THE UNIVERSITY OF SYDNEY

COPYRIGHT AND USE OF THIS THESIS

This thesis must be used in accordance with the provisions of the Copyright Act 1968.

Reproduction of material protected by copyright may be an infringement of copyright and copyright owners may be entitled to take legal action against persons who infringe their copyright.

Section 51 (2) of the Copyright Act permits an authorized officer of a university library or archives to provide a copy (by communication or otherwise) of an unpublished thesis kept in the library or archives, to a person who satisfies the authorized officer that he or she requires the reproduction for the purposes of research or study.

The Copyright Act grants the creator of a work a number of moral rights, specifically the right of attribution, the right against false attribution and the right of integrity.

You may infringe the author's moral rights if you:

- fail to acknowledge the author of this thesis if you quote sections from the work
- attribute this thesis to another author
- subject this thesis to derogatory treatment which may prejudice the author's reputation

For further information contact the University's Copyright Service.

sydney.edu.au/copyright

OBSERVATIONS ON ORAL HEALTH AND THE ORAL CARE SYSTEM

C.E.TAYLOR

M.D.Sc.
1983

Some observations on aetiological and epidemiological parameters of oral health, diseases and conditions and their use in planning and systems analysis for a just oral care system.

by

Catherine E. Taylor B.D.S., M.H.P.(Univ.of N.S.W.)

UNIVERSITY
OF SYDNEY
DENTAL LIBRARY

A thesis submitted in partial
requirement for the degree of
Master of Dental Science

DEPARTMENT OF PREVENTIVE DENTISTRY UNIVERSITY OF SYDNEY

October, 1983

ACKNOWLEDGEMENTS

I wish to acknowledge the inspiration and encouragement given by Professor N.D. Martin, the co-operation and time in discussion by Professor P.D. Barnard. Also the other members of the Preventive Dentistry Department of the University of Sydney, and my international dental colleagues who alerted my thoughts to the many problems involved in analysing the oral care system and helped me to place them in this written form.

TABLE OF CONTENTS

		Page
i.	Acknowledgements	ii
ii.	Index	iii
1	INTRODUCTION	1
2	CONCEPTS OF PLANNING	6
	2.1 Theories of planning	11
	2.2 Reasons for planning	13
	2.3 Applications to the health care system	14
	2.4 Planning methodology	19
	2.5 System analysis	21
3	CONCEPTS OF HEALTH	35
	3.1 Health care	38
	3.1.1 Justice - collective solutions or individual responsibility	40
	3.1.2 Public health and a health ethic	43
	3.2 Oral health and problems to oral health	45
	3.3 The value of oral health and oral health care	48
	3.3.1 Economic	54
	3.3.2 Individual	55
	3.3.3 Community	55
4	ORAL DISEASES AND CONDITIONS: Observations on some aetiological and epidemiological factors contributing to oral health status	58
	4.1 Dental caries	63
	4.2 Periodontal disease	92
	4.3 Dento-facial anomalies	105
	4.4 Cleft lip and cleft palate	108
	4.5 Diseases and conditions of the oral mucosa	111
	4.5.1 Pre-cancer and oral cancer	115
	4.6 Defects of teeth	118
	4.7 Disorders of bone	121
	4.8 Defects and impairment of function: disability and handicap	122
	4.8.1 Dysfunction of the masticatory system	123
	4.8.2 Aging	125
	4.8.3 Communication disorders	131
	4.8.4 Head and neck surgery and trauma	133
	4.8.5 The dying patient	134
	4.8.6 Chronically ill and handicapped persons	135
5	CONCEPTS OF NEED FOR ORAL HEALTH CARE	140
	5.1 Need and demand	141
	5.1.1 Normative need	142
	5.1.2 Felt need	143
	5.1.3 Expressed need or demand	145
	5.1.4 Comparative need	147
	5.2 Oral health indices	155
	5.2.1 Periodontal indices	157
	5.2.2 Dental caries indices	164
	5.2.3 Malocclusion indices	168
	5.2.4 Malocclusion and dento-facial anomalies	172
	5.2.5 Combined indices of need for treatment	173

Page

5.3 Use of estimates of need for oral health care 174

6 THE ORAL HEALTH CARE SYSTEM.....183
6.1 Status/Intervention Index.....188
6.2 Formal pattern system.....190
6.2.1 The purpose of the activity (F1).....190
6.2.2 The performers of the activity (F2).....193
6.2.3 The environmental form (F3).....196
6.3 System description - intervention 197
6.3.1 The purpose of the activity (F1) 197
6.3.2 F1-F2 relationship.....198
6.3.2.1 Description of promotional and preventive practices.....198
6.3.2.2 Description of therapeutic practice ...200
6.3.3 Further description of performers .....202 (consumer/provider) (F2 I and II)
6.3.3.1 Consumers of the activity 202
6.3.3.2 Providers of the activity 206
6.3.3.3 Environmental form.....223
6.4 Factors influencing the system.....228
6.5 Use of oral care services 235

7 DISCUSSION 237

8 CONCLUSION 243

9 BIBLIOGRAPHY 246

LIST OF TABLES

		Page
Table 1:	Some reported Australian studies on malocclusion	109
Table 2:	Utilization behavour patterns for health care	144
Table 3:	Model for oral health status	191
Table 4:	Status/intervention in oral health	192
Table 5:	Oral care in terms of status intervention	194
Table 6:	Status intervention and therapeutic care	201
Table 7:	Oral morbidity	204
Table 8:	Oral care system description	225
Table 9:	Oral care system description - Australia	225

LIST OF FIGURES

Page

Figure 1: Simplified model of public health system 18

Figure 2: Hierarchy of planning goals 20

Figure 3: Operating system model 24

Figure 4: Constraints on the administrative process in a programme system 33

Figure 5: Stages of the planning process 34

Figure 6: Schematic model of factors affecting motivation for oral care 53

Figure 7: Interrelationship of factors affecting dental caries.....65

Figure 8: Factors relevant to dental caries.....67

Figure 9: Interrelationship of major factors in the resistance to caries 67

Figure 10: Schema of the mechanism of post-eruptive, metabolic, effect of various factors on teeth 73

Figure 11: Food factors and their effect on caries post-eruptively.....74

Figure 12: Factors in the relationship between eating and caries.....75

Figure 13: Concepts of need and demand 148

Figure 14: Caries prevalence at 12 years.....176

Figure 15: General components of oral care system 186

Figure 16: The process component as intervention strategy 186

Figure 17: Health service system factors.....189

Figure 18: Model of relationship between the individual and social systems 233

Figure 19: Model of stages in the health care process 234

Figure 20: Model of analysis of medical care process 234

Figure 21: Evaluation model for oral care systems.....240

1 INTRODUCTION

In 1977 the Thirtieth World Health Assembly resolved that the main social target of governments and the World Health Organization in the coming decades should be "the attainment by all citizens of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life". (30) The constitution of the World Health Organization (448) and many Health Assembly resolutions has re-affirmed that health is a basic human right and a world-wide social goal, and that it is essential to the satisfaction of basic human needs and the quality of life. Doctrines that have been enunciated by World Health Organization member states embody a number of fundamental principles for health development. Among these are the responsibility of governments for the health of their people; the right and duty of people individually and collectively to participate in the development of their health; the duty of governments and the health professions to provide the public with relevant information on health matters so that people can assume greater responsibility for their own health; the inter-dependence of individuals, communities and countries based on their common concern for health; more equitable distribution of health resources within and among countries, including their preferential allocation to those in greatest social need, so that the health system adequately covers all the population; emphasis on preventive measures integrated with curative, rehabilitative and environmental measures; the pursuit of relevant biomedical health service research and the speedy application of research findings; the application of appropriate technology through well-defined health programmes, integrated into country-wide health systems, based on primary health care and incorporating the above concepts; the social orientation of health workers of all categories to serve people and their technical training to provide people with the services planned for them. (460a) Australia, as a participating member of the World Health Organization, has taken part in the formulation of these principles and has been a signatory to the resolutions. (85a) A national health policy is an expression of goals, and the main directions in attaining them. A national strategy should be based on a national health policy and establishes the broad lines of action required in all sectors to give effect to that policy. A national

plan of action is a broad intersectoral master plan for attaining the national health goals through implementation of the strategy and is a framework within which detailed programming, budgeting, implementation and evaluation can take place. (460a)

Signatories to the World Health Assembly Resolution of Health for all by year 2000 have enunciated a concomitant goal of oral health for all by the year 2000. (30) Australia, at State and Federal levels, should be following a national strategy to work towards the expressed oral health goal. (85a, 280b, 321a) Part of a national strategy is to identify and make use of all favourable conditions and factors, as well as to recognize conditions and identify existing and potential obstacles that could impede attainment of national goals. The overall social goal of health for all has to be expressed in more concrete social policies aimed at the improvement of the quality of life and maximum health benefits to all. (460a) As suggested by the World Health Organization (460a) a national plan of action implements a national strategy which is based on policy. Australia does not yet have such a formalized plan. (21, 75e, 85a, 280b, 321a)

Planning activities occur in response to some form of dissatisfaction with the end result of the operating process or as a response to exogenous forces which impinge on the operating system. (350a) This dissatisfaction is expressed as an inconsistency with the normative notions of the planner or as non-optimization of the objective function.

The dissatisfaction can take a number of forms; for example, the mix of outputs is wrong, the quantity is insufficient, the distribution of output is wrong, the quality is inadequate, wrong people are making the decisions, there is a wrong ratio of inputs to outputs. The dissatisfaction and rightness and wrongness will be influenced by one's concept of how much social justice prevails.

If planning is to be based on the needs of a population rather than demand, and integrated at each level with social and political values and priorities, it requires an information system that will adequately inform decision-makers. That is, provide information that will allow choices between alternatives to be made on as rational a

basis as possible. The just community allocates the human good or means to it in accordance with valid claims. (147a)

The primary requisite for planning in the oral care system is to establish that there is an oral health problem in the community and that there is dissatisfaction with the intervention intended to answer that problem; that is with the oral health care system.

The goal of oral health for all (30) embodies the principle of the development of health. Before being able to set forth any plan of action to work towards such a goal, it is necessary to examine what is meant by health. How does our society define health?

In looking at this question of our concept of health in the light of our professed goal, one must also ask the question: Oral health - who cares?! This then raises the concept of social justice. Does social justice prevail? This can only be ascertained by an examination of the health care system. As a concept of justice entails the understanding of dispersion of equality and fairness by rule of reason and rationality (312a), society has a role to seek justice in the common interest of all and to adjust the good we wish to procure for all to the needs and merits of each person. (312a)

A tool which can be used to make this adjustment, is planning, for planning has as its raison d'etre rationality and reasonableness, equality and fairness, in that it is formalized measurement of these concepts.

Formalized planning has not been used to the fullest extent in the health field. (21, 40, 44) If social justice is to prevail, formalized planning needs to be implemented. One reason why this tool has not been used by governments is that the area of the problem, in this case oral health, has not been formally described in such a way that planning methodology can be fully utilized accordingly to examine the oral health problem in order to understand how it can fit into our theories of planning and social justice. We need to describe (a) the causes and manifestations of diseases and conditions which are hazardous to oral health;

(b) the ways and means used to measure these diseases and conditions;
(c) the system used by society which takes care of this problem.

This will be done by examining the reported literature in these areas and particular account will be taken of this problem, with a global perspective, relating also the Australian community where reports are available.

It is necessary however to firstly examine the theories of planning and how they relate to the field of health and health care.

2 CONCEPTS OF PLANNING

2.1 Theories of planning

2.2 Reasons for planning

2.3 Applications to the health care system

2.4 Planning methodology

2.5 System analysis

"Administration is the process by which knowledge, energies and social structures are systematically meshed to achieve agreed-upon goals. In our society government, community groups and individuals at various levels come together to try to achieve agreed-upon goals, that is, they administer our social systems."(365a) This may be in a formal and/or informal way. The growth of formalization of this administrative process has occurred as our society has become more complex and the need for social organization has been recognized in order that we cope with developments of population growth, industrialization and urbanization. There has been an increase in awareness that social problems - those involving our social and physical environment - are highly complex and interrelated. Yet, too often, they have been defined and dealt with in an overly fragmented way.

"The lack of social planning at the national level and the differing rates of change in social institutions, has created social gaps between the purpose of some institutions and the degree to which they are effective in satisfying human needs." (70)

The overall goal of health care is to make a positive change in the health of an individual or community. This is a form of social intervention.

Since health programmes are among the most useful and expensive investments a community can make in the well-being of its members, their expert administration is properly a matter of social concern. Inadequacies in a society's administration of agreed-upon goals can be detrimental to the community interest and can determine the extent to which social justice prevails.

The administrative process has two functional components. A planning function and a management function. The planning function "involves analysing the problems to be dealt with, deciding on the appropriate solutions, determining the intervention technology .... fixing programme objectives, and projecting future actions." (365a)

The management function consists of "procuring, arranging and applying human, material and informational resources according to priorities derived from planning." (365a)

Administration, in both its planning and management functions, makes use of the processes of communication and decision making, the latter being highly dependent on evaluation. (365a) Planning is the administrative instrument that provides a rational basis for decision making. (175) It is a process, not an event. It is the first phase of the administrative process which also covers organization, opinion and evaluation. The purpose of planning is to "rationalize" the activities on which planning is imposed, also to make subject to calculation what was previously left to chance; to organize what was previously unorganized; to replace spontaneous adjustment with deliberate control. (4c, 18a) Planning involves conceiving future states of affairs and ways to get there. It is therefore just one function in the process of decision making. (127)

The reasons for introducing the concept of planning into the service sector of the economy are to publicly change and oversee the provision of services, to determine how resources are to be allocated, and to establish responsibility for reorganization and identification of a desired framework, (12) in order to ensure that social justice prevails. The community cannot afford to leave its strength at the mercy of the purchasing public, that is, to make the apparatus of production solely dependent upon the law of demand.

A need for more sophisticated methods of management has proceeded from intensified competition, growth in size and the complexity of organizations and from an accelerating rate of technological change. (337) Consequently, an increased use of scientific management has developed. Long range planning has emerged as a systematic formalized process in which organizational aims are defined and long term strategies are determined after considering alternatives. Strategies are expressed as long term plans with specified quantitative objectives and possible subjective constraints. Responsibilities for implementing individual programmes are assigned to organisational units with specified budgets and predetermined standards are used as a basis for control. Continuous evaluation

enables a comparison of performance with standards and periodic appraisal facilitates a revision of long term plans and appropriate future plans. Increasingly, policy decisions and assessment of performance and control are being based on scientific information rather than on incidental observations and suppositions. (365a) Schaeffer defines planning as "an orderly process of defining a problem through analyses, identifying the unmet needs and demands that constitute the problem, establishing realistic and feasible goals, deciding on their priority, surveying the resources needed to achieve them and projecting administrative action based on the weighing of alternative intervention strategies for solving the problem ...." "planning is a process, when successful it produces a product - a plan that can be put into effect." (365b)

If one defines planning as the administrative instrument that provides a rational basis for decision making, (175) it can be an optimizing process. Hall (175) states that formal techniques achieve their real impact by helping people to perceive their problems more adequately; by facilitating exact communication and by providing a basic structure of rationality and objectivity as a background to the interplay of personalities and power groups in management. Quantitative techniques provide a clearer basis for dialogue and discussion of priorities than can be achieved by intuitive methods. Planning can help rationalize decisions, reduce waste, provide a fairer distribution of resources and contribute to social justice. The role of the planner is seen as that of a catalyst, able to demonstrate the disadvantages of the status quo and the need to set out in new directions. (175)

Planning without political support, however, is no more than an academic exercise and politics without planning is usually irrelevant to the needs and aspirations of society. (175b) Planning explores the uncertainties of how the best use can be made of limited resources to meet priority needs. It is a dynamic process, an unending spiral of incremental efforts towards improvements. It is also an education process, in that it modifies public attitudes and demonstrates areas of deficiency requiring attention. Some problems encountered with health planning include unclear and conflicting expectations held for planning, the involvement of political power as well as technical

expertise. (12) Another problem is that powerful incentives or sanctions are needed to overcome resistance to planned change. (127)

The way in which planning decisions are made and the outcome depends upon characteristics of the system being planned for, the socio-political environment, the type of problem to be solved and the "decision making style of the country or the community." (365)

2.1 Theories of Planning

Four styles of planning can be elaborated upon, according to Schaeffer: (365)

1. Centralized national economic planning. This is found in countries with highly integrated political systems, limited distribution of power to non-government institutions. The value system is oriented to the development of the community as a whole, rather than particular individual groups or organizations.
2. Economic allocation planning. This seeks to achieve the best use of resources and is used in countries where there are diverse and numerous socio-economic interests which are strongly influenced and motivated by government, but not fully controlled by it. This type of planning makes choices amongst policy alternatives.
3. Ideological or advocacy planning. This is concerned with improving the position of certain groups within the community. It involves identification of the groups and their needs and interests. Usually reliable information for basing decisions on is lacking, and goals are vague and usually evolve, rather than are set.
4. Interest-adjustive planning. This has prevailed in countries with a plurality of interest groups who organize on a "market" basis. The central or sectional planning mechanism is weak. Observable planning is short-range and is divided among many organizations. Planning usually consists of resolving conflicts and differences among value preferences and goals of various interest groups.

Different planning systems imply different planning procedures and techniques, as well as differences in how the problems are identified and how the analyses are organized. Four broad approaches to planning methodology can be differentiated: (448a)

1. Deductive planning. The broad policies are set out by a central authority (e.g. ministry) and details are also worked out centrally and standards are accordingly normative. That is, they are developed by experts derived from the current experience.
2. Inductive planning. Local experiences, services and practices are identified and efforts are made to co-ordinate and consolidate, so that greater benefits are more widely available or improvements are made on what is already available, so that the overall services

will be improved and one must know the overall goals and detailed actions, otherwise the planning can be aimless.

3. Impressionistic planning. This is *ad hoc* professional and institutional decision making. Decisions are made on the basis of experience, pressures, minimal information and rough estimates of needs and possibilities, both intuitive and political.

4. Idealistic planning. Aims are stated in ideals, actions by exhortation and there are no precise objectives or programmes.

Most planning is a combination of the above approaches.

Eight different planning modes have been described by Blum: (61)

1. *Laissezfaire* - no planning. The core of this approach is the competitive market, which is supposed to provide the consumer with a number of alternatives from which to choose and to encourage greater efficiency and consumer orientation on the part of the suppliers. The question one can ask about this approach is whether there is a true competitive market and how competent is the consumer to choose, or do they really choose between alternatives?

2. Disjointed Incrementation - minimal planning. This approach is a pragmatic one which involves making relatively small improvements based on a comparison of a limited number of concrete programme alternatives. By taking only small steps, decision makers have an opportunity to evaluate programme results and test political acceptance. Goal decisions are resolved in the pluralistic competition among private interests and the pressure they put on public decision makers.

Blum comments as follows: (61)

(a) an individual has limited problem-solving capabilities;

(b) there is a lack of comprehensive information on which to base decisions on cost comparisons;

(c) the unlimited nature of alternatives and the openness of system variables;

(d) the inability to construct a satisfactory method for evaluating values or goals

3. Allocative Mode - minimal planning for the present or the near future. A maximal marginal gain is to be achieved with given resources available and the limitations perceived. There is a continuous overview of the problem so that its current status can be compared with

other problems and with that of its past and decisions can be made at the margins.

This is a short-range approach and has a need for early warning procedures so that adjustments can be made. It needs anticipatory techniques so that technological and structural solutions can be implemented, usually by careful budgetary balancing.

4. Articulated and Guided Incrementalism with Problem Solving - planning for present or near future. This involves an analysis of the problems as systems and then interventions are designed which are then selected for efficacy and compatability with larger sectoral goals. Small steps are taken on a resource allocation basis with continued updating. This approach tries to avoid undesired side-effects and also tries to modify the larger system enough to control the problem.

5. Exploitive Mode - planning the future. This takes advantage of forecastable situations in a way that allows goals to be reached at a level of costs not otherwise possible. The avoidance of some problems and the cashing-in on others without major concern for the emergence of new problems. This is only concerned with the probability of prophecies and is not alert to system implications.

6. Explorative Mode - planning for future. This approach involves the exploration of possible future trends from current trends, capacities and expectations and resources. Resources are allocated according to what is seen as the feasible future. It is adaptive and output-oriented. There is a need for predictive technique and it is generally slow-moving and costly. It works from what could be, by extending the present.

