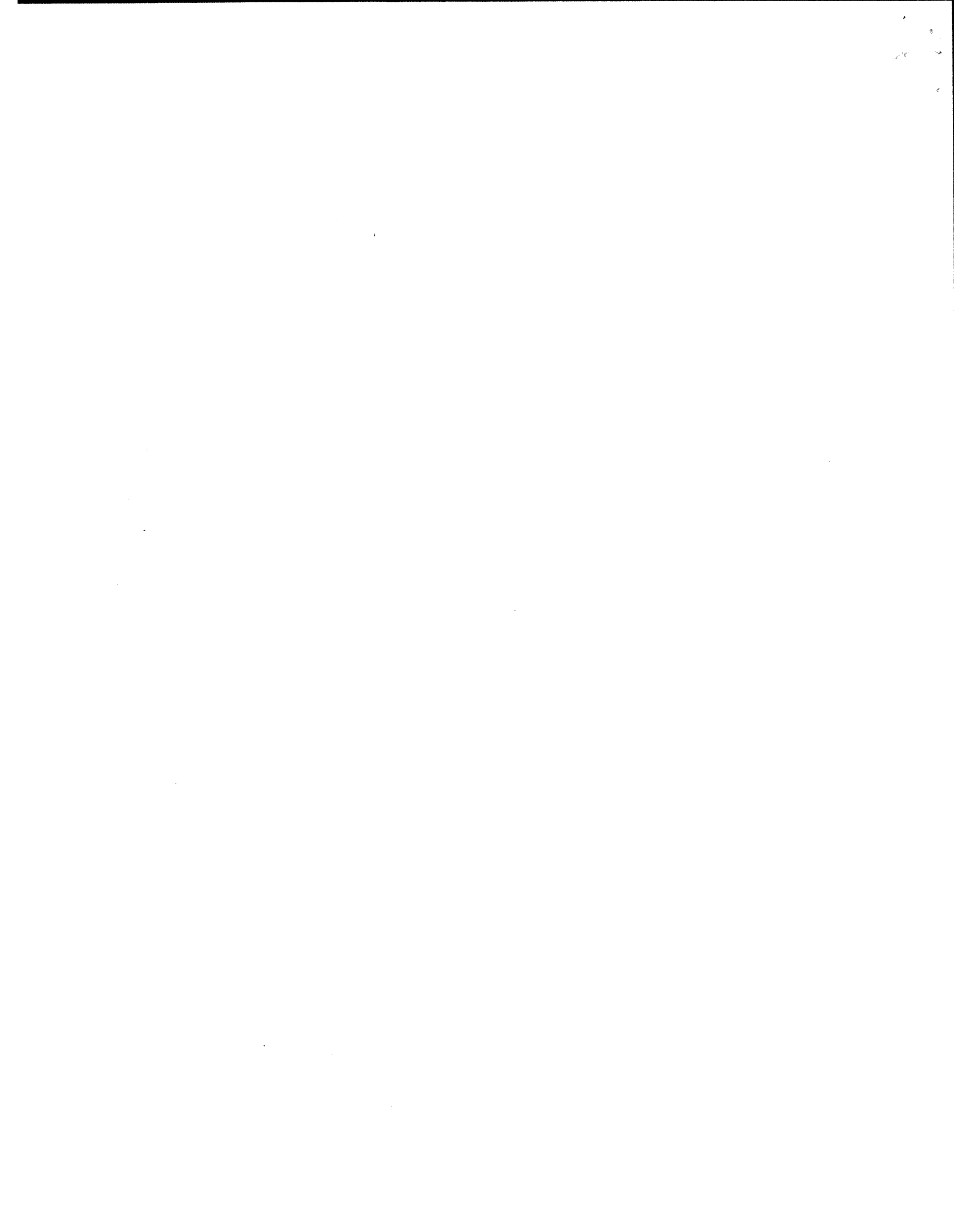


**A QUALITY EVALUATION OF SPECIFIC DENTAL SERVICES
PROVIDED BY CANADIAN DENTAL THERAPISTS**

Gordon Trueblood, M.P.H., Ph.D.

