15.12.77

THE PLANNING AND EVALUATION OF A SCHOOL DENTAL PROGRAMME

PART ONE

A thesis submitted to
fulfil the requirements
for the degree of Doctor
of Dental Science

David Murray Roder, B.D.S., M.P.H.,
Dental Health Branch,
South Australian Department of Public Health

Faculty of Dentistry,
The University of Adelaide,
April 1977

AUTHOR'S STATEMENT AND ACKNOWLEDGEMENTS

The author certifies that the writing of this thesis and the original research were his own undertaking, except where the contrary is stated in the text.

The thesis contains no material which has been accepted for the award of another degree or diploma, nor material written by another person, except when due reference is made in the text.

Mr. D.H.L. Banfield, M.L.C., Minister of Health in South Australia, Dr. P.S. Woodruff, Director General of Public Health, and Dr. H.D. Kennare, Director of the Dental Health Branch, are thanked for their co-operation and for approving the submission of the thesis to The University of Adelaide for the degree of Doctor of Dental Science. Dr. E.A. Fanning, Reader in Preventive Dentistry at The University of Adelaide, is acknowledged for editorial assistance.

Gratitude is extended to members of the following organizations who assisted in the manner described in the text: the Australian Bureau of Statistics, the Commonwealth Scientific and Industrial Research Organisation, and the South Australian Government's Hospitals Department.

David Murray Roder

GENERAL PRESENTATION OF THE THESIS

The thesis is presented in three parts with the following contents:

TEXT - PART ONE

SUMMARY

There is broad acceptance that information from data collection systems and scientific studies should be used for the planning and evaluation of health services.

The administrative complexities which result from greater specialization, the increased sizes of dental practices, the extended use of auxiliaries, forcible consumerism and from more extensive third party payment, apparently have created demands for scientific planning and evaluation in dentistry.

The South Australian Department of Public Health established a dental research unit in 1969. The unit's evaluation studies are reviewed according to their relevance to the total School Dental Programme, individual aspects of the Programme, and to peripheral schemes which could directly influence the Programme's performance.

Investigations based on school dental records suggest that this care has achieved major decreases in the extent of untreated decay, reduced decay rates, and improved oral hygiene.

If school dental care for pre-schoolers and primary school children is to be a basis for a high standard of community dental health, secondary school students might need to seek private care and practise good dental habits. Surveys of second-year secondary school students indicate that school dental care reduces the number of teeth with untreated decay, and improves oral hygiene and gingival health in some instances. Although increased dental knowledge appears to ensue, only about 40 per cent of

students have reported a dental visit since leaving the School Dental Programme.

New Zealand research into tooth loss raises questions about the long-term value of school dental care. Surveys of complete tooth loss were undertaken for South Australian adults, in order to establish a base-line for evaluation of the effects of school dental care and of other dental influences.

The mean annual cost of care per child in a fully developed primary school dental programme was estimated in 1975 values at $27 for South Australia. The cost seemed reasonable when it was compared with specified "fee-for-service" cost standards.

Insofar as available data are relevant to appraisals of the therapists' performance, cost of employment and acceptance by the community, there is support for the contention that these auxiliaries should be employed.

A survey of school dental staff indicated that many dentists felt a need for further training in orthodontics, dental health education, administration and public health dentistry. Most dentists considered that therapists were competent in the performance of their assigned duties.

Studies are described which suggest the effects of sweets in school canteens on decay rates, the impact of programmes directed towards the improvement of school canteen menus, the early benefits of fluoridation, and the effects of features of occlusion on oral hygiene, gingival health, decay and on the incidence of fractured teeth. There should be an adequate availability of

orthodontic specialists to manage the patients referred by school dentists.

The dental research unit's cost has ranged from one to $1\frac{1}{2}$ per cent of the School Dental Programme's budget. This cost seems reasonable when the unit's relevance to "scientific management" is considered.

GENERAL SUMMARY

There is broad acceptance that the planning and evaluation of health services should be a systematic process supported by information from data collection systems and scientific studies, but apparently there has been a lack of objective information for Australian health planning. In South Australia, the Committee of Enquiry into Health Services reported that the collection of data for planning had been rudimentary. This attitude was endorsed in an intra-departmental study by the Department of Public Health, and the advisability of establishing a Bureau of Health Services Development for planning and evaluation was considered. A trend towards scientific planning and evaluation applying to both government and private industry is evident in many countries. The trend apparently is augmented by the growth in size and complexity of organizations, the greater competition for resources, the increased sophistication of schools of administration, and demands imposed by the rapid rate of social and technological change. The hiatus between developments in health technology and their availability throughout the community has signified the need for deliberative health planning so that limited resources might be used more beneficially.

The administrative complexities of dental systems, which follow from greater specialization, the increased sizes of practices, the extended use of auxiliaries, forcible consumerism, and increased third party payment, apparently have created demands for scientific planning and evaluation.

In 1969, a research unit comprising one half-time dentist and two half-time assistants was established by the South Australian Department of Public Health to evaluate fluoridation and the School Dental Programme, which was developing rapidly following the introduction of dental therapists. It was appreciated that pragmatic management would continue to be necessary because many administrative considerations were not suitable for scientific analysis. Nevertheless, it was expected that "scientific management" would increase as the research unit gathered the necessary information. In the present thesis, the research unit's studies are reviewed in the perspective of the planning and evaluation of

(i) the total School Dental Programme;

(ii) individual aspects of the Programme, and

(iii) peripheral schemes which could directly influence the Programme's performance.

1. The total School Dental Programme

A. Dental need and short-term effectiveness of school dental care

At the outset, it was evident that a State-wide survey employing ideal sampling procedures and a small group of calibrated examiners would be appropriate to enable

(i) a systematic placement of clinics according to dental need, and

(ii) a precise evaluation of the short and longer-term effects of school dental care.

Nevertheless, resources were limited and so information

was obtained primarily through data from a base-line fluoridation survey of nine schools, a study in eight schools to determine the dental effects of sweets in canteens, clinical records at the School of Dental Therapy and at 14 dental clinics in regional schools, and from a survey of dental knowledge, attitudes and habits in 1,000 children.

For children without histories of school dental care, it appeared that the mean number of permanent teeth with untreated decay varied from $1\frac{1}{4}$ in 6-year-olds to $2\frac{3}{4}$ in 8-year-olds, $3\frac{2}{3}$ in 10-year-olds and $6\frac{1}{2}$ in 12-year-olds. The corresponding figures for the primary dentition ranged from $5\frac{2}{3}$ in 6-year-olds to $4\frac{3}{4}$ in 8-year-olds, $2\frac{2}{3}$ in 10-year-olds and $\frac{2}{3}$ in 12-year-olds. That is, the total mean number of permanent and primary teeth with untreated decay varied with age from approximately $6\frac{1}{3}$ to $7\frac{1}{2}$. The number appeared to be higher in the lower socio-economic areas. Differences by sex and region were not consistent across the permanent and primary dentitions. The respective approximate mean DMF(T) and df scores were as follows:

(i) $1\frac{1}{3}$ and $6\frac{1}{4}$ for 6-year-olds;

(ii) $3\frac{1}{4}$ and $5\frac{1}{3}$ for 8-year-olds;

(iii) $4\frac{2}{3}$ and three for 10-year-olds, and

(iv) $8\frac{1}{4}$ and $\frac{3}{4}$ for 12-year-olds.

Higher decay rates were evident for both dentitions in the lower socio-economic areas.

Corresponding data on oral hygiene and gingivitis indicated considerable scope for improvement. School dental staff qualitatively rated the following proportions of children as having "good" or "very good" oral

hygiene:

(i) just over 50 per cent for 6-year-olds;

(ii) about 30 to 40 per cent for 8-year-olds;

(iii) approximately 40 per cent for 10-year-olds, and

(iv) about 40 to 50 per cent for 12-year-olds.

A tendency for females to have cleaner mouths was evident. Data from the School of Dental Therapy revealed that staff rated about 40 per cent of subjects qualitatively as having "moderate" or "severe" gingivitis, and this percentage was highest for 8-year-olds.

Data on the children's concurrent dental habits indicated the following:

(i) approximately half consumed sweets or chocolate more frequently than once per week, and frequent consumption was more evident in the lower socio-economic areas;

(ii) approximately three-quarters ate cakes, sweet biscuits or cream buns more frequently than once per week;

(iii) fewer than half always used a fluoride toothpaste, and this proportion was smaller in the lower socio-economic areas, and

(iv) the proportion of primary school children who evidently had taken fluoride tablets daily or "often" decreased with age and varied from about a third in somewhat high socio-economic areas to about one-tenth in specified areas of apparent low socio-economic status.

Information from school dental clinics suggested that about a third of patients brushed their teeth less

frequently than daily, and the fluoridation base-line data indicated that brushing was less frequent in the lower socio-economic areas. The latter data indicated that almost half the primary school children might visit a dentist six-monthly, but that this proportion was smaller in the lower socio-economic areas.

A study of dental knowledge and attitudes amongst 1,000 primary school children in four schools in the State capital indicated that children acknowledged the desirability of dental practices which were recommended by dentists, but that

(i) almost two-thirds considered that they would know if they had dental disease; therefore, these children might not consider that a dental visit was appropriate unless they were conscious that disease was present;

(ii) approximately half seemed to overrate the cosmetic and functional qualities of artificial teeth, and

(iii) approximately a quarter considered that natural teeth should be retained only for periods shorter than a life-time.

The highest mean number of teeth with untreated decay for children with histories of school dental care applied to patients at the School of Dental Therapy. This figure averaged about three teeth across the age-sex specific groups and represented the level of dental health immediately before follow-up care. As the figure presumably would have approximated zero immediately after

care, it is anticipated that these children would have averaged about $1\frac{1}{2}$ teeth with untreated decay mid-way between the courses of care. Therefore, considerably fewer teeth would have been affected than the corresponding mean of from $6\frac{1}{3}$ to $7\frac{1}{2}$ teeth apparent for children without histories of school dental care in the reported surveys. It may be concluded that this care has led to a major reduction in the amount of untreated decay. Also, the low DMF(T) scores for children who had received most courses of school dental care suggest that this care has reduced decay rates.

Data from school dental clinics indicated that children with histories of school dental care had better oral hygiene, and that the cleanest mouths usually applied to subjects who had received the most courses of care. That is, improvements in oral hygiene practices apparently have followed school dental care. Examination records at the School of Dental Therapy revealed superior gingival scores for children with histories of this care.

Although these findings lack the reliability that might be anticipated from State-wide samples chosen by ideal procedures and examined by calibrated examiners, the data nevertheless have been useful when demonstrating

(i) the need for dental services, and

(ii) the effects of dental care at school.

Information on dental knowledge, attitudes and habits has been employed when emphasizing the need for dental health education and when planning associated programmes.

Clinic staff may request processed data on dental health for their regions and for the total State at intervals of three months or longer. The information can be employed in communications with regional staff, parents, teachers and community groups, and offers scope for scientific planning and evaluation at the local level.

B. Dental need and intermediate-term effectiveness of school dental care

Hitherto, school dental care has been restricted to primary school children and pre-schoolers. If the care of these children is to be a basis for a high standard of community dental health, secondary school students might need to practise good dental habits.

Research by previous investigators and the base-line fluoridation study had indicated that secondary school students might average about seven or eight teeth with untreated decay. Although it seemed that a comprehensive State-wide survey by calibrated examiners would be desirable for planning and for the total evaluation of past care, resources were insufficient and surveys were restricted to the major secondary schools which received children from primary schools with dental clinics.

Collectively, these surveys demonstrated an extensive need for dental care, although the need was substantially lower in fluoridated areas and amongst subjects with past histories of school dental care. Whereas decay rates seemed similar, irrespective of whether there was a history of this care, students with

this history tended to have cleaner mouths and less gingivitis in some regions. In certain respects, students exposed to school dental care reported superior oral hygiene practices and were better informed on dental subjects, but the effects of dental health education were not pronounced. Perhaps the most important finding was the lack of professional care after departing from the School Dental Programme: overall, only about 40 per cent of second-year students reported that they had visited a dentist since leaving the Programme.

It is disturbing that there is a lack of dental health education methods which are known to be effective on a community basis, and comprehensive research is required. There is a recent tendency for dental health education projects in the School Dental Programme to include parents, secondary school students, and the active participation of primary and secondary school students as health educators for younger children. In one region, the school dentist and local private practitioners have developed a system, whereby the school dentist enrols children with the private dentist of their parent's choice when the child is no longer eligible for school dental care. The private dentists intend to notify parents when their children's forthcoming dental appointments are scheduled. This system will be evaluated and if found to be effective in promoting continued care, will be recommended in other regions.

C. Dental need and long-term effectiveness of school dental care

Research in New Zealand has revealed substantial evidence of tooth loss in adults, despite the extensive history of school dental care in that country. Although many surveyed individuals might not have received this care, the extent of tooth loss raises questions about the long-term value of school dental care.

As too few South Australian adults would have received this care for ready assessment of the long-term effects at this time, it seems that a base-line appreciation of dental health in adults would permit a subsequent evaluation of school dental care and other dental influences.

Because resources were insufficient for a comprehensive dental survey, the author requested data on complete tooth loss, the wearing of dentures and dental habits from general surveys based on interviews. One reported survey was undertaken through the Department of Public Health in south-eastern South Australia, whereas the second was State-wide. Both employed samples which were assumed to be representative by the Federal Government's Bureau of Statistics.

It seemed that the resulting information had these limitations:

(i) complete loss of teeth was rare in young adults, and so a subsequent evaluation of school dental care would be difficult with these data, and

(ii) although unmet past dental needs were apparent, existing needs only could be inferred from past

experience.

In the south-eastern region, complete tooth loss was evident for the following:

(i) 31 per cent of subjects aged 16 years or more;

(ii) three per cent of 16 to 24-year-olds;

(iii) 30 per cent of 35 to 44-year-olds, and

(iv) 88 per cent of individuals 65 years or older.

Similar collective figures were obtained for country areas in the State-wide survey. However, the proportions with complete tooth loss in the State capital apparently were lower, that is:

(i) 24 per cent for subjects aged 15 years or more;

(ii) one per cent for 15 to 24-year-olds;

(iii) 13 per cent for 35 to 44-year-olds, and

(iv) 75 per cent for individuals aged 65 years or older.

The edentulous state seemed to be more common in females, the lower socio-economic groups, and in subjects born in Australia.

The number of denture wearers was highest amongst the aged, females, individuals born in Australia, and those residing outside the State capital. Approximately 58 per cent of denture wearers had full upper and full lower prostheses, and the next most prevalent dentures were

(i) a full upper denture only, and

(ii) a partial upper denture only.

It was evident from the study in south-eastern South Australia that

(i) females were more inclined than males to visit a dentist for a "routine check", and

(ii) more individuals in the upper socio-economic groups had received restorative care, usually visited a dentist for a "routine check", and had seen a dentist in the past 12 months.

The aged apparently had received less restorative care, were more likely to visit a dentist only when in pain, and were less likely to have seen a dentist in the past 12 months.

D. Cost

The eventual mean annual cost of care per child in a fully developed primary school dental programme, after excluding the training costs of dentists and the travelling and accommodation expenses that are unique to providing care in remote rural localities, was estimated in 1975 values at

(i) $27 for the total State;

(ii) $23 for fluoridated areas;

(iii) $37 for relatively urbanized non-fluoridated areas, and

(iv) $42 for sparsely populated non-fluoridated areas.

These costs are based on estimates for the following:

(i) eventual capital depreciation and maintenance costs;

(ii) the spans of working life of staff;

(iii) the appropriate ratios of dentists to therapists and chairside assistants to dental operators, and

(iv) the final patient loads per operator. Collective results were based on the assumption that fluoridation would not extend further.

The cost of school dental care provided from July to December 1972 seemed "reasonable", when compared with specified "fee-for-service" cost standards. The standard fee schedules were chosen because they appeared similar to those that could apply in conventional private practices.

It was not considered that the relative merits of school dental care and conventional private care had been defined, as the following factors were not considered:

(i) the effects on the dental health of exposed individuals in the immediate and longer term, as related to cost;

(ii) the degrees of utilization;

(iii) the levels of dental health amongst non-utilizers;

(iv) the impacts on costs of travelling expenses, the work time lost by accompanying parents, and taxation, and

(v) relevant future changes that might eventuate in school dental and private dental systems.

To assess the comparative merits of the school dental system and alternative models, social acceptability and innate potentials for constructive developments and change also should be considered.

E. Effectiveness of school dental care, costs and services provided

The application at the State and regional level of information on effectiveness, costs and services provided, when

(i) eliciting support for dental health plans;

(ii) attempting to improve methods;

(iii) establishing a plan with incorporated objectives, and

(iv) assessing the quality of care on the basis of prescribed standards,

has been described. A "Regional feedback summary" was designed whereby clinicians could readily interpret features of performance from statistical information.

2. Individual aspects of the School Dental Programme

A. Productivity

Future dental health manpower requirements largely will depend on the eventual patient loads per operator. Information on patients treated, patients receiving complete care, and on courses of treatment provided and completed, was obtained for each year from 1972 to 1975. Regional data were plotted against the percentage of patients "on recall", and projections were based on a linear regression model. Only non-fluoridated regions were studied, because the effects of fluoridation in the State capital were incomplete. Collectively, the data indicated that in a fully developed primary school dental programme with a recall percentage of 85.7,

(i) a mean of 480 patients might be treated per year per operator, and

(ii) the corresponding number of courses of treatment might be 580.

Higher figures were evident for 1974 and 1975. The data are consistent with an interval of nine months between successive examinations during the working year. The possible reason for substantial differences between the numbers of patients treated and receiving complete care was reviewed.

From July to December 1972, all dental staff were asked to record in minutes the duration of each appointment. Shorter mean times were recorded by dentists than therapists for appointments directed towards each of 10 categories of restorations, and collectively the dentists' mean times were 11 per cent shorter. The differences might have resulted from the greater availability of chairside assistants for dentists, who each had one assistant as opposed to one assistant for two therapists.

B. The diagnostic and treatment-planning skills of therapists

In 1964, the Australian Dental Association expressed support for the introduction of dental therapists in its National Dental Health Policy, but stated that diagnosis and treatment planning should remain with the dentist. In the South Australian School Dental Programme, therapists are responsible for the diagnosis of decay and for associated treatment planning after the initial course of care.

In 1972, each of 470 patients was examined

independently by a dental therapist, a dentist who supervised therapists, and a dentist from the School of Dental Therapy. The study included every operator in these categories who was employed throughout 1972. Examination results and treatment plans for each category of operator were compared, and the findings suggested that the therapists could recognize decay, poor oral hygiene and chronic marginal gingivitis, and could plan appropriate treatment for decay. As the therapists would not have referred approximately 23 per cent of the children whom their supervising dentists would have wished to see, it seemed that dentists should maintain a surveillance of each child.

C. The sealing of fissures by therapists

From New Zealand school dental records, it was apparent that sealants only could have a small effect in reducing the need for occlusal restoration of permanent first molars in non-fluoridated areas over the long term, because of the considerable need for occluso-proximal restorations. Even so, approximately 60 per cent of these teeth were restored initially with an occlusal restoration, and subsequently with an occluso-proximal before the age of 13 years. Therefore, sealant could reduce the need to restore many occlusal surfaces more than once. In fluoridated areas, occlusal surfaces of permanent first molars tended to decay at a later age, and this would facilitate the placement of sealant. As almost half of these teeth needed treatment occlusally

but not occluso-proximally in fluoridated areas, apparently there was considerable scope to reduce the need for occlusal restoration prior to 13 years of age.

Following the New Zealand study, 817 South Australian children with a mean age of 6.9 years were examined, and about 42 per cent of their permanent first molars were assessed as suitable for fissure sealant. Of these teeth, 522 were sealed by 16 dental therapists and were compared with control teeth after one year. The retention rate for the sealant was recorded as 25 to 31 per cent, and the decay rate apparently was reduced by 24 per cent on the test surfaces. The retention rate was low when compared with rates for other studies, and possible reasons were discussed. South Australian dental therapists do not place sealants routinely at this time, but further pilot investigations are planned.

D. Dental health education by therapists

As the effects of dental health education in the School Dental Programme did not seem pronounced, a pilot project was undertaken in which 15 to 17-year-old secondary school students acted as chairside assistants, explored aspects of dental care, and provided dental health education to primary school children. The students were prepared for these tasks by dental therapists, who organized the students' daily schedules.

Each secondary school student participated for four days, and comparisons of 91 test subjects with controls indicated that oral hygiene and gingival health were

improved. The use of recommended types of toothbrushes and fluoride toothpaste seemed to increase, but there was no indication that dental visits increased as a result of the educational programme.

Although the effects on primary school children were not evaluated because of limited resources, the programme seemed an effective means of educating secondary school students, and a potentially effective and efficient method of providing health education to primary school children. Therefore, the programme has been adapted and introduced to other regions, and is being promoted throughout the State.

E. The appropriateness of employing therapists

It is apparent that the following characteristics should be reviewed when considering the appropriateness of employing therapists:

(i) the quality of their care;

(ii) their productivity as related to their cost of employment, and

(iii) their acceptability to the community.

Therapists provide a wide scope of care which was selected for them on the basis of frequent need, the contention that they could acquire the necessary skills in a two-year training programme, and the subjective assessment that qualified therapists performed competently in this regard. Statistical evaluation indicates that therapists can

(i) diagnose decay and chronic marginal gingivitis;

(ii) plan treatment for decay, and

(iii) provide data to indicate the approximate prevalence of certain dental conditions.

Limited information on the failure rates of restorations suggests that the therapists' quality of restorative care is satisfactory. Data suggest that therapists have achieved preventive benefits, and that their placement of fissure sealants has been ineffective, but standards based on the achievements of dentists in this environment are not available for comparisons.

In the perspective of their more limited access to chairside assistants, therapists seem reasonably productive, and this subjective assessment is supported by statistical evaluation of their restorative productivity. The cost of employment per operator in teams of dentists and therapists seems lower than for dentists alone, and the high utilization rates for care provided by teams of dentists and therapists suggest a level of acceptance of these auxiliaries by the community.

Insofar as available data are relevant to appraising the therapists' performance, cost of employment and acceptance by the community, there is support for the claim that they should be employed. Additional relevant considerations, when reviewing the appropriateness of therapists, include

(i) the need for dental manpower;

(ii) the necessary flexibility of the dental system to

accommodate changing manpower requirements and technological innovations;

(iii) the availability of adequate means for controlling auxiliaries, and

(iv) the relative desirability of alternative types of auxiliaries.

F. The attitudes of school dental staff

A survey of the attitudes of field staff in 1974 suggested that central administrators might be too remote, and that general staff might not contribute sufficiently to policy decisions. Static clinics often appeared to lack storage space and waiting areas of an adequate size, and a need was expressed for separate radiography rooms. Maintenance and supply services seemed limited.

Many dentists felt a need for further training in orthodontics, dental health education, administration and public health dentistry, in order to discharge their school dental responsibilities more effectively. Therapists usually were regarded to be as competent as dentists in performing the therapists' tasks. However criticisms were levelled at their performance and training in "community relations", patient management, exposing x-rays, extractions, obtaining impressions for study casts and orthodontic models, administration, and in the maintenance of equipment.

Staff apparently considered their occupations to be relatively interesting in most instances, but regional dentists sometimes were critical of their narrow

clinical scope, the limited opportunity for extended education, and the tedium associated with the repetitive examinations of each therapist's patients. Therapists apparently received least satisfaction from administration, examinations, exposing x-rays, obtaining impressions for study casts and orthodontic models, and from prophylaxes and topical applications of fluoride.

Actions taken to overcome specified problems were discussed, and included

(i) the more frequent visits of administrative staff to field clinics;

(ii) the employment of task forces of field staff to specify organizational goals, to formulate mechanisms for the feedback of data, and to establish standards for dental materials;

(iii) the convening of conferences for all staff;

(iv) the establishment of larger waiting rooms and more storage space in field clinics;

(v) the increase in numbers of maintenance staff and storemen;

(vi) the provision of more scope for extended training in orthodontics and public health, and

(vii) the stronger emphasis of therapy training on areas of perceived weakness.

G. The exposure of x-rays

Approximately 50 x-ray films are exposed per 100 patients in the School Dental Programme each year, but there are large differences in the extent of exposure by region. The detailed policy on the use of x-rays must

be formulated by the dentist, but he may delegate decisions on the need for bite-wing films to therapists, providing that the latter do not obtain films for individual patients at a greater frequency than once every 18 months.

Dental records have indicated that multi-surface restorations might be more common in regions where there is an extensive use of x-rays, and this finding supports the conclusion that x-rays increase diagnostic sensitivity for proximal lesions. Additional diagnostic benefits of x-rays relate to discerning

(i) recurrent decay;

(ii) faulty adaptations of restorations at the gingival margin;

(iii) the location of unerupted teeth, and

(iv) peri-apical lesions and other intra-osseous pathology.

If the use of bite-wing x-rays can introduce economies by increasing the intervals possible between successive examinations, and by reducing the need for multiple restorations of one tooth, their use should be encouraged unless there are major drawbacks which warrant a pre-eminent consideration. It seems that research would be appropriate to determine the potential of x-rays to further the cost-effectiveness of school dental systems.

3. Peripheral schemes

A. The sale of sweets in school canteens

It has been customary for school canteens to

provide sweets, despite contrary advice from health authorities. In 1969, it was apparent that only 24 per cent of canteens in the State capital's government schools and 20 largest private schools did not sell sweets.

Exploratory studies indicated that

(i) decay rates were directly associated with the sale of sweets in canteens;

(ii) decay rates were higher amongst frequent users of canteens which sold sweets, and

(iii) it was not definite that the gross incomes and profits of canteens were related to the sale of sweets.

In a detailed investigation, four test schools removed sweets and 757 students were compared with 753 controls at four schools where the sale of sweets continued. Collectively, the test students had lower decay increments over a two-year period, and this finding was confirmed in each age specific group by scores for subjects who were matched by initial DMF(S) values and by histories of exposure to fluoride tablets. According to the headmasters, the collective profitability of the canteens remained unchanged after the removal of sweets.

The results of surveys have been used when promoting improved menus in canteens. It seems that health educators must maintain constant personal contact with canteens in order to retain "health-promoting" menus. School dental staff can provide this contact, and it is reassuring to find that menus in schools with clinics

are markedly superior to menus at other schools.

B. Fluoridation

The State capital was fluoridated in February 1971 and a base-line survey of students aged six, eight, 10, 12, 14 and 16 years was undertaken at nine primary and six secondary schools. An interim evaluation in 1974 was based on six, eight and 10-year-olds at the nine primary schools.

Results indicated reductions in decay rates for both the permanent and primary dentitions. The reductions in DMF(T) scores approximated 19 per cent for six-year-olds and 15 per cent for both the eight and 10-year-olds. The greatest apparent reduction for the permanent teeth applied to the incisors of 10-year-olds where a 60 per cent decrease was evident, whereas the smallest apparent reduction was seven per cent for the permanent first molars in this age group. Many of these molars only would have been exposed to fluoride after eruption.

Subsequent evaluative studies will be more comprehensive and will include 12, 14 and 16-year-olds. It is anticipated that the reductions in decay rates which will result from fluoridation will diminish markedly the need for school dental manpower.

C. Malocclusion: its significance and treatment

When the decision was made to increase the School Dental Programme's size by introducing therapists, it was recognized that the first priority would be the control of dental decay, followed by the prevention of advanced periodontal disease. It seemed that the comprehensive management of orthodontic disorders would be expensive, and that the provision of specialist care should be

restricted almost entirely to private practitioners. As orthodontic care is an aspect of comprehensive care, it seemed that there should be an adequate availability of private orthodontists to manage the patients referred by school dentists. In this regard, the increase in the number of private specialists from one in 1950 to five in 1960, nine in 1970 and 19 in 1975 is relevant.

Because a common attitude was apparent outside dentistry that orthodontic care was a cosmetic service only, the statistical associations of occlusal characteristics with oral debris, gingival disease, decay and fractured teeth were investigated in prescribed areas of the mouth. A study of 2,057 six to 16-year-olds indicated that certain arbitrarily defined occlusal features were prevalent and were statistically associated with pathology. Specifically, there were positive associations of

(i) crowding with oral debris, gingival disease and proximal decay;

(ii) overjet with oral debris, gingival disease and fractured teeth, and

(iii) crossbite with oral debris and gingival disease.

Although not considered to be proof of causal relationships, these positive associations support plausible theories of cause and effect, and therefore suggest that adequate provision should be made for orthodontic services.

The problem of defining occlusions which should be treated is serious in view of the expense of care and

the apparent high prevalence of potentially detrimental occlusions. The psychological and social significance of single occlusal syndromes in different individuals seems especially difficult to assess.

4. General comments

The cost of the dental research unit has ranged from one to $1\frac{1}{2}$ per cent of the School Dental Programme's budget. This cost seems reasonable when the unit's relevance to "scientific management" is considered. Research enables the improvement of dental procedures, and provides information for communications with Government, the community and health providers. Evaluation mechanisms can enable a system of accountable management to develop whereby the maximum authority for decision-making can be delegated to the regions, and to the lowest organizational levels, without a loss of the appropriate central oversight and control.

Weaknesses are apparent in total manpower planning in South Australia where dentists, therapists, hygienists, technicians, and chairside assistants are trained by separate organizations, and no planning body has the direct responsibility to advise on the relative requirements for these categories of personnel. An excessive output of dental health providers would be wasteful and could lead to industrial conflict, whereas a short-fall would be detrimental to community health.

The most beneficial application of information obtained by the research unit appears to depend on the skills of administrators and clinicians. If these personnel cannot think in quantitative terms, it seems

that the application of this information would be more limited. The desirability of training in public health and health administration for dentists in the School Dental Programme is apparent.

Evaluation of health outcomes should enable health providers to concentrate more on health standards than on care standards. Accordingly, care standards could become more flexible, and might be adjusted more readily to further effectiveness and efficiency.

It is evident that a national dental survey of a representative sample of Australians would be desirable. The employment of calibrated groups of examiners and interviewers could permit the acquisition of data of greater breadth, reliability and sophistication than seems possible from general clinical records and isolated surveys.

