The Forsyth Experiment
AN ALTERNATIVE SYSTEM FOR DENTAL CARE

Ralph R. Lobene with Alix Kerr
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RALPH R. LOBENE, with ALIX KERR

The largest unmet health need in this country—and potentially the most costly—is for dental care; meeting this need would strain existing personnel and facilities beyond capacity. This book reports an experiment in delivering dental care by means that are not traditional but preserve the high standards that have been achieved by American dentistry.

At the Forsyth Dental Center in Boston, Massachusetts, graduate dental hygienists received additional training in the administration of local anesthesia, drilling decayed teeth, and filling them. The program was designed to prepare dental auxiliaries to undertake restorative treatment under the direct supervision of a dentist who assumes ultimate responsibility for planning treat-
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Ralph R. Lobene, D.D.S., M.S.
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Alix Kerr

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Dedicated to my wife
The invitation to write a foreword for *The Forsyth Experiment* was an interesting and welcome one because it provided an opportunity to recall a similarly named adventure precisely forty years ago and to speculate on what had happened, if anything, in the intervening two generations.

There must be something in the enduring New England winters that provides thoughtful hours for thoughtful persons to develop programs for the enhancement of the service which the dental profession renders to the public. In 1905, Alfred C. Fones, Bridgeport, Connecticut, proposed the basic concept of what is now dental hygiene and organized the first training program in the same city in 1913. In 1949, the legislature of the Commonwealth of Massachusetts enacted legislation to permit the Forsyth Dental Infirmary, Boston, to establish a five year research project in the training of dental hygienists to prepare and fill simple cavities in the teeth of children. In the next year, under drumfire from the profession, the law was repealed.

But good ideas sometimes have a long gestation period.

So it was not until 1961, that the Commission on the Survey of Dentistry of the United States recommended that "the dental profession conduct studies designed to develop and expand the duties of auxiliary personnel. The broadening of services should begin with dental hygienists because there is already an approved program of education and licensure for this group. The legal and educational restrictions against male hygienists should be removed."

It is a commentary on our egalitarian times that the last recommendation was carried out before the other two were implemented
strongly enough to provide the profession with a basis for needed decisions.

But there was a generation of long New England winters between 1949 and 1969 when Dr. John W. Hein, Director of the Forsyth Dental Center, decided that it was time again to experiment with expanding the duties of dental hygienists to drilling and filling the teeth of children. The program was to be compatible, except for its sophistication and longer duration, to the training of the New Zealand dental nurse who has met with the approval of the dental profession in that country since 1921.

Dr. Hein was successful in obtaining all of the cooperation and approvals needed for such a program which was launched with Dr. Ralph R. Lobene as Project Director in March 1972. The interesting story of the stops and starts, the failures and successes, of Project Rotunda is Dr. Lobene’s to tell and he does it with precision, objectivity, and skill.

This program was also terminated, in June 1974, under pressure of an opinion from the attorney general of the Commonwealth stimulated by the board of dental examiners. There must be something else about those New England winters that has not yet been fully revealed.

The experiment was carried to the point of team configurations and simulated private practice but other studies could not be completed. Nevertheless, the experiment and this good account of it will be a very valuable contribution to the literature on the subject of expanded duties and a firm step toward meditation, decisions, and actions by the dental profession.

Harold Hillenbrand, D.D.S.
Chicago, Illinois
The omnipresence of change in society can also be seen in world­wide systems for the delivery of dental care. During the past two decades, American dentistry, once described as a cottage industry, has been challenged by alternative systems to provide more high quality care for more people at the lowest possible cost. This is a worthy goal in the best American tradition of more for less. At the Forsyth Dental Center we saw a need and we searched for an answer.

A plan was carefully designed and carried out on an experi­mental basis to test a system in which the solo private practice den­tist was the central figure supervising teams of auxiliaries with dif­ferent levels of skills, providing patient services under the direction of the dentist. Our research centered on ways of providing restora­tive dental services because most general dentists spend most of their productive treatment time on this basic need. If the dentist's productivity could be maximized here, the public might achieve important savings.

Our research was terminated in 1974 when legal objections to the experiment were raised. A final report of this study of new duties for dental hygienists was issued in September 1975. This report included all the data available at that time and made recommendations for implementation of an alternative system for dental care. The findings were controversial. Stories in local and area newspapers engendered lively discussions among dental professionals, legislators, and the public. The Massachusetts Dental Society challenged the credibility of the report and its recommendations. After a stormy period of debate and with the support of the American Dental Association, the Massachusetts Dental Society appointed a
"blue ribbon commission" to evaluate the report. (The commission's findings are published in *The Journal of the Massachusetts Dental Society*, Volume 25, Number 4, pages 200-216, Fall 1976.) Most of the data used in this book have been distilled from the final report of 1975; additional findings, not available at that time, have also been included here, as have other analyses of the data.

We have tried to look at our work critically, secure in the knowledge that research thrives on replication and that the conclusions reported here are by no means to be considered the final word. They are offered to the dental profession (educators, students, and practitioners), the administrators of third party payment plans and governmental regulatory bodies, legislators, and health officials so that they can make unemotional, rational decisions concerning oral health. Our plan—Project Rotunda—has proposed an alternative system for dental care delivery. In a society of free men and women and free enterprise, it deserves the opportunity to prove its worth in open competition with existing and other innovative systems to serve the dental needs of the people.

Ralph R. Lobene, D.D.S., M.S.
An endeavor of the magnitude of Project Rotunda would not have been possible without the commitment of many individuals and organizations to the Forsyth Experiment. It is with a deep sense of gratitude that I acknowledge their contributions to the success of the project and this book.

Dr. John W. Hein was in a real sense the moving force behind the efforts to revive the aborted 1949 Forsyth study of new duties for dental hygienists. With his guidance, the Trustees of the Forsyth Dental Center enthusiastically supported the project from the outset. My assistant project director, Dr. Lloyd B. Chaisson, merits special mention for his outstanding skills in restorative dentistry and for his role in the design of the experimental curriculum. His ability to communicate effectively with our advanced skills hygienists and dental assistants fostered the team spirit that was necessary to sustain us.

A special note of thanks is due to Doctors Roy A. Colella, Melvin Gulbrandsen, Minoru Horiuchi, George L. Keleher, and Leonard F. Nolan, private practitioners who served as staff dentists, and to Mary B. Newman, administrative assistant, and Maureen McCarthy, supervisor of auxiliaries, who had the responsibility of coordinating the efforts of doctors and auxiliaries.

Lorna Bronhard, Maryann Carrazza, Kathy Daley, Christel Koppel, Barbara McCormack, Lisa O'Loughlin, Marcia Seltzer, Cheryl Singer, Constance Stone, and Denise Vezina, the advanced skills dental hygienists, contributed their knowledge to alternative systems for dental care, and I am grateful for their dedication to the project. They were ably supported by Denise Anderson, Willie Brooks, Susan Jenkins, Marilyn Keenan, Carol Lund, Patricia
McGoldrick, Denise Meehan, Carol Mucci, Susan Palmeri, Eileen Regan, Ellen Roberts, Lynn Scaffidi, and Maureen Sullivan, the dental assistants who completed the teams. For her secretarial labors, I am indebted to Leslie Levitt. If there are errors of omission or commission in the text, they are mine alone.

We are all deeply indebted to the Frederick J. Kennedy Memorial Foundation, which provided the funds to construct and equip the dental rotunda for research in the delivery of dental care. The availability of this facility was the key to the success of Project Rotunda. Today it continues to serve the needs of new innovative programs for dental care delivery.

The late Dr. Nathaniel H. Barish, of the National Center for Health Services Research, will long be fondly remembered for his encouragement and guidance in arranging grants which in part supported this research project.

Recognition is also due to The Robert Wood Johnson Foundation for grants supporting the final phase of the study of new duties for dental hygienists and the preparation of this book.
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to the Experiment</td>
<td>1</td>
</tr>
<tr>
<td>Experiments Elsewhere</td>
<td>16</td>
</tr>
<tr>
<td>Design of the Experimental Study</td>
<td>44</td>
</tr>
<tr>
<td>Results of the Educational Experiment</td>
<td>60</td>
</tr>
<tr>
<td>Evaluation of Results</td>
<td>67</td>
</tr>
<tr>
<td>Application of Results to Simulated Clinical Practice</td>
<td>92</td>
</tr>
<tr>
<td>Summary and Conclusions</td>
<td>113</td>
</tr>
<tr>
<td>Epilogue</td>
<td>118</td>
</tr>
<tr>
<td>Appendix 1 Evaluation Manual: Criteria for the Evaluation of Restorative Procedures</td>
<td>133</td>
</tr>
<tr>
<td>Appendix 2 Summary of Key Events</td>
<td>138</td>
</tr>
<tr>
<td>References</td>
<td>140</td>
</tr>
<tr>
<td>Index</td>
<td>147</td>
</tr>
</tbody>
</table>
The Forsyth Experiment
CHAPTER 1

INTRODUCTION TO THE EXPERIMENT

THE EXPERIMENT REPORTED HERE explores one approach toward meeting the most formidable challenge that dentistry faces in the next decades: delivering high-quality oral health care to the entire population—approximately twice the number of Americans who now annually receive at least minimal dental therapy. This goal can be met only by greatly reducing the costs of dental training and service so that the necessary manpower and money will be available to organize an efficient delivery system. In line with the trend toward increased use of auxiliary personnel throughout the health field, the Forsyth Dental Center undertook to evaluate the results of giving a well-established category of auxiliaries—dental hygienists—the relatively brief extra training necessary to perform routine procedures that tradition holds should be executed exclusively by dentists.

These delegated duties include the two basic phases of restorative dentistry—drilling and filling cavities in decayed teeth—as well as administering local anesthetic injections. Because procedures that penetrate or cut oral tissues are deemed irreversible, in the sense that they cannot literally be undone, the investigation and its potential application in care delivery were based on the principle that the expanded duty auxiliary should always work under the direct supervision of a dentist. The latter would assume ultimate responsibility for treatment planning, performance quality, and patient safety.

Outside the United States, a pioneer program that delegated restorative dentistry to personnel with less training than a dentist was successfully inaugurated by New Zealand in 1921. However, the
first such American auxiliary training experiment, which the Forsyth Dental Center initiated in 1949 with a federal grant from the Children's Bureau, was swiftly halted by unanticipated professional misinterpretation and opposition. The aborted study lasted just long enough to provide evidence that the educational goals were achievable. Thus, when American dentistry entered a period of change and reassessment in the 1960s, Forsyth set about planning a revised and much more cautiously introduced experiment, the subject of this book.

**Forsyth: Change and Growth**

The unique history and philosophy of the Forsyth Dental Center produced an especially favorable environment for the controversial experiment of educating and evaluating dental auxiliaries in a greatly expanded area of responsibility. Founded in 1910 with a bequest from James Bennett Forsyth, an industrialist who became interested in oral health after many talks with his dentist, the Boston center was the first philanthropic institution in the world devoted to carrying out dental service, education, and research.

Initially the emphasis was on providing training and service in the hitherto neglected field of children's dental problems. The handsome Greek revival building, opened in 1914, was originally named the Forsyth Dental Infirmary for Children. For several decades, the infirmary's internship program was the only postdoctoral experience available to dentists, and thousands of school children received free pedodontic care each year in the Forsyth clinics.

At about the same time, increasing interest in preventing oral disease gave rise to dental hygiene as a field of training. In 1916 Forsyth showed its early recognition of the value of adding auxiliary workers to the dental team by founding the nation's second school of dental hygiene. In the 1960s the Forsyth School for Dental Hygienists was the largest in the country and is still the largest private training center.

The Forsyth charter committed the institution to serve scientific purposes and "aim higher than the mere repair" of decayed teeth. In the 1920s a program of research directed toward finding and eradicating the causes of oral disease was deemed essential; the infirmary's restorative treatment of Boston children could not keep up
with their rate of caries development. But there were no established dental scientists to hire: a new breed of investigators had to be cultivated. Forsyth's small but sound research program made many contributions to basic knowledge and set a pattern that was greatly expanded after World War II.

The order of Forsyth's priorities has shifted according to perceived needs. As other institutions developed pedodontic training and service programs, the infirmary's internships and clinical care delivery to school children were curtailed. In 1963 the institution was renamed the Forsyth Dental Center, and its diverse functions were assigned to three separate divisions: the Forsyth Dental Infirmary, which at a modest level continues to provide patient care and advanced training in the dental specialties; the Forsyth School for Dental Hygienists, which includes all research and training activities related to the education of dental auxiliaries; and the Forsyth Institute for Research and Advanced Study in Dentistry.

In recent years, the internationally recognized research institute with a staff of nearly a hundred investigators has been ascendant. Its studies run the gamut from extremely basic inquiries, such as ultrastructural analyses of dental enamel by electronmicroscopy and new ultrasound techniques, to applied research, including clinical trials of experimental anticaries agents. The microbiology and chemistry of dental plaque formation have received major emphasis in a great variety of studies using germ-free animals infected with pure cultures of bacteria isolated from human mouths.

Ample space for both the institute's laboratory research activities and a clinical teaching facility designed especially for the expanded duty auxiliary study was obtained when a large new building, the Austin Smith Research Wing, was linked to the original Forsyth infirmary and completed in 1970.

**Trends in American Dentistry**

For dentistry, the last decade has been a time of flux and transition. Rising demands for dental service, emerging role changes among dental practitioners, and sweeping recommendations for reorganizing both the training and practice of the profession's generalists and specialists reflect the feeling of impending crisis throughout the whole health care delivery field. Proposals for expanding
Greater sophistication about health matters finally made the average American realize that dental care is everyone's right (Lobene, 1968). The outdated philosophy that this health service is a privilege to be enjoyed only by people affluent enough to afford it has long been tacitly accepted by the dental profession. As a result, American dentistry's manpower, educational facilities, and styles of practice are geared to meet the needs of, at best, half the population. It is conservatively estimated that in 1975 more than half of the American people received no dental care at all. Among those served, only about half received comprehensive care, while the others merely obtained emergency treatment. Dr. John Greene, deputy surgeon general and chief dental officer of the United States Public Health Service, recently stated that the largest and most costly unmet need in the entire health field is the need for dental care.

It is not surprising, therefore, that political forces as well as organized pressure from labor and consumer groups call for rapid extension of our ability to provide service—probably to all children, as a first step—even though achieving a much more favorable dentist-to-population ratio is beyond our educational capabilities in the foreseeable future. To make the best use of available manpower and promote cost effectiveness, consumer organizations have expressed their support for greater use of auxiliaries supervised by dentists (Angevine, 1973). Moreover, about 80 percent of dental school deans surveyed have predicted that increasing the productivity of existing dentists can probably best be achieved by using more chairside auxiliaries and expanding auxiliary functions (Wechsler, Williams, and Thurn, 1972).

