

A QUALITY EVALUATION OF SPECIFIC DENTAL SERVICES PROVIDED BY THE SASKATCHEWAN DENTAL PLAN

Final Report

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1. INTRODUCTION

The use of dental nurses to provide basic dental services to school children is not a recent innovation. It had its start in 1921 in New Zealand, and by 1970, 19 countries were experimenting with or utilizing this type of dental manpower. In Canada, New Zealand dental nurses have been providing dental care since 1962. Little known throughout the rest of the country, the Yukon dental nurse program has been an essential part of the total dental care delivery system there. In 1972 the Province of Saskatchewan launched a dental nurse training program and the first graduates from this program began working in the field in 1974.

After the Saskatchewan program had entered its second year of operation, the program's director undertook to have certain specific aspects of the operation evaluated. Precisely, it was the director's wish to assess whether the quality of the most common restorative treatment services were being carried out at an acceptable standard of quality. A team of three expert clinicians from outside of Saskatchewan was selected to come to the Province in order to evaluate the quality of treatment provided under the program. A chairman was selected from among the team and from this point forward, all decisions as to the procedures to be followed were made by the evaluating team.

From February 1 to 6, 1976 the three examiners were in Saskatchewan to carry out the clinical phase of the evaluation project. What follows is a report resulting from that visit.

1.1. Background

Saskatchewan is a Canadian province comprising an area of 251,700 square miles and supports a predominantly agricultural economy whose major product is grain. As of January 1, 1976, Saskatchewan's population stood at 929,000, which translates into a very low population density of 3.7 persons per square mile. About one third of Saskatchewan's population lives in or around the two largest cities, Saskatoon and Regina (the capital), so that throughout the remainder of the Province the population is rather sparse.

The great distances and low population have always imposed a burden on the Saskatchewan people, par-

ticularly with regard to public services such as education and health. Nevertheless, because of demographic factors, the influence of the Great Depression, and the historical tendency to be neglected by the central government and other powerful interests in eastern Canada, Saskatchewan has reacted by creating and implementing innovative public policies, particularly in the health field. The creation of the municipal doctor scheme and the establishment of "union hospital districts" were tax-based programs which commenced around 1920. By 1939, the Saskatchewan municipality of McKillop established a tax-supported health insurance program and in 1946, the Swift Current medicare program (which included dental services for children) was launched. Saskatchewan's greatest achievement, however, was the introduction of a province-wide, universal health insurance program, North America's first, in 1962. A brief but lively review of these developments has been provided by Badgley and Wolfe.¹

Once the health insurance program was well established, it was natural that Saskatchewan should turn to the dental health field. In 1968, the Dental Health Division of the Saskatchewan Department of Public Health completed a preliminary dental survey of school children in Saskatoon and Regina and found that the level of dental care was inadequate. Further dental surveys of other school units in 1971 confirmed and indeed strengthened the earlier findings. Could the dental profession respond and provide more dental care for children? An analysis of dental manpower in Saskatchewan provided three important findings.

1. The available dental manpower was concentrated in the two major cities. Data from 1973 indicated that 54.8% of Saskatchewan dentists were practising in either Regina or Saskatoon which between them contained only 29% of the Saskatchewan population.²
2. Beyond maldistribution, there was a clear-cut lack of dentists. In 1970, Saskatchewan had a total of 206 licensed dentists for a dentist to population ratio of 1:4,573.
3. In 1970, there appeared to be little hope that the number of dentists could be significantly augmented in the future. Between 1957 and 1970, Saskatchewan had a net gain of only 4 licensed dentists. Emigration of dentists appeared to be the major problem,

Saskatchewan's dentist retention index being the lowest in Canada for this period.³

Given the poor state of dental health in children and the quantitative deficiency in dental manpower, the Saskatchewan Government began to orient its dental care policies towards the concept of a school dental service staffed by dental nurses as originated in 1921 by New Zealand.

In 1970, with the assistance of the Federal Government, an experimental dental care project was begun in Oxbow, Saskatchewan. This project utilized two British-trained dental nurses who worked in a team comprising a dentist, the two dental nurses and dental assistants. An evaluation of the Oxbow pilot project was done and the results were most encouraging. By September of 1972, the Saskatchewan Government had launched a training program for dental nurses in Regina. The 2-year program was offered by the Wascana Institute of Applied Arts and Sciences and had an initial capacity for 36 graduates. As of 1976, the program has been much expanded to include a one-year certified dental assistant program in addition to increasing the dental nurse graduating class size to 60 per year.

The Saskatchewan dental nurse training program, under the direction of Dr. G. Keenan, is based on the original New Zealand model but incorporates a number of significant modifications. In contrast to her New Zealand counterpart, the Saskatchewan dental nurse takes and interprets x-rays, uses local block anesthesia where indicated, and places stainless steel crowns as well as space maintainers. The emphasis on preventive dentistry by the New Zealand and Saskatchewan dental nurse is approximately the same in terms of time allotted. In opting for a dental nurse approach, Saskatchewan, like Australia, has generally adopted an extended version of the New Zealand system.

In 1974, utilizing the first 34 graduates of the Saskatchewan dental nurse program as well as an additional 19 British-trained dental nurses, the Saskatchewan Government implemented the field phase of the program under the title of the Saskatchewan Dental Plan. In conjunction with the Saskatchewan Department of Education, 215 permanent dental clinics were installed in elementary schools. Most of these clinics incorporate a single chair design although a few larger clinics were built where the size of the eligible population warranted it. During the first year of operation, the program covered approximately 15,000 children, eligible by virtue of having been born in 1968. In September of 1975, the coverage was extended to include children born in 1968, 1969, and 1970.

1.2 Quality Evaluation of Dental Services

As an operationalized procedure, quality evaluation of dental services is still in the developmental phase. In some aspects, the process of quality evaluation of dental care is ahead of its medical care counterpart. For exam-

ple, the accessibility and visibility of the disease processes and their treatments makes evaluation easier for dental conditions than for many other medical problems. The irreversible nature of dental caries and, to a lesser extent, periodontal disease are features which may assist in the evaluation process. The durability and cumulative nature of restorative dental treatment makes this easier to grade than many, if not most, health services. On the other hand, a satisfactory conceptual framework for the assessment of quality in dental care is still in a relatively early stage and has certainly received less study than on the medical care side.

The arrival of the third party in the dental care delivery system has led to a significantly greater concern about the quality of dental services. One early result of this concern has been the gradual disentanglement of professionalism and quality care. It has thus become increasingly acceptable to the Profession as well as the public it treats to study the elements that lead to better dental care. Consequently, most of the pertinent literature relating to formal criteria and standards as they apply to quality in dental care have appeared since 1970. Particularly worthwhile are the reports by Abramowitz and Mecklenburg,⁴ Cons,⁵ and Soricelli⁶ which describe some approaches and specific methodologies related to public dental programs. Different models for the general evaluation of dental care have been described by Friedman⁷ and Schonfeld⁸.