Specialist, Health Education and
Human Resources Development
Medical Services Branch
Epidemiology and Community Health Specialties
Health and Welfare Canada
Room 1195, Jeanne Mance Building
Tunney's Pasture
Ottawa, Ontario
Canada K1A 0L3



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Introduction

Down through the years vast differences have existed in the health of the Indian and Inuit population of Canada and that of the general Canadian population. Cultural patterns, changing and changed dietary patterns, and changing lifestyles create direct threats to dental health in aboriginal communities. Although a reduction in the prevalence of dental caries appears to be occurring throughout the industrialized world, a recent report on the oral health status of Canada's aboriginal children found that the secular decline in dental caries is not extending into aboriginal communities in Canada¹.

The majority of aboriginal Canadians live in rural, remote, and isolated communities cut off from a continuing and organized supply of care and services. Although efforts were consistently made in the past by the Department of National Health and Welfare to recruit Canadian dentists to provide dental care to this segment of the population, very little response was received as service demands in urban areas were more than sufficient to maintain heavy practice loads for dental practitioners. When dentists could be available, it would only be for a short time for emergency treatment only, consisting mostly of extractions.

The chronic disparity between rising dental health care needs in aboriginal communities and the limited resources available for coping with them spurred the development of a new type of dental health personnel to address the dental care needs of this population. In September, 1972, the dental therapy program in Canada was established when Medical Services Branch of the Department of National Health and Welfare opened a school of dental therapy. Dental therapists are persons usually with high school education or more, trained over a two-year period to a defined level of competency in the techniques of basic restorative and preventive dentistry. Upon successful completion of the formal training program, dental therapists are qualified to deliver local anaesthetics, prepare cavities, place restorative materials, and extract primary and permanent teeth. They also carry out scaling, cleaning and polishing of teeth, place pins and crowns, apply topical fluorides and fissure sealants and provide dental health education at the chairside, in the schools, and in the community.

Diagnosis and treatment planning are not included in the scope of duties of dental therapists. Although they often work under indirect supervision of a dentist, they do not initiate except on treatment plans provided to them by a dentist, and in cases of emergency.

The purpose of this study is twofold: to observe how the quality of care provided by dental therapists compare with the level and quality of care provided by dental practitioners in achieving the same service objectives, and to identify what effect the dental therapy program is having on the dental health status of communities.

Methods and Data

The data for this study was obtained from an earlier study by Drs. P. Ralph Crawford and Bradley W. Holmes. In 1989 Drs. Crawford and Holmes, both past presidents of the Canadian Dental Association, were contracted by Medical Services Branch of Health and Welfare Canada, to assess the technical perfection of dental restorations placed by dental therapists and dentists. The two researchers evaluated restorations placed by dental therapists and dentists within the preceding 18 months in five communities on Baffin Island, Northwest Territories. The researchers employed a rating guide developed by Ryge and Snyder for post-treatment evaluation of clinical services². All restorations were rated as "superior", "satisfactory", or "failed".

The final report (Table I) submitted by the researchers was in the form of frequency counts and percentages. One limitation of the study was the failure to make maximum use of the data collected. The application of additional statistical techniques serve to more accurately communicate the nature of the findings and how seriously to regard the apparent differences found between dental therapists and dentists.

The effectiveness of dental therapy interventions on community dental health status was assessed using two indices: the ratio of restorations to extractions and the ratio of restorations to preventive work. The two ratios are highly sensitive to the resolve of dental therapists to render comprehensive care³ and have been shown to correlate excellently with the quality of services provided to patients and communities^{4,5}.

Results and Discussion

Quality of clinical services

Table I summarizes the findings of Crawford and Holmes. Theoretically, one should not expect a difference in the frequency of ratings assigned to dentists and those assigned to dental therapists. To measure the discrepancy between observed and expected frequencies, a chi-square test of independence was computed.

A 2 x 3 independent samples chi-square analysis of Table I revealed $\chi^2 = 199.24$, $p < 0.0001$, $df = 2$. The sample χ^2 clearly falls beyond the critical value. It is concluded that the quality of dental restorations is dependent upon the provider.