7. Normative Mode - planning for future. This approach is entirely based on forecasting and works back from chosen goals of what ought to be. It tries to match outcomes to desires. There is generally widespread involvement and hence it is slow-moving. The mode is output-oriented in an innovative way.

8. Total Planning Mode - planning for all activities, present and future. Decisions are made on the future according to the specific goals desired and all resources are organized. It is directed to output and forces actions to fit the proposed systems. Usually it is fairly prompt and direct effects are widespread and fairly controlled.

Blum outlines the terms in current usage to compare the planning modes under the dominant themes above: (61c)

(a) Adaptation: is there a balance of present and/or past orientation?
(b) What is the future interventive orientation?
(c) Is it idealistic or value promoting, as well as having a future orientation?
(d) What client or participative orientation is present?
(e) How is control oriented?
(f) What time span is mooted?
(g) How is the implementation to be achieved?
(h) What are the boundaries used?

By looking at the planning modes under these orientations, one can attempt to formalize an evaluation of different planning modes. In analysing a problem one can take four different approaches:

i Reference protection (where one continues on as in the past).
ii Advanced reference projection (exploratory).
iii Wishful projection (normative).
iv Planning projection (estimation of how far our planning can take us towards (iii) and away from (i) and (ii).

The size of the gaps between (iii) and (ii) or (i) provides a quick review of what are likely to be the largest or most painful problems. (61b)

Another relevant dimension to consider when planning is that of the time scale typified by the distinction between long, medium and short term planning. This can be defined as follows: (175, p. 38)

Short term - concerned with using resources currently available to meet problems already in evidence.

Medium range - concerned with trends and problems that can be foreseen and with resources likely to be available in the light of these trends.

Long term - concerned with deliberate attempts to intervent to alter such trends as can be modified and with finding acceptable means for the achievement of broadly desirable ends.

The significant difference between short and long term planning lies not in the time scale involved, but in the extent to which presently forseeable trends can be modified. The time dimension also relates to uncertainty, hence to the extent to which it is sensible to think in terms of optimization (in the short term) or the adoption of robust policies (in view of long term uncertainties).

2.2 Reasons for Planning

Health services are essentially social services and society accepts some responsibility for their availability and performance. They serve the needs of the ill, seek to prevent disease and set goals for the maintenance and promotion of health. They can be defined as purposeful processes in which health care personnel and other resources are organized and financed with varying degrees of formality and they strive to meet the health needs of the community.

In modern society these concerns have developed recognizable relationships which have been described as a health service system. The system is one of many service systems which have emerged to facilitate the attainment of health and quality of life in the individual and in the community.

There is widespread belief that better management of health care is essential if social justice is to prevail and higher standards of health care and, concomitantly, health are to be achieved. The following are typical of symptoms demonstrating the need for better management and the use of the tool of planning within the health service sector of the community. (45)

(a) Overlapping, conflicting and competing organizations within the "health system".
(b) Widely scattered funding mechanisms with little control over costs.
(c) Decisions on the mixture of facilities and services without reference to population needs and with no information about those who do not use the service - management being based on currently met demand, not need.
(d) No formal description and measurement of community needs, resources, expectations, priorities of concern.

There is a "need for a health plan within the context of, and in harmony with, national socio-economic development, with stated policies and definitions of aims and objectives with established priorities inside the health system which take into account the essential needs of the population and the available resources (human, material and financial) and with provision for public acceptance and participation and political endorsement." (455a) This need for planning is a response to increasing evidence of the effect of one being upon another.

2.3 Applications to the Health Care System

The health care system has been defined as the "mechanism that transforms a society's resources (knowledge, personnel, capital) into special services aimed at meeting the society's health problems. It includes all of the society's institutions, activities and efforts related to the health of its people."

If we take the existence of the health care system for granted and concentrate on the problem of adopting and changing this system in order to improve its performance, we are trying to "manage" the system. This involves planning, as planning formalizes the managerial process. It is necessary in planning to determine the characteristics for the values, goals and objectives underlying the political setting of the health system. One can consider these characteristics as follows. Firstly, health as a societal value. This is maximal when society takes full financial and organizational responsibility for health promoting and health care services. Secondly, collectivism as opposed to individualism. The extent of individual and group tolerance to regulations and guidance. This is minimal when all health and health care are viewed as problems of the individual unless they pose a direct threat to society. Thirdly, the distribution of responsibility. This is maximal when every citizen is eligible in theory and practice to the same standards of health care and health promotion and there are no barriers to utilization of service. Alternatively, this is negligible when no influence is exerted on the distribution of resources and services. (175d)

The health care system has both static and dynamic elements. Previously, the tendency has been to concentrate on the static or material elements (e.g. dentist:population ratios, numbers of decayed teeth) because they are tangible and can be easily expressed in terms of numbers to the detriment of the dynamic elements (e.g. policy making, decision-making processes, standards of performance, outcomes) and their relationships to social and political theory. (175c)

As planning is a tool that provides a rational basis for decision making, its application to the health care system is such that it can facilitate analysis of the dynamic elements which make up this system.

By analysing both the static and dynamic elements of the system (previously traditionally only the static elements were studied), there will be a more accurate analysis of the totality of the factors acting on the health of the individual and the community.

Purola (324) describes the policy and decision making process as follows (see Figure 1).

There are complex relationships between decision makers at political and administrative levels which are central regulatory mechanisms at the macro level; regulators at the micro level are providers of services, and then there are the individual decision makers in their search for health care.

Health and its relative value to the individual and to the community is a dynamic concept. The intervention by society in this dynamic process to achieve positive change occurs by many pathways and decisions are continually being made as to which pathway to take.

This "choice between alternatives" is variously made using methods ranging from scientific research to individual subjective judgement. (455b) The appropriate mixture depends upon the difficulty of reaching a decision in the particular case and this is synonymous with uncertainty. Uncertainty can be regarded as of three basic kinds:

1. uncertainty regarding the effects likely to result from the alternatives under consideration (leading to demands for surveys or research),

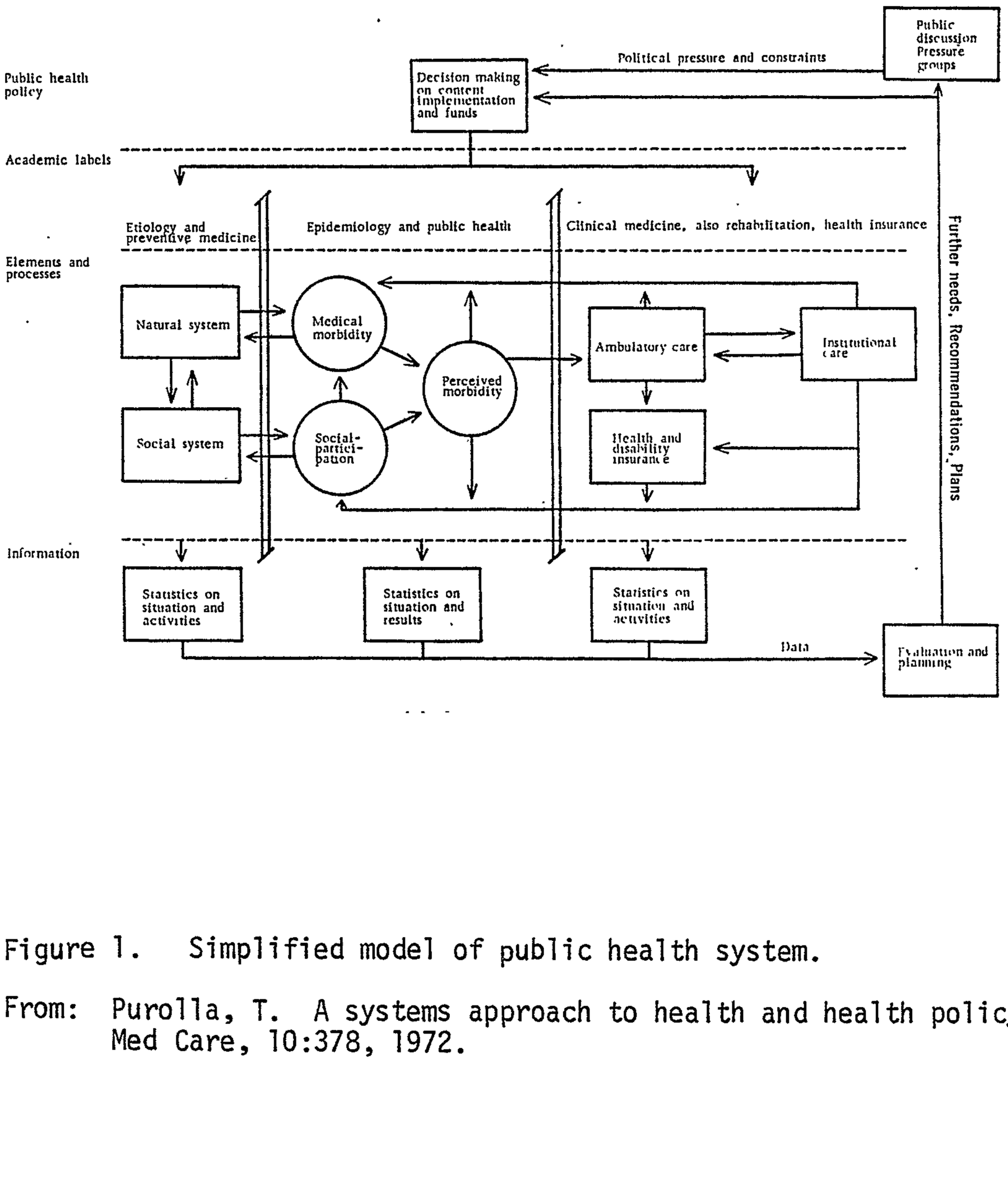

Figure 1. Simplified model of public health system.

From: Purolla, T. A systems approach to health and health policy. Med Care, 10:378, 1972.

2. uncertainty as to values to be attached to effects of the alternatives (leading to requests for policies, guidance or political procedures),
3. uncertainty regarding other decisions that will have to be made now or at some future time (leading to demands for planning). (455b)

Techniques available for reducing the first kind of uncertainties are statistical analysis of data and forecasting, epidemiological and sociological surveys, field experiments and controlled trials, simulation studies, and input/output techniques.

The second kind of techniques include cost-benefit analysis and cost-effectiveness; linear programming. However, the real pressure on a managerial environment is with the relationship with other decisions. This is where co-ordination and planning is important. Formal co-ordination procedures are PPBS (planning programming and budgeting system) and network analysis.

As the health care system has been defined as a "transforming mechanism", it necessarily has a large component of decision making involving uncertainties. Hence one can understand that formal techniques for reducing uncertainties can achieve their real impact by helping people to perceive their problems more adequately; by facilitating exact communication and by providing a basic structure of rationality and objectivity as a background to the interplay of transforming mechanism which makes up the health care system.

2.4 Planning Methodology

On the basis of a hierarchy of goals, planning has three phases: policy planning, programme planning, and operational planning. (474) (See Figure 2)

Health Policy Planning

This is the development of long and medium term goals, considering alternative future health developments in the society and the financial limitations. One then outlines a set of regulating principles.

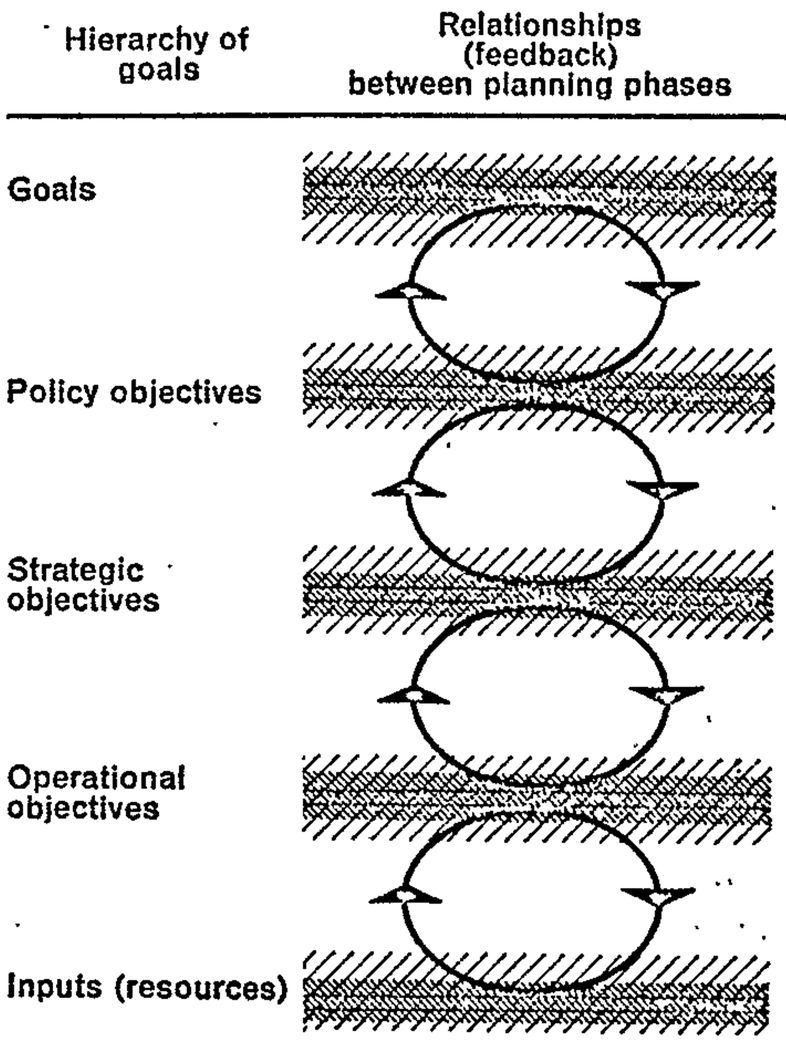

Figure 2. Hierachy of planning goals.

From: World Health Organization. Application of systems analysis to health management. Report of a WHO expert committee. Geneva, WHO Tech Rep Ser No.596, 1976.

Health Programme Planning

The aim is to select from alternative health strategies those that can achieve medium term objectives consistent with the values and the norms of society and where goals are defined in the policy plan.

Health strategies are courses of action based on specific techniques and resources and permitting the achievement of one or more strategic objectives. An analysis of the feasibility of alternatives to determine those compatible with other developmental objectives of society leads to the formation of a health programme. This is a timed series of service activities requiring physical human and financial resources for the implementation of a selected health strategy.

Operational Health Planning

This is specific and localized. It deals with services and projects focusing on the specification and implementation of objectives. This whole planning process has been illustrated. (see Figure 2) (474)

2.5 System Analysis

Throughout the world there is increasing awareness that social problems are highly complex and inter-related, yet all too often these problems have been defined and dealt with in an overly-fragmented way. Technological specialization, fostering inefficiency, has enlarged the scope and comprehensiveness of the health system and hence its social effectiveness. The applications of general systems theory to the health system is a way to make a comprehensive analysis of social problems and can help to determine the extent to which social justice prevails in the attainment and maintenance of oral health.

System Analysis refers to a general process of analysing and explaining inter-related elements that constitute a system whole.(365d) Traditionally, the major tool used to acquire knowledge and analysis has been the scientific method which proceeds by breaking problems into even smaller parts and then studying these intensively. This "partitioned" approach led to an explosive growth of knowledge and technology but it has also had far-reaching social repercussions. As science has become highly specialized and fragmented, this has been

mirrored and magnified in the professions and technologies whose task it is to apply science to individual and social problems. However when one acknowledges that the ultimate goal of professionals and their technology is to approach health and the total person as part of a community, different patterns of thinking emerge from these differing professional orientations. Communications are not understood - the problem to be solved is perceived differently, key features are disputed, each specialized group sees the problem and possible solutions in their own frame of reference. The utility of a systems approach is in its inherent ability to define relationships among separated parts. It describes, analyses and discusses the nature of things in comparatively few general terms, also making possible a common basic language among people working in many different fields, permitting people to use analogies in their reasoning with a high probability that analogies will be valid for their own particular situation.

The classic definition by Von Bertalanffy (429) of a system is that a system consists of "elements standing in interaction" - "a set of elements so related that a change in the state of any element induces changes in the state of other elements."

Summary of Basic System Concepts (365e)

A person describing a system sets the level of the system to suit the problem they are attempting to solve. A system's composition depends on the problem to be solved on the objectives of the analysis, i.e.,

"1. Interactions (interdependent relationships) must exist for a system to exist (or be hypothesized).
2. A system is greater than the sum of its parts since it consists of interactions among its elements as well as the elements themselves.
3. A system may appear to be less than the sum of its parts or some of the latter belonging simultaneously to another system.
4. When an element belongs to more than one system, its state in one system may be altered by a change in its state in another system.
5. The state of the system is a function of the state of its elements and of their interaction with each other and the system's environment.

6. Any system that is in interchange with its environment is an open system.
7. The primary forms of interchange between a system and its environment are the receipt of inputs and the provision of outputs. The latter may be positively valued goods and services or negatively side effects.
8. Forces from the environment that condition the system - its inputs, the way it functions and the way its outputs are treated - are called external constraints.
9. The capacity of a system to adapt to changes in the environment is limited by its need to maintain a steady state (homeostasis). This accounts for many of the systems internal constraints.
10. The level and composition of the system or subsystems or supersystem to be studied are selected by the analyst to suit the problem at hand." (365c)

Social systems are those based on interactions and interdependent relations amongst members of a population. The health system is an open system. It interacts with the environment and depends on the environment for inputs and exists in most cases to produce outputs for consumers in the environment. Health and health-related functions are distributed among a number of agencies. The co-ordination of such a system results from the way in which each essentially independent subsystem reacts to the actions of other subsystems. In societies where the private sector is large, the health system takes a loose form of a "market". In centralized societies, health systems may be under the control of a unitary authority and subject to its policies. Between these two extremes, the health system is autonomous or semi-independent: organized into either "federations" or "confederations" - federations being where only certain specified functions are distributed to a central regulating unit. A confederation is when the subsystem has greater autonomy and the central entity functions more as a secretariat, rather than as an authority. Figure 3 (338) is offered as an aid to the conceptualization of an operating system, with terms defined.

Systems analysis provides well organized information, an analysis of alternatives and a method of evaluating the consequences of decision making practices. (337)

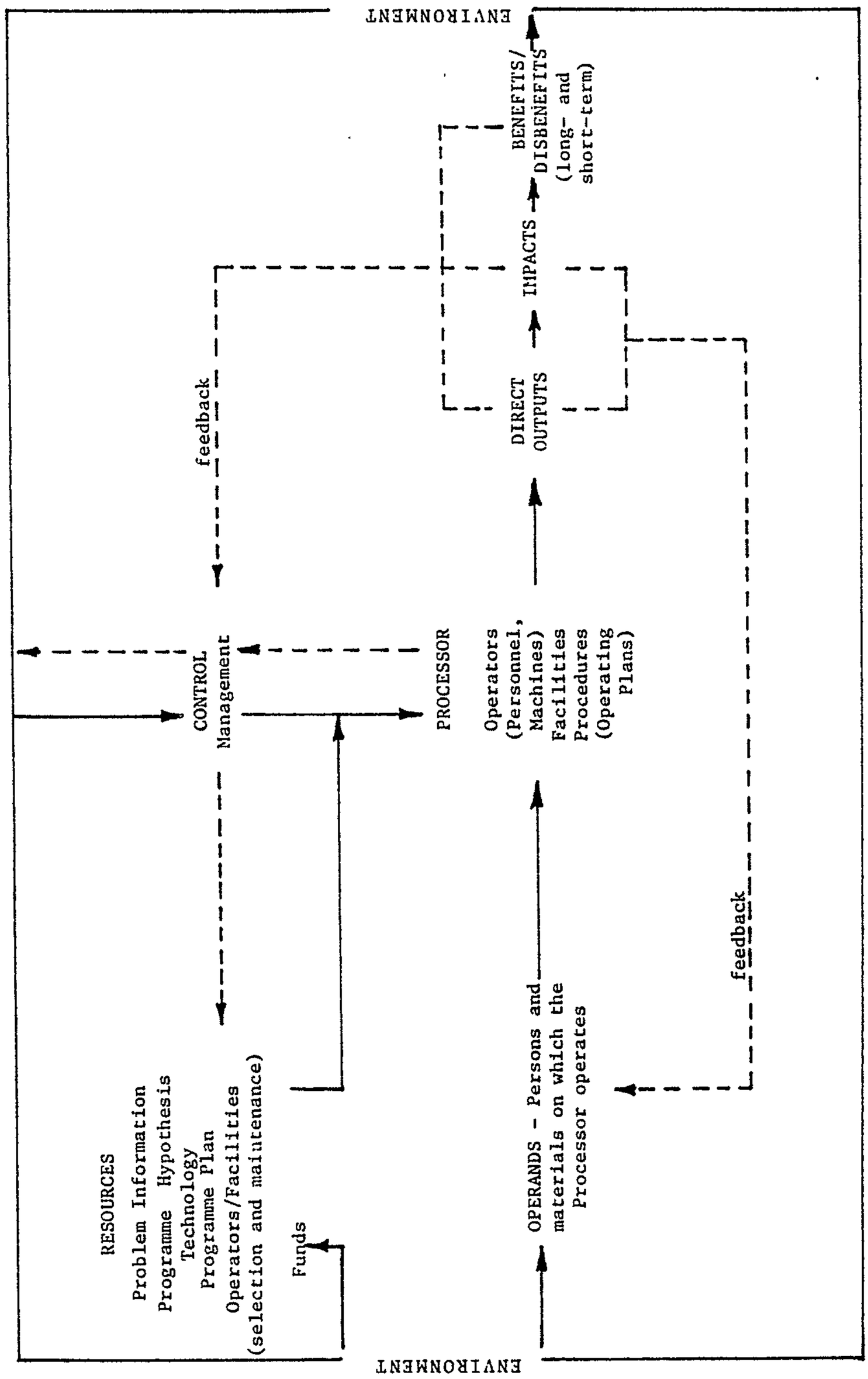

Figure 3. Operating system model.

