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USE OF OPERATING DENTAL AUXILIARIES
FOR SCHOOL AGE CHILDREN

MOHAMED ELHERMA AMER
BDS (LIBYA)

A THESIS SUBMITTED IN PARTIAL REQUIREMENT
FOR THE
DIPLOMA IN PUBLIC HEALTH DENTISTRY

UNIVERSITY OF SYDNEY
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DEPARTMENT OF PREVENTIVE DENTISTRY
FACULTY OF DENTISTRY
UNIVERSITY OF SYDNEY
1986
SUMMARY

Those who assist the dentist in the provision of dental services to patients may be classified into two major categories:

1. Operating dental auxiliaries.
2. Non-operating dental auxiliaries.

This thesis is primarily concerned with the first category. Operating auxiliaries were first introduced in New Zealand and the United States of America about seventy years ago. Dental auxiliaries may be grouped into various vertical strata and horizontal levels according to their degree of training. The strata classification was adopted by the Fédération Dentaire Internationale (FDI) in 1983. It recognizes the possible mobility of the world dental workforce; where it offers guidelines for the training and development of auxiliaries. Moreover, it seeks to facilitate the recognition of the qualification of auxiliaries in countries other than the countries of qualification.

Approximately 404 training programmes for operating dental auxiliaries were in operation in seventy-seven countries around the world in 1981. About forty-two countries utilized 74,539 dental hygienists. Thirty-five countries utilized 9,540 New Zealand's type school dental nurses (school dental therapists). However, fifteen countries utilized both types of operating auxiliaries. Therefore, the total number of operating dental auxiliaries in the world (in 1981) was reported as 84,079.
According to the manpower classification given in the New Delhi 1968 World Health Organization (WHO), Inter-regional Seminar on training and utilization of dental personnel in developing countries, operating dental personnel include the professional dentist and the operating auxiliary. The operating auxiliary is trained to carry out certain procedures in the mouth under the direction and supervision of a dentist. This thesis describes the main types of operating dental auxiliaries: New Zealand type school dental nurses, dental therapists, dental hygienists, expanded function dental auxiliaries and denturists. A review is made of the training, functions, duties, provision of dental services, supervision of operating dental auxiliaries, productivity and utilization for school dental programmes and includes a review of some studies and analyses which have appeared on the quality, quantity and cost of services provided by the operating dental auxiliary.

The role of different types of operating auxiliaries in delivery of dental services in various countries of the world are reviewed. Arising from this review, general principles for the development of operating auxiliaries have been put forward:

1. Each nation should have a national dental health plan which integrates the production of manpower with the delivery of services.

2. National shortages of dental manpower should be solved with the inclusion into the workforce of appropriate types of operating auxiliaries.
3. Manpower production and utilization should be based on need as well as demand.

4. Control of standards must be included in any system utilizing operating dental auxiliaries.

5. An auxiliary can be trained effectively to carry out a range of preventive and curative procedures at less cost than when provided by dentists.

6. There are potential advantages to be gained by using operating dental auxiliaries in school dental programmes.
ACKNOWLEDGEMENTS

In particular I wish to thank P.D. Barnard, Associate Professor of the Department of Preventive Dentistry, University of Sydney, and Director of Preventive Dentistry at Westmead Hospital, for his supervision, valuable guidance and assistance given to me in the compiling of this thesis.

My thanks are also due to Professor N.D. Martin for his support and special assistance.

I gratefully acknowledge the support and encouragement and sacrifices of my wife Iman during the period of my studies.

Finally, I would like to thank the Libyan Arab Society through the People's Conferences and their people's Committees who granted me their support and the opportunity to continue my studies in Australia.
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INTRODUCTION

The Expert Committee on Auxiliary Dental Personnel of the World Health Organization (WHO) met in Geneva from the 30th of June to the 6th of July, 1958. This Committee reported on auxiliary dental personnel in order to provide governments and other organizations responsible for health programmes with information on the use that could be made of such personnel. Those nations with relatively advanced dental care programmes had found that with the help of auxiliaries they could achieve significant gains in providing dental care for the public. The Committee considered this fact and made recommendations to those nations that might be seeking to expand their dental health care system. (WHO 1959) In 1967 there was an inter-regional seminar on the training and utilization of dental personnel in New Delhi, and in 1968 a survey of legislation on auxiliaries, including dental auxiliaries, was published. (WHO 1968) WHO activities in this area have included the development of curriculum outlines for use in training courses for dental auxiliaries, the establishment of training programmes in Senegal and the provision of technical assistance to many countries.

These auxiliary personnel are seen as one possible solution to the problem of the worldwide shortage of dental staff by increasing the number of dental personnel and using them more efficiently. As it is not practicable to effect a radical increase in the number of dentists within
the next few decades, other types of personnel are required to assist them in providing dental care. The use of various types of auxiliary personnel has enabled the dentist to use his skills more effectively and economically.

Specialization in dentistry has increased the need for auxiliaries trained to carry out a limited and defined range of preventive, curative and educational dental services. The training of such personnel - known as Operating Dental Auxiliaries - began in 1913 in the United States of America and in 1921 in New Zealand. These auxiliaries are not substitute dentists but have their own functions which are carried out under the supervision and direction of dentists (Myers 1973).

Dental auxiliary personnel have become an integral part of modern dental practice in the United States. A survey of dental practice in 1977 revealed that only six per cent of dentists in solo practice did not employ any auxiliaries, while thirty-three per cent employed four or more auxiliary personnel. Ninety-one per cent of all dentists practising alone in the United States employed a dental assistant while forty-five per cent employed a full or part-time dental hygienist. The utilization of dental auxiliaries is increasing through the U.S.A. and provision for licensing of various categories of auxiliary personnel exists in forty-nine states (Furstman 1981).
Although the value of dental auxiliary personnel has been convincingly shown (Trevathan 1967, Berman 1969, Holt & Murray 1980), the decline in dental caries is bound to affect the attitudes of general dental practitioners towards their utilization in private practice. The New Zealand School Dental Nurse was introduced into government service to assist the dentist in his attempt to deal with the ravages of caries (Lbikunle 1985). People are demanding health services that will improve their health status and further increases in the demand for dental services can be predicted from changes taking place in the characteristics of the population. People are better educated and incomes are rising. These two factors are important positive influences on the number of people who will seek dental services (Young, Striffler 1964).

The use of operating dental auxiliaries is an attempt to make the best use of available manpower and promote cost effectiveness in the provision of dental services. Consumer organizations have expressed their support for greater use of auxiliaries, supervised by dentists (Am Dent Assoc 1967).

As early as 1962 the American Dental Association (ADA) adopted a resolution that indicated that the duties of auxiliaries must exclude:

(1) Diagnosis, treatment planning and prescription;
(2) Surgical procedures on hard and soft tissue;
(3) All restorative, prosthetic, orthodontic and other procedures which required the knowledge and skill of the dentist;
(4) Prescriptions for drugs, medicaments and/or authorization of work (Abramowitz, Berg 1973).

There may be different combinations of functions of auxiliaries in the areas of treatment, prevention and dental health education. The administrative authorities decide whether operating auxiliaries are employed in public health services or in private practice or in both, and the population group for which they may provide dental care (Myers 1973).

The dental therapist is an operative auxiliary who performs a limited range of restorative and preventive procedures for children under the direction of a registered dentist. She or he performs complete units of restorative and surgical treatment (extraction of teeth) and has a major role in the direct provision of care. A training school for therapists was established in Adelaide by the South Australian Government in 1967 to provide adequately trained dental therapists for employment in the school dental service (Blaikie 1974).

In California, U.S.A., in 1974 a Bill was adopted (Assembly Bill 1455 authorised by Assembly Gordon Duffy) which substantially amended the Dental Practice Act provisions pertaining to the licensing and practice of dental auxiliaries (Furstand 1981). The Bill established five categories of dental auxiliary personnel and directed the Board of Dental Examiners to adopt regulations delineating the duties which could be performed by each of these auxiliaries, and the settings within which they
would be permitted to practice. However, six years later licensing of two of the categories defined in this legislation had not yet begun. A legislative inquiry into dental auxiliary licensing and utilization in 1972 resulted in the adoption of Assembly Bill 1953 (Duffy) which mandated the appointment of an advisory committee to report on the following matters:

(1) The current practice of dental auxiliaries, their number, the nature of the education they receive prior to their utilization and the existing legal framework governing their activities;

(2) The recommended arrangement of categories of dental auxiliaries to provide maximum utilization of skills of dentists and maximum availability of high quality dental services to the people of California (Furstman 1981).

Few countries in the world, if any, have sufficient qualified dental manpower to satisfy their own demand for dental health services. In many countries a high proportion of dental care is carried out by unqualified persons. The measurement of dental manpower supply involves a number of variables that determine the validity of the measurement. Among these variables the most important is the personnel who are included, and the function that they perform. In different countries, different job titles are attached to personnel carrying out similar functions. For example; in Papua New Guinea
dental technicians and orderlies are trained to carry out dental hygienist functions (Sheiham 1981).

The arguments in favour of employing dental nurses (a type of operating dental auxiliary) are compelling when there is a shortage of dentists. Roder, in a review of operating auxiliaries (Roder 1978) gave a number of examples of their introduction to dental services. A British Governmental Committee stated that when there is a manpower shortage in a professional field it is a well-established practice to assign simpler duties to auxiliaries thereby reducing the burden on the fully trained professional. School Dental Nurses originated because of insufficient dental manpower in New Zealand. It has been suggested that dental practitioners possibly provided little care for children at that time, and therefore did not perceive the dental nurse scheme as a great threat to their livelihood. The need for increased dental manpower in New Zealand was highlighted by bad dental health in children and in troops during World War 1. In 1949 Malaysia became the first of several developing nations to introduce dental nurses. This intervention also was attributed to an acute shortage of dental manpower (Roder 1978).

"New Cross dental auxiliaries" (dental nurses) were first trained in the United Kingdom in 1960. The Priority Dental Services Sub-Committee of the British Dental Association had indicated the need for more school
dental manpower and it seemed that the introduction of dental nurses would help meet this need. Similarly in Australia and Canada (in Saskatchewan) a shortage of dentists and the intention of the government to extend school dental services led to the training and employment of dental nurses (Roder 1978). Dental auxiliaries today have many different functions and titles. Their legal status varies, as do their opportunities for employment. General acceptance by the dental profession in their countries also varies greatly. Approximately 84,079 operating auxiliaries can however be identified in more than sixty countries in the world (see Table 1). They can be classified according to the training they have received, the tasks they are expected to undertake and the legal restrictions placed upon them. While different titles have been given to groups of auxiliaries classified in this way, the terminology is not consistent from one country to another (Elderton 1981).

Dental auxiliaries may also be grouped into various vertical strata and horizontal levels according to their degree of training and education. The classification is designed so that the majority of known types of auxiliary personnel may be located within it. In strata training there is instruction in fundamental or core subjects at each level of the strata and additional training permits progression to a higher stratum and to more complex tasks (F.D.I. 1983).
Table 1. Operating Dental Auxiliaries by Country, 1981.

<table>
<thead>
<tr>
<th>Country</th>
<th>New Zealand Type School Dental Nurses</th>
<th>Dental Hygienists</th>
</tr>
</thead>
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<td>Australia</td>
<td>847</td>
<td>75</td>
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<tr>
<td>Botswana</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Brunei</td>
<td>31</td>
<td>-</td>
</tr>
<tr>
<td>Burma</td>
<td>94</td>
<td>3</td>
</tr>
<tr>
<td>Canada</td>
<td>-</td>
<td>3126</td>
</tr>
<tr>
<td>Colombia</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Cook Island</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>31</td>
<td>-</td>
</tr>
<tr>
<td>Cuba</td>
<td>1000</td>
<td>-</td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>-</td>
<td>470</td>
</tr>
<tr>
<td>Denmark</td>
<td>-</td>
<td>275</td>
</tr>
<tr>
<td>Fiji</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Finland</td>
<td>-</td>
<td>165</td>
</tr>
<tr>
<td>Gambia</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Dem. Rep. of Germany</td>
<td>-</td>
<td>350</td>
</tr>
<tr>
<td>Ghana</td>
<td>11</td>
<td>-</td>
</tr>
<tr>
<td>Grenada</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Guam</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Haiti</td>
<td>-</td>
<td>46</td>
</tr>
<tr>
<td>India</td>
<td>-</td>
<td>820</td>
</tr>
<tr>
<td>Indonesia</td>
<td>759 + 420</td>
<td>-</td>
</tr>
<tr>
<td>Iran</td>
<td>-</td>
<td>250</td>
</tr>
<tr>
<td>Jamaica</td>
<td>39</td>
<td>-</td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>16964</td>
</tr>
<tr>
<td>Kenya</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Korea</td>
<td>-</td>
<td>505</td>
</tr>
<tr>
<td>Malaysia</td>
<td>718</td>
<td>-</td>
</tr>
<tr>
<td>Mexico</td>
<td>75</td>
<td>30</td>
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<tr>
<td>Netherlands</td>
<td>-</td>
<td>600</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1178</td>
<td>-</td>
</tr>
<tr>
<td>Nigeria</td>
<td>12</td>
<td>76</td>
</tr>
<tr>
<td>Norway</td>
<td>-</td>
<td>300</td>
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<tr>
<th>Country</th>
<th>New Zealand Type School Dental Nurses</th>
<th>Dental Hygienists</th>
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<tr>
<td>Pacific Islands</td>
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<td>Pakistan</td>
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<td>10</td>
</tr>
<tr>
<td>Panama</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>92</td>
<td>47</td>
</tr>
<tr>
<td>Peru</td>
<td>-</td>
<td>60</td>
</tr>
<tr>
<td>Poland</td>
<td>-</td>
<td>1843</td>
</tr>
<tr>
<td>Senegal</td>
<td>5</td>
<td>32 + 10</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Singapore</td>
<td>256</td>
<td>-</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>380</td>
<td>-</td>
</tr>
<tr>
<td>Sweden</td>
<td>-</td>
<td>650</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-</td>
<td>180</td>
</tr>
<tr>
<td>Syria</td>
<td>-</td>
<td>39</td>
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<tr>
<td>Taiwan</td>
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<tr>
<td>Thailand</td>
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<tr>
<td>Tobago</td>
<td>36</td>
<td>-</td>
</tr>
<tr>
<td>Turkey</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Uganda</td>
<td>85</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>400</td>
<td>1100</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>-</td>
<td>46000</td>
</tr>
<tr>
<td>Upper Volta</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Uruguay</td>
<td>-</td>
<td>88</td>
</tr>
<tr>
<td>Venezuela</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Western Samoa</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>1785</td>
<td>-</td>
</tr>
<tr>
<td>Zambia</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>-</td>
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</tr>
</tbody>
</table>

| Number of Countries      | 35                                     | 9540              |
|                          | 42                                     | 74539             |
|                          | 77*                                    | 84079             |

* 15 Countries utilize both types of operating dental auxiliaries.
In South Australia the Dental Health Branch of the Department of Public Health has treated primary school children in country regions that have had no private practitioner services since 1922. In 1969 dental therapists were included in the school dental team in order to reduce the cost of dental care and to extend the service to more children. The school dental therapist who works on school children under the supervision of a registered dentist is an operating auxiliary similar in type to the New Zealand Dental Nurse. The aims of the South Australian programme are, in the first instance, the control of existing dental disease by treatment and more importantly the prevention of disease by fluoride therapy and the education of children towards patterns of behaviour that are favourable to good health (Blaikie 1976). In 1980 the South Australia school dental services discontinued training new dental therapists. The dramatic decrease in prevalence and complexity of caries in children, falling class rolls, increased programme efficiency and longer employment trends quickly reduced the number of therapists requiring to be trained. The flexibility of the service has minimized personnel problems. In 1980 the service was poised to expand to secondary school children. A temporary change in government policy postponed the expansion (Jones 1984).
The dental auxiliary New Cross type (Dental Nurse) in the United Kingdom, working in association with a dental surgeon in a hospital or in the school service, carries out simple fillings, extracts primary teeth under local anaesthesia, carries out certain preventive procedures and takes part in dental health education. She is well qualified to undertake much of the preventive and treatment care needed by children (Fit for future 1976).

The task of establishing priorities for utilization of operating dental auxiliaries is a complex and important issue. A well planned dental workforce should be more effective and the whole oral health services more efficient. An examination of the quality and quantity of work done by different operating dental personnel may indicate that some tasks would be more efficiently carried out by highly skilled personnel while others may be performed just as well or more efficiently by less highly trained and lower paid workers. Priorities for utilization of operating dental auxiliaries must retain as their central objective the provision of a high quality oral health service. The criteria for quality must meet with the objectives of the profession as well as the needs of the consumer. Quality oral health care is therefore based on professional diagnostic and technical excellence and on service delivery concerned with adequacy, efficiency, effectiveness and appropriateness (Sheiham 1981). The use of auxiliaries
and their integration into dental services to provide certain aspects of dental care appears logical and valuable, particularly for countries where no such auxiliaries exist; as is the situation in the writer's own country. The aims of this thesis are to review:

1. The development of dental auxiliaries with special reference to operating auxiliaries;
2. Their different types of training and utilization;
3. Their contribution to the oral health of school children,
4. Their use in developed and developing countries; and
5. The future need for operating auxiliaries for school age children with particular reference to developing countries.
2. CLASSIFICATION OF DENTAL AUXILIARIES

Dental practice can be considered as "the rendering of services aiming to prevent, alleviate or cure a dental disease, and to repair or correct a dental anomaly or defect" (WHO 1959). If one wishes to restrict the definition of dental practice to certain groups of countries a further limiting statement such as "by a fully qualified practitioner" should be included. The World Health Organization (WHO 1959) accepts the broader definition as more adequate for discussion at an international level of the types of personnel involved directly or according to the level of their training. They are classified as follows:

(a) Professional personnel (qualified practitioners and dental specialists);
(b) Sub-professional personnel (auxiliary personnel);
(c) Non-professional personnel (unqualified practitioner and indigenous practitioners).