I GENERAL INTRODUCTION

There is broad acceptance that the planning and evaluation of health services should be an orderly and deliberative process supported by information from data collection systems and scientific studies.[1,2,3,4,5,6,7,8,9,10] Nevertheless, it seems that objective information for Australian health planning has been lacking.[11,12,13] Sometimes the aims of health services have not been explicit, and evaluation has been a subjective process based on incidental observations and supposition.[11,13,14]

The Committee of Enquiry into Health Services in South Australia reported that data collection for planning and evaluating was rudimentary, and recommended that there be a Director of Research, Planning and Development in a reorganized health system.[13] With the increasing costs of health care, it seems appropriate that planning, evaluation and the collection of data have been listed prominently amongst the proposed functions of the forthcoming South Australian Health Commission.[14,15,16] Moreover, the advantages of establishing a Bureau of Health Services Development to perform these functions were emphasized in an intra-departmental study by the Department of Public Health.[17]

In 1968, the South Australian Government decided to fluoridate the State capital and adjacent country regions.[18] In 1969, dental therapists were introduced to school dental clinics, and a rapid expansion of the State's School Dental Programme commenced.[19]

The need to evaluate these developments was appreciated, and so a research unit comprising one half-time dentist and two half-time assistants was established. Therapists had been employed in the New Zealand School Dental Service for about 50 years, but in accordance with the era, evaluation had been incomplete.[20,21,22,23]

It was anticipated that the initial planning of the developing South Australian School Dental Programme would largely depend on New Zealand information and intuition, but that the results of subsequent evaluation would enable planning to become more reliable and precise.

The piecemeal nature of health planning and evaluation often has paralleled the fragmentary organization of health services, and comprehensive assessments of total performance have been difficult.[3, 6,13,24]

Whereas the dental research unit principally was established to evaluate the School Dental Programme, the analysis of peripheral schemes which could directly influence the Programme's performance was regarded as a major function of the unit. It was anticipated that this broader perspective would permit a comprehensive assessment of a Programme, which primarily was directed towards children in order to establish a basis for a high standard of community dental health.

In this thesis, the programme of planning and evaluation is reviewed according to its relevance to

(i) the total School Dental Programme;

(ii) individual aspects of the Programme, and

(iii) peripheral schemes which could directly influence the Programme's performance.

An initial review of the literature and of materials and methods is general, and relates to the total programme of planning and evaluation. Further details are provided with the appropriate results and discussion when individual components of this programme are described. Subsequently, there is a general discussion with conclusions directed towards the total programme.

II GENERAL REVIEW OF THE LITERATURE

1. Planning in government and private enterprise

A need for more sophisticated methods of management apparently has proceeded from intensified competition, the growth in size and complexity of organizations, and the accelerating rate of technological and social change.[25,26,27]

Consequently, an increased use of "scientific management" has been reported.[2,25,27,28] Long-range planning has emerged as a systematic formalized process in which organizational aims are defined and long-term strategies determined after considering alternatives.[25, 27,28] Strategies are expressed as long-term plans with specified quantitative objectives and sub-objectives.[25, 27,28] Responsibilities for implementing individual programmes are assigned to organizational units with specified budgets and predetermined standards as a basis for control.[25,27,28] Continuous evaluation enables a comparison of performance with standards, and periodic appraisal facilitates a revision of long-term plans and appropriate planning for the future.[25,27,28] Increasingly, policy decisions, assessments of performance and control seem to be based on scientific information, rather than on incidental observations and supposition.[25,27]

There have been accommodations in occupational roles to accompany this change. Historically, accounting has been orientated towards stewardship, and financial accounts have been arranged so as to facilitate inspections by governments, creditors, shareholders, prospective

investors and others.[25,27] Recently there has been a greater emphasis on using data for planning, establishing standards and for monitoring, in order to minimize the need for conjecture.[25,27]

New disciplines have emerged. The development of operations research was stimulated by technical complexities which accompanied the introduction of radar approximately 40 years ago.[2,29,30,31] Scientists have employed mathematical models for the following: to determine the appropriate stock levels; to maximize the benefits derived from resources; to predict the appropriate organization of queues; to plan the appropriate routing of mobile services; to arrange suitable maintenance and replacement cycles for equipment, and to define the costs and benefits of alternative procedures.[27,30]

The development of "scientific management" has been attributed to Frederick Taylor, whose interest was prompted by a desire to increase productivity in the late nineteenth century.[25,26,32] His enthusiasm for applying scientific methods to industry established a basis for further and more sophisticated developments.[26]

During the formation of General Motors in the 1920's, a system of accountable management was developed, whereby maximum authority for decision-making was delegated to the lowest organizational levels with objective yard-sticks for the measurement of performance.[25,33] It is reported that the continuous feedback of data facilitated an extensive delegation without a loss of the necessary

central control.[25]

In government service, an increased employment of "scientific management" also is evident.[34] In 1950, the Budget Accounting Procedures Act was passed by the United States Congress requiring that certain agencies provide cost data for organizational units so as to facilitate control accounting.[25]

In 1961, the Planning-Programming-Budgeting System (PPBS) was applied in the United States Department of Defense.[3,7,25] Results were sufficiently encouraging for the President to announce in 1965 that this technique would be employed in all Federal agencies.[3,24,25] Accounts were classified according to specific programmes, as opposed to items; the aims of organizations were determined; alternative multi-year plans were designed, and anticipated costs and benefits were compared; methods of measurement were defined for the formulation of quantified objectives and for the assessment of achievement according to predetermined standards, and selected plans were revised continually as indicated by experience.[3,7,25]

A similar scheme was introduced in Canada after the Government Organization Act of 1966.[25] The introduction of PPBS in the British government commenced in the Ministry of Defence in 1963.[25]

During the 1960's, an objective-setting routine termed "management by objectives", which was developed in the United States, gained acceptance in the United Kingdom.[25] Managers and their superiors prepared statements of purpose and specific objectives, which the

managers then were committed to pursue.[25]

It appears that the introduction of "scientific management" has been impeded by several factors. Government administrators often are preoccupied with immediate requirements, including those related to Parliament and to the public responsibility of Ministers.[25] Long-term planning seems to receive inadequate attention in this environment.[25]

The quantification of social benefits can be difficult, and scientists have been criticized for developing elaborate mathematical models for data of doubtful validity.[25] Administrators have been frustrated when scientists seemed to underestimate the subtleties of social considerations, quantify simplistically and then treat the data as highly reliable.[25]

Control accounting has been difficult when individual programmes were distributed across large numbers of independent organizations.[25,35]

Methods of "scientific management" evidently have been treated with suspicion. It is reported that the United States Legislature tended to regard PPBS as a tool for the Executive to gain greater power, whereas government agencies sometimes feared that the procedure would increase the external control of their operations.[25] The appropriateness of cost-benefit analyses has been questioned in circumstances where decisions are governed by political requirements.[25]

It is evident that many cost-benefit studies were not conducted in an impartial manner, but were employed

only when they supported vested interests.[25] Exponents tended to over-estimate the competence of organizations to perform these studies when administrators were not accustomed to thinking quantitatively.[25] Organizations without data collection systems frequently could not introduce effective "scientific management".[25]

When planning units were remote from line management, and systems of control were introduced without the participation of staff and in an authoritarian fashion, the rigging of data has been reported and staff have neglected aspects of their responsibilities which were not measured.[25,26]

Traditionally, accounting in government has been directed towards stewardship.[25] The system has not been suitable for "scientific management", and control has been exercised negatively by ensuring regularity and by questioning departures from the norm.[25]

Although the introduction of "scientific management" has been limited by several factors, sufficient benefits seem to have followed for the approach to gain acceptance.[25] It has been reported that organizations have clarified their aims and that administrators have become accustomed to interpreting scientific data.[25] Apparently the approach has led to a greater knowledge of the operations of specific agencies with resulting administrative improvements.[25]

It has been claimed that research clarifies problems so that the authority of the situation tends to replace the authority of individuals or offices, and that this

can reduce interpersonal friction.[36]

2. Health planning

The World Health Organization has resolved that an important prerequisite for the effective organization of national health systems is the establishment of general national plans and local planning.[37]

Numerous reports indicate that there has been an increased employment of "scientific management" in health services, which has paralleled similar trends elsewhere.[3,4,6,7,9,10,11,12,15,24,38,39,40,41]

It has been claimed that the growing hiatus between developments in clinical technology and their availability throughout the community, together with a more common attitude that health is a right, has encouraged the introduction of "scientific management".[4]

Limited resources, the increased sophistication and cost of care, and the competition for resources between the health industry and other community interests apparently have increased demands for modern methods of health planning and evaluation.[2,6,7,8,9,10,11,15] It has been claimed that "scientific management" is particularly appropriate when resources are scarce and the need to maximize their contribution is paramount.[7] Increasingly, politicians and economists seem to expect that quantitative information be presented to support theoretical arguments for resources.[8]

Even so, management still is considered to rely excessively on intuition.[1,9,10] Under the auspices of the European Regional Office of the World Health

Organization, a working party reported that scientific evaluation usually was regarded as essential, but that the process had not been developed sufficiently in any country in the Region.[1]

Although health planning has been comprehensive in socialist countries, its general adoption by nations with free economies has been rare.[1,8,10,11,12,42]

Finland has a five-year national health plan with incorporated objectives and provision for review.[12] Sweden is reported to be testing an innovative objectives-orientated national planning model after considerable experience in the planning of comprehensive health services.[7,12]

Health planning in the United States has emerged with the support of the American Public Health Association, the Association of Management in Public Health, and the United States Public Health Service.[3] The number of planning agencies increased significantly following the enactment of the Community Health Services and Facilities Act of 1961, which authorized financial grants for the area-wide planning of hospitals and related facilities.[24] Further legislation in 1966 led to the replacement of categorical grants by block grants, and to a resulting need for State and local planning.[3] The introduction of PPBS also stimulated activity in health planning.[3,24] Following the National Health Planning and Resources Development Act of 1974, the National Council on Health Planning and Development was established to advise the Department of Health Education and Welfare on national guidelines, the

implementation of programmes and on evaluation mechanisms.[12]

Consideration of a national health plan for Canada followed the publication of a discussion paper by the Department of National Health and Welfare in 1974.[12]

An increased emphasis on planning also is apparent in Australia. In both 1973 and 1974, the Federal government allocated approximately one million dollars for research and planning in the field of health care.[12] The States of New South Wales, South Australia and Western Australia are reported to have health planning bodies.[12] Federal funds have been allocated for planning and evaluation in the Community Health Programme and in the Health Services Planning and Research Programme of the Hospitals and Health Services Commission.[12] Funds have been provided through the Department of Social Security for applied research into rehabilitation.[12]

The Committee of Enquiry into Health Services in South Australia considered that the collection of data for evaluation was undeveloped and that there was a need for personnel who were skilled in evaluation procedures.[13] The Committee recommended that a Health Research Advisory Committee be established to stimulate the flow of resources for research and to co-ordinate the activities of separate research groups.[13] Furthermore, the Committee recommended that the position of Director of Research, Planning and Development be created.[13]

The Committee advised that the administration of health services be regionalized.[13] It has been claimed

that the advantages of decentralization can be achieved only to the extent that standards and measurements are feasible.[43] Evaluation systems must be well-developed if the span of central control is to be widened and lengthened.[43] Accordingly, the regionalization of health administration in South Australia might foreshadow the further introduction of "scientific management".

Although scientific planning and evaluation have increased in health systems, difficulties have been reported. Perhaps the greatest impediment is the difficulty of quantifying variables.[1,2,4,6,7,8,9,24,25,37,39,44,45,46] Health plans should allow for political and social requirements, but these factors can be difficult to measure.[1,4,6,7,44] The concept of health is not definitive, and no universally accepted index is available.[2,6,8,9,24,25,39,44,46] Especial problems are encountered when assessing changes in emotional health, and when immediate evaluation is required but tangible benefits only are anticipated in the long term.[8,37,45]

The comparative performance of programmes can be difficult to interpret when outcomes pertain to different dimensions of health which must be quantified arbitrarily.[31,39] The setting of priorities is complicated when potential effects are obscure.[37]

Because some aspects of health are intangible, features of the delivery process, the health organization and of the associated resources have been compared with standards.[39,40,45,47] Sometimes the relevance of these standards to outcomes has been questionable, and

standards have been modified frequently to conform with changing professional customs.[45] It seems that a consequent lack of confidence can undermine the value of standards for measuring performance.[29] Apparently, standards nominated by reputable clinicians are authoratative, but might be unrealistic for the average health provider with subsequent disillusionment.[45]

It is evident that planning and evaluation cannot rely on scientific methods alone.[4,6,7] Many aspects of health and of the social, political and administrative environment cannot be measured, and so pragmatic administration must continue.[4,6,7] It is claimed that administrators should strive for the ideal balance between pragmatic and scientific methods.[4,6,7]

Frequently, the introduction of scientific methods is opposed by administrators and health providers.[6,40,48,49] Administrators sometimes identify with past methods and resist change.[49] Confronted with immediate responsibilities, staff might not be predisposed to planning.[6,9]

Staff might be suspicious of planners and of unfamiliar, mathematical, planning techniques.[6,9] The fear that planning and evaluation will reduce the health professional's freedom has been reported.[24] In this context, it has been asserted that health providers should become familiar with operational research by participating in these projects.[6]

Comprehensive planning has been limited by insufficient funds, inadequate data and by a shortage of

competent staff.[6,8,40] The report of technical discussions at the World Health Assembly in 1972 stated that only about a third of the world's schools of public health included health economics, sociology, research methodology, and organization and management in their basic postgraduate courses for physicians.[8]

The planning and evaluation of health services have been complicated by the scattered responsibility for providing care.[6,24] For example, apart from the care delivered by private practitioners, health care in South Australia has been supplied by the Federal government, two State government departments, approximately 140 local boards of health, voluntary organizations and hundreds of private hospitals and nursing homes.[13]

Planning and evaluation have been difficult when organizations have indistinct aims.[6,37,40] Sometimes, priorities based on assessments of need, effectiveness and cost, have been changed to satisfy political interests.[7,31] Funds for planning apparently have been withheld because of general economic restraints, even though planning seemed particularly important to maximize the beneficial use of resources in that climate.[6,7,12,15]

Despite these difficulties, the employment of scientific methods in health administration apparently has increased.[3,4,6,7,9,10,11,12,15,24,38,39,40,41] It seems that stages in the planning process can be classified as follows:

(a) Planning the planning, and developing the planning competence [5]

It has been emphasized that the policy-making body should have representation from the political

power structure, the public and from health providers, with health providers contributing increasingly as the planning becomes more detailed and technical.[3,5,7,10,37,39,48,49,50] There is a need for a broad scope of technical skills, and the following types of specialists have been proposed for planning bodies: epidemiologists, biostatisticians, economists, accountants, administrators, social scientists, political scientists, operations research scientists, systems analysts, architects, lawyers and demographers.[3,9,39,40,41,43,45,47,51] It has been stressed that planning bodies should be multidisciplinary and should avoid a composition that is predisposed towards sectional interests.[5,52]

(b) Statement of policy and broad goals[5]

In government health agencies, these aspects are determined politically, but planning bodies may influence political decision-making by providing information.[2,5,7,8]

(c) Data collection[5]

Data and qualitative information might be compiled on the following: the population characteristics and projections; the epidemiological features of health problems; the existing health services and their effectiveness, efficiency, quality, breadth, adaptability, availability, utilization and acceptability to the community; the demand for various types of services; the current

and projected availability of manpower and facilities; the standards pertaining to staff, facilities and performance; the responsibilities and interdependence of various types of health personnel, and the total organization of the health system.[2,4,7,13,38,40,44,50,51]

(d) Statement of priorities[5]

This process has been termed the most intuitive phase of planning.[44] Accordingly, group decision-making might be appropriate to avoid the biases which are associated with individual disciplines.[5,44] For example, an epidemiologist might over-emphasize the importance of disease prevalence and a sociologist might be influenced excessively by community attitudes, whereas an economist might be preoccupied with cost.[5]

Priorities have been decided after reviewing the disease prevalence and severity, the availability and effectiveness of appropriate methods of treatment, their cost, the perceived acceptability of care programmes to the community and to politicians, the legality and propriety of programmes, and the availability of suitable staff.[3,9,38,39,40,41,43,44]

(e) Outline of a plan with a statement of major alternative proposals[5]

The plan should include the following: a definition of the technical requirements; an outline of the appropriate organizational structure and of the required personnel and facilities, and

a statement of the costs and anticipated benefits as related to priorities.[5]

The cost-benefit characteristics of alternative strategies might be difficult to compare by precise mathematical techniques, and so intuitive comparisons may be necessary.[5,8,31,53]

(f) Development of a detailed plan with objectives and standards[5]

It would be appropriate to incorporate long-term goals with relevant objectives and sub-objectives.[1,5,10,38,40,41,52,54] The desirability of organizational units detailing programmes for which they will be responsible has been mentioned as a means of gaining co-operation.[5,10,15,49,54]

It has been reported that when administrative authority is decentralized, well-developed evaluation procedures are necessary to enable the necessary central oversight and control.[43] Consequently there should be standards for staff, facilities and performance, together with agreed targets scheduled for specified periods of time.[29,39,40,41,45,47,52] Standards might relate to health changes and to the quality, quantity and cost of care.[29,39,40,45,47,52]

It is fundamental that staff should regard standards as credible.[29] Apparently standards which consist of statistical interpretations of the past performance of the respective individuals or their peers often are regarded as particularly acceptable.[45]

(g) Implementation as part of the planning process[5]

Frequently implementation is regarded as a part of planning, as through evaluation, it indicates modifications which should be introduced to the plan.[5]

(h) Evaluation[5]

Planning, implementation and evaluation have been regarded as one cyclical process.[5]

Although the final determinant of effectiveness is the health change, difficulties in measurement often have led to assessments of features

(i) of the process of delivering care, such as quantity and quality of care, or

(ii) of the structure for providing care, for example: health manpower, facilities, organizational systems, and working patterns of various types of personnel.[29,39,40,41,45,47,52]

The attitudes of the community have been appraised regarding such features as the programme's acceptability, availability and utilization.[9,39,40,41]

Costs have been assessed and compared with standards.[9,29,40,41,47]

Evaluation often is regarded as two separate processes, namely:

(i) a continuous activity whereby performance is monitored and compared with standards, and

(ii) an episodic comparison of the extent of achievement with objectives.[5,6,40,52]

Apparently the latter usually is undertaken as a basis for reviewing the plan, whereas the former is employed in routine management.[5,6,40,52]

Data can be collected by health personnel in the normal course of their occupations, or through independent surveys.[1,6] The former method may be preferred for reasons of economy or because health providers have local knowledge which facilitates the collection of information.[1,6] Independent surveys often are employed, because more sophisticated techniques are possible and because a greater objectivity in the collection of information is anticipated.[1,6]

Evaluation enables health planning to be supported by objective assessments of experience.[6] Long-range plans may be detailed in the short term only, with further details included only after

(i) an assessment of performance in the early phases of implementation, and

(ii) a review of changes in requirements with time.[44]

When insufficient information is available to justify adoption of a procedure on a broad scale, pilot studies have been undertaken.[49] It has been claimed that the special nature of these studies can prompt superior performance to that associated with normal operations.[49] Apparently an allowance should be made for this factor when assessing the merits of the test procedure. Pilot studies enable testing without disrupting an entire health programme. If evaluated positively, the procedure may be introduced generally, and personnel who participated in the pilot study can assume a training role.[49]

The increasing application of operations research in health administration has been described.[9] Cost-

benefit analyses have limitations when it is difficult to assign long-term investment characteristics to health programmes.[8,31,53] The similar procedure of cost-effectiveness analysis is orientated more towards the short term, and has been considered a valuable means of indicating methods for increasing the ratio of effects to costs.[31] The procedure has been applied to the problems of heart disease, cancer, strokes and injuries from road accidents, but the difficulties of measuring health and of predicting the effects of care, have been emphasized.[29, 31,39,40,41,45,47,52]

Operations research has been employed in health administration in the United Kingdom and France, and has been particularly evident in hospital planning in the United States.[7] The application of this technique has been reported for determining the following: the appropriate frequency of training courses for health personnel; the efficient scheduling of interdependent activities; the probable patient loads; the anticipated periods of confinements in hospitals; the appropriate organizational arrangements of queues; the suitable cycles for the maintenance and replacement of equipment; the possible outcomes of alternative decisions; the segments of large-scale problems that can be managed sequentially; the stock levels appropriate to ensuring supply; the requirements for facilities, and the desirable staffing patterns.[2,3,9] The employment of operations research in health administration apparently has developed markedly since its early use in the British

National Health Scheme over 20 years ago.[29]

Most techniques in systems analysis are recent developments, but they are receiving an increasing application in health administration.[2,7,28] Theoretical models have been employed to indicate which health strategies should be introduced.[2,7,28]

In the United States, PPBS has been used in health administration.[7,24] In Australia, the introduction of methods of "scientific management" to health administration also has been evident.[12,13,15,55]

There is a tendency for comprehensive health planning to be integrated into total social and economic planning, because of the close interdependence of these functions.[7,8,12,37,42,50] The establishment of national planning bodies to achieve this purpose is most evident in socialist countries, but attempts to integrate these activities also are apparent in Australia.[12,13,42]

3. Dental health planning

It seems that "scientific management" has increased in dentistry, in accordance with trends elsewhere.[56,57,58,59,60,61,62,63,64,65,66,67]

The organization of dental care generally reflects the social and political climate.[20,60,68,69] Dental health providers usually are employed by the State in Russia and Eastern Europe, and dental health planning is incorporated into centralized systems of comprehensive social and economic planning.[10,20,68,69] In Western Europe, Scandinavia and the United Kingdom, free economies exist, but social philosophies often support

the participation of governments in the provision of care either by employing health personnel or by the financing of care through private practices.[20,69] In North America and Australia, it has been customary for care to be provided by private practitioners and to be financed by direct payment.[20,69] Apparently the development of dental services in these countries has been influenced more by demand than by deliberative planning.[69]

Nevertheless, an increase in the formalized planning of dental services is evident in these latter countries also.[56,57,59,60,61,64,67,70,71] Moreover, recognition of the need for dental health planning to be compatible with comprehensive health, social and economic planning has emerged.[60,69]

It appears that the need to direct more resources into the field of community health was recognized during the Great Depression of the 1930's.[60,67] In the United States, the Social Security Act of 1935 led to financial grants to the States for the extension of public health services.[67] The number of State health departments with dental divisions increased from 13 in 1935 to 23 in 1940, 45 in 1951 and to 48 in 1968.[67] The first American curriculum in public health dentistry was introduced by The University of Michigan in the late 1930's, and reputedly established a scientific basis for the practice of dental public health.[67] After the development of the DMF index, scientific analyses of the association between decay and fluoride progressed, and fluoridation became a major public health measure.[67,72] The first major

American textbook on dental public health was published in 1949 in response to initial efforts by the Dental Health Section of the American Public Health Association.[67] Four additional comprehensive textbooks on this subject have been published subsequently.[59,60,67,73] In 1951, the American Dental Association approved the American Board of Dental Public Health to certify specialists in dental public health.[67] In the 1960's, Federal grants encouraged the establishment of departments of community dentistry in dental schools, and a report published in 1969 indicated that 32 schools had these departments as opposed to 21 in 1966.[74] In the late 1960's, Federal categorical grants for dentistry were decreased, and dentists were required to participate in planning bodies to ensure funding at the State level.[57] A perceived need for operational research is apparent from the recent offer by the American Fund for Dental Health to finance research and projects aimed at improving the delivery system.[75]

Following a reorganization of the British National Health Service, health planning teams were established at the local level.[58] The area dental officer apparently became responsible for monitoring and co-ordinating the total dental system in his area.[58] It has been reported that a continuous flow of precise data will be needed for planning, management and evaluation.[58]

The expansion of Australian school dental programmes and the introduction of dental insurance might foreshadow an increased emphasis on planning and evaluation.[70,

[76,77,78] School dental care is administered principally by the State governments, which have participated in a special funding agreement with the Federal government since 1973.[78] Although the Australian Dental Services Advisory Council can advise the Federal government on planning and evaluation, and receives recommendations from its Review and Evaluation Committee, only one State has established a unit for dental planning and evaluation.[70]

Although the evaluation of the total New Zealand dental system has been incomplete, it is evident that overseas investigators have been permitted to examine patients and to assess performance.[20,79,80,81,82,83,84,85] Since 1961, the New Zealand Division of Dental Health has employed a dentist on a full-time basis for planning and evaluation.[21] In 1973, New Zealand provided data for an international collaborative study which was performed by the World Health Organization in association with the United States Department of Health, Education and Welfare.[86] Information on health, attitudes and behaviour was collected in six countries with diverse dental systems to assess effectiveness and efficiency.[86]

National dental surveys have been undertaken in the United States, New Zealand, the United Kingdom and Denmark to support planning and evaluation.[21,87,88,89,90] The World Health Organization considers that planning and evaluation should be an integral component of the development of health services.[66] The Organization has produced a manual to assist survey teams to collect dental

data in a similar manner for international comparisons.[66] The manual provides advice on sampling, calibration, the organization of surveys and the presentation of reports.[66] Data processing facilities have been offered for information which is collected as specified in the manual.[66] The trend towards "scientific management" is unmistakable and is exemplified by the Tennessee dental health plan which was introduced in the late 1950's.[20,71] Nevertheless, few public dental programmes employ a systematic approach to planning and evaluation.[20] Auxiliary programmes apparently have developed haphazardly, and more in response to pressures from governments than as a result of deliberative planning by the dental profession.[91] It has been reported that barriers to the introduction of formalized dental health planning include the inflexibility of management styles, the lack of available competence in planning, the difficulties perceived when plans are governed by social and political influences, and the low priority assigned to planning when allocating resources.[20,62] It has been claimed that there is payment for planning directly, or indirectly when a lack of planning leads to reduced performance.[62] Despite an increase in "scientific management", dental administration apparently persists mostly as an art which is based on intuition and opinion.[20,75]

The stages in dental health planning are essentially the same as for general health planning, namely:

(i) planning the planning, and developing the planning competence;

(ii) defining policy and broad goals;

(iii) collecting data;

(iv) defining priorities;

(v) outlining a plan with alternative proposals;

(vi) developing a detailed plan with objectives and standards;

(vii) implementing the plan as part of the planning process, and

(viii) evaluating.[5]

The following information has been reported as essential:

(i) population size, rate of growth, urban-rural distribution, density and age distribution;

(ii) socio-economic characteristics of the community and sources of funds;

(iii) government attitudes towards health services, the levels of authority of dental administrators, and whether dentistry is based on private practice or government employees;

(iv) transport systems and geography;

(v) population characteristics such as ethnic, educational, cultural and religious qualities;

(vi) dental disease patterns, and

(vii) the types, availability, distribution, training characteristics and educational standards of dental health manpower.[20,69,92,93] Information on the water supply system and on fluoride levels also has been regarded as relevant.[92]

As dental health and the effects of exodonture and restorative dentistry can be observed directly, dental

health planners often can assess outcomes readily.[60,94] Compared with many areas of health, there is little need to resort to indirect evaluations based on the delivery process or on the dental health system.[39,45] Nevertheless, difficulties are encountered

(i) when attempting to assess changes in attitudes and behaviour, and

(ii) when predicting treatment needs and costs from the prevalences of conditions.[60,69,95]

These predictions are particularly difficult in the orthodontic field, where cultural and psychological considerations are paramount.[95]

Treatment statistics have been used for quality assessments in the British National Health Service.[60,96] The comparisons of treatment statistics with standards and targets seem to be well established in public health for monitoring performance.[20,60,96,97] For example, the following characteristics might be analysed:

(i) the number of individuals treated per year;

(ii) the percentage of the population treated per year;

(iii) the average number of visits per patient;

(iv) the average number of visits per course of treatment;

(v) the average number of teeth restored per visit;

(vi) the average number of permanent teeth extracted per 100 visits;

(vii) the average number of miscellaneous treatments per 100 individuals;

(viii) the percentage of patients receiving a complete course of treatment;

(ix) the average period of time taken per treated individual;

(x) the average cost of care per patient and per visit, and

(xi) the percentage of individuals requiring restorations.[20,97]

Sometimes, the patterns of care provided by individual operators have been compared with the general pattern to discern discrepancies.[60,96] Although benefits are claimed from the analysis of treatment statistics, the restriction of evaluation to this process has been criticized.[20] It has been reported that the ideal evaluation of effectiveness should incorporate information from dental surveys of samples of the entire community.[20]

The Review and Evaluation Committee of the Australian Dental Services Advisory Council has advised that the evaluation of school dental programmes be based on health changes as well as on treatment statistics.[70]

Increasingly, dental health seems to be regarded as a right, and the apparent inability of the traditional private system to meet community needs and demands has been reported.[98,99] It has been claimed that the system is not suited to overcoming the maldistribution of dentists, the high cost of care, the inadequate use of auxiliaries, the fragmentation of services or the lack of quality control.[99] The cost of dental care provided through Medicaid in New York has been cited to demonstrate the high cost of traditional methods of delivering care.[100] A recent publication describes the relevance of

"scientific management" to traditional general practice.[62] Processes like systems analysis, functional analysis, task inventory analysis, break-even analysis, network analysis, linear programming, and the application of queueing theory, probability theory, cost-benefit analysis and "management by objectives", have been specified as means for improving dental performance.[56,60,62,101,102,103,104,105,106,107,108]

The extended use of auxiliaries, whether they be therapists, hygienists, "expanded duty dental auxiliaries" or chairside assistants, has resulted partly from the desire to reduce costs without losing quality.[56,60,67,109,110] Experimentation with combinations of auxiliaries with different functions has been undertaken, in order to determine how the most desirable cost-effective qualities might be obtained.[98,111] This research and the testing of experimental findings in community settings apparently require sophisticated analyses and judgement.[98] The use of data from the Experimental Dental Care Project at The London Hospital Dental School, when deciding the appropriate combination of dentists and auxiliaries to most efficiently satisfy the specified treatment needs of an institutionalized population, has been described.[111]

The administrative complexities which result from greater specialization, the increased sizes of practices, the extended use of auxiliaries with diverse functions, forcible consumerism and from more extensive third party payment, have created demands for "scientific management".[56,62,63,75,98,103,112,113,114,115,116,117,118,119]

The use of auxiliaries apparently has increased demands for objective quality control.[63,98] Standardized methods of quality assessment which require the direct examinations of patients have been employed.[79,81,84,120,121,122,123] Also, the observed performance of care has been compared with standards, but this method presents logistic difficulties except in contrived experimental circumstances.[60,122]

The third party payment of care has led to cost analyses and quality control.[56,60,63,75,96,106,113,114,115,116,119,124,125,126,127,128] The cost-effective characteristics of dental systems have been compared and absolute costs assessed.[56,100,101,125,127] Although dentists have objected to quality control, apparently they have regarded peer review as more acceptable than scrutiny from outsiders.[56,128]

The introduction of peer review in the United States was deemed by many dentists to be the lesser of two evils.[56,128] Quality control by the direct examinations of patients by a third party has occurred in dental insurance programmes, the Indian Health Service, a dental service for poverty groups in the southern United States, and in city clinics in Philadelphia.[56,60,96,115,126]

Comparisons of treatment statistics with standards have been mentioned for the British National Health Service, and a similar method based on recorded aspects of the examination, the treatment, the process of completing treatment, and the provision for recall, has been investigated.[60,96,129]

It has been claimed that quality may be considered in the context of four levels of service and four dimensions of resources. The levels of service are

(i) the individual treatment;

(ii) the mouth;

(iii) the person, and

(iv) the community,

whereas the dimensions of resources are

(i) the technical;

(ii) the professional logistic;

(iii) the organizational, and

(iv) the funds.[119]

It is apparent that "scientific management" has increased in dentistry, and will extend further as the delivery system becomes more complex, third party payment develops, and efforts are made to contain costs. Numerous studies indicate that the feelings of consumers and dental health providers are being considered.[130,131,132,133,134,135,136,137]

III GENERAL MATERIALS AND METHODS

Details of the materials and methods for individual aspects of the total research programme are presented with the corresponding results, but generalizations are possible.