The case for including a formal quality assurance review process in a dental care program is strong. For example, Bagramian et al⁹ report that of 838 fourth grade children examined in a large mid-western U.S. city, 44.3% were judged as presenting with poor or very poor quality dental restorations. Bellin¹⁰ has reported on the prevalence of poor and fraudulent dental care provided under New York's Medicaid program. In discussing the role of Professional Standards Review Organizations, Friedman¹¹ reports of the occurrence of dental misdiagnosis as judged over a two-year period by the U.S. Administrators organization. Moore and Stewart¹² as well as Richardson and Boyd¹³ have described the extent to which defective restorations occur and must be replaced. Some further examples have been reviewed by Sheiham¹⁴.

1.3. Quality Dental Care by Non-Dentists

For a variety of reasons, quality of treatment services has always been an important consideration in dental programs that have relied on dental nurses, expanded-function dental hygienists, expanded-duty dental assistants, dental therapists, etc., to provide a measure of restorative dental care. With regard to the New Zealand dental nurse program, the quality of treatment provided appears to be of a generally high level.^{15, 16, 17} Of the three reports on the subject, Gruebbel's was the most negative.¹⁵ Even using Gruebbel's data, Dunning¹⁸ demonstrated that New Zealand children had more good

restorations in their mouths than their American counterparts. The ability of expanded function dental hygienists to perform reversible restorative services has been studied as part of the Prince Edward Island dental manpower study.¹⁹ Among other duties, the expanded function dental hygienists were able to place matrix retainers and to insert, finish and polish amalgam and composite resin restorations. A subsequent, independent evaluation of dental restorations placed by both hygienists and dentists indicated that the amalgams placed by the former were slightly superior to those placed by the latter. A similar result was obtained by an Ontario demonstration project.²⁰ American studies on the productivity increases made possible by the use of properly trained expanded-duty dental assistants indicate that the quality of restorative work was equal to that produced by dentists.^{21, 22, 23, 24, 25} Dental therapists, both in the United States and Canada, have demonstrated their ability to carry out a restricted number of restorative procedures to the same quality standard attained by dentists.^{26, 27, 28}

1.4. General Framework For The Present Quality Evaluation Project

Different models for assessing the quality of dental health care have been proposed. As previously stated, Friedman⁷ and Schonfeld⁸ have each elaborated approaches that have been used in practice. Dunning and De Jong²⁹ have reviewed three different methods. However, the system which has found the greatest acceptability and use is that provided by Donabedian³⁰ for the evaluation of quality in medical care. Donabedian's scheme is conceptually simpler than most others, and allows the most satisfactory classification of evaluation procedures. Three different ways for quality appraisal have been suggested by Donabedian: (a) *Assessment of structure* "involves the evaluation of the settings and instrumentalities available and used for the provision of care. While including the physical aspects of facilities and equipment, structural appraisal goes far beyond to encompass the characteristics of the administrative organization and the qualifications of health professionals"; (b) *Assessment of process* "is the evaluation of physicians (dentists) and other health professionals (para-dental personnel) in the management of patients. The criterion generally used is the degree to which management of patients conforms with the standards and expectations of the respective professions. These standards and expectations may be derived from what is considered to be 'ideal', 'good', or 'acceptable' practice as formulated by recognized leaders in the profession. Such standards of care may also be inferred from patterns of care observed in actual practice"; (c) *Assessment of outcomes* "is the evaluation of end results in terms of health and satisfaction. That this evaluation in many ways provides the *final evidence* (our italics) of whether care has been good, bad, or indifferent is so because of the broad fundamental social and professional agreement on what results are deemed desirable.

Furthermore it is assumed that good results are brought about, at least to a significant degree, by good care."

Upon being asked to evaluate the quality of dental care being provided by the Saskatchewan Dental Plan, certain choices had to be made. For example, should the evaluation procedure be aimed at reviewing the dental nurse teaching institution, the facilities available in the school dental clinics, and the general organization of the Plan itself? This would have been akin to the appraisal of structure. But it is generally conceded that structural components have no or only a little bearing on the actual quality of dental services rendered to the public. The reason that the quality of dental care is so often expressed in terms of structure assessment is straightforward. Structural data are easy to obtain and categorize. However, ease of procedure is not sufficient justification. In rejecting structure appraisal, the suitability of process evaluation was raised. In the Saskatchewan setting, this would have involved, among other things, the direct observation of treatment activities as performed in the various school dental clinics. Such an approach presents many important problems. First, the criteria for the evaluating process are by no means agreed upon and much less scientifically demonstrated. The relationships of process to the actual quality of care provided are tenuous. For example, to what degree is the use of rubber dam associated with quality dental care? A further problem with direct observation of treatment activities is that the sample size is cut down tremendously. It is simply not practical to observe the actual treatment phase of a large enough number of dental nurses for long enough to reliably evaluate the quality of care that is routinely provided. A third complication arises from the obvious effect of having an observer peering over the operator's shoulder. Process evaluation in medical care overcomes some of these problems by emphasizing a review of patient records. Such a procedure is of doubtful validity by itself³¹ and is probably not applicable to dental care.

This leaves outcome or end-result evaluation — the approach chosen for the evaluation of dental care provided by the Saskatchewan Dental Plan. A distinct advantage gained by focusing on health outcomes to assess quality of care is that a good deal of interference is removed from the scheme. As such, outcome appraisal is a more direct technique. In the context of the present project, outcome evaluation is taken to mean the direct examination and evaluation of treatment some time after it has been completed. In actual fact, this does not precisely equate with Donabedian's definition of outcome appraisal, a point which is occasionally overlooked. Nevertheless, the procedure of examining previously inserted amalgam restorations, stainless steel crowns and previously exposed radiographs will be defined as one form of outcome assessment.

2. METHODS

2.1. Examination Team

The Director of the Saskatchewan Dental Plan engaged the services of three highly qualified dentists to conduct the clinical examination phase of the evaluation project. The examiners were Dr. E. R. Ambrose, Dean and former chairman of operative dentistry at McGill University; Dr. A. B. Hord, chairman of restorative dentistry at the University of Toronto; and Dr. W. J. Simpson, chairman of children's dentistry at the University of Alberta. The three examiners' combined dental practice and teaching experience exceeded 60 years. Once the examiners had been chosen, Dean Ambrose assumed the chairmanship of the team which collectively became responsible for all further aspects of the project including the design of the investigation, choice of treatment components to be evaluated, establishment of criteria to be used, the design of the recording form, and the data analysis.

2.2. Blind Technique

A key feature of the survey design was that a "blind" technique was employed. From the outset it was decided that classrooms would serve as the sampling unit and that all children in a selected classroom would be examined and, as a result, all restorative work would be evaluated. Only subsequent to the evaluation of treatment were the children to be classified according to whether or not they were enrolled in the Saskatchewan dental plan. If enrolled, each restoration was individually categorized as to whether it had been placed by Saskatchewan Dental Plan personnel or by a private dentist. All restorative work in the mouths of non-enrolled children was assumed to have been placed by dentists in private practice. By following this procedure (see Fig. 1) the evaluation of treatment quality was done in the complete absence of any knowledge as to the origins of the treatment. It was hoped that a major source of bias might thus be eliminated.