This classification accepts the fact that dental services in many countries are still being rendered, in the main, by untrained nonprofessional workers. The dental profession worldwide recognizes the up-grading of this group as one of its most important problems and looks to the day when dental services will be provided only by the first two groups (WHO 1959). The WHO has long been
concerned with the worldwide shortage of health manpower, including dental manpower, and its policy has been to support the use of auxiliaries as a means of achieving the most effective use of more highly trained professional personnel (Myer 1973).
2.1 WHO CLASSIFICATIONS

In 1959 a WHO Expert Committee reported on auxiliary dental personnel and described two basic types: the Dental licentiate and the Dental Aide. These two were proposed for those nations where there is little or no dental health care available to a large proportion of the population.

1 - Dental Licentiate:

In many areas of countries in which dental services are in the early stages of development, the licentiate will, of necessity, act as the normal dental practitioner. He must therefore receive a technical training which will fit him to work in a health service under possibly remote supervision and control. Candidates for such training should therefore have a standard of basic education sufficient to support professional study and equivalent to that required for a similar category of medical personnel.

2 - Dental Aides:

Before a sufficient number of dental licentiates can be trained it may be necessary to train dental aides who would, after a much shorter course, be capable of relieving pain by the extraction of affected teeth (WHO 1959). Elderton (1981) has looked at the different types of auxiliaries which have developed around the world and the definitions that were suggested by WHO in 1968. Dental auxiliaries may be classified according to
the training they have received, the tasks they are expected to undertake, and the legal restrictions placed upon them. While different titles have been given to groups of auxiliaries classified in this way terminology is not consistent from one country to another. The primary 1968 WHO classification (Figure 1) uses the categories of non operating and operating dental auxiliaries personnel:

1 - Operating Dental Auxiliaries:

This is a person who, not being a professional, is permitted to carry out certain treatment procedures in the mouth under the direction and supervision of a professional (dentist).

(1) School Dental Nurses: (New Zealand type)

This is a person who is permitted to diagnose dental disease and to plan and carry out certain specified preventive and treatment measures including some operative procedures on the defined group of people, usually school children. The school dental nurses prepare cavities and restore teeth under the direction of a dentist but not necessarily in his presence.

He or she has to refer to the dentist those patients requiring diagnosis or treatment that he or she is not able or legally entitled to carry out. Other titles that are used in some countries to refer to this type of auxiliary include dental nurses and "dental therapists".
Figure 1: Classification of Auxiliary Dental Personnel

Source: Adapted from Elderton (1981)
(2) Dental Therapist:

This is a person who is permitted to carry out, to the prescription of a supervising dentist, certain specified preventive and treatment measures including the preparation of cavities and restoration of teeth. In the United Kingdom the dental therapist has to work in the public health service, but in Western Australia a dental therapist may work under a dentist in private practice.

(3) Dental Hygienist:

This is a person who is permitted to carry out the prescription of a supervising dentist, certain specified preventive and treatment measures including some operative procedures in the treatment of periodontal disease. The dental hygienist is not permitted to carry out any operative procedures for the treatment of dental caries.

(4) Expanded function dental auxiliaries:

This is a person who is permitted to carry out certain specified preventive and treatment measures including reversible aspects of some operative procedures in the treatment of dental caries. Tasks include the placing of restorations into cavities that have been prepared by a dentist. The auxiliary necessarily works in close co-ordination with the dentist who is directly involved with each patient visit. These auxiliaries are
often referred to as expanded function dental assistants; expanded function dental hygienists, expanded function auxiliaries (Elderton 1981).

The classification by WHO (1968) generally covers most auxiliaries around the world but it should be noted there is an additional group of operating auxiliaries called Denturists. This group are usually dental technicians trained by apprenticeship and/or technical college courses to carry out dental laboratory procedures, and, in addition, intra-oral procedures. In the states of Victoria, New South Wales and Tasmania, Australia, they are registered to have direct contractual relations with the public for the making and fitting of dentures. Courses for denturists are currently operating in Victoria and New South Wales (Barnard 1981a).
2 - Non Operating Auxiliaries:

- Clinical: This a person who assists the professional (dentist) in his clinic work but does not carry out any independent procedures in the oral cavity.

- Laboratory: This a person who assists the professional by carrying out certain technical laboratory procedures.

(1) Dental Surgery Assistant:

This is a person who assists the dentist with his clinical work but who does not independently carry out any procedures in the mouth. Other titles that are commonly used for this category in some countries include dental assistant, chairside dental assistant and dental nurse. The title "dental technician" is used in some armed forces.

(2) Dental Secretary or Receptionist:

This is a person who assists the dentist with his secretarial work and patient reception duties.

(3) Dental Laboratory Technician:

This is a person who works in a laboratory constructing dental appliances to the prescription of the dentist; the title "dental mechanic" is also applied to this type of auxiliary.
(4) Dental Health Educator:

This is a person who instructs in the prevention of dental disease and who may also be permitted to apply preventive agents intra orally.
2.2 CLASSIFICATION BASED ON PREVENTION OF ORAL DISEASES

The World Health Organization (1959) has strongly advocated the use of dental auxiliaries in improving the oral health of people especially in the developing nations; to buttress their support for the use of auxiliaries in dental care delivery systems, the organization at an inter-regional seminar on the training and utilization of dental personnel in developing countries, held in New Delhi, India in December, 1967, (WHO 1968) recognized two broad divisions of dental auxiliaries, namely:

1 - Operating dental auxiliaries
2 - Non-operating dental auxiliaries

There is ample evidence to show that the two most common oral diseases, dental caries and periodontal disease, are preventable and the above-mentioned auxiliaries can play a significant role.

The procedures involved in the prevention of these diseases are well known: dental health education and plaque control. To educate the public about the different methods used in the prevention of these diseases, dental auxiliaries of various categories will be needed. Therefore Jeboda (1982) has suggested the following levels of auxiliaries for the prevention of oral disease and has adopted the World Health Organization nomenclature of operating and non-operating dental auxiliaries with the introduction of the word "preventive" in his classification: (Jeboda 1982)
1 - Operating Preventive Dental Auxiliaries:

(1) Dental Health Educators Type I:

These are the typical British-trained types who may be used in the urban areas and in institutes of learning; for example, elementary schools, secondary grammar schools, teacher training colleges and other institutions of higher learning. Usually they are broad-based functionally and few of them may be available at any one time. They are trained in the organization of community dental health activities, and in most cases have been previously trained as dental hygienists.

(2) Dental Hygienist Types I and II:

These are the broadly trained types who apart from scaling and polishing will be able to give dietary counselling, instruction on oral hygiene, topical application of fluoride and dental health education.

(3) School Dental Nurses:

Their function is similar to those of the school dental nurses trained in New Zealand and the dental therapists trained in the United Kingdom (U.K.).

(4) Topical Fluoride Application Auxiliaries:

These auxiliaries are trained for a short time in the procedures involved in different methods of applying topical fluorides.
(5) Fissure-Sealant Application Auxiliaries:

They are trained in all the techniques involved in the application of fissure sealants.

2 - Non-Operating Preventive Dental Auxiliaries:

(1) Dental Health Educators Type II:

These include:

(a) Interested individuals
(b) Community leaders
(c) Peer group leaders
(d) School teachers
(e) Parents

(2) Tooth brushing supervising auxiliaries

(3) Oral disease recognising auxiliaries

(4) Plaque disclosing auxiliaries. (Jeboda 1982)
2.3 CLASSIFICATION BASED ON LENGTH OF TRAINING

Jeboda (1982) suggested a classification based on that adopted by WHO (1968) in New Delhi. He recognised the following categories:

1 - Long term trained: this period should be not less than two calendar years and may be up to four years. Included in this category are:

   (1) Dental Health Educators type I.
   (2) Dental Hygienists type I.
   (3) School Dental Nurses.

2 - Short term trained: this period of training might last from four to six months. Included in this category are:

   (1) Dental Health Educators type II.
   (2) Dental Hygienists type II.
   (3) Topical Fluoride Application Auxiliaries.
   (4) Fissure Sealant Application Auxiliaries.
   (5) Toothbrushing Supervising Auxiliaries.
   (6) Oral Disease Recognising Auxiliaries.
   (7) Plaque Disclosing Auxiliaries.
2.4 FDI CLASSIFICATION BASED ON STRATA-TRAINING

CONCEPTS

According to the technical report of the Commission on Dental Education and Practice adopted by the General Assembly of the FDI at its meeting in Vienna, in October 1982 (FDI 1983), dental auxiliaries may be grouped into various vertical strata and horizontal levels according to their degree of training and education. The strata levels are based on a series of integrated courses of education and training in which knowledge and skill gained in one course serve as the foundation for progress to a higher level course in the series. The system proposed allows direct entrance to the advanced strata of those with higher general education standards. The term dental auxiliary may include the chairside assistant, dental nurse, dental health educator, hygienist, school dental therapist, dental therapist, extended function (duty) dental assistant (E.F.D.A.).

The classification is designed so that the majority of known types of auxiliary personnel may be located within its structure. It serves as a model to confine the development of future auxiliaries to established guidelines, as well as providing mechanism for the assessment of the training and qualifications of a dental auxiliary. In countries where certain
strata or levels of auxiliary are precluded by law, only that part of the classification which is applicable need be used. The system is not a recommendation to introduce all the strata and levels described.

Principle classification system:

(1) - This classification is based on strata training with instruction in fundamental or core subjects at each stratum. An example of core subjects is shown on Table 2 for one such stratum. Additional training permits progression to a higher stratum and to more complex tasks. Levels within each stratum recognize additional duties within the scope of the training, knowledge and skills implicit in that stratum.

(2) - Admission requirements at the first level are those required for technical training (usually 9-10 years formal education and age 15-16 years). Students with higher educational standards may commence training in a higher stratum.

(3) - Strata-training: The various strata and levels are described in Table 3.

Stratum 1:-

Level I:

This represents the dental assistant who undergoes practical training within the dental office and for whom there is no formal training course certificate available.
Table 2.

The core subjects in strata-training programme

<table>
<thead>
<tr>
<th>General studies</th>
<th>Biological sciences</th>
<th>Dental science</th>
<th>Dental assisting and clinical practice</th>
<th>Principles of dental radiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication Psychology</td>
<td>Anatomy</td>
<td>Dental materials</td>
<td>Principles of practice</td>
<td>Development, handling</td>
</tr>
<tr>
<td></td>
<td>Histology</td>
<td>Oral anatomy and management and filing of X-ray</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physiology</td>
<td>physiology</td>
<td>chairside assisting films</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbiology</td>
<td>Oral pathology</td>
<td>Legal and ethical Principles of radiography</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pathology</td>
<td>Dental pharmacology and aspects of dentistry</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diet and nutrition</td>
<td>therapeutics</td>
<td>First aid and dental Radiation hygiene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hygiene</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.

Admission requirements and training period by stratum and level for various auxiliary personnel

<table>
<thead>
<tr>
<th>Designation</th>
<th>Admission requirements</th>
<th>Training period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratum 1 Level I</td>
<td>Dental Assistant: no formal training</td>
<td>in service experience</td>
</tr>
<tr>
<td></td>
<td>9-10 years formal education</td>
<td></td>
</tr>
<tr>
<td></td>
<td>minimum age 15-16 years</td>
<td></td>
</tr>
<tr>
<td>Level II</td>
<td>Trained Dental Assistant with education; clinical training;</td>
<td>3-6 hours per week for 1 year and in service experience</td>
</tr>
<tr>
<td></td>
<td>certificate</td>
<td></td>
</tr>
<tr>
<td>Level III</td>
<td>Oral Health Educator</td>
<td>4-6 weeks full time</td>
</tr>
<tr>
<td></td>
<td>Stratum 1 Level II certificate</td>
<td></td>
</tr>
<tr>
<td>Stratum 2 Level I</td>
<td>EFDA-multiple certificates in special skills</td>
<td>8-10 weeks full time</td>
</tr>
<tr>
<td></td>
<td>Stratum 1 Levels II or III certificates</td>
<td></td>
</tr>
<tr>
<td>Stratum 3 Level I</td>
<td>Dental Hygienist</td>
<td>(a) 4 semesters-2</td>
</tr>
<tr>
<td></td>
<td>(a) direct 12 years education</td>
<td>2 semesters-1 year</td>
</tr>
<tr>
<td></td>
<td>(b) Stratum: Stratum 2 certificate</td>
<td>1 semester</td>
</tr>
<tr>
<td></td>
<td>(b) Stratum: Stratum 3 certificate</td>
<td></td>
</tr>
<tr>
<td>Stratum 4 Level I</td>
<td>School Dental</td>
<td>(a) 4 semesters-2</td>
</tr>
<tr>
<td></td>
<td>(a) Direct: Matriculation</td>
<td>2 years</td>
</tr>
<tr>
<td></td>
<td>(b) Stratum: Stratum 3 certificate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) 3 semesters</td>
<td></td>
</tr>
<tr>
<td>Level II</td>
<td>Tutor Therapist</td>
<td>1 semester</td>
</tr>
<tr>
<td></td>
<td>Stratum 4 Level I certificate</td>
<td></td>
</tr>
</tbody>
</table>

Level II:

This represents the person who has had initial instruction in core subjects (Table 2) of 3-6 hours per week for one year with in-service clinical experience. Examination and certification are necessary. Duties include office and chairside assisting under the supervision and/or the direction and control of a dentist; for example, the trained dental (chairside or surgery) assistant.

Level III:

This is attained through basic training as for Level II with additional full-time training in oral hygiene instruction and health education, diet and nutrition. An additional certificate is necessary; for example, in oral health education.

Stratum 2:-

All stratum 1 auxiliaries who have received formal training (Levels II and III) are eligible to proceed to this stratum which has only one level. It requires additional instruction in core subjects: 8-10 weeks full-time with practical and clinical tuition in special areas: for example, oral surgery, orthodontic preventive dentistry (prophylaxis), radiography. Duties may include all stratum 1 duties plus simple dental radiography, orthodontic duties (sizing sutures, irrigation), periodontal duties (preventive instruction, simple prophylaxis, fluoride application, placement of
periodontal packs). In general these tasks are reversible. Supervision and/or direction and control by dentists is required; for example, the extended functions (duty) dental assistant in a specially designated area.

Stratum 3:-

This stratum also has only one level. It is attained by further study of core subjects plus study of additional basic science subjects. Course duration (full-time) is a minimum of twenty weeks (one semester) for stratum 2 auxiliaries or forty weeks (full-time) for stratum 1 level II III auxiliaries or students with general education to the end of secondary schooling; that is, one level below university admission standard. The most numerous auxiliaries of this type are the dental hygienists. Direction and control by the dentist is necessary, although the auxiliary may operate in an adjacent office. Specification in legislation of the permissible duties is desirable.

Stratum 4:-

Level I:

This is attained by a further step in vertical training including extension in range and depth of core subjects with an additional basic science component and further clinical training to develop the skills required. Course duration for entrants from stratum 3
is three semesters full-time in training establishments with adequate clinical and laboratory facilities. Students entering the course on the basis of higher general education (matriculation or basic university entrance standard) would require four semesters study over a two year period. Examination leading to appropriate certification is mandatory. This auxiliary is an operating auxiliary able to carry out limited irreversible dental procedures not requiring the full education, training and skill of the dentist. Permissible procedures should be prescribed by law. The auxiliary is under the direction and control of the dentist; for example, the (school) dental (nurses) therapist.

Level II:

Further study and experience (one semester) would lead to a higher level in this stratum; for example, the tutor therapist (FDI 1983).
3. OPERATING DENTAL AUXILIARIES

With growing populations, limited resources and an abundance of dental disease, countries around the world have introduced operating dental auxiliaries to help meet the demand for services (Barmes 1969). Operating dental auxiliaries have been variously named and classified according to their training and function (Elderton 1918). According to the manpower classification given in the New Delhi WHO Inter-Regional Seminar on training and utilization of dental personnel in developing countries, operating dental personnel include the professional and operating auxiliaries (WHO 1968). A professional is defined as a University or College trained graduate who is registered to practice independently: "The operating auxiliary is not professional but is trained to carry out certain procedures in the mouth under the direction and supervision of a professional"; that is, the dentist. The latter include the New Zealand type School Dental Nurses, the Dental Therapist, the Dental Hygienist and the Expanded Functions Dental Ancillary. In recent years due to political expediency and pragmatism, some countries like Australia, Denmark and some states in America, have also allowed the emergence of the denturist, a dental technician who has been permitted, through legislation, to take impressions and make and fit dentures for patients (Elderton 1981).
3.1 **SCHOOL DENTAL NURSE (NEW ZEALAND TYPE)**

This type of auxiliary was established in New Zealand in 1923 (training began in 1921) to deal with the large amount of dental disease present amongst school children. The government made provision for training of young women, to be known as school dental nurses, who would provide the bulk of the treatment in the school dental service which was introduced at the same time. It should be realized that operating auxiliaries, with functions similar to those of the New Zealand school dental nurse, are also employed in a number of other countries, many of which have started their own training schemes. There are at least thirty-five countries apart from New Zealand with this type of operating auxiliary; they include Australia, Botswana, Brunei, Burma, Colombia, the Cook Islands, Costa Rica, Cuba, Fiji, Ghana, Grenada, Hong Kong, Indonesia, Jamaica, Kenya, Malaysia, Mexico, New Zealand, Nigeria, Pakistan, Papua New Guinea, Senegal, Sierra Leone, Singapore, Sri Lanka, Taiwan, Thailand, Tobago, Turkey, Uganda, the United Kingdom, the Upper Volta (Burkina Faso), Western Samoa, Yugoslavia and Zambia (FDI 1981a).