A similar chi-square analysis was carried out by collapsing the "superior" and "satisfactory" categories of quality for both providers into one category labelled "acceptable" to form two variables: "acceptable" and "failed". A 2 x 2 independent samples chi-square analysis revealed $\chi^2 = 47.31$, $p < 0.0001$, $df = 1$. Once again it is concluded that there is a relationship between the provider and the level of care.

Table I
Assessment and Evaluation of Dental Treatment in the Baffin Region
 by P. Ralph Crawford, D.M.D. and Bradley W. Holmes, D.D.S.

| Type of Restoration | Dental Therapists | | | | | | | | | | Dentists | | | | | |
|-----------------------|-------------------|-----|----------|-----|-------------------|----|--------|-----|-------|------|----------|------|-------------------|------|--------|-----|
| | Total | | Superior | | Satis- factory | | Failed | | Total | | Superior | | Satis- factory | | Failed | |
| | No. | N | (%) | N | (%) | N | (%) | N | (%) | No. | N | (%) | N | (%) | N | (%) |
| One Surface Amalgam | 537 | 153 | 28.5 | 379 | 70.6 | 5 | 0.93 | 295 | 24 | 8.1 | 257 | 87.1 | 14 | 4.7 | | |
| Two Surface Amalgam | 231 | 88 | 38.1 | 140 | 60.6 | 3 | 1.3 | 198 | 18 | 9.1 | 158 | 79.8 | 22 | 11.1 | | |
| Three Surface Amalgam | 71 | 37 | 52.1 | 34 | 47.9 | 0 | 0.0 | 93 | 8 | 8.6 | 74 | 79.6 | 11 | 11.8 | | |
| Four Surface Amalgam | 14 | 8 | 57.1 | 6 | 42.9 | 0 | 0.0 | 20 | 4 | 20.0 | 15 | 75.5 | 1 | 5.0 | | |
| Composite 1 Surfaces | 73 | 3 | 4.2 | 56 | 76.6 | 14 | 19.2 | 196 | 10 | 5.1 | 146 | 74.5 | 40 | 20.4 | | |
| Composite 2 Surfaces | 16 | 3 | 18.8 | 11 | 68.7 | 2 | 12.5 | 55 | 4 | 7.3 | 43 | 78.2 | 8 | 14.5 | | |
| Composite 3 Surfaces | 2 | 0 | 0.0 | 1 | 50.0 | 1 | 50.0 | 13 | 3 | 23.0 | 8 | 61.5 | 2 | 15.4 | | |
| Stainless Steel Crown | 39 | 20 | 51.3 | 19 | 48.7 | 0 | 0.0 | 7 | 0 | 0.0 | 5 | 71.4 | 2 | 28.6 | | |
| Totals | 983 | 312 | 31.8 | 646 | 65.7 | 25 | 2.5 | 877 | 71 | 8.1 | 706 | 80.5 | 100 | 11.4 | | |

Table II
Reported Frequencies and Percentages for Quality Ratings of Dental Restorations by Dentists and Dental Therapists

| Quality | Dentists | | Dental Therapists | |
|--------------|----------|--------|-------------------|--------|
| | N | % | N | % |
| Superior | 71 | 8 | 312 | 32 |
| Satisfactory | 706 | 81 | 646 | 65 |
| Failed | 100 | 11 | 25 | 3 |
| Total | 877 | 100.00 | 983 | 100.00 |

$$\chi^2 = 199.24, p < 0.0001, df = 2$$

The chi-square tests are based on overall ratings for all types of dental restorations. They do not identify which of the eight types of restorations are responsible for the overall chi-square. Analytical comparisons that will identify specific differences between types of restorations by provider require an arithmetic mean and standard deviation. To obtain these two measures, a weighted index was used in which ratings of "superior", "satisfactory", and "failed" were assigned values of 3, 2, and 1, respectively. Multiplying the frequency of each rating by the appropriate value provided an overall score for the rating of restorations by service provider. Accordingly, the *t*-test of independent samples was used to test the statistical significance of the differences between dental therapists and dentists for each type of restoration.