The author performed all the research and the writing of reports, except where the contrary is stated in the text.

Occasionally data were obtained through other personnel, for example; school dental staff in the course of their normal duties; interviewers employed by the State's Department of Public Health or the Federal government's Bureau of Statistics, or a research assistant attached to the School Dental Programme. In these instances, the data obtained and the methods of collection were prescribed by the author. When data were processed at a Federal or State government computing centre and members of those organizations performed the computer programming, the author detailed the requirements. Occasions where advice was sought from a statistician or an accountant are indicated in the text.

Attempts were made to apply ideal random sampling techniques, but logistic difficulties led to compromises. Therefore, systematic routines based on random starts occasionally were employed.

Dental inspections ordinarily were performed in a mobile dental clinic with mouth mirrors, sickle probes and standard lighting from a head-lamp.

The validity of data frequently was checked by confirming predictable statistical associations, for example:

(i) decay scores with age and sex.[67]

(ii) gingivitis scores with oral hygiene and sex.[67]

(iii) tooth fractures with sex.[138]

(iv) reported dental visits with evidence of restorative care.

(v) reported consumption of cariogenic foods with decay scores.

(vi) reported toothbrushing with oral hygiene and gingival health.[67]

The validity of results also was considered when comparing results with expectations. If results were surprising, possible weaknesses in the research design or in the methods of data collection were reconsidered.

Attempts were made to avoid bias from diagnostic inconsistency. Duplicate examinations were performed to evaluate examiner variability whenever practicable. Except for surveys based on general clinical records, only one examiner was employed, and so inter-examiner calibration was irrelevant. Where possible, test and control subjects were surveyed "blind" and in a haphazard sequence in order to minimize bias from diagnostic variability. Whenever a "mixing" of test and control subjects was not possible, other methods were used to avoid false conclusions from examiner variability. For example:

(i) probes routinely were used for standard numbers of patients.

(ii) short surveying periods were alternated between the test and control groups to reduce bias from changes in diagnostic interpretation with time.

(iii) bite-wing x-rays were exposed with a paralleling device, and were interpreted "blind" after standard processing. Confidence in clinical results was enhanced when they were consistent with x-ray findings.

(iv) the outcomes for test students who had received different exposures to the test variable were compared to see if trends were consistent with total differences between the test and control groups.

(v) when varying effects on different teeth were anticipated, results were compared with this expectation.

(vi) methods of scoring were employed which seemed especially objective. In one survey, a mechanical device was constructed to facilitate objective assessments of the degree of proclination of incisors.

(vii) the time period between the surveying of the test and control groups was minimized to avoid bias from progressive changes in the condition under investigation.

During the surveys, one assistant recorded while another organized the flow of subjects. This procedure, together with the mass sterilization of instruments, the preparation of all forms in advance, and planning to avoid a conflict with school schedules, led to a continuous flow of subjects and a smooth surveying routine. Pauses usually coincided with "school breaks", because

subjects were difficult to locate and it seemed appropriate to relieve surveying fatigue at these times.

Usually the pre-testing of procedures was not practicable, but in several instances this was achieved. Interviewing methods and the designs of questionnaires were tested in pilot surveys, and particular efforts were made to phrase questions so as to elicit a valid response. Subjects were informed that information would be confidential, and "dummy" questions normally preceded those of interest to allow time to gain the subject's confidence.

From 1969 to 1972, access to electronic data processing facilities was limited, and data sometimes were processed with a "Contex 30" mechanical calculator. Accordingly, analyses for that period occasionally were more superficial than subsequently when computer facilities were more readily available and a Canola 167P electronic calculator was purchased.

Statistical means include from one to three decimal places, depending on the appropriate level of accuracy or the design of the computer programme. As employed programmes often were written initially for another of the author's investigations, sometimes the level of accuracy might seem greater than is warranted. The style of presentation of the results has been varied to meet specific requirements and to facilitate interpretation.

IV THE TOTAL SCHOOL DENTAL PROGRAMME

1. Research relevant to the assessment of dental need and effectiveness

1.1 Dental need and effectiveness in the short term

1.1.1 Introduction

Therapists were introduced to South Australian school dental clinics in 1969.[19] At the outset, it seemed that a State-wide survey of dental health and related knowledge, attitudes and habits should be undertaken so that

(i) clinics could be located according to need;

(ii) health education could be directed towards existing problems, and

(iii) an evaluation of subsequent changes in health characteristics would be possible.

It seemed that the employment of ideal sampling procedures and a small number of calibrated examiners would enable schools receiving clinics to be matched with others on the basis of dental characteristics, socio-economic factors and location. Follow-up surveys would facilitate assessments of changes in health and behaviour which followed from school dental care and extraneous influences.

Dental clinics were to be constructed in primary schools only.[19] Existing information on the dental health of primary school children was limited to a report by Reade in 1961 for 199 seven to 14-year-olds.[139] In that study, the mean number of decayed, missing and filled permanent teeth was 6.3, and 4.1 of these teeth

had untreated decay, as assessed with mouth mirrors and probes.[139]

The need for a comprehensive State-wide survey was evident, but resources were insufficient, and so information was obtained from isolated surveys and from school dental records. Although these data would not define the variations in dental health throughout the State, it seemed that collectively they would suggest

(i) the approximate extent of dental disease and unsuitable dental attitudes and habits in school children;

(ii) the appropriate areas for emphasis in health education programmes, and

(iii) the short-term effects of school dental care.

It was expected that data obtained by uncalibrated school dental staff would be too unreliable to detect subtle changes in health, but that major changes would be disclosed. It seemed that this information would be employed for the following purposes:

(i) to inform parents, teachers, the health professions, community groups, health administrators and politicians of the needs for dental care and of the effects of the School Dental Programme, and

(ii) to alert dental staff to the effects of various preventive and educational methods, so that the most effective procedures might be adopted.

Data were collected from these sources:

(i) a base-line fluoridation survey;

(ii) a survey to determine the dental effects of sweets

in school canteens;

(iii) clinical records from the School of Dental Therapy and from school clinics, and

(iv) a survey of dental knowledge, attitudes and habits in 1,000 children.

Studies based on these data are reported separately and discussed collectively.

1.1.2 Base-line fluoridation survey

1.1.2.1 Introduction

The decision to fluoridate the State capital and adjacent country areas, where almost 75 per cent of the State's population reside, was made in 1968 and the process commenced in February 1971.[18,22,140]

In 1969, children from nine primary and six secondary schools in the capital were examined to establish a base-line appreciation of dental health for the evaluation of fluoridation.

1.1.2.2 Materials and methods

A. Sample

Questionnaires on dental habits were sent to the parents of the 4,578 children aged six, eight, 10, 12, 14 and 16 years at the surveyed schools. The schools were selected arbitrarily from widely scattered areas of diverse socio-economic level. The occupations of the examined children's fathers, as indicated by school records, are presented in Table 1.

A sharper socio-economic contrast is evident at the primary than secondary school level (Table 1). Subjectively it seemed that "high" socio-economic primary schools were associated with some of the most affluent

areas of the State, whereas regions served by the "low" socio-economic primary schools contained marked poverty.

Questionnaires were returned for 3,791 (82.8 per cent) children. A total of 2,026 subjects was selected at random for examinations after excluding individuals who apparently

(i) had not resided in the State capital since birth (9.3 per cent). Absences shorter than three months were disregarded.

(ii) had received fluoride tablets (14.8 per cent) or topical fluoride therapy (10.2 per cent). The exclusion of these children might have prompted an underestimation of the level of dental health. As a relatively small proportion was excluded, the total effect possibly would have been small.

(iii) drank tank water more than "city water" (7.3 per cent).

(iv) did not have parental consent for an examination (3.9 per cent).

B. Examination techniques

(a) Clinical

Examinations were performed in a mobile clinic with mouth mirrors, sickle probes which were replaced after 50 examinations, and standard lighting from a head-lamp. Posterior bite-wing x-ray films were exposed with a paralleling device.[141]

The author examined each subject and interpreted the x-ray films, whereas an assistant obtained the x-ray films in a uniform manner.

A classification of decay was made from x-ray films when a definite V-shaped area of increased radiolucency was apparent in the enamel, or when there were definite signs of decay in the dentine. The clinical diagnosis of decay was based on criteria outlined in a World Health Organization Publication.[142]

The DMF(T), DMF(S) and df scores were obtained, as mentioned previously.[142,143] Two changes were introduced, that is:

(i) missing teeth were classified as Mc or Ms, depending on whether their absence was attributed to caries or not respectively, and

(ii) filled teeth were coded as Fc(fc) if carious, and as Fs(fs) if non-carious.

Although independent duplicate examinations were performed on 67 subjects to assess examiner variability before the survey, examinations for the appraisal of examiner variability during the survey were not practicable. The extent of examiner inconsistency may be inferred from Table 2.

(b) Questionnaires

Parents completed questionnaires on the dental habits of their children. Multiple choice questionnaires were used, and an example is presented in Appendix 1. It was anticipated that bias would affect the responses and that judgement would be necessary in the interpretation of results. It was intended that findings primarily would be employed to compare the behaviour of children

from schools representing a "high" and "low" socio-economic level (Table 1).

The statistical associations of reported habits with dental characteristics are evident from Table 3. The numbers of children differ slightly from those included in the base-line results because

(i) there were omissions in the reporting of habits for several children, and

(ii) the numbers in Table 3 included several children who evidently had not resided in the State capital since birth. The gingival disease and oral debris scores were derived from adaptations of the periodontal index and oral hygiene index respectively.[144,145,146]

Although tests of statistical significance have not been performed, it is apparent that the reported dental habits are supported by the examination results. A direct association is evident between

(i) the reported frequency of dental visits and evidence of fillings;

(ii) the DMF(S) scores and the apparent frequency of consumption of sweets and cakes, and

(iii) the reported frequency of brushing and oral hygiene and gingival health

(Table 3). A degree of validity therefore is evident.

C. Statistical analysis

Data were processed at a State government computing centre.

Comparisons are based on the evidence of trends across age specific groups. When calculating standard errors of the mean, each individual was assumed to be an independent element in the sample.

It was predicted that the numbers of males and females in each socio-economic category would be similar, and that socio-economic differences therefore would not result from sex-related dissimilarities. Therefore, the habits of males and females were not analysed separately when undertaking socio-economic comparisons.

Statistical advice was obtained from Mr. K.M. Cellier, Principal Research Scientist, Division of Mathematical Statistics, the Commonwealth Scientific and Industrial Research Organisation, Adelaide.

1.1.2.3 Results and comments (Fluorid. survey)

A. Permanent teeth

There was a considerable extent of untreated decay. The mean number of teeth with untreated lesions ranged from 1.24 for 6-year-olds to 8.03 for subjects aged 14 years (derived from Table 4). In the younger ages, females apparently had more teeth with untreated decay, but this did not apply to 14 and 16-year-olds (Table 4). In five age specific groups, subjects from the "low" socio-economic schools had more teeth with untreated decay (Table 5).

The mean DMF(T) value increased from 1.33 for subjects aged six years to 12.56 for the 16-year age group (derived from Table 4). The mean DMF(T) was higher for females in each age group (Table 4). Also, subjects from

the "low" socio-economic schools had higher DMF(T) scores (Table 5). These differences also were apparent from the DMF(S) scores (Tables 4 and 5).

The mean number of filled teeth was lower in males for five age specific groups (Table 4). Similarly, subjects from the "low" socio-economic schools presented fewer filled teeth in five age specific groups (Table 5).

The mean number of teeth, which apparently were missing as a result of decay, increased from zero for subjects aged six years to 0.60 for 16-year-olds (derived from Table 4) and usually was higher in subjects from the "low" socio-economic schools (Table 5). Approximately a quarter of the 16-year-olds apparently had lost a tooth because of decay (Table 4).

Whereas the percentages of subjects with a positive DMF(T) score increased from 55.1 for 6-year-olds to 99.7 for those aged 16 years, the percentages with a filling were 4.5 and 89.9 respectively (derived from Table 4). At all ages, a smaller percentage of subjects from the "low" socio-economic schools had a filling (Table 5). Only for 16-year-old females did the F to DMF(T) ratio exceed one-third (Table 4). Generally this ratio increased with age and was lower in subjects from the "low" socio-economic schools (Table 5).

The mean number of teeth classified as missing for reasons other than decay usually was lower than the number attributed to decay in the younger age groups, but not so for older subjects (Table 4).

B. Primary teeth

There was extensive decay in the primary dentition

(Tables 6 and 7).

In each age group, the number of teeth which were missing for any reason was higher for females (Table 6). This possibly resulted from earlier exfoliation.[147] Similarly this number was higher in each age group for subjects from the "low" socio-economic schools (Table 7). Possibly more teeth were lost as a result of decay at these schools.

In each age group, subjects from the "low" socio-economic schools had more teeth with untreated decay and fewer fillings (Table 7). The mean number of decayed teeth varied from 6.02 for 6-year-olds to 0.75 for subjects aged 12 years (derived from Table 6).

At all ages, the total number of decayed, missing (for any reason) and filled teeth was higher for subjects from the "low" socio-economic schools (derived from Table 7).

Although the percentages of subjects with positive df values ranged from 93.9 for 8-year-olds to 30.7 for subjects aged 12 years, the percentages with a filling were 42.2 and 11.3 respectively (derived from Table 6). At all ages, fewer females than males and fewer subjects from the "low" than "high" socio-economic schools had a filling (Tables 6 and 7).

The f to df ratios ranged from 0.15 for 8-year-olds to 0.06 for subjects aged 12 years (derived from Table 6). These ratios were consistently lower for subjects from the "low" socio-economic schools (Table 7). Perhaps the lower values in the older age groups followed

decisions not to fill teeth which were about to exfoliate.

C. Permanent and primary teeth

The percentage of subjects with untreated decay was as follows:

(i) 91.7 for 6-year-olds;

(ii) 97.7 for 8-year-olds;

(iii) 98.2 for 10-year-olds;

(iv) 97.9 for 12-year-olds;

(v) 98.2 for 14-year-olds, and

(vi) 98.8 for 16-year-olds.

D. Dental habits

Reported dental habits are summarized in Table 8. Although subjects from the "high" and "low" socio-economic schools apparently consumed cakes, sweet biscuits or cream buns at a similar frequency, a smaller number from "low" socio-economic schools evidently

(i) restricted their intake of sweets to once per week or less;

(ii) had received fluoride tablets daily or "often";

(iii) visited a dentist every six months;

(iv) brushed their teeth at least twice per day, and

(v) used a fluoride toothpaste.

Unfavourable dental habits apparently are common in South Australian children (Table 8). Moreover it is possible that parents might have been defensive and that these results understate the extent of unfavourable dental habits.

1.1.3 Canteen survey

1.1.3.1 Introduction

During 1969 and 1970, four schools removed cariogenic items from their canteens. Two were government schools which clearly were located in low socio-economic regions, whereas two were private schools for boys which seemed to represent a high socio-economic level.

These schools were matched with four additional schools according to

(i) subjective assessments of their socio-economic levels;

(ii) whether they were government or private, and

(iii) the sexes of the students.

A base-line survey was completed at each school for an evaluation of the dental effects of removing cariogenic items from the school canteens. The DMF(T) scores which were derived from this survey are presented.

1.1.3.2 Materials and methods

A. Sample

In the government schools, 1,072 subjects were selected at random from grades two, three and four. The parents of 902 subjects (84.1 per cent) agreed to include their children in the study. In the private schools, 1,154 students aged from seven to 13 years were selected at random from six grades. The parents of 936 students (81.1 per cent) consented to their children's inclusion in the study.

The examinations of 1,729 (94.1 per cent) students had been completed when the DMF(T) characteristics were computed on a "Contex 30" mechanical calculator in order

to satisfy an immediate need for information.

B. Examination techniques

The examinations were performed in the manner described for the base-line fluoridation survey, and duplicate examinations associated with that survey were used to indicate examiner variability in the present study also. It is emphasized that both surveys were undertaken during overlapping periods.

The DMF(T) index was used, as described in a World Health Organization publication.[142]

C. Statistical analysis

Because the purpose of the analysis only was to gain an approximate appreciation of the extent of dental decay, and as processing facilities were restricted to a mechanical calculator, the analysis was cursory and only a determination of DMF(T) scores by age was undertaken.

1.1.3.3 Results and comments (Canteen survey)

The extent of untreated decay seemed considerable. The mean number of teeth with lesions rose from 1.00 for 6-year-olds to 7.03 for subjects aged 13 years (Table 9).

The mean DMF(T) score was 1.07 for 6-year-olds and increased to a maximum of 9.46 for the 13-year-old age group (Table 9).

The F to DMF(T) ratio was lowest in the two youngest age groups (Table 9).

1.1.3.4 Discussion (Canteen survey)

About 85 per cent of subjects under nine years of age attended a government school, and both sexes were represented. The mean numbers of teeth with untreated decay in the fluoridation base-line survey were 1.24 and

2.65 for the six and 8-year-olds respectively (derived from Table 4), as opposed to 1.00 and 2.27 respectively for the present survey (Table 9). In this survey, subjects over nine years of age were males from private schools. The mean numbers of teeth with untreated decay were 2.68 and 5.19 for subjects aged 10 and 12 years respectively (Table 9), whereas the corresponding figures for males in the fluoridation survey were 3.46 and 5.58 respectively (Table 4).

Although the results from these surveys were somewhat similar, consistently better levels of dental health were apparent from the canteen survey. Examiner variability might have been influential, but it seems that the exclusion of children with histories of fluoride therapy from the fluoridation survey, and variations in socio-economic and regional characteristics, could have affected the results.

1.1.4 Surveys based on clinical data: School of Dental Therapy

1.1.4.1 Introduction

The teaching clinic at the School of Dental Therapy commenced operations in July 1968, and children at four neighbouring primary schools were offered care at no direct cost during the subsequent 17 months.

The percentages of parents who enrolled their children for this care varied from 70 to 75 per cent with the school, and did not differ appreciably during the ensuing five years.

Therapy students provided the care at the direction

of dentists. All patients received a prophylaxis, a topical application of "acidulated phosphate fluoride" solution, and dental health education at the chairside. The 12 per cent of children with the worst oral hygiene assessments received additional health education in groups of five.

At the direction of dentists, therapy students also provided the following:

(i) local anaesthesia with infiltrations or inferior dental nerve blocks;

(ii) cavity preparations in permanent and primary teeth and their restoration with silver amalgam or silicate cement;

(iii) extractions of selected primary teeth;

(iv) pulpotomies of vital primary teeth and mummifications of pulpal remnants with formocresol, and

(v) intra-oral x-rays.

Dentists provided care beyond the clinical scope of therapists, for example:

(i) minor orthodontic therapy;

(ii) extractions of permanent teeth;

(iii) endodontic care;

(iv) the treatment of fractured incisors;

(v) the placement of stainless steel crowns, and

(vi) oral surgery.

After the initial course of care, children were recalled for follow-up attention at regular intervals of about eight months.

In this report, the dental health of subjects at their

initial school dental appointment in the 1968-1969 period is compared with the corresponding health of matched individuals in 1971 and 1972. The dental health of subjects classified by exposure to school dental care also is analysed.

The schools and adjacent residential areas received fluoridated water from February 1971.

1.1.4.2 Materials and methods

A. Samples

The records of the initial school dental examinations of 721 patients aged six, eight, 10 and 12 years were selected at random from the total records for the 1968 and 1969 periods. All subjects who were eligible for care were treated at this time, and so a representative sample of the enrolled children was assumed.

A sample of patients presenting in 1971 and 1972 was selected at random, after matching patients with individuals in the base-line by age, sex and school. The number of Greek and Italian children at the schools seemed appreciable, and so subjects in the base-line and follow-up samples also were matched according to whether they were Greek, Italian or another race. The most recent examination record for each patient was used.

Incomplete records were excluded during the processing, and so the numbers of children in the base-line and follow-up samples decreased to 712 and 705 respectively. The samples classified by age, sex and exposure to school dental care, are presented in Tables 10 and 11.

B. Examination techniques

Examinations were performed with mouth mirrors, sickle probes and standard lighting. Posterior bite-wing x-ray films were exposed when considered appropriate, and this applied to 56 per cent of the examinations.

Ten examiners participated in each survey, and there was no formal calibration. Diagnoses therefore related to the patients' clinical needs, as assessed by these examiners.

Records were coded for

(i) electronic data processing at a State government computing centre, and

(ii) compilation of DMF(T) and df scores, as specified in a publication of the World Health Organization.[142]

The assessment of oral hygiene and gingivitis was most subjective. Oral hygiene was classified as "very good", "good", "poor" or "very poor", and gingivitis as "absent", "mild", "moderate" or "severe".

C. Statistical analysis

Differences in the dental health of subjects, classified by exposure to school dental care, were assessed by investigating trends across age-sex specific groups.

When calculating standard errors of the mean, each individual was assumed to be an independent element in the sample.

Results for a sub-group of two subjects were excluded because of insufficient numbers.

1.1.4.3 Results and comments (Clinical data: School of Dental Therapy)

A. Permanent teeth

When the results for subjects without histories of

school dental care were accumulated for both surveying periods, it was evident that the mean DMF(T) score ranged from 1.325 for 6-year-olds to 3.217 for 8-year-olds, 4.846 for 10-year-olds and 7.862 for 12-year-olds (derived from Tables 10 and 11). The mean D scores were

(i) 1.257 for 6-year-olds;

(ii) 3.030 for 8-year-olds;

(iii) 4.408 for 10-year-olds, and

(iv) 7.056 for 12-year-olds

(derived from Tables 10 and 11).

The mean DMF(T) scores for subjects without histories of school dental care were not consistently lower in the 1971-1972 than 1968-1969 period, and therefore did not reveal an effect of fluoridation (Tables 10 and 11).

The F to DMF(T) ratios for subjects, who had not received school dental care, ranged from 0.011 for 8-year-old males to 0.143 for 10-year-old males in the 1971-1972 period (Tables 10 and 11).

Subjects previously treated in the School Dental Programme had considerably fewer teeth with untreated decay. For example, whereas the mean D score varied by age and sex from 0.864 to 3.053 for treated subjects, the extremes for "new" school dental patients were 1.117 and 7.551 (derived from Tables 10 and 11). In each age-sex specific group, treated subjects presented lower mean D scores and higher F to DMF(T) ratios (Tables 10 and 11).

In seven of the eight age-sex specific groups, the collective mean DMF(T) score was higher for "new" school dental patients than for the aggregate with histories of this care (derived from Tables 10 and 11).

In six age-sex specific groups, subjects who had received most courses of school dental care presented the lowest mean DMF(T) score (Tables 10 and 11).

Adequate numbers were apparent in six age-sex specific groups for comparisons between groups of patients who had received school dental care for varying durations. Subjects exposed to more than two courses of care provided a lower mean DMF(T) score in five groups and a lower mean D score in each instance (Tables 10 and 11). The F to DMF(T) ratio was higher for these subjects in five of the six age-sex specific groups (Tables 10 and 11).

The percentages of subjects with positive D scores, amongst those without histories of school dental care, varied from 43.0 for 6-year-olds to 87.2 for 8-year-olds, 94.6 for 10-year-olds and 96.5 for 12-year-olds (derived from Table 12).

In five of the eight age-sex specific groups, the percentage with positive D scores was lowest amongst subjects who had received the most courses of school dental care (Table 12). As permanent first molars usually erupt at about six years of age, little opportunity would present to treat these teeth at an earlier age.[147] If 6-year-old subjects therefore are disregarded, the lowest percentage of subjects with positive D scores in five of the six groups pertained to children who had received the most courses of school dental care (Table 12).

B. Primary teeth

When the results for subjects without histories of school dental care were accumulated for both surveying periods, the mean df score ranged from 5.853 for 6-year-

olds to 5.532 for 8-year-olds, 2.507 for 10-year-olds and 0.724 for 12-year-olds (derived from Tables 13 and 14). The corresponding mean d score was as follows:

(i) 5.543 for 6-year-olds;

(ii) 5.170 for 8-year-olds;

(iii) 2.323 for 10-year-olds, and

(iv) 0.638 for 12-year-olds

(derived from Tables 13 and 14).

The f to df ratios for subjects who had not received school dental care ranged from zero for 12-year-old females in the 1971-1972 period to 0.250 for 12-year-old males and females in the 1971-1972 and 1968-1969 periods respectively (Tables 13 and 14).

Subjects previously treated in the School Dental Programme presented considerably fewer teeth with untreated decay. The mean d score varied with age, sex and the period of the survey as follows:

(i) from 0.156 to 3.059 for subjects with histories of school dental care, and

(ii) from 0.375 to 6.045 for the other children

(Tables 13 and 14).

Subjects with histories of this care presented a lower mean d score and a higher f to df ratio in each age-sex specific group (Tables 13 and 14).

The percentage of subjects with positive d scores was lower amongst individuals with histories of school dental care in each age-sex specific group (Table 12).

No consistent association of d and df scores with the extent of past school dental care was apparent for subjects with histories of this care (Tables 13 and 14). The analysis of decay rates in the primary dentition

is complicated by exfoliation.[67] When the percentages of retained teeth with positive df scores were derived from data presented in Tables 13 and 14, no consistent association of these percentages with the extent of exposure to school dental care was evident.

C. Oral hygiene and gingival health

Prior to school dental care, the percentages of males and females

(i) with "poor" or "very poor" oral hygiene were 58.2 and 53.8 respectively, and

(ii) with "moderate" or "severe" gingivitis were 39.6 and 37.2 respectively

(derived from Table 15).

In each age-sex specific group, subjects with histories of school dental care collectively had superior oral hygiene scores (derived from Table 15). This difference also is apparent when data for the 1971-1972 period are considered separately (Table 15).

Similarly in each age-sex specific group, subjects who had received school dental care collectively presented a superior level of gingival health (derived from Table 15). It seemed that this difference might have applied within the 1971-1972 period, as subjects with histories of school dental care presented better gingival scores in six of the eight age-sex specific groups (Table 15).

1.1.4.4 Discussion (Clinical data: School of Dental Therapy)

When data in Tables 4, 6, 10, 11, 13 and 14 are analysed, it appears that the dental characteristics of

"new" school dental patients in this study were similar to the corresponding characteristics of subjects in the fluoridation base-line survey. In the present study, mean D scores usually were slightly higher, whereas mean df scores and F to DMF(T) and f to df ratios generally were lower. In the fluoridation study, females presented consistently higher mean DMF(T) scores, but a similar trend was not apparent in the present study (Tables 4, 10 and 11). Both surveys revealed an appreciable extent of untreated decay in the permanent and primary dentitions.

Over half of the subjects without school dental histories in the present survey had "poor" or "very poor" oral hygiene, and over a third had "moderate" or "severe" gingivitis.

Although comparisons of data collected by uncalibrated examiners should be interpreted cautiously, several features of this study are important.

Subjects in the 1971-1972 sample had fewer teeth with untreated decay than children in the 1968-1969 sample, and these subjects were matched by race, age, sex and school.

Subjects with histories of school dental care presented consistently fewer mean teeth with untreated decay (D and d), and higher F to DMF(T) and f to df ratios than the other subjects. Higher collective mean DMF(T) scores usually applied to individuals who had not received school dental care. Recorded levels of oral hygiene and gingival health ordinarily were superior in subjects with histories of this care.

It was anticipated that considerable examiner variability might have occurred between the 1968-1969 and 1971-1972 periods. Therefore it is significant that within the 1971-1972 period

(i) individuals who had received school dental care had lower mean D and d scores, higher F to DMF(T) and f to df ratios, and better oral hygiene and gingival assessments.

(ii) individuals who had received more than two courses of school dental care had the lowest mean D and DMF(T) scores, and the highest F to DMF(T) ratios.

No tendency for subjects to be allocated to specific examiners according to histories of school dental care was evident, and so differences within the 1971-1972 sample probably should not be attributed to inter-examiner variability.

It is emphasized that subjects with varying exposures to school dental care were not matched within the 1971-1972 period, and so the possibility of bias from extraneous factors cannot be totally disregarded.

Although inconclusive, results suggest that school dental care has achieved a decrease in the number of teeth with untreated decay, improved oral hygiene and gingival health, and a reduced decay rate in the permanent dentition.

1.1.5 Surveys based on clinical data: school clinics

1.1.5.1 Introduction

Clinics first were established for dental therapists in 14 regional primary schools in 1969 and 1970, and

students henceforth were offered care that was free of direct cost.

The proportion of students with parental consent for care was essentially the same in each school, and constituted 93 per cent when pooled.

In this report, the dental health of students is compared, according to whether they were presenting for initial school dental care or for follow-up attention. Data were selected for the 1969-1970 and 1972-1973 periods. Dental habits were assessed in 1969 and 1970 to indicate appropriate areas for emphasis in dental health education.

1.1.5.2 Materials and methods

A. Samples

The first school dental examination records for all patients (6,697) during the 1969-1970 period were included.

Of these patients, 977 attended two schools with histories of school dental care. One school had received treatment in each of the preceding four years, whereas the other had obtained care in three of these preceding years, including the year immediately before the survey. An undefined number of children at these schools would have been "new arrivals" who had attended schools without histories of this care. Their data possibly would have led to less desirable mean scores for the two schools.

A sample of 6,780 patients was selected for the 1972-1973 period by employing a systematic routine based on a random start. The most recent examination record for each patient was included, and the numbers used per clinic

approximated 500.

It was apparent that the distribution of records by clinics would have differed marginally between the two surveys, and so geographic variations in dental characteristics could have led to differences between the pooled scores. Nevertheless, it seemed that these variations would be small as all schools were located in non-fluoridated country towns with limited general dental services.[70]

B. Examination techniques

(a) Clinical

Information was obtained for each survey by nine dentists with the purpose of providing care and without calibration.

Examinations were undertaken with mouth mirrors, sickle probes and standard lighting. Posterior bite-wing x-ray films were exposed when considered appropriate, and this applied to 31 per cent of the examinations.