Most of these countries employ under 100 school dental nurses. Countries employing a significant number in 1981 were Yugoslavia (1785), New Zealand (1178), Taiwan and Cuba (1000), Australia (847), Malaysia (718), United Kingdom (400), Sri Lanka (380) and Singapore (256) (FDI 1981a).
The length of training, conditions of employment and specific duties vary slightly from country to country (FDI 1981a). Operating auxiliaries, known as dental aides, whose function is mainly the relief of pain by extraction, exist in a number of African countries where they are particularly valuable in remote areas (Elderton 1981).
3.2 DENTAL THERAPIST

This type of auxiliary, originally called a dental auxiliary, began operating in the United Kingdom in 1962. Training commenced in 1960 following a revision of the Dentist Act in 1957 (British Dental Association 1968). Dental therapists have been likened to the New Zealand-type school dental nurses but their role is quite different as they are not permitted to diagnose and plan dental care. They are permitted to work to written treatment plans devised by the supervising dentist, though the operative procedures they are entitled to carry out are similar to those of the New Zealand school dental nurses, including the administration of local infiltration analgesia. The supervising dentists give nerve-block analgesia when it is required. It is clear that the United Kingdom dental therapist functions much less independently and consequently accepts less responsibility. She does not have to learn clinic management to the same degree. However, both types of auxiliary undergo a training course of two years duration; perhaps a case could be made for reducing that of the therapist. In the United Kingdom dental therapists may only work in the local authority and hospital services and they are required to carry out their duties under the direction of a registered dentist. Direction does not imply "personal supervision" though before a change in Auxiliary Dental Workers Regulations in 1968 this was the case (British Dental Association 1969).
Dental therapists in the Canadian Armed Forces are permitted to organize and conduct dental inspections and to categorize patients into priority order (FDI 1977). In South Australia the degree of supervision falls between that in New Zealand and that in the United Kingdom, for a dentist is only required to examine the patients at every alternate course of treatment (Lobene & Kerr 1979).
3.3 **DENTAL HYGIENIST**

This type of auxiliary was first employed in 1906 in a private dental practice in the United States of America and in 1913 the first formal training course for hygienists was established (Steele 1978). The duties of the dental hygienist are essentially the scaling and polishing of teeth, the topical application of fluoride and the provision of dental health education. In some countries dental hygienists are permitted to take radiographs, make impressions for study models and polish restorations. In Denmark, Norway and the Netherlands, they are allowed to make a preliminary examination and charting of the teeth, while in Manitoba, Canada, they are permitted to take impressions, record jaw relationships and repair some broken dentures (FDI 1977). Dental hygienists usually work with adults, though in many countries there is no legal restriction for this to be the case. They are employed both in private dental practice and in public dental services. Hobdell (1973) has pointed out that since dental hygienists must work under the direct supervision of a registered dentist, they are under closer control than comparable workers in medicine. Dental hygienist training is usually of 1-2 years duration, though one year training was thought appropriate by an expert from the Committee of the World Health Organization for countries wishing to train hygienists to enter their governmental health services (WHO 1959). In the United Kingdom, training is from
nine months to one year while a number of schools in the United States of America offer a four-year degree programme in dental hygiene as well as a two-year certificate programme which is standard in that country. Training may or may not take place in an undergraduate dental school (FDI 1977) (Elderton 1981). About thirty-five countries in the world now have dental hygienists, including Australia, Botswana, Burma, Canada, Colombia, the Cook Islands, Czechoslovakia, Denmark Fiji, Finland, Gambia, the Democratic Republic of Germany, Guam, Hong Kong, Haiti, India, Iran, Japan, Kenya, Korea, Mexico, the Netherlands, Nigeria, Norway, the Pacific Islands, Pakistan, Panama, Papua New Guinea, Peru, Poland, Senegal, Sierra Leone, Sweden, Switzerland, Syria, Thailand, the United Kingdom, the United States of America, Uruguay, Venezuela and Zimbabwe. In 1981, in the U.S.A. there were 46,000 hygienists, in Japan 16,964 and in Canada 3,126. Poland and the United Kingdom had between 1,000 and 2,000, India the Netherlands and Korea between 500-800 and Norway, Denmark, Iran, Switzerland between 180-300. (Table 1) The largest number are in the U.S.A and most of them are employed in private practice (FDI 1981a). In Japan, at the end of 1978, they were employed in public health centres, dental hospitals, clinics and schools (FDI 1981a). Young & Striffler (1969) have pointed out that in America a peculiar relation exists between the supply of hygienists and the demand for their services by the dentists. In the States, with
relatively large numbers of hygienists, the demand exceeds the supply whereas in areas with few hygienists this is not the case. The former areas have had hygienists for many more years than the latter. This seems to demonstrate, perhaps not surprisingly, that as dentists become more accustomed to employing hygienists they realize the advantages of doing so and consequently increase their demand for them. This is a different mechanism from that which operates for school dental nurses and dental therapists in countries where they cannot be employed by a dentist in private practice and therefore cannot directly influence him. In other words, while it is the dental needs of the community that maps the way for school dental nurses and dental therapists (except in Western Australia), this same situation appears not to have existed with regard to some dental hygienists (FDI 1977). In 1972, dental hygienists were employed only in the Armed Services and their number increased from twenty-nine in 1972 to thirty-five in 1976. In 1976, twenty-three dental hygienists were registered in South Australia and were employed by private practitioners and government services (Barnard 1981a).
3.4 EXPANDED FUNCTION DENTAL AUXILIARIES (EFDA)

Especially in North America auxiliaries are being trained to carry out certain restricted restorative procedures on patients. In particular they are taught to undertake such procedures as placing rubber dams and restoring, with amalgam and other plastic filling materials, teeth that have had cavities prepared by a dentist. The taking of radiographs and making of certain impressions are also undertaken by some of these expanded function auxiliaries.

The procedures delegated exclude diagnosis, treatment planning, the cutting of hard or soft tissue, and the prescription of drugs. This leaves these parts of the dental procedures that have been described as "reversible" to be carried out by the auxiliaries, who must necessarily work with dentists to provide a treatment service. Being "reversible" it is considered that the aspects undertaken by the auxiliary could be repeated by the dentist without excessive "harm" to the patient in the event of the auxiliary's work being of unacceptable quality. This is in keeping with a policy statement by the American Dental Association regarding experimentation in training and utilization of auxiliaries (Elderton 1981).

Expanded Function Dental Auxiliaries are not confined to North America. In Costa Rica, dental surgery assistants are trained at the University of San Jose to
place rubber dams, polish the mouth and apply fluoride topically (FDI 1977). They are also instructed in certain laboratory duties, including the production of study models, impression trays, and the moulding, casting and polishing of inlays and dentures.

The first report of an investigation into the possibility of expanding the functions of dental auxiliaries concerns a study undertaken by the Royal Canadian Dental Corps (Baird et al. 1962, Baird et al. 1963). Male dental hygienists were given training to enable them to undertake clinical duties of the type mentioned above.
3.5 DENTURIST

The denturist was first introduced in Tasmania, Australia, to legally provide dentures directly to the public without the dentist. Other countries, like Denmark and some parts of the United States, also permit dental technicians who pass an examination to prescribe, make and fit dentures for the public (Elderton 1981). More recently, several other states in Australia have introduced legislation to allow independent practice of the denturist. In New South Wales, the Department of Veterans Affairs employs two full time denturists to help look after the denture needs of its veterans (Barmes 1983). In Victoria, in 1976, 470 dental technicians had registered with the Dental Technicians Board and 122 were licensed as Advanced Dental Technicians (Barnard 1981a).
4. PROVISION OF DENTAL SERVICES BY OPERATING DENTAL AUXILIARIES

Dental services are provided through a dental delivery system. The system is an organized group of related and interdependent activities that can be bound together because they are designed to accomplish a purposeful objective. The objective of what has come to be called a dental delivery system is the resolution of explicit dental needs through the delivery or provision of dental services. (The word "delivery" is widely used in the United States to mean the provision of services) (Burt 1983).

The efficient and productive use of auxiliary teams in a programme to deliver complete primary dentistry, from administration of anaesthesia through finishing of inserted fillings, is obviously predicated upon a large case load of patients in need of their services as well as those provided by their supervising dentist. One of the major premises on which the Forsyth experiment was based was that the demand for dental service would greatly increase in the near future as a result of new payment mechanisms. However management and scheduling of patients to keep all personnel occupied has been cited as a potential problem. In Project Rotunda it was found that judicious overbooking of patients and close coordination of the auxiliary's and dentist's activities were required to maintain a
steady flow of appropriate patients and smooth delivery of care. However this did not necessitate hiring a special manager (Lobene & Kerr 1979). This section of the thesis will outline the provision of dental services in selected countries using operating dental auxiliaries.
4.1 NEW ZEALAND SCHOOL DENTAL NURSES

The New Zealand School Dental Nurses plan was introduced in 1921 and has acted as a model for the development of similar or slightly modified programmes in many other countries.

New Zealand is a nation of some three million people in the South Pacific Ocean, some 1500 miles off the eastern coast of Australia. It is predominantly rural, with little industrialization and living standards are high. New Zealand is a world leader in a number of social programmes: Old-age pensions, visiting maternal and child health nurses and, interestingly enough, the secret ballot at political elections. A number of these programmes began in the late nineteenth century, about the time that social security programmes were initiated in Bismark's Germany. Given these traditions the introduction of the school dental nurses plan was probably not as radical an innovation as it seemed, though there was some concern among dentists at the time. The stimuli for the programme were the extensive dental disease found in army recruits in World War 1 (1914-18) and the concomitant resolve, at government level, that action was required to alleviate this problem. Dentists were in short supply and treatment of young children was not as accepted an area of dental practice at that time as it is now. Dental caries was and still is highly prevalent in New Zealand.
When the service began care was offered only to younger school-age children, but eligibility now extends to all preschool children and all children in primary and intermediate school (2½ to 13½ years of age). Children up to age sixteen are eligible for treatment by private practitioners, at public expense, but beyond that age dental care is provided through traditional private practice, with some exceptions for special groups who receive public assistance. School dental clinics are attached to primary and intermediate schools throughout the country and an extensive re-equipment programme of installing modern equipment began in the mid 1970s.

There is only one dental school, but until recently there were three training schools for dental nurses in New Zealand. The nurses' training course is two years long (Burt 1983). The provider of dental services in the school based system is the dental nurse, a dental auxiliary trained to provide basic restorative and preventive procedures without direct supervision. The dental nurse's position in the school system is comparable in status and salary to the New Zealand teacher (Jones 1984).

The active working force of dental nurses in New Zealand totalled 1,178 in 1981. This is a large number compared with a total population of 3,148,400 persons. The ratio is one nurse to every 2,672 people (1:2672)
in the total population and one nurse to about 590 children from age 2½ to 13½, the group actually served (FDI 1981a). Dunning reported on the service in 1972. At that time one nurse could provide regular semi-annual care for (450-500) children in non-fluoridated areas and for 700 to 1000 children in areas where the benefits of fluoridation have appeared. Thus a sufficient working force exists to realize the objective of comprehensive basic dental care for all eligible children, specialities excluded.

In addition to the original training school at Wellington, training schools were established in Auckland (see Figure 2) and Christchurch. Each school has further decentralized its clinical teaching to bring the trainees in contact with an elementary school (see Figure 3). These three schools turn out about 200 graduates a year and this recruitment seems sufficient to maintain the working force at current levels. Actually the director of the programme estimates the working life of a nurse to be even longer. Many married women return to work either full or part time when their own children are of school age. These older women are from the experienced core of the nurse's group and occupy senior positions in the more important clinics. The number of older women is increasing yearly. The dental nurses' programme is administered by fourteen dentists in the
Figure 2. Main Clinic of School Dental Nurse Training School Wellington, New Zealand.

Source: Dunning (1972)

Figure 3. New Zealand School Dental Nurse Trainees in Elementary School.

Source: Dunning 1972)
country. A typical district is in the charge of one principal dental officer whose duties chiefly are to maintain the proper scope and quality of clinical service. He is assisted by one or two nurse inspectors, whose duties include the maintenance of equipment, records, dress and deportment. Under these leaders 75 to 120 dental nurses care for 35,000 to 60,000 children (Dunning 1972).
4.2 DENTAL THERAPISTS IN OTHER COUNTRIES

The New Zealand type of school dental nurse has been extended to many countries with variations in functions and terminology. The terms dental therapist or school dental therapist are widely used.

1 - South Australia

The state of South Australia has a land mass comparable to the combined size of Texas, Oklahoma and Kansas and a population of only 1.3 million. Just over one million or 77 per cent of the state's population reside in the city and suburbs of Adelaide. Most of the remainder of the state is sparsely populated with two thirds of the state's area containing only 500 people. No child in South Australia is without access to comprehensive periodic dental services.

The dental therapist is the primary provider of dental care for school children, providing treatment beyond the limits of the New Zealand nurse. They routinely treat pulpal pathoses in primary teeth, use the rubber dam, apply pit and fissure sealant, provide alginate impressions, prepare study-models and polish all restorations.

The dental therapists also work with dental assistants whereas the New Zealand dental nurses do not. Dental care is provided at no charge by the Dental Health Department.
The South Australia system differs from the New Zealand system in another major way. Field dental officers are employed for direct patient care. Dentists indirectly supervise, on average, five dental therapists. Each dentist is responsible for about 5,100 children. They screen each child once every two years and provide more advanced endodontic, orthodontic and oral surgical treatment, acting as a specialized clinical public health dentist. All other procedures for prevention and treatment are completed by the dental therapist. Unlike the New Zealand Dental Nurse's referral to private dentists, all complete procedures with the exception of orthodontics are treated within the School Dental Service (Jones 1984).

2 - Western Australia

In Perth, Western Australia, a new school for dental therapists graduated its first class of sixteen women in 1972. In curriculum and scope of activity, this therapist programme resembles the plan in South Australia but differs sharply in that dental therapists will be permitted by law to enter private practice as well as government service (Dunning 1972).

3 - In Canada

All ten provinces have publicly funded dental care plans for children, most of which are based on provision of care by a dentist. The province of Saskatchewan introduced its plan, whereby children aged 3-12 were to be treated by dental nurses, in September
1974. By 1976-77 there were approved positions for 134 dental nurses and eighteen dentists. Each nurse was expected to provide complete treatment annually for 446 children; this was anticipated to increase to 550 children in time. Children are being phased into the programme from the younger age groups. Older age groups will be included as the number of trained nurses increases (Burt 1983).

4 - Latin America

In 1968, the Pan American Health Organization surveyed member countries in order to obtain a sound basis for planning its auxiliary development programme for Latin America. Use of auxiliaries similar to the school dental nurse were reported in only four countries; Colombia, Paraguay, Cuba and Jamaica. There is no doubt that effectiveness and efficiency in providing dental services are maximized through teamwork. Each member of the team should be trained to perform specific functions with all team members supporting one another. Teamwork does not always have to occur at the same location; team members can work together effectively in a number of ways, physically together or separated, but linked organizationally, administratively and through communications systems. All personnel should be considered as professionals on the team, each making meaningful contributions to the provision of health care (Garza 1973).
In Botswana

Botswana has concentrated on dental therapists as their principal dental health personnel cadre. Family Welfare Educators, Dispensers and Nurses continue increasingly to provide the greater part of primary dental health care, such as first aid treatment and education. For these workers the dental therapist provides training and supervision.

The education of dental therapists should be intimately related to and reflect the general aims for dental health in the society. This means that the following skills are of major importance and should be considered as the primary aims of a dental therapist training programme in Botswana:

(1) To prevent oral diseases, primarily caries and periodontal diseases, through realistic prophylactic efforts both towards individuals and groups.

(2) To initiate support and follow-up preventive programmes in schools and health institutions.

(3) To diagnose oral diseases and plan treatment, particularly concentrating on the selection of high risk individuals/groups and referrals.

(4) To develop clinical skills particularly in extractions, simple periodontal treatment
(scaling depuration) and simple restorative work; and

(5) To register and evaluate epidemiologic dental health care.

(Eriksen & Condon 1983)
4.3 OTHER OPERATING DENTAL AUXILIARIES

1 - Dental Hygienists

Dental hygiene is a relatively young profession, the first training course having been established in 1914. Since that time, dental hygiene has become accepted as an integral part of dentistry in the United States, where the profession originated, and in a number of other countries as well. In 1980 there were estimated to be 38,400 active dental hygienists in the U.S.A., 250 per cent increase since 1970 (See Table 4) (Burt 1983). As at the 31st of December, 1981, there were estimated to be 46,000 active dental hygienists (FDI 1981).

A dental hygienist is an operating auxiliary licensed and registered to practice dental hygiene under the laws of the appropriate state, province, territory or nation. To be licensed, hygienists like dentists, certain qualifications must be satisfied:

(1) Completion of an approved period of education in an approved institution;

(2) Demonstration of competence; and

(3) Demonstration of satisfactory personal qualities.