From: Schaefer, M. Administration of environmental health programmes; A systems view. Geneva, WHO, 1974. p.162.

The use of administrative systems theory is the progressive substitution of rule and discipline method for instinct and guesswork. (365g) However, the decision maker's choice of strategy will depend on the alternatives perceived and assessment of outcomes that might result. This assessment involves the valuation placed on various outcomes and the likelihood that given strategies will produce particular outcomes.

In system analysis the following steps are necessary: (338)

1. Identification of elements of the system, e.g. characteristics and health needs of inhabitants served by the system, the existing workforce, facilities and organisational base plus the underlying laws, regulations, practices and procedures.
2. Establish interrelationships, e.g. roles analysed in relation to the health needs in the particular situation under investigation, it also relates to the financial organizational and logistical constraints existing.
3. Relationships between health officials, politicians, health agencies, other agencies need to be portrayed.
4. Statement of goals: this is required to guide the system defined in terms of operations that will have been realized when the goals are attained.
5. Development of an analytical model plus a graphic description of the system and its subsystems.
6. Consideration of possible modifications of the system using clearly defined criteria for evaluation, i.e. assessment of alternatives.
7. Selection of an improved set of relationships.

Various observations (175e, 365h) can be made concerning the application of systems theory to the health field. The way a problem is identified determines the nature of its solution. The quality of decision making and evaluation can determine the system's potency and effectiveness. Frequently interventions in the health field do not solve problems directly, but rather enable the individuals and groups concerned to solve them.

Health systems do not produce "health" as such, but produce a service whose impact on health is indirect: if the service is not

utilized at the time and place it is available, it cannot, unlike a physical product, be 'stored' for later use. (455a) There is a lack of knowledge as to the extent to which health care delivery services contribute to health.

Health services often improve the status of health indirectly by influencing the biological and behavioural processes of people, singly or in groups. This often requires programme activities that seek to modify both the human environment and the biology and behaviour of people.

Organized personal and environmental health services are only a part of the factors influencing the biological and behavioural processes of individuals and communities. "Geographical and climatic factors, urban and rural situations, local customs and beliefs, socio-economic conditions and stages of development not only are more powerful determinants of biology and behaviour than organized health services, but frequently constrain what health care services are provided, how they work and the efforts they can achieve." (365i)

The reasons for the applicability of the systems approach to oral care planning can be summarised as follows. Oral care is in a state of change. The traditional curative dentist-delivered services are being challenged and new approaches are being sought in repsonse to a number of converging developments. These are:

1. The cost to the public in terms of expensive equipment, salaries, materials, e.g. cost of the school dental service.
2. Preventive techniques of proven effectiveness, e.g. fluoridation.
3. A growing awareness of the multiplicity of disciplines, e.g. health education, social sciences, computers, research, which can contribute to solutions, e.g. behavioural science research.
4. The recognition of the relationship between the social and physical environment and the human responses to it - i.e. the cultural background and its effect on health status, e.g. the International Collaborative Study of Dental Manpower Systems in Relation to Oral Health Status, sponsored by the World Health Organization and the United States Public Health Service.
5. Better scientific knowledge and the use of evaluation techniques

with firmer measurement criteria being used to analyse current and future programmes, e.g. cost-benefit analysis.

6. Knowledge already available needs to be codified to improve provision of services, e.g. the records of oral care services insurance system and records of oral care providers.
7. Challenges are being made as to who is to deliver oral care and whether it is to be directed or supervised, e.g. dental prosthetists and dental therapists.

A comprehensive approach is needed to conceptualize and plan (245) rather than the traditional segmented approach. One is operating in a context charged with political and economic conflict, and, in any such context, the goals of health may receive secondary or minor attention. There is a "need for a set of descriptions and analyses which have been rationally arrived at, openly debated and commonly understood, in order to create a more functional relationship over time among the various participants in and components of the medical care system." (387) This need applies also to the oral care system. (30)

The use of the project systems analysis approach may contribute to oral health planning and management as:

1. The health sector is perceived as a system (448a) because
   a) its internal organization and processes are seen as system elements.
   b) its relationship with the larger social system (socio-economic and political) are defined.
   c) its interrelationships with other sectors (e.g. education) are viewed as interactions amongst subsystems of society.
2. Health is a variable,subject to multiple causation with roots in other systems.
3. Use can be made of interdisciplinary planning teams and socio-economic effects on health may be delineated.
4. The systems analysis approach views health planning as a sub-system of health sector management.
5. It is a means of changing one or more elements of the health system from an existing state to a desired state by the use of planning, and allows model building and simulation techniques.(448a)

The following pre-requisites are necessary before a planning process can occur. Leadership and community readiness for, and commitment to change, enabling legislation for planning and subsequent plan implementation and the administrative capacity and willingness to implement the plan.

Comprehensive planning for national health systems is a relatively recent phenomena. Prior to the 20th Century, government intervention was deemed appropriate only in respect of illness and conditions that presented distinct and proven hazards to public health, e.g. epidemics. Since the end of the Second World War the government participation in the provision of health care has increased. (108) The cost demand spiral has confronted policy makers with increasingly complex choices and the need for orderly incisive planning is becoming obvious. The elaboration of planning mechanisms is now widespread. Leadership in stimulating this development has been taken by the World Health Organization, both centrally (175, 365, 448a, 451, 455, 460) and regionally. (238)

The techniques that different Australian states have undertaken are varied but they have usually focused on efforts to co-ordinate with other branches of government and other organizations (e.g. the Australian Dental Advisory Council contains representatives of Federal and State governments, the Australian Dental Association and universities) and have involved provision for guidelines for action at regional and local levels. The recognized difficulty with this process is that it usually is more effective in reinforcing the status quo than in promoting change; normative guidelines dealing with constraints on personal standards tend to be created by the experience of the 1950's rather than the needs of the 1980's.

Both planning and management are utterly dependent on relevant up-to-date information about what is going on in the existing health care systems. Despite deceptively impressive volumes of statistics generated by those systems, such information is now largely lacking (21, 44, 85, 459a)

Effective health planning requires a combination of quantitative data, acceptable conceptual models, clearly expressed objectives,

explicitly stated policies and responsible decision making.

Staticians and mathematicians, operational researchers, systems analysts, planners, policy makers and administrators all have a vested interest in and responsibility for the health services available to the populations they serve. The most important factor in health planning is thus the administrative link between these various groups. The constructive application of information in planning involves data collection, analysis, interpretation and use. Independence and objectivity must characterise the first two functions and feasibility and policy orientation the second two. Statistics for use in health planning and evaluation need to be problem oriented, population based and related to persons and events. Traditionally health statistics, in contrast to vital statistics, have tended to be activity-oriented and institution based. The development of statistical systems that make possible the identification and measurement of perceived and professionally defined needs and the evaluation of the effectiveness of health services in relation to these needs is not a simple matter.

Linking these measures with efficiency of health care processes, and all of them with social and environmental indicators, makes the task more complicated. Health information systems should have the following requirements [448a]:

The system should be population based and problem orientated. It should be able to detect and assess the significance of developments and changes in the situation. The information should be collected in a uniform manner, consistent with the statistical system. The terms used must be functional and operational and express the information briefly yet imaginatively. Also provision must be made for feedback of data.

One example of information gathered by the oral care delivery system is statistics regarding the number of fillings done and the number of patient visits. [15a] This information does little or nothing to identify the systems problems, e.g. the repair rate of restorations, whether the rate of progression of dental caries has increased or decreased, the quality of services delivered, incipient

changes in disease patterns, e.g. disease prevalence in non-users of services. Progressive planning and management hinges first on information on system effectiveness. Conceptual work on systems to provide evaluative data is advancing [455] and research is being carried out in a number of countries to test these theories. [459] Indicators, indices and monitoring techniques are being developed, e.g. periodontal disease index, periodontal treatment needs index [457]. These are important, as they not only monitor what is going on in the health care system, but they monitor what is going on in the general population, much of which is not in contact with the system. A need has been expressed to identify the population's state of health and also its satisfaction with its state of health, i.e. the social context in which policies and practices can be designed. [84]

Health is an important part of socio-economic development. Development planning is primarily conducted within an economic framework and uses economic concepts because decisions and choices are made about how resources are to be used.

"Economics is a system for defining choices and the challenge is to define choices that are attainable in the sense that they are compatible with national goals and maximize the social benefits at any given social and economic cost level." [175a]

Choice can be a political act and can change over time, and thus necessitates frequent adjustment to plans. However, choice in the health sector also has economic implications in that priority given to health care has resource implications, since it means some other sector will receive fewer resources, i.e. there are opportunity costs.

Also because there is an absence of a well-defined relationship between health outcomes and health services, planning is open to the possibility of much error.

Consumers of health care make decisions based on very imperfect knowledge and are influenced to an inordinate extent by the opinions of the suppliers. Individuals can also modify their own health independently of the provision of health care. There is a growing

awareness that the ability of people to utilize health resources is almost limitless and yet there is a limit to the resources that can be devoted to health. There is therefore a need to plan and develop programmes that are directed to overcoming the most significant health problems in the most efficient and effective manner. In the area of oral health, the need for planning is particularly important as virtually everyone needs access to oral care, yet this care is limited and choices have to be made.

Planning provides a rational administrative instrument to aid in this decision making. Health planning occurs at three levels in a country through national health policy formulation, national/regional health programme planning and finally, health project formulation. (459c) It occurs explicitly by formalized planning procedures and implicitly by a continuous process of allocation of resources by governments, organizations and individuals.

The planning process involves the identification and analysis of problems, the identificationof needs and resources, the formulation of alternative options, the selection of appropriate solutions by establishment of realistic and feasible priority goals and the determination of technical methods to be used. This is by setting administrative actions required to meet the goals and by defining programme objectives and future action to be taken. Planning needs to be spelled out by programming. That is detailing allocation of tasks and resources and detailing the implementation of specific objectives within a given time.

Planning for a positive change in health is part of a systematic co-ordinated process for the utilization of the countries' resources for formulating and achieving social goals and development. (448a)

In a social system such as the health care system, there are many constraints*, most of which have to be accepted and the system functions within the limits they set. However some may be able to be modified gradually.

---

*constraint: factor that permits, facilitates or retards change and affects the functioning of the system. (448a)

A model describing the constraints on the administrative process in a programme system has been developed. (see Figure 4)

External constraints of a decision to reduce or confine a programme may both influence the problem the programme is trying to solve but also affect the state of the health system. They may change in character and intensity in response to the behaviour of the system itself.

Internal constraints (e.g. the existence or absence of information on which to base evaluation, quantity or quality of programme staff, existing organizational structures) must be either accepted as limitations on the system, or be changed over time. A definition of external and internal constraints and the limits they impose on the system over time need to be continually reviewed.

As planning is a process of intervention by means of planning policies into the activities of an operational system, the system definition should be reviewed to determine the realitive needs for intervention and the need to set priorities for action. Criteria need to be established for problem selection before problem definition. (448a) Once the problem most in need of intervention is determined the planner can formulate objectives.

The situational analysis describing the community profile needs to be placed alongside a model conceptualizing the oral care system. These can then be interrelated and the interactions formally analyzed.

The stages of the planning process can be expressed as shown in Figure 5.

The first step in the planning process is a system definition. Given the objectives of identifying and resolving or decreasing the oral health problems is of prime concern, it is useful to think of the planning area in terms of the oral care system. This then requires a carefully constructed situational analysis describing the community profile which of necessity should begin with what our concept of health entails.

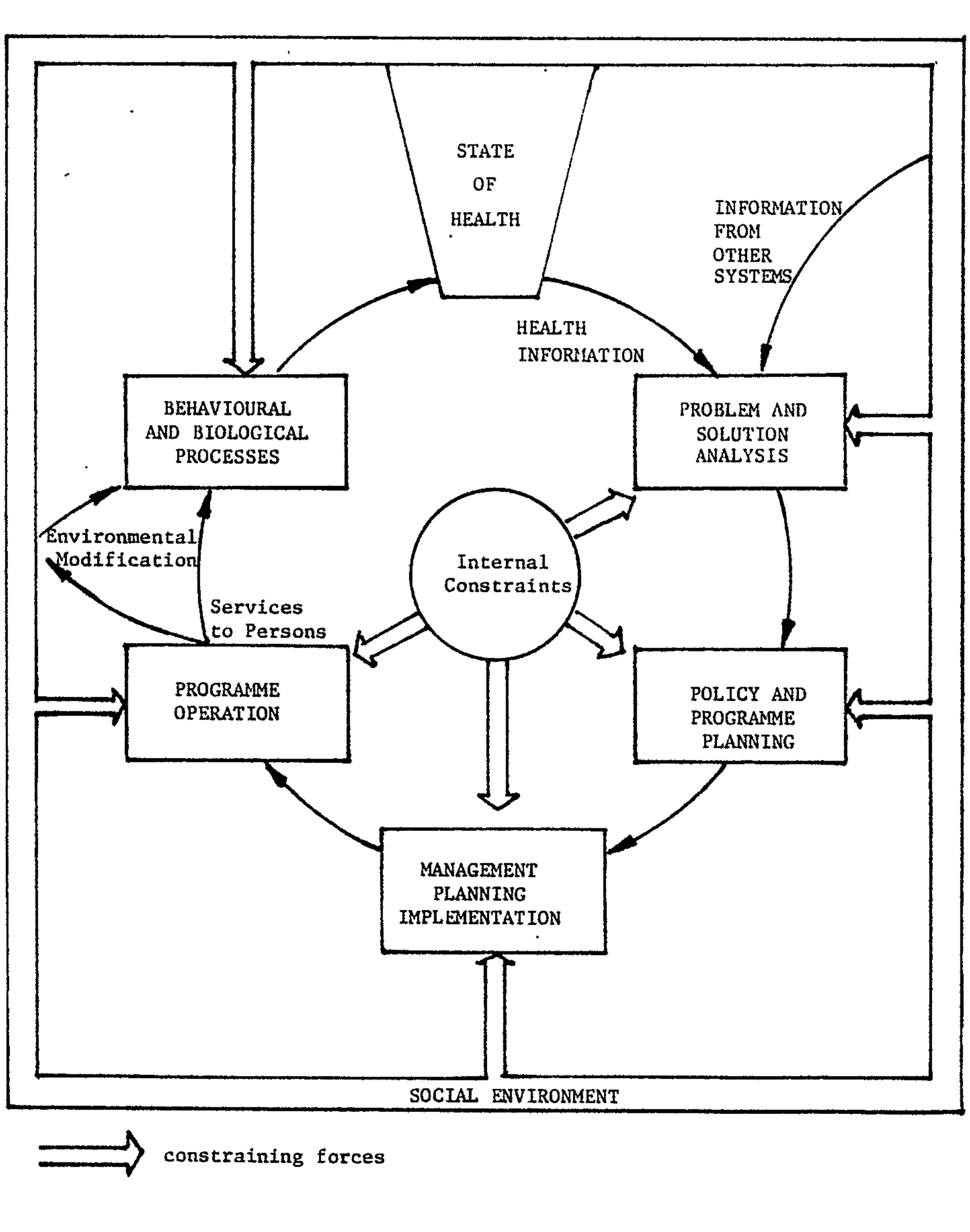

Figure 4. Constraints on the administrative process in a programme system.

From: Schaefer, M. Administration of environmental health programmes; A systems view. Geneva, WHO, Public Health Pap No.59, 1974. p.103.

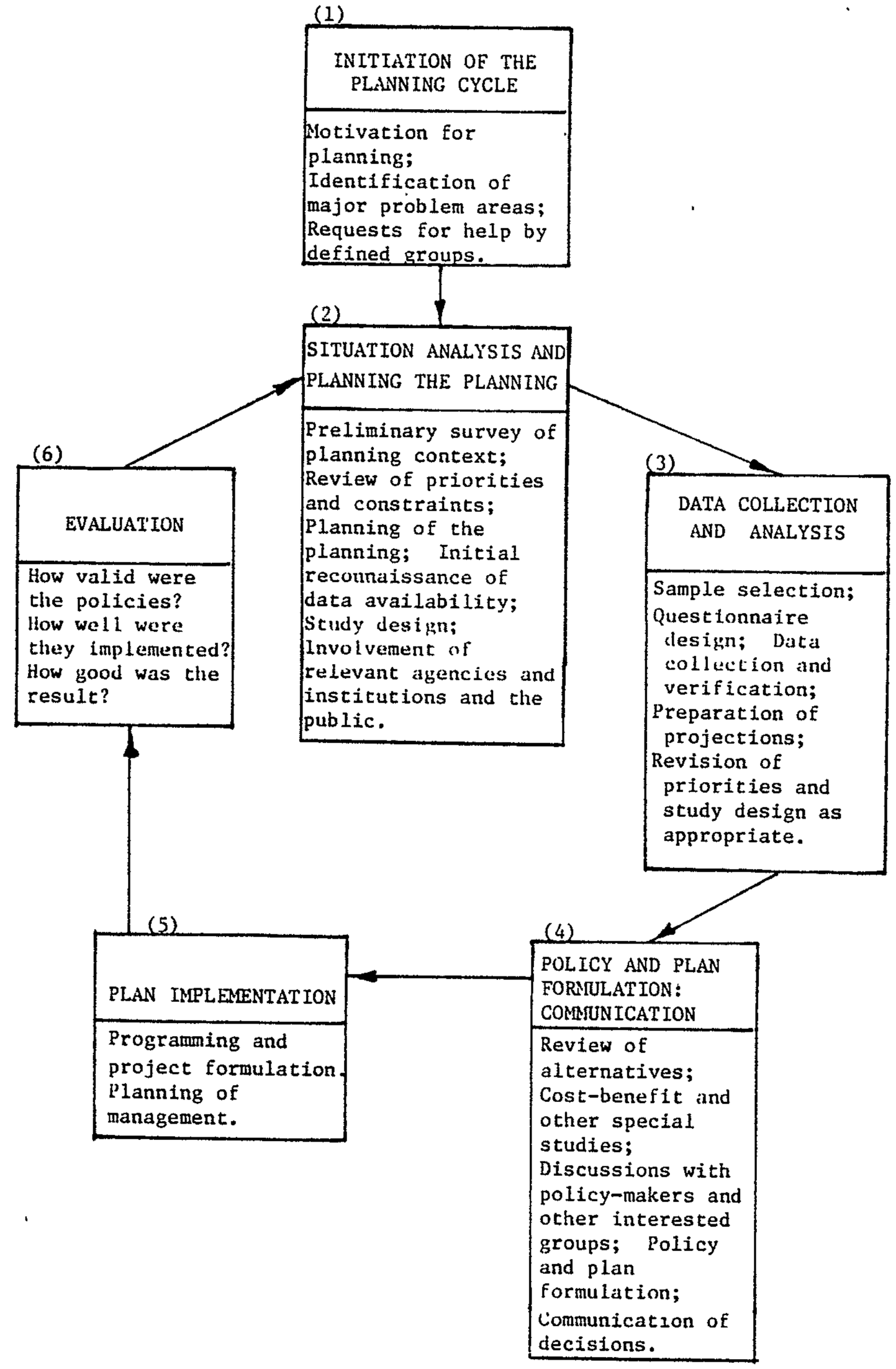

Figure 5. Stages of the planning process.