Meanwhile, the usual mode of practice has been shifting away from the solo practitioner who provides total care as an isolated entrepreneur toward the group practice of dentistry. Consumers strongly endorse group practices for their advantages of peer-review when generalists and specialists work together, depth of available skills, facilitation of consultations, and reduced waiting time for patients (Angevine, 1973).
Enrollment in prepaid group practice plans tends to increase the frequency with which patients obtain regular care and preventive therapy (Dixon, 1970). Added reliance on auxiliaries is also fostered by the dental team approach characteristic of group practices.

The growing emphasis on both team dentistry and group practice has furthermore led to the proposed evolution of expanded duty dentists, or “super generalists,” who can comfortably assume responsibility for supervising expanded duty auxiliaries and serve as primary care coordinators. They may gain their expertise through advanced training and experience or through an expanded dental curriculum incorporating most of the fundamentals and clinical training now provided in postgraduate specialty programs (Stevens, 1969; Hein, 1975). The Council on Dental Education of the American Dental Association favors curriculum changes to produce generalists with a broad range of clinical skills. In addition, group practice itself seems to encourage individual general dentists to develop skills almost to specialist level so that they can treat almost any patient. The group practice’s specialists then devote their time to consulting with the general dentists and treating patients with exceptionally difficult problems (Jerge, 1972).

The rush of more and more dental school graduates into specialty training has been seriously questioned in recent years and may soon taper off. Many authorities contend that much of the work now referred to specialists will be done by the more broadly trained general dentists, while auxiliaries take over the bulk of the restorative work (Coady, 1973; Jerge, 1972; Hein, 1975). This forecast assumes that cost effectiveness will win out over factors that have favored the growth of specialization, such as dentists’ desire to avoid malpractice suits and consumers’ demands for quality assurance. Indeed, the present eight dental specialties may face future survival struggles in which their provinces could be largely annexed or merged (Coady, 1973). If that comes to pass, postgraduate specialty programs would produce small numbers of superbly trained clinician-scientist-educators working in academic settings or major health centers. To ensure competence, mandatory continuing education would keep the versatile generalists abreast of new clinical advances in all areas of practice (Hein, 1975).

Moreover, the bread-and-butter role that restorative dentistry
has played in most general practices can be expected to decline when high priority is given to decay-preventing measures, as is now consistently urged. Wider fluoridation of water is certainly the most important preventive recommendation, but multifaceted approaches including the use of topical fluorides and pit and fissure sealing are undergoing intensive study to quantify their effectiveness in various combinations. A major aspect of caries prevention—education of patients in personal oral hygiene and desirable eating habits—will clearly receive greater attention as prepaid dental plans increasingly cover its cost.

The looming prospects for comprehensive national health insurance and government-subsidized health maintenance organizations magnify the potential for caries-preventing measures and may reduce the prevalence of restorative dentistry. As indicated by existing dental insurance plans set up by unions and other groups, the economic outgrowths of widespread prepayment will include mandatory disclosure of costs, as well as pressure to make the consumer health dollar stretch farther, both of which will require the use of more auxiliaries.

Numerous precedents suggest that most patients will accept and approve the delegation of routine dental functions to auxiliaries. Medicine offers many examples of functions traditionally performed by physicians that are now carried out by nurse practitioners, nurse midwives, physician's assistants, and other new types of paramedical aides. Women patients have reported enthusiastic appreciation for the personalized service given them by nurse midwives, who are licensed in most states to deliver babies in hospitals under a physician's supervision as well as to provide prenatal care and conduct routine gynecological examinations (Foreman, 1976). Several studies of pediatric nurse practitioners, who conduct well baby and child examinations, have demonstrated high levels of parental satisfaction with the care received (Charney and Kitzman, 1971; Day, Egli, and Silver, 1970). Over 90 percent of one group of parents considered this use of nurse practitioners in private pediatric practices to be a desirable and inevitable trend. Another acceptance evaluation of physician's assistants trained in Medex programs yielded the following high ratings: 91 percent of the surveyed patients were very satisfied with provided services, 89 per-
cent thought the auxiliary was very competent, and 71 percent indicated that the quality of care improved after the auxiliary joined their primary care physician's practice (Nelson, Jacobs, and Johnson, 1974).

Experience with expanded duty dental auxiliaries in foreign countries has revealed similarly positive patient responses. Those programs and the relatively few studies conducted so far in the United States, which have also shown high levels of patient acceptance, are reviewed in chapter 2.

Within the American dental profession, however, acceptance of the concept of delegating irreversible procedures, such as routine restorative work, still is not high. One reason suggested is that many dentists may not yet feel as secure about their professional image as physicians do. Older dentists in particular may feel threatened in giving over a large part of their work to a new kind of paraprofessional, since they recall the struggle dentists went through to end their own former categorization as paraprofessionals and win recognition as medical professionals. In any case, dentists have been slower than physicians to delegate duties. For example, the fact that in medicine registered nurses administer drugs by vena puncture has made little impact on dentistry.

Recent surveys of practicing dentists in the states of Georgia (Waller, 1973), Minnesota (McKenzie and Born, 1973), and Connecticut (Tryon, 1974) showed that only about 30 percent of respondents favored allowing auxiliaries to place and finish fillings in cavities prepared by dentists. As for auxiliaries preparing cavities by drilling, the delegation approval rates were less than 20 percent in Minnesota, less than 10 percent in Georgia, and 3 percent in Connecticut. Less than 20 percent of the Georgia dentists said that they would accept the administration of local anesthesia by auxiliaries, and the rate was about 15 percent among responding officers in a U.S. Army Dental Corps survey (Heid and Blair, 1973). Age and the type of care delivery systems in which the dentists practice evidently have some influence on acceptance. Thus, a Washington State survey found that about 50 percent of responding dentists aged thirty or less favored delegating local anesthesia administration and placement and finishing of fillings in contrast to 5 percent or less of responding dentists over age sixty. In the army, with its
free care, mandatory periodic examinations, and extensive preventive dentistry program, the demand for service is high and nearly 60 percent of dental officers approved delegating the placement and finishing of fillings.

The national policy-making body of organized dentistry, the American Dental Association's House of Delegates, has been adamantly opposed to delegating the three types of procedures. Although its Council on Dental Education had submitted to the 1976 annual meeting a liberalized policy statement on the expanded use of auxiliaries, including resolutions permitting hygienists to place and finish restorations and give local anesthesia under some circumstances, the House of Delegates refused to adopt them. Instead it reaffirmed its formal policy that cutting of hard tissues, restorative procedures, and anesthesia administration should not be delegated, even though many state jurisdictions allow auxiliaries to perform the second and third functions. For example, in 1975 nine jurisdictions legally permitted dentists to delegate to hygienists both the administration of local anesthetic agents and the carving of amalgam restorations (Council on Dental Education, 1976).

In good part, professional resistance stems from the serious problem of the maldistribution of American dentists. In many urban middle-class areas, the dentist-to-population ratio is high and competition for work is too keen to encourage delegation of any but the least-skilled office functions. This situation was reflected in the 1976 resolution stating that the American Dental Association "supports the fullest utilization of dentists before the delegation of expanded functions to auxiliaries in the treatment of patients." But it does not answer the problem of supplying care to the millions of Americans who live in underserved rural areas and less-desirable practice settings.

The eventual care delivery configurations and reassignment of functions that will emerge from the present era of change in American dentistry are far from plain. The need for cooperation from the profession's policy-making and credentialing organizations to ensure the orderly development, education, and use of expanded duty auxiliaries is still largely unmet. Even more crucial is the question of whether organized dentistry can meet soaring service demands in
flexible and farsighted ways or whether it will let government take over by default.

**Premises of the Experiment**

Forsyth's rationale for undertaking the recent study is based on the following premises that support assigning restorative dentistry to auxiliaries and selecting hygienists as the most logical auxiliaries to assume the delegated duties (Lobene, 1974; 1975a):

First, only one approach appears to have a realistic chance of both lowering care delivery costs and rapidly expanding the service capability of the dental profession. It consists of greatly extending the effectiveness of the available practitioners by supplying them with competent auxiliaries who can take over a large part of routine dental care. Restorative services now make up the bulk of the public's need for such care. They consume more than half of the typical general practitioner's working time and constitute the area where cost reductions would have the greatest impact on dental economics. Furthermore, the childhood years are the time when dental decay requiring restorative procedures is at its peak, and care delivery systems aimed at treating the entire population will immediately focus on reaching all children.

Second, the much-needed cost reductions can best be achieved by creating a new pool of professionals with no less and no more training than is necessary to perform restorative dentistry's repetitive manual procedures according to a dentist's treatment specifications and with his verification of performance quality. These skills can be acquired through an estimated two years of inexpensive education and internship in contrast to the seven or eight years and more than $60,000 which must be invested to obtain a dental degree and which largely account for today's high hourly charges for restorative work. The Forsyth experiment was designed to test the hypothesis that, by delegating local anesthesia administration and routine drilling and filling operations to one or more auxiliaries, dentists can serve many more patients per day, reduce restorative costs, devote more of their own time to challenging procedures such as endodontics, and actually increase the net income of their practices.
Third, the choice of hygienists as the logical auxiliaries to receive restorative dental training was based on many favorable factors: their long history as a formal part of the dental scene, the fact that hygienists are licensed whereas dental assistants are not, the large number (more than 180) of American dental hygiene schools with well-equipped clinical teaching facilities, and their extensive two-year curriculum emphasizing the basic sciences. Indeed, given their traditional education and duties, it seemed clear that hygienists as a group were being overtrained and underused.

The procedures usually assigned to dental hygienists in private practice—primarily carrying out oral prophylaxis, applying topical fluorides, and instructing patients—and the limits on their functions set by most jurisdictions have not been commensurate with their background in basic biology (516 hours at the Forsyth School for Dental Hygienists). Thus they represent an inadequately tapped resource. Their curriculum already includes many courses educators consider prerequisites for clinical dentistry. Their schools could be expanded to teach advanced skills. And in economic terms, it costs less than $1.5 million to build a new hygiene school as opposed to the $15 million to $35 million needed for a new dental school.

Fourth, Forsyth's aim in training "advanced skills hygienists" was not to create a category of second-class dentists but to help construct a sound career ladder in dental education. Dentistry's two main auxiliary positions—the chairside dental assistant and the dental hygienist—have tended to be dead ends. A very recent exception is the rapidly growing encroachment of dental assistants into the work province of hygienists, which further discounts the hygienists' superior education. Besides being generally unlicensed, dental assistants learn their skills either in one-year courses or, more usually, through on-the-job training. Nonetheless, many jurisdictions now allow them to apply topical fluorides and polish the surfaces of teeth as well as to perform expanded functions such as placing a matrix or rubber dam. In some of the few states that allow dentists to delegate the insertion and carving of amalgam fillings, the rule applies to dental assistants as well as to hygienists. In 1975 the only expanded function legally delegable to hygienists in nine
jurisdictions but not to assistants in any jurisdiction was local anesthesia administration (Council on Dental Education, 1976).

If a career ladder evolves, as seems to be happening, the large gap between the education of dental auxiliaries and of dentists will narrow. But the educational and credentialing rungs should be defined in a systematic way both to ensure competence and to avoid overtraining and underuse. The dental assistant occupies the lowest rung, the traditional hygienist the next, and the advanced skills hygienist (trained in restorative dentistry or routine aspects of other fields) third in line, just below the dental generalist. A recent University of Oklahoma study found that dental hygiene students, given a biostatistics course designed for and taken by dental students, obtained grades that were highly correlated with those of the dental students (Shapiro, Avery, and Ferguson, 1975). The conclusion was that hygienists who have shown academic potential should be able to go back to school with advanced standing and work for a higher degree. The same should be true of assistants.

Fifth, research in preventing tooth decay could suddenly yield a breakthrough. The existence of a major research institute within the Forsyth Dental Center suggests that the ultimate answer lies in prevention but that no miraculous discovery appears to be on the horizon. But at present it makes good sense to concentrate as much routine restorative work as possible in the hands of auxiliaries who have a lesser educational investment in their careers than dentists do. Dentistry will then be in a much better position to allocate the future manpower supply to meet demands and needs.

Finally, the efficiency and economy derived from employing advanced skills hygienists might give the private practice of dentistry a better chance to survive against the threat of socialized alternative systems of dental care delivery. If the auxiliaries were used first in the private sector, they might be of considerable help in demonstrating that government control is not needed to extend adequate dental care to the entire population.

In the early planning for Forsyth’s second attempt at training hygienists in restorative dentistry, it was recognized that a major professional relations effort had to precede the experiment and secure vital support for it. The task was undertaken by Dr. John W. Hein,
former dean of Tufts University School of Dental Medicine, who became Forsyth’s director in 1962 and played a leading role in the project’s conception. From 1966 through 1970 he employed a quiet personal approach in making frequent presentations to state and local dental society members and the board of dental examiners. In portraying the experiment, Dr. Hein stressed the following principles: the plans merely called for educational research; no attempt was made to hide the ultimate full extent of the experimentation; the purpose was to try to provide the private sector of dentistry with a method of delivering more care at lower cost; and only the dental profession, not Forsyth, could implement the findings if results were favorable.

**Fundamental Questions**

The new experimental program to train and evaluate advanced skills hygienists, which the Forsyth trustees approved in 1965, set out to answer three fundamental questions:

1. Can dental hygienists be taught to give local anesthetic injections and do high-quality cavity preparations and restorations through relatively modest and economical additions to their established two-year education?

2. Under clinical conditions, how does the productivity of such trainees, working in four-handed teams with chairside dental assistants under the supervision of dentists, compare with that of dentist-assistant teams?

3. What impact does employing advanced skills hygienist-assistant teams in various practice situations have on the costs and income associated with care delivery?

**How the Educational Experiment and Data Collection Were Conducted**

The first requisite of the experiment was a survey of the considerable world literature on programs in which major restorative functions normally performed by dentists have been delegated to auxiliaries. This discussion, which considers effectiveness and drawbacks and describes Forsyth’s aborted experiment in 1949, is presented in chapter 2.
Chapter 3 details the professional policy understanding on which Forsyth based the experiment and the many factors considered in developing the curriculum. The procedures to be taught are briefly defined for nontechnical readers. Also included are inputs from other curriculums and site visits, design of a new teaching facility and training aids, projected hours and content of didactic and practical experience, a selection of trainees and patients, and use of chairside assistants.

Chapter 4 takes up the first phase of the Forsyth Experiment, Project Rotunda, which deals with the results of the educational experiment. This describes the curriculum modifications which were possible in teaching both the theory and clinical practice of restorative dentistry by using the principle of "need to know" as opposed to "nice to know." The outcome of these changes in teaching strategies are discussed in terms of learning rates, productivity, and the potential impact on the cost of education of these operating auxiliaries.

Results of the didactic and internship training phases are analyzed in terms of the educational planning. The most noteworthy finding was that only about half of the projected instruction and practice time was required for acquisition of the specified clinical skills. Thus, extra hours of more advanced restorative training could be included in the shortened educational period. Chapter 4 also assesses the costs of the advanced skills training and the feasibility of incorporating it within a two-year dental hygiene curriculum. It presents comparisons with the much greater costs and time required in training dentists.