Dental hygienists are concerned with prophylaxis (or "cleaning" teeth), the health of the supporting structures and the education of individual patients and groups. They work under the supervision of dentists,
Table 4.

Number of Active Hygienists, Hygienists per 100 Dentists, Dental Hygiene Training Schools, and Students, for Selected Years, United States, 1970-1980

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Active Hygienists</th>
<th>Active Hygienists per 100 Active Dentists</th>
<th>Schools of Dental Hygiene</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>15,100</td>
<td>14.8</td>
<td>100</td>
<td>5,931</td>
</tr>
<tr>
<td>1975</td>
<td>26,000</td>
<td>24.0</td>
<td>173</td>
<td>10,084</td>
</tr>
<tr>
<td>1978</td>
<td>32,200</td>
<td>28.0</td>
<td>196</td>
<td>11,055</td>
</tr>
<tr>
<td>1980</td>
<td>38,400</td>
<td>30.4</td>
<td>204</td>
<td>10,932</td>
</tr>
</tbody>
</table>

Source: Burt BA (1983b).
either in private dental practice or in an institutional setting such as health departments or school dental programmes (Burt 1983). For most hygienists, delivery of care takes place in a large clinic health facility. The hygienist first conducts a preliminary examination and charts any detected dental problems. Then a staff dentist makes a definitive diagnosis of all oral pathology and draws up a treatment plan based on the charting, radiographs, his confirming examination and the patient's past medical and dental history. The priorities for treatment are determined and the hygienist is given a prescription for the work to be done on one or more visits, including the local anaesthetic to be used, the teeth to be restored and the restorative material to be inserted. Each completed cavity preparation is examined and evaluated by a dentist before work continues. Completed restorations are also assessed for quality by the dentist before the patient is dismissed. Furthermore the dentist might be called upon at any time during the therapy to judge its progress, give advice on succeeding steps or take over the procedures if intervention is warranted (Lobene & Kerr 1979). p.211

This is a different mechanism from that which operates for school dental nurses and dental therapists in countries where they cannot be employed by a dentist in private practice, and therefore cannot directly influence him. In other words, while it is the dental
needs of the community that map the way for school dental nurses and dental therapists (except in Western Australia), this same situation does not seem to exist for some dental hygienists.

2 - Expanded Function Dental Auxiliary (EFDA)

Douglas and Lipscomb (1979) examined the expanded function dental auxiliaries. They indicated that in North America auxiliaries are being trained to carry out certain restricted restorative procedures on patients. In particular ancillaries are taught to undertake such procedures as placing rubber dams and restoring, with amalgam and other plastic filling materials, teeth that have had cavities prepared by a dentist. The taking of radiographs and making of certain impressions are also undertaken by some of these expanded functions ancillaries (auxiliaries). Most of the ancillaries who have been instructed in these duties have been trained previously as dental surgery assistants or dental hygienists and hence the term 'expanded function' has arisen.

Douglas and Lipscomb (1979) asserted that state legislations concerning utilization of dental auxiliaries in the U.S.A. were undergoing constant change and had been summarized in considerable detail by the ADA in 1977. EFDA are not confined to North America. In Costa Rica, dental surgery assistants are trained at the University of San Jose to place rubber dams, polish in the mouth and apply fluoride topically (PDI 1977).
They are also instructed in certain laboratory duties, including the production of study models, impression trays and the moulding, casting and polishing of inlays and dentures.

Douglas and Lipscomb (1979) indicated that the Soricelli project in Philadelphia functions within a school health clinic setting. These clinical settings consist of one dentist with four EFDA's and a roving dental assistant. The results of this Philadelphia Health Department experience have established patient acceptance, increased productivity with decreased operating costs, as well as standards for measuring quality of care.

Douglas and Lipscomb (1979) noted that the issue of quality of services was taken up directly by Hammons et al. (1971) at the University of Alabama, whose findings showed that the quality of services supplied by the EFDA's could be favourably compared to the quality of services provided by dentists. In a review of ten studies of the quality of services delivered by EFDA, Douglass and Cole (1979) found no difference between the quality of auxiliaries' services and dentists' services. However, other studies have shown a slightly higher quality of care delivered by auxiliaries. Many interesting comparisons can be made and well documented academic discussions of the specific details are available in Lathrop's (1968) and Koerner's (1971) separate reviews of the literature. In
preparation for and coincident with these experiments and demonstration projects, many efforts were made to develop appropriate training programmes and curriculum materials for expanded function auxiliaries. Corry and Cannavale (1972) reported on the Indian Health Service programme for training EFDA's and Bethart et al. (1972) reported on the University of Alabama therapist training curriculum. Many reports are also available throughout the nation in dental schools that have the Teaching of Expanded Auxiliary Management (TEAM) programmes (Douglass & Lipscomb 1979).
5. SUPERVISION OF OPERATING DENTAL AUXILIARIES

5.1 PRINCIPLES OF SUPERVISION, DIRECTION AND CONTROL

1. Degree of Supervision

Auxiliaries of all types operate under varying degrees of supervision by dentists, even those auxiliaries who appear to operate more or less independently, such as the school dental nurses of New Zealand. The definition of the degree of supervision required for various types of dental auxiliaries remained confusing until the American Dental Association (ADA) defined four degrees of supervision of auxiliaries in 1975 (Burt 1983). Always with the assumption that ultimate responsibility was assumed by a licenced dentist, those degrees of supervision were defined as follows:

(1) General Supervision:

The dentist has authorized the procedures and they are being carried out in accordance with the diagnosis and treatment plan completed by the dentist.

(2) Indirect Supervision:

The dentist in the dental office authorizes the procedures and remains in the dental office while the procedures are being performed by the auxiliary.
(3) Direct Supervision:

The dentist in the dental office personally diagnoses the condition to be treated, personally authorizes the procedures and before dismissing the patient evaluates the performance of the dental auxiliary.

(4) Personal Supervision:

The dentist personally operates on a patient and authorizes the auxiliary to aid treatment by concurrently performing supportive procedures (Burt 1983).

2 - Principles for the Direction and Control of Dental Auxiliaries Performing Operative Duties

(1) Definitions:

1. Supervision: means the general overseeing of the performance of duties, a master-servant relationship, requiring the physical presence of the person responsible for the supervision.

2. Direction: is the action of aiming, guiding, prescribing, instructing and administering the performance of the duties by the auxiliary.

3. Control: is the checking, verification and regulation of the performance of duties by the auxiliary.

(2) Method of Direction:

1. The dentist shall give adequate instruction to
the dental auxiliary to ensure that the procedures and treatment to be performed are understood.

2. The dentist has a responsibility to ensure that all delegated procedures have been performed satisfactorily.

3. The dentist shall be available for consultation and management of complications that may occur.

(3) General Policy:

1. The dentist is responsible for the safety and well-being of each patient under treatment and for the quality of the dental services.

2. The dentist is responsible for the completeness of the diagnosis, for the consultation with the patient regarding the treatment plan and for referral to specialists.

3. The dentist and the dental auxiliary should have an understanding of each other's roles. This understanding should preclude the delegation of the performance of duties for which the dental auxiliary has not been trained (Aust Dent Assoc 1984).

3 - Categorization of Duties of Operating Dental Auxiliary Personnel

The duties of operating dental auxiliary personnel are frequently categorized as "Reversible" or "Irreversible".
(1) Reversible Procedures:
are those that can be reversed without
permanent changes in the oral status of the
patient; for example, the application of a
rubber dam.

(2) Irreversible Procedures:
are those that can or do leave a permanent
change such as preparing cavities and giving
local anaesthetic injections.

Many dentists appear willing to allow some extension
of reversible duties for hygienists if legally permitted.
but not irreversible procedures. Much debate centres
about procedures such as the packing and carving of
amalgam into cavities prepared by the dentist. In a
resolution passed by the 1975 House of Delegates (Burt
1983) the ADA strongly opposed the performance of such
procedures by hygienists, despite research evidence from
a study at the Forsyth Dental Clinic which showed that
hygienists were quite capable of doing them adequately
(Lobene 1974).
5.2 SUPERVISION IN DIFFERENT COUNTRIES

1 - In New Zealand

A philosophy of executive control exists which directs the dentist to maintain the proper scope and quality of clinical service overall, and the programme enables the dentist to assess the degree of supervision necessary. Consequently, the nurses usually possess a high degree of independence with the supervising dentist/nurses ratio being 1:50. Here the dentist makes periodic visits to where the nurses are based (Dunning 1972). Many young children in New Zealand are examined and treated totally by dental nurses and never see a dentist until their teen years. While this fact has disturbed some American observers, there is no evidence that the dental or general health of the children suffers as a result. One measure of the acceptance of the service is the high degree of utilization among the target population. Some 98.5 per cent of the primary and intermediate school population are treated by the service as are 64 per cent of preschool children. Comparable figures for the utilization of dentists in the United States are 58.8 per cent and 11 per cent (Burt 1983).

2 - In the United Kingdom

Where nurses are employed by local authorities and in hospitals, they work under the direct supervision of a dentist. They are not independent operators and are
not allowed to diagnose and plan care nor to perform nerve block injections. In a country where dentists are badly distributed programmes have failed to provide care to children in areas not well served by dentists (Slack 1981). Supervision is more direct and completed care must be checked by the supervising dentist before the patient is dismissed. There are still only a few hundred New Cross auxiliaries in Britain compared with over 20,000 dentists. It should be recognized that Britain has had a long-established school dental service with salaried dentists and its own facilities well before the introduction of New Cross auxiliaries. Although their introduction was met with noticeable opposition from some dentists this resistance has largely dissipated as the quality of care provided by the auxiliaries has become accepted as excellent. However, the residual resistance to New Cross auxiliaries probably is based chiefly on economic grounds, a likely reason for their relatively conservative deployment (Burt 1983).

3 - In South Australia

The degree of regional control existing in the South Australian scheme lies midway between the New Zealand and United Kingdom programmes (Blaiki 1974). It is anticipated that one dentist will be necessary for every six therapists, so that each child can be examined regularly by a dentist. With two clinical satellites located within two miles of a central clinic, the
regional dentist can visit them frequently to offer advice, examine children, authorize plans of treatment and provide treatment beyond the scope of the therapist. In late 1971, children were still recalled for regular attention and dentists provided examinations prior to the initial course of treatment and at alternate recalls. Therapists checked for carious lesions and reported other abnormalities found at the interim recalls. A dentist may have elected to examine a child at each recall for a particular condition. Therapists were graduated only after they had shown themselves to be competent and, as a result, treatments were not checked routinely by the regional dentist (Roder 1972).

South Australia began its plan in 1969 and by 1976 had 110 therapists supervised by 20 dentists. They are trained to work as independent operators after the supervising dentist has carried out the initial examination of new patients (Burt 1983).

4 - In Western Australia

In the state of Western Australia school dental therapists are employed in a generally similar fashion to that of South Australia, though they may also be employed by private dental practitioners. In the mid 1970s, Western Australia appeared to be the only jurisdiction in the world where operating auxiliaries were permitted to cut and restore dental hard tissue and could be employed in private practice as well as
public services. In the private practice situation these therapists carry out treatment, including the restoration, scaling and prophylaxis of the teeth of adults (Barnard 1981b).

5 - In Canada

Dental hygienists in Canada work within a "team" situation with a supervising dentist and a team of several nurses (Burt 1983). They are permitted to organize and conduct dental inspections and categorize patients in order of priority (Slack 1981). They become independent operators shortly after graduating and their productivity is closely monitored (Burt 1983).

6 - In the United States of America

In U.S.A., legal acts in every state require hygienists to work under supervision of a dentist, with direct supervision implied if not actually stated. But in December, 1976, a California hygienist, Linda Krol opened her own office next door to that of two dentists whose patients she was treating on a contractual basis. Her action was based on an interpretation of the state dental practice law. Following the lodging of a complaint, the California Board of Dental Examiners ruled, in 1978, that hygienists could not practice independently in their own offices. In agreeing to the Board's ruling, Krol accepted that her office would be considered as an extension of the setting in which the dentist practiced and the case appeared settled. Krol continues to
practice adjacent to her supervising dentists and has stated that "appropriate supervision whether general or direct is well provided for with this arrangement" (Burt 1983).

- Independent Practice of Dental Hygienist

An even more radical departure from tradition is "independent practice" in which the hygienist selects a site, rents or purchases space and secures equipment and supplies. There is no agreement with a dentist regarding supervision, the hygienist hangs out a shingle and goes it alone. Independent practice clearly flirts around the periphery of existing law, though the partners in an independent hygiene practice in Colorado Springs were satisfied after two years that all legal requirements had been met. There are a handful of other hygienists in independent practice around the United States. The future of independent practice is uncertain. Resolutions passed by the 'American Dental Hygienists Association' in October 1980 were worded in such a way that they appeared to support the concept (Burt 1983).

7 - In Japan

The law applying to dental hygienists of 30 July, 1948, as amended, defines a "dental hygienist" as follows: a female who has been licensed by the governor of the prefecture and carries out the following procedures for the prevention of dental and oral disease, under the direct instructions of a dentist:
1. Scaling by mechanical means, adhesions and deposits on the exposed surface of the teeth and under the gingival margin of normal gums;

2. Applications of medicaments to the surface of the teeth and the mucous membranes of the oral cavity.

Licences are granted to persons who have passed the prescribed examination, a register of which is kept at the prefectural office. An examination is held at least once a year by the Minister of Health and Welfare, who may however assign the responsibility for making the necessary arrangements to the prefectural governors. Dental hygienists may not use dental instruments or prescribe or administer pharmaceutical preparations liable to be hazardous to health except under the direction of the responsible dentist (WHO 1968b).
6. FUNCTION AND TRAINING OF OPERATING DENTAL AUXILIARIES

An effective dental training programme depends upon a suitable education system that provides the standard of education necessary for entry to dental school. The objectives of training are to provide a formal educational and certification programme which is appropriate to the needs of the dental services of a country, and to train operating dental auxiliaries to an acceptable standard of knowledge, skill and attitude for the advancement of dentistry and improvement of public health (Nasir 1983).

Course curricula and training standards at each of the training schools should ensure:

(1) The future supply of operators (like therapists) in sufficient numbers required for the expanding services; and

(2) That the standard of trained personnel would enable them to fulfill the duties required under the dental Act (Barnard 1985).

For the length of the training period, it is essential to relate the training of the therapist to his/her role in future practice and, depending on the nature of this role, she/he may be found to need more, or even less than two years of training; that is,
training duration should be strictly decided by the nature of functions to be performed by the future therapist.

The training curricula for dental nurses (therapists) or their counterparts all over the world are very similar and seem to be geared towards tradition rather than need; most of them are based on the New Zealand curriculum which is more reparative then preventive in orientation (Jeboda 1983).
6.1 SCHOOL DENTAL NURSE TYPE

The New Zealand type of dental nurse carries out a number of treatment services, ranging from oral examination through preventive services to cavity preparation and tooth restoration, in addition to dental health education activities and referral of patients with special needs (Gold 1981). In 1983, Burt reported on the New Zealand Dental Nurses clinical duties which were listed by the New Zealand Department of Health. The services they provided to children up to $13\frac{1}{2}$ years of age included:

1. Oral examination.
2. Prophylaxis.
3. Topical fluoride application.
4. Advice on dietary fluoride supplements.
5. Administration of local anaesthesia.
6. Cavity preparation, and placement of amalgam and silicate filling in primary and permanent teeth.
7. Pulp capping.
8. Extraction of primary teeth (not permanent teeth).
11. Referral of patient to private practitioner for more complex services such as extraction of permanent teeth, restoration of fractured permanent incisors and orthodontic treatment.
These duties have changed only slightly from those of 1921, with only topical fluoride application, advice on dietary fluoride, treatment of permanent anterior teeth and classroom dental health education being added since then. Extraction of permanent teeth has been removed as a duty because, as the dental health of the child population improved, there were too few permanent teeth requiring extraction for trainee nurses to learn the procedure (see Figure 4).

The nurses training course is two years in length. The nurses learn a certain amount of basic science as well as technical procedures, and considerable emphasis is placed on learning to recognize conditions that are beyond their competence to treat, which are then referred to a private practitioner (Burt 1983). The dental nurse's position in the school system is comparable in status and salary to the New Zealand school teacher (Jones 1984).

Pre-entry to the training schools requires four years post primary school and applicants must be seventeen years of age. Training is carried out in schools administered by the Department of Health, and courses of instruction lead to an examination and certificate. Training schools are located at Wellington, Auckland and Christchurch with the length of training being two years.

School Dental Therapists in Australia are trained in ten training schools in six states. They are employed
Figure 4.

New Zealand School Dental Nurses Treating Patients in Old and Modern Clinics.

Source: Burt (1983a)
in state government school dental services to treat primary school children up to twelve years of age. They may also, in some states, provide services for children from age 12-16 years. Depending on the state, the degree of dentist supervision varies (FDI 1981). In 1976, the South Australian Government opened a school for dental therapists. Sixteen students were selected from eighty-six applicants. The South Australia school opened with the encouraging support of the health profession. The National Health and Medical Research Council of Australia expressed its support for the introduction of school dental nurses to Australia in 1965. The Australian Dental Association expressed its support through its National Dental Health Policy of 1968 by stating that the ability of trained School Dental Nurses to perform a restricted range of clinical operations efficiently, safely and of high standard had been demonstrated conclusively. The policy adopted stated:

(1) The school dental nurses should be restricted to women and to governmental services;
(2) Diagnosis and planning of treatment should remain with the dentist;
(3) Adequate direction and supervision should be provided by the dentist; and
(4) Treatment, through such a service, should be available to all children of primary school age.
In South Australia it was decided that applicants should be 17-25 years of age and must have completed five years of secondary education successfully. Each applicant was interviewed for approximately thirty minutes by a panel of three persons, including the superintendent of the School Dental Service and the Senior Tutor Dental Officer. The qualities preferred from an applicant included a fondness for children, a mature personality, neatness of dress, a liking for fine manual skill and a sense of entering a vocation (Roder 1972). The curriculum training of the School of Dental Therapy has two major aims:

(1) To produce dental therapists capable of leading children toward good habits in diet and oral hygiene - prevention of "Dental Disease"; and

(2) To produce dental therapists capable of providing a high standard of clinical treatment for primary school children - "Control of Existing Dental Disease".