From: Hall, T. L. and Mejia, A., editors. Health manpower planning : principles, methods, issues. Geneva, WHO, 1978. p.106.

3 CONCEPTS OF HEALTH

- 3.1 Health care
  - 3.1.1 Justice- collective solutions or individual responsibility
  - 3.1.2 Public health and a health ethic
- 3.2 Oral Health and problems to oral health
- 3.3 The value of oral health and oral health care
  - 3.3.1 Economic
  - 3.3.2 Individual
  - 3.3.3 Community

"The concept of health is an evolving one that depends on the level of economic development, individual income, the standard of prevention, health education and on the styles of social and cultural organization. Moreover, health is a subjective notion linked to the degree of tolerance exhibited by each individual and by each society"(88).

If one looks at the various concepts of health which people have written about, one finds that the above statement has a particular ring of clarity.

Furthering this concept of health as being an evolving one and of adjustment to the society, Cornillot (88) describes health as "a dynamic equilibrium, evolutionary in nature and permanently combining genetic potential adaptive capacities against a multitude of attacks from external sources." The health concept is being replaced by the concept of the "compensated state of dynamic equilibrium". In the "state of compensation the organism has the physiological possibility of incorporating an attack or a pathological element in a psychological unit so that this deviation from the normal state can be circumscribed and causes no imbalance perceived by the patient as a pathological state." Thus the notion of compensation is part of the concept of health and the "organism's tolerance is expressed physiologically in relation to a great many physical and psychical attacks. Therefore health is the reflection of the capacity for tolerance compensation and adaptation. Conversely, transition to a pathological state is indicative of an imbalance or decompensation representing the last straw which breaks the camel's back. When this happens the organism is no longer capable of limiting a pathological evolution." (88)
Galen, a Graeco-Roman physician, expressed this idea of health as a sort of "harmony" with a very wide range and not existing to the same extent in everyone. (120) Rossdale discussed health as a harmonized relationship between man and his ecology, or the product of the dissonance between man and his physical environment - the world and his social environment - the society. (351)

By defining health as a relative concept, a condition or quality of the human organism expressing the "adequate" functioning of the organism in given conditions, both genetic and environmental - the concept of health being a degree of conformity to accepted standards is introduced. The acceptance of the above assumption means that health is defined differently in different communities because it is so subjective. This is in contrast to the World Health Organization's definition of health as a "state of complete balance and integration of physical, mental and social components of a state of wellness." (447) The concept of health is subjective in that it is based not on any objective biomedical or socio-economic criteria, but rather, "Health appears as a physical, psychological, mental and social state of tolerance and compensation outside the limits of which any situation is perceived by the individual and/or its environment as the manifestation of a morbid state." (120) This perception or expectation both by the individual and/or the society of a relative, rather than an absolute, state, raises the question of the significance that each individual attaches to its existence and to that of others. Also how the community then defines the concept of relative health, what criteria are used, and by whom, to set the standards which are used to describe whether the adaptation is successful or not. These standards are ever-changing and are linked with both the expectations of the professionals and those of the general public and also of other interests in the community.

The emergence of the socio-economic dimension in the health concept has facilitated its "politicisation", or, rather, has now openly shown the interests involved of those defining the standards and criteria to be used in a relative description of health. The social situation and economic value of each individual depends directly on its "maintaining a state of health compatible with a recognized socio-economic activity." (287) This socio-economic assessment of the value of each life has repercussed on the availability and allocation of resources to the community for the objective assessment of each individual's state of health and for services to maintain a certain state of health.

Siegman (391) has said that health definitions are products of theoretically or pragmatically derived formulations developed from the current context of the societies' health problems and the capacity

of the society to solve them. This further backs up the view that defining 'what is health' is subject to what one's perceptions are of one's self and one's environment and how one adapts to the other. Doyall [118] has stated that to be relevant to human conditions the concept of adaptability must incorporate the needs of day-to-day existence, subject to the limitations and requirements created by desire to preserve the past and modified by anticipations for the future. This concept of modification by anticipation for the future brings up the expressed view that is represented by a resolution that people have a right to health as they perceive it: It is the responsibility of governments to see that all people have a right to services which maintain their health. [448] However what this basically means is that firstly, health is defined by certain groups and they define what they see as society's health problems: secondly, these problems can be solved, i.e. by services offering health care and promotion of group value systems.

3.1 Health care

The concept of a "right to health" carries with it the responsibility that health is no longer defined by special groups but by government, and government now has a social responsibility to promote health and prevent hazards to health, e.g. disease. The community, by expounding the view that everyone has a right to health, does not, however, offer the means of making this right attainable, as they do not state that everyone has a right to health *care*. Laws may in time affirm an individual's right to health services and social supports, but they cannot guarantee health. This embraces many considerations, including an individual's choice of behaviour and life style. For the vast majority of people in society, the life circumstances leading to poor health are not adopted as a matter of personal choice, but are thrust upon people by the social and economic circumstances into which they are born. [280]

Siegman [391] states that the general consumer's conceptualization of health is one of adequate functioning and is derived from criteria relevant to physical activity levels, performance of activities of daily living, psychological conformation, degree of absence of pain and other symptoms, health producing behaviour and informational feedback from the health care system.

Siegman [391] also states that health is viewed as a stock which requires maintenance and protection, as well as repair. Demand for health is differentiated from demand for health care, the latter being one of market inputs into the individual's "production function" for health.

Lerner [244] has stated that even though life is a continuum, human beings subjectively attribute different weights to various points along that continuum and the weight varies according to cultural factors and value systems and is therefore socially defined. The relative weights accorded to each component vary in the problems facing that society at a given moment in its historical development, and with the extent to which any society anywhere has ever met those challenges. [78] The same reasoning is applicable to individuals within society with regard to an index of health status; the components are the same to everyone but weights assigned to a component might vary according to the problems facing that individual, and the best that any individual in similar circumstances has done in solving those problems.

Both this idea of the community weighting and individual weighting of values introduces the idea of solving the problem of reaching a certain level of health. The idea of health care is introduced into this formulation as a way of attaining health. Health care has the potential for improving health status. The idea of weighting of values brings forward the community's and the individual's idea of what to expect which has now become enunciated as a right. It is regarded as a social right within society and is an extension of the community's responsibility for the sick and the infirm.

Growing government expenditure in the health care area illustrates the scale of social demand in this field. [308] People making the policies have noted this growth in expenditure and suggested that this should be constrained and the notions of choice and rationalization have been introduced. [21] These are discrete forms of restriction on the right to health according to social or economic criteria. This new form of hold over health, illness and life of other people represents a form of power which can come into violent conflict with power traditionally wielded and claimed by doctors. There is a temptation that those responsible for the socio-economic side of the

health sector will define health by health care available from mainly a utilitarian or even a political standpoint. (288)

By their very nature, investments in the health care system promote or restrict the actual quality of life imposed on different categories of individuals who are not themselves capable of ensuring their own physical, mental or social independence.

In Australia it is recognised that everyone has a right to health, but since no national policy defining what acceptable standards are to be applied for the assessment of health status has been formulated, this so-called "right to health" is meaningless.

3.1.1 Justice - collective solutions or individual responsibility

This brings up the issue of justice - in the broadest sense, this justice means that each person in society ought to receive their due and that the burdens and benefits of society should be fairly and equitably distributed. (223, 312a)

But what criteria should be followed in the allocation of burdens and benefits? - what end or goal should receive the highest priority? The answers are found in prevailing theories of models of justice. (147a, 223) In most countries these models form the foundation of the country's politics, public policy in general and health policy. These models of justice furnish a framework or organisation of the goals and a blueprint of how to think about and react to the problems the public raises concerning society and whether public and collective solutions are necessitated, or whether individual repsonsiblity should prevail. Justice is linked directly to the sphere of collective existence - societies. Its application requires knowledge and the ability to surmise what is possible within a given situation.

In social systems, discrepancies between what is thought to be both desirable and realistically possible and present levels of performance provide motivation for the formulation and implementation of social policy and initiate remedial action. (243a)

The dominant models of justice in Australian experience have been market justice. Under norms of market justice people are entitled

only to those valued ends such as health that they have acquired by what are considered to be fair rules of entitlement, i.e. by their own individual efforts and abilities. Market justice emphasises individual responsibility, minimal collective action and freedom from collective obligations except to respect other persons' overt fundamental rights. (96) As s society, pure market justice has been compromised in many ways to protect the public's health.

The primary duty still rests with the individual. Radical individualism inherent in the market model encourages us to think only in terms of behaviour rather than in terms of the social forces helping to produce that behaviour. (46) These social forces include norms sanctioning media advertising and eating sweet snack foods. Since the person is free not to eat these foods, the norms of market justice force the conclusion that the individual voluntarily chooses this action and we are prevented from taking strong collective action against the powerful structures encouraging this so-called voluntary, but deleterious, behaviour. (46)

Market ethics also obstruct the possibility for minimizing oral diseases and alibis the need for structural change in attitudes to oral health. It encourages victim blaming. Victim blaming mis-defines structural and collective problems of the whole society as individual problems, seeing these problems as caused by the behavioural failures or deficiencies of the victims, i.e. the individual. These behavioural explanations protect the larger society and powerful interests from the burdens of collective action and encourage attempts to change the faulty behaviour of victims.

Market justice is perhaps a major cause for our over-investment and over-confidence in curative services. Prejudice found in market justice against collection perverts scientific advances into an unrealistic hope for quick solutions from technology rather than envouraging the necessary social change.

Market models of justice encourage us to see problems as due primarily to the failure of individual practitioners, i.e. the individuals themselves or the external provider, and their quality of care, rather than the possibility of failure from the structure of

health care itself. Consequently, we seek to remedy problems by trying to change individual providers through appeals to their ethical sensibilities, or by reshaping their education, or by creating new financial incentives. The vast expansion of government in health policy might seem to signal the demise of the market ethic for health; however most public policy for health continues to define health as health care and thus as a consumption of goods, rather than as planning for structural changes to minimise hazards to health. (279) These goods are allocated by reactive decisions to market forces. The only way in which this type of government policy interferes with the market ethic for health is by subsidising it with public money. It supplements the market system when deficiencies are such that public concern can no longer be ignored. Examples of this within the oral care area are dentures for pensioner patients, school dental service, education of professionals oriented around individualised curative services. Even the government's national health insurance used a public financing mechanism to subsidise private markets in the expectation that curative health services would be more equitably distributed. (45)

Our current efforts to reform the so-called health system are little more than the use of public authority to perpetuate essentially private mechanisms for allocating curative health services.

Public health measures such as fluoridation are isolated exceptions to the norm of market justice. The norm still stands. As long as they are seen as exceptions to the rule of individual response, goals of public health are beyond our reach. The central goals of public health should be ethical in nature. We should be challenging market justice as being deficient in protecting the health of the public.

The fundamental critique of market justice is social justice, i.e. all persons are equally entitled to key benefits, such as health protection.

Unless collective burdens are accepted, powerful forces of environment, heredity or social structure will preclude a fair distribution of these ends. (333) Another way of saying this is that the public health ethic is counter-ethic to market justice and the ethics of individualism as these are applied to health problems of the public.

The historic dream that prevantable death and disease ought to be minimized is a dream of social justice. (46)

3.1.2 Public health and a health ethic

The central goal of public health is the elaboration of a health ethic adequate to protect and preserve all human life. Beauchamp (46) advocates the following four principles:

1. "the controlling of the hazards of this world;
2. the prevention of death and disability;
3. that this should be done through organised collective action;
4. that this should be shared equally by all so that adequate resources should always be available, for those needing more extensive health care and to re-train and re-employ those displaced by the institution of preventive measures. An example of this would be the re-employment of the former tobacco industry workforce in industries non-hazardous to health."

Beauchamp (46) proposed these principles to counter the market justice system:

"The first principle is the focus in identification and control of hazards of the world rather than the focus and culpability of, behavioural defects of those individuals damaged by these hazards." The argument is that causes of death and disability are multiple and frequently behavioural in origin, but we must look for the behavioural origins of the health problems and ask why some people expose themselves to known hazards or perils. One must be careful when looking at behavioural problems since this tends to "blame the victim" and unfairly protects majorities and powerful interests from the burdens of prevention. The latter is market justice philosophy."

Every effort to control a single aspect of health care should be an integral part of the basic structure and total planning. For example, dental caries in Aborigines living in country areas cannot be adequately controlled by the delivery of oral care services alone. Beauchamp's principle would say that the primary focus should be on things such as the provision of a reticulated, potable, fluoridated water supply, adequate nutrition and housing.

"The second principle, prevention, is the logical consequence of the ethical goal of minimizing the numbers of persons suffering death

and disability, i.e. a known way to minimize is to prevent occurrence or to seek to minimize damage when exposures cannot be controlled. In order to maximally protect the public, preventive rules have to replace market rules. (46)

There are three aspects of prevention:

1. control the attack;
2. strengthen the host;
3. repair the host.

As applied to the prevention of dental caries, this becomes

1. reduce the sugar in the diet;
2. optimal fluoride intake in the diet;
3. restore the decayed tooth.

The third principle, collective action:
"Control of hazards cannot be achieved by voluntary mechanisms, but must be undertaken by government agencies through planned, organised and collective action which is obligatory or non-voluntary. (46) The reasons for this are: (a) because market action is typically inadequate for providing public goods* (302) and (b) because people might refuse. These policies frequently require burdens that self-interest or self-protection might see as too stringent, e.g. limiting the amount of alcohol allowable by a driver. With temptations for individual non-compliance, justice demands assurance that all persons share equally the cost of collective action through obligatory and sanctioned social and public policy. (190)

The broad implication of public health is a commitment to protect and preserve human life. A logical flow-on from this is to determine the approach to be taken to such a commitment by the various sections within the community.

Examples of community challenges to individualism have been shown in the fluoridation of water supplies, anti-tuberculosis campaigns and quarantine regulations. The commitment to public health requires on-going challenges to the market justice system.

Public commitment needs not merely organisation and symbolic expression but it also perhaps needs statutory expression. The question

*Public goods are those that are universal in impact and affect every person equally.

of personal liberties is always raised. This is a question the community itself must answer and quite probably different communities answer in different ways, e.g. China and the U.S.S.R. have different regulations for health protection, as do Switzerland and Sweden.

The work of creating collective descriptions of what is public health is of comparatively recent origin. The World Health Organization is a collective organisation currently carrying out public health programmes. (448)

Collective analysis of problems points to solutions of a collective nature. This requires structural change in society to combat voluntary risk to health as well as involuntary risk. When considering voluntary risk, by concentration only on the individual component of lifestyle, we have neglected the structural component inherent in forming that lifestyle. Such a concentration has diverted public attention from identifying powerful groups, such as those of industry and governments, which are involved in lifestyles. It has diverted public attention from questioning whether or not such groups have a self-benefiting motive for encouraging the acceptance as a norm of such a lifestyle which incorporates a health risk. An example of this is the encouragement of bottle feeding of infants in underdeveloped countries.

A commitment to public health requires a public recognition of such facts and a willingness to restructure those aspects of society.

As health is a fundamental concern of each individual, it is necessary for the health care industry to recognise and accept the right of each person to participate in his or her own health decisions and, as a natural extension to this, to participate in the formulation of collective health care decisions. It must be recognised that participation in such decisions should not stop at the national level as forces, organisations, interests and ideologies are often international.

3.2 Oral health and problems to oral health.

The teeth and structures that surround and support them are an important part of the body and their health and disease must be

considered in any evaluation of the human organism. The oral area is governed by the same physiological processes as other parts of the body and shares a common nourishment and metabolic process.

In contrast to other cavities of the body, the oral cavity is subject to unusual stresses and insults as it is in direct contact with the outside environment and must respond to a wide variety of chemical, mechanical and microbial stimuli, and is often a sensitive indication of the general health status of the individual.

"Oral health is an inseparable part of total health but has often been treated as if it were not and left to develop rather independently. This attitude has led to the common experience of initial neglect of the oral health sector because too low a priority was allocated to it, followed by inordinate expenditure, private or public, on curative, restorative and rehabilitative services demanded by a public allowed to regress from low to high prevalence of oral disease. Yet, the main oral diseases are currently preventable or controllable. Oral health is influenced by environment and lifestyle and, in most developing countries, those factors are consistent with low prevalence of dental caries. It is necessary to maintain those standards from which much can be learned by developed countries and to take advantage of better hygiene practices and nutrition to combat the effects of periodontal disease in middle- to old-age. In developed countries the need is to return to the low levels of dental caries that once existed and can be achieved by the effective range of preventive methods now available, while maintaining an already improved regime to control periodontal disease .... The philosophy and goals are clear:

to concentrate on a preventive approach to optimization of the relevant factors in the environment and lifestyles, using methodology which we have now or can soon develop, and in doing so, achieve a massive social improvement in health and economic benefit." (253)

Since the way that one looks at one's body and begins to notice it is when it is not functioning properly, or is causing a problem, the way oral health is described is when there is a problem which is occurring in, or because of a reason centering on, the teeth, jaws, mouth and associated structures.

Oral health problems affect general physical health through:

a. dysfunction of oral apparatus;
b. direct extension of infection;
c. metastases from oral sites;
d. manifestation of systemic conditions;
e. impact on emotional status. (467)

a. Dysfunction of the Oral Apparatus

As the mouth is the portal of food and teeth are designed to crush and chew solid foods, any dysfunction of the dentition will have both dietetic and nutritional effects. Any such dysfunction affecting people with chronic diseases or aged people must be acute, as these people have lowered resistance. Speech and communication are also impaired by malfunction of oral structures. The two most common diseases of the oral cavity are dental caries and periodontal disease. Both diseases affect the dentition and have the common characteristics of universal prevalence, continuity of attack; they do not undergo remission, but destroy oral structures. Severe dysfunction can be produced by trauma, burns, oral cancer, radiation surgery - radiation, gross oro-facial defects, e.g. cleft palate.

b. Direct Extension of Infection

Infections can be localised, e.g. abscess, cyst, and they can spread systemically. The origin may be a degenerated pulp, periodontium, wound, infection. The extension of infection can lead to cellulitis (spread through tissue spaces and facial planes). Removal of the cause of infection and antibiotics (if necessary) can treat the problem. Before the antibiotic era, serious complications ensued. Where health care is at a primitive level, oral infections are significant in that they can be a greater hazard to life.

c. Metastases from Oral Sites

The two common examples are subacute bacterial endocarditis, and malignant cells causing cancer in other parts of the body. The cure rate from oral cancer is relatively low. (317)

d. Oral Manifestations of Systemic Conditions

1. Nutritional disturbances, e.g. vitamin deficiencies: Metabolic diseases and mal-absorption syndromes, e.g. Addison's disease, porphryia.
2. Bacterial, viral and mycotic infections, e.g. tuberculosis, herpes, poliomyelitis, mumps, actinomycosis.
3. Diseases of specific systems, e.g. Bone: cleidocranial dysostosis, osteoporosis (Paget's disease). Blood: anaemias. Skin: lichen planus. Nerves and muscles: myopathes, trigeminal neuralgia. Periodontium: inflammation, dystrophy.

e. Impact on Emotional Status

The relationship of the individual to the physical and social environment is important in the emotional development of the individual and one's social well-being. No definitive studies have been reported quantifying this interaction. This may be because of the lack of precise methods of measuring emotional states. (467)

The social norms of the society and also the particular group in society to which one belongs or aspires to, have great relevance to the impact on emotional status. Some examples of oral conditions which can affect emotional well-being are: (467)

1. Occlusion - functionally and aesthetically.
2. Disfigured teeth - e.g. staining from drugs, hypoplasia
3. Loss of teeth and need to wear a denture -
   . feeling of inevitability of loss of teeth with age concomitantly resisting loss of teeth as this shows aging.
   . continual readjustment of dentures - mouth as focal point of expression or discomfort.
4. Extensive oral disease - behavioural pattern change, e.g. withdrawal, embarrassment, change in eating patterns.
5. Periodontal disease - fetor oris (bad breath), social discomfort.