2.3. Treatment Components Assessed

After the decision to evaluate treatment outcomes had been made, it became necessary to select a set of treatment components whose quality could be objectively assessed. Taking several factors into consideration, the evaluation team decided that treatment quality evaluation would be limited to the following:

- a. Amalgam restorations in primary and secondary teeth
- b. Stainless steel crowns on primary teeth
- c. Diagnostic radiographs

In addition, it was agreed that noteworthy observations regarding the adequacy of treatment facilities and the im-

plementation of preventive procedures would be recorded since the impressions formed by a recognized team of expert clinicians might have considerable value in explaining any significant findings from the analysis of the quantitative data.

2.4. Criteria To Be Evaluated

To assure a simple and practical evaluation procedure which is both objective and consistent, a specific set of evaluating criteria was developed on which quality standards could be assessed. Previous first-hand experience with quality dental care evaluation in experimental dental programs in Prince Edward Island¹⁹ and Ontario²⁰ as well as a thorough search in the literature contributed to the formulation of the criteria. A reason for providing a specific list of criteria which must be systematically scored is the tendency of examiners to focus on one or two items that deviate from the normal standard and to weigh these rather heavily in assigning an overall score. It was hoped that a more systematic schedule in evaluating specific treatment criteria while leaving the final or overall evaluation to a computer would overcome this tendency.

The tables below list the criteria to be evaluated for amalgam restorations (Table 1), for stainless steel crowns (Table 2), and for radiographs (Table 3).

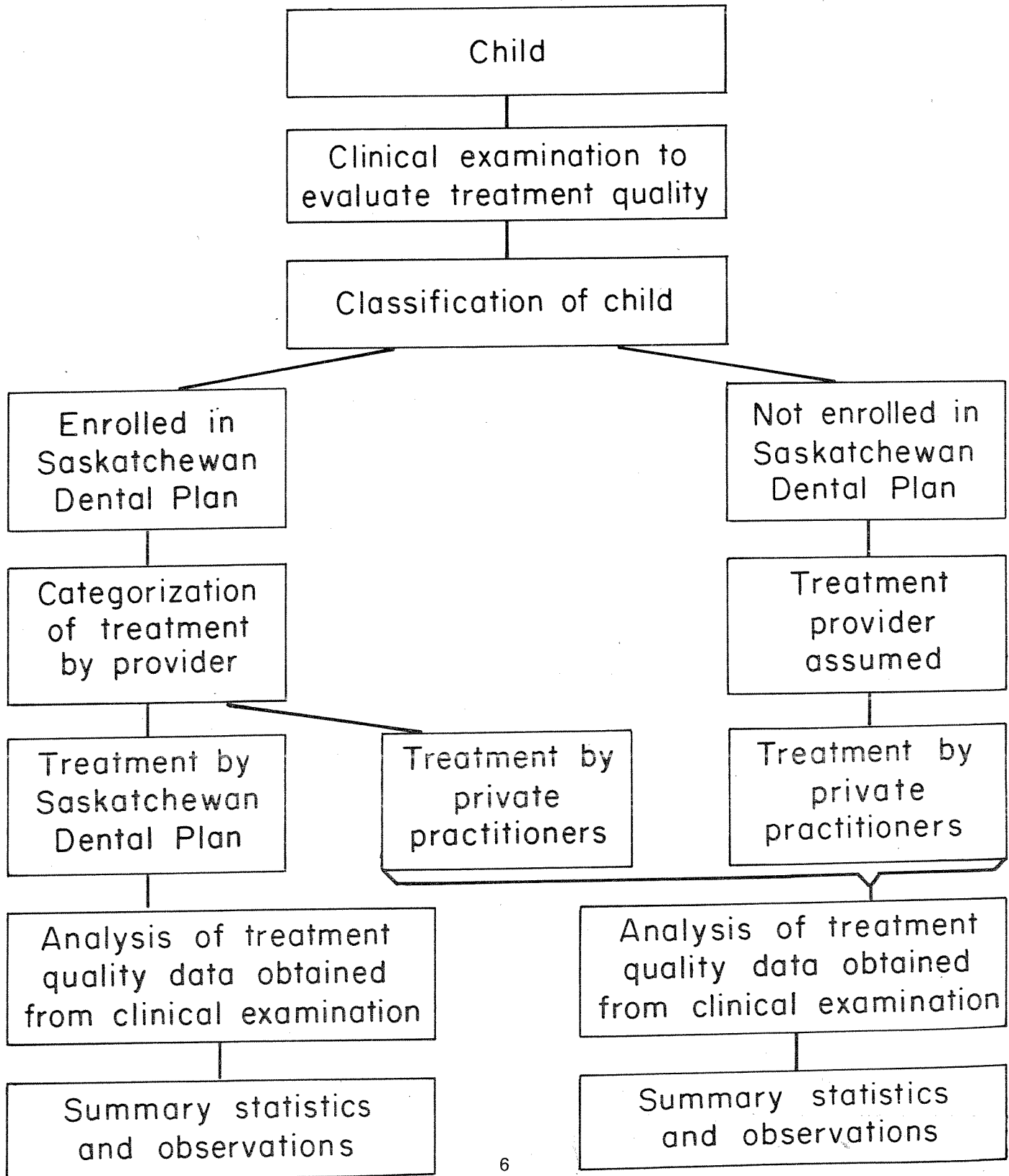
2.5. Standards of Quality

For both amalgam restorations and stainless steel crowns, a series of specific criteria were examined. For any restoration, the criteria of Anatomy, Margin adaptation, etc. were separately and independently assessed. Based on previous first-hand experience as well as that reported in the literature, a scoring scale was developed comprising a 3 level standard of quality which could be applied to the grading of the selected criteria (Table 4). Thus in the case of a class II amalgam restoration, if the interproximal contact(s) was ideally located, of desirable area and sufficiently but not excessively resistant to the passage of dental floss, then this was considered as approaching the ideal situation and as such the interproximal contact of the amalgam was scored as 3 or as being of a superior quality. Had the contact area exhibited similar properties with the exception that it was somewhat rough yet capable of being refinished without excessive loss of contour, then this was scored as 2, or as being of adequate quality. On the other hand, if the interproximal contact was not resistant to the passage of dental floss and gave evidence that food impaction was a problem, then the score assigned would be 1 indicating that this specific criterion of the restoration was considered unsatisfactory and required that the restoration be redone.

On this basis, a class II restoration that was superior according to every criterion scored, Anatomy though to

Figure I

**SEQUENCE OF STEPS
IN QUALITY EVALUATION PROCEDURE**



Surface Consistency, would gain an overall mean score of 3. This represented the highest possible score. Conversely, if every criterion was evaluated as unsatisfactory, then such a restoration was given an overall mean rating of 1. Therefore, the mean standard for amalgam restorations or stainless steel crowns could fall anywhere from 1 to 3 depending on the combination of ratings received by the criteria.

The Procedure for scoring radiographs represents a binary approach. That is, only two possibilities are admitted, namely, the films are acceptable or not acceptable. Acceptability is based on the complete absence of negative criteria.