Chapter 5 discusses the development of criteria and procedures for conducting evaluations of the quality and acceptability of the advanced skills hygienists' performance—including blind comparisons with dentists' work by extramural examiners. This entailed drawing up a performance point scale, an evaluator's manual, and a standardized performance evaluation form. Other evaluations for quality of the auxiliaries' work included daily intramural evaluations by staff dentists. The results of bitewing radiographic assessment for overhanging margins of fillings as a measure of the quality of restorative dentistry are also presented.

Because the administration of local anesthetics for either infiltra-
tion or nerve block anesthesia by auxiliaries is highly controversial in dentistry, the success rate and the safety with which local anesthetics were administered in this study are reported in this chapter. Finally, an estimation of the patient acceptance of auxiliaries doing dentists' work is found here.

Chapter 6 provides data on the auxiliary teams and dentists' use of time, their productivity and projected income and expenses using a variety of clinic settings and mixes of auxiliary personnel. The activities of a dentist supervising one to ten advanced skills hygienist-assistant teams was studied. His productivity and hypothetical income are calculated when he supervises the optimal number of one or two such teams and still has most of his own time to devote to patient care. Cost accounting estimates of gross incomes, expenses, and salaries associated with these combinations, compared with available data on Massachusetts solo dental practices, indicate that it would be economically feasible and attractive for private practice dentists to employ advanced skills hygienist-assistant teams to render high quality restorative service to more patients while containing costs to consumers.

Chapter 7 presents a summary of the findings of the study related to education of advanced skills hygienists, the quality of their work monitored daily and by extramural evaluators, their acceptance by patients, the time allocation of supervising dentists, and an analysis of combinations of dentists and auxiliary teams' productivity, projected incomes, and expenses. These findings support a number of conclusions and recommendations which were made based upon the data and specific assumptions stated at the outset of the study.

In the epilogue, chapter 8, the professional relations outcome of the experiment, which once again drew organized resistance, is described. A small group of Massachusetts dentists attempted to close down the study. Although the experiment was completed as originally planned, further expanded duty auxiliary training and practice research was prohibited by an opinion rendered by the Attorney General of Massachusetts. The epilogue also presents the Forsyth Project Director's appraisal of the future implications of expanded duty auxiliary programs such as the study described in this book, their prospects for gaining professional acceptance, and their potential impact on dentistry in the changing climate of health care
delivery. The passage of a dental practice act in 1977, which liberalized the laws under which nonprofit institutions chartered in the Commonwealth of Massachusetts could conduct research in dentistry and the delivery of dental care, should provide the dental profession with realistic data upon which to structure future systems for the delivery of dental care for all our people.
THE DUTIES OF dental auxiliaries have been greatly enlarged since Dr. C. Edmund Kells of New Orleans hung a sign in his window stating “Lady in Attendance” to make it respectable for women patients to come to his office without bringing a chaperone. Dr. Kells announced the employment of this first known dental assistant in 1885, and by 1900 he was working with both a chairside dental assistant and a secretarial assistant. In 1906 Dr. Alfred C. Fones of Hartford, Connecticut, introduced dental hygiene as an auxiliary function when he trained his office assistant to clean and polish patients’ teeth. He soon opened a prophylaxis training school in his garage and in 1911 coined the name “dental hygienist” to characterize its graduates (Torres and Ehrlich, 1976).

As modern dentistry and its specialties evolved, so did hundreds of potentially delegable new tasks. Virtually all of the many procedures now assigned to American auxiliaries are reversible. Reports from various parts of the world, reviewed in this chapter, chronicle attempts to delegate the two major phases of restorative dentistry—the irreversible operation of drilling decayed teeth and the reversible but exacting process of placing and finishing fillings in prepared cavities. Although local anesthesia administration was also taught in the Forsyth experiment and can now be legally performed by dental hygienists in nine American states, there is no literature on educational programs or evaluations of proficiency and safety. The Forsyth experience with the delegation of local anesthesia is the first published data, as far as we know, to measure the ratio of successful local anesthetics on the first attempt to the number attempted.
THE NEW ZEALAND SCHOOL DENTAL NURSE PROGRAM

In contrast to the cautious approach in the United States, New Zealand's health authorities delegated both drilling and filling of children's teeth to auxiliaries more than half a century ago. The precedent-setting experiment was inspired by the same concern for children's rampant tooth decay that inspired the building of the Forsyth Dental Infirmary for Children in 1914. That was also the year during which Dr. Norman K. Cox, the president of the New Zealand Dental Association, appealed to members to help establish a national dental service for the country's primary school children, who had an unusually high caries rate. Dr. Cox pointed out, “I have no doubts that . . . a fairly short course could be arranged for state oral hygienists or state dentists, which course would not entitle them to the right of private practice but would be amply sufficient to make them thoroughly equipped for this branch of dentistry.”

World War I and moderate dissent from a minority of New Zealand's practicing dentists delayed government efforts at implementation until 1921, when the first class of thirty women entered a two-year program to become “school dental nurses.” Conducted by the Department of Health, the program today continues to prepare auxiliaries to staff clinics located in school buildings. The functions that dental nurses are licensed to perform only as employees of the New Zealand School Dental Service include oral examination and treatment planning, prophylactic therapy, drilling and filling of cavities, extraction of deciduous (baby) teeth under local anesthesia, pulp capping (vital nerve treatment), and oral health education.

The training program now offered by three dental nursing schools located in Wellington, Auckland, and Christchurch entails 2,600 hours of classroom and clinical work. During the first year, preliminary operative dentistry techniques are introduced. The entire second year is spent in operative work, first on a manikin and then in providing restorative therapy for patients.

Many aspects of the socialized program would probably be unacceptable in the United States. New Zealand dental nurses work
without the continuous supervision of dentists, although dental officers and nurse supervisors make frequent visits to verify that provided care meets the department's quality standards. Dental nurses use standardized equipment that would be considered antiquated in America. They do not give anesthesia for drilling and make many small fillings rather than larger, more effective ones. Permanent teeth are restored with carved and polished silver amalgam fillings, but fillings placed in deciduous teeth consist of unpolished copper amalgam. All service rendered by dental nurses is standardized, and the program does not allow for innovations by nurses to improve care, nor does it provide them with continuing education other than a refresher course every five years (Redig et al., 1973).

After an initial evolutionary phase that was described as tortuous, the program became increasingly effective (Bakdash, 1976). It took almost fifty years before there were enough dental nurses to serve the entire elementary school population, but now at least 95 percent of students up to the age of thirteen and 60 percent of preschool children receive free care, usually on a semiannual basis (Friedman, 1972). Furthermore, since 1946 adolescents thirteen to sixteen have been eligible for continued free dental care provided by private practitioners who are paid for these services by the Department of Health. In 1972 there were approximately 1,350 practicing dental nurses in New Zealand.

Recent site visits by American dentists (Redig et al., 1973; Friedman, 1972) have yielded favorable assessments of the program's quantitative and qualitative results. Redig's committee noted, "There is little doubt that dental treatment needs related to caries for most of the children age 2½-15 have been met. The combination of care provided by the school dental nurse and the private practitioner has essentially alleviated the effects of this disease among children covered."

Friedman, commenting on some earlier criticism of the technical quality of restorations, stated, "Having seen the product firsthand, I can attest to the adequacy of training . . . Many of the silver amalgam restorations in permanent teeth look like textbook illustrations . . . The unpolished copper amalgam restorations in deciduous teeth are not as pretty . . . But the teeth are there!" He also reviewed
radiographs of adolescents who had had restorations done by dentists as well as by dental nurses. Friedman observed, "I found no way to tell the difference . . . the majority of restorations made by both types of operators appeared quite adequate in the radiographs." According to Leslie (1970), the New Zealand ratio for extractions (E) to fillings (F) has been drastically lowered from 78.6E:100F in 1923, when the first dental nurses graduated, to 2.9E:100F in 1968.

The New Zealand program is entirely voluntary and has been almost universally accepted not only by parents and patients but also by the country's dental profession. Private dentists are relieved of the burden of routine pedodontic care but have a close working relationship with the dental nurses, who often refer children for complex services beyond their skills. The nurses are taught not to make exacting judgments but to seek consultation with supervisory dental officers. The program's administrators have evidently succeeded in their avowed aim of training "first rate technicians, not second rate dentists" (Friedman, 1972).

**Forsyth's Abbreviated First Experiment**

Suggestions that dental hygienists should be trained to fill American children's teeth in a dentist-supervised adaptation of the New Zealand auxiliary program had been previously suggested by Millberry (1939) and McCall (1944). Around 1947 the federal Children's Bureau became interested in financing an experimental project and asked the Massachusetts Department of Public Health to undertake its planning and execution. In the spring of 1949, the department's commissioner proposed that the Forsyth Dental Infirmary for Children conduct a five-year educational experiment in its hygienist school.

With Forsyth's board of trustees agreeing, the project was brought to the attention of the Massachusetts Dental Society and Board of Dental Examiners, and given a legal basis by the passage of a special law authorizing the hygienist trainees to prepare and fill children's cavities for the duration of the study. Twelve students were selected from the fall 1949 entering class to receive restorative dentistry instruction along with much of the basic hygienist curricu-
ulum. The training period was to last for two years and be followed by three years of clinical practice under dental supervision during which rigorous evaluations were to be conducted.

Almost as soon as the study was announced, however, the American Dental Association's House of Delegates passed disapproving resolutions. A raging battle broke out in the Massachusetts press between supporters who believed the experiment was clearly justified by the high rate of untreated caries among the state's children and opposing dentists who condemned the project as socialist and dangerous. Before the start of the second academic year, a majority of the Massachusetts Dental Society's members voted disapproval of the project, and a bill to rescind the enabling legislation was passed by the legislature and signed by the governor.

The Forsyth's trustees immediately terminated the study, noting that "the basic idea underlying the project was to take the question whether or not the approach could meet the dental care needs of American children out of the arena of debate and establish some facts from which to draw conclusions." In hindsight, two crucial mistakes that contributed to the program's demise can be identified. First, the rank and file of the profession and their leaders were not made fully aware of the study's purposes before its start. Second, incorporating the experimental training into the hygiene school's curriculum provoked and perhaps justified criticism that on graduation the trainees would not be qualified for licensure to practice dental hygiene, because their course was quite different from that approved by the Council on Dental Education. But the abbreviated study was not a total loss: it lasted long enough for several young women to demonstrate considerable proficiency in cavity preparation and restoration.

**Uses of the New Zealand Model outside the United States**

Since the late 1940s, New Zealand's demonstration that auxiliaries can perform highly acceptable restorative dentistry on children's teeth has sparked similar efforts in many other countries with insufficient dental manpower. The majority have been Commonwealth members or territories in the Pacific, Asia, and Africa that are undertaking swift modernization. Included are Malaysia, Sri Lanka, Singapore, Hong Kong, Papua-New Guinea, Brunei,
Ghana, and Zambia. New Zealand helped these developing sister nations to start dental nurse programs by lending them personnel, welcoming observers, and training their students in New Zealand schools. Indonesia and Thailand, never part of the British Empire, have received similar aid. By 1969, dental nurse schools had been built or were being considered in seven of these countries (Leslie, 1966; Berman, 1969). However, little information is available about the programs' recent progress.

The earliest of the projects got under way in Penang, Federation of Malaya (now West Malaysia), where a dental nurse school was opened in 1949. D. S. Berman, a London pedodontist who visited Malaya, observed in a 1963 World Health Organization report, "It is interesting to note that all the dental work I viewed at random (not a scientific survey) was of a very high standard . . . The dental nurses were greatly appreciated by those parents I spoke to and especially by the dental officers supervising the main treatment clinics. Many of them were anxious to explain how they could not have coped with the treatment demands of the area without the aid of the auxiliary" (Berman, 1969).

After two years of training the Malayan nurses were supposed to work under the professional control and supervision of a dental officer. In the 1960s this supervision often was not direct, but every patient was checked by a dental officer after the completion of a necessary course of treatments. Each nurse was responsible for the regular dental inspection, treatment, and oral health education of 550-650 children four to twelve years old.

Singapore started using auxiliaries by recruiting some of Malaya's school dental nurses to supplement its supply of dental officers. After the colony gained independence from the United Kingdom in 1962, the Singapore government set up its own Dental Nurses Training School. As described by Howe (1975), the curriculum consists of one year of didactic and preclinical work and a second year in which a minimum of 700 hours is spent in performing cavity preparations, restorations, and extractions of deciduous teeth in children. For one year after graduation, the dental nurse works in a clinic under the direct supervision of a dental officer. She is then certified and eligible to take charge of a school dental clinic.
Nurses in these government clinics are responsible for maintaining the dental health of about 600 children between the ages of four and twelve. A dental officer usually conducts the initial examination of a new patient, but nurses carry out subsequent routine examinations and make their own treatment plans. They prepare and restore cavities in deciduous teeth and in permanent posterior teeth with metal fillings. Permanent front teeth are given temporary fillings that a dental officer later replaces. The nurses are prepared to cap pulp exposures. By 1972 approximately half of Singapore's 350,000 primary school children were receiving systematic care in the school clinics. In addition, some graduates of the dental nurse school provide service to other segments of the population in hospital, outpatient, and mobile clinics and through a traveling dental health education unit (Howe, 1975).

Of greater significance for Americans are the socialized programs entailing both the drilling and filling of children's teeth that have been set up in the United Kingdom, Australia, and Canada's Yukon and Northwest Territories and Saskatchewan Province. Although a socialized system of dental care is not inevitable in the United States, the health aspirations of Americans are more like those of the British, Canadians, and Australians than those of Malaysians today or New Zealanders fifty years ago. The three economically and medically advanced Commonwealth countries conducted their own evaluations or pilot projects before using the auxiliaries to extend needed care to more children than could foreseeably be treated by their dentists. Unlike New Zealand, which permits its school dental nurses to carry out preliminary examinations and draft treatment plans, the United Kingdom, Australia, and Canada have generally stipulated that their auxiliaries are permitted to perform pediatric restorative dentistry only under the direction and control of a dentist.

The United Kingdom's use of female auxiliary personnel called "dental auxiliaries" got its start as a government-sponsored experiment in 1957 and achieved full legal recognition in 1968, when regulations were enacted establishing the auxiliaries as a permanent part of the National Health Service. They are permitted to work in the school dental service and other national and local health authority programs for children but not in private practices. The reg-
ulations specify that the dental auxiliary must work under the direction of a registered dentist who has examined the patient and prescribed, preferably in writing, the treatment to be given. A dentist must also be within call, in person and not by telephone, when the auxiliary is working on a restoration or doing an extraction. And finally, a dentist must examine the patient immediately after the auxiliary has completed the prescribed treatment to make sure it is satisfactory before the patient leaves the clinic. Besides preparing cavities for simple fillings, inserting the fillings, and extracting deciduous teeth under local infiltration anesthesia, the auxiliary scales, cleans, and polishes teeth, applies topical fluorides for caries prevention, and instructs patients in oral hygiene.