Diagnoses were coded for

(i) electronic data processing, and

(ii) compilation of the DMF(T) and df scores, as specified in a publication of the World Health Organization.[142]

However, electronic data processing facilities were not available for the base-line survey, and so a "Contex 30" mechanical calculator was used. A State computing centre was available to process data for the follow-up survey.

Oral hygiene was classified subjectively as "very

good", "good", "poor" or "very poor". As the manner of recording gingival scores varied between the surveys, this information was disregarded.

(b) Questionnaires

Habits were assessed from questionnaires which were completed by the parents. The questions on dental habits were identical to those in Appendix 1, but with an additional question on the type of toothbrush which was used. It was expected that bias would affect the answers and that judgement would be necessary in the interpretation of results. As a consequence of printing difficulties, the distribution of questionnaires was practicable at only eight of the schools, and questionnaires were returned for the corresponding 4,049 surveyed students. Questionnaire results were processed manually without categorizing into sub-groups.

C. Statistical analysis

Variations in the dental health of subjects, who were classified by exposure to school dental care and by the period of the survey, were assessed by investigating trends across age-sex specific groups.

Standard errors of the mean were not calculated for base-line data, because electronic data processing facilities were not available, and these measures are excluded from the report.

Information for sub-groups with five or fewer subjects is not reported, because of insufficient numbers.

1.1.5.3 Results and comments (Clinical data: school clinics)

A. Permanent teeth

It is evident from Tables 16 to 22 that subjects at schools with histories of school dental care in the 1969-1970 survey had superior dental health to other subjects in that survey. The former subjects presented the following:

(i) lower mean D scores in 17 of the 18 age-sex specific groups. The exception applied to 5-year-old females, who were "new arrivals" at school. As permanent teeth normally do not erupt before that age, little opportunity would have presented for them to receive care;[147]

(ii) lower mean M scores in the twelve age-sex specific groups where permanent teeth evidently had been lost;

(iii) higher mean F scores in 15 of the 18 age-sex specific groups. The three exceptions applied to five and six-year-olds;

(iv) lower mean DMF(T) scores in 13 age-sex specific groups;

(v) higher F to DMF(T) ratios in 15 of the 17 age-sex specific groups with positive ratios. The two exceptions were for 5-year-olds, and

(vi) a lower percentage with positive D scores in 12 age-sex specific groups. In four groups the reverse applied, whereas in two groups equal percentages had positive scores.

No more than three per cent of the State's primary school children had received school dental care in any year prior to 1969, and so the dental health at schools without histories of school dental care possibly was more indicative of the general dental status in the country regions of the State.[22]

Data from these schools in the 1969-1970 survey indicated a considerable extent of untreated decay. The mean number of teeth with untreated lesions rose from 1.54 for 6-year-olds to 3.11 for 8-year-olds, 4.40 for 10-year-olds and 7.06 for 12-year-olds (derived from Tables 17, 18 and 19). Females presented higher scores in each age group (Tables 17, 18 and 19).

The mean DMF(T) value for children at schools without previous histories of school dental care increased from 1.56 for 6-year-olds to 3.39 for 8-year-olds, 5.43 for 10-year-olds, and 8.59 for 12-year-olds (derived from Tables 17, 18 and 19). The mean DMF(T) score was higher for females in each age group (Tables 17, 18 and 19).

The F to DMF(T) ratios for children at these schools were as follows:

(i) 0.02 for 6-year-olds;

(ii) 0.08 for 8-year-olds;

(iii) 0.15 for 10-year-olds, and

(iv) 0.13 for 12-year-olds

(derived from Tables 17, 18 and 19). The mean M scores for subjects aged nine years or more were consistently higher in females, and reached a maximum of 0.75 for 13-year-old females (Tables 18 and 19).

For children at schools without histories of school dental care, the following proportions had permanent teeth with untreated lesions:

(i) 55.8 per cent of 6-year-olds;

(ii) 89.3 per cent of 8-year-olds;

(iii) 90.7 per cent of 10-year-olds, and

(iv) 94.6 per cent of 12-year-olds (derived from Tables 20,21 and 22). The percentage was higher for females in each age group (Tables 20,21 and 22).

It is apparent from Tables 17 to 22 that subjects without histories of school dental care in the 1972-1973 survey had better dental scores than subjects at schools without histories of this care in the 1969-1970 survey. For example, the mean D and DMF(T) scores for the former subjects were consistently lower, and a smaller percentage of these individuals had positive D scores (Tables 17 to 22). Although it is not possible to state the reasons for these differences with certainty, it seems that examiner variability was responsible. A recent practice was evident in 1972 and 1973 to provide only cursory examinations for "new" patients, with the intention of restricting initial care to relatively gross lesions. This practice had become popular throughout the School Dental Programme.

Subjects with histories of school dental care presented fewer teeth with untreated decay than other subjects in the 1972-1973 survey, as indicated by age-sex specific groups for subjects over six years of age (Tables 17, 18 and 19). In 13 of the 14 age-sex specific groups with adequate numbers for a comparison, subjects who had received more than three courses of school dental care presented lower mean D and DMF(T) scores than other treated subjects (Tables 17, 18 and 19).

Subjects who had received school dental care presented higher mean F scores and higher F to DMF(T)

ratios than other subjects in the 1972-1973 survey, as indicated by age-sex specific groups for individuals over six years of age (Tables 17, 18 and 19). In 13 of the 14 age-sex specific groups with adequate numbers for a comparison, subjects who had received more than three courses of school dental care presented higher F to DMF(T) ratios than other treated subjects (Tables 17, 18 and 19).

The percentages of subjects with positive D scores in the 1972-1973 survey were the lowest for subjects who had received the most courses of school dental care: this was evident from 13 of the 14 age-sex specific groups for subjects over six years of age (Tables 20, 21 and 22).

B. Primary teeth

It is evident from Tables 20 to 26 that subjects at schools with histories of school dental care in the 1969-1970 survey were less affected by untreated decay than other individuals in that survey. The former subjects presented the following:

(i) lower mean d scores in 17 of the 18 age-sex specific groups. The exception applied to 5-year-old females, who were "new arrivals" at school;

(ii) higher mean f scores in 15 age-sex specific groups. Two of the exceptions related to 5-year-old subjects;

(iii) higher f to df ratios in 15 of the 17 age-sex specific groups with positive ratios. The two exceptions were for 5-year-olds, and

(iv) a lower percentage with positive d scores in 16 age-sex specific groups. One exception applied to individuals aged five years.

Mean df scores usually were higher for subjects at schools

with previous histories of school dental care, but the assessment of decay rates in the primary teeth is complicated by exfoliation (Tables 24, 25 and 26).[67]

Data from schools without histories of school dental care in the 1969-1970 survey indicated a considerable extent of untreated decay. The mean number of teeth with untreated lesions varied from 5.29 for 6-year-olds to 4.21 for 8-year-olds, 2.13 for 10-year-olds and 0.57 for 12-year-olds (derived from Tables 24, 25 and 26). Females presented lower scores in seven of the nine age groups (Tables 24, 25 and 26).

The mean df value for children at schools without histories of school dental care varied from 5.74 for 6-year-olds to 4.79 for 8-year-olds, 2.53 for 10-year-olds and 0.64 for 12-year-olds (derived from Tables 24, 25 and 26). Females presented lower scores in seven age groups (Tables 24, 25 and 26).

The f to df ratios for children at these schools were as follows:

(i) 0.08 for 6-year-olds;

(ii) 0.12 for 8-year-olds;

(iii) 0.16 for 10-year-olds, and

(iv) 0.12 for 12-year-olds

(derived from Tables 24, 25 and 26).

For children at schools without histories of school dental care, the following proportions had teeth with untreated lesions:

(i) 89.5 per cent of 6-year-olds;

(ii) 88.0 per cent of 8-year-olds;

(iii) 66.8 per cent of 10-year-olds, and

(iv) 27.7 per cent of 12-year-olds

(derived from Tables 20, 21 and 22).

It is apparent from Tables 20, 21, 22, 24, 25 and 26 that subjects without histories of school dental care in the 1972-1973 survey had better dental scores than subjects at schools without histories of this care in the 1969-1970 survey. For example, their mean d scores in the younger age groups were lower and the corresponding proportions of these subjects with positive d scores were lower also (Tables 20, 21, 24 and 25). Although it is not possible to state the reasons for these differences with certainty, it is evident that examiner variability was responsible and resulted from a tendency to provide only cursory examinations for "new" patients in 1972 and 1973.

Subjects with histories of school dental care presented fewer teeth with untreated decay than other subjects in the 1972-1973 survey, as indicated by data for the 16 age-sex specific groups with adequate numbers for comparisons (Tables 24, 25 and 26). A smaller percentage of these subjects presented positive d scores in 15 of the 16 age-sex specific groups (Tables 20,21 and 22). These subjects were associated with higher mean f scores and higher f to df ratios (Tables 24, 25 and 26). In 12 of the 14 age-sex specific groups with adequate numbers for a comparison, subjects who had received more than three courses of school dental care presented higher f to df ratios than other treated subjects (Tables 24, 25 and 26).

C. Oral hygiene

Assessments of oral hygiene were similar for the schools in the 1969-1970 survey, irrespective of past histories of school dental care. Accordingly, they are

accumulated in Table 27.

Numbers were adequate in age groups over six years for comparisons between subjects examined in 1969-1970 and those examined in 1972-1973 who

(i) had not received school dental care;

(ii) had received from one to three courses of this care, and

(iii) had received more than three courses of this care.

In the 14 age-sex specific groups for subjects over six years of age, individuals examined in 1972-1973 with histories of school dental care had superior overall oral hygiene assessments than collectively applied to other subjects (Table 27).

D. Dental habits

Results indicate that about half (47.5 per cent) the children ate sweets or chocolate daily or several times a week, whereas three-quarters (74.8 per cent) evidently consumed cakes, sweet biscuits or cream buns to this extent.

The percentage who did not always use a toothpaste containing fluoride was reported to be 59.2 per cent. Approximately one-third (34.7 per cent) apparently brushed less often than daily, and about three-quarters (74.6 per cent) were said to use hard or medium brushes, which are considered to be unsatisfactory.[148] The remainder apparently used soft or multi-soft brushes, and some of these brushes might not have been ideal.[149]

1.1.5.4 Discussion (Clinical data: school clinics)

Results support the previous reported findings by demonstrating a considerable extent of untreated decay in South Australia. For schools without histories of school

dental care in the 1969-1970 survey, mean D and DMF(T) scores were higher and mean d and df scores were lower than the corresponding scores from the fluoridation base-line survey (Tables 4, 6, 17, 18, 19, 24, 25 and 26).

It is apparent that school dental care reduces the number of teeth with untreated decay, and there is an indication that oral hygiene and decay rates in the permanent dentition improve.

Scope for improving dental habits is apparent.

1.1.6 Survey of dental knowledge, attitudes and habits

1.1.6.1 Introduction

The study was undertaken in 1968 to obtain information so that

(i) the need for dental health education could be identified to support requests to administrators for health educational resources;

(ii) the need for health education could be emphasized to dental personnel, other health providers and school teachers, both at the student and graduate level;

(iii) appropriate areas for emphasis in health education programmes might be apparent, and

(iv) a base-line appreciation of these characteristics might be established for evaluation of change.

Information was obtained through questionnaires. Despite pre-testing and advice from the State's Education Department, it was anticipated that bias would affect the results. Children probably would have guessed, misinterpreted and provided answers which they considered might please dentists. Therefore, results are regarded as providing suggestions rather than definitive accounts of

characteristics.

1.1.6.2 Review of the literature

Kegeles proposed a conceptual model, which could represent the interaction of beliefs which influence decisions on health action.[150] It was suggested that an individual must have a "readiness to act" in order to take a voluntary health action.[150,151]

This "readiness to act" is considered likely, if the individual feels

(i) susceptible to the disease, that is, it seems that there is an appreciable chance of being afflicted;

(ii) that there would be serious consequences following affliction by the disease;

(iii) that the need to act is more important that alternative behaviour;

(iv) that the action will be effective in either preventing or alleviating the disease, and

(v) that the action would not cause greater disability than the disease.[150]

It appears that the criteria for ideal action, as suggested by this model, seldom are fulfilled for dental disease. Decay frequently is considered likely but not serious; periodontal disease often is seen as serious but unlikely, and the benefits of recommended dental practices apparently are underestimated.[150,152,153,154] Kegeles reported data which indicated that 80 per cent of individuals who satisfied the criteria for ideal action did act to prevent dental disease.[155]

Rayner has claimed that attitudes often are products of behaviour rather than predecessors.[156] Although

statistical associations between attitudes and behaviour have been established, the development of causal models of dental behaviour are needed to direct attempts to change habits.[156]

The results of the present survey are reported and are related to aspects of the behavioural model proposed by Kegeles.[150]

1.1.6.3 Materials and methods

A. Sample

A total of 1,000 subjects was selected from a private school for boys, a private school for girls, and two integrated government schools. The four schools were located in the State capital.

The schools were chosen because it seemed that collective characteristics might be similar to those for all the subjects in the prescribed school grades in the State capital.

It appeared that students at the private schools would represent a somewhat high socio-economic level, whereas those from the government schools would possess slightly lower than average socio-economic characteristics.

All subjects, apart from absentees (11.4 per cent), in grades four, five, six and seven were included, representing subjects of mean ages nine, 10, 11 and 12 years respectively. The composition of the sample by school and grade is presented in Table 28.

B. Examination techniques

Multiple choice questionnaires were employed, and examples are attached in Appendices 2.1 and 2.2. Students in grades four and five received questions on knowledge and attitudes only, because it seemed that the section on

behaviour would be too difficult and that their concentration would be insufficient to answer all the questions.

Attempts were made to avoid leading questions, and a pilot survey of 35 subjects enabled refinements in phraseology. Members of the State's Education Department reviewed the questions and advised on their suitability.

Students completed the questionnaires in their classrooms in the latter part of the school week under the supervision of teachers, who received a standard list of directions to promote uniformity in the survey's implementation (Appendix 2.3). The aim of the survey was described and teachers were informed that the results for their classes would not be analysed separately, unless they requested these individual data for their own use. Students were encouraged to answer questions accurately. Their names were not placed on the questionnaires, except for 155 subjects who were identified to analyse associations between health, knowledge and behaviour in a separate study.[157] Students were informed that their individual answers would not be known to another person in their school.

C. Statistical analysis

As electronic data processing facilities were not available, the data received limited manual processing. Data were analysed by race, school grade, sex and school, but these analyses were superficial and are not included in this report.[157]

Data are presented to indicate the collective knowledge, attitudes and habits of children in grades six and seven, and the knowledge and attitudes of those in the

lower grades. Although students at the private schools apparently were better informed and practised more desirable habits, their results ordinarily were similar to those for the government schools.[157] Apart from the records of dental care which did vary markedly, the results for all schools are presented collectively.

1.1.6.4 Results and comments (Dent. knowl., attit. and habits)

A. Subjects in grades six and seven

(a) Habits

(i) Cariogenic food

Over half of the subjects (51.4 per cent) reported eating lollies (candy) or chocolate on the day before the survey. Even so, almost three-quarters (71.2 per cent) stated that they preferred potato crisps and nuts.

(ii) Dental visits

The 210 subjects at the private schools (100 per cent) claimed that they had visited a private dentist during the past year. Of the 297 subjects at the government schools who were yet to be offered school dental care, 73 (24.6 per cent) stated that they had never visited a dentist.

Overall, most subjects (82.6 per cent) declared an intention to visit a dentist within the next year.

(iii) Oral hygiene practices

Approximately half of the subjects (44.5 per cent) indicated that they had not brushed their teeth since eating breakfast.

All the students at the private schools reported a dental visit during the past year, but results for 101 (48.1 per cent) indicated that they could not remember toothbrushing advice from a dentist.

Toothbrushes ordinarily were not taken to school: 92.2 per cent of the 538 subjects who did not board at school reported not taking a brush to school daily. The 42 boarders kept their brushes at school permanently. Approximately three-quarters (78.4 per cent) of the non-boarders indicated that they had never taken a toothbrush to school.

Collectively, 96.9 per cent of subjects claimed that they possessed their own toothbrush and 79.7 per cent apparently used a fluoride toothpaste.

(iv) General dental habits

Almost a third of the subjects (31.4 per cent) contended that they were not taking good care of their mouths.

(b) Knowledge and attitudes

Results are related to aspects of the behavioural model presented by Kegeles.[150]

(i) Perceived likelihood of acquiring dental disease

Students were not asked whether they thought that they would acquire dental disease. However it seems significant that only about one-third (36.6 per cent) considered that they might not be aware that they had dental disease, unless they were

shown by a dentist. That is, it appears that most children might not appreciate a need for regular dental examinations unless a dental problem was apparent.

(ii) Perceived seriousness of dental disease

Whereas only 14.8 per cent of subjects indicated that artificial teeth ("false teeth") were as good or better than natural teeth, over half (54.1 per cent) omitted to support the statement that artificial teeth were inferior because they were less attractive and complicated the process of mastication (Appendix 2.1: Part B: Question 2). The disadvantages of artificial teeth, a frequent consequence of untreated dental disease, did not seem to be appreciated fully.

Although 83.8 per cent of subjects stated that primary teeth needed care like permanent teeth, over half (52.8 per cent) omitted to support the statement that crowded permanent teeth often result from not caring for primary teeth (Appendix 2.1: Part B: Question 15).

It was apparent that virtually all the subjects (91.2 per cent) did not consider that dental disease was serious in some people because it could cause infections of the heart.

Subjects seemed unaware of the extent to which decay and diseases of the supporting tissues could lead to a loss of teeth. Over a third (34.5 per cent) apparently were unaware that children mainly

lose teeth as a result of dental decay, and over half (57.9 per cent) evidently did not consider that the aged mainly lose teeth as a result of diseases of the "gums" and bone. It seems widely accepted by the dental profession that the aged mostly lose their teeth as a result of periodontal disease, and this attitude is supported by North American statistics.[67] However, the attitude is yet to receive statistical confirmation in South Australia.

(iii) Perceived benefits of recommended dental habits

Although most subjects (94.5 per cent) considered that cleaning the teeth after eating was appropriate, and 90.3 per cent stated that they should visit a dentist every six months or yearly, a fatalism in the inevitability of artificial teeth was apparent. Almost a quarter (23.3 per cent) reported that they should retain their natural teeth only for periods shorter than a life-time.

Whereas over a third of the subjects (38.6 per cent) apparently did not know that sugar was more cariogenic than other specified items, 90.5 per cent nominated lollies, cake, biscuits and chocolate as more cariogenic than other stated food-stuffs.

Most children acknowledged the desirability of recommended dental practices, but the percentage considering that they would acquire artificial teeth might reflect a lack of confidence in the benefits of these practices.

(iv) Knowledge of dental anatomy

Subjects were asked to indicate the enamel, dentine, pulp, cementum, periodontal membrane, alveolar bone ("bone") and gingival tissues ("gum") on a diagram. An average of 2.7 structures was nominated accurately per student.

Knowledge of tooth anatomy is not related to the behavioural model described by Kegeles.[150] Accordingly it might be appropriate to emphasize the advantages of good dental health and the effectiveness of recommended dental practices, rather than to concentrate on dental anatomy in health lessons.

B. Subjects in grades four and five

Over half of the subjects (59.3 per cent) omitted to support the statement that artificial teeth were not as good as natural teeth because they were less attractive and complicated the process of mastication. Moreover, approximately a quarter (24.5 per cent) reported that they should retain their natural teeth only for periods shorter than a life-time.

Most subjects indicated that

(i) a dentist or therapist should be visited at least once a year (80.7 per cent);

(ii) primary teeth need care like permanent teeth (81.4 per cent);

(iii) lollies, cake, biscuits and chocolate are more cariogenic than other stated food-stuffs (81.2 per cent);

(iv) teeth should be brushed after eating (87.1 per

cent), and

(v) fluoride was included in toothpaste to prevent decay (90.7 per cent).

Most children acknowledged the desirability of recommended dental practices, but the percentage considering that they would acquire artificial teeth might reflect a lack of confidence in the benefits of these practices.

1.1.6.5 Discussion (Dent. knowl., attit. and habits)

In retrospect, several weaknesses in the questionnaire are apparent. For example, "I don't know" often was not included as an optional answer, and this omission might have encouraged subjects to guess (Appendices 2.1 and 2.2). Sometimes answers did not include every possibility: for example, subjects in grades six and seven might have considered artificial teeth to be inferior to their natural counterparts for reasons which were not related to appearance, function, cleanliness nor gingival health (Appendix 2.1, Part B, Question 2). Appearance and masticatory function were grouped into one answer, and subjects might have possessed different attitudes to each factor (Appendix 2.1, Part B, Question 2).

Despite these limitations and the unsophisticated nature of the study, results indicated that children were practising dental habits which were far from ideal. Although they usually acknowledged the desirability of recommended practices, the results indicated that they might have lacked confidence in the benefits of these practices and might have underrated the limitations of artificial teeth.

Dental health educational technology has been reported to be in its infancy.[158,159] The opinion that an informed community would adopt behaviour which is consistent with knowledge is not supported by the present results, nor by experience elsewhere.[153,160,161,162,163] It has been suggested that few people are receptive to traditional modes of dental health education because dental habits tend to be a manifestation of a person's life-style, and life-style is not influenced readily by dental staff.[164] It seems that attitudes might develop in response to existing habits, rather than the reverse, and that the provision of information frequently might achieve only transitory changes in behaviour and the facility to recite fragments of information.[156,164]

Nevertheless, the need for effective dental health education was demonstrated by the results of this study. Results have been used to guide the planning of educational programmes.

1.1.7 Selected overall results

1.1.7.1 Permanent teeth

A review of data for subjects without known histories of school dental care in Tables 4, 9, 10, 11, 17, 18 and 19 indicates that subjects in the 1972-1973 survey of school dental records had markedly superior DMF(T) scores. It was evident that these patients had received more superficial examinations, as described previously in the report.

If data for these subjects therefore are disregarded, individuals without known histories of school dental care collectively presented the following approximate mean D

scores:

(i) $1\frac{1}{4}$ for 6-year-olds;

(ii) $2\frac{3}{4}$ for 8-year-olds;

(iii) $3\frac{2}{3}$ for 10-year-olds, and

(iv) $6\frac{1}{2}$ for 12-year-olds

(derived from Tables 4, 9, 10, 11, 17, 18 and 19). These tables reveal higher recordings for surveys based on school dental records. The highest scores usually pertained to the regional school dental clinics in the 1969-1970 survey, and these clinics provided the only scores for the country regions (Tables 4, 9, 10, 11, 17, 18 and 19). Although it seems that those dwelling outside the State capital therefore might have been affected more severely, misleading findings could have resulted from examiner variability or sampling error.

A tendency for females to present higher D scores is evident when data in Tables 4, 10, 11, 16, 17, 18 and 19 are reviewed collectively. Less favourable scores were evident for subjects in the lower socio-economic regions (Table 5).

Subjects with histories of school dental care presented lower mean D scores, and these scores usually were the lowest for subjects with the greatest apparent exposures to this care (Tables 10, 11, 16, 17, 18 and 19).

If data for the "new" patients in the 1972-1973 survey of school dental records are disregarded, individuals without known histories of school dental care collectively presented the following approximate mean DMF(T) scores:

(i) $1\frac{1}{3}$ for 6-year-olds;

(ii) $3\frac{1}{4}$ for 8-year-olds;

(iii) $4\frac{2}{3}$ for 10-year-olds, and

(iv) $8\frac{1}{4}$ for 12-year-olds

(derived from Tables 4, 9, 10, 11, 17, 18 and 19). These tables reveal higher recordings for surveys based on school dental records. The highest scores usually pertained to the regional school dental clinics in the 1969-1970 survey, and these clinics provided the only scores for the country regions (Tables 4, 9, 10, 11, 17, 18 and 19). Although it seems that subjects dwelling outside the State capital therefore had higher decay rates, misleading findings might have resulted from examiner variability or sampling error.

A tendency for females to present higher DMF(T) scores is apparent from the collective results presented in Tables 4, 10, 11, 16, 17, 18 and 19. Higher scores are evident for subjects in the lower socio-economic regions (Table 5).

If data for the "new" patients in the 1972-1973 survey of school dental records are disregarded, individuals with the greatest apparent exposures to school dental care presented the lowest DMF(T) scores (Tables 10, 11, 17, 18 and 19).

1.1.7.2 Primary teeth

A review of data for subjects without known histories of school dental care in Tables 6, 13, 14, 24, 25 and 26 indicates that subjects in the 1972-1973 survey of school dental records had markedly superior df scores. It was

evident that the associated examinations only were superficial.

If data for these subjects therefore are disregarded, individuals without known histories of school dental care collectively presented the following approximate mean d scores:

(i) $5\frac{2}{3}$ for 6-year-olds;

(ii) $4\frac{3}{4}$ for 8-year-olds;

(iii) $2\frac{2}{3}$ for 10-year-olds, and

(iv) $\frac{2}{3}$ for 12-year-olds

(derived from Tables 6, 13, 14, 24, 25 and 26). Overall, these tables reveal lower scores for surveys based on school dental records, and in particular for data from the regional school dental clinics. The latter scores were the only ones pertaining to regions outside the State capital, and so it seems that these regions were affected less severely. However, these findings might be misleading as a result of examiner variability or sampling error.

Differences relating to sex were inconsistent, but a slight tendency for females to present lower d scores is apparent from the collective results (Tables 6, 13, 14, 23, 24, 25 and 26). Less favourable scores are evident for subjects in the lower socio-economic regions (Table 7).

Subjects with histories of school dental care presented lower mean d scores (Tables 13, 14, 23, 24, 25 and 26).

If data for the "new" patients in the 1972-1973 survey of school dental clinics are disregarded, individuals without known histories of school dental care

collectively presented the following approximate mean df scores:

(i) $6\frac{1}{4}$ for 6-year-olds;

(ii) $5\frac{1}{3}$ for 8-year-olds;

(iii) three for 10-year-olds, and

(iv) $\frac{3}{4}$ for 12-year-olds

(derived from Tables 6, 13, 14, 24, 25 and 26). These tables reveal lower scores for surveys based on school dental records, and in particular for data from the regional school dental clinics. These clinics provided the only scores for regions outside the State capital, and so it seems that these regions might have had the lowest decay rates. Nevertheless, findings might be misleading as a result of examiner variability, sampling error or the exclusion of teeth extracted because of decay. Differences relating to sex were inconsistent, but a slight tendency for females to present lower df scores is apparent from the collective results (Tables 6, 13, 14, 23, 24, 25 and 26).

There also seemed to be a slight tendency amongst subjects with histories of school dental care for df scores to relate directly to the extent of exposure to this care (Tables 13, 14, 23, 24, 25 and 26).

Differences between the df scores for varying socio-economic levels were inconsistent, but as more teeth apparently were decayed, filled or missing for any reason in lower socio-economic areas, decay rates possibly were higher in these localities (Table 7).

The df scores are not regarded as reliable indica-

tions of decay rates, because teeth extracted as a result of decay are not included.[67]

1.1.7.3 Oral hygiene

A review of data presented in the base-line study of regional school dental clinics, and for subjects without known histories of school dental care in other surveys of school dental records, indicates that few children had "good" or "very good" oral hygiene (Tables 15 and 27).

The proportions with these levels of oral hygiene were as follows:

(i) just over 50 per cent for 6-year-olds;

(ii) about 30 to 40 per cent for 8-year-olds;

(iii) approximately 40 per cent for 10-year-olds, and

(iv) about 40 to 50 per cent for 12-year-olds.

These collective assessments are approximate and considerable variations occurred between the studies (Tables 15 and 27). Despite the qualitative method of assessment, the results indicate that oral hygiene was least satisfactory in 8-year-olds, and this finding is supported by scores based on an adaptation of the oral hygiene index (Table 3).[144]

A tendency for females to present superior levels of oral hygiene is apparent when data in Tables 15 and 27 are reviewed collectively.

Although assessments were less desirable for the State capital, as indicated by data from the School of Dental Therapy, it seems unlikely that this single clinic would have provided representative data for the capital. It also seems that the qualitative nature of the assessments would have prompted examiner variability.

A trend for subjects with known histories of school dental care to be associated with superior assessments is evident from Tables 15 and 27. Moreover, those with the greatest apparent exposures to school dental care usually received the most desirable ratings (Tables 15 and 27).

1.1.7.4 Gingival health

Data from the School of Dental Therapy indicated that about 40 per cent of subjects without known histories of school dental care presented "moderate" or "severe" gingivitis, and that the least desirable assessments applied to 8-year-olds (Table 15). Similar findings were based on an adaptation of the periodontal index (Table 3).[146] Differences related to sex were inconsistent (Table 15).

In each age-sex specific group, subjects who had received school dental care presented a superior collective level of gingival health (derived from Table 15).

1.1.7.5 Dental habits

Data from the fluoridation base-line survey, and for subjects attending regional school dental clinics, indicated that approximately half of the subjects consumed sweets or chocolate more frequently than once per week (Table 8). Furthermore, approximately half of the 1,000 subjects included in the additional study reported eating these items on the day before the survey. A frequent consumption of lollies or chocolate was evident, particularly in the lower socio-economic areas (Table 8).

Approximately three-quarters of the subjects in the fluoridation base-line study and survey of patients at the regional school dental clinics reported consuming cakes, sweet biscuits or cream buns more frequently than once

per week (Table 8). The frequent consumption of these items was equally evident in areas of varying socio-economic character (Table 8).

Overall, fewer than 20 per cent of subjects in the fluoridation base-line study apparently had taken fluoride tablets daily or "often", and the proportion decreased with age and seemed lower in the poorer areas (Table 8).

Fewer than half "always" used a fluoride toothpaste, as assessed in the fluoridation base-line study and in the survey of the regional school dental clinics (Table 8). The proportion seemed less desirable in the lower socio-economic areas (Table 8).

Approximately one-third of the patients at the regional school dental clinics apparently brushed their teeth less frequently than daily. The frequency of brushing seemed less ideal in the lower socio-economic areas, as assessed in the fluoridation base-line study (Table 8). Almost half of the 1,000 subjects included in the additional study reported not brushing after breakfast on the day of the survey, and over 90 per cent of non-boarders reported not brushing at school daily.

The proportion who reported visiting a dentist six-monthly was almost half in the fluoridation base-line study, and less frequent attendance was evident in the lower socio-economic areas (Table 8).

It is considered that bias might have been included as a result of defensive attitudes, and that the extent of desirable habits might have been overstated.