Table III
Means, Standard Deviations, and *t*-Test Results for Dental Restorations

| Restoration | Dental Therapists | | Dentists | | <i>t</i> |
|-----------------------|-------------------|-----|----------|-----|----------|
| | Mean | SD | Mean | SD | |
| One-surface amalgam | 2.28 | .47 | 2.03 | .36 | 8.06* |
| Two-surface amalgam | 2.37 | .51 | 1.98 | .45 | 8.30* |
| Three-surface amalgam | 2.52 | .50 | 1.97 | .45 | 7.33* |
| Four-surface amalgam | 2.57 | .51 | 2.15 | .49 | 2.41** |
| Composite one-surface | 1.85 | .46 | 1.85 | .48 | --- |
| Composite two-surface | 2.06 | .57 | 1.93 | .47 | 1.93 |

p* < 0.001; *p* < 0.03

The test of significance (Table III) indicates a clear difference in favour of the dental therapists for all amalgam restorations. In a similar study in Saskatchewan in 1976, Ambrose, Hord, and Simpson⁶ assessed the quality of the most common restorative treatment services being carried out by dental nurses and dentists. A total of 2,107 amalgam restorations were rated on a scale from 1 to 3 by the examiners. The *t*-tests demonstrated a significant difference for each amalgam restoration at the .001 level. This reveals a similarity of findings with regard to one- two- and three-surface restorations in the above study. In the Saskatchewan study, the values for two- three- and four-amalgams were combined into one variable labelled "multisurface fillings". In the present study, when two- three- and four surface amalgams were combined and analyzed as one variable, parallel results were obtained ($t = 7.85; p < .001$).

The *t*-test of significance for one- and two-surface composite restorations did not approach critical value, indicating that dental therapists and dentists appear to function at the same standard of quality. This finding is as one might expect, given the greater task complexity of composite restorations over amalgam restorations. Statistical analysis was not carried out on composite three surface restorations due to the smallness of the sample size and on stainless steel crowns due to the sample size and obvious violation of the assumption that the two populations are normally distributed.

From a statistical point of view, on the basis of six clinical restorative procedures encompassing 1799 dental restorations, the quality of restorations placed by dental therapists was equal to but more often better than that of those placed by dentists. The significance of these findings is further elaborated by Gruebbel⁴ who utilized the adequacy of dental restorations as an index to the overall quality of dental treatment. Other researchers have also used the quality of dental restorations as an index to overall quality of care. Bagramian, Jenny, Woodbury, and Proshek⁷ studied the quality of dental restorations in a large population of school children (N=838). These researchers detected a significant problem of low quality dental restorations which was found to be unrelated to the socioeconomic status of the parent. Indications of high quality dentistry were illustrated by stainless steel crowns, space maintainers, and orthodontic appliances in association with good quality amalgam restorations. According to these authors,

It is possible...to suggest that the quality of restorative service could reflect or measure the total quality of care being provided to the patient. And certainly the first step in assessing quality is the restoration. If all other levels are adequate but the restoration is unacceptable the service has failed. This is not true in the opposite direction (p. 398).

There are three possible interdependent confounding variables associated with the differential effects found in the quality of clinical care. First, dental therapists in training spend almost four times as much time on the subject of restorative dentistry than undergraduate dental students⁸. Second, an important component of the quality control system built into the dental therapy program is periodic evaluation by dentists of the quality of selected procedures performed by dental therapists. Accordingly, unlike dentists, dental therapists carry out dental

procedures aware that the end-results are subject to future assessment by a dentist. Third, Roder⁹ suggests that a confounding variable associated with the differential effects are those related to salaried (dental therapists) and fee-for-service (dentists) system. The suggestion is that dental therapists are salaried and will suffer no loss in revenue by taking their time; whereas dentists are "piece work" operators whose economic gain is linked directly to output levels.

The above variables offer yet additional evidence of the overall merit of the dental therapy program. dental therapists spend more classroom/clinical time studying restorative dentistry than undergraduate dental students and periodic assessment of the quality of clinical services provided by dental therapists provides assurance to the consumer, to the dental profession, and to dental therapists themselves that the dental therapy program is not a "second rate" delivery system. It also serves to rule out possible criticism that training and supervision are lax or overly lenient.