3.3 Value of oral health.

The community is made up of individuals, groups (e.g. educational, cultural, socio-economic, professional - medical, dental) and policy makers and implementers having attributes which may be considered under the following areas:

a. personal, including age, previous experience of ill-health and health care, occupation.
b. community, including culture, education, pattern of economic organization and resource allocation.
c. environmental, including diet.
d. professional, including position and social status within the community and within the health field.

The face and mouth are major mechanisms by which individuals react with the world in which they live. The mouth forms verbal symbols which are the means of communication, modified and enhanced by facial appearance and expressions which in turn are affected by the characteristics of the dentition. (249)

The mouth is a portal by which foods necessary for survival, strength and vitality, enter the body. It is in the mouth that mastication and the first critical stages of digestion take place. An infant finds the mouth an important facility to explore objects it encounters and to gratify emotional needs. Adults depend on the mouth as an important source of pleasure, savouring foods, enjoying a pipe, communication in a special intimate way with those they love.

Oral health is intimately associated with the face of the individual - the oral structures making up the support for the face and also an inherent part of the overall appearance of the face.

The face plays a very important part in the individual's conception of self and also in another person's conception of that individual. The face is the way one labels and places an individual. (22) It is the way we become an individual separately recognizable from others, as evidenced by changing one's face for disguises, covering one's face in embarrassment. The phrase "losing face" means "losing one's character". The human face, however, can hide as much as it reveals. It can register moods or it can be inscrutable. We look to the face for lines of character to forecast behaviour. Cartoonists depict character in their drawing of the face which is supposed to reveal the invisible character behind the face.

The value of oral health is reflected by attitudes adopted. The attitudes shown by the individual can be influenced by sex, age, social class, educational level, parental attitude, cultural, regional and national factors. (340) Also by susceptibility to oral disease, availability and utilization of oral health care services and the impact of public preventive measures, e.g. diet control, toothbrushing and water fluoridation. (143)

Treatment of teeth and surrounding structures is an important service in all societies, but the type of care considered appropriate and desirable by recipients varies widely in relation to characteristics of society and its stage of development. Various groups have an interest in defining what is appropriate and desirable. The providers of care, e.g. dentists, define appropriate care in the context of their own concepts based on advanced scientific knowledge and their knowledge of the capabilities of sophisticated technical processes in solving the health problem. (279) They are also affected by the community's attitude to what is appropriate. This is expressed by the political system, the media and interest groups within the community.

The needs of individuals are conditioned by the economic, social and cultural characteristics of the society in which they live. The goal is maintenance of a comfortable, attractive and functional dentition for the life of the individual. The precise development of each health service system is a reflection of social priorities, i.e. how much the nation has assumed for the egalitarian distribution of health services and how much intervention in the provision of health care is required to satisfy the citizen's "rights" to health and health care. (234a)

Historically, oral health has always been important if it causes severe malfunction physically, or if it severely disfigures the appearance. However, unless pain, both physical and emotional, has been severe, oral dysfunction has been ignored. The adaptability of the body and the oral structures to their environment has meant that the human has been able to modify, for example, the diet. when the teeth or periodontium are such that specific forms are food are incapable of being effectively masticated.

With the advent of increasing food technology, e.g. cooking food, and, later on, refined foods, the importance of the masticatory apparatus has declined in terms of physical necessity. Many people without teeth and not wearing a prosthesis eat adequately and survive. This may not necessarily mean they have an adequately nutritious diet; however, it is sufficient for survival.

One could state that the community only recognizes the lack of oral health when they cannot perform or use the oral structures for the functions they normally perform as a determinant of the quality of life: (4a)

1. making up the face, i.e., individuality
2. communicating verbally
3. portal of entry for food and first stage of digestion
4. source of pleasure - eating, communicating in an intimate way
5. general well-being, socializing and quality of life

As soon as one of these functions is significantly disturbed so as to arouse the individual, the state of oral health is declared less than adequate. This can be expressed by the individual in a demand for oral health care services, either self-applied or professionally delivered or through community action as manifested by government action or demand for government action. (350)

The community is made up of individuals who group themselves according to various parameters which include education, culture and socio-economic categories. Each group expresses its values according to the situation present in the grouping and the desires of the individual who form the group.

Modern social and behavioural science has begun to investigate various factors considered to be important determinants of health action and behaviour. Underlying most of these investigations is the health belief model (349a) in which high levels of perceived vulnerability, perceived seriousness and perceived benefits interact and increase the likelihood of a person taking a specific health decision action. This model has enabled research in the field of health behaviour though there is questioning of how closely health beliefs and attitudes are related to health behaviour. (22) (106)

Baldwin [22] has presented a scheme which points to factors involved with seeking oral health care (see Figure 6)

In this scheme Baldwin [22] outlines areas where attitudes to oral health and oral care affect one or another aspect of health behaviour. Hence the individual's and community's value for oral health and oral care can be described in terms of an "open" system (429) where many factors from the environment are related to the actions undertaken not just one cause. Various groupings of individuals have differing concepts of what oral health is, what is a problem to oral health and what procedures need to be undertaken to alleviate the problem.

Utilisation of the oral care services provided by the oral care system can be used as a measure of society's perception of the purpose of oral care. On the part of the consumer, the perception of health and morbidity as well as enabling factors are held to determine and modify the use of services. (234b)

Use of services has been a relevant concept to which theories of epidemiology, sociology, political sciences, economics, psychology, administrative and political sciences and other disciplines have investigated in order to analyse the functioning of the health care system. Although there is no well-integrated set of propositions concerning the use of services each discipline has produced within its own theoretical framework concepts and approaches that contribute to our understanding of the processes associated with variations in use and non-use. (234c, 459)

The increasing economic investment in oral health care, the increasing utilisation of oral health care services by the public give weight to the importance placed on oral health. Unmet oral health needs as defined both by the community and the profession lead to concern by the public and thence to parliament. This then leads to legislative acts which have a significant impact on the financing and delivery of oral health care services, (e.g. fluoridation of water supplies, school dental services, policies for government participation and financing of oral health care for the indigent).

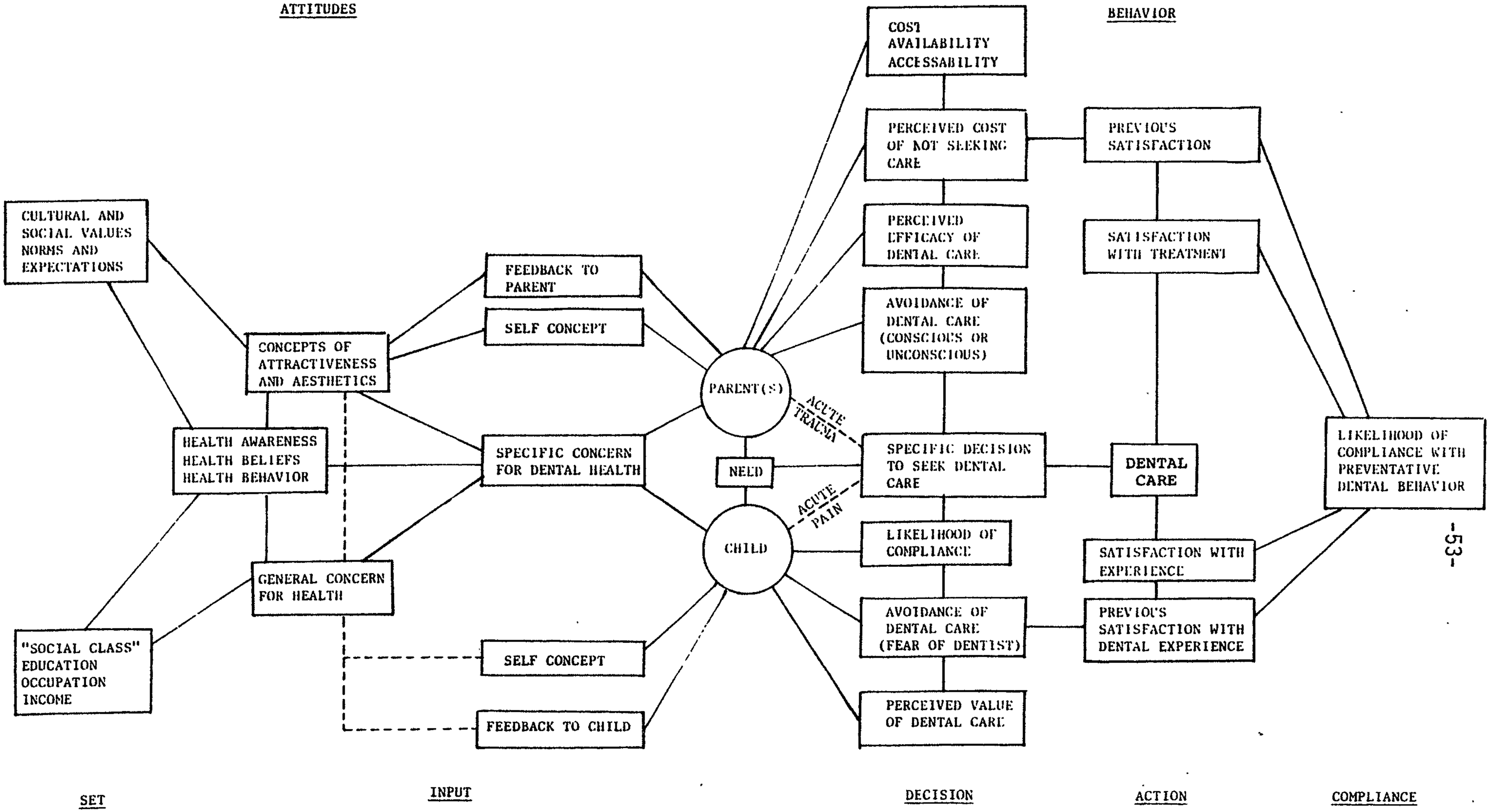

Figure 6. Schematic model of factors affecting motivation for oral care.

From: Baldwin, D. C. Appearance and aesthetics in oral health. Community Dent Oral Epidemiol, 8: Special Issue, 1980. p.251.

The value of oral health to the community can also be assessed by the position or priority placement of oral health within the social welfare and health fields. This has been sporadic, reflecting the inconsistent attitude to oral health itself. Donabedian (114) has described three areas which affect priority placement of health problems, especially in attention for planning and allocation of resources: (a) technical considerations, (b) political leverage, (c) community support.

Striffler has suggested that "in assessing interaction of oral health care and general health services, one might conclude that the inter-relationship is more disparate than integrated. The delivery systems would appear to be attacking different kinds of diseases in different settings with different tools and perhaps with different goals." (468)

An assessment of the priority placement of oral health within the socio-economic milieu can be made from an economic, individual and community (including political) points of view: (114)

3.3.1 Economic:

(a) <u>amount (e.g. in dollars) spent</u> by individuals, by governments, by communities on oral care compared to general health or other social welfare areas. This, however, is also affected by oral care services available, for example, those living in a small country town may not have any oral care services geographically available. A person on a low income may not be able to afford a private practitioner and there are very few government services available in these areas, Government expenditure on oral care services is difficult to assess accurately because, in some cases, it is included in the general health budget.

(b) <u>work days or hours lost in seeking oral care</u> - this does not apply to a large number of people, as most oral dysfunction does not relate to work incapacitation and a great proportion of people seek care out of working hours.

(c) <u>allocation of resources</u> other than financial by the delivery system (government and private) to carry out oral care measures.

(d) <u>availability of these resources</u> to all groups.

(e) <u>demand for attainment of a definitive standard of oral health</u> before being classified by the employer as suitable for permanent employment, e.g. nursing applicants must be "dentally fit", but a teacher needs only a general medical examination.

3.3.2 Individual allocation of priority:

(a) time spent on maintaining oral health by preventive measures such as tooth cleaning as compared to other health promoting activities, e.g. exercise.

(b) behaviour patterns, e.g. restriction of 'normal' behavour patterns:
(i) diet to promote oral health, and
(ii) attitude of parents to children's diet concerning sugar.

(c) demand for oral care services for self and dependents.

3.3.3 Community:

Social and economic status of oral care providers; reflects community priority placement of value of services provided by these personnel. Aspects of this can be shown by a comparison between dentists and doctors:

(a) educational requirements for dentist are equally demanding as those for doctors.

(b) educational facilities for dentists are sometimes not as well provided for as those for doctors.

(c) earning capacity of dentists is similar to that of doctors.

(d) social status accorded to the dental profession is not as high as that accorded to the medical profession.

(e) educational requirements for auxiliaries of the dental profession are not as high or as formalised as those for the medical profession.

Political:

Community attitudes to the value of health are reflected by the placement of care services within government policy making bodies, government provided services and policies promoted by the various political parties and lobby groups. An example can be shown in the Australian political system which is complicated by the Federal/State constitutions. Australia is a Federation of 7 States and 1 Territory. The Federal constitution leaves most of the functions of government to the states. In 1946 a national referendum gave the Federal government

power to alter the constitution to make laws with respect to "medical and dental services" and other social welfare benefits. The National Health Service Act (1948) and National Health Act (1953-1972) gave power to the Commonwealth to allocate resources for health care delivery. To find the political priority placement of oral health, one can examine its place in the organisational structure of the Health Department [75a, 465] and also within the policies of the political parties. [15d] As the government becomes involved in allocating more resources to oral health, this position may change. For example, with the introduction of a Federal School Dental Scheme in 1973, oral health care personnel became involved in allocating resources and determining policies. [75a]

Depending on the policies towards oral care of the particular political party in power and the current state of oral health services, the government's attitude can change. The policies of the political parties can be seen in their pre-election propaganda, their party platform. [15d] If a political party is promising to implement a definite programme, e.g. the School Dental Scheme, oral health can assume a higher priority in terms of publicity and the expressed desires of the community.

Government health care delivery services in New South Wales are organised on a regional basis. Oral health has a special status within this organisational structure as there is a special position for a regional dental officer. However, within the centralized administrative structure the dental section assumes a much lower priority to other areas as there are no special dental officers in the divisions. There is, however, a section used for policy making which has two dental personnel, plus one financial person and one secretary. There are no people with special oral health expertise in the relevant sections of research, planning or hospital services. [465]

One reason for the position of oral health would be the amount of political leverage wielded by oral care personnel and the amount of community support that can be brought forward. This in turn is influenced by the political organisation and strength of the trade union groups representing personnel involved in delivering the oral care. This firstly is a matter of numbers. The more numerous the group and

the more politically active, the stronger the political influence and pressure.

The relative priority within the oral care field given to children is a factor of all three of Donabedian's suggestions. As allocation of resources to services for children is an investment in the future of the community, it receives support. Technically, services for children are easier to implement. They can be school-based, are not as politically threatening to the professional groups involved in delivering the care and resource allocation can be minimized by using operating auxiliaries. In addition, from a political point of view, a programme for children is attractive, especially if the health problem has been well publicised, as had been the situation in Australia regarding the school dental service.

4 ORAL DISEASES AND CONDITIONS: Observations on some aetiological and epidemiological factors contributing to oral health status

- 4.1 Dental caries
- 4.2 Periodontal disease
- 4.3 Dento-facial anomalies
- 4.4 Cleft lip and cleft palate
- 4.5 Diseases and conditions of the oral mucosa
  - 4.5.1 Pre-cancer and oral cancer
- 4.6 Defects of teeth
- 4.7 Disorders of bone
- 4.8 Defects and impairment of function: disability and handicap
  - 4.8.1 Dysfunction of the masticatory function
  - 4.8.2 Aging
  - 4.8.3 Communication disorders
  - 4.8.4 Head and neck surgery and trauma
  - 4.8.5 The dying patient
  - 4.8.6 Chronically ill and handicapped persons

Siegman [391] states that "How health status is measured depends on how health is defined. Health definitions are products of theoretically or pragmatically derived formulations developed from the current context of the society's health problems and the capacity of the society to solve them. The definitions range from a unified concept of health and disease, the concept of freedom from disease, to a broad multifaceted view that incorporates dimensions of social and psychological functioning as well as overall qualities of happiness and qualities of life."

Martin [267] in commenting on patterns of dental health and disease, puts forward the following statements for consideration:

(1) Dental health and dental disease are correlative - or the absence of one denoting the presence of the other;
(2) Freedom from active disease at a particular point in time constitutes health.

However he suggests that this is a very simplistic way of looking at health and instead puts forward a more positive concept, namely, that dental health is the result of primary prevention and is the "complete balance and integration of the physical, mental and social components of a state of 'wellness'". Moreover, he goes on to state that "dental health, like dental disease, is multifactorial. Dental health is the balance of prevention and treatment and these two factors are an overlay on the basic susceptibility and disease pattern of the community. He suggests the "most valid reason in human terms for discussing dental health and dental disease is to produce and maintain dental health". This is the function of the oral health care service.

The aim of any oral care service is to make positive change in the oral health of the population. The problem confronting our society is to provide a satisfactory oral care service.

Kostlan [238] suggests that there are three parameters which must be considered as being parameters of any analysis of the problem.

These are:

1. Biological factors that give rise to need for oral care.
2. Attitudes of the users and personnel of the oral diseases and conditions and provision of oral health care.
3. Managerial factors influencing the concept and functioning of oral care services.

Before looking at the oral health care system it is pertinent to examine the biological factors which give rise to a need for oral care. These are relevant to both the size and character of the disease and the condition. Also one must examine other factors which affect the basic susceptibility and disease patterns of the community. These are

1. the environment affecting the agent of the disease and person.
2. the attitudes and conditions of the individual and the community.

Epidemiological studies help show up aetiological factors involved in oral diseases and conditions. They also quantify factors which point to patterns of susceptibility. However, one must look at the parameters of the problem of the need for oral care.

Friedrich [146] defines the nature and scope of oral care as

A. Preventive care which seeks to prevent
   - i effects of abnormal changes of tissues of the orofacial area through early recognition and therapeutic control.
   - ii potential aberrations in normal growth and development.
   - iii dental caries.
   - iv periodontal disease.

B. Therapeutic neutralization of medical or surgical diseases of, or trauma to, tissues of mouth and jaws, neutralization of dental diseases (caries and periodontics) and management of orofacial problems stemming from a psychogenic base, e.g. burning tongue atypical facial pain.

C. Control guidance and surgical manipulation to correct aberration of growth and development in the orofacial area.

D. Restoration of teeth, mouth and jaws to form and function through replacement of tissue lost by disease, trauma or missing because of birth defects.

E. Maintenance of form and function of restored tissues of the mouth and jaws.

F. Control of fear and pain associated with oral diseases and their management.

The question then arises as to the factors which should be considered as relevant to the oral health of the community. These factors are defined by parameters set by those assessing the need for oral health care, the individual and the providers of oral care and the community.

One can consider these factors as the aetiology of the major oral diseases and conditions and the patterns of prevalence within the community and the incidence amongst individuals.

The World Health Organization [253] has outlined the basic areas in which information is needed as a "basis for planning and evaluating oral health programmes, for estimating the requirements for the application of preventive measures: curative, restorative or palliative treatment".

With respect to information gathering, the World Health Organization [253] suggests final objectives must be kept in mind when oral health assessments are being selected and each piece of information should be essential for planning, evaluation or research purposes.

The first area allocated is personal and demographic information. If one is to look at disease patterns, one must look at differences between groupings of people, i.e., between communities. Then one must examine differences within the group.

Approaching analysis of health problems from the perspective of differing susceptibilities between communities should help explain why differing diseases and ill health and conditions are health problems to those communities.

Analysis of the disease or condition within the group will point out the factors which affect susceptibility. Finally, one can look at the individual and how they cope with the challenge to their personal environment - what factors in their individuality make them susceptible to challenge.

The World Health Organization [458] has defined areas of investigation in which oral health perspectives are necessary. They include

1. dental caries status,
2. periodontal status,
3. dentofacial anomalies,
4. disorders of mucosa, teeth and bone,
5. tooth loss.

Barmes [27] has pointed out that although the International Classification of Diseases - Application to Dentistry and Stomatology (ICD-DA) lists more than one thousand diseases or conditions which the dentist or stomatologist should be able to diagnose and treat, or appropriately refer, there are two very prevalent oral problems - dental caries and periodontal disease. A third set of conditions - dentofacial anomalies - reaches the moderately prevalent classification.