The British “experimental scheme” that led to the general adoption of dental auxiliaries began with the development of a two-year training program and an educational facility under the direction of the General Dental Council. In October 1960 the first sixty students were admitted to the newly established School for Dental Auxiliaries at New Cross.

From 1963 to 1965, the British experiment’s coordinators gathered data and evaluations on New Cross graduates as they entered clinical practice at numerous local health authority clinics in England, Wales, Scotland, and Northern Ireland. In 1965 twenty-eight independent assessors were appointed to evaluate the quality of the auxiliaries’ work on children’s teeth. The experimental period ended in 1966, when the assembled data were appraised in a final report issued by the General Dental Council.

Among 160 dental auxiliaries working in ninety-two different clinics, approximately 95 percent were given ratings equivalent to good or better on their clinical performance by the employing health authorities. The independent assessors chosen by the General Dental Council inspected 13,303 teeth filled by auxiliaries and rated 9.21 percent of the fillings unsatisfactory. The frequency of unsatisfactory fillings varied widely in the findings of different pairs of assessors—from a low of 0.53 percent to a high of 24.65 percent. But the report concluded that the average findings indicated that “most of the work of dental auxiliaries was of high quality.”

There was also wide variation in how much clinical service the individual auxiliaries rendered during six-month employment peri-
ods—one high was 2,217 fillings. The report noted that “the amount of clinical work carried out by dental auxiliaries varies not only with the ability of the auxiliaries but also with the organization and administration of the dental service by employing authorities, the number of children who require treatment, the number allotted to the auxiliary by the supervising dental officer and the number of missed appointments.”

The dental auxiliaries were well accepted by children and parents. In fact, many employing authorities considered that their special value lay in introducing very young children to dentistry in circumstances which made it acceptable or even attractive. However, the British dental profession actively opposed the experiment when it was originally authorized in 1957; when the first graduates of the New Cross school went out into practice, a few local authority dentists resigned rather than accept slight changes in their working conditions. Nevertheless, the council report found that auxiliaries were “generally well accepted by dentists” during the course of their trial employment. As its final conclusion, the General Dental Council report stated, “The experimental scheme has shown that dental auxiliaries can be successfully trained and employed under proper supervision to do, within the limited field prescribed, work of great value, particularly among young children.”

When Lobene visited the New Cross school in 1969 he drew similar conclusions. Examination of patients under treatment by second-year trainees revealed that simple and compound cavity preparations were very well executed and restorations were equally well done. It was apparent that children receiving treatment had great rapport with the auxiliaries and accepted them willingly. Conversations with mothers who had brought their children in for treatment indicated that they were pleased and satisfied with the services rendered by the auxiliary trainees.

At that time, field experience had suggested that the employment ratio of auxiliaries to dentists should be 2:1, and in larger health authorities it might be 5:2. A published retrospective study that sought to provide the first quantitative evidence of the usefulness of dental auxiliaries also supports the suggestion that one dentist is capable of supervising more than one auxiliary (Sutcliffe, 1969). A comparison was made of the amount of service a dental officer in a
school clinic was able to deliver when he worked without and then with a dental auxiliary. Delegation of work to the auxiliary was associated with a 64 percent increase in the average number of patients seen daily and a 51 percent increase in the average number of procedures completed daily. This included a 79 percent increase in the average number of teeth filled per day and a 29 percent increase in the average number of teeth extracted per day.

Australia's use of auxiliaries to restore children's decayed teeth began by diffusion of the idea across the Tasman Sea, an arm of the Pacific that separates Tasmania, Australia's smallest state, from New Zealand. A visit to New Zealand by an administrator from the Tasmanian Department of Health in the early 1960s led to the establishment of a training school for dental nurses in Hobart, Tasmania. The first eight graduates went to work in Tasmania's School Dental Service in 1968. The state of South Australia soon opened its own school in Adelaide for the training of similar auxiliaries who are known there as "dental therapists."

Meanwhile, in 1964 the Australian Dental Association announced its support for the policy of training and employing female auxiliaries like those of New Zealand. A 1965 report on dental auxiliary personnel issued by the National Health and Medical Research Council of Australia pointed out the "vast difference" between the dental treatment needed by the Commonwealth's children and the amount they actually received. After describing the New Zealand program, the report concluded: "Any instrumentality responsible for a comprehensive and systematic programme for the dental care of Australian children should now give consideration to the utilization of auxiliary personnel in the form of the school dental nurse." However, it differed from the New Zealand approach by endorsing the principle that, in Australia, direction and control of the auxiliary's services should be vested in a registered dentist.

In 1973 the Australian government committed itself to financing a vast national school dental program based on the auxiliary concept (Norton, 1975). It undertook to pay for the building and operation of training schools plus most of the cost of establishing and running clinics. The states merely have to provide one-quarter of the clinics' operating costs and administer the provision of service. New training schools were quickly developed in Perth, Sydney,
Newcastle, and Brisbane. The national program permits the auxiliaries to perform the usual restorative, preventive, and educational functions of dental nurses for preschool and primary school children. The list of duties also specifies performing dental examinations including radiography, administering infiltration and block anesthesia, extracting deciduous teeth, and providing emergency treatment for pulp exposure. The auxiliaries are being trained to work with chairside assistants.

Norton (1975) notes that because of "the great haste of implementation there will undoubtedly be many 'growing pains' and the ways to resolve many of the anticipated problems are not yet clear . . . Investigations show that there is an initial reduction in the demand for private dentists' services in places where the scheme is introduced. However, the improvement in the dental health of the children and an increased awareness in the remainder of the community of the need for good dental health suggests that there will be a subsequent increased demand for private dental services."

The training program for "dental therapists" at South Australia's school in Adelaide has been described in some detail by Blaikie (1974). Along with teaching operative and restorative techniques, the curriculum emphasizes the preventive role that the therapist is expected to play in the School Dental Service, her sole employing authority. The service's resources are being focused on the primary school population in the hope of inculcating favorable dental habits. The clinics located on school grounds are considered an integral part of the child's learning environment, and personal relationships with therapists and parental involvement are stressed.

In practice, the degree of control maintained over dental therapists in South Australia falls midway between the extremes of New Zealand's limited supervision and the United Kingdom's nearly total supervision. Patients are examined initially by dental officers and subsequently by dental therapists on alternate visits. A therapist thus does the examination before the patient's second, fourth, and sixth course of treatment. She then becomes responsible for diagnosis as well as cavity restoration, extraction of deciduous teeth, and referral of the patient to the dental officer for other problems. Dental officers work in central regional clinics and direct the
staffs in satellite clinics. Ideally the regional dentist directs up to six therapists in the care of approximately 3,000 children.

Because a therapist is not always under immediate dental supervision, the system requires strict adherence to the methods taught in the School of Dental Therapy in Adelaide. The school experience includes approximately 180 hours in carving wax teeth, 500 hours in preparing cavities and placing amalgam and composite resin restorations in artificial jaws, and about 850 hours of clinical practice. Before graduation, each student treats about 130 children and places over 400 amalgam restorations. At the end of training, the student's work is assessed by two independent examiners.

Canada's use of auxiliaries who both drill and fill children's teeth has been a localized phenomenon with some initial links to the New Zealand and British programs. Rather than start by setting up training facilities, the two local health authorities that sponsored the earliest experimental programs of this type in the Yukon Territory and the province of Saskatchewan hired dental nurses who received their training in New Zealand or the United Kingdom. Other research programs conducted in different parts of Canada have entailed delegating the reversible jobs of placing and finishing fillings to military personnel but not the irreversible function of preparing cavities by drilling.

The Yukon Project, as described by Pugh (1969), was launched by the territorial government in 1963 as a way of stretching its extremely limited dental manpower so that preventive and restorative therapy could be offered to school children. The large rugged territory lying to the east of Alaska had only two dentists for approximately 15,000 people including some 3,000 school children. A third dentist was recruited, and the three were hired on a part-time fee-for-service basis to examine and treat the younger school children, starting with 300 first graders in Whitehorse, the territory's major town. Even this initial workload proved unmanageable until the team took advantage of the restorative capabilities of a New Zealand-trained dental nurse who happened to live in Whitehorse. The extra pair of hands she provided for carrying out simple restorations, extractions of deciduous teeth, and topical fluoride applications, as prescribed and supervised by the dentists, was so helpful
that the Yukon imported other dental nurses from New Zealand and Britain to keep the team supplied with two auxiliaries. It became possible to extend therapy to children in the other school grades in Whitehorse and then to children in outlying areas of the territory.

Preliminary data from the ten-year program indicated a trend toward better dental health. For example, caries findings in the same seventy-eight Whitehorse children were compared after their examinations in the project's first and fourth years. In the first year they had a total of 525 decayed tooth surfaces and in the fourth year only 51. The investigators also reported that complaints about the professional services provided were "few and far between."

More recently, the vast Northwest Territories of Canada undertook to train some of their own residents and some from the Yukon to serve as dental therapists and handle the primary dental care needs of people in the two arctic and subarctic regions. Since the population is dispersed in small settlements, the program is based on the use of portable clinic apparatus, standardization of equipment and procedures, and quality control maintenance without the continuous presence of a dentist. K. W. Davey has described the project's educational and service objectives (1974).

The Northwest Territories' School of Dental Therapy, founded in 1972 at Fort Smith, begins teaching operative procedures on manikins in the third week of the two-year curriculum. But heavy initial emphasis is also placed on providing students with an understanding of the basic sciences as they relate to the practice of dentistry. Davey, who directs the school, notes that teaching such a program to students of many different origins, including Eskimos, and preparing them to function in a northern environment raised a variety of problems. Encouraging a sense of professional identity and group participation proved essential. The logistics of transporting equipment, usually by air, was simplified by selecting compact, lightweight components that could be packed in three shipping cases with a total weight of under 400 pounds, including enough supplies for a month.

Second-year students are given at least one month's field experience in an isolated location. The first group set up a portable clinic in Baffin Island for an Eskimo settlement of 800 people. During this
frontline experience, student output was observed to double. It is hoped that after their training, the therapists will take up residence in settlements and provide continuity of care, which has been lacking in the Canadian North. The plan is to place therapists for a minimum of one year in strategic locations where they will carry out tasks that have been prescribed by supervising dentists. A dentist will come to each settlement for only a few days a month, when he will monitor completed work, examine patients, and map out future work to be done while he is gone. One dentist should thus be able to supervise at least five therapists and still remain in his base area for reasonable working periods.

In the province of Saskatchewan, two British-trained dental auxiliaries took part in a dental pilot project in the rural Oxbow area that has led to the development of an auxiliary training program and adoption by the province of a dental care plan for all children from the preschool years through age twelve, based on the use of the auxiliaries (Curry et al., 1974). Saskatchewan, which started phasing in the province-wide plan in 1974, prefers to use the original New Zealand name “dental nurse” for the auxiliaries that are now trained at the Wascana Institute in Regina.

The Oxbow pilot project, conducted from 1970 to 1973, delivered preventive and restorative care to school children up to the age of twelve in a mobile home equipped as a four-operatory dental office, which moved from school to school. Its staff consisted of a dentist, the two dental auxiliaries, three dental assistants, and a receptionist-recorder. The dentist performed all examinations, and the auxiliaries did most of the drilling and filling of cavities under the dentist’s supervision. After the first year the only restorations the dentist usually did himself were in anterior teeth. In addition, the auxiliaries performed 72 percent of the extractions of deciduous teeth but none involving permanent teeth. The cost of delivering the service was considerably lower than it would have been if a dentist had provided it all and charged according to suggested Canadian fee schedules. Somewhat more than 90 percent of the eligible Oxbow children were enrolled by their parents each year in the voluntary program, indicating a high level of acceptance.

An evaluation of 1,950 restorations in the treated Oxbow children was carried out by two dentists selected by the College of
Dental Surgeons. They related as satisfactory 91.28 percent of the included amalgam fillings, 93.75 percent of the silicate fillings, and 69.1 percent of the temporary fillings. Although the auxiliaries had placed almost 56 percent of the unsatisfactory restorations (mostly temporary), the government authorities administering the project concluded that the auxiliaries could be used to provide acceptable dental care to the province's children at a reasonable cost.

Keenan (1975) has described the aims and curriculum of the Dental Nursing Program started in 1972 at Wascana Institute. Students are selected on the basis of an interview and aptitude test, which assess the candidate's manual ability and rapport with children. The intensive two-year training period includes approximately 2,300 hours of instructional time with 360 hours devoted to general and oral anatomy, histology and bacteriology, and 120 hours to general and oral pathology. Trainees prepare and restore about a hundred dentoform and natural teeth after which they perform 250-300 clinical restorations. A computerized evaluation system keeps track of patient treatments and student performance grades given for each procedure, providing weekly summaries of the class's progress. Final examinations test both academic knowledge and clinical proficiency. Great emphasis is also placed on applying communication techniques to encourage parent participation and preventive care at home.

Eligibility of all children between three and twelve for care through the Saskatchewan dental nurse program is being gradually achieved by adding age groups over a five-year period. Lewis (1976) reports that acceptance rates have ranged between 76 percent and 83 percent among the parents approached. Each dental nurse is responsible for treating about 490 children, typically in a permanent one-chair clinic in a school building but sometimes in portable facilities periodically brought to smaller schools. Saskatchewan dental organizations initially opposed housing the clinics in schools and submitted briefs to the government advocating the development of large separate clinics where many dental nurses would work with over-the-shoulder supervision from dentists. The proposal was rejected because it required busing children an average of thirty-five miles and in some cases seventy-five miles. How-
ever, one large city clinic has been set up to study the centralization concept.

Each supervising dentist in the school program directs the work of eight dental nurses, who are teamed with chairside assistants. The dentist travels between clinics to examine newly enrolled children, make diagnoses, draw up treatment plans, and check the quality of delivered services. The dental nurses have shown themselves to be quite capable of working without a dentist's constant presence; "in fact they respond very well to this challenge," notes Lewis. Advantages gained from situating clinics in schools include greater involvement of parents in their children's oral health, elimination of the need for busing and firm appointments, and better acceptance of care in an environment that is familiar and nonterrorizing to young patients.

The restorations placed by Saskatchewan dental nurses easily meet acceptable standards, as shown by a quality evaluation conducted by three dental educators from other provinces (Lewis, 1976). In classroom visits, they evaluated all the children's amalgam fillings without knowing which had been inserted by dental nurses and which by private practitioners. The consistent finding was that, compared with dentist-placed fillings, a higher percentage of the dental nurses' fillings were at the superior end of the scale and a lower percentage at the unsatisfactory end. The biggest contrasts occurred in the rates of superior fillings in deciduous teeth, which were 45 percent to 50 percent for the dental nurses and 15 percent for the dentists, and in the rates of unsatisfactory restorations in permanent teeth, 13 percent to 19 percent for the dentists and less than 2 percent for the dental nurses.