An important question arising from the very favourable findings in the quality of restorations placed by dental therapists in the study group relates directly to the external validity of the findings: To what extent can these findings be generalized to other dental therapists trained by Health and Welfare Canada and employed in other Indian and northern communities? The carryover of research findings from the experimentally accessible population to the target population can be described by comparing the two populations to determine if they are similar in critical respects. The similarity of the experimentally accessible dental therapists and the target population dental therapists can be described in terms of the extensive standardization of the dental therapy program.

Dental therapists are trained to function as technicians, not professionals. Since most graduates will carry out dental procedures in the absence of direct supervision by a dentist, they need the security of systematic approach. To counteract the lack of direct supervision, the dental therapy program has been carefully and elaborately standardized in virtually every detail. This high degree of standardization is maintained throughout the system including all aspects of training. As a matter of policy dental therapists are carefully trained to only perform specified dental procedures in a specific way. They are trained to the use of one set of source materials and manuals developed explicitly for the program. The standardization pattern includes uniform equipment, instruments, and supplies throughout the system. Subsequently, dental therapists are able to transfer anywhere within the system and become fully operational immediately.

The high degree of standardization in the training of dental therapists and the operation of the program plus its high degree of enforcement, provide a reliable line of evidence of the similarity of all dental therapists in critical respects. Therefore, it may be assumed that the quality of care found in this study is, in general, descriptive of the quality of care provided by the target population of dental therapists.

Effect of dental therapists' interventions on community dental health

In the preceding section the quality of restorative dental care provided by dental therapists and dentists was evaluated. The statistical conclusion is that restorations placed by dental therapists are equal to, but more often better than, those placed by dentists. Although such end-results provide important information on the quality of dental services provided to individuals, it is insensitive to the broad health objectives which lie behind primary health care in general and the related impacts and effects the dental therapy program should be having in the community. Improvement in the community's dental health status should be the decisive factor in determining if the resources consumed by the dental therapy program are commensurate with the results obtained. Mills and Thomas state,

...to the epidemiologists, economists, politicians, planners, and most of all people themselves, it is the knowledge of the ultimate effectiveness of interventions which is of greatest interest¹⁰.

In the absence of direct measures on health impact, it is standard procedure to use measures of intermediate output. A general index of the degree to which dental health has improved in the communities served by dental therapists is the *ratio of restorations to extractions*. This index is highly sensitive to the commitment of dental therapists to render comprehensive care³. The results have also been shown to correlate excellently with the quality of services provided to patients^{4,5}.

The ratio of restorations to extractions (R/E) by dental therapists was calculated by geographical region for the years 1978-1987 (Table IV). A low R/E ratio is suggestive of poorer overall dental health in communities served by dental therapists within a region; while a higher ratio indicates better dental health among the population served. Some fluctuation in the R/E ratio between years within regions is also evident. This generally results from the expansion of the dental therapy program into previously unserved communities.

There are noticeable differences between Regions. The relatively low R/E ratios for Manitoba are suggestive of poorer dental health. The markedly higher ratio for Yukon indicates better dental health among the population served. The favoured position of the Yukon is explained by the fact that even before the dental therapy program was formally established in the Region, New Zealand trained dental nurses were already employed in the dental health program to provide dental health care to school children. Given the longer history of involvement in the dental therapy concept by the Yukon, their higher ratios may be predictive of future patterns in the other regions.

To test this assumption, a secular trend analysis was employed. An historical examination was made of the ratio of restorations to extractions performed by all dental therapists in Alberta Region, Atlantic Region, Manitoba Region, Saskatchewan Region and the Northwest Territories between the years 1978 and 1988 (Table V). Pacific Region and Yukon Region were excluded from the examination since both regions reveal consistently higher ratios than other regions for