Barmes [27] also points out that "Dental caries has increased massively in relatively modern times", whereas periodontal diseases have "flourished at about the same level". "Oral diseases and conditions other than caries and periodontal disease, in particular dentofacial anomalies and oral mucosal diseases, are surely ancient in origin." But he points out that "problems with criteria for dentofacial anomalies makes it difficult to have confidence in population comparisons and to obtain valid historical perspective." High percentages of various populations are reported needing orthodontic care but "there is the confounding of aesthetic needs and demands which may not be too closely related to functional need." However, he postulates that there has been an increase in highly industrialized societies in the prevalence of certain forms of dentofacial anomalies.

Barmes also points out that with the "problems of satisfactory representative population samples for other oral diseases, particularly precancerous and cancerous lesions" it is not possible to have a

historical perspective but we do "know that there are massive differences in prevalence of some of these diseases in various populations."

Pindborg [315] suggests that one must remember that oral mucosal diseases "comprise a tremendous variety of lesions ranging from excessively rare conditions to diseases with a prevalence of about 25 per cent and spanning from malignant tumours, to the most innocent, often congenital, aberrations."

Pindborg [315] points out that from a public health point of view, the diseases with the highest priority would be those which are the most dangerous, and those most prevalent, provided they present a therapeutic problem. Also those which, though rare, are of great nuisance to patients. He also emphasizes that "numerous oral mucosal diseases are expressions, often the first, of systemic diseases" and hence need to be diagnosed and referred to relevant health personnel.

Barmes [27] discusses the historical perspective of tooth loss, pointing out that populations still exist where edentulousness is virtually unknown until the terminal stages of life, and that evidence from ancient times suggests that this was also the situation. Yet there are populations, even where there are comprehensive oral care services, and massive health insurance schemes in which edentulousness is a very common state by the fourth decade of life. He asks the question "how much of this edentulousness and general tooth loss is due to periodontal diseases and increasing dental caries, and how much is due to liberal attitudes on tooth loss of the public and the profession?"

4.1 Dental Caries

Dental caries has been defined as a "localized pathological process of bacterial origin that results in demineralization of the hard tooth structures and progression to cavitation." [453]

The extent of the problem: A widespread proportion of the human population experiences dental caries to some degree [189a], mostly before reaching adulthood but continuing even then. The disease is the leading cause of tooth loss before the age of 35 years in Australia. [35b]

During the past 20 years there have been tremendous advances in the understanding of the causation of the disease, of specific flora associated with smooth surfaces, fissure and root caries, the transmissibility of the flora, and the formation of dental plaque. We now have a better appreciation of the unique role dietary sucrose plays in determining the number of cariogenic organisms able to colonize on tooth surfaces. (289a)

Despite scientific advances and the fact that caries is preventable, the disease continues to be a major public health problem.

Untreated caries can cause considerable pain and discomfort; repair and replacement of carious teeth involves millions of hours per year as well as loss of time from school and work. The cost of treating decayed teeth in terms of facilities, workforce and other resources runs into millions of dollars. (37)

Factors Affecting Basic Susceptibility

Dental caries is a multifactorial disease in which there is an interplay of three principal factors: (289a)

1. the host (particularly the teeth and saliva)
2. the microflora
3. the substrate (i.e., the diet)

Time, however, must also be included in any discussion of the aetiology of caries. (289b) (See Figure 7)

Caries is commonly considered to be a chronic disease in humans because lesions develop over a period of months or years. Epidemiological observations on longitudinal rates and patterns of incidence in a large group of children has revealed that all teeth exhibit similar patterns of annual attack curves. (289b) In general, the annual probability of attack reaches a peak 2-4 years following the eruption of the tooth and declines after. (289c) Hence, studies of dental caries and comparisons are usually age-related: The reasons being if tooth eruption times for certain populations are similar, the susceptibility to caries should be similar.

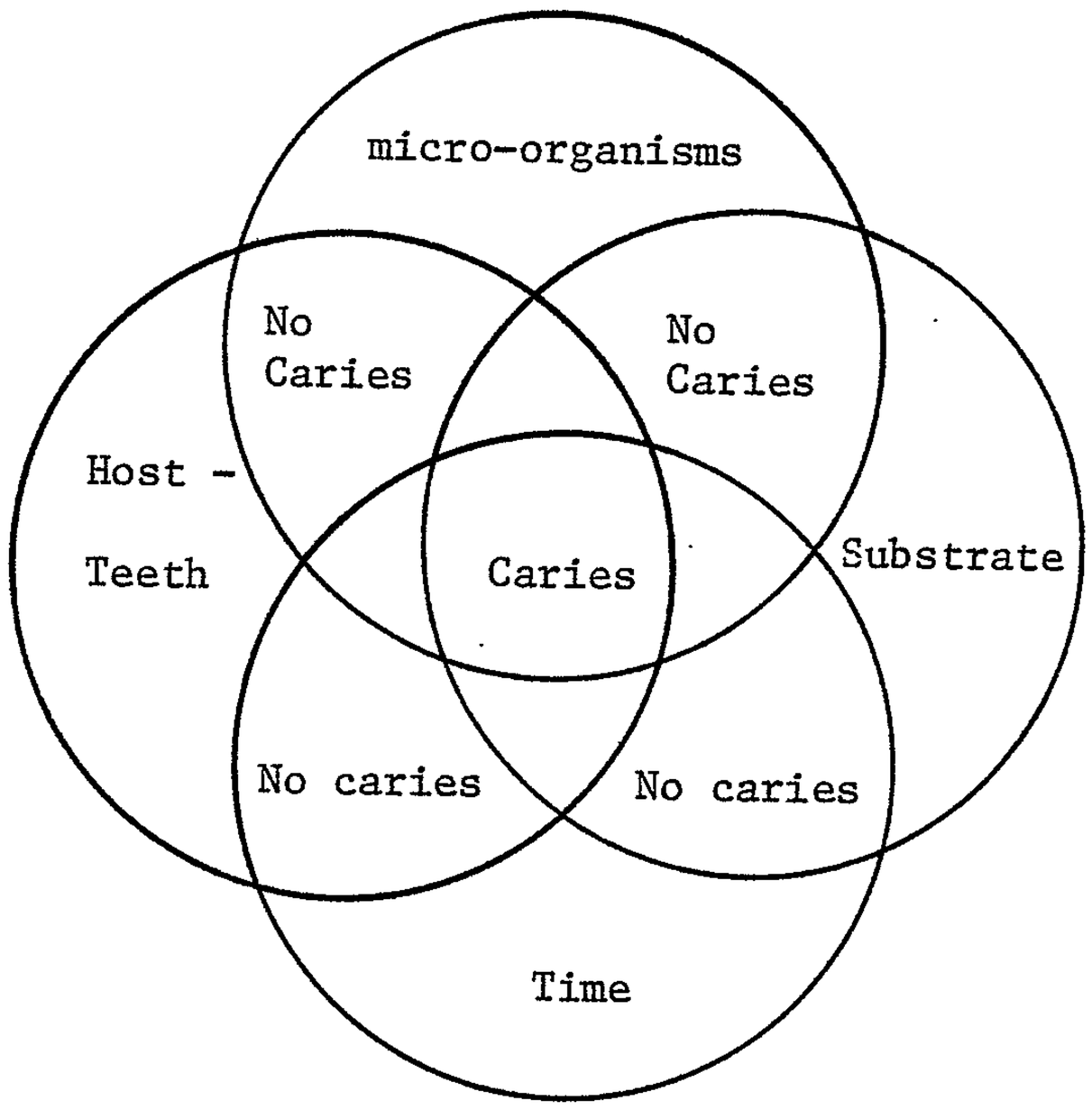

Figure 7. Interrelationship of factors affecting dental caries.

From: Newbrun, E. Cariology
Baltimore, Williams & Wilkins Co. 1978. p.16.

At a symposium on caries, Sognnaes [400a] describes factors influencing dental caries. (See Figure 8).

At the same conference [98] Davies described the interrelationship of major factors in the resistance to caries. (See Figure 9).

A. Microorganisms

Newbrun [289] summarizes what he sees as the overwhelming evidence for the implications of microorganisms in the production of the carious lesion as follows:

- germ free animals do not develop caries.
- antibiotics fed to animals are effective in reducing the incidence and severity of caries.
- unerupted teeth do not develop caries, yet, these same teeth, when exposed to the oral environment and microflora, can become carious.
- oral bacteria can demineralize enamel and dentine *in vitro* and produce carious-like lesions.
- microorganisms have been histologically demonstrated invading carious enamel and dentine. They can be isolated and cultivated from carious lesions.

With regard to specificity of microorganisms causing caries, this has been shown using animal experiments and transmitting the micro-organism from infected animals and recovering the organism from newly infected animals. [299, 305]

"In humans there has been no direct demonstrations of cariogenicity of any microorganisms". However, there is indirect epidemiological evidence of an association between Strep. mutans in plaque and caries incidence and prevalence. [400] Studies [75, 349] have suggested a relationship between caries prevalence and the possible transmission pathways of the bacteria. Also, pathogenicity studies in animals have implicated Strep. mutans in having a strong association with dental caries incidence. [289e]

Strains of other bacteria commonly found in the human oral cavity have also induced caries in animals, depending on the experimental conditions. [289f] These include other Streptococcus species and lactobacillus. Some studies have suggested a greater cariogenicity of

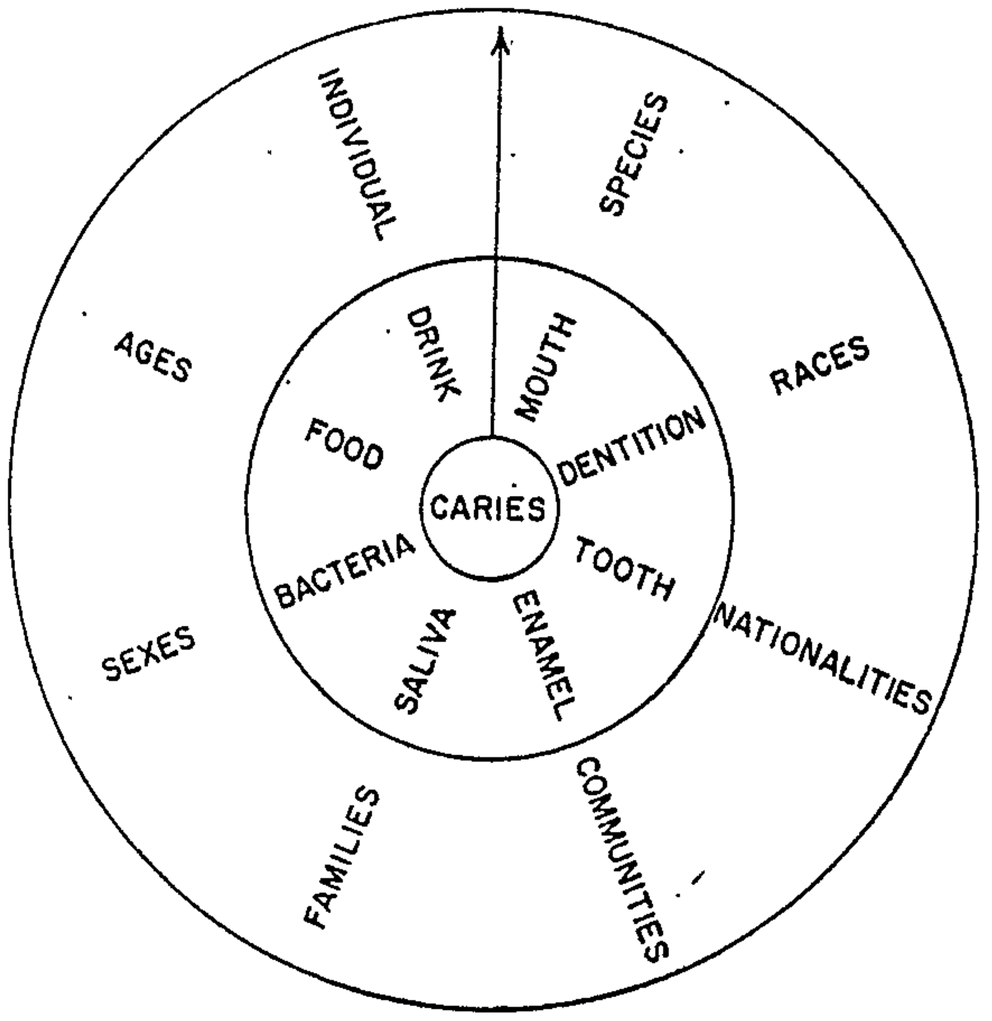

Figure 8. Factors relevant to dental caries.

From: Sognaes, R.F. Chairman's opening remarks. p.3.
In: Wolstenholme, G. E. W. and O'Connor, M., editors.
Caries resistant teeth. London, Ciba Found Symp, Churchill, 1965.

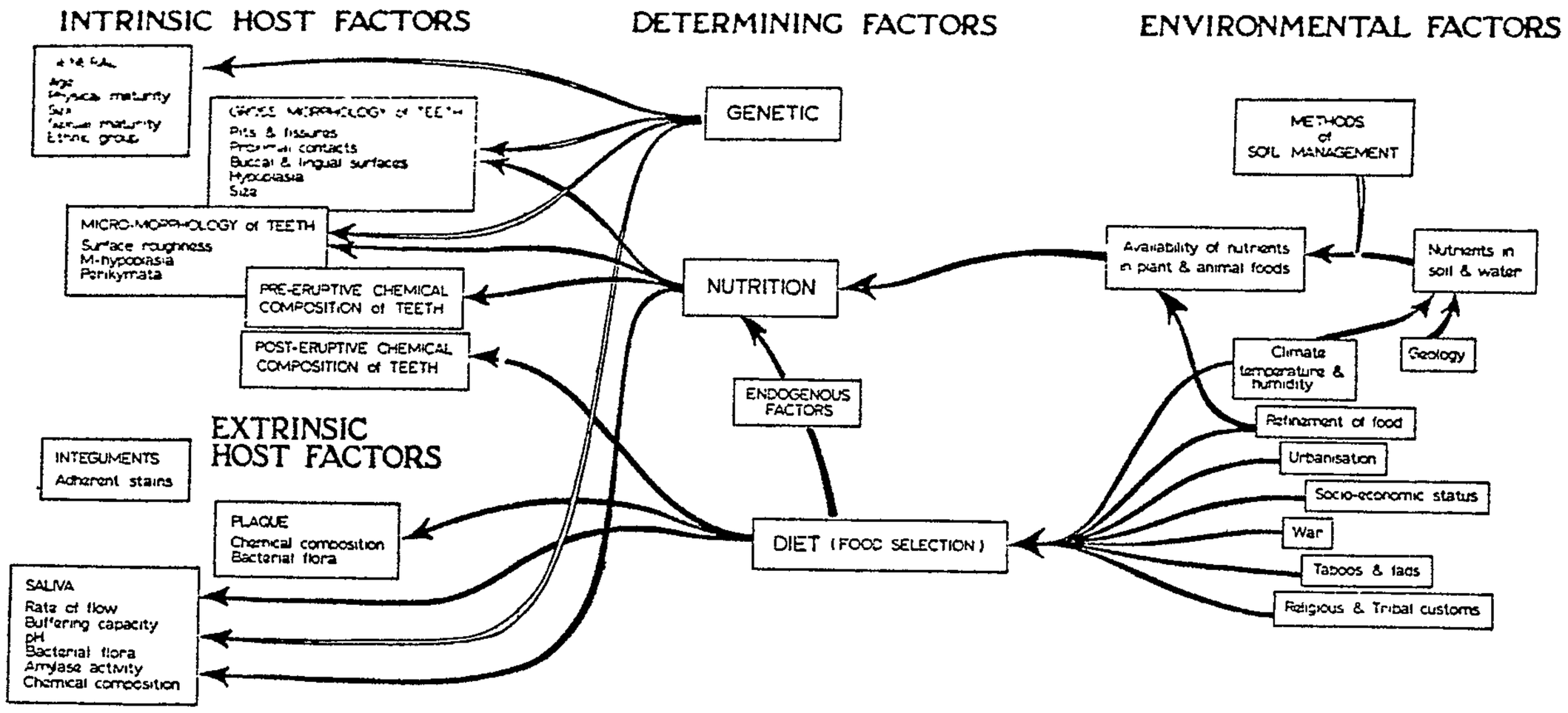

Figure 9. Interrelationship of major factors in the resistance to caries.

From: Davies, G. N. The Significance of epidemiological studies in relation to caries resistance p.9.
In: Wolstenholme, G. E. W. and O'Connor, M., editors.
Caries resistant teeth.
London, Ciba Found Symp, Churchill, 1965.

Strep. mutans compared with a variety of other oral bacteria. (65, 226) However it is generally recognized that these microorganisms responsible for carious attack from acid end-products rapidly form fermentable carbohydrates, especially under anaerobic conditions and are relatively acidic. (233) Also most cariogenic microorganisms form extracellular polysaccharides of high molecular weight which permits them to adhere to enamel surfaces - forming plaque. (289e) The transmission of specific cariogenic organisms has been studied in gnotobiotic animals (229) and their ability to be an infectious agent identified. (289f) Newbrun (289d) reports that different organisms display some selectivity as to which tooth surface they attack and suggest that there are four types of processes involved - pit and fissure, smooth surface, root surface, deep dentinal caries. However, he cautions on extrapolations from findings on monoinfected gnotobiotic rat model systems to naturally occurring caries in humans even though these animal findings have been generally confirmed on observations in humans.

"Microorganisms have been shown unequivocably to be a major factor in dental caries but to date, no single species appears to be uniquely associated with the onset of dental caries." (63)

B. Host Factors

I. Salivary factors

Correlations to caries rate have been found for some salivary factors. There is some data indicating a significant positive relationship between buffering capacity and caries rates. Salivary secretions counteract the development of caries as absence of saliva xerostomia results in rampant caries. (219) The theoretical mechanisms of salivary interaction with the caries process is described by Ericsson (132) as follows: "...Salivary flow and buffering enhance exchange and neutralization, respectively of acids formed in the dental plaque; viscosity reduces the exchange rate; high values for pH, Ca and P increase the degree of supersaturation for hydroxyapatite in the saliva, and presumably in the plaque fluid and lower the critical pH level below which the enamel apatite may be dissolved.". Ericsson (132) also notes that several of these factors are interrelated.

Levels of phosphorus in saliva, being a local effect of food, has a dominant role in the reduction of animal caries. But this role has not be successfully duplicated in man. However, phosphate additives

may play a significant role in caries prevention. (9) The concentration and combination of calcium and phosphate content of plaque and the range of changes in pH values are both influenced largely by accessibility and composition of saliva and are related to the power of plaque to reduce caries. (219)

To what extent the antibacterial action of saliva contributes to caries prevention is not clear. Studies (9) have shown that high salivary viscosity and slow rate of secretion is related to caries susceptibility. Secretions with higher activity products, retard enamel dissolution and support calculus deposits in local areas. The pH varies with the flow rate of saliva. Low pH favours hydroxyapatite dissociation, high pH favours formation and stability. (376) Post-eruptive maturation of the tooth can be regarded as a function of the saliva in which the mineral components (e.g. calcium, phosphates), trace elements (e.g. fluoride) and organic components (e.g. urea and salivary proteins) can play a part, either directly or indirectly by providing a chemical environment favourable to mineralization. (295)

It has been suggested by Jenkins (219) that saliva from "caries free" individuals has higher values than average for the following:

. rate of flow (therefore higher pH and buffering power)
. calcium and phosphorus concentrations
. adenosine and A.T.P.
. smaller number of acid-producing organisms especially lactobacillus acidophilus or Streptococcus mutans.

However, it is very difficult to isolate specific factors of saliva influencing caries susceptibility as it is difficult to determine "normal" values for salivary constituents, and salivary secretion. There has been a lack of standardization in the many studies on saliva, (217) but it is certainly a factor to be considered carefully in caries susceptibility.

II. Tooth factors

a) Tooth morphology has been recognized as a factor in disease susceptibility. (289g) Investigations have shown a relationship between caries susceptibility and sites subject to retention and stagnation of food, e.g. fissures on occlusal surfaces, interproximal areas. (98, 240, 264)

b) Tooth position in the mouth is also a factor. The onset of caries occurs in an orderly fashion, according to the type of tooth. Canines are least susceptible, incisors, premolars and molars being increasingly more susceptible. (74) Because these teeth erupt into the mouth at different times, duration of exposure to a caries-causing environment may also account for their apparently different susceptibility.