Experiments within the United States and Canada

After preparations were well under way for the second Forsyth experiment, three other research programs in which auxiliaries were trained to perform both the irreversible and reversible phases of restorative dentistry were initiated in the United States. In 1969 the College of Dentistry at Howard University in Washington, D.C., began developing a two-year expanded dental hygiene curriculum to train auxiliaries called dental therapists. In 1972 the Col-
lege of Dentistry at the University of Iowa in Iowa City similarly expanded its four-year dental hygiene program, which leads to a bachelor of science degree. The Iowa graduates are referred to as expanded function dental hygienists, and their skills include performing minor periodontal surgery such as root planing, curettage, gingivectomy, and gingivoplasty, in addition to restorative procedures. Meanwhile at the University of Kentucky in Lexington, experimental training of auxiliaries, called expanded duty dental hygienists, in the areas of restorative dentistry, pedodontics, and anesthesia administration also began in 1972. This program, originally part of a B.S. in dental hygiene, has since shifted focus toward exploring an augmented two-year curriculum, particularly an expanded duty dental hygiene teacher preparation course.

One report has been published (Powell et al., 1974) concerning Howard University's dental therapist program. The advanced training adds four hours a week to the regular dental hygiene curriculum. The rationale is that graduates will be able to meet certification requirements as hygienists and also acquire competence in cavity preparation, restoration placement, and local anesthesia. Dental therapist trainees study all the basic sciences taught to dental students, but in a condensed format. They begin clinical training in the second half of the first year.

The reported study compared evaluations of restorations done by dental therapist trainees at the beginning of their second year with those done by second-year dental students. Seven evaluators independently rated the work—amalgam restorations performed on patients and cavity preparations done on dentoforms. None of the evaluators knew which type of student had performed the individual procedures. Statistical analyses of the scores achieved by the two student groups indicated that there was no significant difference between their mean performance levels.

Plans for the Iowa educational experiment, which was completed in 1976, have been described in detail by Sisty (1972). In essence, the new curriculum augmented basic college work and dental hygiene training with instruction and clinical practice in anesthesiology, restorative dentistry (about 475 hours), and periodontology (about 455 hours). Part of this training was given in a summer session between the junior and senior years.
The Iowa trainees took part in two evaluations of patient acceptance of expanded duty auxiliaries. Sisty and Henderson (1974) distributed a questionnaire to patients treated in the operative and periodontal clinics of the University of Iowa College of Dentistry. They were questioned about their experiences when treated by third-year dental students and by fourth-year expanded function dental hygiene students. Both student groups were considered by teachers to be at the same competence level in performing restorative and periodontal procedures.

The responses indicated that patient acceptance was equally high for services rendered by each group—well above 90 percent of the respondents were satisfied with their treatment, whether it was restorative or periodontal, or performed by a dental student or a hygiene student. The authors noted, however, that these high ratings by clinic patients might have been biased positively since they knew their treatment was performed by students, supervised by faculty members, and delivered at a reduced cost.

Martens et al. (1975) carried out another patient survey at the University of Minnesota School of Dentistry, where graduates of the Iowa program were employed in an experimental TEAM (Training in Expanded Auxiliary Management) clinic. Questionnaire responses indicated that the care delivery system selected by patients and their experience with auxiliary performance influenced acceptance of delegated functions. A control group of patients who attended a private group practice and experienced only auxiliary service of the traditional variety gave largely negative responses to questions about which expanded functions should be delegated to auxiliaries. In this group, only 7 percent favored delegation of drilling, 33 percent favored delegation of the placement of amalgam fillings, and 42 percent favored delegation of anesthesia administration.

By contrast, among TEAM clinic patients who had had work done by auxiliaries, 56 percent favored delegation of drilling, 81 percent favored delegation of the placement of amalgam fillings, and 70 percent favored delegation of anesthesia injections. Moreover, 95 percent of the patients attending the TEAM clinic reported satisfaction with their treatment. The authors point out that TEAM patients, 94 percent of whom cited financial considerations to ex-
plain their choice of the clinic, may have perceived a dual level of service. Although they chose the clinic and were satisfied with auxiliary service, they might have wished they could afford treatment by a dentist. Conversely, the authors speculate that many private patients might readily accept supervised expansion of auxiliary duties if it resulted in financial savings.

Results of the University of Kentucky experimental expanded duty dental hygiene project have not yet been published, but preliminary findings were made available by the senior investigator of the project (Spohn, 1976). Between 1972 and 1974, thirty-six students completed a four-year dental hygiene curriculum that was compressed to make room for approximately 200 hours in operative dentistry, pedodontics, and anesthesia courses as well as 150 hours of clinical practice. Toward the end of their training, the expanded duty auxiliaries participated with senior dental students in blind evaluations of both groups’ cavity preparations and restorations. The evaluators—a faculty member and ten private practitioners—found there was no significant quality difference between the hygienists’ and the dental students’ work. A study was also made of the retention rate of fillings placed five to fourteen months earlier by the two student groups. In this evaluation, based on radiographic and clinical inspections, there was no significant difference in radiographic scores, but the auxiliaries achieved slightly better clinical scores.

The subsequent career paths followed by graduates of the Kentucky program are of interest, not only because existing dental practice laws prevented them from applying their training in cavity preparation anywhere in the United States but because the alternatives chosen have influenced the University of Kentucky to begin developing an auxiliary career ladder. Four of the graduates went to work in Canada in areas where their skills could be used. Another four were admitted with advanced standing to the University of Kentucky College of Dentistry and obtained degrees in dentistry. Seven ultimately became educators in various American and foreign programs. Most of the others, though, are working as hygienists in the United States practicing only their legally permitted advanced skills.

The Kentucky program has therefore turned its attention to of-
fering training in “experimental” expanded duties (including functions not generally permitted in the United States), within the format of teacher preparation. The reasoning is that a new educator rung will thus be added to the career ladder for auxiliaries, and a potential gap in the educational system will be filled. It is proposed that auxiliary educators would teach at least the reversible expanded duties when the present state of uncertainty in auxiliary training and practice gives way to acceptance. Then dentists would not have to be diverted from practice to provide such instruction.

Since 1959 at least ten different research programs in the United States and Canada have demonstrated that auxiliaries with relatively brief advanced training can fill dentist-prepared cavities, achieve finished restorations of high quality, and significantly increase a supervising dentist’s productivity and net income. It bears repeating that none of these studies was comparable to the recent Forsyth experiment, since the trainees performed only reversible functions. They did not produce complete work units as did Forsyth trainees who carried out, under supervision, the irreversible duties of anesthesia administration and cavity preparation in addition to placing and finishing restorations.

Nonetheless, the findings of consistent performance quality and excellent patient acceptance, along with significant productivity dividends, formed an encouraging body of experience from which to approach delegating irreversible procedures in the United States. The studies are also of interest for the varied backgrounds of the trainees, widely differing lengths of advanced training given, and the range of practice settings investigated. The expanded functions that most trainees were taught to perform included a variety of preliminary procedures associated with diagnosis and treatment as well as the placement and finishing of amalgam, silicate, and resin restorations.

The two earliest studies were conducted by military dental authorities. In 1959 the U.S. Naval Training Center in Great Lakes, Illinois, undertook an experiment in which naval dental technicians were given a seven-week course in expanded functions to supplement their regular sixteen weeks of training. Afterward, various team configurations were tested to find the most efficient operating
system through which cavities could be prepared by a dental officer and filled under his supervision by advanced duty technicians. These investigators (Ludwick, Schnoebeln, and Knoedler) found that teams consisting of one dental officer working at three chairs with four of the special technicians averaged twice as many completed restorations per hour as the same officers did when they worked at one chair, had two technicians performing only conventional duties, and carried out all treatment procedures themselves. In blind evaluations of randomly selected restorations, independent examiners gave comparable ratings to fillings performed by the dental officer-technician teams and to fillings placed by dental officers.

In 1960 the Royal Canadian Dental Corps began a series of studies to determine the usefulness of creating a career ladder of auxiliaries, who interspersed periods of service with advancing levels of training. The first level equipped the trainee to serve as a dental assistant with the title of "clinical assistant." The second level qualified him to function as a dental hygienist with the title of "clinical technician." The third level conferred the ability to place and finish fillings and the highest title of "clinical supervisor." Experienced clinical technicians received fourteen to sixteen weeks of special training in restorative dentistry and other expanded duties to move up to the level of clinical supervisors.

Baird, Covey, and Protheroe (1967) reported that the ideal support team for one Canadian dental corps officer consisted of one clinical supervisor and two clinical assistants working with him in two fully equipped and one partially equipped treatment bays. The addition of the clinical supervisor and his partially equipped bay resulted in a 46.1 percent increase in productivity over that achieved by a dental officer working with two assistants in two fully equipped bays.

The remaining seven studies all focused on civilian treatment settings. The University of Alabama School of Dentistry in 1963 launched an experimental training program for high school graduates with no dental experience who passed aptitude and personality tests administered by a psychologist. The two-year curriculum, which included basic science courses, was primarily devoted to
teaching the students to perform reversible restorative functions. Hammonds and coworkers showed through several blind evaluations by independent examiners that the graduates, known as dental therapists, were able to place and finish fillings of higher quality than those done by senior dental students and of equal quality to those done by practicing dentists (Hammonds and Jamison 1968; Hammonds, Jamison, and Wilson 1971).

Auxiliary training in the reversible aspects of restorative dentistry is now being offered on a nonexperimental basis by the University of Alabama in Birmingham. As described by Bethart et al. (1972), the dental therapist curriculum has been reduced to forty-two weeks and consists of an eleven-week didactic phase, a fourteen-week preclinical phase, and a seventeen-week clinical phase. Admission requirements merely include a high school diploma and passing scores on a battery of aptitude tests.

Pelton et al. (1973a; 1973b) studied the economic implications of adding the skills of the dental therapist (trained in the 42-week Alabama program) to a simulated private practice. A team composed of a dentist, one dental therapist, and three chairside assistants was able to provide 26 percent more services than the dentist could when working with two chairside assistants. The added productivity was computed to yield a 37 percent increase in the dentist's hypothetical gross annual income of $120,000. When the practice was further enlarged to include one dentist, two dental therapists, and four chairside assistants, productivity in provided services rose 27 percent above that of the team with one dental therapist, and the gain in hypothetical gross annual income was 19 percent. The authors noted that the study was plagued by a high rate of employee absence and turnover, and that "obviously these same problems will have to be faced by the average practitioner who enlarges his corps of ancillaries."

In 1965 the Indian Health Service, a branch of the U.S. Public Health Service with a staggering dental manpower shortage, expanded its training and use of Indian women as dental assistants to include the placement and finishing of restorations. In an exploratory study employing blind evaluations by outside examiners, Abramowitz (1966) demonstrated that IHS dental assistants, given
eight weeks of practical training by dental officers with whom they worked, could complete amalgam restorations comparable in quality to those done by the participating dentists.

The expanded function training was subsequently formalized into a four-week laboratory phase and an eight-week clinical phase, given after dental assistant students had completed six months of didactic, laboratory, and chairside instruction. As described by Corry and Cannavale (1972), the concentrated twelve-week course offered at three training centers usually resulted in an acceptable quality level of performance, but an additional two to six months of on-the-job supervision was needed to develop speed. Plans called for placing the expanded duty dental assistants in civil service positions at selected IHS dental clinics serving Indian and Alaskan native populations.

From 1965 to 1970 the U.S. Public Health Service conducted another study of restoration placement and completion by dental assistants at the Dental Manpower Development Center, a specially built facility in Louisville, Kentucky, featuring sixteen operatories arranged to form two large wheels. For the experiment, which has been described by Lotzkar, Johnson, and Thompson (1971a; 1971b), dental assistants were given approximately forty-eight weeks of combined classroom, laboratory, and clinical training in restorative and other expanded functions. Quality evaluations, which were not blind, rated most trainees' fillings comparable to those done by dentists. However, the work of six of the twenty-seven assistants who finished the course failed to meet the project's quality standards, indicating that "careful selection of candidates for such training is essential." In productivity studies, dentists who worked with four assistants performing expanded functions were able to increase the total procedures performed per day by 133 percent over their base-line performance when working with one traditional chairside assistant. The use of three expanded function assistants increased the dentists' daily total of procedures by 84 percent.

The next investigation, begun in 1967 by the University of Minnesota in Minneapolis, entailed assigning reversible restorative procedures in pediatric dentistry to dental assistants, who were given an extra three months of didactic and laboratory instruction fol-
lowed by approximately nine months of experience performing expanded duties in the university's pediatric dental clinic. Rosenblum (1971) and Brearley and Rosenblum (1972) have reported that the trainees' work, evaluated by instructors, was consistently as good as that of senior dental students. Adding an expanded duty auxiliary to a team composed of a dental student and a traditional chairside assistant resulted in a 33 percent increase in productivity. An attitude survey of participating and observing dental students revealed that 91.3 percent favored expanding the dental assistant's role to help alleviate the dental manpower shortage.

The continuing program started by the Philadelphia Department of Public Health in 1969 was a service-oriented response to a 1967 change in the Pennsylvania Dental Practice Act that authorizes a licensed dentist to delegate to an auxiliary technical procedures which he will fully supervise and be responsible for, with the exception of tissue cutting. When no other institution promptly offered auxiliary training in restoration insertion, the department initiated its own system for giving instruction in the expanded duties. Soricelli (1972) and Della Pelle et al. (1973) have described the undertaking. The didactic and clinical instruction, which lasts approximately seven months, qualifies students who received prior on-the-job training as dental assistants in the department to serve there as "technotherapists."

Among various criteria used by the Philadelphia Department of Public Health to select candidates for the advanced dental auxiliary training, work attendance records proved the best indicator of success in terms of final performance as a team member. The team configuration that was most efficient for the average dentist included three technotherapists in addition to two chairside assistants and a clerk. This combination of workers was able to provide the same amount of care as four dentists each working with at least two chairside assistants. On the average, work quality evaluations carried out by department chairmen from the Temple University School of Dentistry showed that 75 percent of the restorations placed by technotherapists were outstanding or superior, less than 1 percent required improvement, and the remaining 24 percent were satisfactory. Patient acceptance in department clinics appeared to be "overwhelmingly favorable."
The final three studies—two in Canada and the other in California—examined the utility and acceptability of delegating reversible restorative procedures to auxiliaries in private practice settings. A three-year Canadian project, called the Prince Edward Island dental manpower study for its locale in the country's smallest province, began in 1969. Six dental hygienists received training in the insertion and finishing of fillings in a ten-week course given at Dalhousie University in Halifax. Afterward they worked in a public health clinic for children as well as in six private dental offices.