The subjects studied are arranged in three overlapping programmes which continue throughout the two year course:

Programme 1: Social and Preventive Dentistry -

(1) Preventive and public health dentistry.
(2) Human relations.
(3) Art.
(4) Visits to child-care institutions.
Programme II: Dental Science -
(1) Dental anatomy.
(2) Dental histology.
(3) General dental and applied pathology.
(4) Anatomy.
(5) First aid.
(6) Dental medicine.

Programme III: Clinical Dentistry -
(1) Operative dentistry.
(2) Radiography.
(3) Clinical dentistry for children.

Trainee School Dental Therapists spend approximately 18 hours in carving wax teeth, 500 hours in preparing cavities and placing amalgam and composite resin restoration in artificial jaws and 550 hours gaining practical experience in the clinic where each student treats about 130 children and places over 400 restorations of silver amalgam.

It is the practice for each graduating class of dental therapists to be assessed by two independent examiners, usually a representative of the South Australian Branch of the Australian Dental Association and a senior member from the teaching staff of Adelaide University's Dental School.

Clinical duties:

The range of clinical procedures which may be delegated routinely to dental therapists in South Australia have been listed as follows:
(1) A screening examination of the patient, including bite-wing roentgenograms on the initial visit and at subsequent alternate examinations;

(2) The examination and planning of treatment for caries on the occasion of the second course of treatment and at subsequent alternate examinations;

(3) The control of dental caries by excavation of softened dentine and insertion of temporary restoration;

(4) An oral prophylaxis and topical application of fluoride solution to the teeth (1.2% sodium fluoride);

(5) The instruction of patients in correct methods of maintaining hygiene and in dietary practices favourable to good oral health.

(6) The processing of X-ray films;

(7) The injection of local anaesthesia using the inferior dental nerve block or supra periosteal infiltration technique;

(8) The preparation of cavities in primary and permanent teeth and their restoration with silver amalgam or composite resin;

(9) The treatment of the exposed vital pulp in primary teeth by coronal pulpotomy and five minute application of formo-cresol to the pulp tissue in the root canals;

(10) The capping of the exposed pulp of a permanent tooth in an emergency;
(11) The application of a rubber dam for all composite resin restorations and pulpotomy operations (its use for amalgam restoration is also encouraged);

(12) The extraction of all primary teeth;

(13) The polishing of all restorations;

(14) The taking of alginate impressions and the pouring of study casts of the teeth; and

(15) The placement of copper bands over sedative dressings (Blaiki 1974).

The School Dental Nurse in the United Kingdom is approved by the Dental Council after following a prescribed course and passing a statutory examination. The course curriculum is based on that of the New Zealand auxiliary. In 1983, S.O. Jeboda noted in his study that there was a conspicuous absence of inferior dental block injections in the training curriculum of the New Cross therapist. Holt (1979) reported that therapists claimed that the greatest problem they faced in their work in Britain was their inability to administer inferior dental block injections (Jeboda 1983). The duties of the United Kingdom School Dental Nurses are: scaling and polishing of teeth, extraction of deciduous teeth, filling of teeth (confined to so-called "simple filling") and dental health education (FDI 1981).

The training programme of Dental Nurses in Malaysia consists of two phases within a three-year course. The first phase is full-time formal training at the Dental
Training School Malaysia, Penang, for a period of two years. The second phase is practical training in the various government dental clinics as directed by the Ministry of Health for a period of one year. The programme curriculum is somewhat similar to the New Zealand curriculum. All facilities like laboratory, dental operating units, reference books and journals, audio-visual material and equipment are available and they have the physical facilities to achieve the objectives of a dental nurses training programme. Most of the duties are similar to the New Zealand type but some special categories are different:

(1) Diagnosis:

The dental officer is responsible for carrying out routine examination of all school and preschool children before handing them over to the dental nurses for treatment. Subsequent follow-up examination of treated patients at six monthly intervals can be continued by dental nurses.

(2) Promotive:

The dental nurse organises and provides oral health education to children and adults individually or in groups, taking into consideration their socio-economic background and cultural differences, taboos and educational levels, using educational aids to suit the situation and condition wherever necessary. The trainees at the Dental Training
School in Penang were prepared for the tasks pertaining to preventive dentistry but were unable to or did not perform fully these tasks once in the school dental service due to a multitude of factors:

(a) Unavailability of materials;
(b) Monthly service evaluation which stressed curative service;
(c) The enormous number of patients requiring treatment;
(d) The attitude of patients to preventive service; and
(e) Lack of supervision.

The performance of dental nurses in Penang is influenced by the background training they receive at the Dental Training School and the field service environment. There were many instances when the tasks they were trained to perform were not implemented when they were in the field clinics. However, the dental nurses were able to perform their duties to an acceptable level but their weaknesses seemed to be in the area of Dental Health Education (Nasir 1980).

The Dental Education and Training Programme in Papua New Guinea was reviewed by an Expert Committee, in June, 1972, consisting of consultants from within the country and two overseas consultants:

- Professor N.D. Martin, Dean of Faculty of Dentistry, University of Sydney, Australia;
- Dr. D.E. Barmes, Dental Epidemiologist, World Health Organization (WHO), Geneva.
The Committee made new recommendations with regard to training programmes. Applicants for training as therapists could be male or female, with an entry standard from Form 3 (preferably Form 4) of high school, with a pass in science, mathematics and English. The length of training was two years and the qualification obtained was a Certificate of Dentistry (dental therapist). The length of the dental therapist course at that time (1972) was ninety-five weeks. The length of the course had been considerably shortened from that originally designed and used by Barmes and Schamschula, which was based on the number of hours in the New Zealand Dental Therapist's course (Veale 1973). The Committee recommended changes in the course design with a general time allocation of:

1st Year - First Semester 560 Hours.
       Second Semester 700 Hours.

2nd Year - First Semester 700 Hours.
       Second Semester 700 Hours.

That is, the length of the course was 2,600 hours for a two year period. It was also recommended that after graduation, dental therapists carry out a number of prescribed clinic assignments under positive supervision and guidance for a minimum period of six months to a maximum of twelve months (Veale 1973).
6.2 OTHER OPERATING DENTAL AUXILIARIES

1. Dental Hygienist

The first training course (in the U.S.A.) provided an intensive six months of study for the express purpose of demonstrating the value of dental health education as a preventive measure in diminishing dental disease among school age children. Now dental hygiene has many ramifications and there has been much evidence of advancement since Dr. Fones' first programme in 1913. Through the years dental hygienist education has become more developed. In the beginning there were no stipulations regarding the standardization of course content or curriculum length.

About the year 1937 considerable emphasis was being placed on the necessity for evaluating dental hygiene curricula and for encouraging the extension of all courses to a minimum of two academic years. Since change occurs slowly, it was not until 1959 that all schools in the U.S.A. finally conformed to the policy of providing at least a two-year programme (Steele 1978). The duties of a dental hygienist are similar in most countries where they are established. These duties are associated with the preventive aspect of dental care: scaling and polishing teeth; applying fluoride and other preventive agents; and educating patients to practice sound dental habits (Burt 1983).

In 1980, there were 200 training programmes including those in thirty-eight dental schools. The
The pre-entry training required graduation from an accredited secondary school with a college preparatory course or equivalent. Some dental hygiene schools also required two years of college level study before admission. The length of training is a 2-year college level professional course, leading to registration in dental hygiene. Those schools which require two years of college as a prerequisite, grant a baccalaureate degree in dental hygiene after completion of the two-year professional programme. Licensure examination is by individual States but the Licensing Jurisdiction National Board examination in Dental Hygiene is recognized in fifty-one of fifty-four licensing jurisdictions (FDI 1981a).

The dental hygienist is recognized in approximately forty countries, and is generally accepted as providing preventive services to patients. There are occasional differences in specific duties; for example, some dental hygienists in certain provinces in Canada are trained and permitted to place, condense, carve, and finish plastic restorations in addition to their normal duties.

In Australia, the Royal Australian Navy conducts a sixteen week training course for hygienists to be employed in the Armed Services only. In South Australia, the Department of Further Education trains hygienists for a forty-three week period to be employed in private practice. The duties of these dental hygienists are examination, scaling and polishing of teeth and dental
health education. They can treat both children and adults only under the supervision, direction and control of a dentist.

The education and training of dental hygienists in Japan is obtained through eighty-one dental hygiene schools recognized by the Ministry of Health and Welfare. Of these, thirteen dental hygiene courses and schools are attached to dental schools, recognized by the Ministry of Education. Pre-entry training is completion of high school education and the length of training is from 1-2 years (FDI 1981a); that is, the duration of the course is about 1,100 hours of instruction of which 35% is devoted to theory, 20% to practical laboratory work and 45% to in-service training. The curricula are identical at all the training institutions and include the following subjects: anatomy and physiology, pathology and bacteriology, pharmacology and clinical practice. The diploma awarded is recognized by the national authorities (WHO 1977).

In Poland, the pre-entry to dental hygienist training is primary and secondary education. Training is through a one year course in Dental Hygiene at a Medical School. Diploma examination is required before the hygienists can legally perform the following duties: preparing the patient for treatment and assisting the surgeon in the treatment of the patient and maintaining the instruments and equipment and the surgery premises; participation in the health centre prophylactic
activities; applications of fluoride and cleaning teeth; conducting dental health education; record keeping and selected data analysis.

The training programme in Czechoslovakia is for those with two years experience as a dental surgery assistant (nurses). Special training for two years is organized by the Institute for Further Education of Health Auxiliaries. The duties of the trained dental hygienist are: cleaning, polishing and scaling of teeth; topical application of prophylactic solution, taking of radiographs; taking of impressions for orthodontic use and dental health education (FDI 1981a).
2. EXPANDED-FUNCTION DENTAL AUXILIARIES

The functions that dental auxiliaries in the United States of America may legally perform are increasing, though the duties are not uniform throughout the country; rather they are governed by individual dental practice acts enacted by State legislature. For this reason there is a wide variation in the legal provision for delegation of duties to dental auxiliaries, ranging from strict limitation on the intra-oral duties to fairly broad provisions for expanded functions. By 1980, 42 states had amended their dental laws to provide for expanded duties of dental hygienists. Examples of these duties include placement of rubber dams, polishing of amalgam, and placement and carving of restorations (Furstman 1981).

In the late 1970s the State of California introduced Registered Dental Assistants with Extended Functions. These auxiliaries, who upon completing post-licensure training and passing an examination set by the State Dental Board, are permitted to perform the following duties:

1. Retraction of gingiva for impression procedures;
2. Taking of impressions for cast restorations;
3. Taking of impressions for space maintainers, orthodontic appliances and occlusal guards;
4. Preparation of teeth for bonding by etching;
5. Determining root length and endodontic file length;
6. Fitting of trial endodontic filling points; and
7. Application of pit and fissure sealants (Burt 1983).

In the field of training firm curricular patterns have not yet emerged but the U.S. Department of Health, Education and Welfare has encouraged university programmes through TEAM (Training for Expanded-Duty Auxiliary Management) grants to dental schools.

In many locations it is possible for dental schools to combine facilities with community colleges (junior colleges) and other institutions that have special programmes in paramedical subjects (Dunning 1979). In Alabama, a group of dental assistants was trained over a two year period in such a way as to receive basic instruction in dental science to approximately the level of a dental hygienist (Hammons & Jamison 1967).

The first report of an investigation into the possibility of expanding the function of dental auxiliaries concerned a study undertaken by the Royal Canadian Dental Corps. Male dental hygienists were given training to enable them to undertake extended function clinical duties (Elderton 1981).

3. Denturism:

Elderton (1981) discussed the denturists in Slack's 1981 textbook. Several countries have gone against the recommendations of the WHO Expert Committee, 1959 which stated that only qualified dentists are permitted to work directly with patients who require dentures. These countries allow Laboratory Technicians to work directly with the public. Tasmania, a State
in Australia, was probably the first place where technicians were legally permitted to provide a prosthetic service (Elderton 1981). Denturists in New South Wales are called Dental Prosthetists. They are licensed by the Dental Board to deal directly with the public for the construction of full and partial dentures provided the patients oral health is good. They are trained to recognise the presence of pathology in the oral cavity and are not permitted to construct dentures where obvious pathology exists. They must work in a proper clinic suite similar to that of a dental surgeon, with certain specified requirements as stated in the regulations of the Dental Act governing dental prosthetic practice. They are obviously not permitted by law to carry out any other form of dental treatment.

Entry to the Dental Prosthetists Course, which is conducted by the Department of Technical and Further Education, is only available to Dental Technicians registered in New South Wales. Dental technicians who are graduates of the course conducted at Randwick College (TAFE) are exempt from year one of the Dental Prosthetists Course. The full course runs for nine hours a week, thirty-six weeks a year, for three years (Dental Auxiliaries Division 1986).

Denmark uses the term 'denturist' to describe a special category of dental technician who sits an examination which enables him/her to prescribe, make and fit removable dentures without supervision (Elderton 1981).
Oregon, in the United States, is also proceeding along these lines and, in spite of considerable opposition from dentists, the states made 'denturism' lawful in 1979 though the law requires patients to be provided with dental certificates of health prior to visiting a denturist (Elderton 1981). In the state of Maine, U.S.A., denturists are permitted to take impressions and fit dentures but only under the direction of a dentist (FDI 1977).

In Papua New Guinea, dental technicians are trained as prosthetic therapists. Pre-entry is Form 3 of high school and training takes three years, after which a Certificate of Dental Mechanics (prosthetic therapist) is awarded. The course comprises 2,660 hours, including the clinical component (Vele 1973).
6.3 TRAINING PROGRAMMES IN DEVELOPING COUNTRIES

Approximately 404 training programmes for operating dental auxiliaries (New Zealand school dental nurse type and Dental Hygienists) are in operation in various countries throughout the world. These courses are conducted in university dental schools, special auxiliary schools and other educational institutions (FDI 1981a). Integrated training of both professional dentists and auxiliary personnel was strongly recommended by the New Delhi Seminar Committee (WHO 1968) to enable the dental profession to promote proper training. As operating auxiliaries become more widely accepted the dental profession will need to give guidance on educational objectives and on specific details of the curriculum as adapted to local requirements.

A brief review of some examples of programmes for operating dental auxiliaries in developing countries is presented:

1. Botswana:

The general emphasis of the Ministry of Health in Botswana is on primary health care. A preventive approach concentrating primarily on dental health among the young is the first priority. Emergency treatment is also considered of importance due to problems arising from the accumulated need for dental treatment in the population. Therefore Botswana has concentrated on dental therapists as their principal dental health
personnel cadre. As well as providing facilities for training, jobs and clinic facilities have to be made available in order to utilize and benefit from the training programme. The curriculum consists of a three year programme for which the Cambridge School Certificate is a requirement for entry. Training is by a three year course with a Supplementary Course after three years of work in the public health area. Services provided by the therapists are: scaling, extraction of teeth, conservation of moderate size cavities only, dental hygiene and health instruction in schools. The dental profession in Botswana has indicated complete acceptance of the dental therapist (Eriksen 1983, PDI 1981).

2. Papua New Guinea:

Training of dental therapists has continued at the Port Moresby Dental College since the inception of the programme in 1956. Various aspects of training for all categories of dental personnel (dentist, operating and non-operating auxiliaries) have been integrated at the school. The two year therapist course is open to men and women who have completed at least three years of secondary education. In 1973 sixty dental therapists were working in the public health services under the supervision of dental officers and senior auxiliaries providing preventive, education and curative, and emergency dental care. Approximately 90% of their work is with school children and 10% with other sectors of the population. WHO has assisted Papua New Guinea with
the development of the dental auxiliary training
programme by providing several consultants to advise on
different aspects of curriculum development and the use
of these auxiliaries in dental public health services
(Myer 1973).

3. Senegal:

As part of a WHO dental health project in Senegal
two dental auxiliary training programmes were initiated
by the Institute of Odontology and Stomatology at the
University of Dakar. In 1971, the first one year course
began with students from each of the seven regions of
Senegal. The graduates have returned to work in health
establishments of the Ministry of Public Health. These
Agents Sanitaire Odontologist Courses (ASO) are providing
such services as simple treatment of infections,
extractions of primary and permanent teeth, and oral
prophylaxis for the prevention of periodontal disease
which is especially prevalent among young children in
Senegal. Community and individual dental health
education activities are also an important part of the
auxiliary's responsibilities. The second auxiliary
programme began in 1973, with a two year course to train
an auxiliary (infirmier sanitaire odontologist) to
provide preventive and operative dental care for children
as part of the school dental service. In addition to
carrying out the previous functions, these auxiliaries
(ASO) also insert simple fillings in carious primary and
permanent teeth. The pre-entry course requirements call
for completion of six years elementary school (CEPE Certificate) and students must be between 18 and 30 years of age (FDI 1974, FDI 1981a).