By altering the availability of saliva and the retention of carbohydrates, dentition morphology and position would affect the entry and exit functions of the plaque system, the availability of regulators of plaque metabolism and as a result, both microbial flora and formation and accumulation of acids by dental plaque. (233)

C. Tooth Composition

There is good evidence to indicate that the enamel surface is more caries resistant than the subsurface. (289h) Changes in enamel, e.g. decrease in density, increase in nitrogen and fluoride content occur with age. These alterations are part of the post-eruptive "maturation" process where teeth become more resistant to caries.

Many studies (285, 289h) reported have shown that teeth of people living in either a naturally or artificially fluoridated area contain more fluoride than those in non-fluoride areas and, concomitantly, that there is a much lower prevalence of dental caries. Jenkins (218) suggests that the effect of fluoride is not only to favour the remineralization of enamel, but also to ensure that the salt precipitated is of the apatite structure which is less soluble than other possible crystalline forms. (See Page 81 for further discussion on fluoride)

D. Nutrition concerns the assimilation of foods and their effects on the metabolic processes of the body. Nutrition can only act through a systemic route and therefore influences the host during tooth development. With the exception of the well-established caries reducing effect of systemic fluoride, it has not been conclusively shown that human teeth are more or less susceptible to caries depending on the exposure to various nutritional conditions in early life and before eruption. However pre-eruptive nutritional effects have been demonstrated in histological structure, chemical composition, gross morphology, tooth size, and eruption time. (51, 378)

Animal studies [276, 277, 278] have shown a relationship between protein deficiency and increased caries susceptibility but there are no human studies which unequivocally link developmental protein deficiency with increased caries susceptibility.

It appears that the number of hypoplastic defects on tooth surfaces may be greater in those people who have a low nutritional status during tooth formation [367] and that this may be a contributing factor in high caries prevalence. [98] The hypoplastic area or hypocalcified area providing an area or tooth surface more susceptible to plaque retention and acid dissolution. There is some epidemiological evidence [366] which suggests that there might be a developmental nutritional component to dental caries susceptibility. Nutritional conditions may be relevant in dental caries aetiology when the substrate is of a certain type which alters the balance between host and substrate structure to such an extent that tooth structure achieves a more susceptible role in caries attack. [367]

E. Systemic diseases or conditions may play a major role in tooth morphology and structure in that they can affect the calcification of the tooth, hence making it more susceptible to dental caries. [238, 289g]

The other way systemic diseases can influence caries susceptibility is by affecting the state of the gingiva, the type and frequency of carbohydrate intake and the ability to pursue effective oral hygiene measures. [132] Increased fragility of tissues inhibits persons from effective prophylaxis and increased prevalence of caries can be related to high plaque retention. [232] Also medicaments used to treat diseases are either sucrose-based [157] or change the morphology of the gingival tissue, e.g. dilantin, predisposing the dental tissues to increased plaque retention and increased sucrose available for microbial substrate.

F. There are hereditary defects in the dentition [375] which cause a change in tooth form and composition but there is no positive conclusion that heredity *per se* has definitive relationship to caries incidence. However the possibility exists [80a] and if so, it may be mediated through inheritance of tooth form or structure which predisposes to caries immunity or susceptibility. [318] What can be inherited is genetic material which sets the limits of an individual's capacity to

react to the immediate environment. For example, Winter (443) discusses hereditary determined factors which may influence the predisposition of children to rampant caries in early childhood, of dizygotic twins on comparable diets and comforter habits.

The fact that local factors may also alter the caries susceptibility (e.g. exposure to a highly refined diet) (50) would indicate that heredity does not exert a strong influence in determining an individual's caries susceptibility. This may also be suggested by the fact that tooth morphology, e.g. in the Australian Aborigine has flatter cusps, less fissures (69a) and by extension, has less predisposition to plaque retention does not markedly alter the caries prevalence to communities confronted with an abrupt change in diet to refined western food. (41a) Davies (98) has suggested that in a community where environmental factors promoting caries are of relatively low intensity, genetic factors may play an important role in determining resistance to the disease.

III. Substrate factors

a) The influence of diet on the caries process

Diet refers to food and drink customarily taken by a person from day to day. Diet may exert an effect on caries locally in the mouth by reacting with the enamel surface by influencing salivary excretion and composition, (107) and by serving as a substrate for cariogenic micro-organisms. (289i) Nutrition concerns the assimilation of foods and their effect on the metabolic processes. While nutritional effects are dependent upon diet, dietary effects on dental caries need not be related to nutritional responses of the body.

Nikiforuk (295) describes the influence of food ingestion on teeth as being (1) metabolic, and (2) local. (See Figure 10) and lists food factors and their effects (See Figure 11)

Konig (236) suggests that a person's eating regime influences an individual's caries activity. He suggests that this is modified by variables as shown in Figure 12.

Animals which receive their entire diet by gastic intubation remain caries-free. In contrast, rats which receive their essential nutrition by gastric intubation and sugar by mouth develop extensive carious lesions. The number of lesions is directly related to the

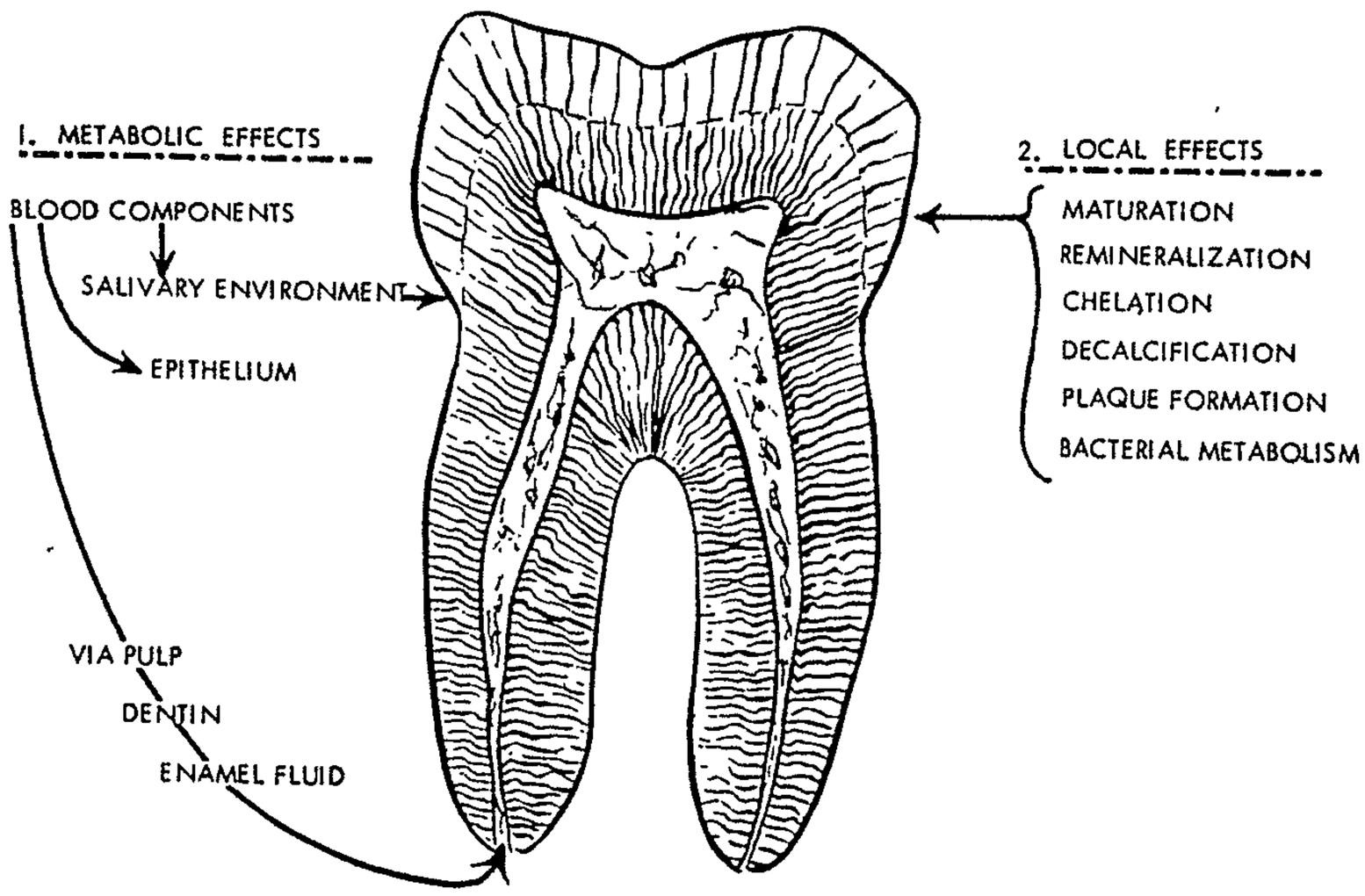

Figure 10. Schema of the mechanism of posteruptive, metabolic, effect of various factors on teeth.

From: Nikiforuk, G. posteruptive effects of nutrition on teeth p.1253. In: Bibby, B. G., ed. Role of human foodstuffs in caries; Proceedings of a workshop conference. Eastman Dental Center, New York, March 1970. J.Dent.Res, 49: Suppl 6, 1970.

Food Factors	Effect on Caries	Mode of Action
Food types		
Proteins	Cariostatic	Local and systemic; increases buffering capacity of saliva (?); increases blood and salivary urea (?); reduces enamel solubility (example: casein in milk) by adsorption on the enamel hydroxyapatite.
Fats	Cariostatic	Protective molecular films on teeth; vitamin D content; antimicrobial action: decreases caries-producing potential of carbohydrates.
Carbohydrates	Cariogenic (disaccharides> monosaccharides>polysaccharides)	Substrate for glycolytic organisms to form complex organic acids; substrate for bacterial synthesis of intra-, and extra-cellular polysaccharides (dextram, levan); predisposes implantation of caries-inducing streptococci. and predisposes formation and attachment of dental plaque on tooth surface.
Nutrient elements		
Fluoride	Cariostatic	Favors formation of OH-apatite crystal structure during dissolution and remineralization of enamel; antimicrobial (anti-enzymatic); increases rate of maturation of enamel surface; reduces enamel solubility.
Phosphorus—inorganic, organic	Cariostatic	Common ion effect; buffering; complexing of calcium.
Trace element content	Cariostatic (?)	Reduces enamel solubility; maturation effects.
Properties of foods		
Acid content	Potentiates caries	Demineralizes hard tissues.
Type of acid formed by bacteria in plaque	Potentiates caries	Demineralizes hard tissues.
Water content	Cariostatic	Dilutes cariogenic substrates.
Antimicrobial	Cariostatic	Reduces cariogenic flora.
Detergent (factors)	Cariostatic	Reduces cariogenic substrates and cariogenic flora; stimulates salivary flow.
Sucrose content	Cariogenic	See carbohydrates.
Sialogenic	Cariostatic with higher salivary response	Cleansing and buffering effects of saliva.
Organoleptic properties		
Frequency of eating	High frequency potentiates caries	Increased substrate level in oral cavity.
Quantity of food	Large quantities may be cariogenic	Slower food clearance from oral cavity.
Dry foods	Cariogenic	Slower food clearance; more food impaction.

Figure 11. Food factors and their effect on caries posteruptively.

From: Nikiforuk, G. Posteruptive effects of nutrition on teeth P.1254. In: Bibby, B.G., ed. Role of human foodstuffs in caries; Proceedings of a workshop conference. Eastman Dental Center, New York, March 1970. J. Dent. Res. 49: Suppl 6, 1970.

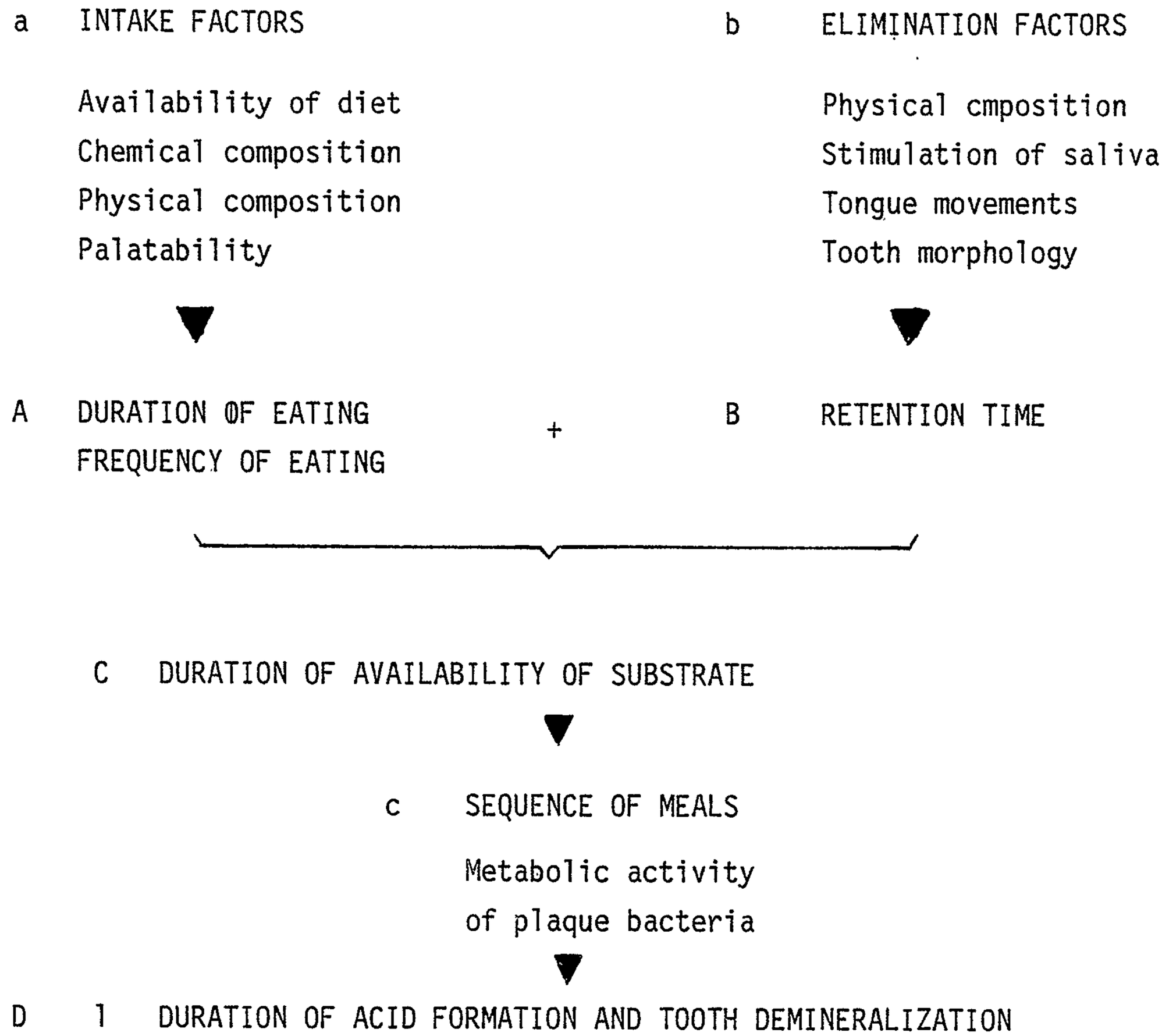

Figure 12. Factors in the relationship between eating and caries.

From: Konig, K. G. Feeding regimes and caries p.1331.
In: Bibby, B. G., ed. Role of human foodstuffs in caries; Proceedings of a workshop conference. Eastman Dental Center, New York, March 1970. J. Dent. Res. 49: Suppl 6, 1970.

frequency of ingestion of sugar. It has also been observed that plaque formed on humans or primates receiving their entire diet by gastric intubation lacked the ability to lower the pH of sugar solutions. (409a)

Many researchers (5, 50, 136, 257, 346, 385, 387) have pointed out the relationship between intake of sugars and caries incidence. Sheiham (385) demonstrated the relationship of dental caries and trends in sugar consumption and his report supports the theory that the high levels of dental caries found in industrialized countries and the increasing dental caries in developing countries as they adopt industrialized countries' diet are principally due to the frequent intake of simple sugars, in particular, sucrose.

Other dietary factors have been associated with the development of caries (49) and such factors include trace elements, phosphates and fats.

Bibby (49) suggests that there are modifying factors other than sucrose in human diets which have a part in determining caries prevalence. He divides these factors into:

1. Differences in cariogenicity of foods:
   a) Clinical Evidence - carbohydrate content
      - food adherence
      - food texture

   b) Laboratory Evidence - acid production from foods
      - enamel demineralization
      - acid formation in dental plaque
      - animal caries.

2. Effects of various additional constituents in the mouth can either retard or accentuate caries producing action of sugar content.

Sheinan (387) suggests that the process of caries is affected in various, even antagonistic, ways by dietary carbohydrates. He suggests that any substrate which is subject to microbial degradation would exhibit various levels of cariogenic potential. This potential is counteracted by other orally localized effects common to the sugars. These include salivary secretion, elevation of certain electrolyte concentrations and increased buffering of saliva. He also suggests that

the latter protective effects might be rendered valueless due to the marked decrease of pH on tooth surfaces caused by bacterial breakdown of various substrates.

Conclusive evidence of the role of sugars in increasing dental caries can be summarised by studying the following areas of review.

a) epidemiological studies (57)
b) historical studies of sugar consumption and dental caries (177)
c) animal studies (276, 277, 278)
d) controlled human studies, e.g. the Vipeholm Study (173) and the Hopewood House Study (180)
e) reduction of carbohydrate during World War II and concomitant reduction in dental caries. (385, 423a)

The Vipeholm Study (173) changed the frame of reference of studying the total intake of sugar to studying the effect of form and frequency. (257) This change in emphasis was backed up by studies such as those of Weiss (439a), Zita (472), Fanning et al. (136) and Bibby (50).

Other studies where diet has been controlled, for example, in institutionalized children (180), diabetic children on a low sucrose diet (in contrast with diabetic children on insulin and an average diet having an increased caries incidence), people with hereditary fructose intolerance (264a), Seventh Day Adventists (197) - all these diets restrict sugar intake and all have significantly lower dental caries than their age group in society. A correlation exists between a reduced carbohydrate intake and a reduced frequency of intake because of food rationing during World War II and a reduction in dental caries. (51, 385) The caries attack rate had a direct statistical relationship to post-eruptive sugar intake during the period of tooth maturation. The reduction in caries rate in non-fluoride areas also occurred in fluoride areas with war-time carbohydrate restrictions. (385, 423a)

f) Winter (443) shows an increased incidence in caries when sugar is added to the feeding bottle or pacifiers used by infants.
g) Dental caries experience in remote and underdeveloped areas is low compared to urbanized and industrialized countries. As diet changes to include refined carbohydrates, dental caries experience increases rapidly. (209, 271)

The degree of damage the sucrose intake does may be affected by the extent to which the individual practises oral hygiene or drinks fluoridated water, or even the order in the meal in which sucrose is consumed. (132) Resistance to dental decay varies from one individual to another, from one community to another (170) and it cannot be expected that even identical diets and identical oral hygiene practices will produce the same dental caries rates. (138b, 359)

In the Vipeholm Study (173) there were persons in whom dental caries was noted while they were on a diet very low in carbohydrate content. This observation suggests the existence of some types of caries in which sugar and other carbohydrates play only a minor role as a causal factor.

b) Plaque

There is no doubt that mechanical oral hygiene techniques for example, toothbrushing, must be considered the most effective method for controlling plaque. (4) However epidemiologists have not been able to demonstrate a direct relationship between dental plaque scores and dental caries prevalence. (203) One reason may be because the two indices measure items which occur over considerably different time periods. Caries prevalence measures total caries experience accumulated since eruption of teeth, whereas plaque and oral hygiene indices measure a transient state. The only studies which corroborate the claim that a clean tooth does not decay are where a certain standard of oral hygiene was maintained by professional cleaning for a period. (18, 19) The oral hygiene and plaque indices tend to emphasize buccal and lingual surfaces and are more subjective in measuring interproximal surfaces. The occlusal and interproximal surfaces are most likely to become carious but are least likely to be cleaned by toothbrushing alone. (4)

"Dental caries is a consequence of the metabolic activity of the oral flora, particularly that of the microorganisms of the dental plaque. The complex symbiotic relationships in the plaque result in the production of acidic metabolic end-products. It is not only the production of acid which is important, but its accumulation at the tooth surface." (181)

A great deal of work *in vitro* has confirmed empirically, what could be expected theoretically that the solubility of tooth substance in saliva depends on whether the pH is above or below some critical figures. (216) Many factors affect or influence this "critical" pH, for example, concentrations of calcium and phosphate ions and complexing substances, fluoride ions, ionic strength and buffering power. Jenkins (216) has shown that the pH of plaque from different areas of the same mouth varies with caries-proneness of each area. Factors associated with the differences are pH, rate of flow of saliva, and thickness of plaque, alkalai production and ionic balance.