Table IV
Ratio of restorations to extractions performed by dental therapists, 1978-87

| Year | Alta | Atlc | Man | Pac | Sask | NWT | Yukon |
|------|-------|-------|------|-------|-------|------|-------|
| 1978 | 6.22 | 4.45 | --- | 18.95 | --- | 2.38 | 19.77 |
| 1979 | 9.37 | 5.63 | 3.37 | 15.17 | --- | 5.21 | 29.20 |
| 1980 | 7.32 | 6.98 | 3.40 | 13.76 | --- | 4.85 | 26.65 |
| 1981 | 5.53 | 7.29 | 3.57 | 13.54 | 6.69 | 4.70 | 21.00 |
| 1982 | 9.47 | 10.00 | 3.42 | 15.64 | 10.01 | 5.05 | 19.61 |
| 1983 | 13.07 | 9.23 | 4.72 | 20.06 | 9.37 | 7.21 | 24.20 |
| 1984 | 12.18 | 9.35 | 4.35 | 20.66 | 14.04 | 8.40 | 20.49 |
| 1985 | 12.78 | 11.69 | 4.06 | 23.12 | 15.26 | 7.29 | 25.41 |
| 1986 | 19.33 | 13.07 | 4.66 | 20.10 | 19.21 | 7.66 | 24.12 |
| 1987 | 19.37 | 13.36 | 5.81 | 14.55 | 14.55 | 8.04 | 22.48 |

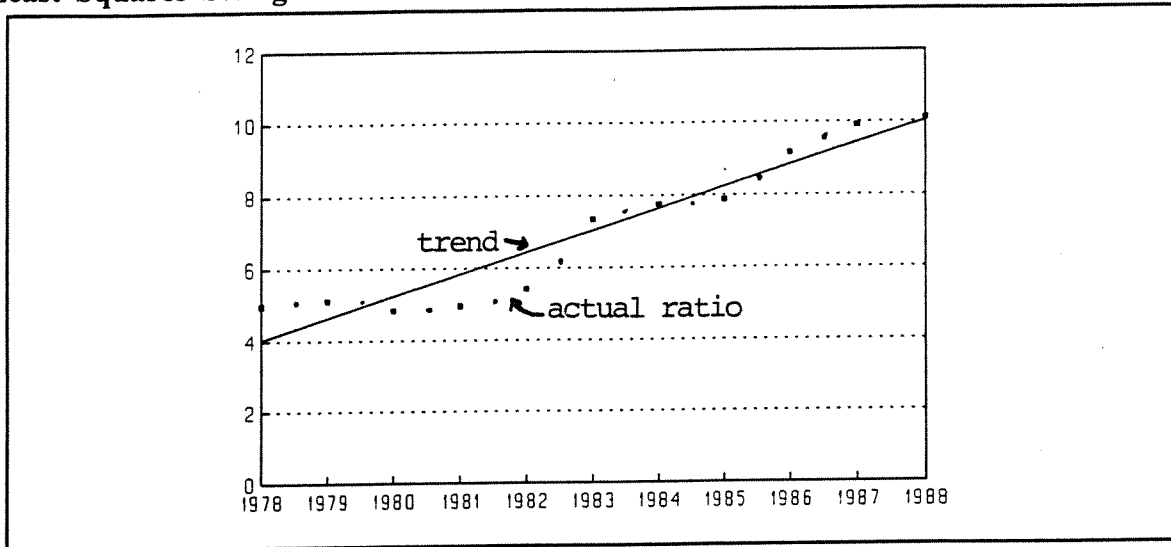
Table V
Ratio of Restorations to Extractions by Dental Therapists, 1978-1988

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|-----------|------|------|------|------|------|------|------|------|------|------|-------|
| R/E Ratio | 4.97 | 5.10 | 4.83 | 4.95 | 5.42 | 7.33 | 7.74 | 7.86 | 9.15 | 9.92 | 10.16 |

each year. These extremely large fluctuations would bias the trend pattern.

The data clearly shows a steadily increasing ratio which reveals dental therapists are having increasingly better effects on dental health in the communities they serve. The data plotted on an arithmetic scale (Fig. 1) shows basically an upward moving straight line. The least squares method was used to establish the "best-fitting" trend line. The slope of the trend line indicates a positive linear relationship of the R/E ratio to time. This steadily increasing trend is the result of a steady decrease in the number of required extractions over time relative to restorations which suggests that dental therapists are being successful in treating dental emergencies and in reducing them through regular on-going care. The steadily increasing trend is the first important line of evidence of the overall effectiveness of the dental therapists in improving dental health in the communities in which they work.