TABLE 1

*Saskatchewan Dental Plan
Post-Treatment Restorative Quality Evaluation Project*

**AMALGAM RESTORATIONS —
CRITERIA TO BE EVALUATED**

Anatomy	The remaining tooth structure should serve as the guide for anatomical form. The marginal ridge and related fossa should approximate the anatomy of the natural tooth. The outline form should reflect current concepts of tooth preservation and exhibit reasonable principles of extension for prevention.
Proximal contour	It should closely reproduce the original contour of the proximal surface. This will be influenced by the matrix band techniques employed by the operator.
Interproximal contacts	This should be firm enough to prevent food impaction and allow dental floss to pass with a definite "snap". The location and area of the proximal contact will be determined by the anatomy of the tooth and arch alignment.
Margins	These should blend with the adjacent enamel so that the margins are imperceptible or slightly detectable to the tine of an explorer passed over the junction between enamel and restoration. No overhang should be apparent at the gingival margin.
Occlusion	The intensity of contact for a restored tooth during occlusion should be the same as for the other teeth. The restoration should not interfere with or prevent the functioning of any other teeth.
Surface consistency	The accessible, completed surfaces should be (a) free from scratches, pitting and any gross irregularities, (b) smooth in appearance, and (c) preferably have a satin or lustrous finish.

TABLE 2

*Saskatchewan Dental Plan
Post-Treatment Restorative Quality Evaluation Project*

**STAINLESS STEEL CROWNS
CRITERIA TO BE EVALUATED**

Margin extension	The margin of the preformed stainless steel crown should extend to just (i.e. up to 1mm) below the free margin of the gingiva on all four surfaces. The contouring of the crown margin must be such that it is not underextended (particularly on the vestibular surfaces) nor overextended so as to damage the epithelial attachment.
Margin adaptation	The crown margins must be adapted as closely to the tooth as possible. In most instances, this requires proper crimping of the gingival margins. Gross spaces between crown margin and tooth should not be apparent.
Occlusion	The crown must be properly seated and the occlusal surface should be in proper contact with the opposing teeth. The height of the occlusal surface will usually approach that of adjoining teeth. The occlusal surface of the crown should not have a flat, squashed appearance nor should intrusion of an opposing tooth be visible.
Tissue health	The gingival tissue surrounding the crown should demonstrate normal colour and architecture. Swollen, edematous tissue from overextended or rough irritating margins is unsatisfactory. Care should be taken to distinguish this cause of irritation from that caused by retained cement as the latter condition would be correctable.

TABLE 3

*Saskatchewan Dental Plan
Post-Treatment Restorative Quality Evaluation Project*

**RADIOGRAPHS —
CRITERIA TO BE EVALUATED**

Radiographs should be scored as <i>acceptable</i> unless their diagnostic value is significantly reduced because of one or more of the following:	
Over exposed	The film appears too dark hindering accurate reading of anatomical and diseased structures.
Under exposed	The film appears too light hindering accurate reading of anatomical and diseased structures.
Poor contrast	The range of light density of the film is too narrow so that radiolucent structures

may not be accurately differentiated from radiopaque structures. Pulp chambers and periodontal ligament spaces are not clearly visible.

Overlap	This is considered a significant problem when more than $\frac{1}{2}$ the interproximal enamel layer on approximating teeth is superimposed on the film.
Cone cut	Should be considered a diagnostic problem only when critical structures are involved. On bitewing films, critical structures would include the interproximal surfaces from the distal of the deciduous canines to the mesial of the first permanent molars if these are present. On periapical films, the full length of the teeth should be visible.
Image off film	This would be the case if the film is not cone cut and yet critical structures, as defined above, are not present on the film.

TABLE 4

*Saskatchewan Dental Plan
Post-Treatment Restorative Quality Evaluation Project*

STANDARD

Scale To Be Used For Scoring Restorative Procedures
According to Criteria Selected For Detailed Evaluation

Rating		Score
Superior	Is designated for work equivalent to that expected from a very conscientious practitioner. Work carried out needs no alteration. Includes designations such as exceptional, outstanding, etc.	3
Adequate	Is designated for work meeting minimum quality standards but which could have been better executed. Included in this category is work which can be improved by simple procedures. Examples applicable to amalgam restorations are recontouring occlusal surfaces, refinishing rough contact points, etc., etc.	2
Unsatisfactory	Is designated for work that is clearly unacceptable or inferior to minimum quality standards. In general, ought to be applied to all work which for one reason or another would be recommended to be redone.	1

2.6. Geographical Location

From the outset it was determined that the broadest possible geographical representation should be worked into the sample of children to be evaluated. For the purpose of administering the Saskatchewan Dental Plan, the province of Saskatchewan is divided into 6 regions. Of these 6 administrative regions, one, namely the Swift Current Health Region, has run a children's dental program since the late 40's. Hence, it was decided to examine children from all the remaining 5 health regions. Furthermore, within any one region, an effort was made to see children from as many different public schools as practical.

2.7. Examination Procedure

The examination procedure took place in the school dental clinics constructed by the Saskatchewan Government. These clinics were equipped with lounge-style dental chairs, Pelton-Crane dental lights and Adec dental units. The clinical examination was carried out with a #4 dental mirror, #5 explorer and waxed dental floss. Compressed air was available from the dental units' three-way syringe.

On the first half-day of the survey, all three examiners and their recorders worked together in order to test the recording form and to standardize their evaluation procedure. (A copy of the original recording form is attached on Appendix I). As a result of this initial session, one of the six criteria suggested for the evaluation of amalgam restorations was deleted. The discarded criterion was Occlusion which was dropped because it turned out to be redundant in view of the fact that the anatomy criterion routinely picked up the cause of the poor occlusion. Therefore, restorations that were undercarved and consequently in heavy occlusion and possibly even fractured, or restorations that were over carved and thus out of the occlusion were correspondingly scored low under Anatomy.

Following the first half-day, the examiners proceeded separately in order to see as many children in as many different schools as possible. As the child presented himself, the person assisting the examining team filled in the administrative data on the form. At this stage, no verbal reference was made as to whether the child was being treated under the Saskatchewan Dental Plan. The following illustrates the information recorded:

Case No.	Leave blank. To be used for analysis only.
Date	- Day-Month-Year
Region	- Applicable dental region.
School No.	- To be taken from dental record.
Patient name	- Full first and last name.
Sex	- Use letters M or F only.
Age	- In years. Verify with patient chart where possible.

- Registration No. – From dental record for S.D.P. patients only.
- Evaluator – The evaluator's first and last name initials.

At this stage, the child was seated and the clinical examination was begun.

2.7.1 Amalgam Restorations

Using the Federation Dentaire Internationale nomenclature system, the teeth were sequentially examined going from 16 or 55 around the maxillary arch to 26 or 65, then starting at 36 or 75 and going around to 46 or 85 on the mandibular arch. When the first tooth with an amalgam was reached, the examiner called out the tooth number and the type of restoration (surface letter(s) designation). This information was recorded by the examiner's assistant who then guided the examiner sequentially through the evaluation criteria as follows.

Without delay, the recording assistant called out "Anatomy" to which the examiner replied by calling out the appropriate score of 3, 2, or 1 depending if the anatomy of the restoration was superior, adequate, or unsatisfactory as previously defined. This score was entered into the appropriate space on the form and the recorder then called out "Proximal Contour", to which, if applicable, the examiner again responded with the appropriate score. This procedure was repeated for the remaining 3 criteria, namely, Interproximal Contact, Margin and Surface Consistency. When Surface Consistency had been scored, the recorder indicated that the examiner should proceed to the next restoration and the procedure would be repeated.