As reported by Romcke and Lewis (1973), the addition of one expanded function dental assistant and a third operatory to a clinic dentist's usual working situation with two traditional assistants and two operatories resulted in a 73 percent rise in productivity and a 29.6 percent reduction in the unit cost of treatment. Dentists whose teams included two dental hygienists performing expanded duties achieved productivity increases of 106 percent to 134 percent and unit cost reductions of 14 percent to 22.4 percent. Blind evaluations by professors of restorative dentistry from other provinces indicated that fillings placed by hygienists were "equal to, if not better than, restorations placed by four experienced dentists under whose supervision the hygienists worked."

Moreover, when the Prince Edward Island hygienists were employed in private dental offices, two dentists maintained productivity increases of approximately 50 percent over a twelve-month period. The average productivity increase for shorter periods of employment under less than ideal conditions in six dental offices was 37.4 percent. In all offices, the costs of adding the hygienists were less than the dollar value of the increased services rendered. Very few objections were raised by the more than five thousand private patients who received treatment from the expanded function dental hygienists. In the two private practices where they worked for nearly two years, only one patient refused to have a restoration completed by a hygienist.

The second Canadian experiment was a demonstration project organized and designed by the Ontario Dental Association—an unusual involvement of organized dentistry that followed upon the federal government's strong recommendation that the provinces should initiate dental auxiliary research. The project began in 1972
with an intensive eight-week training course in restoration insertion and finishing that was given to eight dental hygienists and carried out at the University of Toronto. The hygienists received 240 hours of instruction, of which 120 hours were clinical with one instructor supervising each two students. Afterwards the hygienists' technical proficiency, acceptability, and incorporation in care delivery were studied as they performed the expanded duties in eight varied Ontario private practices (Hord and Ellis, 1972; Hord, Thompson, and Ellis, 1974; Ellis, Hord, and Thompson, 1974).

Two recognized academic authorities in restorative dentistry served as evaluators in a blind quality assessment of 237 restorations inserted and finished by the practices' dentists or by the hygienists. The pooled and analyzed data showed that the hygienists' work was at least equal to and in most cases superior to the dentist-performed restorations. The difference was most striking in amalgam fillings, with 37.4 percent of those done by hygienists rated as excellent as compared with 17.6 percent of those done by dentists. None of the examined resin restorations and only a negligible percentage of the amalgam fillings were rated unsatisfactory.

Another phase of the Ontario study gathered unquantified subjective reactions of the participating dentists, hygienists, and patients to the reassigned roles and their integration in the team delivery of care. Almost all patients readily accepted treatment from the auxiliaries and were evidently satisfied with received services. Among team members, one specified problem was adjusting to the greater need for coordinating activities when restorative duties were shared. Careful organization of appointment times, therapy requirements, and patient flow was found to be essential, and smooth functioning of the new system often required adding an extra operatory and chairside assistant. Each office was able to accomplish the necessary adjustments and reorganization in a short time, however. The hygienists themselves expressed a preference for varying their workday with a combination of restorative duties and preventive services. None wished to revert to her original limited duties, but the more sophisticated level of service in the enlarged dental teams seemed to raise the potential for personnel conflicts and personality incompatibility, the investigators noted.

Rounding out the ten varied demonstrations, in the early 1970s
the University of the Pacific School of Dentistry in San Francisco assessed the results of adding auxiliaries with training in reversible restorative functions to private dental offices serving American patient populations in the middle and upper income levels. Redig et al. (1974) decided to tamper as little as possible with the normal operation of the four selected offices. No outside evaluations of auxiliary work were scheduled, since the supervising dentists assumed responsibility for performance quality in their offices. The study settings included Office A, a suburban group practice engaged in general family dentistry; Office B, a two-dentist urban practice with a primarily adult patient population; Office C, a three-dentist suburban practice providing full dental services; and Office D, a suburban solo practice limited to pedodontics.

Six experienced chairside dental assistants already working in these offices were given ten weeks of technical training at the school of dentistry, with major emphasis on the placing and carving of all types of restorations. Even though dentists from the four offices took part in providing the instruction, it was found that further on-the-job training was required to meet the unique needs of each practice. In the first year of work experience, the expanded duty dental assistants completed 50 percent to 83 percent of the restorations started by their supervising dentists. Among the recorded productivity increases was the ability of one dentist in Office A using two of the assistants to schedule twenty patient visits per day instead of his base line of fifteen.

In economic terms, the same dentist using two of the assistants had a 25 percent increase in expenses, but his net income went up 44 percent. In Office B, a dentist using one expanded duty assistant had a 7 percent increase in expenses and a 38 percent increase in actual net income. The pedodontist in Office D found that using one special assistant was associated with a 14 percent rise in expenses and a 26 percent rise in net income.

The authors caution that using expanded duty dental assistants in private offices is not a simple undertaking: "Integration of the auxiliary into the operation of an office requires changes in the dentist's work patterns, in the procedures of the office, and changes in the work patterns of other office staff, as well as a patient demand
that will match the potential increase in productivity." But all the studied offices reported a high degree of patient acceptance and virtually no instances of negative patient reactions. Commented Redig et al. (1974), "It seems that the patient's confidence in the dentist is the governing factor and that this confidence extends automatically to the auxiliary staff assisting the dentist."
FORSYTH'S ADMINISTRATION DECIDED in 1963 that the re-organized center with its leading school of dental hygiene should try again to test the merits of training auxiliaries to do restorative dentistry. After the board of trustees and senior staff members of the center's other divisions had approved the controversial plan, three major steps were necessary. The most problematic one was to reach a professional policy understanding with state dental authorities that would enable Forsyth to conduct the experiment in a favorable climate and, furthermore, permit the performance of essential clinical studies. A quiet professional relations campaign was started concurrently with the two other time-consuming gestational processes—obtaining space for and equipping a training facility and drawing up a new curriculum in restorative functions. Both of the latter developments were kept separate from the dental hygiene school, in order to avoid criticism that had been directed at the earlier Forsyth experiment because it was conducted within the dental hygiene program. The new study's design also had to encompass trainee selection, experiments in care delivery, and the collection of evaluative data.

**Interaction with the Dental Community**

Although it was generally accepted in the mid-1960s that drastic changes would have to occur if the private sector of dentistry were to meet the challenge of providing oral health care for the entire population, the thought that this might require delegating simple restorative procedures to auxiliaries had only grudgingly been faced by general practitioners. A major professional relations effort was obviously needed, but the question remained whether it should
be a low-key personal approach or a group effort carried out with fanfare. Advice from a variety of sources indicated that an aggressive campaign might further harden negative attitudes. In fact, every portent at the time suggested that the likelihood of reencountering Forsyth’s 1949 opposition was high.

The low-key personal approach was selected, and it seemed logical for Forsyth’s director Dr. John W. Hein, who had recently been president of the Massachusetts Dental Society, to take on the assignment. First Dr. Hein and Dr. Lobene met informally with members of the State Board of Dental Examiners and the Massachusetts Dental Society to inform them of Forsyth’s interest in exploring the feasibility of extending the duties of dental hygienists. All of the dental society’s district chairmen and secretaries were then informed of Dr. Hein’s willingness to speak on the subject; eleven of the thirteen districts accepted his offer in 1968 and 1969. The society’s board of trustees twice invited him to describe the project’s progress.

During this period, the rapidly advancing care delivery crisis arising from Medicaid coverage of dental payments did much to bring home the need for change to the profession’s rank and file. A dramatic shift in opinion was reflected in the more open-minded response to Dr. Hein’s presentations. Dr. Ira Colby, then president of the Massachusetts Dental Society, became a staunch supporter of the research program and arranged a workshop on the expanded duty auxiliary concept in September 1968. The tenor of this workshop was typified by the closing words of the secretary of the board of dental examiners: “Either we expand duties or we contract services.”

Dr. Hein drew a highly enthusiastic reception in April 1969, when he addressed the New England regional meeting of state dental examiners. But the climax came in January 1970, at the winter meeting of the dental society. After Dr. Hein conducted a full discussion of the Forsyth plans, the society’s House of Delegates passed by an overwhelming margin (134 votes yes, 5 no) the following motion: “RESOLVED, that the Massachusetts Dental Society, recognizing the future dental health needs in the Commonwealth of Massachusetts and in the light of the preliminary efforts of the committee relating to the expansion of duties of dental auxil-
iaries, approves and accepts experimental studies related thereto by institutions having educational programs accredited by the Council on Dental Education of the American Dental Association or other not for profit organizations chartered by the Commonwealth of Massachusetts."

This action, Forsyth decided, constituted an adequate professional policy understanding with which to pursue the study. True, it did not afford the specific legal sanction provided by the special law passed by the legislature in 1949 that allowed Forsyth to depart from the Dental Practice Act in experimentally delegating tissue cutting to hygienists. But that law had been quickly rescinded under pressure. Moreover, in Massachusetts, the board of dental examiners, which administers conformance with the practice act, works closely with the state dental society. The approval from the society’s House of Delegates seemed to put Forsyth on ground firmer than the shifting sands of the state legislature. Accordingly the society was asked to appoint two of its members as liaison representatives to the project; it agreed. As preparations for the study proceeded, the board of dental examiners was kept fully informed of Forsyth’s plans.

Creating a Special Facility

Besides Forsyth’s determination not to repeat the error of mingling the research program with undergraduate dental hygiene instruction, there was another compelling argument for outfitting a special facility. To assure that the results would have maximum weight and impact, it was decided that the experiment should be conducted in as rigorously supervised and controlled a fashion as any experiment in the laboratories of our research institute. Hence the need for a large isolated space with operatories specifically designed to facilitate teaching, supervision, efficient care delivery, and professional evaluations was recognized from the start of planning.

The opportunity to begin developing such a facility arose in 1967 when the construction contract for Forsyth’s new research wing was being completed. The cost of adding an extra floor as empty shell space proved to be attractively low, and an eleventh-hour fund appeal to alumnae of the dental hygiene school raised the nec-
necessary money in just three weeks—a generous display of support from auxiliaries themselves. With a work space in sight, design features and funding sources for the research clinic's physical development and operation were investigated while the professional relations effort continued. Architectural and equipment plans had thus been carefully laid by 1970 when grant awards as well as the dental society's action permitted Forsyth to move ahead.

The new facility incorporated an unconventional circular design concept that quickly gave the study its code name, Project Rotunda (Lobene et al., 1974). As shown in the floor plan and photograph (figs. 3.1, 3.2), ten operatories were arranged like the spokes of a wheel in a spacious work area with a shared supply station in the hub. This dental clinic concept was not completely new and had demonstrated its usefulness when applied at the Naval Dental Research Institute as well as at the Dental Manpower Development Center in Louisville, Kentucky, where expanded duty auxiliaries were trained, and in a California private practice.

At Forsyth, low partitions separate the spokelike operatories to give patients privacy without preventing observation by instructors regardless of where they are stationed in the rotunda. Each operatory is open at the foot end, providing access to the central supply station. Circling the periphery are facilities for radiology and automatic processing of X rays, examination, sterilization, storage, and television monitoring and recording, along with offices, waiting and recovery areas for patients, and three closed operatories used in conducting blind evaluations of cavity preparations and restorations performed by trainees. A large classroom and a lounge-seminar room completed the self-contained experimental setting, which flexibly served as an instructional facility during the students' didactic education, preclinical training, and clinical internship, and as a patient treatment facility during the study of dental care delivery by the advanced skills hygienists.

**Developing the Curriculum**

Planning of Forsyth's experimental instruction program began with an analysis of four other expanded duty training courses for auxiliaries—those of the United Kingdom's New Cross School (table 3.1), the New Zealand Dental Nurse Program, the Royal Cana-
Figure 3.1  Plan of the rotunda clinic, showing ten operatories in the circle and support facilities in the periphery, including three isolation operatories, offices, television studio, and radiology and sterilization rooms.
Figure 3.2  The rotunda clinic in use, with patients facing the distribution center. The partitions are low so that the supervising dental staff can observe all operators while the patient has privacy and comfort.

dian Dental Corps, and the University of Alabama. In addition, we looked at the hours of biological sciences included in the curriculum of the Forsyth School for Dental Hygienists (table 3.2), which is a typical two-year hygiene program, and the hours of restorative instruction given in a typical American dental school curriculum (table 3.3).

It was immediately apparent that the Forsyth graduate with 516 hours of biological sciences, as compared to the New Zealand dental nurse with 340 hours and the United Kingdom's dental auxiliary with 263 hours, already has a favorable, and indeed much broader, oral biology background to bring to mastering restorative dental procedures. This finding suggested that our curriculum could be considerably shorter than the New Zealand total of 2,600 hours and the New Cross total of 2,052 hours, a conclusion also supported by the fact that students in both these programs have had no prior dental experience. (The Alabama course totaling 2,085 hours and the Canadian Dental Corps program totaling 1,852 hours were
Table 3.1  
*Length of curriculum in dental auxiliary training programs*

<table>
<thead>
<tr>
<th>Program</th>
<th>Length</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand Dental Nurse</td>
<td>2 years</td>
<td>1608</td>
</tr>
<tr>
<td>New Cross School Auxiliary</td>
<td>2 years</td>
<td>2052</td>
</tr>
<tr>
<td>Canadian Dental Corps Auxiliary</td>
<td>44 weeks</td>
<td>1852</td>
</tr>
<tr>
<td>Alabama Expanded Auxiliary</td>
<td>2 years</td>
<td>2085</td>
</tr>
<tr>
<td>Forsyth Dental Hygienist</td>
<td>2 years</td>
<td>1742</td>
</tr>
<tr>
<td>Predental-Dental School</td>
<td>8 years</td>
<td>9700</td>
</tr>
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</table>

Table 3.2  
*Length of curriculum in biological sciences*

<table>
<thead>
<tr>
<th>Program</th>
<th>Hours</th>
</tr>
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<tbody>
<tr>
<td>New Zealand Dental Nurse</td>
<td>340</td>
</tr>
<tr>
<td>New Cross School Auxiliary</td>
<td>263</td>
</tr>
<tr>
<td>Forsyth Dental Hygienist</td>
<td>516</td>
</tr>
</tbody>
</table>

less pertinent because they omit training in cavity preparation.) It furthermore seemed likely that the amount of instruction in restorative techniques and anesthesia administration needed to train advanced skills hygienists at Forsyth would fall about midway between the 924 hours devoted to such procedures in a typical dental school curriculum and the 1,781 hours given at New Cross.