1.1.7.6 Dental knowledge and attitudes

Relevant data only were obtained from the study of 1,000 students, and these have been described previously. Overall, it seemed that most students acknowledged the desirability of recommended dental practices. Nevertheless,

(i) almost two-thirds considered that dental disease would be apparent to them if present;

(ii) approximately half seemed to overrate the cosmetic and functional qualities of artificial teeth;

(iii) virtually all students seemed unaware that dental disease could lead to infections of the heart in some individuals, and

(iv) approximately a quarter considered that natural teeth should be retained only for periods shorter than a life-time.

1.1.8 Discussion

It is evident that the number of permanent teeth with untreated decay was considerable in school children without histories of school dental care, and that this especially applied to

(i) older subjects, and

(ii) possibly females and subjects in the lower socio-economic and country regions.

When the number of primary teeth with untreated decay also is considered, an extensive need for dental care is evident. Levels of oral hygiene and gingival health indicated a need for dental health education. Dental habits seemed far from ideal, particularly in the lower socio-economic areas. Moreover, attitudes related to the awareness of dental disease, the extent to which natural

teeth should last a life-time, and the cosmetic and functional qualities of artificial teeth, appeared to be inconsistent with those of the dental profession.

It seems that school dental care leads to

(i) a reduction in the number of teeth with untreated decay;

(ii) a reduced rate of decay in the permanent dentition, and

(iii) improved levels of oral hygiene and gingival health.

Comparative assessments of dental need by locality and evaluation of the effects of school dental care were imprecise, because of limitations in the sampling procedures and the lack of calibration of examiners. It seemed that the qualitative assessments of oral hygiene and gingival health would have been particularly susceptible to examiner variability.

Nevertheless, resulting information has been useful when informing health administrators, politicians and other interested groups of the need for dental care and of the effects of the School Dental Programme. School dental staff have received State-wide data together with specific data for their regions, and this information has been included in communications to parents, teachers, community groups and secondary school students. The purpose of these communications usually was to elicit support for dental health plans. Information on dental knowledge, attitudes and habits has been a basis for planning dental health education programmes. Surveys of these characteristics at the secondary school level have

enabled assessments of the intermediate-term effects of dental health education, and these studies will be reviewed subsequently.

Whereas previous surveys of school dental records have been performed three-yearly and have been based on samples, a recent recommendation by the Review and Evaluation Committee of the Australian Dental Services Advisory Council stated that the data from each examination should be included annually.[70]

In South Australia, carbon copies of examination records are translated to punch cards in the conventional manner, and then to magnetic tapes. Duplicate tapes are forwarded to the Federal Department of Health for the inclusion of data in national figures, and original tapes are retained for local use.

The employment of Optical Character Recognition in preference to punch cards has been reported for the Danish Public Health Services and in the United States.[88, 165] Advantages of reduced cost and of improved speed and accuracy have been mentioned.[165] This facility is not available in South Australia, and therefore was not considered.

An Optical Mark Reader was available at The University of Adelaide, and it conceivably could have been hired by the South Australian Government for the present programme.[166] An appropriate clinical record form was designed, but it was evident that the form would not have been ideal for general clinical application. Considerable space would have been required for the registration of findings, and the replacement of all existing clinical records in the school dental system would have been

necessary.

Accordingly, the present method of obtaining carbon copies for the translation of data to punch cards was preferred. The existing coding instructions, clinical record form, and an example of a copy of clinical data are attached in Appendix 3. The clinic number, post code, "exam" serial number, year of the patient's enrolment in the School Dental Programme, birth date and "exam" date are placed at the top of the copy, together with a record of whether the examination was the subject's first, second or third for the calendar year (Appendix 3.3).

Data are processed using two computer programmes. The first provides mean D, I, M, F, DIMF, d, i, f and dif scores, as recommended in a World Health Organization publication.[66] Results are classified according to age, sex, and whether the subjects are "new" school dental patients or have received this care for three years or less, or for longer periods respectively. The percentages of subjects with each oral hygiene score are classified similarly. The second computer programme processes these characteristics, associated prevalence figures, orthodontic assessments, and information on the crowding of teeth, gingival health, hypoplasia, fractured teeth, the numbers of teeth present, defective restorations, teeth lost for reasons other than decay, and teeth banded or restored but not as a result of decay. These data also are classified by age, sex and exposure to school dental care, and means are presented with standard errors.

Regional dentists may request processed data for

their regions and for the total State at intervals of three months or longer. The information can be employed for on-going evaluation and in communications with dental staff, parents, teachers, community groups and secondary school students. It is envisaged that regional staff will be able to develop dental health plans with definitive health objectives, and that requested data will enable periodic appraisal.

Provision has been made for data to be separated, as prescribed by the regional staff. Therefore, performance may be assessed according to its relation to various dental procedures. Local calibration may be undertaken to increase the reliability of data. Supplementary computer programmes are available on request, if staff wish to compare increments of decay or other scores by applying such inferential statistical tests as the paired t-test. 167

It is expected that provision for evaluation will enable regional staff to improve their methods and will increase the scope for "scientific management".

Nevertheless, without detailed State-wide surveys, the locating of future school dental clinics only will be based on intuitive or indirect interpretations of need. Assessments of dental need seem especially important when resources are limited and considerations relating to demand, cost or political factors do not predetermine the appropriate plan for development.

1.1.9 Summary

These studies collectively indicated a considerable need for dental care in both the permanent and primary

dentitions of school children without histories of school dental care. The number of permanent teeth with untreated decay increased with age, and possibly was higher for females and in the lower socio-economic and country regions. The number of primary teeth with untreated decay decreased in the older age groups, and possibly was higher for the lower socio-economic groups but lower in the country regions. Comparisons between regions possibly were misleading as a result of examiner variability or sampling error.

Subjects without histories of school dental care presented poor levels of oral hygiene and gingival health, which improved in the older age groups. Females seemed to have a better standard of oral hygiene. Although a general acknowledgement of the desirability of recommended dental practices was apparent from one study, dental attitudes and habits seemed far from ideal. Undesirable habits were most evident in the lower socio-economic regions.

Results indicated that school dental care markedly reduces the number of teeth with untreated decay. Findings suggested that decay rates in the permanent dentition, oral hygiene and gingival health also might improve as a result of this care.

The disadvantages of the employed sampling procedures and of the lack of calibration of examiners were discussed. Nevertheless, the value of data when seeking support for a dental health plan, and when planning programmes of dental health education, was emphasized.

The existing method of supplying dental health data to regional staff was described, and its relevance to "scientific management" was mentioned.

1.2 Dental need and effectiveness in the intermediate term

1.2.1 Introduction

The goal of the South Australian Dental Health Branch is to achieve a high standard of community dental health. This has been pursued through universal dental health education and by the direct provision of care to special groups. Although the Branch has administered a programme in which Aborigines receive "free" care from private practitioners, and has provided a limited service to indigent populations, virtually all the resources have been reserved for the treatment of children. Hitherto, school dental care has been restricted to primary school children and pre-schoolers, but it has been expected that this care would extend to secondary schools eventually.[70]

If the care of pre-schoolers and primary school children is to be a basis for a high standard of community dental health, secondary school students might need to practise good dental habits. If these students do not seek follow-up care, the long-term value of school dental care might be negligible.

Therefore, it was decided that the dental characteristics of secondary school students would be surveyed frequently. Resulting data would be used for these purposes:

(i) to assess the intermediate-term effects of school dental care by comparing groups with varying histories of this care;

(ii) to determine the needs for care according to histories of school dental care, and

(iii) to plan dental health education programmes for secondary school students.

Although a State-wide survey of all secondary schools would have permitted a broad assessment of dental needs by region, resources were insufficient. Therefore surveys were restricted to the major secondary schools which received students from the primary schools with dental clinics.

It was anticipated that the resulting information would be conveyed to health administrators, politicians and to other interested groups when accounting for and seeking support for dental health plans.

Two surveys have been completed. The first was undertaken in 1971 and 1972, and the second in 1974. These surveys are reported separately and discussed collectively.

1.2.2 Survey of secondary school students: 1971-1972

1.2.2.1 Introduction

The effect of treatment provided by school dentists and therapists in 1969 and 1970 was assessed by surveying second-year students in 1971 and 1972 respectively. Students with histories of school dental attention received this care at least 17 months before the survey, and in their final primary school year only.

The care was similar to that described for the School of Dental Therapy, although the qualified therapists received less professional supervision than students.

Dental health education was provided at the chairside with the aid of disclosing material, and also in the classroom. In approximately half the regions, instruction routinely was provided to children in small groups. As fewer than 15 per cent of parents visited a school clinic, parents received written information on the dental health of their children. The dental health education programmes were designed by the regional dentists, and the programmes varied considerably.

1.2.2.2 Review of the literature

No previous surveys had been undertaken to evaluate the intermediate-term effects of school dental care in South Australia.

In 1969, Fanning, Gotjamanos and Vowles reported a survey of 2,258 students at eight government and two private schools in the State capital.[168] The mean D score for students of mean age 14 years was 7.40, whereas the corresponding mean DMF(T) was 11.72.[168] Treatment needs were more apparent amongst the lower socio-economic groups.[168]

Similar results were obtained from the fluoridation base-line survey. That is, the mean D and DMF(T) scores for 14-year-olds were 8.03 and 11.08 respectively, and treatment needs were more evident amongst the lower socio-economic groups (derived from Tables 4 and 5).

1.2.2.3 Materials and methods

A. Samples

The surveyed students were selected from the 10 country schools which corresponded to the regions where clinics staffed by dentists and therapists first opened

in 1969 and 1970.

Second-year students, who claimed a history of school dental attention during their final primary school year, were selected for comparisons with control subjects from the same secondary schools. In six schools, the controls were class-mates who were matched by sex but were selected at random. In the other schools, the number in both groups was similar and all second-year students were included.

A total of 1,476 subjects was selected, but 116 (7.9 per cent) did not participate either because they were absent from school or because their parents preferred that they be excluded. A further nine subjects (0.6 per cent) were not examined because of orthodontic appliances, but nevertheless were interviewed and completed questionnaires. The loss of subjects from the test and control groups was equivalent.

The 1,351 examined subjects presented the following school dental histories:

(i) 650 apparently had received attention from school dentists and therapists in their final year at primary school only;

(ii) 645 stated that they had not received school dental care, and

(iii) 56 students from outlying rural communities had been treated by school dentists who were not assisted by therapists.

Information for the last group is excluded from the report, because of insufficient age-sex specific numbers.

In 1969, school dental clinics commenced operations in industrial urban centres, whereas those established in 1970 were located in communities with an apparent agricultural base. The corresponding secondary schools were surveyed in 1971 and 1972 respectively, and their results are presented separately.

Subjectively, the socio-economic characteristics of the test and control groups were equivalent. This factor possibly was balanced indirectly by matching test students with class-mates in six of the schools. Students had been assigned to classes so that class-mates would have similar academic abilities and vocational aspirations, and these characteristics apparently are associated with socio-economic level.[169] The percentages of students in classes directed towards a preparation for a high level of tertiary education were 33.6 for the test group and 32.0 for the controls.

The samples classified by area, age, sex and history of school dental care, are presented in Tables 29 and 30.

B. Examination techniques

(a) Clinical

The author performed the examinations in a cursory manner, so as to reduce the surveying period and therefore conserve limited resources.

Examinations for decay were undertaken as for the fluoridation base-line survey, except that probes were replaced after 100 examinations and x-ray films were not used. Restorations were identified as "defective" when a cavity wall was visible at a glance.

Modifications of the periodontal index and oral hygiene index were employed, and assessments were based on the labial faces of the anterior teeth and gingivae.[144,145,146] The former (gingival disease score) was obtained by assigning a score of 0, 1 or 2 to each tooth, according to whether the labial gingiva was healthy, partly or totally inflamed respectively, and the subject's score was the mean for the teeth included. The oral debris score was assessed by assigning a score of 0, 1, 2 or 3 to each tooth, according to whether the labial surface was free of debris, or displayed debris on the gingival third only, on more than a third but less than two-thirds of this surface, or on more than two-thirds of this surface respectively. The subject's score was the mean for the included teeth.

Students presented in haphazard order and were not asked whether they had received school dental attention until they were interviewed. By obtaining gingival disease and debris scores at the commencement of the examinations with the students' teeth clenched, a "blind" technique ordinarily was possible.

The circumstances of the survey did not enable duplicate examinations to indicate the degree of examiner variability. Nevertheless, duplicate examinations were performed for separate studies and are reported elsewhere in the thesis (Tables 2 and 115).

(b) Interviews

Immediately following the examinations, students were interviewed by an assistant at a separate location. They were not identified as test or control subjects

until after the interview, and so a "blind" technique was achieved.

Questions were unstructured and ordered and phrased so as to elicit a valid response. The purpose was to determine the proportions of test and control students, who had performed the following:

(i) consumed sweets or chocolate on the day preceding the survey;

(ii) brushed their teeth on the morning of the survey;

(iii) ordinarily used a fluoride toothpaste;

(iv) normally used a soft toothbrush, and

(v) visited a dentist since leaving a primary school.

It was anticipated that bias would affect the results, but that relative differences between the test and control groups nevertheless would be apparent. A degree of validity is evident: for example, more females claimed that they had brushed on the morning of the survey and had visited a dentist since leaving a primary school, and females had lower debris scores and more restorations than males (Tables 29, 30 and 31).

(c) Questionnaires

The questionnaire contained multiple choice questions, and an example is presented (Appendix 4.1). Two questions related to the possession of a brush and whether a brush was taken to school daily, whereas the remainder were directed towards knowledge and attitudes (Appendix 4.1).

It was anticipated that there would be bias but that relative differences between the test and control groups

nevertheless would be apparent.

C. Statistical analysis

For the purpose of the analysis, it was assumed that each subject was an independent element in the age-sex specific sub-sample. Differences between the dental health of test and control subjects were assessed by investigating trends across age-sex specific groups, and by applying the t-test of statistical significance to differences within these groups.[167] The mathematical formulae are presented in Appendix 4.2.

The proportions of subjects with desirable knowledge, attitudes and behaviour were compared by using 2 x 2 contingency tables for each age-sex specific group. Tables were pooled by a technique which tests and allows for heterogeneity between age-sex specific associations.[170] Details are included (Appendix 4.3).

Whereas all data are incorporated in the percentages in Tables 32, 33 and 34, age-sex specific groups were excluded when calculating the p values if an expected value was less than five.

Statistical advice was received from Mr. K.M. Cellier, Principal Research Scientist, Division of Mathematical Statistics, Commonwealth Scientific and Industrial Research Organisation, Adelaide. Data were processed using a Canola 167P electronic calculator.

D. Limitations in the research design

Subjects could not be allocated to test and control groups at random, and it is conceivable that the placement of school dental clinics was associated with

extraneous dental influences. Furthermore, about seven per cent of parents chose not to have their primary school children treated at school, and 7.9 per cent of the selected subjects were not surveyed because of absences from school or a lack of parental consent. Nine subjects were not examined on account of orthodontic appliances. It seems that spurious possibilities could have been reduced by controlling for age, sex and academic and vocational characteristics.

The research design would have been strengthened, had test and control students been examined and matched before school dental care, but resources were insufficient for that exercise.

A "blind" technique applied to the interview and in most instances to the assessment of debris and gingival disease scores, but once the mouth was opened fully, it usually was apparent whether a student was a test subject. This factor could have affected the DMF scores and the discernment of defective restorations, although the investigator was unaware of such an effect.

As bite-wing x-ray films were not used, it was anticipated that test students would present higher DMF scores: it seemed that restorations would be more obvious than decay interproximally. Scores for the proximal surfaces of the anterior teeth were obtained separately, because it seemed that bias would be inconsequential for these surfaces.

Approximately 30 per cent of the students who had been treated by school dentists and therapists had left the region. It was assumed that there would have been a

similar loss for other subjects, and that this factor together with statistical control of the variables mentioned would have minimized bias.

1.2.2.4 Results and comments (Sec. schl. survey: 1971-1972)

A. Decay

In the test groups, 90.3 per cent of males and 88.1 per cent of females had positive D scores, as opposed to 97.6 and 95.3 per cent respectively for the other students. Whereas 3.1 per cent of males and 2.1 per cent of females in the test groups had no restorations, the percentages for the controls were 43.2 and 31.3 respectively.

Students with histories of school dental care usually averaged between three and four teeth with positive D scores (Tables 29 and 30). Mean D scores for the controls ranged from 4.81 for 13-year-old females in the agricultural areas to 8.59 for 15-year-old males in those areas (Tables 29 and 30). Control subjects presented higher mean D scores in each age-sex specific group, and the difference was statistically significant in 10 of the 12 groups (Tables 29 and 30).

In 11 age-sex specific groups, test subjects had significantly more restorations and in each group, higher F to DMF(T) ratios (Tables 29 and 30). The difference in mean M scores was inconsistent (Tables 29 and 30).

Predictably, test students usually presented higher mean DMF(T) and DMF(S) scores, but the DMF(S) values for the anterior proximal surfaces were similar for the test and control groups (Tables 29 and 30).

The percentage of restorations which were defective in the test group was 1.8 (88 in 5,005), as opposed to 2.8 (62 in 2,212) for the controls.

B. Oral hygiene and gingival health

Although test students had lower debris and gingival disease scores in eight of the 12 age-sex specific groups, and the difference was statistically significant in two instances and in one instance respectively, differences usually were small and might have occurred by chance (Table 31).

C. Dental habits

The proportions of test students who evidently had visited a dentist since leaving a primary school were 24.6 and 48.1 per cent in the industrial and agricultural areas respectively. The corresponding percentages for the control groups were 54.4 and 65.3 respectively (Table 32). The differences were statistically significant (industrial areas - $X^2_m = 71.32$: df=1 : p<0.001 : agricultural areas - $X^2_m = 13.47$: df=1 : p<0.001) - (Appendix 4.3).

Students reported undesirable dental habits with regard to diet, oral hygiene and the use of a fluoride toothpaste. The proportion claiming that they did not eat sweets or chocolate on the day before the survey was small, that is, 26.5 per cent for the industrial areas and 43.1 per cent for the other areas. Although virtually all the students possessed their own toothbrush, only 23.5 per cent apparently used a soft variety, as recommended by school dental staff. Over three-quarters (76.8 per cent) reported brushing on the morning of the survey, but only 1.1 per cent apparently took a toothbrush to school daily.

The percentages using a fluoride toothpaste were 27.7 and 45.5 in the industrial and agricultural communities respectively. These data are classified by exposure to school dental care in Table 32.

Significantly more test than control students apparently used a fluoride toothpaste (X^2_m = 4.75 : df = 1 : $p<0.05$) and a soft toothbrush (X^2_m = 11.23 : df = 1 : $p<0.001$) in the agricultural areas (Table 32).

D. Dental knowledge and attitudes

In no instance did a significantly higher proportion of control students present desirable results, but test students were considered to have performed more satisfactorily on the following topics:

(i) teeth should be cleaned after eating (industrial areas - X^2_m = 5.23 : df = 1 : $p<0.05$: agricultural areas - X^2_m = 7.59 : df = 1 : $p<0.01$).

(ii) soft toothbrushes are best (industrial areas - X^2_m = 29.41 : df = 1 : $p<0.001$: agricultural areas - X^2_m = 17.49 : df = 1 : $p<0.001$).

(iii) toothpaste with fluoride should be used (industrial areas - X^2_m = 4.52 : df = 1 : $p<0.05$: agricultural areas - X^2_m = 4.25 : df = 1 : $p<0.05$).

(iv) a dentist should be visited following a transitory toothache (industrial areas - X^2_m = 8.95 : df = 1 : $p<0.01$: agricultural areas - X^2_m = 10.81 : df = 1 : $p<0.01$).

(v) dental visits were not unpleasant (industrial areas - X^2_m = 4.22 : df = 1 : $p<0.05$).

(vi) they might have decay and not know it (industrial

areas - $X^2_m = 6.78$: df = 1 : $p<0.01$).

(vii) malocclusion often resulted from the neglect of primary teeth (agricultural areas - $X^2_m = 5.82$: df = 1 : $p<0.05$).

(viii) primary teeth need care like permanent teeth (industrial areas - $X^2_m = 4.56$: df = 1 : $p<0.05$).

(ix) artificial teeth were not as attractive and functional as natural teeth (industrial areas - $X^2_m = 12.26$: df = 1 : $p<0.001$).

(x) dental disease can cause pain (agricultural areas - $X^2_m = 4.29$: df = 1 : $p<0.05$).

Results are presented in Tables 33 and 34.

Many students seemed to overrate the cosmetic and functional qualities of artificial teeth, and to consider that artificial teeth might be inevitable even if they cared for their teeth. Almost half of the students apparently did not realize that they might have decay without their knowledge. Over 90 per cent did not consider that their chances of acquiring decay were "very high". The proportion who did not consider that their chances of acquiring periodontal disease were "very high" was almost 100 per cent.

Whereas the overwhelming majority apparently recognized the need for regular dental care and for frequent toothbrushing, and also that sweets, chocolate, cakes and biscuits were worse for the teeth than other specified items, an appreciable number apparently

(i) did not recognize the need for a dental visit after a transitory toothache;

(ii) disliked dental care, and

(iii) did not consider that soft toothbrushes were best. About 30 per cent evidently did not realize that teeth usually were lost in children because of decay, rather than as a result of periodontal disease, trauma or hereditary factors. Approximately 40 per cent did not consider that malocclusion often resulted from the neglect of primary teeth.

1.2.2.5 Discussion (Sec. schl. survey: 1971-1972)

Perhaps the most important finding was the lack of professional care after students had left the School Dental Programme. Most subjects apparently knew that six-monthly dental visits were recommended, but often they did not act accordingly.

The impression was received that fewer subjects with histories of school dental care had visited a dentist since leaving primary school, because

(i) they had suffered less pain, and

(ii) they possessed a false sense of security following treatment at school.

Test students were treated by school dentists and therapists in their final primary school year only. Perhaps follow-up dental examinations of secondary school students will be more common when subjects have longer histories of school dental care at the primary school level.

Students with histories of school care were better informed, but apparently their dental habits usually were not improved. Even the more extensive use of soft toothbrushes and fluoride toothpastes, which was evident amongst

the test subjects in the agricultural areas, might have been spurious and a result of defensive responses in the interviews.

The discrepancy between knowledge and behaviour is consistent with the difference observed in the study of 1,000 primary school children already reported. Other prevalent attitudes apparent from the two studies were as follows:

(i) artificial teeth might be inevitable, and

(ii) decay would be evident to the individual if present.

Also the cosmetic and functional qualities of artificial teeth seemed to be overrated.

A considerable extent of untreated decay was evident amongst both the test and control students, although more extensive treatment needs pertained to the controls. Decay rates seemed equivalent in the two groups.

The treatment needs of the controls apparently were less pronounced than for the fluoridation base-line study or for the survey by Fanning, Gotjamanos and Vowles, but the present study did not incorporate x-ray findings.[168] The DMF scores tended to be higher for females in each study.[168]

The quality of school dental resorations seemed satisfactory. A direct interpretation of the relative quality of restorations provided by private dentists and school dental staff was complicated by the following:

(i) students with histories of school care frequently had restorations placed by both sectors of the profession, and these restorations were not differ-

entiated, and

(ii) the mean times which had elapsed since the placement of the two groups of restorations, and their respective complexities, possibly varied and influenced the relative failure rates.

1.2.3 Survey of secondary school students: 1974

1.2.3.1 Introduction

This survey included second-year students at the major secondary schools which received children from a primary school where a dental clinic was established before 1973.

It was anticipated that the apparent effect of school dental care in the country regions might be greater than indicated by the 1971-1972 survey, because some students would have had school dental care over a four-year period.

1.2.3.2 Materials and methods

A. Samples

All second-year students at the major secondary schools were eligible for inclusion. Where two secondary schools qualified equally for a single primary school, one was chosen at random.

In the country areas, all second-year students were selected. Numbers were inadequate for students with histories of school dental care to be matched with classmates as described for the 1971-1972 survey. Without this attempt to control for socio-economic characteristics, it seemed that bias might result.[67] Only students aspiring to high levels of tertiary education had the opportunity to study foreign languages. The proportion of subjects with

this opportunity was 25.7 per cent for students with histories of school dental care (test subjects) and 32.1 per cent for the controls. The higher proportion for control subjects supports the regional dentists' opinion that this group would represent a higher socio-economic level. 169

In the State capital, teachers obtained a provisional record of the students who had received school dental care. These students were matched with class-mates of the same sex who were selected at random. Subsequent interviews during the survey were used in the final allocation of students to the test and control groups. School records were not available to check the socio-economic levels of the test and control groups.

The State capital had been fluoridated in February 1971, that is, over three years before the survey. Results for the capital and country regions are presented separately.

Collectively, 2,436 subjects were chosen from nine country schools and from four in the capital. The following students were excluded:

(i) 64 (2.6 per cent) because their parents preferred that they not participate;

(ii) 104 (4.3 per cent) because they were absent from school during the survey, and

(iii) 59 (2.4 per cent) because they had left the school before the survey.

A further 56 (2.3 per cent) with fixed orthodontic appliances were not examined, but nevertheless were inter-

viewed and completed questionnaires. The loss of subjects from the test and control groups was similar.

Of the 2,153 students examined:

(i) 302 had received school dental care over a longer period than two years;

(ii) 1,117 had received this care, but not over a longer period than two years, and

(iii) 734 had not received school dental care.

The sample is presented by area, age, sex and history of school dental care in Tables 35 and 36. Data for subjects with histories of school dental care were accumulated, because dental characteristics did not vary with the extent of exposure to this care. The number of control subjects in the country areas was small as a result of the broad provision of school dental care in these areas. Many students in the State capital informed teachers that they had received school dental care, but a further enquiry during the survey led to contradictory conclusions. Therefore the number of controls in the State capital was exceeded by the number of test students.

B. Examination techniques

The examinations were undertaken by the author with the methods employed in the 1971-1972 survey, but with these exceptions:

(i) the examinations were more superficial, in order to conserve resources.

(ii) examinations for the DMF(T) scores pertained to half mouths only, as described elsewhere.[66,171] These scores were doubled to estimate scores for whole

mouths. If no tooth was carious, further teeth were examined to determine whether the subject had a carious tooth. A similar procedure was used to identify individuals with a restored tooth.

(iii) tooth surfaces were not scored for decay specifically, except for the proximal surfaces of the upper six anterior teeth.

Interviewing procedures and the contents of questionnaires were the same as for the 1971-1972 survey.

Methods of attempting to avoid bias in the clinical examinations and interviews also were common to the two surveys.

C. Statistical analysis

Analytical procedures were identical in the two studies with this exception: the t-test for the DMF(T) values was applied to scores for half mouths. It is emphasized that the standard errors in Tables 35 and 36 apply to scores for half mouths, even though the associated mean DMF(T) values have been doubled to estimate scores for whole mouths.

D. Limitations in the research design

These limitations were described for the 1971-1972 survey. The added difficulty of matching test students with class-mates in the country areas might have led to bias from an uneven distribution of socio-economic and geographic influences.[67,169] The test group seemed to represent a lower socio-economic level, and the fluoridation base-line study indicated that this characteristic could prompt inferior DMF scores. Therefore it seemed

unlikely that superior DMF scores would result in test students from socio-economic influences.[67] The separate analyses of data for the country areas and State capital might have prevented bias from geographic influences.

1.2.3.3 Results and comments (Sec. schl. survey: 1974)

A. Decay

(a) Country areas

In the test group, 87.0 per cent of males and 83.6 per cent of females had positive D scores, as opposed to 91.9 per cent and 89.3 per cent respectively for the controls. Whereas 4.7 per cent of males and 2.7 per cent of females in the test group had no restorations, the percentages for other subjects were 34.4 and 29.3 respectively.

The mean D scores for test subjects ranged from 2.95 to 3.68, whereas the extremes for the controls were 3.86 and 5.54 (Table 35). Test subjects had lower scores in each age-sex specific group, and the difference was statistically significant in four instances (Table 35).

Test subjects presented higher F to DMF(T) ratios in each group (Table 35). The mean M scores were lower for these subjects in four of the six age-sex specific groups, and the difference was statistically significant on one occasion (Table 35).

Bite-wing x-ray films were not exposed, and it was anticipated that test subjects might have higher DMF(T) scores because restorations would be more obvious than decay interproximally. In fact, the mean DMF(T) was higher for test students in each group (Table 35). When the DMF(S) scores for the proximal surfaces of upper

anterior teeth were compared, no consistent difference between the test and control groups was apparent (Table 35). It seemed that bias from the lack of x-rays would be inconsequential for these surfaces.

(b) State capital

In the test group, 73.6 per cent of males and 75.2 per cent of females had positive D scores, as opposed to 82.6 per cent and 83.7 per cent respectively for the controls. Whereas 4.1 per cent of males and 1.5 per cent of females in the test group had no restorations, percentages for the controls were 24.6 and 17.0 respectively.

The mean D scores for test subjects ranged from 1.79 to 2.67, whereas the extremes for the controls were 2.93 and 4.88 (Table 36). The difference was consistent across the age-sex specific groups and was statistically significant on four occasions (Table 36).

Test subjects presented higher F to DMF(T) ratios in each age group, but differences in the mean M scores were inconsistent (Table 36).

As anticipated, the mean DMF(T) values usually were higher for test subjects (Table 36). Differences between the mean DMF(S) scores for the proximal surfaces of the upper anterior teeth were inconsistent (Table 36).

B. Restorations

In the country areas, 72 of the 3,729 restored teeth (1.9 per cent) in the test subjects had defective restorations, as opposed to 15 of the 706 restored teeth (2.1 per cent) for the controls.

In the State capital, these percentages were 1.8

(15 in 838) for the test subjects and 2.0 (13 in 664) for the controls.

The differences appear trivial. Subjectively, the quality of the restorations in the test subjects seemed good.

C. Oral hygiene and gingival health

(a) Country areas

Debris and gingival disease scores were lower in the test subjects for 13-year-old boys, and the differences were statistically significant (Table 37). Even so, differences were not consistent across the age-sex specific groups.

(b) State capital

Debris scores were lower for test subjects in each age-sex specific group, and the differences were statistically significant in two instances (Table 37).

Gingival disease scores were lower for the test subjects in five age-sex specific groups, and the difference was statistically significant on one occasion (Table 37).

D. Dental habits

These habits are presented in Table 38. Differences between scores for the test and control groups were not statistically significant, with these exceptions:

(i) the proportion reporting that they had visited a dentist since leaving a primary school was significantly higher for the control subjects in both areas (country areas - $X^2_m = 72.63$: df = 1 : $p<0.001$: State capital - $X^2_m = 46.83$: df = 1 : $p<0.001$).

(ii) the proportion who evidently used a soft toothbrush, as recommended by the school dental staff, was

significantly higher for the test subjects in both areas (country areas - $X^2_m = 6.71$: df = 1 : $p<0.01$: State capital - $X^2_m = 12.03$: df = 1 : $p<0.001$).