2.7.2 Stainless Steel Crowns

Although in most cases stainless steel crowns were not present and the next treatment component would be assessed, where such restorations were in evidence, a scoring procedure similar to that for amalgams was employed. The major difference was that the criteria were different and fewer in number, but the system remained the same. Once the examiner identified the tooth with the crown, the recording assistant called out "Margin Extension" to which the examiner replied with the appropriate 3, 2, or 1 score. Margin Adaptation, Occlusion, and Tissue Health were similarly assessed. Since stainless steel crowns are preformed, anatomy is not a relevant criterion. However, the occlusion of the crown with opposing teeth, where applicable, takes on a distinct meaning.

2.7.3 Radiographs

In most cases, stainless steel crowns were not present and the assessment of x-rays followed the evaluation of amalgam restorations. The examiners were instructed to look only at mounted bitewing or periapical films and to do this with the aid of an x-ray viewing box or daylight. The evaluation of radiograph quality relied rather more heavily on the clinical judgement of the

examiners. The diagnostic quality of bitewing and/or periapical films was scored as acceptable unless clearly defined objections could be specified. Thus, an acceptable film implied the absence of the negative criteria previously described.

The last step in the examination procedure was to categorize the child as to whether the individual was enrolled in the Saskatchewan Dental Plan or not. If the child was so enrolled, it became necessary to go to the child's dental chart to establish which of his restorations had been done by government personnel and which had been done in private dental practice. This information was recorded on the form for every individual amalgam restoration or stainless steel crown evaluated. For children not participating in the Saskatchewan Dental Plan, it was simply assumed that all restorative work present was done in private dental practices and this was similarly recorded in the appropriate space on the form.

2.8. Data Analysis

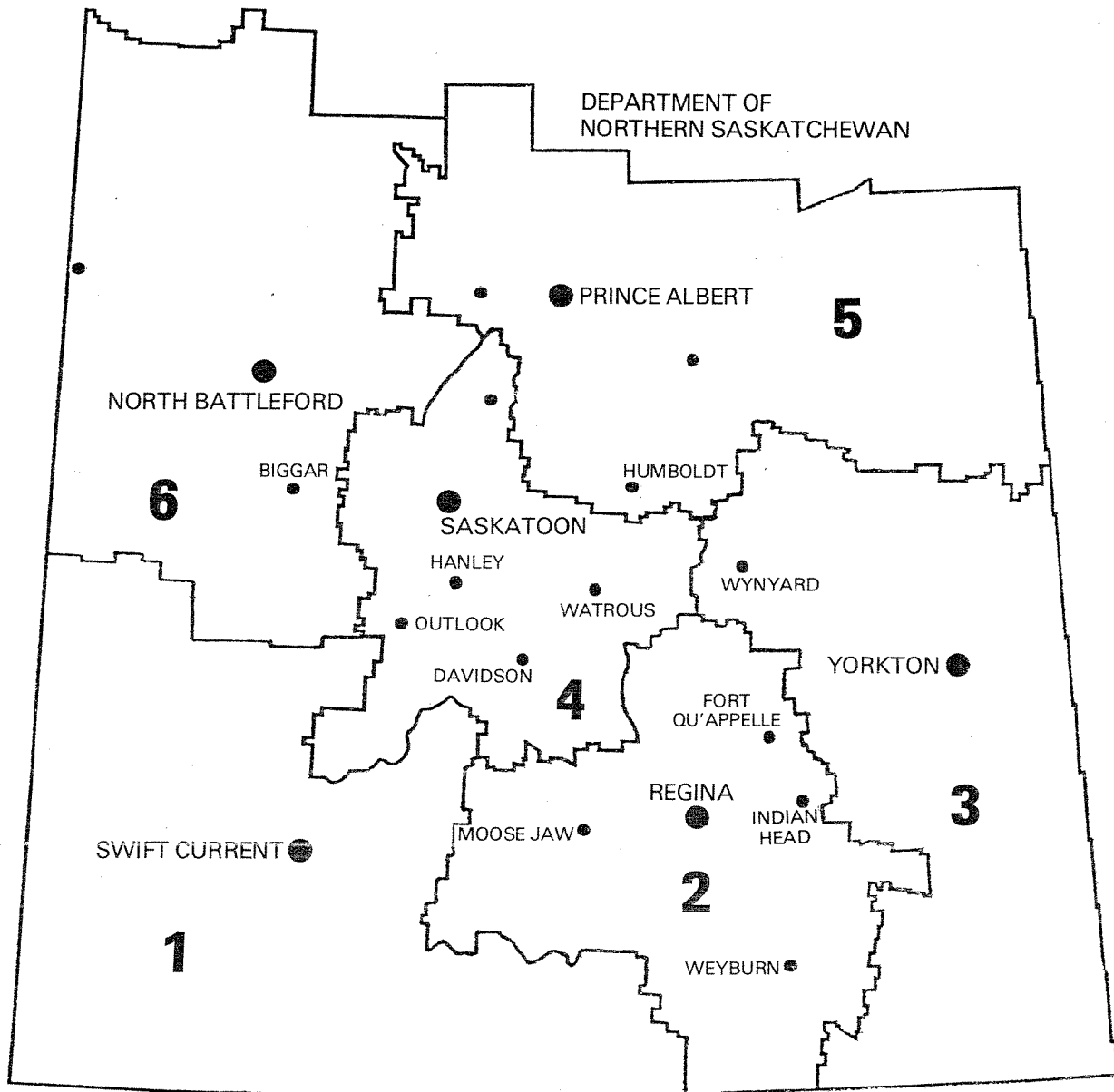
The completed recording forms were returned to the Faculty of Dentistry, McGill University where all subsequent data analysis was carried out. As a first step, all the evaluation forms went through a hand-edit to correct obvious errors, obtain missing information, and to eliminate correctable inconsistencies. Subsequently, certain non-numerical data on the forms were transposed to a quantitative mode. Next, all the data were transferred to computer cards and from there onto a system file.

The actual data analysis was designed to provide the following information:

- the number of children examined.
- The number of health regions and public schools represented in the sample.
- The number of amalgam restorations, stainless steel crowns and radiographs evaluated.
- The mean number of amalgam restorations and stainless steel crowns evaluated per child.
- A comparison of the quality of amalgam restorations and stainless steel crowns placed by the Saskatchewan Dental Plan personnel and by private practice dentists.
- The acceptability rate of radiographs taken by the personnel in the Saskatchewan Dental Plan.

FIGURE 2

SASKATCHEWAN DENTAL PLAN ADMINISTRATIVE REGIONS



KEY TO ADMINISTRATIVE REGIONS

NO. 1 SWIFT CURRENT	NO. 4 SASKATOON
NO. 2 REGINA	NO. 5 PRINCE ALBERT
NO. 3 YORKTON	NO. 6 NORTH BATTLEFORD

3. RESULTS

The field phase of the evaluation project took place from February 1 to 6, 1976. An orientation meeting was held on the first day of the project and the morning of the second day was used to standardize examination procedures and to test the form. Following this step, the three teams comprising the examiner and a recorder moved to different schools and independently carried out the clinical examinations. With the exception of Swift Current, all health regions were included. An indirect overview of the geographical distribution of children examined for this project can be obtained from Table 5 and Figure 2. The dental examinations took place in 16 different clinics as follows: Prince Albert, Saskatoon, (4), North Battleford, Biggar, Outlook, Humboldt, Watrous, Hanley, Davidson, Moose Jaw, Fort Qu'Appelle, Indian Head, and Weyburn. A total of 410 children from kindergarten through to grade two were examined. Of these children, 300 were registered with the Saskatchewan Dental Plan while 110 were not enrolled. Of the children participating in the plan, those in grade two were in the second year of the program while children in kindergarten and grade one had been enrolled as of September, 1975.