As ultimately developed by the Project Rotunda instructional staff with part-time help from educators and instructional designers, the curriculum plan initially called for a total of 1,396 hours spanning a 47-week training period divided into didactic, preclinical, and clinical internship phases as shown in table 4.1. This allotment of hours was merely a projection, however, because the actual amount of time required for hygienists to acquire specific skills and meet the defined performance objectives could not be accurately predicted. It was not known, for example, how much their previous clinical experience in carrying out oral procedures would help
### Table 3.3  Typical dental school curriculum related to restorative procedures

<table>
<thead>
<tr>
<th>Curriculum</th>
<th>Hours</th>
<th>Hours per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>First year</td>
<td></td>
<td>143</td>
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<tr>
<td>Preclinical lectures</td>
<td>11</td>
<td></td>
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<tr>
<td>Dental materials</td>
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<td></td>
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<tr>
<td>Operative techniques</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Second Year</td>
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<td>198</td>
</tr>
<tr>
<td>Dental materials</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Operative techniques</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Operative clinic</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Third Year</td>
<td></td>
<td>198</td>
</tr>
<tr>
<td>Operative clinic</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>Lectures</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Fourth Year</td>
<td></td>
<td>385</td>
</tr>
<tr>
<td>Operative clinic</td>
<td>352</td>
<td></td>
</tr>
<tr>
<td>Lectures</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>924</td>
</tr>
</tbody>
</table>

to shorten learning times. Also, the Forsyth curriculum combined a variety of instructional approaches and aids, some adapted from other auxiliary programs and some developed by the Forsyth staff, that seemed to offer advantages over traditional dental school methods for teaching restorative procedures.

Site visits by the principal investigator to both the University of Alabama and the New Cross School yielded valuable observations that could not have been made without direct access to faculties and students as they participated in these training programs. For instance, the Alabama course demonstrated the value of teaching auxiliaries from the start to work in a seated position with a chair-side assistant and practice efficient four-handed dentistry. At the New Cross School, great emphasis was placed on cultivating manual dexterity and skills, found to be essential for the success of graduates. Students learned cavity preparation first by working on plaster teeth three times natural size and then by carving life-size
wax, plaster, and natural teeth set in a phantom head. The Forsyth curriculum designers heeded these effective precedents in planning the hygienist's preclinical and clinical working arrangements and learning exercises. Other borrowed concepts included learning cavity preparations and restorations by working on a manikin placed in the same environment and position that the patient would occupy. This approach should enhance the transfer of skills.

The applied educational plan called for presenting lectures, demonstrations, and exercises in the various types of cavity preparations and restorations on a "need-to-know" basis whenever possible. First a task analysis of each procedure was carried out with the students, and then the exercise was described in terms of performance objectives. In teaching drilling, for instance, the staff prepared ideal examples of each type of cavity preparation, and the students' major objective was to produce similar results within a tolerance range of ± 0.5 mm. To help them achieve this degree of precision, exercises in metric measurement were given, and the students learned to use the known dimensions of individual burrs and hand instruments as aids in judging whether the depth, width, and length of cavity preparations were within the acceptable range.

The teeth used in these preclinical exercises were removable typodonts consisting of either ivorine or extracted natural materials and mounted in a new manikin training aid developed by the U.S. Public Health Services, Division of Manpower Education (fig. 3.3). The manikin, which has a lifelike latex face, oral cavity, and tongue, simulates a patient lying supine on a dental lounge chair. During most of the preclinical training, the hygienists worked without chairside assistants, but four-handed dentistry was employed for their entire clinical experience. All cavity preparations were made using high-speed dental handpieces and standard instrumentation. The curriculum's content in terms of individual restorative techniques, anesthesia procedures, and materials used is listed in table 4.1.

Throughout the instruction period, completed exercises and clinical work were rated by student self-evaluation and peer-review as well as by instructors. After the class fulfilled a given exercise's performance objectives, the next task was introduced, analyzed, and
Life-like manikin used to teach all classes of cavity preparation and restoration in typodont teeth.
practiced without adhering to a fixed time schedule. Clinical internship was slated to start as soon as the class mastered the preclinical curriculum and developed competence in four-handed dentistry through a period of preclinical work with chairside assistants. The clinical internship was planned to continue until the trainees were able to perform restorative work equal in quality to that produced by a control panel of dentists.

The Postinternship Period

Once the basic performance goals of the educational phase were achieved, the study's design called for intensive examination of the advanced skills hygienists' usefulness in continued clinical care delivery during a data-gathering period planned to last about fifteen months. One objective was to measure further increases in the hygienists' speed and proficiency through frequent internal evaluations. A second aim was to gauge the acceptability of their services to patients. Securing objective appraisals of the quality of the hygienists' restorative work in comparison with that of staff dentists and local private practitioners through a series of blind evaluations by outside examiners was also considered essential.

The final and paramount goal of the study was to explore various clinical team configurations, identify the most effective working combination of dentists, advanced skills hygienists, and supporting personnel, and establish whether the optimal combination could make it possible to deliver quality care to more patients at lower cost. In testing the latter hypothesis, Forsyth postulated that each staff dentist and his auxiliaries, in terms of economics, constituted a solo private practice. Cost accounting methods were applied to their recorded productivity to compute hypothetical earnings and expenses. Because patients treated in Project Rotunda were charged no fees, the best available data on recent Massachusetts and New England fee schedules were used to assign dollar values to the services delivered. Similarly, the dollar values assigned to expenses were derived from a regional practice survey and deducted from the estimated gross incomes to determine the net income of each practice—and so reveal any significant increase in net income, expressed as a percentage of the gross, which might make
it possible to provide consumers with high-quality restorative dentistry at lower unit cost.

**DATA COLLECTION AND ANALYSIS**

From the beginning of didactic instruction to the completion of the simulated private practice experiments, Project Rotunda offered opportunities to amass voluminous amounts of data. Prime considerations in deciding what to record and analyze were: the quality of service provided by the advanced skills hygienist working under the direct supervision of the dentist, patient acceptance of auxiliaries providing traditional dentist services, and the productivity and cost effectiveness of the use of these auxiliaries in a variety of dental services.

During the planning period it was recognized that one of the most critical needs would be a standardized system for rating work quality throughout the study's preclinical, internship, and experimental care delivery phase. If the productivity data was to be meaningful, it had to be based on the performance of high-quality work. Verification of continuing high quality could only be achieved through the application of consistent standards by external and internal examiners, as well as by the trainees in self- and peer-reviews. Although evaluations of any given procedure are necessarily subjective and can vary markedly among different observers, we sought to minimize this variation by adopting a simple, explicit rating scale (see appendix 1) which awards one to four quality points for each performance criterion.

The criteria for rating each type of procedure were described in detail in an evaluators' manual (appendix 1). A comprehensive performance evaluation form (fig. 3.4) was used to record quality point ratings and all other descriptive data concerning each preclinical exercise or clinical procedure. Two questionnaires were developed to gather patient reactions. In addition, throughout the internship and postinternship clinical experience, productivity data was collected to compute monthly summaries of the services and income produced by the advanced skills hygienists and simulated private practice teams.
## Performance Evaluation Form, Forsyth Dental Center

**Date**

- **Mo.**
- **Day**
- **Year**

**Operator Name**

- **Code**

**Prophy - Prevention**

- **FL**
- **Seal**

**Time**

- **In**
- **Out**

**Circle as appropriate:**

- **Quadrant**
  - 1
  - 2
  - 3
  - 4

- **Tooth**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8

- **Check here if primary tooth**

- **UR**
- **UL**
- **LL**
- **LR**

- **Surfaces**
  - O
  - F
  - L
  - M
  - D
  - C

- **Type Restoration**
  - 1
  - 2
  - 3

- **Amal Sil/Res Trt.**

**RATING SCALE**

1. Unacceptable
2. Unacceptable but correctable by simple procedures
3. Acceptable
4. Acceptable and up to the standards
5. Procedure or stage completed by instructor or completed after instructor intervention

**RUBBER DAM**

- **Hyg./Instr.**
  - Time - Min.

- **Orientation**
  - 12345

- **Stabilization**
  - 12345

- **Isolation**
  - 12345

**CAVITY PREPARATION**

- **External Outline**
  - 12345

- **Internal Form**
  - 12345

- **Caries Removal**
  - 12345

- **Base**
  - 12345

**MATRIX BAND**

- **Adoption**
  - 12345

- **Stability**
  - 12345

- **Tissue Integrity**
  - 12345

**RESTORATION**

- **Contour**
  - 12345

- **Contact**
  - 12345

- **Margins**
  - 12345

- **Occlusion**
  - 12345

- **Finish**
  - 12345

**POLISH**

- **Number of surfaces**

**ANESTHESIA (Check)**

- **Infiltration**
  - (Circle one)

- **Mandibular Block**
  - 1
  - 2
  - 3

**If this restoration must be done over, check at right**

**If this evaluation is on a task done over, check at right**

---

**FORSYTH DENTAL CENTER**

---

**Figure 3.4** Performance Evaluation Form, Forsyth Dental Center.
The major types of data gathered and analyzed during the study were:

1. Quality points, number of attempts, and time required to carry out preclinical and internship exercises, used to analyze learning performance.
2. Quality points assigned by outside examiners to cavity preparations and restorations performed by advanced skills hygienists and dentists during three blind quality evaluations, which permitted comparisons of the two types of operators' performance.
3. Data from a radiographic evaluation of restorations inserted by the hygienists.
4. Daily intramural evaluations by staff dentists of all work performed by the hygienists.
5. Success rates of anesthesia administration attempts by the hygienists.
6. Data from two surveys of patient satisfaction.
7. Time profiles of dentists' and hygienists' activities during clinical care provided with various team configurations.
8. Clinical productivity and hypothetical income and expense data on various team configurations.

**Selecting Trainees**

To aid in the selection process, Forsyth considered using a battery of personality and aptitude tests to obtain psychological profiles of hygienists who had graduated from two-year programs and wished to take part in the advanced skills experiment. Our consulting psychologist advised against this, however, because only ten students were to be chosen, and conclusions based on differences in the profiles in later performance would not be significant. Moreover, it appeared that the best predictor of successful performance would be the strength of each candidate's commitment to remain in the program to its end. In interviews, a special effort was made to assess a candidate's resolve to complete the experiment. Past performance in hygiene school as reflected in grade point averages also served as an important aid in narrowing the field.

Various populations of hygienists were screened. Restricting the
trainees to Forsyth graduates was considered, but representation from several different educational backgrounds seemed preferable. The ten trainees selected graduated in June 1971 from three New England schools of dental hygiene—Bristol Community College, Fones School for Dental Hygienists, and the Forsyth School for Dental Hygienists—and all were licensed to practice in Massachusetts. Prior academic and clinical accomplishments of the hygienists selected ranged from average to superior. Although selection was completed in time to start the experiment in September 1971, unexpected delays in the construction and equipping of the rotunda postponed the beginning of instruction until March 1972. Thus, the students accumulated seven months of experience as conventional hygienists in private practices before entering the advanced skills training.

Patient Recruitment and Characteristics

Patients for the clinical phases of the study were recruited from as wide a variety of backgrounds as possible. They included residents of the core city, suburbanites, and college students. Because of the focus on meeting restorative dental needs, the target group was five to thirty-five years of age, but small numbers of younger and older patients with appropriate clinical requirements were accepted. Access to a range of populations in the Boston area was made easier by securing the cooperation of community service agencies and educational institutions.

Since service was rendered to patients without charge, inability to afford private care probably motivated most patients willing to be treated by the experimental auxiliaries. The presence of supervising dental educators, who carried out some of the treatments, made acceptance more likely. Thus the patients presumably were similar to those seen in dental school clinics.

In all, 2,980 patients were examined and screened for admission to the research program (table 3.4). Diagnostic criteria for acceptance included the need for preventive services and the restoration of decayed teeth that could be completed using tooth-colored filling materials and amalgam. Generally excluded were those needing complex fixed bridges.

All patients were found to need treatment, but 312, or 10.5 per-
Table 3.4  Project Rotunda: distribution of patients by age and sex

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>10</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>5-9</td>
<td>132</td>
<td>149</td>
<td>281</td>
</tr>
<tr>
<td>10-14</td>
<td>178</td>
<td>180</td>
<td>358</td>
</tr>
<tr>
<td>15-19</td>
<td>173</td>
<td>226</td>
<td>399</td>
</tr>
<tr>
<td>20-24</td>
<td>451</td>
<td>414</td>
<td>865</td>
</tr>
<tr>
<td>25-29</td>
<td>190</td>
<td>138</td>
<td>328</td>
</tr>
<tr>
<td>30-34</td>
<td>61</td>
<td>55</td>
<td>116</td>
</tr>
<tr>
<td>Over 35</td>
<td>70</td>
<td>89</td>
<td>159</td>
</tr>
<tr>
<td>Total</td>
<td>1,265</td>
<td>1,265</td>
<td>2,530</td>
</tr>
</tbody>
</table>

1. No sex and/or age data, 138; patients examined, not accepted, 312; total patients examined, 2,980.

cent, were not accepted because the sophisticated dental work they required was beyond the scope of the study. For the most part, rejected patients needed either extensive bridgework or the specialized services of an orthodontist or periodontist. All were told the nature of their dental problems and referred elsewhere for treatment. Although in an average general practice some of them might have been treated, Forsyth felt that selectiveness was consistent with the custom followed in most private practices—not automatically accepting every case, but referring to specialists the kinds of work that exceed the practice's capabilities.

It is important to note that during the first three decades of life, the need for restorative dentistry is highest; because this research emphasized restorative services (which occupy 40 percent to 60 percent of a general dentist's practice time) most patients accepted for treatment were five to thirty-five years of age. Table 3.4 presents an overview of patients examined and shows the distribution according to age and sex of 2,530 of the enrolled patients; an additional 138 who were enrolled and treated are omitted because one or both types of data were missing from their records.
THE EDUCATIONAL EXPERIMENT'S salient finding was that the hygienist trainees met the required performance objectives much more quickly than had been projected in the tentative curriculum, which allowed 1,396 hours of preclinical and clinical instruction and practice. Actually, the goals were achieved in 746 hours, reducing the required training period from forty-seven weeks to twenty-five weeks (table 4.1). The important implication is that individuals with a dental hygiene background can learn to provide quality restorative dentistry in a relatively short period of additional training which could readily be incorporated into a two-year hygiene program by revising the existing curriculum. A comparison of educational costs clearly demonstrates that large savings could be achieved if the expected great expansion in the demand for restorative care is filled by training more advanced skills hygienists and fewer dentists.