4. Cuba:

Cuba is one country which utilizes the New Zealand School Dental Nurse type. The programme commenced in 1968 in two centres at La Habana and Santiago de Cuba. About 340 students were accepted in the programme. The centres accept women only, between the ages of 16-35 with a 10th grade pass, who must undergo an aptitude test. The length of training is four terms of six months study each. The title for this auxiliary is Stomatology Technician. They are employed in full time government service, working in teams with dentists and dental assistants under the supervision of dentists. The duties of the stomatology technician (like the New Zealand type) are: preparation of cavities; amalgam; silicate and acrylic restoration in children and adults; radiography; topical applications of fluoride; prophylaxis; local anaesthesia; tooth extraction and dental health education (FDI 1981a).

5. Indonesia:

Indonesia also provides services through a New Zealand type of school dental nurse. The first training school at the Department of Health opened in 1953 in Djakarta, and others were opened as follows: Bandung 1969, Makassar 1968, Surabaya 1970, Medan 1972, Bandjarmasin 1972, Palembang 1974. The school dental
nurse is employable only in government service and provides the following services: prophylaxis, simple cement and amalgam fillings, extractions for children only and dental health education. Dental Nurses (dental therapists) are accepted by the Indonesian Dental Association. The length of training is three years (FDI 1981a).
7. DENTAL SERVICES FOR SCHOOLAGE CHILDREN

BY OPERATING DENTAL AUXILIARIES

In Strasbourg, Germany, the first children's dental clinic was established in 1865. Hannover followed suit in 1885, Offenbach and Wurzburg in 1898. In England, through the stimulation of W. MacPherson Fisher of Dundee, the British Dental Association appointed a committee to carry out oral hygiene work in the schools of that country. The committee was formed in 1890 and within the succeeding two decades influenced the appointment of dentists to many elementary schools. The opening of the twentieth century saw various groups within the U.S.A. ready to approach the problem of dental public health along the lines of dental treatment for indigent children, and education of all children on the subject of mouth hygiene, chiefly toothbrushing (Dunning 1979).

Public dental services for school children were initially introduced in Denmark in 1910, in a part of the Copenhagen area (Hansen 1981).

In New South Wales, Australia, dentists realised that public dental services were necessary if large sections of the population were not to be deprived, mainly for economic reasons, of dental treatment. The genesis of school dental services was considered at a meeting in 1904, but the appointment of dentists to the Department of Public Instruction was to wait until 1915 when the first travelling school dental clinic was
established. The following year six such clinics were in operation within the state.

In 1972 New South Wales implemented a training programme for school dental therapy at Westmead and accepted twenty-five trainees (Barnard 1985). In 1967 the South Australian Government opened a School for Dental Therapists; these auxiliaries are similar to the New Zealand Dental Nurse which was initiated in 1921. Tasmania had become the first Australian state to commence such a programme in 1966, and in March, 1971, Western Australia became the third Australian state to introduce a school dental therapist for school dental services (Roder 1972).
7.1 PROGRAMME NEEDS AND OBJECTIVES

7.1.1 Dental Disease

Because of the prevalence of dental caries in children and teenagers it has been common practice to give almost exclusive attention to this disease in planning school health services. The destructive effect of tooth decay should not be minimized, but there are other dental defects and conditions that should be given their share of attention in programme planning (Am Dent Assoc 1965). In 1983, Carr reported on data collected at the annual examinations conducted by the school dental service of the States and Territories throughout Australia. The years 1977-1982 inclusive were used to assess the dental health of children and to determine trends. The data covers almost four million examinations.

(1) Dental Caries:

In the period 1977-1982 there was a decline of 41.4% in the DIMF indices for children aged six to thirteen years. In 1977 the index was 2.97 compared with 1.74 in 1982. For twelve year old children, the figures were 4.79 and 3.01 respectively. Two of the more obvious reasons for the fall in prevalence of dental caries are fluoridated water, which is used by 66% of the population, and fluoridated dentifrices which are almost universally used. The data for children examined in 1977-1982 are shown in Table 5 (Carr 1983).
<table>
<thead>
<tr>
<th>Age</th>
<th>Mean DIMF 1977</th>
<th>Mean DIMF 1982</th>
<th>Decline DIMF</th>
<th>% Decline DIMF</th>
</tr>
</thead>
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<td>0.16</td>
<td>0.35</td>
<td>68.6</td>
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<td>7</td>
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<td>0.47</td>
<td>0.74</td>
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<td>1.02</td>
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<td>13</td>
<td>5.83</td>
<td>3.85</td>
<td>1.98</td>
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<tr>
<td>All ages</td>
<td>2.97</td>
<td>1.74</td>
<td>1.23</td>
<td>41.4%</td>
</tr>
</tbody>
</table>

Source: Carr (1983).
The Danish national average of caries prevalence in children shows decreasing levels from 1972 when registration started (Schwarz & Hansen 1979). Children start school with gradually lower defs - and DMFS - scores and the longitudinal score level of each cohort is year by year lower than the year before (see Figure 5). However, the severity of the caries situation increases with age. In the school year 1977/78 an average DMFS score of 13.7 was recorded for fifteen year old children. The major part of this figure consisted of filled surfaces (Fehr 1981). The National Board of Health in Finland has collected statistics on dental caries since 1974. The prevalence of individuals with no caries experience in the age group six years had increased from 6% in 1974 to almost 30% in 1979. For the nine and twelve year old children there has been an increase in the number of caries-free individuals. There is a clearly defined annual decrease in the DMFT scores for all age groups combined (6-17 years) (see Figure 6) (Rolla 1981).

A number of factors might influence the decrease in caries prevalence, namely: the use of fluorides, the systematic approach in children's dentistry, information and education, and an increase of dental personnel (Rolla 1981).

(2) Periodontal disease:

Children in the school years develop gingivities and from age seven years onwards at least half the
Figure 5. The Longitudinal Developments of Mean defs - and DMFS - Scores in Co-horts of Danish Children.

Source: Fehr (1981).
Figure 6. The dmf-index of 0-5 Year Olds and DMF-index of 6-17 Year Olds in Finland from 1974 to 1979.

children were affected. There is a strong relationship between debris on the teeth and inflammation of the gums. Gingivities in childhood leads to chronic periodontitis in adults which is a major cause of tooth loss in adults (Fit For the Future 1976).

In Scandinavian countries it is still hard to evaluate a programme by epidemiological methods in the age groups below fourteen years because of the continuous change in the anatomical picture during the period of shedding the primary teeth and eruption of the permanent teeth. At the age of 14-15 years, plaque and gingival registration may be more meaningful in an epidemiological sense (Rolla 1981). The oral hygiene in school children in Australia has improved by 21% from 1977 to 1982. Undoubtedly the school dental services have played a major part in this improvement.

(3) Malocclusion:

In 1960, a study of more than 1,000 Michigan school children showed that about 30% of the children of any given age group needed some form of orthodontic supervision and treatment (prevention and correction of irregularities of tooth position) (Am Dent Assoc 1965). In 1974, Sutcliffe studied and examined children in a dental health survey in the United Kingdom. Between 7-15 years of age, at least half the children were found to have some degree of crowding and in addition many other variations in occlusal development occurred (Fit For the Future 1976).
Accidental injury:

Sutcliffe (1974) reported in the later years of school life, between the age of twelve and fourteen years, 20% of boys and 10% of girls had damaged their front teeth through accident (Fit For the Future (1976). The rate of 6% of students who had suffered traumatic injury to an anterior tooth agrees with other findings (Andreasen 1981). Only one tooth was usually injured (more likely to be maxillary), and this is similar to experience in other countries (Grundy 1959).

The ratio, showing that twice as many boys received injuries to teeth as girls, has been documented in other studies. The reasons for this seem obvious due to boys rougher style of play and a significant decrease in dental injury can be achieved by the wearing of mouthguards (Burton, Prike, Rob, Lawson 1985).
7.1.2 Objectives of School age children programme

Dental health is known to affect the general health, the appearance and social adjustment of an individual throughout his lifetime. The control of dental disease and defects, and the establishment of good oral hygiene habits are best accomplished during childhood. The American Dental Association in 1965 adopted a statement of objectives of a community dental health programme that might be paraphrased and so apply to school dental health programmes. These objectives so paraphrased are:

1. To help every school child appreciate the importance of a healthy mouth;
2. To help every school child appreciate the relationship of dental health to general health and appearance;
3. To encourage the observance of dental health practices including personal care, professional care, proper diet and oral habits;
4. To enlist the aid of all groups and agencies interested in the promotion of school health;
5. To correlate dental health activities with the total school health programme;
6. To stimulate the development of resources for making dental care available to all children and youth;
7. To stimulate dentists to perform adequate health services for children (Dunning 1979).
In 1973 the Health Commission of New South Wales (N.S.W.), in over viewing the situation in relation to dental disease, adopted several strategies:

1 - It supported water fluoridation as the major approach to the prevention of dental caries;

2 - It supported the then recently elected Australian Labor Government's initiatives in assisting the States in the expansion of their School Dental Services, recognising that the treatment provisions of the scheme would indeed bring dental care to thousands of children hitherto unattended.

3 - The Commission considered that dental health education and preventive procedures such as fluoride rinse programmes were of paramount importance.

New South Wales, therefore, in common with all other States, undertook to develop a school dental service offering free dental care to all school children under fifteen years of age.

The main features of the scheme adopted were:

1. That the service would be staffed basically by school dental therapists working under the general direction and control of dentists;

2. That the programme would be implemented gradually with a target of covering all infant and primary school children by 1982, and then expanding to cover infant and secondary school children, that is, under fifteen years;
3. That treatment would be provided at school dental clinics, fixed or mobile types, located in school grounds;

4. That the service would offer free dental care and treatment to each child; and

5. That dental health education would be regarded as an integral part of dental care and would accordingly be provided to all school children.

In pursuance of these objectives the Commonwealth offered financial assistance for:

a. The training of school dental therapists.

b. The recruitment of dentists.

c. The construction and equipping of clinics (Barnard 1985).

As part of the WHO/FDI Goals for the Year 2000, WHO has suggested the setting of objectives in oral health and the monitoring of the achievement of these objectives. A global goal of three DMF teeth for twelve year old children by the year 2000 was proposed and has now received international recognition. However, individual countries were encouraged to set goals which were appropriate to the particular conditions within each country and which had a reasonable chance of being achieved.

In 1982, Australia reached the goal of three DMF teeth for twelve year old children. It is estimated
that the index will decline to 1.8 per child by the late 1980s.

The International Dental Federation (FDI) has adopted a number of goals for oral health, which involved caries in children and edentulousness in adults. One of these goals is that 50% of five and six year old children should be caries-free. The FDI has clarified this as meaning children with no caries experience (Carr 1983).
7.2 DENTAL CARE PROGRAMME FOR SCHOOL-AGE CHILDREN

In the field of dental health the professional groups best fitted to carry the load are the dental hygienists, the dental therapists and the school nurses. The dental hygienists are specifically trained for dental-health education, and wherever a school system is large enough to employ one or more hygienists they are the ideal persons to spark the dental programme.

They are at some slight disadvantage, however, in motivating children to seek dental care, not only because they are "interested parties" on account of their special training, but also because their viewpoint upon the whole spectrum of a child's health problems is not as broad as that of a school nurse. Hygienists are also difficult to hire in small systems because employees of broader usefulness have to be hired first. The school nurse (medical in the U.S.A.), therefore, is always a person of importance in the conduct of the dental health programme, and often the only auxiliary available. The functions of the dental hygienist and school nurse in a dental health programme are similar in many important respects, in spite of differences in their training. In order to picture the daily life of a dental hygienist, the Massachusetts Department of Public Health carried out a survey of the time devoted to certain specific activities by dental hygienists employed in state and local public health programmes (Dunning 1978).
Several countries have dental care programmes for children which employ different delivery systems. The United Kingdom, Denmark and U.S.A. have programmes that are dentist-based systems with dental hygienists just assisting in the delivery system. Conversely, South Australia, New Zealand, Saskatchewan and most developing countries utilize delivery systems whose existence depends on a major input by operating dental auxiliaries, such as the school dental nurses and dental therapists (Jones 1984, Roder 1978).

School dental programmes are generally based on incremental care with recall periods dependant on budgetry constraints, disease patterns and the priority given to high risk groups. Programme emphasis should be on the prevention of dental disease, and it is advisable that school based dental clinics be made available whenever possible because of their desirability as a favourable social setting in the treatment of children (Barmes 1983). Depending on their respective costs and benefits, mobile systems and/or private contract services should provide access to care for rural or geographically isolated areas. Attempts must also be made to provide services for the particular needs of the school age children (Dunning 1972).

According to the level of training, functions and duties of operating, dental auxiliaries previously discussed can be utilized in dental care programmes for school age children in the following ways:
1 - Preventive:

(1) Examination of children, charting and recording of dental disease or oral conditions;

(2) Supervised rinsing or brushing with fluoride solutions;

(3) Supervised application of fluorides in rubber or wax trays;

(4) Identifying dental disease or oral conditions;

(5) Cleaning the teeth by removing calculus and other oral deposits;

(6) Application of pit and fissure sealants; and

(7) Applying topical preventive agents such as fluorides.

2 - Dental Health Education:

(1) Instructing children on the principles of oral hygiene and the prevention of dental disease;

(2) Instructing children in diet and eating habits;

(3) Organizing and conducting group instruction on oral hygiene procedures and prevention of dental disease;

(4) Use of plaque disclosing material routinely; and

(5) Participating in the organization and implementation of community dental activities.

3 - Treatment:

(1) Providing emergency dental care within the scope of training;

(2) Applying topical medicaments for treatment of oral infections;
(3) Preparing cavities in carious primary or permanent teeth so that fillings may be inserted;
(4) Filling cavities;
(5) Use of local and/or regional block anaesthesia;
(6) Administering fluoride tablets in primary schools;
(7) Extracting primary or permanent teeth;
(8) The placement of copper bands on teeth over sedative dressings;
(9) The application of rubber dams especially for all composite resin restorations and pulpotomy operations;
(10) Performing periodontal soft-tissue curettage;
(11) The capping of the exposed pulp of a permanent tooth in an emergency;
(12) Taking and processing of radiographs; and
(13) Taking of alginate impressions and the pouring of study casts of the teeth (Myer 1973, Blaikie 1974).

4 - Referral for Dental Care:

Referral of children to a general practitioner (dental officer), a specialist in the public service or in private practice, for more complex services such as orthodontic treatment or root canal treatment or any treatment outside the scope of their duties (Dunning 1979).

The FDI (1977, 1979) Working Group on Oral Health Promotion was designed to describe preventive dental programmes for school age children in ten countries. A mail questionnaire was developed to obtain information about programme philosophy, target population, preventive
programme components, promotion and educational methods, barriers to programme development, programme priorities and evaluation methods. In this pilot phase a total of twenty-seven questionnaires were returned from eight countries (Argentina, Federal Republic of Germany, France, Japan, Singapore, Sweden, Thailand, United Kingdom). Respondents generally recognized the need to include three major programme elements in order to build comprehensive programmes. These elements were primary preventive measures, early detection and treatment services, and instructional activities for children (FDI 1981b).

The following is a review of the procedures of both preventive and treatment programmes for school age children:
7.2.1 Preventive Programmes

A preventive appointment with a parent present has been emphasized since 1976 in the New Zealand school dental services (Jones 1984). In addition to the application of topical fluoride in the schools, fluoride tablets are distributed to children in fluoride-deficient rural regions. In a comprehensive school-based system of care continuity is virtually ensured. Periodic preventive measures are ensured. No child in the country misses a prescribed preventive appointment at periodic intervals. If a child moves from one end of the country to another the records follow and another school dental nurse would complete the prescribed procedure. Modified actions in diagnostic criteria have also had an impact on the system, with fewer restorations being placed in pits and fissures (Jones 1984).

The report on preventive dentistry by the Working Party on Dental Services (Department of Health and Social Security, London 1973) considered the problems raised by dental diseases in school children. They recommended that the best means of prevention was the fluoridation of public water supplies. They also suggested that properly formulated fluoride, applied by the operating dental auxiliaries under the control and supervision of dentists, effected a reduction in incremental caries over a two or three year period. The New Cross Dental Nurses in the United Kingdom carry out certain preventive procedures like pit and fissure
sealants, apply topical preventive fluoride, supervise rinsing or brushing with fluoride solutions and take part in dental health education. They are well qualified to undertake much of the preventive care needed by children (Fit For the Future 1976).

School-based fluoride brushing and rinsing programmes were started about 1960 in the Scandinavian countries (Heloe 1982). Reports on mass fluoride caries prophylactic programmes in Norway (1976/1977) and Sweden in 1978, showed a participation rate of 84-97% among seven to fifteen year olds. Rinsing once a week or once a fortnight at school was performed by about 94% of Swedish school children; the remaining 2% brushed with a fluoride solution five to six times a year. Fluoride brushing three to five times per year dominated in Norway, but this has been gradually substituted by fortnightly or weekly rinsing with 0.2% fluoride solution, usually under the supervision of specially trained personnel, dental assistants or dental hygienists (Heloe 1982).

In 1973, in New South Wales, Australia, it was considered that preventive programmes such as "brush-ins" and "rinse-ins" should be almost universal in application. Attempts were made to include school children throughout the state in such programmes. It has become obvious that fluoride has its main effect on smooth surface and less effect on pits and fissures. Some overseas studies have shown that 94% of tooth decay in children is in pits and fissures, whilst a study of twelve year old
children in the Northern Metropolitan Region of New South Wales has revealed that, based on surfaces affected by decay in the permanent molars alone, 70% of the DF figures result from decay in pits and fissures (Barnard 1985).