3.1 Quality of Amalgam Restorations

A total of 2,107 amalgam restorations were assessed by the three examiners. These restorations were classified as follows:

- One-surface restorations in deciduous teeth
- Multi-surface restorations in deciduous teeth
- One-surface restorations in permanent teeth
- Multi-surface restorations in permanent teeth

Within each of the above categories, the quality of the restorations placed by dental nurses is compared to that achieved by dentists. The sample sizes in all categories are sufficiently large to allow such an approach. The results in Table 6 to 9 inclusive are based on a method that rates a superior standard in restorations as 3, an acceptable standard as 2, and an unsatisfactory standard as 1.

TABLE 5
Distribution of Kindergarten, Grade 1 and 2 Children By School And Health Region

Health Region	No. of Schools Represented	No. of Children Examined
2	6	116
3	10	163
4	1	31
5	3	58
6	9	42
Total	29	410

It must be reemphasized that the evaluations were done by three highly qualified clinicians who had no knowledge as to whether restorations had been placed by dentists or dental nurses. The results in Tables 6 and 7 indicate that for deciduous teeth, just over 20 per cent of amalgam restorations placed by dentists tended towards a rating of unsatisfactory whereas from 3 to 6 per cent of restorations placed by dental nurses were so rated. Conversely, approximately 15 per cent of deciduous tooth amalgams placed by dentists tended towards a rating of superior, while amalgams placed by dental nurses were rated as approaching a superior standard in 45 to 50 per cent of restorations. Tables 6 and 7 show the mean quality standards achieved by both dentists and dental nurses and the test of significance indicates a clear difference in favour of the latter group.

The pattern repeats itself when amalgam restorations in permanent teeth were evaluated. From Tables 8 and 9 it can be seen that permanent tooth amalgams placed by dentists tended towards a rating of unsatisfactory in 13 to 19 per cent of restorations while dental nurses placed unsatisfactory amalgams in less than 2 per cent of the restorations assessed. Conversely 22 per cent of permanent tooth amalgam restorations placed by dentists tended to the rating of superior as against a corresponding figure of 45 to 50 per cent in the case of dental nurses. Tables 8 and 9 also indicate the mean quality standards attained by both types of operators and the t-tests demonstrate a significant difference in favour of the dental nurse.

TABLE 6
Quality Of Amalgam Restorations Placed By Saskatchewan Dentists And Dental Nurses — Deciduous Teeth, One-Surface Fillings

Amalgam Quality Level	Percent Distribution	
	Dentists n = 191	Dental Nurses n = 352
	%	%
1.00-1.49	22.5	3.7
1.50-2.50	61.2	44.7
2.51-3.00	16.3	51.6
Mean Quality Level	1.86	2.48
Significance Test	t = 13.0	p < .001

TABLE 7

*Quality Of Amalgam Restorations Placed By
Saskatchewan Dentists And Dental Nurses —
Deciduous Teeth, Multi-Surface Fillings*

Amalgam Quality Level	Percent Distribution	
	Dentists n = 290	Dental Nurses n = 706
	%	%
1.00-1.49	23.1	5.6
1.50-2.50	61.7	49.5
2.51-3.00	15.2	44.9
Mean Quality Level	1.89	2.37
Significance Test	t = 13.2	p < .001

TABLE 8

*Quality Of Amalgam Restorations Placed By
Saskatchewan Dentists and Dental Nurses —
Permanent Teeth, One-Surface Fillings*

Amalgam Quality Level	Percent Distribution	
	Dentists n = 107	Dental Nurses n = 358
	%	%
1.00-1.49	13.1	1.2
1.50-2.50	65.4	49.1
2.51-3.00	21.5	49.7
Mean Quality Level	2.02	2.49
Significance Test	t = 9.02	p < .001

TABLE 9

*Quality of Amalgam Restorations Placed By
Saskatchewan Dentists And Dental Nurses —
Permanent Teeth, Multi-Surface Fillings*

Amalgam Quality Level	Percent Distribution	
	Dentists n = 16	Dental Nurses n = 87
	%	%
1.00-1.49	18.8	0.0
1.50-2.50	59.7	53.0
2.51-3.00	21.5	47.0
Mean Quality Level	1.89	2.50
Significance Test	t = 5.18	p < .001

3.2. Stainless Steel Crowns

A total of 61 children presented with 97 stainless steel crowns. Every crown was assessed by the following criteria: Margin Extension, Margin Adaptation, Occlusion and Tissue Health. The standard used was the same as for amalgams, namely, superior was rated as 3, acceptable as 2 and unsatisfactory as 1. Tables 10 to 13 compare the performances of dentists and dental nurses in each of the 4 criteria relevant to the placement of stainless steel crowns.

In assessing the quality of stainless steel crown restorations placed in the mouths of children examined, the evaluating team, using the procedure analogous to that employed for appraising amalgam restorations, came up with quite a different picture. On all four criteria applied, the dentists and dental nurses appeared to function at the same standard of quality. In no case does the chi-square test of significance approach the critical value. Indeed, the consistency between the two groups is noteworthy.

TABLE 10

*Margin Extension In 97 Stainless Steel Crowns
Placed By Dentists and Dental Nurses*

	Per Cent			N
	Superior	Acceptable	Unsatisfactory	
Dentist	42.1	13.2	44.7	38
Dental Nurse	52.5	18.6	28.8	59

Chi-square = 2.61, 2 df, not significant

TABLE 11

*Margin Adaptation In 97 Stainless Steel Crowns
Placed By Dentists And Dental Nurses*

	Per Cent			N
	Superior	Acceptable	Unsatisfactory	
Dentist	34.2	28.9	36.8	38
Dental Nurse	32.2	35.6	32.2	59

Chi-square = 0.48, 2 df, not significant

TABLE 12

*Occlusion In 86 Stainless Steel Crowns
Placed By Dentists And Dental Nurses*

	Per Cent			N
	Superior	Acceptable	Unsatisfactory	
Dentist	47.1	47.1	5.9	34
Dental Nurse	46.2	46.2	7.7	52

Chi-square = 0.96, 2 df, not significant

TABLE 13

*Tissue Health In 96 Stainless Steel Crowns
Placed By Dentists And Dental Nurses*

	<i>Per Cent</i>			<i>N</i>
	<i>Superior</i>	<i>Acceptable</i>	<i>Unsatisfactory</i>	
Dentist	42.1	42.1	15.8	38
Dental Nurse	37.9	44.8	17.2	58

Chi-square = 0.17, 2 df, not significant

3.3. Radiographs

Three hundred of the 410 children examined were enrolled in the Saskatchewan Dental Plan. Of these 300, the dental charts of 289 children contained mounted sets of bitewing films while 181 charts contained mounted sets of periapical films. The procedure used for evaluating x-ray films was that the whole set was assessed as either acceptable or unacceptable. If one or more of the film sin the sets was unacceptable, the set was so rated and reasons for the negative evaluation were indicated on the form. The latter step was merely to impress the need for precision on the evaluators. Table 14 presents the results of the appraisal of x-ray films. The relative frequency of acceptable films is generally high though 1 in 5 sets of bitewing films was rated as unacceptable. No comparison with the quality of x-ray films routinely taken in private practice was possible.