Collectively, dental habits in the country areas seemed similar to those for the agricultural areas in the 1971-1972 study (Tables 32 and 38). It is apparent from the 1974 data that the consumption of sweets or chocolate might be higher in the State capital than elsewhere (Table 38).

E. Dental knowledge and attitudes

The proportion with favourable knowledge and attitudes was found to be higher for the test subjects in 28 of the 36 comparisons (Tables 39 and 40).

The scores for test subjects were regarded as significantly better on the following topics:

(i) a dentist should be visited following transitory toothache (country areas - $X^2_m = 4.26$: df = 1 : $p<0.05$).

(ii) teeth should be cleaned after eating (country areas - $X^2_m = 7.23$: df = 1 : $p<0.01$: State capital - $X^2_m = 12.01$: df = 1 : $p<0.001$).

(iii) they might have decay and not know it (country areas - $X^2_m = 4.96$: df = 1 : $p<0.05$).

(iv) artificial teeth were not as attractive and functional as natural teeth (country areas - $X^2_m = 6.77$: df = 1 : $p<0.01$: State capital - $X^2_m = 11.21$: df = 1 : $p<0.001$).

(v) malocclusion often resulted from the neglect of primary teeth (State capital - $X^2_m = 17.95$: df = 1 : $p<0.001$).

In the country areas, more control subjects considered that sweets, chocolate, cakes and biscuits were worse for the teeth than other specified food-stuffs, that is, 98.5 per cent as opposed to 96.1 per cent for the test subjects. The difference is statistically significant ($X^2_m = 6.21$: df = 1 : $p<0.05$), but it should be known that only one age-sex specific group presented adequate numbers for the statistical test.

As assessed from the 1971-1972 and 1974 surveys, overall dental knowledge and attitudes were similar(Tables 33, 34, 39 and 40).

1.2.3.4 Discussion (Sec. schl. survey: 1974)

In accordance with the 1971-1972 study, the lack of professional care after leaving the School Dental Programme has emerged as a major problem. Whereas about two-thirds of the control subjects reported a dental visit since leaving a primary school, this proportion approximated 40 per cent for students with histories of primary school dental care. The proportion of test subjects with untreated decay, as indicated by superficial examinations unsupported by x-ray findings, approximated 85 per cent for the country areas and 74 per cent for the State capital. Therefore, the need to remedy the lack of continued professional care seems particularly important. A lower need for care in the State capital possibly resulted from fluoridation.

It is evident that a history of school dental care was associated with lower mean D scores. Students who had received this care were better informed and reported using

recommended types of toothbrushes more than the controls. Improved oral hygiene and gingival health was apparent amongst the test students in the State capital. It is possible that improvements also occurred in the country areas, but were masked by socio-economic influences.[67,169]

The superior knowledge and hygiene habits apparent in the test students suggest that school dental staff have endeavoured to educate with some success. Nevertheless, this education has had only a limited effect. A comparison of data for the country areas in the two surveys does not suggest that substantial benefits accumulate progressively.

Students usually were aware that regular professional care and frequent toothbrushing were advisable, and that sweets, chocolates, cakes and biscuits were bad for the teeth, but habits were inconsistent with this knowledge. Whereas most realized that they should use a fluoride toothpaste, a majority did not consider that soft toothbrushes were best as claimed by the school dental staff. It was apparent that many students

(i) disliked dental care;

(ii) did not recognize a need for a dental visit following a transitory toothache;

(iii) underrated their chances of acquiring decay and periodontal disease;

(iv) did not realize that they might have decay without their knowledge;

(v) overrated the cosmetic and functional qualities of artificial teeth, and

(vi) considered that artificial teeth might be inevitable even if they cared for their teeth.

It seemed that treatment needs were extensive in secondary school students. The lower DMF(T) scores in this study, when compared with scores for the fluoridation base-line survey, probably resulted partly from the more cursory nature of the present examinations and from the effects of fluoridation in the capital.

The levels of oral hygiene and gingival health were inferior for males, but DMF(T) scores were higher for females. These findings are consistent with the results of the 1971-1972 survey (Tables 29, 30, 31, 35, 36 and 37). Debris and gingival disease scores were lower in the State capital, but these differences could have resulted from sampling error or examiner variability (Table 37).

No effects of school dental care on decay rates were evident from the DMF(S) scores. It is possible that an effect might have been present, but of an insufficient degree to be detected by the employed techniques.

Subjectively, the quality of school dental restorations seemed satisfactory, but direct comparisons with the quality of care provided by private practitioners were prevented by the factors described for the 1971-1972 study.

1.2.4 Discussion

Collectively, the 1971-1972 and 1974 studies indicated an extensive need for dental care in secondary school students, which was substantially lower in the fluoridated areas and amongst subjects with histories of school dental care.

Subjectively, the quality of school dental restorations seemed good. The failure rates of restorations were similar, irrespective of whether subjects had histories of school dental care.

Comparisons between decay rates classified by exposure to school dental care were complicated by the cursory nature of the examinations. Nevertheless, reductions from school dental care were not apparent.

Debris scores indicated improvements from this care in the State capital, and possibly a marginal improvement in the country areas, as indicated by the 1971-1972 results. It is emphasized that beneficial effects were not evident from data for the country areas in the 1974 survey, but as the matching of students was not possible, bias could have followed readily from socio-economic influences.[67,169]

In some respects, students with histories of school dental care had better oral hygiene practices and were better informed, but the effects of dental health education were not pronounced.

Perhaps the most important finding was the lack of professional dental care after subjects had left a primary school and no longer were eligible for school dental care.

It is apparent that there should be comprehensive research into methods of dental health education. The opinion that an informed community will adopt appropriate behaviour is not supported by the present studies, the survey of dental knowledge, attitudes and habits already reviewed, nor by experience elsewhere.[153,160,161,162,163]

Rayner and Cohen have reviewed reports of school dental health education which emphasize a need for the following:

(i) to encourage parents and mothers in particular to improve the care of their own mouths as examples to their children;

(ii) to use disclosing material as an aid to oral hygiene instruction, and

(iii) to introduce educational programmes which incorporate performance of the desired behaviour.[158]

Their report indicates that dental health education for senior secondary school students might be more effective in the long term than education for young children.[158]

Data from secondary school surveys have been accumulated for use at the State level, but separate regional data have been forwarded to the regional staff. This information has been included in communications with dental staff, other health providers, dental and dental therapy students, parents, teachers, community groups and health administrators.

Secondary school students now are included in dental health education programmes, and teaching courses for dental therapy students have been adjusted accordingly.

Dental staff vary considerably in their apparent interest in dental health education. Some personnel seem to ignore the problem of discontinued care at the secondary school level. Others have attempted remedial programmes in secondary schools, for example:

(i) classes in dental health;

(ii) screening examinations and the referral of students

to private dentists, and

(iii) notifying parents of the need for follow-up dental care for teenagers.

Secondary school students routinely provide health education to primary school children at 10 of the 54 permanent school dental clinics. This programme commenced in 1975 in order to benefit all the students, but particularly to improve the habits of secondary school students through "active participation". The programme has been evaluated and regarded as successful, and will be reported subsequently.

A pilot programme, which is being evaluated scientifically by a school dentist, consists of a series of eight classes for secondary school students. The students receive basic information through lectures and discussions, which are accompanied by slides. Student activities include the following:

(i) staining plaque and recording hygiene scores in their own mouths and in those of their classmates;

(ii) staining plaque and comparing the effectiveness of various oral hygiene procedures;

(iii) growing bacterial cultures from plaque and identifying micro-organisms with a microscope;

(iv) establishing a "plaque tunnel" which consists of a darkened area where sodium fluorescein disclosing solution can be seen to fluoresce under a "black" light;

(v) performing surveys on dental topics, and

(vi) constructing visual aids which demonstrate the progress of decay and stages in the placement of a restoration. Students prepare cavities in plaster teeth and restore them with amalgam.

Following discussions with dental staff, several schools have reserved a room for dental health activities. These rooms feature dental exhibits, and it is anticipated that "plaque tunnels" might be introduced to assist students to monitor their own oral hygiene.

Senior primary school children have been trained as dental health educators for younger children in several schools. Student health educators regularly check disclosed plaque and provide appropriate oral hygiene instruction. The aim of the programme is to improve the health educators' oral hygiene and also to benefit other students.

The lack of dental care at the secondary school level has been emphasized in classes for school teachers who organize health education courses. Dental staff frequently provide health education directly to students in the classrooms, but it is intended that the staff's future role will be more as resource personnel, and that school teachers will participate more directly.

Parental participation apparently is increasing in the School Dental Programme. Between 1974 and 1975, the numbers of consultations with parents increased from about 150 to 220 per 1,000 patients.

Discussions have been undertaken with dental staff in the regions to review potential solutions to the

problem of discontinued dental care after children leave the School Dental Programme. It has been resolved that secondary school students will be surveyed frequently to monitor the extent of follow-up-care. One regional dentist has discussed the problem with local private dentists. As a result, school dental staff enrol children by telephone with the private dentist of their parents' choice. At the request of the private dentist, aspects of the child's school dental history may be forwarded from the school clinic. The private dentist will notify parents of appointment times for the follow-up examinations of their children. Children whose parents do not nominate a private dentist will be identified as a "high risk" group and could receive a special emphasis in health education activities. Further programmes of this type are being developed in two other regions.

1.2.5 Summary

These studies collectively indicated extensive treatment needs in secondary school students throughout the State. The DMF(T) scores were lower for males, whereas oral debris and gingival disease scores were higher for this sex. Although sampling error and examiner variability might have affected the results, it seems that the DMF(T) scores and the levels of oral hygiene and gingival health were more favourable in the State capital than in the country areas. Frequently, students seemed to have unsatisfactory dental knowledge, attitudes and behaviour.

Students who had received school dental care presented fewer teeth with active decay and better oral hygiene and gingival health in certain localities. They also reported a greater use of recommended toothbrushes. Although they were better informed, more of the other students apparently had visited a dentist since leaving a primary school. The lack of professional care after leaving the School Dental Programme has been identified as a major problem.

The quality of restorative care provided by school dental staff seemed good, but reductions in decay rates as a result of school dental care were not apparent.

The value of data when seeking support for dental health plans and when planning dental health education was emphasized.

1.3 Dental need and effectiveness in the long term

1.3.1. Introduction

A survey by questionnaire of 3,277 New Zealanders in 1968 revealed extensive tooth loss.[172] The proportions reported as wearing full upper and full lower dentures were as follows:

(i) 13.4 per cent for 20 to 29-year-olds;

(ii) 33.3 per cent for 30 to 39-year-olds, and

(iii) 41.9 per cent for 40 to 49-year-olds.[172]

The sample consisted of the individuals responding amongst 5,000 subjects, who were chosen from 10 randomly selected electorates by a systematic routine following a random start.[172]

Since the early 1920's, the New Zealand School

Dental Service had treated school children through school dental nurses (dental therapists).[23,80] The Service apparently had been extended to approximately 53 per cent of the New Zealand primary schools by 1935 and to about 95 per cent by 1950.[173] The proportion of parents who enrolled their children for this care in those periods is not known, but it now approximates 98 per cent.[174]

Although some New Zealanders would not have been enrolled in the Service, and an unknown number of these subjects and of recent immigrants probably would have been included in the 1968 survey, the extent of tooth loss nevertheless suggests that school dental care might not be supported by adequate follow-up care on some occasions.[172]

The long-term effects of South Australian school dental care have not been evaluated, and it seems that this task would be complicated in the short term by an insufficient availability of adults with histories of this care.[22] Nevertheless, it has been claimed that school dental care would be made available to all children under 15 years of age by 1985, and so many future adults would have this history.[78]

Accordingly, it seemed that a base-line appreciation of dental health should be obtained for adults without histories of school dental care. These data would facilitate subsequent evaluation of the effects of school dental care and other dental influences in the State.

It seemed that ideal sampling procedures and the collection of data by calibrated examiners, interviewers

and questionnaires would enable a comprehensive evaluation of changes in dental characteristics. Differences in groups with histories of school dental care, as assessed by comparisons with the base-line, could be attributed to this care and to extraneous influences. Corresponding differences in groups without histories of this care could be ascribed to extraneous influences only. Cross-sectional comparisons between groups with varying histories of school dental care would enable specific inferences of the long-term effects of this care.

Although the Review and Evaluation Committee of the Australian Dental Services Advisory Council has recommended that there be a national dental survey which would include adults, no broad initiatives have followed.[70]

It was anticipated that national surveys would assist

(i) an evaluation of the effects of school dental care and of other dental influences, and

(ii) an assessment of dental needs by race, age, sex, location, socio-economic characteristics and by the presence of physical and mental handicaps.

It seemed that this information would be useful to health planners.

It became doubtful whether a national dental survey of adults would eventuate, and so limited data relating to tooth loss and to the wearing of dentures were obtained for South Australia. These data were requested by the author and were obtained from surveys based on interviews which were undertaken by the State's Department of

Public Health and the Federal government's Bureau of Statistics.

It was not considered practicable for interviewers to determine the numbers of missing teeth. Therefore information was limited to the presence of the edentulous state in each jaw separately, and subjects were classified by age, sex, socio-economic characteristics, location and place of birth. The presence of complete and partial removable dentures also was recorded for each jaw.

It seemed that the resulting information would have these limitations:

(i) complete tooth loss might be rare in young adults, and so an early evaluation of the effects of school dental care might be difficult with these data, and

(ii) although the data would demonstrate the relative extent to which past dental needs were not met, existing needs for care would not be evident directly. Therefore, it would be necessary to infer these needs from the evidence of past unmet needs.

Nevertheless, it was apparent that the information could be obtained efficiently with resources that were invested for other purposes, and would establish a base-line for future evaluations of change.

Three surveys have been completed, but only two have been analysed thoroughly and are reported in this thesis, that is:

(i) a survey in south-eastern South Australia, and

(ii) a State-wide survey.

1.3.2 Tooth loss and denture wearing in the South East

1.3.2.1 Introduction

In 1972, a survey of health characteristics was undertaken in south-eastern South Australia by the State's Department of Public Health to facilitate the evaluation of health programmes and the planning of future services.

The survey was organized by a medical epidemiologist, but the dental questions were specified by the author who also was responsible for the processing and analysis of dental data and the writing of the corresponding reports.

1.3.2.2 Features of the South East

The South East was defined as the 12 local government areas in the south-eastern extremity of the State. The region covers 14,730 square kilometres.[175]

The population numbered 48,778 in June 1971 and 63.5 per cent dwelt in urban centres.[175] The corresponding accumulated percentage for other country areas in the State was 48.5 per cent.[175]

Apart from isolated highlands elsewhere, the South East has the highest and most even rainfall in the State.[175] Over a quarter of the employed labour force was associated directly with primary industries; for example, agriculture, forestry and fishing.[175] The next largest number was employed in manufacturing industries, and particularly in enterprises related to local forestry, namely: the production of timber, furniture, paper and other products of wood.[175]

The proportion of inhabitants who evidently regarded themselves to be of European origin was 99.6 per cent,

as opposed to a collective figure of 98.0 per cent for other country areas of the State.[175]

In 1971, there were 10 private dentists in the South East. The dentist to population ratio of one to 4,880 was more favourable than the pooled ratio of one to 8,710 for other country areas of the State.

1.3.2.3 Materials and methods

A. Sample

The sample was selected in conjunction with the South Australian Office of the Federal government's Bureau of Statistics, and was obtained in two stages.

Initially, 48 Census Collectors' Districts were chosen from the 88 Districts in the South East. The latter Districts included a mean of 175.8 private dwellings. As the Districts were chosen by a systematic selection of these dwellings, the probability of a District being included was proportional to the associated number of dwellings.[175] Subsequently, a similar number of dwellings was chosen from each selected District.

Both stages of the selection were based on a systematic routine which followed a random start. The aim was to obtain a representative sample of about 500 dwellings, which it seemed would fully extend the resources for the survey. Subjects to be included would be the usual residents of these dwellings.

In fact, 516 dwellings were selected, but the occupants of 79 (15.3 per cent) could not be contacted, despite a maximum of three visits. A census in 1971 had indicated that 1,429 of the 9,354 dwellings (15.3 per

cent) in these Districts were unoccupied.[175] It was apparent that many were reserved for holidays or usually were vacant for other reasons.

Attempts were made to encourage participation by publicising the reasons for the survey through the press, and by notifying householders by post of forthcoming visits. Opportunities were provided for mutually convenient times to be arranged. In fact, co-operation was obtained from 327 (74.8 per cent) of the occupied dwellings. The proportion of these dwellings in an urban area was 59.6 per cent (195 in 327). The 1971 census indicated that 61.7 per cent (9,540 in 15,467) of all private dwellings in the South East were in urban areas, that is, a similar proportion to the one for the present survey.[175]

A total of 1,030 occupants was included which constituted approximately 2.1 per cent of the population.[175] However, information for one subject was excluded because of misrecording. Although co-operation was obtained from 327 households, a number of occupants could not be reached or would not participate. An average of 3.1 individuals were included per occupied dwelling, whereas the 1971 census indicated that there was an average of 3.6 inhabitants per occupied dwelling in these Districts.[175]

The age distributions of the sample and of the total population were similar (Table 41). Females represented 49.1 per cent of the population in 1971, whereas the corresponding proportion in this sample was 52.5 per cent (540 in 1,029). In fact, it was apparent that males were

harder to reach and this difference was anticipated.

It is difficult to estimate the effects of non-participation on the results. The interviews included a wide range of subjects and it is unlikely that non-participation related solely to dental factors. One may conclude that the results pertain to a major proportion of a sample that was selected to be representative of the South East of the State.

The socio-economic levels of the householders were derived from the occupations of the main income earner. Occupations were ranked into the four groups described by Congalton.[176] A fifth category was added for invalid pensioners and the chronically unemployed. Examples of occupations in each group are as follows:

(i) directors or owners of large enterprises, and individuals in eminent professions, for example: medicine, law and architecture (A).

(ii) managers of large enterprises, owners of a substantial business, graziers and well established farmers, and individuals with a tertiary qualification but not a university degree (B).

(iii) owners of a small business, established farm labourers and tradesmen (C).

(iv) unskilled individuals not included elsewhere (D).

(v) invalid pensioners and the chronically unemployed (E).

The largest socio-economic group in the sample was category C (38.3 per cent), followed by B (34.5 per cent), D (22.4 per cent), A (1.8 per cent) and E (1.7 per cent). Insufficient information was presented for the other 1.4

per cent of subjects to be classified effectively.

A total of 155 individuals (15.1 per cent) reported histories of school dental care, and 88 (56.8 per cent) were under 16 years of age.

B. Interviewing techniques

Five general nurses were trained as interviewers, and they practised techniques for one week before the survey. Attempts were made to amend misleading questions.

The interviewing sequence depended on the answers to key questions. Answers were recorded in code on a single sheet to facilitate the transfer to punch cards.

The duration of the interview varied with the number of questions that was appropriate, but ranged from 20 to 45 minutes.

The following information applied to the dental section, namely:

(i) the age;

(ii) the sex;

(iii) the socio-economic level;

(iv) whether there was a history of school dental care, and

(v) whether the individual had a full denture, or a partial denture, or natural teeth only, or neither natural teeth nor a denture in

  (a) the upper jaw.

  (b) the lower jaw.

Although the main purpose was to discern the extent of tooth loss and wearing of dentures, the following information also was obtained:

(i) whether dental visits usually were undertaken

(a) because of pain.

(b) for a routine check.

(ii) whether the individual had received a filling.

(iii) whether a dentist had been visited in the past 12 months and if so, whether this service was

(a) difficult to obtain.

(b) readily available.

(iv) if a need for dental care was experienced during the past 12 months, but treatment was not received because of

(a) the absence of a dentist in the area.

(b) a difficulty in obtaining appointments.

(c) cost.

(d) another reason.

C. Statistical analysis

Data were processed at a State government computing centre, and programming details were prescribed by the author.

Inferential statistical tests were not applied, and comparisons were based on the evidence of trends across age specific groups.

Results for subjects under 16 years of age with histories of school dental care are presented separately only when they clearly are different from the other results. Nevertheless, these two sets of results are not compared because the corresponding age distributions would differ. For example, few pre-schoolers would have received school dental care.

The number of subjects over 16 years of age who evidently had received school dental care was too small to present meaningful information in any age-sex specific group. Accordingly, their data are not presented separately.

1.3.2.4 Results and comments (Tth. loss: the Sth. East)

A. Edentulous state in both jaws

A total of 1,015 subjects (98.6 per cent) presented suitable information and 210 of these (20.7 per cent) were edentulous in both jaws (Table 42). Several were infants without erupted teeth. Therefore, results only are discussed for subjects aged 16 years and over, and age-sex specific data for England and Wales and for the United States are used for comparisons.[87,89]

For subjects aged 16 years or more, 31.4 per cent (199 in 633) apparently were edentulous, and the proportion increased from 3.3 per cent (4 in 122) for 16 to 24-year-olds to 88.0 per cent (44 in 50) for those aged at least 65 years (Table 42).

Complete tooth loss evidently was more common in the South East than in the United States (Table 42). This condition also seemed to be more prevalent in the South East than in England and Wales for subjects under 45 years of age, but no so for the older groups (Table 42).

In the South East, 25.6 per cent of males (72 in 281) apparently were edentulous, and the corresponding proportion for females was 36.1 per cent (127 in 352). This proportion was higher for females in four of the six age groups in the South East, and in each age group in the other two studies (Table 42).

Collectively, 28.4 per cent of subjects in socio-economic categories A and B (67 in 236) were edentulous, as opposed to 33.2 per cent (132 in 397) for other subjects, and the percentage was higher for the latter in five age groups (Table 43). Similar findings were reported for England and Wales.[87]

Of the 199 edentulous subjects, 165 (82.9 per cent) apparently had a full upper and full lower denture, whereas four (2.0 per cent) had a full upper denture only and 30 (15.1 per cent) were reported to have no dentures (derived from Table 42).

The percentages of edentulous males and females with full upper and full lower dentures were 83.3 (60 in 72) and 82.7 (105 in 127) respectively, and no consistent difference was apparent across the age specific groups (Table 42).

The proportion of edentulous subjects in socio-economic categories A and B who had full upper and full lower dentures was 91.0 per cent (61 in 67), as opposed to 78.8 per cent (104 in 132) for the other subjects. Despite small age specific numbers, the difference was consistent in five age groups (Table 43).

New Zealand data indicate that a high proportion of individuals have full upper and full lower dentures.[172] Although comparisons between the New Zealand and South East data are complicated by different age clusters, it nevertheless appears that complete tooth loss is as common in New Zealand as in the South East (Tables 42 and 44).[172]

B. Edentulous state in the upper jaw only

Apparently, 8.1 per cent (82 in 1,015) were so affected, but two were infants without erupted teeth (Table 45). Accordingly, results only are presented for subjects over 16 years of age.

For those subjects, 12.6 per cent (80 in 633) apparently were edentulous in the upper jaw only, but maximum proportions of 22.0 per cent (11 in 50) and 16.9 per cent (11 in 65) were reached for males and females respectively in the 45 to 54 year age group (Table 45). The maximum occurred at a younger age for the lower socio-economic groups (Table 46). The lowest scores were at each end of the age spectrum (Table 45).

The proportion of affected subjects with a full upper denture was 91.3 per cent (73 in 80), and this proportion was 96.6 per cent (28 in 29) for socio-economic categories A and B and 88.2 per cent (45 in 51) for other subjects. A lower percentage was evident for the latter in five age groups, despite the small numbers (Table 46).

C. Edentulous state in the lower jaw only

Only eight individuals were so affected, and all were over 16 years of age. Seven of these (87.5 per cent) had a full lower denture.

D. Denture wearers

Collectively, 29.4 per cent (298 in 1,015) evidently wore dentures, and this proportion increased from 0.5 per cent (2 in 382) for subjects under 16 years of age to 80.0 per cent (40 in 50) for individuals aged 65 years or more (Table 47). Subjects under 16 years of age with

histories of school dental care apparently had no dentures.

The proportion of males with dentures was 24.6 per cent (118 in 480), as opposed to 33.6 per cent (180 in 535) for females, and more females had dentures in six of the seven age groups (Table 47).

Thirty per cent of subjects in socio-economic groups A and B (112 in 373) had dentures, as opposed to 29.0 per cent (186 in 642) for the other subjects. The difference was small and inconsistent across the age specific groups (Table 48).

Over half of the subjects with dentures (55.7 per cent) had a full upper and full lower prosthesis (Table 47). The numbers with the next most common dentures are listed as a proportion of the 298 denture wearers, that is:

(i) 22.5 per cent with full upper dentures.

(ii) 12.1 per cent with partial upper dentures.

(iii) 3.7 per cent with partial upper and partial lower dentures.

The other subjects are presented by type of denture(s) in Table 47.

Of the 487 dentures, 416 (85.4 per cent) were described as full prostheses, and this proportion is higher than for previous Australian studies. However these studies were based on military personnel or on patients of certain dental practices, rather than on direct samples of community groups (Table 49).[177,178,179]

Full dentures comprised a larger proportion of all dentures in the senior age groups (Table 49). Similarly,

the proportion of individuals with full upper and full lower dentures amongst denture wearers increased with age to 95.0 per cent (38 in 40) for subjects aged 65 years or more (derived from Table 47).

There seemed to be a small difference in the types of dentures worn by males and females. For males, 84.0 per cent (157 in 187) of all dentures were full prostheses, whereas for females the corresponding proportion was 86.3 per cent (259 in 300). Higher scores for females were evident in five age groups (Table 49). There seemed to be a greater tendency for males to wear a partial upper denture only, although the numbers were small and possibly misleading (Table 47).

The types of dentures did not vary appreciably with the socio-economic level, but individuals in the lower socio-economic groups apparently had a higher proportion of full dentures (Table 49). The difference was most evident in the younger age groups (Table 49).

E. Reasons for dental visits

Satisfactory information was obtained for 90.2 per cent of the subjects (928 in 1,029), but this proportion reached a minimum of 73.9 per cent (226 in 306) for individuals under 16 years of age without histories of school dental care.

Collectively, 49.4 per cent (458 in 928) reported that usually they visited a dentist because of pain, and this proportion increased from 27.7 per cent (86 in 311) for subjects under 16 years of age to 75.6 per cent (34 in 45) for subjects aged 65 years or more (derived from Table 50). The proportion was the lowest for subjects

under 16 years of age who had received school dental care, that is, 9.4 per cent (8 in 85).

For males, this proportion was 51.3 per cent (225 in 439), whereas for females it was 47.6 per cent (233 in 489), and females presented a lower proportion in six age groups (Table 50).

The proportion in socio-economic groups A and B who usually visited a dentist because of pain apparently was 41.7 per cent (146 in 350), as opposed to 54.0 per cent (312 in 578) for other subjects. The proportion was higher for the latter in six age groups (Table 50).

F. History of restorative care

A total of 1,004 subjects (97.6 per cent) provided useful information, and 622 (62.0 per cent) apparently had received a filling during their life-time (Table 51). This percentage was lower at each end of the age spectrum (Table 51). Nevertheless, the percentage was 82.6 (71 in 86) for subjects under 16 years of age with histories of school dental care. The inclusion of young infants probably would have reduced the percentage for other subjects in this age group.

There was little difference in the extent to which males and females had received fillings. A total of 289 males (60.7 per cent) had this history and the corresponding number of females was 333 (63.1 per cent). The difference was inconsistent across the age specific groups (Table 51).

Of the 371 subjects in socio-economic categories A and B, 260 (70.1 per cent) apparently had received a

filling, and this figure was 362 (57.2 per cent) for the other subjects. The proportion was lower for the latter in each age group (Table 51).

G. History of a dental visit in the past 12 months

Satisfactory information was obtained for 962 subjects (93.5 per cent). Collectively, the proportion who reported a dental visit in the past 12 months was 48.5 per cent (467 in 962).

The other 495 subjects comprised the following:

(i) 466 (94.1 per cent) who had felt no need, and

(ii) 29 (5.9 per cent) who had felt a need. Apparently 14 of these individuals did not receive care because there was no dentist in the area, or because appointments were difficult to obtain. Seven did not do so for financial reasons. One stated a dislike of dentists, and the other seven indicated that they were disinterested in dental care or were yet to arrange an appointment.

Of those who had received attention, 34.7 per cent (162 in 467) claimed that the service was not readily available.

The percentage who evidently had received care in the past 12 months was greatest for those under 16 years of age with histories of school dental care. This percentage was 80.2 (69 in 86). If this group is disregarded, the maximum percentage was for 16 to 24-year-olds, that is, 70.1 per cent (82 in 117). Thereafter, the percentage decreased with age (Table 52). It is presumed that the inclusion of young infants would have lowered the percentage for all subjects under 16 years of age.

Collectively, the percentage was 46.4 for males (214 in 461) and 50.5 for females (253 in 501). More females apparently had attended a dentist in the past 12 months in age groups under 45 years, but not so in the older groups (Table 52).

The proportion in socio-economic groups A and B with a history of a dental visit in the past 12 months was 60.6 per cent (214 in 353), as opposed to 41.5 per cent (253 in 609) for the other subjects. The proportion was lower for the latter in six age groups (Table 52).

1.3.2.5 Discussion (Tth. loss: the Sth. East)

Approximately 90 per cent of individuals aged 65 years or more were edentulous, and this proportion had reached about 30 per cent in the 35 to 44-year-olds. With the extent of unmet past dental needs indicated by these figures, it seems that existing needs also might be extensive, particularly in the lower socio-economic groups. Of the totally edentulous subjects in the lower socio-economic groups, relatively few apparently had full upper and full lower dentures.

The higher prevalence of the edentulous state in females might reflect a greater concern for appearance by this sex, rather than less attention to care. Compared with males, more females

(i) usually visited a dentist for a "routine check", and

(ii) reported a dental visit in the past 12 months in the younger age groups.

The proportion of dentures, which were complete

protheses, apparently was higher in females and in the lower than upper socio-economic groups. Perhaps females preferred full dentures to partial prostheses for cosmetic reasons, whereas the lower socio-economic groups tended to acquire full dentures because they were relatively disinterested in natural teeth.

It appeared that fewer individuals in the lower than upper socio-economic groups

(i) had received restorative care;

(ii) usually visited a dentist for a "routine check";

(iii) reported a dental visit in the past 12 months, and

(iv) possessed natural teeth.

This cross-sectional study should not be interpreted as a longitudinal record. For example, the proportion of individuals with histories of restorative care apparently decreased in the older age groups. Accordingly, it should not be assumed that the present dental status of the aged represents the future for younger subjects. Older individuals seemed relatively unlikely to visit a dentist when not in pain, and this might reflect a life-long habit rather than a product of age.