Figure 2
Ratio of Restorations to Extractions by Dental Therapists, 1978-1988, with
Least Squares Straight Trend Line



A second ratio was calculated (Table VI) for the dental therapists from 1978 to 1988. This is the *ratio of restorative to preventive work*. This ratio is an important measure from the view point of public health dentistry and economics. The ratio is affected by the natural shift from restorations to more preventive work, and thus correlates quite nicely with improvements in dental health in the communities served by dental therapists. The ratio is derived by dividing the total restoration RVUs by the total preventive dentistry RVUs.

Table VI
Ratio of restorations to preventive work performed by dental therapists, 1978-87

| Year | Alta | Atlc | Man | Pac | Sask | NWT | Yukon |
|------|------|------|-------|-------|------|------|-------|
| 1978 | 3.71 | 2.58 | --- | 10.59 | --- | 4.00 | 1.83 |
| 1979 | 2.56 | 2.56 | 18.06 | 3.97 | --- | 3.62 | 1.58 |
| 1980 | 2.56 | 2.01 | 5.18 | 4.43 | --- | 3.13 | 1.50 |
| 1981 | 1.47 | 2.82 | 4.42 | 4.60 | 2.81 | 3.01 | 1.54 |
| 1982 | 1.89 | 1.61 | 5.06 | 3.93 | 2.23 | 3.42 | 1.44 |
| 1983 | 2.18 | 1.42 | 4.05 | 3.75 | 1.54 | 3.18 | .90 |
| 1984 | 1.75 | 1.26 | 3.08 | 3.11 | 1.16 | 2.19 | .83 |
| 1985 | 1.32 | 1.05 | 1.52 | 2.01 | 1.19 | 1.30 | 1.06 |
| 1986 | .78 | 1.06 | 1.47 | 1.66 | .75 | 1.19 | .98 |
| 1987 | .55 | .93 | 1.24 | 1.52 | 1.52 | .98 | .79 |

The ratio of restorative to preventive work was calculated by geographical region for all dental therapists from 1978-1987. This ratio should decrease over time to show the desired shift from restorative services to preventive work. A low ratio indicates more preventive work than restorative work, suggesting overall improvements in the dental health of communities served by dental therapists.

To examine the trend over time, an historical examination was made of the ratio of restorative to preventive (R/P) work performed by all dental therapists in all regions, except the Yukon, for the years 1980 through 1988 (Table VII). The Yukon was excluded from the examination since the region reveals consistently lower (thus, favourable) R/P ratios than the other regions for each year which would bias the trend pattern. Also, years 1978 and 1979 were not included in the historical examination due to the extremely large ratios for Pacific Region (1978) and Manitoba Region (1979) which are not consistent with the ratios for the succeeding years for both regions.

The data in Table VII reveals a steadily declining ratio indicative of consistently improving levels of dental health in the communities served by dental therapists. The data plotted on an arithmetic scale (Fig. 2) reveals a basically downward moving straight line. The least squares method was used to establish the "best-fitting" trend line. The slope of the trend line indicates a negative relationship of R/P ratio to time. The trend is the result of a steady decrease in restorations required resulting in more preventive work being done. The actual ratio line displays a levelling off effect after 1986. This indicates that dental therapists are being successful in bringing communities to maintenance level. The steadily decreasing trend is clearly in the direction of encouraging prevention and promoting positive outcomes and is the second important line of evidence of the overall effectiveness of the dental therapists in improving dental health in the communities in which they work.

This steadily declining ratio, indicative of improving levels of dental health, also points to additional savings to Health and Welfare Canada in the form of reduction in future treatment costs and costs directly associated with treatment (e.g., transportation). This is one of the main arguments for preventive measures^{11,12}. According to the R/P ratio, the need for clinical dentistry may be decreasing in communities served by dental therapists. Therefore, the dental therapy program may be justified on the grounds of savings in future treatment expenditures alone.