3.4. Additional Comments

The facilities, equipment and instruments with which the dental nurses work are of a generally high standard. Though the size of the school clinics vary, and their locations occasionally reflect the available rather than the ideal space in the school, the facilities were entirely adequate. In the opinion of the evaluating team, the equipment and instruments provided for the dental nurses were of high quality and particularly well chosen. From the first annual Saskatchewan Dental Plan³² report, it would appear that the over 200 school dental clinics were equipped in a very cost-effective fashion. The decisions to concentrate on a well distributed network of fixed dental clinics and to equip these with modern, functional dental equipment appear to have helped in the successful launching of the program.

TABLE 14

*X-Ray Films — Acceptability of Films
Taken By The Saskatchewan Dental Team*

<i>Type of projection</i>	<i>No. of sets assessed</i>	<i>Percent acceptable</i>
Bitewing	289	81.3
Periapical	181	94.5

Although the physical layout of the 16 clinics visited varied somewhat, certain observations were made repeatedly. Most important, the cleanliness of the clinics was good. The staff appeared to possess a solid grasp on the need to maintain neatness and cleanliness. In addition, the dental nurses and assistants made considerable efforts to maintain an ambiance in the clinics. Quite often this took the form of interesting posters and signs that also served a dental health education function. This is a particularly important factor when managing a dental program for school children.

It was a little difficult to evaluate the effectiveness of the prevention component of the program in as much as it has been in operation for just under two years. As of yet, the results from the preventive dental services provided have not had a chance to appear. Nevertheless, the dental nurse and the dental assistant have attempted to place prevention in proper focus. Time and again it was observed that the emphasis placed on this important aspect of dental care was being received and practiced by children under their care. In this regard, the service rendered by these teams was outstanding. Preventive counselling played a major role in the care of the children. While all clinics were required to have parents present during the initial appointment, the dental nurse-assistant teams felt periodic parental reinforcement was important in maintaining good dental health. Many of the children questioned knew about dental floss but unfortunately, only a relatively small per cent seemed to have this available in their homes. Most of the children questioned were aware of when to clean their teeth. Perhaps more important, almost all children enrolled had received a rubber-cup and pumice application. Virtually all enrolled children had received an initial dental examination and a bite-wing radiograph survey.

A few comments were made in connection with charting. While most of these related to minor inconsistencies, it follows that these should be easy to correct. In some cases there was no definitive treatment plan in the sense that a logical sequence of procedures was omitted. While not being able to compare the appearance of these treatment plans with those routinely seen in private dental practice, it does appear that those persons responsible for outlining a proper treatment plan must continually strive to carry out this function in a satisfactory manner. Occasionally, the performance of clinical treatment procedures were inadequately recorded. Merely checking off the corresponding steps listed in a treatment plan is not, in the evaluating team's opinion, a satisfactory method of recording treatment. For example, it does not cope well with the need for adjusting or changing somewhat the treatment indicated because of unforeseen or altered circumstances. It seems preferable to place the onus on the one carrying out the treatment to properly record all necessary details of the service provided. In spite of these comments, the treatment plan outlined in most cases was easily understood, and the comparison between the treatment proposed and the services provided was impressive.

4. DISCUSSION AND CONCLUSIONS

At the two year point in the operation of the Saskatchewan Dental Plan, the quality of children's dental services assessed by an independent evaluating team must be considered very acceptable. This conclusion is based on the findings made as a result of following the most careful and objective examination methods possible. Aside from the high standard of the treatment services, there is little doubt that the personnel of the Saskatchewan Dental Plan place a good deal of emphasis on the preventive aspects of dental care. Furthermore, the utilization of the Plan is approaching 75 per cent. This must be considered a remarkable achievement, particularly in a province where distances and a low population density are a problem relative to health services delivery. As it presently operates, there is no question that the children's dental program functioning in Saskatchewan is providing much needed dental care to large numbers of children who otherwise would not be receiving it. Together, the very acceptable quality of dental treatment observed, the emphasis placed on prevention, and the impressive coverage achieved by the program left a most favourable impression on the evaluating team.

The evaluating team acknowledges that the results obtained are somewhat consistent with those reported in connection with other studies on expanded duty dental auxiliaries. Thus the excellent performance in placing amalgam restorations achieved by dental nurses is consistent with the results obtained in formal studies, by operating dental auxiliaries functioning in Prince Edward Island¹⁹, Ontario²⁰, Oxbow², Alabama²⁶, Kentucky²², Philadelphia⁶, Minnesota²⁴ and the U.S. Indian health Service³³. In most of the reported studies, operating dental auxiliaries have performed their prescribed restorative procedures at a level equivalent or somewhat superior to dentists. The present findings, therefore, represent no departure from the accumulated evidence.

The standards of quality employed by the evaluating team represented a practical evaluation method. The formulation of the standards reflected a normative approach (what dentists should do in practice) rather than an empirical approach (what dentists actually do in practice) to the evaluation of treatment quality. The normative concept, nevertheless, requires that scoring reflect a realistic rather than an unattainable idealistic standard. The results from the project attest to the fact that the evaluation system was sound and useable. From the tables showing the amalgam data, it is clear that the standards were neither too stringent (unsatisfactory restorations represented fewer than 6 per cent in the case of dental nurses) nor too lenient (unsatisfactory restorations represented up to 23 per cent of fillings in the case of dentists).

How fair was the comparison between dentists and dental nurses in regard to amalgam restorations? Since

the evaluation was done only 18 months after the inception of the program, is it not possible that the fillings placed by dental nurses were newer than those placed by dentists? These are important questions and the evaluation team had to turn its attention to this matter. In the first place, the age of the subjects examined (e.g. kindergarten through grade 2) greatly lessened the potential difference that might have existed in restorations. In the 110 non-enrolled children who provided the greatest number of control restorations, it may safely be assumed that the bulk of the restorations were placed nearer to age 6 or 7 than to age 3. This follows from the combined factors of caries incidence in the primary dentition, dentist practice preferences, and patient utilization patterns, all of which tend to result in slightly later rather than earlier treatment care.

Secondly, the amalgam restorations were not scored on general impression but rather were scored on each of several specific criteria such as Anatomy, Contour, Contact Margins, and Surface Consistency. Some of these criteria are much less likely to be affected by the age of the restoration. Thus the Anatomy of a restoration, including outline form and extension for prevention, should be less influenced by time than would be, say the criteria of Margins and Surface Consistency. In multi-surface restorations, the Proximal Contour and Interproximal Contacts (if applicable) would also be little affected by the age of the restorations. Careful statistical analysis of the data based only on those criteria that would be relatively unaffected by the age of the restorations showed that dental nurses maintained the same favourable performance level.