Despite the cross-sectional nature of the study, longitudinal inferences can be drawn. For example, the upper jaw usually became edentulous before the lower jaw, as indicated by the larger number of individuals who were edentulous in the upper jaw only as opposed to the total with complete tooth loss in the lower jaw only.

Comparisons between data from different surveys should be undertaken cautiously, because of differences in

research methods. Nevertheless, it seems that complete tooth loss might be as prevalent in New Zealand as in the South East.[172] Although the edentulous state might have been less prevalent in young to middle-aged adults in New Zealand had there not been a School Dental Programme, the desirability of monitoring the long-term effects of this care nevertheless is apparent.

Although the South East presented a more favourable dentist to population ratio than collectively applied in other country areas, historically the ratio had been more desirable in the State capital, and so the retention of teeth might be greater in that city.[22]

In the South East, more subjects cited lack of ready availability of dental care than cost as a barrier to care, but cost was the major deterrent nominated by individuals in a survey in the State capital.[13]

Whereas data for subjects with different histories of school dental care were accumulated in this report, it is intended that these data will be separated when presenting the results of serial studies.

1.3.3 Tooth loss and denture wearing: South Australia

1.3.3.1 Introduction

In 1974, the Federal government's Bureau of Statistics completed a survey of chronic disability in South Australia. A dental component was appended so that the extent of tooth loss and denture wearing could be estimated. The author requested this information and prescribed the computer programming for data processing.

South Australia is the driest Australian State and

extends for approximately 1,100 kilometres from east to west and from about 600 to 1,300 kilometres from north to south. Its population was estimated at 1,211,000 for December 1973, with 879,000 residing in the capital.[180] The next largest town had a population of 34,000.[180]

1.3.3.2 Materials and methods

A. Sample

The sample for the quarterly Labour Force Survey was employed. It is reported that this sample was based on a master sample, which had been selected with data obtained in the 1971 Census of Population and Housing.[181]

Dwellings were allocated to mutually exclusive strata by type, location and socio-economic factors, and each stratum was sampled separately. In each instance, a multi-stage self-weighting method was used. For example, the sample of private dwellings in the State capital was obtained in three stages. Initially, Census Collectors' Districts were selected, followed by blocks of houses within Districts. Finally, dwellings were selected from within these blocks. The probability of including each dwelling and person in the State was the same, that is, one in a hundred. Further details of the sampling procedure have been documented.[181]

A total of 4,557 dwellings was selected, and interviewers were instructed to make up to five visits in the State capital and up to three visits in other regions when attempting to contact householders. A totally co-operative response was obtained from 3,858 dwellings (84.7 per cent) and refusal from six (0.1 per cent). A

further 693 dwellings (15.2 per cent) were vacant, under construction or only associated with a partial response of householders.

The sample included 8,298 subjects aged 15 years or more, and is presented by age, sex, place of birth, place of residence, and socio-economic level in Tables 53 and 54. The method of classifying socio-economic level will be described subsequently.

B. Interviewing techniques

Five interviewers completed a pilot study of 60 dwellings to test and finalize the interviewing procedures, and 61 experienced interviewers then implemented the survey.

The dental component was the same as for the South East survey, except that the demand for dental care was not investigated. Dentures which were never worn were disregarded.

Householders were classified according to whether

(i) they were born in Australia, and

(ii) they had received school dental care.

Their occupations also were noted.

C. Statistical analysis

Data were processed at a Federal government computing centre.

Inferential statistical tests were not applied and comparisons were based on the evidence of trends across age specific groups.

Data obtained from the sample were projected to a standard population, namely, the population projection

for May 1974, which was based on the 1971 Census.

Standard errors were calculated by averaging the estimates obtained from two sub-samples with estimates derived from this formula:

$$\text{standard error} = 150 \times \sqrt{\frac{\text{population} - \text{estimate*}}{\text{sample size} \times \text{estimate*}}}$$

A population estimate of 3,000 in any cell is associated with a standard error of approximately 18 per cent. The Bureau of Statistics considers figures of under 3,000 to be too small for use as population estimates. Nevertheless, these figures have been included to provide complete data and indications of trends.

Data are presented by age, sex, place of birth, place of residence and socio-economic level. Members of a family income unit were ascribed a common socio-economic rating, which was drawn from the highest ranked occupation in the unit according to Congalton's classification.[176] The upper and lower two ranks were accumulated because of limited numbers. Full-time students at tertiary institutions were not classified. The definition of an urban centre was the one employed by the Bureau of Statistics.[181]

In view of the limited apparent value of information relating to the edentulous state in a single jaw only, and in order to reduce processing time, this information was not obtained. Nevertheless, by subtracting the number of totally edentulous subjects with a denture in a single jaw only from the total number who had a full denture in that jaw only, an indication of the prevalence of the edentulous state, in that single jaw only, would be available.

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*___population estimate for the cell

A total of 466 subjects reported a history of school dental care. Of these, 217 (46.6 per cent) were aged from 15 to 24 years and a further 100 (21.5 per cent) from 25 to 34 years. An extremely small proportion of the sample was edentulous in these age groups, and the numbers with histories of school dental care in the older groups were too small to provide information of value. Therefore, the data for these subjects are not presented separately.

Occasionally, the projected totals differ marginally from the additions of projected sub-totals. This resulted from cumulative "round-off" error and should be disregarded.

1.3.3.3 Results and comments (Tth. loss: Sth. Aust.)

A. Edentulous state in both jaws

All subjects presented suitable information. The projected percentage of edentulous subjects by age, sex, and place of residence is presented in Table 55. This percentage was 26.2 for South Australians aged 15 years and over, and increased from about 1.3 per cent for 15 to 24-year-olds to 77.8 per cent for subjects aged 65 years or more.

Apparently, complete tooth loss was more common in South Australia than in the United States, but less common in the older groups than in England and Wales (Tables 42 and 55).[87,89]

In each age group, more females than males apparently were edentulous in South Australia (Table 55). This difference was consistent in all age groups in the State capital and in five age groups in country urban centres, but the difference was not consistent in the rural areas (Table 55).

A higher proportion of subjects was edentulous outside the State capital in 11 of the 12 age-sex specific groups (Table 55).

A higher proportion of individuals in the lower socio-economic category apparently was edentulous in nine age-sex specific groups (Table 56). Only four age-sex specific comparisons were based on estimates of over 3,000 and in each of these instances, the edentulous state was more common in the lower socio-economic category (Table 56).

In each age-sex specific group, a higher proportion of subjects who were born in Australia was edentulous (Table 57).

It is projected that there were approximately 228,400 edentulous South Australians aged 15 years and over. Of these subjects, about 95 per cent wore full upper and full lower dentures, almost three per cent wore full upper dentures only, and approximately two per cent did not wear dentures (Table 58).

Pooled percentages of edentulous subjects who wore specified dentures are presented in Table 58, but age specific data are not tabulated in order to conserve space. Nevertheless, it was evident that more edentulous females than males wore full upper and full lower dentures in all but the 15 to 24-year-old age group. Collectively, the relevant percentages were 96.0 for females and 93.1 for males (Table 58). More edentulous immigrants wore full upper and full lower dentures in six age-sex specific groups, whereas the reverse applied in four groups and the numbers were the same in the other two instances.

When age-sex specific percentages of edentulous subjects with full upper and full lower dentures were analysed according to the locality, the highest percentages pertained to

(i) the rural areas in five instances;

(ii) the State capital in three instances, and

(iii) the country urban centres in two instances.

For two age-sex specific groups, the three percentages were identical, and collectively they were similar (Table 58). These proportions were higher for

(i) the upper socio-economic group in six age-sex specific categories, and

(ii) the lower socio-economic group in three age-sex specific categories.

Overall, more edentulous subjects in the upper socio-economic group wore full upper and full lower dentures, but the difference was small (Table 58).

Although comparisons are complicated by different age clusters, it seems that complete tooth loss is more common in New Zealand than in South Australia (Tables 44 and 55).[172]

B. Denture wearers

Overall, 42.9 per cent of South Australians apparently wore dentures, and this proportion increased from 5.9 per cent for 15 to 24-year-olds to 90.1 per cent for subjects aged 65 years or more (Table 59). More females had dentures in five age groups (Table 59).

The projected number of dentures in South Australia was 616,454, and 519,157 (84.2 per cent) were full

prostheses (derived from Table 59). The proportions which were full dentures were greater for the aged and for females (Table 60).

More of the subjects wore dentures outside the State capital in five age groups (Table 61). Furthermore, the proportion of dentures which were full prostheses apparently was greater outside the State capital in each age group (Table 60).

The projected percentage of subjects who wore dentures was higher for the lower socio-economic category in each age group (Table 62). The proportion of dentures which were full prostheses did not vary consistently with the socio-economic level (Table 60).

Fewer immigrants wore dentures in five age groups, and smaller proportions of their dentures were full prostheses (Tables 60 and 63).

The combinations of dentures are presented by age, sex, place of residence, socio-economic level and place of birth in Tables 59, 61, 62 and 63. Over half of the subjects with dentures (58.0 per cent) had full upper and full lower prostheses (Table 59). The numbers with the next most common denture(s), expressed as proportions of the 373,835 projected denture wearers, were as follows:

(i) 19.0 per cent with full upper dentures;

(ii) 14.5 per cent with partial upper dentures, and

(iii) 3.4 per cent with full upper and partial lower dentures.

The other subjects are presented by type of denture(s) in Table 59.

1.3.3.4 Discussion (Tth. loss: Sth. Aust.)

Apparently, the pooled prevalence of the edentulous state outside the State capital in South Australia is similar to that for the South East (Tables 42 and 55), and prevalence figures for the State capitals in South Australia and New South Wales are similar.[182] Comparisons between different studies should be interpreted cautiously, as methods of sampling and of obtaining information varied.[87,89,172,182]

The higher proportion of edentulous individuals in the South East, who reported not wearing a full upper and full lower denture, possibly was misleading and resulted from differences in the interviewing procedures. In the State-wide survey, special care was taken to record individuals as denture wearers if they wore a denture at some time, even though they might not have worn one during the interview.

Approximately 80 per cent of South Australians aged 65 years or more were edentulous, and this proportion had reached about one in six for 35 to 44-year-olds. With the extent of unmet past dental needs inferred by these data, it seems that current needs also might be extensive, particularly outside the State capital and amongst the Australian-born and low socio-economic groups.

The larger proportion of edentulous subjects amongst females possibly reflects a greater concern for appearance by this sex, rather than less attention to dental care. It was apparent that more edentulous females than males wore full upper and full lower dentures.

As in the South East, more of the females' dentures were full prostheses, but a consistently higher proportion of full prostheses amongst dentures in the lower socio-economic groups was not evident.

This proportion was higher outside the State capital, and might reflect a relative disinterest in retaining natural teeth in these areas. Conversely, the proportion was lower for immigrants.

It was evident that fewer immigrants were edentulous. Data presented in Table 53 indicated that immigrant groups were concentrated in the State capital to a greater extent than other subjects. When Tables 55 and 57 are compared, it is apparent that immigrants throughout the State had a lower prevalence of the edentulous state than the total population of the capital. Accordingly, the lower prevalence figures for immigrants could not be explained merely by their greater concentration in that city.

Whereas the data for subjects with varying histories of school dental care were accumulated in this report, it is intended that these data will be separated when presenting the results of serial studies.

1.3.4 Discussion

These studies collectively indicated an extensive level of complete tooth loss in South Australia, which was most evident amongst the aged, females, the lower socio-economic groups, individuals born in Australia and those residing outside the State capital.

Although research methods varied and comparisons should be undertaken cautiously, it appeared that tooth

loss was more common in New Zealand, despite that country's longer history of an extensive School Dental Programme.[172]

As anticipated, too few South Australian adults reported histories of school dental care to facilitate an evaluation of the long-term effects at this time.

The low prevalence of complete tooth loss in the younger age groups, particularly in the State capital, could prevent the early evaluation of school dental care with these data. Perhaps householders should be informed of future surveys in advance and be asked to determine the actual numbers of teeth which are visible in their lower jaws. This information might be obtainable and could enable a more sensitive method of evaluation to be established, which would be more applicable to the younger groups than the present approach.

1.3.5 Summary

A survey of New Zealand adults revealed extensive tooth loss, and raises questions about the long-term effects of school dental care. Too few South Australian adults have received school dental care for ready assessment of its effects.

With the rapid extension of the South Australian School Dental Programme, it seems desirable that a baseline appreciation of the dental health of adults be obtained

(i) to permit subsequent evaluation of this care and of other dental influences, and

(ii) to assist health planners.

Although a national dental survey has been proposed, no initiatives have followed, and so information on complete tooth loss and the wearing of dentures was obtained through interviews in two South Australian surveys.

The data have these limitations:

(i) complete tooth loss is rare in young adults, and so early evaluation of the effects of school dental care might be difficult with these data, and

(ii) although results indicate the extent of past unmet dental needs, existing needs are not evident directly.

Nevertheless, the collection of these data required minimal resources and established a base-line for future evaluation of change.

Whereas both surveys indicated a high prevalence of tooth loss in South Australia, which apparently exceeded the prevalence in the United States, it seems that more tooth loss has occurred in New Zealand. Comparisons should be regarded cautiously as a result of procedural differences between the studies.

The edentulous state seemed more common outside the State capital and amongst the aged, females, lower socio-economic groups and individuals born in Australia.

The number of denture wearers apparently was highest amongst the aged, females, individuals residing outside the State capital and those born in Australia. One study suggested that there were more denture wearers in the lower socio-economic groups. Over half the denture wearers possessed full upper and full lower prostheses,

and the next most prevalent prostheses apparently were

(i) a full upper denture only, and

(ii) a partial upper denture only.

Most dentures were full prostheses, and these dentures apparently represented a higher proportion of prostheses amongst the aged, females, subjects residing outside the State capital, and those born in Australia. One study indicated that this proportion was higher for the lower socio-economic groups.

It was evident from one study that

(i) more females usually visited a dentist for a "routine check", and

(ii) more individuals in the upper socio-economic groups had received restorative care, usually visited a dentist for a "routine check", and had seen a dentist in the past 12 months.

Fewer subjects in the older age groups had received restorative care, or had seen a dentist in the past 12 months. The aged seemed more likely to visit a dentist only when in pain. In a country survey, lack of ready availability of care was the major reason apparent for not obtaining dental care when a need was felt.

2. Assessment of cost

2.1 Introduction

In 1972, the Australian Dental Association supported a national dental scheme for children and claimed that evaluation should define the care rendered, its cost and degree of utilization by the community.[183] An expert committee established by the World Health

Organization emphasized that research and evaluation were necessary, if there were to be an ultimate appreciation of how to provide the best care at the lowest cost.[184]

It is important for health planners to consider the potential benefits and costs of programmes when establishing a plan. In this report, the estimated cost of care provided in the South Australian School Dental Programme from July to December 1972 is compared with standards based on "fee-for-service" schedules. Fee schedules were chosen that apparently resembled those which could prevail in conventional private practices, and which therefore might offer a credible basis for deciding whether school dental costs were "reasonable".

The costs of school dental care in 1975 also were reviewed, and future costs were estimated after considering the eventual patient loads per dental health provider, the required numbers and types of staff, and the associated salaries and overhead expenses.

2.2 Cost of school dental care in 1972

2.2.1 Introduction

Estimated costs of dental health programmes often seem reliable because salaries are tangible and represent most of the outlay.[185,186] Costs associated with capital depreciation and the long-term maintenance of clinics and equipment often must be estimated, but they usually represent a small component of the total cost.[185,186]

Even so, accurate determinations of school dental costs for 1972 seemed more complicated because 47 of the 62 dental operators were therapists. These auxiliaries

were females and it seemed that their New Zealand counterparts might work for an average of about seven years only.[187] Therefore it appeared that their training costs might be a substantial proportion of total costs, and so inaccurate predictions of working life spans might affect total cost estimates significantly.

This study is not posed as a precise assessment of cost-effectiveness, nor is it considered that the relative cost-effectiveness of government and private dental care has been reviewed. The following intangible factors were associated with estimated school dental costs:

(i) the average working life span of therapists;

(ii) capital depreciation, and

(iii) the long-term costs of maintenance.

Although fee schedules were chosen which apparently resembled those which could apply in conventional private practices, it was evident that dentists applied numerous schedules. The South Australian Branch of the Australian Dental Association had stressed that no single fee was appropriate to all varieties of a single category of service.[188] Accordingly, dentists often modified fees to satisfy the requirements of individual operations. Furthermore, it seemed that fees were influenced by the expectations of consumers. For example, if patients did not expect a fee which was appropriate to the time required for diagnostic or preventive services, some dentists apparently charged less. If the time per unit of service was reduced by providing multiple services at one appointment, it seemed that the fee per unit of service sometimes

was reduced.

If the relative cost-effectiveness of government and conventional private care for children were to be defined, it seemed that the following characteristics should be reviewed:

(i) the cost of government dental care imposed by salaries, the training costs of staff, stores, electricity, water, gas, laundry, telephone, postage, transport, and the capital depreciation and maintenance of clinics and equipment;

(ii) the cost of private care associated with the relevant fees for services and the training costs of staff;

(iii) the respective levels of dental health which would be achieved in recipients by these two modes of care in the immediate and longer term. If these levels varied, quantification of dental health quality would be necessary for the calculation of cost-effectiveness ratios; and

(iv) the numbers of children who would receive the two forms of care, as related to cost.

If it were the aim of a programme to improve dental health throughout the community, the respective percentages of individuals who would not be treated, and their levels of dental health in the immediate and longer term, would require quantification to determine cost-effectiveness ratios.

Indirect costs resulting from the travelling of patients and from the work time lost by accompanying parents could be included, and costs to government could

be adjusted to account for the effects of taxation.

It is evident that many of these factors cannot be quantified readily. Moreover, the existing private and government systems of care might change. A greater inclusion of auxiliaries in the private sector could reduce costs. If the working life spans of school dental therapists were to increase, costs probably would decrease. Furthermore, changes in the relative incomes of dental health personnel and in taxation structures could affect the respective cost-effectiveness of different systems of care.

It also seems that a cost-effectiveness ratio does not embody the merit of a system. For example, a community might prefer a less desirable ratio, if it were associated with a system which was more effective, accessible or agreeable.

It should be appreciated that the purpose of the present study was not to compare the merits of a government and private system. The aim was to assess school dental costs from July to December 1972 and to interpret whether they were "reasonable" by comparisons with "fee-for-service" standards. Although it seems that these standards might constitute a credible frame of reference, it is doubtful whether some fees were appropriate to school dental care. For example, whereas identical fees were offered by the Federal government's Repatriation Department for restorations of the primary and permanent teeth, this might not have applied had the proportion in primary teeth normally been as high as for school dental care.[189]

Moreover, it is difficult to assign appropriate fees for the daily supervision of toothbrushing at schools, health lessons in class-rooms, and addresses to community groups.

2.2.2 Review of the literature

Other studies have compared the cost-effectiveness of dental systems. Boggs analysed the potential costs and benefits of providing prosthetic services for Indians through the following:

(i) dentists employed by the Indian Health Service who used a laboratory service established within the organization;

(ii) dentists employed by the Indian Health Service who were supported by a commercial dental laboratory, and

(iii) private dentists who used a commercial laboratory.[190]

It was concluded that the relative cost-effectiveness depended on the volume of turnover.[190]

Abramowitz compared the cost of care provided in the Indian Health Service with contractual costs, and concluded that the latter would be more expensive.[190]

Posnick calculated the costs of care at a Minneapolis health centre.[186] Results indicated that the care might have been slightly more expensive had it been financed through fees drawn from the schedules for Minnesota Medicaid and the Minnesota Dental Service Plan.[186]

Jong and Leverett estimated the cost of care at a Boston health centre.[185] Compared with hypothetical costs based on the fee schedule for Massachusetts' Medicaid, the health centre seemed expensive, and this apparently resulted to some degree from the number of

broken appointments.[185]

Johnson compared the cost of supplying care to first-grade children through a government mobile clinic with a hypothetical "fee-for-service" cost.[191] Results suggested that the costs were similar.[191]

These studies compared assessments of actual costs with hypothetical alternatives based on fee schedules. Therefore, the methods were similar to those of the present study.

Fisher contended that each system of financing dental care aimed to reward the health provider for productivity, irrespective of whether payment related to services, visits, the number of individuals treated or salaries.[100] Each system had limitations.[100] Fisher claimed that the "fee-for-service" approach rewarded productivity, but discouraged quality and the performance of preventive and time-consuming services.[100] When fees were based on the number of visits, there appeared to be inefficiency, multiple short visits, and the avoidance of services which required long appointments.[100] Capitation fees apparently encouraged inexpensive care and the neglect of certain needs; frequently, time was devoted to co-operative rather than unco-operative patients.[100] Salaried services promoted inefficiency and over-utilization.[100] On the basis of these opinions, it may be anticipated that a government dental programme might be associated with inefficiency and over-utilization, whereas a "fee-for-service" system might be over-productive to the detriment of quality, particularly with regard to preventive

services.[100]

2.2.3 Materials and methods

A. Clinical recording

The author introduced a modified system of recording in order to facilitate the application of certain "fee-for-service" schedules to the care provided from July to December 1972 (Appendix 5.1). The system was in operation throughout the School Dental Programme during that period with the exception of the surgery for teaching staff at the School of Dental Therapy, where the system was used for approximately $2\frac{1}{2}$ months only. Estimates for the staff surgery which related to the total six months were based on the $2\frac{1}{2}$ month period. If substantial inaccuracies were included, it nevertheless seemed that the total error would be small as the services provided in that surgery represented less than two per cent of the total.

The new recording system was introduced two months before the study period, and the author reviewed all the records and clarified misunderstandings with the staff throughout this preliminary stage. Subsequently the records were checked during the study period by a research assistant, who contacted staff when misrecordings were evident. Although it seemed that some omissions and misrecordings would have escaped detection, it was considered that records would represent close approximations of the numbers and types of services provided.

B. Estimations of cost

(a) Training

Information on the training costs of the dentists was not readily available and was excluded from the study. Therefore, the total costs of providing care through the School Dental Programme and through hypothetical "fee-for-service" systems were underestimated. As only about 24 per cent (15 in 62) of school dental clinicians were dentists, and as dentists appeared to practise for approximately 30 years, it seemed that the exclusion of their training costs would cause only a minor underestimation of the total cost figure.

In 1972, the School of Dental Therapy was a College of Advanced Education and was eligible for Federal funding. Accordingly a record of costs was submitted to the Federal government for that year. Estimates of training costs have been based on that record.

The mean number of second-year students in 1972 was 13.5, but the annual mean from 1968 to 1972 had been 15. Therefore, the specified costs for these students in 1972 were increased by 11.1 per cent to approximate costs for the mean number of 15 students.

Estimates for the capital depreciation of the School of Dental Therapy were added. It was assumed that the basic structure would depreciate to zero value over 30 years, and that major equipment would depreciate similarly over 15 years. The existing maintenance cost was increased to the level anticipated as a yearly average over 15 years. The average was derived from the estimates for similar items and facilities in field clinics by a maintenance technician. Examples of these estimates are

presented in Appendix 5.2. It was assumed that items of minor equipment would continue to require replacement at prevailing rates, and so existing costs were used. To avoid an underestimation, the capital costs of minor equipment also were accumulated with the costs of major equipment when estimating annual depreciation rates. The term "major equipment" referred to items like air compressors, air conditioners, dental chairs, x-ray machines, sterilizers and furniture, whereas the "minor equipment" category included hand instruments, probes, mouth mirrors, "rubber dam" instruments, components of hand pieces and plastic instruments.

Costs were expressed in the dollar value of the study period by adjusting actual purchasing costs to account for increases in the State capital's Consumer Price Index.[192]

(b) Field Services

The salaries for clinical staff were factual, but the appropriate proportional salaries for supportive personnel were estimated. These proportions were as follows:

(i) 60 per cent for storemen;

(ii) 50 per cent for lay administrators and instrument technicians, and

(iii) 20 per cent for secretarial staff.

Rates of capital depreciation and long-term maintenance costs for basic clinic structures and equipment were estimated as for the School of Dental Therapy. However, the rate of capital depreciation of basic mobile

clinic structures was assumed to equal the rate for major equipment.[190]

It was assumed that the towage vehicle would depreciate to zero value over $5\frac{1}{2}$ years, and the corresponding annual depreciation was included with the operating costs for 1972. It was considered that 80 per cent of these costs would relate to the School Dental Programme, as opposed to other government services.

Postage costs had been pooled with the expenditure for other government departments, and so these school dental costs were estimated. The costs of stores, the replacement of minor equipment, laundry, water, gas, electricity, telephone and travel were factual for 1972, but were not available for the precise period of the study. As 53.1 per cent of the total operator days pertained to this period, 53.1 per cent of these costs was included.

All costs were calculated in the dollar value of the study period by adjusting for increases in the State capital's Consumer Price Index.[192]

It is apparent that numerous estimates were included, but that these mostly related to items of minor cost. In fact, salaries alone were responsible for approximately three-quarters of the estimated cost of delivering care in field clinics (Table 64).

The costs of accommodation and travel which were unique to serving remote rural areas from mobile clinics were excluded. It was presumed that the fee schedules which were used for comparative standards did not provide for these expenses.

C. Assessments of hypothetical "fee-for-service" standards

Fee schedules were based on three lists of fees, namely:

(i) the 1972 basis for fee assessment prepared by the South Australian Branch of the Australian Dental Association;

(ii) the fees reported in a survey of South Australian dentists in 1971, and

(iii) the fees provided by the Federal government's Repatriation Department in 1972 for the treatment of certain population groups.[188,189,193]

The schedules were termed schedules one, two and three respectively. Adjustments were incorporated to facilitate their application to the school dental care. For example, fees reported by dentists in 1971 were modified to account for mean percentage increases in the State's Average Weekly Earnings and the State capital's Consumer Price Index, in accordance with a method established by the Australian Dental Association.[188,192,194] The employed schedules are presented in Appendices 5.5, 5.6 and 5.7.

Inevitably, individual dentists would consider that some fees might be inappropriate and so they should interpret the findings accordingly. The process of determining certain fees is discussed under relevant headings:

(a) Examination

Fees for schedules one and two were appropriate

to about six minutes of time.[188,193] Higher fees were not selected because school dental staff did not need to devote time to discussing fees with patients. The actual fee presented by the Repatriation Department was chosen, but for the purpose of this study it also was assumed to provide some reimbursement for dental health education.[189]

(b) Prophylaxis

The fees in schedules one and two were approximately a quarter of the hourly rate, whereas the Repatriation Department's fee was used for the third schedule.[188,189,193]

(c) Topical application of fluoride

The fee in schedule three was the one listed by the Repatriation Department.[189] Although school dental staff applied fluoride manually, fees appropriate to about eight minutes of time were chosen for the other schedules on the assumption than an application with trays would require this time.[188,193]

(d) X-rays

The maximum fee applied to a full mouth survey, which was assumed to include 20 films for schedules one and two.[188,189,193] After the first three films, each was assigned an equal fee in those schedules so that 20 films would impose the fee for a full mouth survey.[188,193]

(e) Dental health education

Education was directed towards all patients from the chairside and towards groups of children and

parents. Its value was assumed to be equivalent to about 10 to 15 minutes of time per examination, and a corresponding fee was assigned in the first two schedules.[188,193]

(f) Restorations

Apart from cuspal restorations and those which were supported by at least one pin, the maximum fee for an amalgam restoration applied to the three-surface variety which included two proximal areas.[188, 189,193] When two surfaces were restored by one-surface restorations, or by a two-surface restoration which did not include a proximal surface, the fee was mid-way between a one and a two-surface restoration.[188,189,193] A two-surface restoration which included a proximal surface, together with a one-surface restoration on a separate surface, received a fee mid-way between a two and a three-surface restoration.[188,189,193]

The methods which were used to derive fees for all types and combinations of restorations were numerous, and seem unimportant. If it appears that some fees are inappropriate, then the findings should be interpreted accordingly.

(g) Extractions

The maximum fees were the ones listed for extractions under general anaesthesia in the original lists.[188,189,193] When combinations of primary and permanent teeth were removed, the first tooth extracted was assumed to be a primary tooth in order

to avoid excessive standards.[193]

(h) Endodontics

The charge for a root canal treatment provided for four x-ray films, and the number of isolated films included in the calculations of costs was reduced accordingly.[188,189,193]

The fee which was listed for pulpotomies by the Repatriation Department also was applied to mummifications in the third schedule, whereas these treatments were assigned a fee appropriate to about 10 minutes of time for the first and second schedules.[188,189,193]

(i) Orthodontics

Fees were applied with the knowledge that two-thirds of the orthodontic treatments included the placement of space-maintainers. If more than one appliance was employed at one time, these devices were regarded as part of the one treatment.

(j) Sedative dressings

Both the Repatriation Department's schedule and the fees reported in the 1971 survey included a charge for dressings.[189,193] The fee for the first schedule was assigned arbitrarily. In schedules one and two, dressings additional to the first were allotted a fee which approximated 40 per cent of the single rate.

As the Repatriation Department placed restrictions on the number of dressings for which reimbursement was automatic, only half of the calculated cost of dressings was used for the third schedule.[189]

The School of Dental Therapy was considered separately, because numerous dressings apparently were associated with the teaching process. Only a quarter of their calculated cost was included for the third schedule, and only a half for schedules one and two.

(k) Miscellaneous operations

This category included various treatments, for example: the removal of sutures, frenectomies and the treatment of ulcers and hypersensitive areas. It was assumed that the mean required time would be about five minutes, and fees were assigned accordingly.

The combinations of examinations, prophylaxes and exposures of bite-wing x-ray films varied between the solo dentists and the teams of dentists and therapists. It seemed that dentists frequently provided several clinical examinations and directed therapists to expose x-ray films at a later appointment. Attempts were made to adjust the combinations of these services which were supplied by teams of dentists and therapists to approximate the combinations for the solo dentists. In making this adjustment, it was assumed that the delivery systems associated with the "fee-for-service" standards did not include therapists.

Reductions in fees per unit of service sometimes applied when multiple services were provided during the one appointment, for example:

(i) examinations with the exposure of x-ray films and

prophylaxes;

(ii) multiple exposures of x-ray films;

(iii) several restorations of one tooth;

(iv) multiple extractions;

(v) the placement of more than one orthodontic appliance, and

(vi) the insertion of several sedative dressings.