If the dental therapy program is being effective in improving the dental health of the communities in which dental therapists work, over time one would expect to find in these communities a consistent relationship between the ratio of restorations to extractions and the ratio of restorations to preventive work. To examine the strength of this relationship ratios were calculated for the common elements (Regions and years) in Tables VI and VII, and their correlation checked using Pearson's Product-Moment Correlation. Its value was found to be -.94 (Table VIII), indicating a very strong negative correlation between the two ratios.

Table VII
Ratio of Restorations to Preventive Work by Dental Therapists, 1980-1988

| | | | | | | | | | |
|-----------|------|------|------|------|------|------|------|------|------|
| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| R/P Ratio | 3.30 | 3.10 | 2.90 | 2.27 | 1.82 | 1.29 | .99 | .97 | .91 |

Figure 2
Ratio of Restorations to Preventive Work by Dental Therapists, 1980-1988
with Least Squares Trend Line

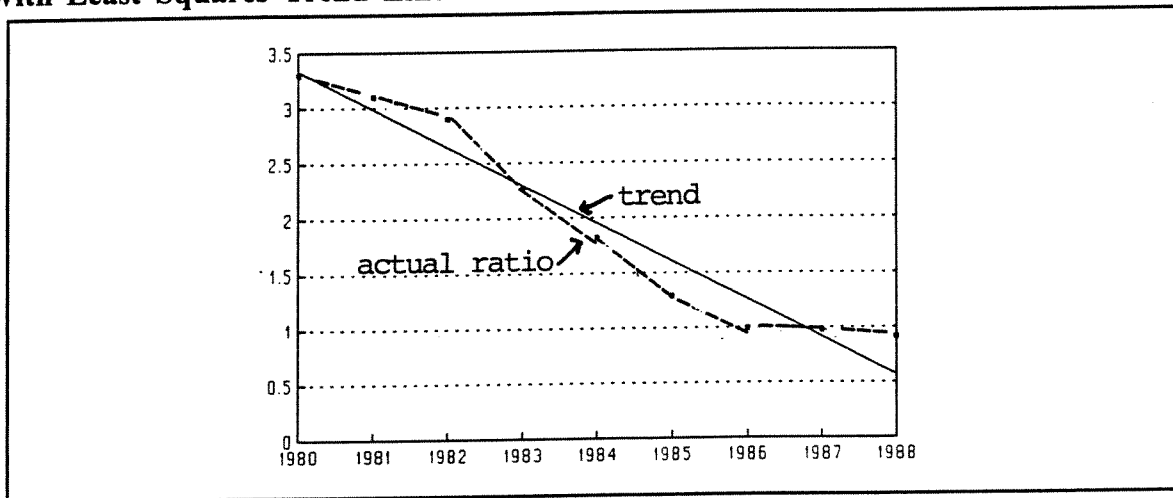


Table VIII
Relationship between the Ratio of Restorations to Extractions and the Ratio of Restorations to Preventive Work in Dental Therapist Communities, 1981-1988

| <u>Year</u> | <u>R/E</u> | <u>R/P</u> |
|-------------|------------|------------|
| 1981 | 4.95 | 2.82 |
| 1982 | 5.86 | 2.68 |
| 1983 | 7.33 | 2.28 |
| 1984 | 7.74 | 1.77 |
| 1985 | 7.86 | 1.27 |
| 1986 | 9.15 | 1.00 |
| 1987 | 9.92 | .99 |
| 1988 | 10.28 | .93 |

Pearson's $r = -.94, p < .00033.$

Although the strong relationship between the two ratios does not provide evidence of a cause-and-effect relationship, the presence of the correlation makes such a relationship more plausible. Indeed, the absence of a correlation would be used to rule out a cause-and-effect relationship.

Conclusions

The foregoing analyses provide convincing evidence that dental therapists provide high quality services resulting in positive outcomes for both the patient and the community. These findings reveal that dental therapists are a good pool of health manpower who can treat patients with high quality of care at low cost. Considered in the light of the spiralling cost of health care, dental therapists can make an important contribution in bring the government's rising health care costs under control.

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