Thirdly, the data in Tables 6 to 9 were presented separately for the deciduous and the permanent dentition. Considering the age of the child at which the permanent dentition begins to erupt, the age of the children at the time they were examined by the evaluating team, and the length of time the Saskatchewan Dental Plan had been in operation, it seems highly likely that the lifespan of the permanent tooth restorations up to the time of examination was similar regardless of whether dentists or dental nurses had been the operator. From this it is concluded that the differences in quality demonstrated in Tables 8 and 9 could not have been the result of a time influence. On the whole, therefore, it is concluded that the comparison between dentists and the Saskatchewan dental nurses as it pertains to the quality of amalgam restorations is valid at this juncture of the Saskatchewan Dental Plan.

Before leaving the discussion of amalgam restorations, it may be well to ask how one can explain the favourable performance by the dental nurses. In the eyes of the evaluating team, at least three interdependent factors may be at work and there may be a host more that have not been considered. In the first place, it seems very likely that the Saskatchewan dental nurse program

is perceived as an experimental, or metaphorically more apt, a pioneering project. As such, there likely exists the well-known Hawthorne effect which surely must be responsible for an undetermined part of the superiority demonstrated by the dental nurses' amalgam work. Such an effect is temporary in nature and this, though in the context of productivity rather than quality, may have been responsible for the tendency of dental teams incorporating extended-duty dental auxiliaries to have difficulty maintaining peak performance levels.³⁴

Secondly, the nature of the dental nurse training program at the Wascana Institute and particularly the relationship of the clinical training provided in the school to the work requirements in the field must receive considerable credit for the results observed by the evaluating team. Following the team's visit to the Wascana Institute, it is safe to say that the training program is well designed. Noteworthy was the fact that dental nurses appear to gain quantitatively greater experience in placing amalgam restorations than do most students graduating from Canadian dental schools. This is also the pattern in the New Zealand and Australian dental nurse training programs. Under the direct supervision of a large and qualified staff, the carefully selected trainees learn to place quality restorations at a speed commensurate with that required in their future work environment. There is little need for the dental nurse to break stride once they leave the training institution.

A third factor for the present success of the program is probably related to the high degree of organization, standardization and emphasis on continuing education. While it is not the team's intention to review these separately, it is worth noting that already after the first year of operation, the Plan sponsored a three-day course by Dr. E. Spohn and colleagues from Kentucky on the subject of four-handed dentistry. These types of activities are to be encouraged.

Turning to the results of the stainless steel crowns, relatively little can be added to the findings presented in Tables 10 to 13. Dentists and dental nurses are qualitatively similar in their ability to place stainless steel crowns. Two of the three examiners felt that more frequent use of these restorations should have been made, particularly on deciduous first molars exhibiting mesial and distal caries. When questioned, some of the dental nurses expressed a lack of confidence in their ability to place stainless steel crowns properly. This appeared to result in a reluctance on the part of the dental nurses to employ this type of restoration which in turn would decrease their familiarity and aptitude with the stainless steel crown technique. Steps should be taken, both in the training and the field program to rectify this tendency.

The quality of the x-rays taken appeared to be generally good. Though no direct comparison could be made with films taken by dentists, Friedman¹¹ has found that approximately 35 per cent of x-rays taken in dental offices were "diagnostically unacceptable". If this is a

correct figure, then the performance achieved under the Saskatchewan Dental Plan is quite satisfactory. Initially, there appeared to be some problems with the film developing system employed in the school clinics. However, these difficulties seem to have been overcome.

Before proceeding to the conclusions reached by the evaluating team, some general observations should be made. Firstly, an outcome evaluation of specific dental services provided under the Saskatchewan dental Plan indicates that the quality of these services is at a generally high level. In view of this finding, which has been repeated so many times in other studies, one wonders whether the quality of dental services is really at issue. It seems to the three examiners that the findings and conclusions contained in the present report do not reflect a difference in technical ability between dentists and dental nurses, but rather, do reflect the possibility that quality dental services, of a specified nature, are more consistently delivered in a structured rather than open setting. When this is added to the fact that school dental programs achieve considerably higher participation rates, it becomes obvious that the approach taken by the Saskatchewan Dental Plan is very defensible.

This leads to a second general consideration, namely, supervision. As Roder has put it, "The most frequent criticism of the New Zealand program is the limited degree of supervision by dentists."³⁵ Supervision has also been a controversial matter in England.³⁶ While the sixteen dentists employed by the Saskatchewan Dental Plan were responsible for all initial examinations and treatment plans, it is obvious that they could not exercise any measure of direct supervision over the treatment procedures carried out by the dental nurses. On the basis of the data presented here, it would be difficult to insist that more direct supervision of dental nurses take place without making the same suggestion in the case of dentists. Any other conclusion would have to be based on considerations outside the scope of this report. On the whole, it would appear that the essential ingredient in a successful dental nurse program is not supervision as much as it is good organization. A structured and well organized children's dental program would only incorporate that level of supervision which is required to ensure high quality care.

Finally, it must be recognized that the approach used to evaluate the quality of dental services provided under the Saskatchewan Dental Plan was a restrictive one. As Schonfeld⁸ has pointed out, there are several levels on which the quality of dental care can be evaluated. Given the present stage of development of the Saskatchewan Dental Plan, it seemed that any evaluation approach which went beyond the level of the actual services provided would have been premature. Hence, to assess the impact of the children's dental program by looking at the increase in treatment ratios, the decrease in tooth mortality, etc., on a community basis was simply not considered at this time. It is however, an important way of

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assessing the Plan's future success. It is vital that the Children's Dental Program be properly linked to the dental care provided by dentists to the remainder of the Saskatchewan community. Neglecting this point could lead to the same adult dental health problems experienced for many years, though now largely rectified, in New Zealand. No opportunity should be lost to seek and maintain the active support of Saskatchewan dentists for this new children's dental program. Only in this way will the dental health of Saskatchewan people be assured in the future.

Conclusion

1. On the basis of the 410 children examined and the 2,107 amalgam restorations evaluated, the Saskatchewan dental nurse placed amalgam fillings that on the average were better than those placed by dentists.
2. On the basis of 97 stainless steel crowns evaluated, there was no quality difference between the performance by dentists and that by dental nurses.
3. The x-ray films taken under the Saskatchewan Dental Plan were acceptable in 80 per cent of cases. Comparable data for films taken in Saskatchewan dental offices were not available.
4. The incorporation of a method known as the "blind technique" is a major factor in maintaining examiner objectivity.
5. The significant difference in amalgam restoration quality which favoured the dental nurses may have been partially attributable to a combination of the Hawthorne effect, the Wascana Institute's dental nurse training program, and the structure and organization of the field program itself.
6. Though not based on data from this project, it seems likely that the ability differences between the two types of personnel compared is less important than is the different degree of structure found in the respective work settings.
7. Though not based on the obtained data, supervision may be subservient to organization in explaining the current success of the children's dental program.
8. The combined quality and coverage of care achieved by the Saskatchewan Dental Plan after nearly two years of operation is impressive.
9. An evaluation of restorative dental care is adequate for the short term assessment of the Plan, but the long term evaluation must be based on the degree to which dental health has improved in the community as a whole. This implies that the Saskatchewan Dental Plan must earn and maintain the wholehearted support of the Saskatchewan Dental Profession.

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