The improvement in oral health extends through the community and dental disease patterns continue to change in Australia. The reduction of the DIMF/dif indices from 2.97% in 1977 to 1.74% in 1982 for children aged six to thirteen years in Australia is a prime example of the effectiveness of school programmes because it shows the success of the various preventive activities (Carr 1983).
7.2.2 Treatment Programmes

A United Kingdom survey of children in 1973 suggested that in the last year of primary school life 80% of their treatment could have been provided by dental auxiliaries (New Cross Nurses in the United Kingdom), had a sufficient number been available (Fit For the Future 1976). Treatment needs in New Zealand children have been reduced 69% in eleven years. DMF and caries-free ten year targets established for children in 1978 for 1988 have already been met and further revised (Jones 1984). In the fluoridated city of Timaru in New Zealand the DMF in eight to nine year olds, in the period 1973-1981, has declined from 3.16 to 0.89 with 59% being caries free (Hunter 1982). Caries prevalence in the primary teeth of five year olds fell by 30% between 1977 and 1982. The percentage of caries-free five year old children increased from 34% to 44% in the same time span. A national target of 50% of five year old children being caries-free by 1988 appears to be within reach. Almost 90% of these five year olds were enrolled in the service prior to their first school year (Hunter 1984). Much of the improvement in dental health of the children in New Zealand is the result of employment of School Dental Nurses in this programme.

In response to the poor condition of children's oral health and lack of children's dental services in the 1960s, the South Australian School Dental Service adopted a static-design school-based system in 1969.
By 1982 some 102 static school clinics were in operation; thirty-five in country centres and sixty-seven in metropolitan Adelaide. There were also seventeen mobile centres in operation. Each fixed school clinic cares for approximately five additional feeder schools with children bussed to the central school for care. The dental care is provided at no charge. Pre-schoolers and 83% of all primary school children participated in the school-based programme in 1982-83. In 1983, the School Dental Service began treatment of low socio-economic status secondary school students in addition to all pre-school and primary school children (Jones 1984).

According to a review of dental services in New South Wales by the Principal Dental Advisor in 1979, studies with mobile school clinics showed that, once the backlog of untreated dental decay was overcome, the maintenance of dental health by the treatment of the annual increment of dental caries was a relatively small problem; for example, a mobile clinic in its first circuit of ten country schools took eighteen months to complete treatment; the second circuit ten months; the third five months. This was an even smaller problem where the schools were in fluoridated areas. Only 20% of the state's children were being covered by the treatment service. Whilst 81% of the state's population were receiving fluoridated water there was a considerable variation in the child population's exposure to this preventive measure (Barnard 1985).
Analysis of the situation in 1983 indicated that the establishment of at least 290 therapists (preferably 300), plus additional dental assistants, were required to permit New South Wales to achieve the coverage of children similar to that of other states in Australia. Increased coverage of school children from 30% to 100% could be achieved with this slight increase in staff through the development of a programme amended as a result of the following information:

1 - 20% of children have 60% of caries.

2 - 70%-90% of dental caries is in pits and fissures.

3 - A large number of children are now caries-free.

It would not be necessary to examine caries-free children every six months, nor to provide additional fluoride treatment for children of 10, 11 and 12 years of age who are caries-free.

In accordance with improvement in health conditions, it would appear logical to provide more chemical treatment of deciduous teeth than amalgam fillings (Barnard 1985).
7.3 PRODUCTIVITY UTILIZING OPERATING DENTAL AUXILIARIES

In this section factors that should be considered when deciding whether to introduce operating auxiliaries are discussed. Although data exist on the operating dental auxiliaries, productivity, quality of restorative care, and other aspects such as quantity and cost, the effects on dentists' job satisfaction or on public access to care have not been evaluated statistically and are open to conjecture (Roder 1972).

The concept of increased productivity through the use of a trained dental assistant was discussed as early as 1925 by Johnson (1925). However, it was not until Klein (1944) Survey 1943 that a correlation was established between the number of chairs and assistants to the number of patients that could be treated per week. These crude data were refined by Waterman (1956) publication in the middle 1950s. Waterman was the first to report on actual procedures performed by the assistant.

The five-year Richmond-Woonsocket study performed on a population of school children in the U.S.A. showed that an increase of 52% in dentists' productivity could be expected using one assistant, and 70% using two assistants.

The history and polemics of the dental auxiliary movement has been well documented by Lathrop (1968). A good example is the New Zealand Dental Nurse who can perform practically all dental operations needed for elementary school children (Douglas, Lipscomb 1979).
Scarrott (1973) claims that the economic advantages of dental auxiliaries would depend to a large degree on the tasks delegated. Advantages would be possible to the extent that more frequently required tasks were delegated, thereby increasing the potential ratio of auxiliaries to dentists. Accordingly, in New Zealand where nurses diagnose and plan treatment for caries, it might be expected that nurses would effect greater economies than in the United Kingdom where these generally required tasks are the dentist's responsibility prior to delegating other functions to operating auxiliaries (Roder 1978).
7.3.1 Quality

In 1980, Kaplan conducted a study in an established private practice in which the two dentists had been utilizing EFDA's for reversible intra-oral procedures for five years prior to the study, although in fact little delegation of placing and carving restorations had occurred. Six assistants in a private dental practice received clinic training in selected expanded functions, including the insertion and carving of both amalgam and synthetic restorations. Each auxiliary's ability to perform the expanded functions was documented by three types of evaluation:

(1) An end-of-training evaluation by a trainer of auxiliaries affiliated with the University of Kentucky's College of Dentistry;

(2) Daily evaluations by the dentists who employed the assistants; and

(3) A 'blind' evaluation of restorations by two other private dental practitioners who served as independent evaluators. In addition, each dentist in the practice recorded his reason for not delegating to an assistant whenever he chose to perform himself a function that he could legally delegate.

Although requests to participate in the product evaluation were sent to sixty patients from each research phase, there were actually twelve patients from baseline (when the dentists performed all intra-oral procedures) and
twenty patients from the expanded phase who volunteered to participate. However, with restorations as the unit of observation, there were thirty-three restorations evaluated from each of the two phases for a total of sixty-six observations. From the baseline phase, six one-surface restorations, twenty-one two-surface restorations and six three-surface restorations were evaluated. From the expanded phase, twenty-three one-surface restorations, ten two-surface restorations and no three-surface restorations were evaluated.

Table (6) presents the frequencies of rating across phases. The hypothesis tested was that the proportion of "satisfactory" and "not acceptable" ratings did not differ between the baseline and the expanded phases. Since the expected frequencies for the "not acceptable" ratings were less than five, the Fisher exact probability test was used. At an 0.05 level of significance for a two tailed test $p = .242$, indicating no statistical difference between the phases (Kaplan 1980).

The results of the study indicated:

(1) There was no difference between the quality of restorations that were placed and finished by EFDAs and those by dentists as determined in a "blind" quality evaluation. Moreover, the delegated functions met the quality standards of the dentists in practice, with only four per cent of all delegated functions having to be redone.

(2) The dentists' decision not to delegate a substantial number of complex restorations, because of quality
# Table 6.

**Rating by Evaluations of 66 Restorations Completed by New Cross Dental Auxiliaries**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Baseline Phase</th>
<th>Expanded Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Not Acceptable</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Kaplan (1980).
concerns, contributed to the satisfactory quality of delegated restorations and to the small percentage of redos.

(3) Administrative concerns, such as there being no other task for the dentist to do, or the delegation not being the most economical use of time, were as important as quality concerns in affecting the extent to which functions were delegated (Kaplan 1980).

In the 1950s, at the time of the initial Massachusetts experiment with dental nurses, the American Dental Association sent a staff member, Gruebbel to New Zealand to evaluate the dental nurses' care (Gruebbel 1950). The report published in 1950 revealed 3,220 restorations were inspected in the permanent teeth of ten to fourteen year olds in five geographic areas; 28% were considered "defective" either because of inadequate margins (11%), poor form 10%, or fracture of the restoration 5% or tooth 2%. Assessments relied on empirical judgement without definitive criteria. A total of sixty-one bite-wing radiographs were obtained from children selected at random from 121 ten to fourteen year olds. Easlick reviewed the radiographs and concluded that they revealed a poor quality of care by U.S. dental school standards, but, that radiographs of practising dentists' care in U.S. were not available for comparative purposes. Gruebbel's report would have been improved had the sampling method been defined, and
comparative quality standards based on dentists' restorations been provided (Roder 1978).

Fifteen years elapsed before, in 1966, an additional statistical assessment of dental nurses' care was reported (Fulton 1951). The British General Dental Council appointed twenty-eight "independent" dentists to assess the quality of restorations placed by "New Cross dental auxiliaries". These dentists inspected 13,303 teeth restored by auxiliaries for 2,892 patients in various geographic locations. Attempts were made to obtain a representative sample, but administrative complexities precluded an ideal random approach. The method of selecting the twenty-eight dentists was not detailed. The dentists were asked to examine each restoration's surface, outline contour and edges, and note the presence of neighbouring carious lesions, when empirically assessing quality. Collectively, 91% of nurses' restorations were rated as "satisfactory" which was interpreted as a favourable endorsement of the nurses' performance. Comparative standards, based on the quality of dentists' restorations were not used (Roder 1978).

Roder's evaluation of the South Australian dental nurses programme was directed more at overall public health aspects, rather than quality of individual items of clinical care (Roder 1978). Nevertheless, inferences of quality of nurses' restorative care can be drawn. The dental nurses' programme included only primary
school children (aged from five to twelve years). Roder surveyed secondary school students who had ceased to be eligible for care from nurses about eighteen months beforehand. Students were drawn from the major secondary schools located near each primary school that had a clinic for nurses. All subjects with a history of care in the dental nurse system were examined, along with a comparison group which had never been treated in that system, and were selected at random from the same secondary schools. Of the 8,734 restored teeth in subjects who had been treated in the dental nurse system, 1.8% had a defective restoration as opposed to 2.6% for teeth in children treated only by private dentists. To be "defective" an interior wall of a cavity had to be clinically visible. The results, though based on superficial criteria, suggest that nurses can perform adequate quality of care (Roder 1978).
7.3.2 Quantity and Kind of Service

The data for the measurement of the quantity and kind of services for the following four phases shown in Table 7 were extracted through the routine dental data system of the Indian Health Service in the United States of America; the first of the four phases served as the control. Two dentists and three dental assistants operated in the standard manner. The dentists and assistants performed the function traditionally expected of them; in the Indian Health Service the assistant applies topical fluorides, does prophylaxes and takes radiographs.

Phase two served as the first test period. The dental facility was staffed by one dentist and three auxiliaries. The dentist selected was one of the two used in phase one. The auxiliaries performed the expanded duties and the routine functions of chairside and roving assistants. If necessary to make the best utilization of the available time, the dentist also was to assume the expanded duties.

The third phase served as the second test period. The same dentist who participated in the previous two phases functioned in this phase. The teams included four dental auxiliaries who performed the expanded functions in addition to the duties of chairside and roving assistants.

Phase four served as the final test period. The same dentist who staffed each study facility in the
### Table 7.

**Distribution of Services by Kind of Services by Phases of Dental Teams Using EFDA**

**Indian Health Services, U.S.A.**

<table>
<thead>
<tr>
<th>Service</th>
<th>Phase 1</th>
<th></th>
<th>Phase 2</th>
<th></th>
<th>Phase 3</th>
<th></th>
<th>Phase 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. services</td>
<td>%</td>
<td>No. services</td>
<td>%</td>
<td>No. services</td>
<td>%</td>
<td>No. services</td>
<td>%</td>
</tr>
<tr>
<td>Examination</td>
<td>2,846</td>
<td>19.6</td>
<td>5,097</td>
<td>22.3</td>
<td>5,729</td>
<td>22.9</td>
<td>6,556</td>
<td>24.8</td>
</tr>
<tr>
<td>Topical fluoride treatment</td>
<td>1,846</td>
<td>12.7</td>
<td>3,405</td>
<td>14.9</td>
<td>3,962</td>
<td>15.8</td>
<td>4,350</td>
<td>16.4</td>
</tr>
<tr>
<td>Prophylaxis</td>
<td>169</td>
<td>1.1</td>
<td>227</td>
<td>1.0</td>
<td>410</td>
<td>1.6</td>
<td>410</td>
<td>1.5</td>
</tr>
<tr>
<td>Space maintainer</td>
<td>1</td>
<td>*</td>
<td>4</td>
<td>*</td>
<td>5</td>
<td>*</td>
<td>3</td>
<td>*</td>
</tr>
<tr>
<td>Extraction (orthodontics)</td>
<td>23</td>
<td>0.1</td>
<td>52</td>
<td>0.2</td>
<td>36</td>
<td>0.1</td>
<td>23</td>
<td>0.1</td>
</tr>
<tr>
<td>Extraction (caries)</td>
<td>1,029</td>
<td>7.1</td>
<td>1,803</td>
<td>7.9</td>
<td>1,692</td>
<td>6.8</td>
<td>1,760</td>
<td>6.6</td>
</tr>
<tr>
<td>Extraction (periodontics)</td>
<td>125</td>
<td>0.9</td>
<td>302</td>
<td>1.3</td>
<td>280</td>
<td>1.1</td>
<td>727</td>
<td>1.0</td>
</tr>
<tr>
<td>Extraction (other)</td>
<td>299</td>
<td>2.0</td>
<td>503</td>
<td>2.2</td>
<td>462</td>
<td>1.8</td>
<td>605</td>
<td>2.3</td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>89</td>
<td>0.6</td>
<td>103</td>
<td>0.4</td>
<td>115</td>
<td>0.5</td>
<td>122</td>
<td>0.5</td>
</tr>
<tr>
<td>Restoration</td>
<td>7,954</td>
<td>54.9</td>
<td>11,067</td>
<td>48.5</td>
<td>11,451</td>
<td>45.8</td>
<td>11,664</td>
<td>44.2</td>
</tr>
<tr>
<td>Prosthetic unit</td>
<td>50</td>
<td>0.3</td>
<td>99</td>
<td>0.4</td>
<td>116</td>
<td>0.5</td>
<td>79</td>
<td>0.3</td>
</tr>
<tr>
<td>Periodontal treatment</td>
<td>65</td>
<td>0.4</td>
<td>117</td>
<td>0.5</td>
<td>765</td>
<td>3.1</td>
<td>621</td>
<td>2.3</td>
</tr>
<tr>
<td>Orthodontic appliance (interceptive)</td>
<td>1</td>
<td>*</td>
<td>12</td>
<td>*</td>
<td>7</td>
<td>*</td>
<td>4</td>
<td>*</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14,497</td>
<td>100.0</td>
<td>22,791</td>
<td>100.0</td>
<td>25,030</td>
<td>100.0</td>
<td>26,469</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Percentages not calculated for denominators less than ten

previous phases also participated in this one. The staff included five dental auxiliaries who performed the expanded functions in addition to the routine functions of the chairside and roving dental assistants.

The first phase included a staffing pattern of two dentists and three dental assistants, the data resulting from the activities of one dentist and one and a half dental assistants were used. The dentist at each location whose data was used for the first phase was the same one who continued and participated in the remaining three phases. In this manner, a vertical study could be established whereby the same dentists were compared with themselves in all phases. Therefore, the ability and speed of the dentist did not become a variable.

Table 7 indicates that the percentage of total services devoted to examinations increased significantly from about a fifth of the total services in phase one to about a fourth in phase four. Topical fluoride treatments, which include prophylaxes, follow a pattern similar to that of examinations, increasing from about 13% to 16%. An opposite trend exists for restorations. They decreased from about 55% of the total in phase one to about 44% in phase four. Prosthetic services show an increase between phase one and phase four (t test p = <0.05). Periodontal treatments sharply increase in phase three but also drop in phase four (Abramowitz & Berg 1973).
The clinical productivity of the New Cross dental auxiliaries in London, employed in the community dental services, has been investigated in three published studies. The first report on the experimental scheme for training and employment of dental auxiliaries (G.D.C. 1966) included an assessment of the productivity of 160 auxiliaries in 176 employment situations. The second study, published three years later in 1969, assessed the productivity of one dental officer and one auxiliary (Sutcliffe 1969). The third investigation was set up in 1976 with fourteen of the sixteen area health authorities making up the Greater London area who employed a total of fifty-five auxiliaries. A summary of the results of these three studies is given in Table 8. From this summary it can be seen that the dental auxiliaries in the 1976 study had, on average, carried out more prophylaxis per session than had auxiliaries in the other two studies. Within dentistry, there has been a trend towards preventive care and recent changes in the training course for auxiliaries have emphasised preventive aspects of their role. This trend would seem to be reflected in the greater attention given to preventive treatment items by auxiliaries in these studies (Holt & Murray 1980).

In 1980, Nasir reported on the evaluation of School Dental Nurses in the state of Kedah (Malaysia). He obtained a general picture of the delivery of dental care by dental nurses. A summary of the findings is
### Table 8.