Reductions possibly would have been appropriate for other combinations of services also, for example: restorations of several teeth, and extractions with the exposure of x-ray films. Therefore, the accumulated costs of exposing x-ray films without an associated examination and of restorations, extractions, sedative dressings and miscellaneous operations have been reduced arbitrarily by 15 per cent in order to make further provisions for multiple services. These adjustments were applied to cost estimates based on schedules one and two only, because the Repatriation Department's fee schedule was inflexible in this regard.[189]

D. Comparisons of estimated costs with standards

Comparisons initially were made without accounting for the training costs of therapists. Subsequently, these costs were included for the salaried system only, and it was assumed that similar operative auxiliaries would not be employed in the system associated with the "fee-for-service" standards. It was assumed that the therapists' average span of working life would be six years, which was less than previously indicated.[187] One twelfth of the training cost of a therapist therefore was added to the accumulated six-monthly salary of each auxiliary.

Although costs have been calculated to the nearest cent, this degree of accuracy should not be regarded as credible on account of the numerous estimates which were incorporated. Small apparent discrepancies should be ignored. For example, when estimating the maintenance and operating costs of the towage vehicle from annual rates, 53.1 per cent of these rates was employed because this proportion of the total operator days pertained to the study period. As the percentage which actually was employed included more decimal places, slight discrepancies would be apparent if the results were checked by taking 53.1 per cent of the annual costs. These minor "round-off" differences should be disregarded.

Advice on procedures was obtained from the accountant of the State government's Hospitals Department.

2.2.4 Results and comments (Schl. dent. cost : 1972)

A. Estimated costs

The total estimated cost of providing care through the field clinics approximated $321,000 when the training costs of therapists were excluded (Table 64). The six-monthly rates of capital depreciation and the maintenance costs were derived from annual figures, which are presented in Appendix 5.3.

The estimated annual cost of the School of Dental Therapy for the average number of students was $232,000, that is, $210,000 for operational expenses (Table 65) and $22,000 for capital depreciation (Appendix 5.4). As the mean number of graduating students from 1968 to 1972 had been 14.8, the mean estimated cost per graduate would

have been $15,700 (231,805.53/14.8).

The School of Dental Therapy provided a dental service equivalent to a cost standard of $48,000 based on schedule one, $37,000 based on schedule two, and $40,000 based on schedule three, as indicated in Table 66 and detailed in Appendix 5.5. There were 13 clinical students throughout this period, but the mean from 1968 to 1972 had been 15 with 14.8 subsequently graduating. It was estimated that productivity in the first six months of the year when students obtained their initial clinical experience would be 85 per cent of that for the second six months. Therefore the total "fee-for-service" cost standard for care per graduate per year was estimated at $6,900 based on schedule one (47,725.09 x 1.85/13 x 15/14.8), $5,300 based on schedule two (36,692.06 x 1.85/13 x 15/14.8), and $5,800 based on schedule three (40,321.40 x 1.85/13 x 15/14.8). Therefore, the effective cost of training a therapist was estimated at $8,800 based on schedule one (15,662.54 - 6,883.43), $10,400 based on schedule two (15,662.54 - 5,292.12), and $9,800 based on schedule three (15,662.54 - 5,815.59).

The mean number of qualified therapists throughout the study period was 47.3. If it is assumed that their average span of working life would be six years, then the training costs relevant to the study period would have been $35,000 based on schedule one (8,779.11/12 x 47.3), $41,000 based on schedule two (10,370.42/12 x 47.3), and $39,000 based on schedule three (9,846.95/12 x 47.3).

Accordingly, the total cost of providing care through the field clinics was estimated at $355,000 based on schedule one (320,849.75 + 34,604.33), $362,000 based on schedule two (320,849.75 + 40,876.74), and $360,000 based on schedule three (320,849.75 + 38,813.39).

B. Hypothetical "fee-for-service" standards

The components of cost standards are presented in Table 67 and are detailed in Appendices 5.6 and 5.7.

The cost standards were as follows:

(i) $476,000 based on schedule one;

(ii) $366,000 based on schedule two, and

(iii) $390,000 based on schedule three,

as derived from the care provided by the dentists and therapists and by solo dentists (Table 67).

C. Comparisons of estimated costs with standards

If it is assumed that therapists would be employed in the delivery systems associated with the "fee-for-service" standards, then it seems justified to disregard their training costs. Therefore, it may be concluded that the estimated cost of delivering care in the field clinics, namely $321,000, was lower than the lowest cost standard of $366,000 which was based on schedule two.

If the therapists' training costs were included for the salaried system only on the assumption that these auxiliaries would not be included in the delivery systems associated with the "fee-for-service" standards, then it may be concluded that the highest estimated cost of delivering care through the field clinics, namely $362,000, would approximate the lowest cost standard of $366,000

(schedule two).

2.2.5 Discussion (Schl. dent. cost : 1972)

It is apparent that school dental costs were at least as favourable as the employed cost standards. Accordingly, it may be concluded that school dental costs were "reasonable", unless the standards and methods of comparison were inappropriate.

If the standards related to delivery systems which employed dentists only, then it seems that taxation would reduce the associated community costs more appreciably than for a school dental system where most operators were therapists on lower taxable incomes.

As the State prohibits the employment of therapists in private practices, perhaps more severe cost standards should have been applied than standards orientated towards conventional private practices.

If salaried services are associated with over-utilization, as contended by Fisher, then the inclusion of costs for unnecessary services which would not have been provided in a "fee-for-service" system would be inappropriate.[100]

Fisher claimed that "fee-for-service" systems encouraged low quality, particularly with regard to preventive services.[100] If this contention is justified, comparisons of costs with "fee-for-service" standards might not be appropriate unless an allowance is made for differences in quality.

Features like the immediate and longer-term health benefits, the respective numbers of individuals reached,

the health characteristics of non-utilizers, and the social acceptability of different systems of delivery, also have been disregarded.

If the employed fee schedules provided higher reimbursements for restorative than for preventive services, school dental costs could be expected to compare progressively less favourably with "fee-for-service" standards as backlog treatment needs were satisfied and as an increasing proportion of the services therefore were purely preventive. This kind of bias might be associated with the Repatriation Department's fee schedule, in which no reimbursement is nominated for dental health education.[189]

South Australian school dental records indicate that the loss of therapists from 1969 to 1975 has averaged $12\frac{1}{2}$ per cent per year, which equates with a span of working life of eight years. It is anticipated that the span will be longer because

(i) the therapy programme is recent and a number of the therapists who have left are expected to return;

(ii) the tendency for females to be included in the work force apparently has been increasing, and

(iii) the State government has resolved that males may enrol in schools of dental therapy.[195,196]

Accordingly, it appears from subsequent experience that the estimated training cost per year of working life might have been excessive for the 1972 period.

Furthermore, the dentist to therapist ratio in the field clinics has been reduced from one to 3.2 (15 to 47.3)

for the study period to one to 3.8 (29 to 110) for 1976. Therefore clinic staff would have had a lower mean salary in 1976. Information will be presented in a subsequent section which indicates that the cost of care is lower for therapists than for dentists in the School Dental Programme.

The following additional factors were not considered in the analysis:

(i) the training costs of dentists;

(ii) the travelling expenses of patients and parents, and the associated work time lost by parents;

(iii) the finance returned to public revenue through interests on loans, and

(iv) any future changes in dental delivery systems, disease prevalence or social patterns which might influence cost-effectiveness.

Whereas school dental costs seemed "reasonable" when compared with the specified cost standards, a conclusive judgement appears inappropriate on account of the numerous speculative considerations.

2.3 Cost of school dental care in 1975 and projected costs

2.3.1 Cost in 1975

A. Training of therapists

Capital depreciation costs were not defined for 1975 and are disregarded. Operational costs for the training of 48 first-year and 45 second-year students are presented in Table 68. The classification of items varied between 1972 and 1975, but differences apparently pertained to areas of minor cost only (Tables 65 and 68).

The percentages of costs which related to salaries and to student money allowances were similar for both periods, namely, 82.4 and 81.8 for 1972 and 1975 respectively. Furthermore, the percentages for stores and minor equipment replacements were 8.9 and 8.8 respectively (Tables 65 and 68). Evidently, these two items accounted for approximately 90 per cent of the operational costs in each year. The costs are not strictly comparable because of an adjustment to the 1972 figures to account for an estimated future increase in maintenance costs (Table 65). Nevertheless, this adjustment affected the total cost to a minor degree only, and so tentative comparisons of the percentage distributions of costs for the two periods seem justified (Table 65).

Costs in 1975 applied to a school with a training capacity three times greater than for 1972. If it is assumed that the average number of therapists graduating from the School would be 44.4, that is, three times the mean from 1968 to 1972, then the mean operational outlay for the training of each therapist would be about $23,000 (1,035,076.35/44.4). The corresponding figure for 1972 approximated $14,000 (210,279.30/14.8). The State capital's Consumer Price Index had increased from 123.7 for July to December 1972 to 180.0 for 1975.[197] Therefore the mean outlay in 1972 was about $21,000 in 1975 values (210,279.30/14.8 x 180.0/123.7). That is, the operational outlays for 1975 and 1972 were approximately the same.

B. Field services

Capital depreciation costs have not been defined

and are excluded. The costs for accommodation and travel, which were unique to serving remote rural areas from mobile clinics, also were disregarded to permit comparisons with the 1972 data.

Operational costs are presented in Table 69. The classification of items varied between 1972 and 1975, and estimates for capital depreciation were included for the former (Tables 64 and 69).

After excluding estimates for capital depreciation from data in Table 64, it was evident that the percentages of costs which pertained to the major items were similar. The percentages for salaries were 85.1 and 80.2 for 1972 and 1975 respectively, whereas the corresponding figures were 9.9 and 10.7 for stores and minor equipment replacements in the respective periods (derived from Tables 64 and 69).

C. Care provided

Details of the care provided at the School of Dental Therapy and through field clinics are presented in Appendices 5.9 and 5.10 respectively.

Although the data are considered to be approximately accurate, it is known that staff frequently omit to record activities, and that this particularly applies to services that are not provided at the chairside. For example, the supervision of toothbrushing for groups of children and dental health education in schools or at civic centres often are not recorded. Also, many parents apparently do not return with their children for final prophylaxes and the polishing of restorations, and so courses of care

frequently are recorded as "incomplete", even though all carious lesions have been treated.

Nevertheless, the data in Table 69 and Appendix 5.10 indicate that the cost of care provided through the field clinics in 1975 averaged about $40 per patient treated (1,458,905.53/36,514) and about $51 per patient receiving a complete course of treatment (1,458,905.53/28,408). Accordingly, the cost per patient would have averaged between 40 and 51 dollars, assuming that each were to receive at least one complete course of care. This cost estimate excludes provisions for capital depreciation and for the training of therapists. As approximately 40 per cent of the patients were "new" to the School Dental Programme, it is apparent that eventual costs would be lower.

2.3.2 Projected costs

The cost per operator of all overheads for the period from July to December 1972, after excluding the salaries of chairside assistants and the training costs of therapists, was estimated at $1,529.28, that is,(320,849.75 - 104,953.80 - 76,962.85 - 43,658.97)/62.3 (Table 64). This estimate was 68.9 per cent of the mean salary of a therapist for that period, that is, 1,529.28 x 47.3/104,953.80 x 100 (Table 64).

For the purpose of the projection, it was assumed that this percentage would continue to prevail for therapists, and that the mean absolute cost of these overheads for all the categories of clinical operators would be the same. The salary structures for the therapists, regional dentists and field dentists, as existing in June 1975, are

presented in Appendix 5.11. If it can be assumed that the average working life span would be as follows:

(i) eight years for therapists;

(ii) 30 years for regional dentists who direct therapists in static clinics, and

(iii) five years for field dentists who serve remote rural populations in mobile clinics,

then the mean annual salaries would be $7,064.25 for therapists, $15,488.20 for regional dentists and $11,188.80 for field dentists (derived from Appendix 5.11). The respective overheads per operator would represent 68.9 per cent of the mean annual salary of therapists, and 31.4 per cent (68.9 x 7,064.25/15,488.20) and 43.5 per cent (68.9 x 7,064.25/11,188.80) of the corresponding salaries for regional dentists and field dentists respectively.

The median estimate of mean training costs for therapists, after excluding the "fee-for-service" cost standard for care provided at the School, was about $9,800 for 1972. If the average working life span of therapists was eight years, which is consistent with past experience, then their training costs would have represented 27.7 per cent of their mean salary in 1972, that is, 9,846.95/8 x 47.3/(104,953.80 x 2) x 100 (Table 64). For the purpose of the projection, it is assumed that this percentage will continue to prevail, although the proportion might be high because therapists were comparatively recent graduates and consequently had low salaries in 1972.

The effective numbers of patients treated and completed in individual non-fluoridated regions in 1975 were

associated directly with the percentages of patients being recalled for follow-up care.[198] The association was analysed by Sundram with 1975 data and considered to be represented by the following linear regression equation:

patients treated (and completed) per operator =

1.7 x recall percentage + 331

Therefore, in a fully developed primary school dental programme in which six of the seven school grades were receiving incremental care (85.7 per cent), it seems that the mean number of patients treated and completed per operator would be 476.7.[198] As there is no South Australian community where children have received the full benefits of fluoridated water, a similar projection for fluoridated areas is not possible. Data have been presented which indicate that chairside time is approximately 60 per cent higher for incremental care in a non-fluoridated than fluoridated community, and this difference is reasonably consistent with the relative patient loads managed by New Zealand therapists in these types of communities.[70,199] Accordingly, it is assumed tentatively that the mean patient load per operator in a fully developed primary school dental programme eventually might be 762.7 (476.7 x 1.6) for fluoridated areas.

It has been evident that regional dentists could direct more therapists when the percentage of patients "on recall" increased, and fewer patients per therapist therefore presented with consequences of unchecked dental disease requiring treatment by a dentist. Regional dentists have been able to direct up to eight therapists in

non-fluoridated areas. Subjectively it seems that when the percentage of patients "on recall" stabilizes, the maximum number of therapists who could be directed per regional dentist might be about nine or 10.

No region has received the full effects of fluoridation, and so a corresponding estimation for fluoridated areas is more difficult. As more patients would be treated per therapist in fully developed primary school dental programmes in fluoridated areas, it seems that a regional dentist would not be able to direct so many therapists. For the purpose of this projection, it is assumed that the mean number of therapists per dentist in fluoridated areas would be seven.

There are three distinct types of areas in South Australia, namely:

(i) fluoridated areas with approximately 75 per cent of the population which would support static clinics;

(ii) non-fluoridated areas with about 12 to 13 per cent of the population which would support static clinics, and

(iii) non-fluoridated remote areas with the remaining population which would be served by mobile clinics only.

For the purpose of this projection, it is assumed that dental staff would be distributed as follows:

(i) for the first area, a mean of seven therapists and $4\frac{1}{2}$ chairside assistants per regional dentist;

(ii) for the second area, a mean of nine therapists and $5\frac{1}{2}$ chairside assistants per regional dentist, and

(iii) for the third area, one therapist and one chairside assistant per field dentist, which would be consistent with the envisaged assignment of one dentist, one therapist and an assistant to a two-chair mobile clinic.

As dental operators in the third area need to travel between small communities, it is assumed that their mean patient load would be 10 per cent lower than for other non-fluoridated areas, that is, 429.0 (476.7 x 0.9).

Eventual annual mean costs of treatment per child for the basic dental teams may be anticipated from the following calculations:

(a) the first area - 75 per cent of patients

salaries

- one regional dentist : $15,488.20
- seven therapists : $49,449.75 (7 x 7,064.25)
- $4\frac{1}{2}$ chairside assistants : $25,756.88 ($4\frac{1}{2}$ x 5,723.75)

It is assumed that assistants would be qualified and would have a mean working life span of eight years (Appendix 5.11).

training costs of therapists : $13,697.58 (49,449.75 x 27.7/100)

overhead costs

- based on regional dentist : $4,863.29 (15,488.20 x 31.4/100)
- based on therapists : $34,070.88 (49,449.75 x 68.9/100)

Therefore, the costs for eight operators and 6,101.6 patients (8 x 762.7) = $143,326.58

That is, the cost per patient = $23.49

(b) the second area - $12\frac{1}{2}$ per cent of patients

salaries

- one regional dentist : $15,488.20
- nine therapists : $63,578.25 (9 x 7,064.25)
- $5\frac{1}{2}$ chairside assistants : $31,480.63 ($5\frac{1}{2}$ x 5,723.75)

training costs of therapists : $17,611.18 (63,578.25 x 27.7/100)

overhead costs

- based on regional dentist : $4,863.29 (15,488.20 x 31.4/100)
- based on therapists : $43,805.41 (63,578.25 x 68.9/100)

Therefore, the cost for 10 operators and 4,767 patients (10 x 476.7) = $176,826.96

That is, the cost per patient = $37.09

(c) the third area - $12\frac{1}{2}$ per cent of patients

salaries

- one field dentist : $11,188.80
- one therapist : $7,064.25
- one chairside assistant : $5,723.75

training cost of therapist : $1,956.80 (7,064.25 x 27.7/100)

overhead costs

- based on field dentist : $4,867.13 (11,188.80 x 43.5/100)
- based on therapist : $4,867.27 (7,064.25 x 68.9/100)

Therefore, the total cost for two operators and 858 patients = $35,668.00

That is, the cost per patient = $41.57

Accordingly, the collective projected mean annual cost per patient in 1975 dollars would be $27.45, namely (23.49 x

75/100) + (37.09 x 12.5/100) + (41.57 x 12.5/100).

This projection excludes the costs of training dentists and of accommodation and travel which would be unique to serving remote rural areas from mobile clinics.

Although costs have been presented to the nearest cent, data should not be interpreted precisely as numerous questionable assumptions were incorporated, for example:

(i) that the specified overhead costs for all categories of operators were and would continue to be similar;

(ii) that the overhead costs as a proportion of the therapists' salaries would continue as for 1972;

(iii) that the working life spans of the various categories of staff would be as predicted;

(iv) that the relativities of the various salaries would continue as for June 1975;

(v) that the types of staff and the proportional "mix" would eventuate, as predicted;

(vi) that the patient loads for the three types of areas would be as assumed, and

(vii) that the existing percentages of patients in each area would continue to prevail. It is evident that these percentages could change as a result of extensions of fluoridation or urban development.

2.4 Discussion

Estimates of past and future costs of school dental care should be interpreted cautiously as numerous intangible factors must be considered.

It is evident that the proportional contribution of

the major items to operational costs in 1972 and 1975 was similar, both for the field clinics and for the School of Dental Therapy. Moreover, the mean outlay associated with the operational cost of training each therapist appeared similar for the two periods after accounting for inflation. It seems that these similarities add credibility to cost estimates and support the appropriateness of using these data for predicting future costs.

2.5 Summary

It is important for health planners to consider the potential benefits and costs of programmes when establishing a plan.

The cost of care provided through the South Australian School Dental Programme was estimated for July to December 1972, and was compared with "fee-for-service" standards. Although fee schedules were chosen which apparently resembled those which could be used in conventional private practices, it was not considered that the relative merits of school dental care and conventional private care had been defined. The following features of these modes of care were not considered:

(i) the effects on the dental health of recipients in the immediate and longer term as related to cost;

(ii) the degrees of utilization;

(iii) the levels of dental health amongst non-utilizers;

(iv) the impacts on costs of travelling, work time lost by accompanying parents, and of taxation, and

(v) relevant future changes in these systems.

The training costs of dentists were disregarded and

numerous questionable assumptions were incorporated. The relative social acceptability of school dental and private dental systems also was not considered.

Nevertheless, it seems that the cost of school dental care was "reasonable", as assessed by comparisons with the specified cost standards. The mean annual cost of care per patient apparently was between $40 and $51 in 1975, but the following costs were not included:

(i) capital depreciation;

(ii) training costs, and

(iii) the costs for accommodation and travel which were unique to providing care in remote rural areas from mobile clinics.

The eventual annual cost per child in a fully developed primary school dental programme was estimated at

(i) approximately $23 for the fluoridated areas of the State;

(ii) approximately $37 for the relatively urbanized non-fluoridated country areas;

(iii) approximately $42 for the sparsely populated non-fluoridated country areas, and

(iv) approximately $27 for the total State.

These costs are expressed in 1975 values and exclude the training costs of dentists and the costs for accommodation and travel which would be unique to providing care in remote rural areas. The assessments of cost required numerous estimates and should be interpreted as a tentative guide only.

3. Application of studies of dental need, effectiveness, cost and services to State-wide and regional planning

3.1 General

The application of information on dental needs and on the effectiveness of school dental care when seeking support for health plans from politicians, health administrators, community groups, health providers, parents and teachers, already has been mentioned. The potential of continuous evaluation for improving methods and for facilitating "scientific management" also has been reviewed.

Recognition of the lack of professional care after children leave the School Dental Programme, and of the minor effects of past dental health education, has led to changes in plans. Health education now is directed increasingly towards secondary school students, parental participation is more common, "active" as opposed to "passive" learning experiences are emphasized, and programmes associated with the direct referral of children to private dentists of their parents' choice are developing. The details have been discussed previously.

Assessments of existing and potential costs, and of whether these costs are "reasonable", are employed to determine the efficiency of school dental care. This information may be used in communications with politicians, health administrators, community groups, health providers and others.

Dentists receive information on the annual costs of their specific programmes. The costs are estimated by

including actual salaries with estimates for

(i) the training costs of therapists, and

(ii) the overheads associated with stores, the replacement of minor equipment, capital depreciation, maintenance, supportive staff and utilities.

Cost standards which are obtained by applying a "fee-for-service" schedule to lists of local services enable assessments of whether costs are "reasonable". Occasionally regional dentists have been concerned that costs might be too high and have taken action to increase productivity. Regional dentists may obtain information for specific local programmes to compare the relative costs. The standard format for this feedback is presented (Appendix 6.1).

3.2 Quality of care

It seems that quality should be evaluated in the context of effectiveness, efficiency, social acceptability, utilization and adaptability. However, as effectiveness often cannot be assessed simultaneously with the process of delivering care, standards relating to the delivery process have been used to indicate quality.

These standards are imprecise and are based on notions of the appropriate patterns of care, for example, the pertinent

(i) number of x-ray films for 100 examinations;

(ii) number of prophylaxes and topical applications of fluoride for 100 completed courses of care;

(iii) extent of verbal consultations and courses of dental health education for children and parents when

treating 100 children;

(iv) number of pulp treatments, root canal therapies and extractions for decay when treating 100 children with the relevant percentage "on recall", and

(v) extent of orthodontic care for 100 children in the specified age groups.

The pattern of State-wide services is compared with these standards. It has been claimed that standards, which consist of statistical means or ranges based on the performance of the individuals and their peers, often are regarded as particularly acceptable by staff.[45] Therefore, the patterns of care in the individual regions are compared with accumulated patterns for regions which are matched by the presence of fluoridation and the percentages of patients "on recall". Detailed reports are forwarded to the regional dentists.

It would be possible to compare the types of restorations with accumulated patterns for similar regions. Frequency distributions could be analysed according to

(i) the surfaces covered, and

(ii) the need for supportive pins or for the restoration of cusps.

Comparisons between distributions for the right and left sides of the mouth could indicate the extent of diagnostic consistency in this dimension. The degree to which primary teeth were restored in older children might infer over or under-prescription, and the extent of replacement of restorations might suggest the level of restorative performance. The standard recording systems would facili-

tate these analyses, and resulting data could assist

(i) regional dentists to monitor quality in their regions, and

(ii) administrators to consider State-wide performance over time

(Appendices 3.1 and 5.1).

Peculiarities in data, as identified by comparisons with accumulated information from similar regions, are used to indicate areas for consideration. They are not interpreted as conclusive evidence of poor quality. It is possible that local needs might be atypical and that peculiarities in care might represent programmes which are highly effective and efficient.

The system of feedback has assisted administrators and regional dentists to assess performance and to introduce policies for improvement.

The recording system enables records of a therapist's care to be reconciled with the range of duties that these auxiliaries may assume. Discrepancies could be relevant to quality and legality, and would receive prompt corrective action.

3.3 Regional feedback summary

In 1976, a method of condensing data to facilitate ready comprehension was developed. Several regional dentists had stated that their ability to interpret statistics was limited, and that they would appreciate a more succinct form of feedback.

All regional dentists were invited to join a task force to discuss appropriate feedback. In fact, a working party of 10 dentists enabled the author to develop the

"Regional feedback summary", which is presented in Appendix 6.2

Data on dental health and services are adjusted to represent a standard population with an even distribution across the age-sex specific groups. It is anticipated that by classifying subjects according to their periods of exposure to school dental care, assessments of progressive effects might be facilitated.

The "regional performance" is compared with standards nominated by the regional dentist. Standards might be means or ranges based on

(i) accumulated data from similar regions, or

(ii) the past performance of the respective region.

Alternatively, the regional dentist might choose to employ other standards. The "regional performance" may be expressed as a percentage, where 100 per cent represents peformance equal to the standard and higher percentages indicate superior performance. Percentages are presented to facilitate interpretation (Appendix 6.2).

The "acceptance rate" constitutes the percentage of children whose parents accept school dental care (Appendix 6.2). The goal of the School Dental Programme is to achieve dental health throughout the community, and so the "acceptance rate" seems an important aspect of performance. It is anticipated that these rates will be determined regionally, but that periodic State-wide surveys will enable the establishment of comparative standards.

The "continuation rate" is the percentage of students who visit a dentist within 18 months of leaving the School

Dental Programme (Appendix 6.2). The dentists considered that this rate was significant, as follow-up care would be necessary to achieving dental health throughout the community. It is expected that the rate would be determined regionally through surveys at secondary schools. Periodic State-wide surveys would enable associated standards to be provided.

School canteens often provide a wide range of cariogenic confectioneries.[200] It has been demonstrated that this practice is associated with high decay rates.[200,201] Although normally regarded as a peripheral activity, endeavours are undertaken by school dental staff and other health providers to improve canteen menus. Canteens could be assigned a "canteen rating" from one to five, in which one would represent a canteen with a comprehensive range of cariogenic items and higher scores would relate to progressively superior menus. Regional dentists could classify the canteens locally and periodic State-wide surveys would enable standards to be established (Appendix 6.2).

The "estimated cost" of the regional dental programme would be calculated and expressed as a proportion of a "fee-for-service" standard. This proportion could be compared with corresponding proportions for similar regions (Appendix 6.2).

Similarly the patient load, as represented by the number of patients treated, the number of patients receiving a complete course of care, and the number of patients receiving two complete courses of care, was regarded as an important characteristic. The patient load relates

directly to the proportion of patients "on recall", and can be predicted using linear regression equations as will be demonstrated in this thesis. Therefore, accumulated data from similar regions can be employed to obtain linear regression equations so that the patient load per operator can be predicted from the percentage of patients "on recall". That is, standards based on similar regions would be available (Appendix 6.2).

Dentists in the task force considered that dental health features should be indicated by the following:

(i) the mean number of teeth with untreated decay (D + d);

(ii) the mean DMF(T) and df;

(iii) the mean oral debris score, and

(iv) the mean gingival disease score.

By analysing data according to the period of exposure to school dental care, progressive effects might be identified. No suitable index for the evaluation of orthodontic care was known, and the exclusion of orthodontic feedback is regarded as a weakness in the system (Appendix 6.2).

The quality of care also would be indicated by the following:

(i) the proportion of the restored teeth requiring treatment because of restorative failures;

(ii) the proportion of teeth experiencing pulpotomies;

(iii) the mean number of permanent teeth extracted because of decay, or to be extracted for this reason, and

(iv) the mean number of primary teeth to be extracted because of decay

(Appendix 6.2).

Minor alterations to the present data processing system would be necessary to obtain the information on "defective" restorations and pulpotomies.

The task force considered that the "Regional feedback summary" would facilitate the interpretation of statistical feedback, and therefore would encourage the establishment of regional plans with incorporated objectives. It was decided that feedback should be available at intervals prescribed by the individual regional dentists. The "Regional feedback summary" should be provided to all regional dentists, and more detailed information should be available on request.

3.4 Discussion

A review of published studies indicated that many students chose dentistry as a career because of its apparent individualistic and autonomous characteristics. 202

It seems imperative that evaluation is not perceived as a means whereby authoratarian administrators will place oppressive controls on regional staff. This perception could lead to industrial conflict, and evaluation could become counter-productive. Information collected by the staff could be biased deliberately, and this aspect of the evaluation system rendered useless. In fact, the dependence of an effective system on the active co-operation of clinic staff seems to be a safeguard against administrative abuse of this kind.

Numerous features of the regional programmes are not evaluated statistically, for example, the intermediate-term effects of orthodontic care. Therefore, the sole

dependence on data for assessing performance would not be justified, and might lead to disregard for aspects of care which are not evaluated statistically.

In the South Australian School Dental Programme, the research unit treats data confidentially. Individual regions receive their data, but never specific feedback for another region. Codes are assigned to operators and regions for electronic data processing, and these codes are regarded as confidential. The Director of the Programme may instruct the research staff to provide him with an individual operator's statistical records, and the information for a specific therapist may be requested by the corresponding regional dentist. In these events, the individual operator would be informed and would receive the information also.

Routinely, feedback is presented for regions rather than for smaller organizational units. A regional dentist may request information for these smaller units and in that event staff in the respective units would be informed and would receive the information also.

The aim of the system is to assist administrators and regional staff to assess performance against standards and objectives, and to improve their planning. Regional dentists are directing a maximum of eight dental therapists dispersed over considerable distances. Without daily contact with these staff and their patients, the dentists' ability to assess performance intuitively is reduced, and so assistance from statistical feedback is particularly relevant. The need for intuitive assessment nevertheless

remains, and so administration should neither rely entirely on a pragmatic nor a scientific approach.

Time and effort are required when regional staff forward statistics. Therefore it seems particularly important that these staff consider the investment worthwhile in the context of the feedback's relevance to local administration. For this reason, evaluation is being directed towards the needs which are expressed by representatives of the regional as well as central staff. Participants in the task force for the "Regional feedback summary" now are receiving this feedback, and opportunity will present for the system to be refined before it is extended further.

3.5 Summary

The application of information on the need for dental attention and on the effects and costs of school dental care to planning, and when communicating or seeking support for dental health plans, has been mentioned.

The relevance of evaluation to improving the methods of care also has been discussed. For example, evaluation has indicated

(i) a lack of professional care after children leave the School Dental Programme, and

(ii) only minor effects from past methods of dental health education.

Remedial action is being taken to improve these aspects of performance.

Patterns of care have been compared with standards to indicate peculiarities which require further investigation,

and to emphasize the desirability of introducing various policies.

Although detailed statistical information is available to regional dentists, a more succinct form of feedback has been designed by the author upon the advice of a task force of these dentists. This feedback should facilitate statistical interpretation and "scientific management".

The aim of evaluation is to assist administrators and regional staff to assess performance against standards and objectives, so that they can improve their planning. The dependence of the evaluation system on the active co-operation of clinic staff has been stressed, and endeavours to maintain this co-operation have been discussed.