An extensive study of plaque pH on 18 different tooth surfaces showed that regional plaque pH levels showed a distribution pattern similar to the intra-oral distribution pattern of caries. (232)

Ultrastructural research provides confirmation of a close association between bacteria and carious destruction of enamels and dentine. Many studies comparing microbial populations of dental plaque in caries-free and caries-active subjects show a clear increase in bacteria. (264) Different substrates affect plaque pH. The most extensively studied ones are sugar solutions which lower the pH. Certain types of foods provoke a larger fall in pH than others: for example, boiled sweets. Some of the factors governing the acid provoking potential have been identified, e.g. the amount or physical consistency of the carbohydrate, the food pH and its ability to stimulate salivary flow. (216)

The significance of plaque and its role as a factor in the basic susceptibility to dental caries and patterns of prevalence cannot be underestimated. (233) However, the influence of its removal and how completely removed has still not been clearly demonstrated. (203) The World Health Organization (462) concluded that the efficacy of toothbrushing as a public health measure to prevent caries should not be overestimated. An alternative to measuring the efficacy of plaque removal is to question children about toothbrushing frequency. It has been reported (5) that children who brush twice a day had significantly less caries on smooth surfaces than those who brushed only once a day or less.

From the above discussion one can state that plaque is a factor influencing basic susceptibility and prevalence of caries but further analysis is needed to determine which plaque removal practices are most effective in reducing incidence of dental caries and severity of dental caries at particular sites of attack.

One must note also the multifactorial nature of dental caries and the fact that if factors such as a frequent consumption of a sucrose diet is present, toothbrushing may have a minimal effect in altering the prevalence of the group, compared to those having a less frequent sucrose consumption. (5)

Studies with children brushing with fluoride toothpaste (137) have shown a significant reduction in dental caries prevalence. However one must note that the fluoride may be the overwhelming operative factor in the reduction.

There has been very little analysis of dental caries incidence and prevalence with other plaque removal procedures besides toothbrushing. However, one study (463, 464) showed a significant reduction in proximal caries when researchers flossed childrens' teeth at school. Other oral hygiene procedures, e.g. mouthrinsing with water or chemotherapeutic agents have shown no significant differences in dental caries incidence. (253)

Long term studies are needed on oral hygiene procedures on different groups within the community having different disease patterns, to see if certain procedures significantly alter dental caries incidence.

Environmental Factors Affecting Basic Susceptibility

One factor affecting dental caries prevalence and basic susceptibility is occupation in terms of the atmospheric conditions in the workplace. Studies (10a) have shown a significant increase in caries susceptibility by process workers in the sweet industry and also by non-process workers in the workplace. The sucrose dust prevalent in the workplace seems to pervade all areas - process and non-process. Not many studies have been reported in this area of industrial pollutants, however mercury (134) and lead (13) have both been indicated as having an association with high caries prevalence.

The most extensively studied environmental factor affecting the basic susceptibility to dental caries and patterns of dental caries is fluoride.

Fluoride is a trace element found occurring naturally in soil and water supplies. One can list the possible mechanisms [285, 178] whereby trace elements may act on the teeth as: [285, 278]

1. By their incorporation chemically in the hard dental tissues either during tooth formation or post-eruptively, thus rendering the tooth less susceptible to the carious process. The theory of action of fluorides on dental caries postulates the reduction of the solubility of enamel in acids.

2. By a direct effect, probably enzymatic, during formation either on the structure of the dental enamel, rendering it defective, or on the form of the tooth, e.g. as seen in hypoplastic enamel as a result of excessive ingestion of fluoride. Mild mottling and hypoplasia from fluoride helped to identify communities where there was a specific fluoride concentration in the water. The identification of these communities and their lower prevalence of dental caries stimulated further studies on fluorides in drinking water as a factor in oral health.

3. By changing the environment of the tooth, (e.g. by changes in chemical composition, physical characteristics or rate of flow of the saliva).

4. By direct action, probably enzymatic, of trace elements present in food debris on the metabolic pathways or on the growth and reproduction of the caries-producing organisms, thus producing changes in the balance of oral flora, and in the end-products formed on the tooth surface by the breakdown of the food debris and saliva. Thus the hypothesis of the enzymatic effect of fluoride on bacterial metabolism and hence a change in the proportions of caries producing bacteria in plaque containing high concentrations of fluoride. [68b, 132a]

The recognition of the effects of a trace element arise from: [178, 285]

1. Observations that a lesion is associated with a characteristic distribution usually geographical or geological. Hence the clinical

observation that dental caries incidence was low in certain geographical areas, related to the water supply in which mottled enamel was endemic. (271a, 428a)

2. The association of a particular trace element with this distribution. Hence the demonstration of a high fluoride content in the water supplies of these areas. (80b) (428a)

3. The demonstration of an abnormal concentration of a trace element in tissues or cells where it is likely to have an effective action. Hence the demonstrations of fluorides in teeth and of exceptionally high concentrations in surface enamel and in dental plaque. (209a, 367a)

4. The demonstration that the condition can be cured by remedying the excess or deficiency of the trace element. Hence the demonstrated effectiveness of artificial fluoridation of the water. (110)

There appears to be more than one mode of action involved in the mechanism by which fluoride protects the teeth against dental caries. (109)

Water fluoridation, either natural or artificial, has been shown to affect dental caries susceptibility in the following ways: (285)

1. Adults and children continuously exposed to fluoridated water from birth show on average 50 per cent reduction in caries incidence in permanent teeth and a similar reduction in deciduous teeth. (110)

2. Protection is conferred on teeth already present in the mouth when fluoridation has begun. (409)

3. Fluoridation reduces the number of large cavities which endanger the tooth pulp and often lead to tooth extraction. (110)

4. The protective effect is not uniform throughout the mouth, the greatest reduction being on the interproximal and gingival surfaces of teeth (4a) and on the upper incisors. (110)

5. The rate of initiation and progress of carious lesions is slower in children consuming fluoride. (240, 321)

As a result of numerous studies showing the benefits of fluoride (for a review, see 285) many different agents have been used to bring to the tooth the benefits of fluoride, both systemically and topically. In this way the disease pattern of dental caries has been significantly altered and also the basic susceptibility of the tooth.

The following methods have been used successfully but with varying degrees of effect. (290)

1. water fluoridation
2. salt fluoridation
3. fluoride supplements
4. topical fluorides: (a) solutions, (b) mouthrinses, (c) gels, (d) slurries, (e) fluoride dentifrices, (f) varnishes, (g) adhesives

A workshop on the relative efficiency of methods of caries prevention in dental public health made an assessment of the different fluoride methods and their application to changing the pattern of dental caries in communities. (71a)

The most successful method reported by this workshop (71a) and in other reports (110, 112, 239a) was community water fluoridation. Many studies have shown a conservative benefit of 50 per cent caries reduction in permanent teeth in schoolchildren who have had a lifelong exposure to water fluoridation. Dirks (110) quotes studies showing caries reductions in deciduous teeth of 50 per cent in 2-5 year old children.

Systemic effects of fluoride can also be achieved by other methods, for example, school water fluoridation, fluoridated salt, fluoride tablets or drops. (199a) Commensurate effects (community water fluoridation) have been achieved with tablets (54, 135, 263, 300) and salt fluoridation (265). There is a significant difference if the supplement (for example, tablets) are administered from birth (54) as the benefits are imparted to tooth structure while it is forming. Any school-based programme of fluoride supplementation (school water fluoridation, fluoride tablets) only imparts its systemic and topical effect from the time the child begins school, usually at the age of 6 years. This means that those permanent teeth which have already

calcified do not receive the benefits of systemic fluoride [290]. In a review of school fluoride supplement regimes, Driscoll [122] has shown that there was an overall reduction in carious permanent teeth of up to 35 per cent. Marthaler's [263, 264] studies show a greater reduction in new carious surfaces as distinct from carious teeth in school fluoride supplement programmes.

Fluoride, besides reducing the number of teeth and surfaces decayed [112], will reduce the severity of the carious lesion [290, 385] and hence the treatment requirements [263] in terms of larger or smaller decayed areas and pulpal involvement. Dirks [110] also points out that as there is a greater reduction in interproximal and smooth surface decay, the pit and fissure decayed areas remaining need less complicated restorations.

The topical effect of fluoride on teeth can also alter the pattern of dental caries especially in terms of treatment requirements. [290]

Topical methods can be classified in the following manner [199a]:

1. Operator applied fluorides:
   - i solutions, gels, slurries, varnishes
   - ii prophylaxis pastes

2. Self applied fluorides:
   - i mouthrinses
   - ii toothbrushing with solutions and gels
   - iii toothbrushing with prophylaxis pastes
   - iv fluoride gels in tray applications
   - v fluoride dentifrices
   - vi dietary supplement - fluoride tablets

Scientific support for adopting these caries preventive methods comes largely from the findings of controlled clinical trials. The results in terms of evaluations can be different in terms of "experimental" clinical trials and "community" clinical trials. [303] However, the overwhelming evidence is that professionally administered and preventive agents are successful in reducing caries in non-fluoride areas by up to 40 per cent. [200]

In a fluoridated community the percentage reduction in dental caries increment is about 20 per cent. (185)

Fluoride mouthrinsing programmes have variously reported reductions of from 20-50 per cent in incremental caries. (185) These also report a 20 per cent reduction in caries with supervised tooth-brushing with fluoride solutions and gels and a 25 per cent reduction using fluoride containing prophylaxis paste. Studies on gel applied in trays gives a reduction of up to 55 per cent when administered daily (131), 25 per cent when given four times per year for three years. (425) Studies (135) have shown a caries preventive effect of fluoride dentifrices in non-fluoride areas. In Australia (38) over 80 per cent of all dentifrices sold contain fluoride. Heifetz (185) reports that studies conducted in non-fluoride areas have shown that the effect of topical fluoride therapy is greater on smooth or proximal surfaces than on pit and fissure surfaces.

The ability of topical fluorides to show additive benefits in a fluoride area is limited. (438a) Modest reductions have been demonstrated however. (112, 199) Corpron (89) points out also the benefits of fluoride therapy for special patients, e.g. physically and mentally handicapped, medically compromised, e.g. patients with leukemia, haemophilia or orofacial irradiation.

As discussed, fluoride significantly alters the basic susceptibility to dental caries and also the disease pattern in terms of sites affected, caries increment, progression within the lesion. The factors which then become relevant to the pattern of disease are the methods used to bring fluoride to the tooth systemically and topically, and their effectiveness since fluoride has been shown to affect the host microflora and the substrate, as well as being relevant over time. (233)

Bookstein and de Paola (62) in discussing a potential model for the interaction of enamel fluoride and plaque in the development of dental caries, suggests at low fluoride levels, challenge overwhelms resistance and at high fluoride levels, resistance overwhelms challenge. This yields a plaque caries dependency in an intermediate zone. The dental caries is a result of simultaneously opposing forces of challenge and resistance.

Epidemiology is the study of the incidence, prevalence, distribution and control of a disease or disability in a population or group and its associated variables. (101)

Dental caries is a universal disease affecting all populations. However there are social factors which significantly affect the basic susceptibility and disease patterns. These can be approached in the conceptual framework provided by the epidemiological model and encompass factors related to host (personal, groups or institutions), agent (intervention methods, strategies and materials) and environment (social, economic and political factors affecting host susceptibility or resistance to intervention activities), at levels of the individual, primary family networks, institutions, community, and nation. (447)

The influence of the above group of factors can act on all the factors previously described under the host, microflora, substrate and time model. When examining social factors, one can interpret them in a wide sense as the personal, social and cultural components of oral diseases and conditions. (341)

Area and Community Factors

Variations in diet and oral habits, both between and within populations, may also be dependent on social factors. These may have a profound effect on oral diseases and conditions, as well as an intimate relationship with sex and age.

Differences in caries prevalence have been reported in urban and rural populations. (27, 32) In general, caries prevalence is lower in rural than urban communities, but services for oral health care are more available in urban areas, hence untreated caries is likely to be higher in rural communities. (459a) Urban-rural differences in dental caries levels are properly determined only after statistical adjustment for socio-economic status, presence of water fluoridation, diet, and possibly the availability of the oral health work force. (409)

Differences in caries prevalence have been reported to be present in geographical climatic areas. (27) In cool, temperate zones, 85-90 per cent of the population samples examined are affected. (27) In lower latitudes, partic ularly in rural areas where traditional diets have been

retained, the prevalence is much lower. Geographical differences according to climate are also apparent in studies of dental caries prevalence in Australia.[15a], a higher prevalence occurring in the latitudes furthest from the equator. However the real reasons for the prevalence differences may be multiple.

Classification for caries prevalence can also be attempted on other area criteria of industrial|economic development. This gives a fairly consistent division, the highly industrialized nations having high or moderate prevalence and the developing nations a low, or very low, prevalence.[27, 189a]

Within either group there are further contrasts. The United Kingdom and mainly European cultures which were formerly British colonies have high disease levels. Data from other technically advanced European countries, e.g. Austria, Spain and the U.S.S.R. have recorded a moderate prevalence[27] Part of the explanation for these differences may be found in the cariogenicity of different diets. Also, different behaviour patterns and cultural attitudes to oral health and treatment needs are other possible factors influencing prevalence.

However data from the 1970's has shown distinct improvement in industrialized countries which traditionally have had high caries levels.[189a]

Ethnic factors, in addition to social and community variables, may play a role in differences in decay patterns between areas.[20a, 80a, 318, 353, 427, 466]

Socio-economic Status and its Concomitants - occupation, income and education.

A wide variety of indices have been used to measure and quantify socio-economic status. Socio-economic status has been defined in many different ways by dental epidemiologists and some investigators have collected data on one of its particular characteristics, e.g. occupation-income and equated this with socio-economic status. However as has been defined, most studies have pointed to a significant correlation between the presence of dental caries (measured by decayed (D) and missing due to caries (M) rates) and socio-economic status.[35, 353, 427, 459a]

When occupation, income, education and social class have been correlated to dental caries, significant relationships have been shown with income and education. (35, 341, 427, 428)

The studies have concluded that children in low socio-economic areas had the highest decay rates. However some studies have shown that the correlation of low socio-economic status and caries prevalence is not significant but that there was a significant correlation with treatment needed (35), that is, more unmet needs (i.e. decayed teeth) in those in low socio-economic groups or those with a lower income (341).

Occupation, while closely allied with income, has been considered by itself in a number of studies. Social class has been determined in terms of occupation in British studies. (71) Occupation studies have not shown strong correlations with prevalence except in specific occupations such as in the sweet industry or bakers and cooks. (10a, 341)

An area related to patterns of dental caries treatment that has been investigated with respect to socio-economic status is the number of missing teeth and the rate of edentulousness. With adults, edentulousness can also be the result of periodontal disease. Strong correlations have been found in the rate of edentulousness - income, occupation and social class. (83, 35b) The higher the income, the more skilled occupation and the higher social class have all had a lower rate of edentulousness. Studies (82, 459) have also pointed out that the rate of edentulousness also correlated with provider attitudes and service delivery policy and organisation and availability and accessibility of dental services.

A further modifying element of the socio-economic status is education. This is usually studied under years of education and levels of education. The length of full-time education has been shown to be related significantly with numbers of teeth affected by caries and tooth loss. (459a) The more education, the higher the standard of oral health and less loss of teeth. Some studies in children have shown that prevalence of dental caries declined as standards of parental education rose. (362) Types of school attended has been found to differentiate between children and their caries rates. (254) Differences

in the number of teeth decayed between children attending government and fee-paying schools have been discussed. (137) A lower caries prevalence was found in children of dentists than in children of other professional parents. (6)

Other Social Factors

Religion, family size and feeding habits all have social aspects and have been studied with respect to caries prevalence. (197, 255) Caries experience of Seventh-Day Adventist children has been studied and they showed a lower caries prevalence when compared to non-Adventist children. (197) It has been suggested that this might result from the educational programme of the sect which discourages excessive use of sweets and between-meal snacks.

Winter (443) considered the role of infant feeding habits and social status and showed that there was a relationship between social status, feeding habits and dental caries prevalence, the latter being higher in those using sweetened comforters and this was more commonly used in lower social classes.

Behavioural and Personality Factors

One study (207) related teeth affected by caries to I.Q. scores in 12 year old children and concluded that there was a trend for those with a higher I.Q. to have a higher standard of oral health. "Conflicting views are presented and further testing is required; however there does seem to be a basis for looking at personality factors and dental caries". (341, 390) Rayner (334) has pointed out the oral hygiene practices of the mother directly influences that of the child and that children have a low caries prevalence if their mother's oral hygiene practices are better.

Sex as a Factor in Patterns of Dental Caries

Some studies have shown sex differences in dental caries patterns, (36, 353) with females having a slightly higher dental caries prevalence. However no studies have shown which factors, if any, are related to this difference or whether it is influenced by earlier eruption of teeth in females. As dental caries prevalence studies are indexed according to age, females would have more tooth surfaces exposed for a longer period of time to caries environment of microflora and substrate. Adkins (1) suggests that post-eruptive tooth age exerts a profound influence on the

expected increase in decay rates during any given period of time.

Also there does not appear to be any reference to studies relating diet differences and age and caries prevalence to see if this could perhaps be a factor influencing this pattern. Oral hygiene practices at which females appear to have a higher frequency performance [36] do not seem to have a significant difference in altering dental caries patterns. Utilization of dental services by females [36] more frequently than males may be a factor in the differences in total decay rates between females and males. The female filled component is significantly higher. [385]

Previous Dental Caries Experience

Many studies have shown a very strong correlation between lifetime experience of dental caries and treatment for this and the presence of dental decay. [36, 55, 344, 422, 469]

Adkins [1] shows that dental caries increment is a unimodal function of initial caries experience. When groups of teeth are correlated for this factor, 60 per cent of the variance can be identified.

Rise et al [344] showed that prevalence of filled surfaces at 9 years could be used as a screening criterion for prediction of future caries incidence.

Zadik [469] showed an association between caries of deciduous teeth and caries of permanent first molars of 5 year old children. Practically none of the children in the survey had treatment and it was not possible to study the factor of early treatment of the deciduous teeth on the caries experience of the permanent dentition.

Parent-Child Similarities in Dental Caries Rates

Garn [148] reports a study which shows a positive and statistically significant correlation between parent and child dental caries rate. Also another factor emerged. That mother-child similarities in DMFT scores were statistically higher than father-child similarities and Garn notes previous reports of this factor and suggests that it does not have a simple genetic explanation. When considering parent-child similarities, genetic factors, diet, and behavioural oral hygiene practices are involved.

In summary, the main epidemiological characteristics of dental caries are: It is a disease of modern man, is common worldwide but uneven in prevalence. The prevalence increases following adoption of diets common to highly developed societies and there is a definite and positive relationship between caries attack rates and the use of refined sugar. Carious lesions begin to develop soon after tooth eruption in susceptible populations and the attack rate is highest during childhood and adolescence. The carious process in populations whose susceptibility is moderate to high is inhibited by the intake of fluoride from birth through the tooth maturation period and by topical application during this period and after. (166)

"In broad terms, the aetiology of dental caries may be considered as a conflict between factors conducive to tooth decay and factors promoting resistance to the disease, each of these opposing forces being susceptible to environmental influences." (453)

When variables affecting resistance, environment and virulence are standardized as far as possible in experimental situations, certain features of dental caries process are recognizable. The disease does not occur in the absence of bacteria, and it requires the presence of readily-fermentable carbohydrates in the oral cavity.

Both these factors - micro-organisms and dietary substrates contribute to the formation of dental plaque and its maintenance on tooth surfaces and are conducive to dental caries. (453)

Resistance to dental caries may reside in the intrinsic structure and composition of the teeth. This includes the surface configuration of teeth, increased fluoride content of enamel and trace element content of enamel. Also, the oral environment and saliva may be factors in this resistance. Systemic factors include genetic, prenatal, post-natal maternal influences, nutrition and general metabolic functions. External and environmental factors that modify both resistance of the teeth and the factors conducive to dental caries are firstly, geographic factors which include the presence of fluoride and other trace elements in the soil, water and food. Geography may also modify socio-economic conditions which in particular affect diet and health beliefs and concomitantly as a result condition health practices. (453)