**Comparison of Clinical Productivity, New Cross Dental Auxiliaries.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of dental</td>
<td>160</td>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>sessions included</td>
<td>171,136</td>
<td>228</td>
<td>9,430</td>
</tr>
<tr>
<td>No. of patient visits</td>
<td>5.2</td>
<td>5.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Teeth filled</td>
<td>2.09</td>
<td>1.25</td>
<td>2.12</td>
</tr>
<tr>
<td>Teeth primary</td>
<td>3.00$^3$</td>
<td>5.95</td>
<td>1.77</td>
</tr>
<tr>
<td>Teeth permanent</td>
<td>0.18</td>
<td>0.55</td>
<td>0.26</td>
</tr>
<tr>
<td>Teeth extracted</td>
<td>1.02</td>
<td>0.20</td>
<td>1.18$^3$</td>
</tr>
<tr>
<td>Operations Prophylaxes</td>
<td>?</td>
<td>1.15</td>
<td>1.61</td>
</tr>
<tr>
<td>Operations</td>
<td>?</td>
<td>9.10</td>
<td>7.76</td>
</tr>
</tbody>
</table>

$^1$Based on a 3.8 hour session.  $^2$Fillings placed.  $^3$Includes topical fluoride applications and teeth fissure sealed.

Source: Holt (1980).
presented in Table 9. The analysis of the delivery of dental care by dental therapists showed that:

(a) The dental nurses saw an average of 20 patients per day, that is, an average fourteen patients in the morning and seven patients in the afternoon;

(b) The dental nurses carried out an average of 28 operations per day. Nasir found that 23% of the total working time per day was non-productive. The remaining 77% was spent on duties the nurses were expected to perform (Nasir 1980).

The Forsyth Experiment in Boston, the United States of America, where dental hygienists were trained in local analgesia, cavity preparation and restoration procedures, is perhaps the best known study (Lobene & Kerr 1979) (Slack 1981). Of a total of 2,980 patients screened and examined for treatment by the auxiliaries, only 312 (10.5%) were not accepted because their oral disease was so severe that they could not significantly benefit from the hygienist-dental assistant team's services. Of the 2,668 patients who received a full course of treatment, forty-five per cent volunteered their opinions on whether they were satisfied with treatment. Of the 1,200 volunteered opinions, 98.6% were favourable concerning the operator's competence and 99.1% were satisfied with the quality of treatment. Only 46.3% correctly identified the therapist as a dental hygienist. Of this group 98.8% said that they would choose the same teams again. Only 1.1% stated a preference for treatment by a male
Table 9.

Dental Services Provided by
Malaysian School Dental Nurses

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous teeth restored</td>
<td>3.2</td>
</tr>
<tr>
<td>Permanent teeth restored</td>
<td>8.4</td>
</tr>
<tr>
<td>Deciduous teeth extracted</td>
<td>10.8</td>
</tr>
<tr>
<td>Examination</td>
<td>3.4</td>
</tr>
<tr>
<td>Prophylaxes</td>
<td>0.6</td>
</tr>
<tr>
<td>Topical application of fluoride solution</td>
<td>0.6</td>
</tr>
<tr>
<td>Miscellaneous treatments</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Average number of operations per day 27.6
Average number of patients per day 19.6

Source: Nasir (1980)
rather than a female (Lobene & Kerr 1979).

A study of New South Wales Dental Therapists' productivity figures would indicate a local need for 300 therapists with a ratio of 1 therapist to 2,100 of the total target population being a ratio of 1:1370 for the caries exhibiting population. These figures were considered realistic provided the number of dental assistants was raised to the ratio of 1 assistant to 1.5 therapists (Barnard 1985).
7.3.3 Cost of Care

Dunning (1972) quoted New Zealand data on direct costs of two government-financed dental programmes for school children. In the first, salaried dental nurses treated children under fourteen years of age, whereas the second programme reimbursed dentists on a fee for service basis to treat teenagers. Dunning noted that the annual cost per patient was almost 50% lower in the dental nurse system. In other words, nurses appeared to be more economical in New Zealand, had they been reimbursed in the same manner as dentists. Dunning's observations on costs were confirmed by Reding, Dewhirst, Nevitt and Snyder in a later visit to New Zealand (Roder 1978). Roder (1977) has calculated, from South Australian data, that dental nurses would be more economical than dentists. Only direct costs to a government employing agency were considered. Because dentists were educated separately, their training costs were not included; therefore, the calculations were weighted against the nurses.

Roder made direct comparisons of salaries. One eighth of the direct costs of training nurses was included in their salaries, since the prevailing annual loss rate (12½%) was consistent with an eight year span of working life. On this basis, the salaries cost per operator for teams of one dentist and seven therapists was 25-30% lower than for dentists. When calculating the dentists salaries, Roder assumed that their average
working-life span would be thirty years. He also contended that there was a division of labor between dentists and nurses in South Australia, with no duplication of effort (Roder 1978).

Lobene in the United States of America indicated that by the end of the clinical practice period, twenty-five weeks after the start of training, the hourly productivity of the hygienist dental assistant teams closely approached that of the dentist, while maintaining the high quality of completed work. Spending $2,300 for twenty-five weeks additional training, compared to about $50,000 needed to educate dentists, makes training hygienists to take over selected restorative dental procedures economically attractive (Lobene & Kerr 1979).

In 1980, Holt and Murry reported on a pilot study set up in 1976, which examined fifty-five auxiliaries (New Cross) employed in fourteen area health authorities in Greater London. An evaluation of the items of treatment provided by the group of auxiliaries during the 9,430 sessions analysed and for which a standard fee is available under the terms of the general dental services (G.D.S.) is given in Table 10, together with the mean value per session for the group of auxiliaries. Of the total value of £84,114, 75% was for teeth filled, 5% for teeth extracted and 14% for prophylaxis. The mean value per session for the items included was £8.35; the lowest value per session was £4.54 and the highest £14.04.
Table 10.

Value of Items of Treatment Provided by New Cross Dental Auxiliaries

(Value of items of treatment on G.D.S. Fee Scale, 1976)

<table>
<thead>
<tr>
<th>Diagnosis Radiographs taken</th>
<th>Treatment of Caries</th>
<th>Prevention</th>
<th>Total</th>
<th>Prophylaxes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,555</td>
<td>20,796</td>
<td>17,058</td>
<td>2,749</td>
<td>4,316</td>
<td>44,919</td>
</tr>
<tr>
<td>Total fee (£)</td>
<td>1,578.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.022.32</td>
<td>29,493.58</td>
<td>4,123.50</td>
<td>3,452.60</td>
<td>71,092.0</td>
<td>11,443.84</td>
</tr>
<tr>
<td>Fee per session (mean) (£)</td>
<td>0.13</td>
<td>3.46</td>
<td>3.00</td>
<td>0.38</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Source: Holt (1980).
The analysis of cost factors in dentistry has proved to be extremely complex and often confusing. The analysis of cost effectiveness has been defined as study to find the cheapest way of reaching a stated objective, and cost benefit analysis as an attempt to measure benefits in monetary terms and relate this value to the cost of achieving them (Burt 1977). In these terms it may be extremely difficult to find true ratios of either cost-effectiveness or cost-benefit for dental auxiliaries employed in the community dental services. In the first place, the cost of dental treatment provided by the community dental services has not been identifiable and the true cost of employing dental auxiliaries or hygienists in community services is not known. In any event, aspects of the work of auxiliaries such as the supervision they receive, would be difficult to evaluate in financial terms. However, most dental treatment provided for children in the United Kingdom is carried out under general dental services and the fee scale used by these services does provide a yardstick against which aspects of the work of auxiliaries may be measured.

In this investigation the average gross value for items included in the 1976 scale was £8.35 per session (1980). The fee scale represents a gross value which includes factors for overheads and salary. If overheads made up 50% of the total, the salary factor per session would be £4.18.
In applying the general dental services fee scale to items of treatment provided by auxiliaries it must be borne in mind that nearly all treatment provided was for children, much of it for children under the age of ten years. Although fees payable for deciduous teeth filled are lower than for permanent teeth filled in the G.D.S., because of the difference in patient management, especially amongst young children, fillings in primary teeth may take just as long to provide. This may not affect general dental practitioners insomuch as they carry out more treatment for adults than for children, but it may reduce the earning capabilities of auxiliaries working almost solely with children.

It is also significant that the mean value of £8.35 per session excludes any factor for topical fluoride applications or for fissure sealing. These two items were not included on the G.D.S. scale in 1976, but they made up 9% of the items recorded per session by the auxiliaries (Holt, Murry 1980).

McHugh (1966) in the United Kingdom, estimated that after adjusting for differences in working life span, employing dental nurses would cost the community about a third less than employing dentists. It does not follow automatically that the cost of care would be reduced; the relative productivity of dentist and dental nurses should also be considered (Roder 1978). Barmanes (1983) concluded that the therapist-based option is cheaper than that for a dentist.
8. DISCUSSION

The importance of including extended dental care as a component of national health programmes has been well recognized by the World Health Organization (1959). The planning of such programmes is an integral part of public health dentistry and requires the consideration of factors such as the dental needs of the community, the resources available to meet those needs and finally the objectives to be fulfilled in meeting these needs. Such objectives may be severely curtailed to just the relief of pain or an extraction service if only meagre resources and manpower are available; for example, in economically underdeveloped countries with few dental resources. Even populations with strong financial backing, government support and a highly trained dental profession may find that their manpower is insufficient to cope with their dental needs.

This insufficiency of manpower has caused many countries to consider the use of auxiliary personnel within the framework of the existing profession to effect an adequate dental health programme.

With a growing population, limited resources and an abundance of dental disease, countries around the world have introduced operating dental auxiliaries which have been variously named and classified according to their training and function: school dental therapist, dental therapist, dental hygienist, expanded function
dental auxiliary and denturist. We see in these countries two contrasting national systems. One national system uses operating auxiliaries within public health services; the other, an independent service, has not yet developed an effective force of these auxiliaries. The independent system uses operating auxiliaries of the hygienist type in private dental practice. The national system using operating auxiliaries has a clear definition of responsibilities in terms of age and status of population served; for example, school children. Whereas the independent system specifies only a restriction in duties. National systems not using an effective force of operating auxiliaries attempt to make dental services available to all by a national health programme using existing dental manpower.

The role of operating dental auxiliaries is clearly defined and the duties performed are appropriate to their training. The length of the training period essentially relates to the training of the operating dental auxiliary for her/his role in future practice and depends on the nature of the role. It may need more than two years of training, or at times less. Training duration should be strictly decided by the nature of the function to be performed by the dental therapist. The training curricula throughout the world are similar and they all seem to be geared towards tradition rather than practice and most of them are based on the New Zealand curriculum which is oriented more to reparative rather than preventive treatment.
Dental hygienist training is more directed towards the preventive aspects of oral health care or the public rather than restorative treatment. The role of the hygienist may be classified broadly into three categories - preventive management of adults and children, conservative periodontal therapy and chairside duties. Common duty procedures performed by hygienists include multiple preventive therapy, scaling, polishing, root planning and the taking of impressions and radiographs under the supervision of the dentist. The role of the school dental therapist (or nurses) can be described as one of improving the dental health of children through performing a limited range of restorative and preventive procedures under the supervision of the dentist. Their responsibility varies with each country.

In New Zealand the school dental nurse was primarily employed within the School Dental Service which is an integral part of the National Dental Health System. It is the aim of the School Dental Service to improve the health of pre-school and school children by giving them systematic care every six months. Preventive as well as restorative work is part of this endeavour. The dental nurse is under the general control of the principal dental officer, who checks clinical work at random and deals with any specific queries and referrals by the dental nurse.

The aims of the Australian programme are, in the first instance, the control of existing dental disease
by treatment and more importantly, the prevention of
disease by fluoride therapy and by the education of
children towards patterns of behaviour that are favourable
to good dental health.

The school dental service in South Australia
concentrates its resources on the primary school
population and attempts to inculcate lasting and desirable
dental practices in the children. The presence of
clinics in the schools should ensure that, during the
child's formative years, favourable dental habits are
an integral part of his learning environment. Children
are accessible on a daily basis if necessary, and the
therapist is able to form a close association with her
patients outside of the treatment situation.

The dental nurse in Malaysia is considered as a
member of a team and an auxiliary to the qualified dental
officer, to free him from tedious routine work and allow
him to devote his time to more complicated professional
work. She remains under the professional control and
supervision of the dental officer, which should as far
as possible be direct supervision, but this may not
always be possible. The principle that supervision
should be as close as possible is adopted so that every
completed case is checked by the dental officer and the
fact recorded on the patient treatment card.

In the United Kingdom the dental nurse (therapist)
is only permitted to work within the local authority,
school dental services or hospital services, which are
a part of the National Health Service. They are not
permitted to work in general dental practice. Unlike New Zealand there is no overall standardisation for the use of auxiliaries throughout the United Kingdom; local authorities and principal dental officer exercising a degree of autonomy in utilization or non-utilization of auxiliary personnel.

Especially in North America, auxiliaries carry out certain restricted reversible restorative procedures on patients. In particular they are taught to undertake such procedures as placing rubber dams and restoring with amalgam, and other pastic filling material, teeth that have had cavities prepared by a dentist. These types are called expanded function dental auxiliaries.

Dental plaque is an essential etiologic factor for caries and gingivitis. Judging from experiments in humans gingivitis, periodontitis and caries can be satisfactorily controlled when plaque is effectively removed. It is however, difficult to obtain proper oral hygiene especially in children. Caries is the predominant oral health problem among children and adolescents. Even with the presence of plaque, substantial caries prevention has been observed in children taking part in controlled trials as well as those involved in public health programmees with local fluoride applications. These preventive programmes have been used in the public dental health services for Scandinavian children.

Several countries have shown dramatic improvement in the oral health of people resident in areas with
natural and artificial fluoridation. These changes in the pattern of oral health are bound to have serious implications for dental manpower development like operating dental auxiliaries, general dental practice, and the form of education that future generations in dental practice undergo. Many of these measures, tested alone under good conditions, have been found to give improvement and reductions in dental caries. Tooth-brushing, dental flossing for plaque removal, oral rinsing with fluoride solutions, the reduction of refined carbohydrate intake, and the selection of carbohydrate for most rapid oral clearance all improve the oral environment markedly. Topical fluoride therapy raises the resistance of enamel and dentine surfaces to caries attack. Among measures affecting development of teeth, water fluoridation is by far the best from a practical standpoint. Fluoride application to the individual by an operating auxiliary, hygienist or dental therapist, can be easily carried out in the community as well as in school service programmes and has proved to be effective.

The school children are usually an accessible and receptive population, but it is difficult to reach substantial numbers of adults with dental community preventive programmes, unless these are focussed on special groups such as employees in a particular office, store or factory. Dental disease starts and tends to progress most rapidly in children, and as a result they
are the most important and susceptible segment of population and the principal focus of almost every community dental programme.

In addition to fluoridation measures, dental health education, palliative emergency treatment, preventive measures, case finding through dental inspection and other means, and referral to other sources of treatment can be provided by operating dental auxiliaries through the school dental health programme. Community programmes in which various preventive and therapeutic measures are combined, have been tested in various parts of the world. The great potential of mechanical plaque removal for almost complete prevention of caries and gingivitis can be realized by operating dental auxiliaries and these programmes can be cost effective. It seems however, that a remarkable degree of dedication by both the subjects and operating dental auxiliaries is necessary for these regimens to be fully effective.
9. CONCLUSIONS

Utilization of operating dental auxiliary personnel is necessary for the provision of adequate oral health services to meet social demands. These services can only be successfully implemented in an environment with economically and politically acceptable health policy support.

Priorities for the use of operating dental auxiliaries must be based on objectives that have been set down for the provision of oral health services for the community.

Major factors predisposing the introduction of operating dental auxiliaries are shortage of dental manpower, lack of money and equipment, poorly distributed services and increase in prevalence of dental disease, especially in developing countries.

Chronic periodontal disease is very common in developing countries and dental caries is on the increase. Operating dental auxiliaries are used and will continue to be useful in prevention and control of these dental diseases.

There are many types of operating dental auxiliaries trained and used throughout the world:

1. In 1981 there were 9,540 school dental therapists (New Zealand type school dental nurses) used in thirty-five countries; 1,785 in Yugoslavia, 1,178 in New Zealand, 1,000 in Cuba and 847 in Australia.
They are employed to carry out curative, preventive and educational dental care for school children.

2. In 1981 there were 74,539 dental hygienists used in forty-two countries, with the United States of America having 46,000, Canada 3,126, Poland 1,843, the United Kingdom 1,100 and India 820. They are employed to carry out preventive procedures, including dental health education, scaling and prophylaxis of teeth.

Control of the operating dental auxiliaries scope of services has been undertaken through legislation.

The operating dental auxiliaries perform their duties under control and supervision of a dentist, with the exception of denturists.

Operating dental auxiliaries are able to provide, at a high standard, curative and preventive services for which they have been trained.

Operating dental auxiliaries can be quickly trained and utilized, at a reduced cost, for limited duties that are confined to priority target groups.

From the results of studies designed to determine the productivity of utilization of operating dental auxiliaries it can be concluded that:

1. Operating dental auxiliaries are able to provide dental care of acceptable quality.

2. The ability to increase the amount of service provided can greatly help to improve the oral health status of a community.
3. The efficient utilization of operating dental auxiliaries will result in decreased costs and increased productivity for the community.

School dental programmes that include treatment and prevention have long been recognized as truly effective dental public care systems for provision of dental services for school age children.

Potential advantages of a school dental programme utilizing operating dental auxiliaries include:

1. Guaranteed provision of comprehensive care on a continuous periodic basis.

2. Access for all children regardless of their family's income, educational level or social-cultural beliefs.

3. Operation in a familiar (and thereby less threatening) educational environment.

4. Facilitation of quality control by supervision of a dental officer.

5. Increased cost effectiveness for services provided.
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