Curriculum Modifications

It had been estimated that 184 hours would be needed for lectures, demonstrations, and laboratory exercises in restorative dentistry to provide an adequate foundation for clinical practice. However, only 129 hours were actually required to cover the planned content. The estimated time for preclinical manikin practice in preparing and filling cavities was 296 hours, but only 172 hours were needed to develop the required proficiency. Some of the saved time was devoted to giving 76 hours of instruction in the preparation of extensive large complicated cavities requiring the placement of pins. Thus the curriculum was not only shortened but augmented
Table 4.1  *Project Rotunda: training of dental hygienists*

<table>
<thead>
<tr>
<th>Experimental curriculum</th>
<th>Projected hours</th>
<th>Actual hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures, demonstrations, and laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restorative dentistry—cavity design—preparation</td>
<td>40</td>
<td>52</td>
</tr>
<tr>
<td>Instrumentation lecture—demonstration</td>
<td>40</td>
<td>18</td>
</tr>
<tr>
<td>Dental materials laboratory exercise</td>
<td>64</td>
<td>26</td>
</tr>
<tr>
<td>Amalgam, cements, silicates, plastics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant utilization lecture—demonstration</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>Subtotal</td>
<td>184</td>
<td>129</td>
</tr>
<tr>
<td>Preclinical manikin exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber dam</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Matrix</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>Amalgam—Class I, II, V</td>
<td>160</td>
<td>110</td>
</tr>
<tr>
<td>Composites, resins, silicates—Class III, V</td>
<td>80</td>
<td>46</td>
</tr>
<tr>
<td>Subtotal</td>
<td>296</td>
<td>172</td>
</tr>
<tr>
<td>Extensive preparations, cusp reduction, pins</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>Local anesthesia—instruction and practice</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Subtotal</td>
<td>20</td>
<td>85</td>
</tr>
<tr>
<td>Clinical practice</td>
<td>896</td>
<td>360</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1396</strong></td>
<td><strong>746</strong></td>
</tr>
</tbody>
</table>

1. Projected training time: 47 weeks, 30 hours per week.
2. Actual training time: 25 weeks, 30 hours per week.

with extra training in sophisticated procedures we had not expected to be able to present.

The preexperiment estimate of the length of the clinical internship had been 896 hours. Here is where the greatest time reduction occurred. Based on the accelerated accomplishments of the preclinical period, the original projection of about thirty weeks had been revised to about seventeen; only twelve weeks of internship were actually required. So the actual speed of learning during internship was even faster than had been anticipated from the rate of preclinical progress.
APPLICATION OF TEACHING METHODS

The success of the instructional program, which in turn determined its pace, was regularly assessed by comparing preinstructional and postinstructional didactic test scores. New material was introduced when it was found that deficiencies in specific areas of knowledge, which had existed before the instruction, had been remedied.

Mastery of the manual procedures of the various cavity preparations and fillings was facilitated by the careful grounding the trainees received in evaluative techniques. They had to demonstrate a thorough understanding of the criteria for evaluating each cavity preparation and restoration and be able to apply the performance scale of quality points consistently. The training in metric measurement using certain hand tools as aids helped to increase their ability to duplicate ideal preparations performed by instructors. Self- and peer-evaluation preceded formal evaluation and recording of scores on the performance evaluation form by the dentist instructors. During the preclinical period, two out of three of the instructors had to agree as to the acceptability of a preparation or restoration. Each procedure was rated for all appropriate criteria. If any one criterion—for example, the external outline of a cavity preparation—was not met, the procedure was unacceptable and had to be repeated.

LEARNING RATES

The recorded times required and quality points awarded for preclinical exercises show a consistent trend of reduced time for each repetition of a procedure and a reduction in the percentage of unacceptable attempts. For example, the mean time required for the completion of the very first Class I occlusal cavity preparation on the manikin was thirty-four minutes while the fourth preparation took only nineteen. On the first attempt, 70 percent of the preparations were acceptable and on the third attempt all were acceptable.

Figure 4.1 shows the mean times required to perform four successive cavity preparations for Class I, II, III, and MOD cavities. As would be expected, the more difficult multisurface preparations, Class II and MOD, initially required considerable time—a little
Figure 4.1  Mean time required to perform each of four successive cavity preparations of each class.

over an hour each. But the mean time decreased with successive attempts, and was approximately halved on the fourth attempt at a Class II preparation. There were also wide variations in speed between individual trainees. The time needed to complete Class IV cavity preparations requiring the placement of pins ranged from ten to seventy-five minutes, depending on the operator, and the mean on the fourth attempt was thirty-five minutes.

The use of trained chairside dental assistants had a profound impact on the time required to complete the more difficult multisurface cavity preparations. It reduced the working time by about half
without any loss of quality. But for the easiest cavity preparations, the use of an assistant made little difference. More significantly, the use of an assistant did not result in much of a reduction in the mean time required to condense and finish restorations of any type, even the most extensive. This finding suggests that the assistant could be better occupied elsewhere while restorations are inserted and could serve more than one operator.

Table 4.2 shows the times required by the group to insert and finish the various types of restorations. The Class IV restoration, in which the incisal edges of an anterior tooth must be rebuilt, was considered most difficult and taught last. The mean finishing time for this procedure was forty-seven minutes, but the success rate was high. Only 15 percent of these fillings were unacceptable, in contrast to higher rates for the less extensive restorations taught earlier.

**Productivity**

At the end of the twelfth week of internship, the instructors judged that the trainees' performance of cavity preparations and restorations was equivalent in consistent quality to that of dentists. This decision was affirmed in the first blind quality evaluation held shortly after the internship was terminated. As productivity studies began, in the thirteenth week of clinical practice, the advanced skills hygienists were averaging between 3.0 and 3.5 surfaces of

<table>
<thead>
<tr>
<th>Restoration Material</th>
<th>Restorative Range</th>
<th>Finishing Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Amalgam 2-33</td>
<td>5-40 14</td>
</tr>
<tr>
<td>Class II</td>
<td>Amalgam 7-30</td>
<td>5-30 16</td>
</tr>
<tr>
<td>MOD</td>
<td>Amalgam 10-45</td>
<td>8-60 17</td>
</tr>
<tr>
<td>Class V</td>
<td>Amalgam 2-15</td>
<td>2-20 7</td>
</tr>
<tr>
<td>Class III</td>
<td>Composite —</td>
<td>3-30 11</td>
</tr>
<tr>
<td>Class IV</td>
<td>Composite —</td>
<td>7-100 47</td>
</tr>
</tbody>
</table>
completed restorative dentistry per hour. During the succeeding weeks of the experiment in delivery of care, productivity steadily increased so that by the time twenty-five weeks had elapsed, the trainees could consistently produce 5.0 surfaces of completed restorations for every hour spent with a patient. (See table 4.3 for the increments in speed during the twenty-five weeks). By comparison, the staff dentists working under the same conditions in the rotunda environment consistently produced a mean of 6.0 to 6.5 restored surfaces per patient hour. Thus, the hygienist closely approached the productivity of dentists while maintaining high work quality.

**Educational Costs**

Based on a ratio of one dentist-instructor to ten students, the cost to Forsyth of providing the advanced skills training to each hygienist who took part in the study was $2,300. Since the tuition for two years of traditional hygiene education at the Forsyth School for Dental Hygienists was $5,400 in 1970, the total cost of producing one advanced skills hygienist was thus approximately $7,700. The total instruction time was ninety-seven weeks, including the two years of hygiene school, which are really thirty-six weeks each, and the twenty-five weeks of advanced skills class work and internship. Thus, integration of the advanced skills training into the traditional two-year hygiene curriculum could be accomplished by adding two summer sessions and condensing or combining some courses.

**Table 4.3**  Project Rotunda: clinical group productivity: restorative procedures

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.3-2.7</td>
<td>1.8</td>
</tr>
<tr>
<td>5</td>
<td>1.8-3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>10</td>
<td>1.9-3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>15</td>
<td>2.1-4.2</td>
<td>3.5</td>
</tr>
<tr>
<td>20</td>
<td>3.0-4.7</td>
<td>4.0</td>
</tr>
<tr>
<td>25</td>
<td>4.2-6.1</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Table 4.4  Comparative costs of education

<table>
<thead>
<tr>
<th></th>
<th>Tuition per year</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental student</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predental</td>
<td>$3,600</td>
<td>$14,400</td>
</tr>
<tr>
<td>Dental school</td>
<td>9,000</td>
<td>36,200</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>50,600</td>
</tr>
<tr>
<td>Dental hygienist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two years</td>
<td>2,700</td>
<td>5,400</td>
</tr>
<tr>
<td>36 weeks per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced skills hygienist</td>
<td>2,300</td>
<td>2,300</td>
</tr>
<tr>
<td>25 weeks per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7,700</td>
</tr>
</tbody>
</table>

Moreover, the total costs for the integrated program would probably be well under $10,000, even allowing for some inflation.

Table 4.4 contrasts the investment in money and time that produced one of the original advanced skills hygienists with the contemporary investment required to educate a dentist. Average tuition in the early 1970s for four years of predental study in college and four years of dental school amounted to about $50,000 (Institute, 1974). The economies that might be realized in educating auxiliaries to take over restorative dentistry therefore appear to be on the order of at least 400 percent in money, as well as 300 percent in time.
QUALITATIVE RATINGS of clinical care delivered by the advanced skills hygienists were obtained in eight separate assessments. These included three blind evaluations by extramural evaluators, daily ratings by intramural evaluators, a follow-up radiographic evaluation of completed restorations, success-rate monitoring of local anesthesia administration attempts, and two surveys of patient acceptance of the auxiliaries and the services they provided.

Designing the Evaluation Plan

The clinical standard set as the goal of Project Rotunda was that the advanced skills hygienists should be able to provide highly acceptable restorative services that were at least equal in quality to those performed by experienced practicing dentists. This was a higher standard than most previous American studies of expanded duty auxiliaries have employed. Earlier qualitative comparisons of auxiliary performance were usually made with the work of senior dental students (Hammonds and Jamison, 1968; Powell et al., 1974; Sisty and Henderson, 1974; Brearley and Rosenblum, 1972). When possible, data on dentists' and hygienists' performance quality was gathered under the same conditions in the rotunda setting. Some radiographic data from other studies of dentists' restorations was also used for comparative purposes, but there seemed to be no published data on the success rate of anesthesia injection attempts by either dentists or dental students.

Clinical judgments of quality and acceptability are inevitably subjective. As Ryge and Snyder (1973) have pointed out, quality assessment of restorative work is an especially touchy subject with-
in the profession, and one that remains complicated by great semantic confusion as to levels of acceptability. These authors also concluded that the evaluation systems used in auxiliary studies have tended to lack written specificity and operational practicality or both.

Forsyth’s evaluative approach anticipated and attempted to avoid these shortcomings in ways that would not overly complicate the experiment. From the beginning of instruction, intramural assessments were based on written criteria for each important aspect of each restorative procedure. The same concise specific descriptions of traditionally accepted criteria for quality in restorative procedures comprised the Evaluators’ Manual (appendix 1) given to the extramural evaluators who took part in the three blind assessments. This practical written guide, which for some criteria included approximate measurements and their equivalents in instrument dimensions, helped to reduce subjective inconsistency and standardize most of the norms applied by different assessors in the various clinical evaluations.

The fundamental decision to assign one to four quality points in a numerical rating scale was based on several considerations. An even number of points, with no median number as would exist in a three- or five-point scale, was chosen to prevent “fence-straddling” and force evaluators to decide whether or not criteria had been met. Using a four-point scale instead of one consisting of just “acceptable” and “unacceptable” was intended to elicit more sensitive and informative determinations in borderline cases.

With the four-point scale, it was thus possible to distinguish between two types of unacceptably executed procedural criteria: those that were grossly unacceptable (one point) and those that could be made acceptable with a simple correction (two points). Likewise, two types of acceptably executed procedural criteria could be designated: those that were minimally acceptable (three points) and those that the raters believed were equal to the standard expected of practicing dentists (four points). Ryge and Snyder themselves (1973) have proposed and tested a four-category rating system, which, like ours, divides both satisfactory and unacceptable restorations into two subgroups.

At Forsyth, the total quality point score assigned by an evaluator
to a cavity preparation or a restoration depended on how many criteria were pertinent to the specific tooth and type of cavity or restoration. Most important, the total scores fell within ranges, and their position within the ranges indicated smaller gradations in quality. For example, when there were three pertinent criteria—as in all of our evaluated cavity preparations and single-surface restorations—and each was awarded one to four points, a total score of 3 to 5 was “grossly unacceptable,” 6 to 8 was “acceptable with simple corrections,” 9 to 11 was “acceptable as is,” and 12 was “equal to a dentist’s expected quality level.” When four criteria were evaluated—as was true of most multisurface restorations—a score of 4 to 7 meant “the filling is grossly unacceptable,” 8 to 11 meant “will be acceptable with simple corrective work,” 12 to 15 signified “acceptable as is,” and 16 equaled a dentist’s expected quality standard. It is worth noting that only seven out of fifty blindly judged procedures performed by dentists during the three evaluations were awarded the maximum number of quality points, suggesting that the examiners were applying stricter-than-normal professional standards or that textbook standards are not routinely met by practitioners with dental school degrees and years of clinical practice.

Another feature of the quality point system in need of comment is the theoretical possibility that a cavity preparation or restoration might be scored irreparably unacceptable (one quality point) in respect to a single criterion, and yet earn enough quality points on other criteria to receive a total score in the acceptable range. During the blind evaluation, none of the advanced skills hygienists’ cavity preparations—which, of course, entail the irreversible cutting of tooth tissue—was given a one quality point score for any criterion. Experience during the clinical care delivery period showed, moreover, that it was hardly possible for a hygienist to fail completely in executing one criterion and yet achieve an acceptable total point score by fully meeting the other criteria for a cavity preparation or filling.

Ryge and Snyder’s proposed rating system requires that examiners receive several days of preparatory training and calibration (standardization of evaluation) to maximize their consistency. Because the extramural examiners were busy practitioners appointed by society officers to serve on the Massachusetts Dental Society’s
Forsyth Special Liaison Committee, calibration was limited to a half day using carefully prepared models and established criteria for restorative procedures. A subsequently added group of professors of restorative dentistry from the dental school faculties of Tufts, Harvard, and Boston University had equally heavy demands on their time. Although the professors had extensive experience in applying generally accepted clinical standards to student work, they were calibrated in the same way as the members of the society’s liaison committee.

While extensive formal calibration was not feasible, it was considered unlikely that examiner biases would have a major distorting effect on the data. Because all the extramural examiners blindly evaluated every piece of work being studied, any biases on the strict or liberal side were distributed over the entire sample and were likely to neutralize each other. Moreover, the final quality point score allotted to each procedure was the mean of the scores given by the different extramural evaluators, and the standard deviations for the means were well within the range generally accepted as an indicator of reliability.

The staff dentists who served as instructors and intramural examiners were also not formally recalibrated during the delivery-of-care phase of the study. But during the training period they had been calibrated and two out of three instructors had to agree on the acceptability of each criterion of each procedure performed by a hygienist. This experience acquired in six months of teaching advanced skills fostered informal standardization of the criteria assessments made by the instructors and thus fostered increased inter-rater reliability during the clinical care delivery phase, when each procedure was assessed by a single staff dentist.

There were obvious fundamental differences between the one-day blind extramural evaluations and the sixteen months of intramural evaluations during care delivery studies. The advanced skills hygienists had the benefit of routinely available supervision and step-by-step review by staff dentists during those months, and they performed many procedures. Conversely, several examiners could individually score very few procedures in one-day blind evaluations. In order to facilitate objectivity and make certain that the quality of the hygienists’ procedures was entirely a reflection of
their ability, the hygienists were not supervised, but worked completely on the basis of their own clinical judgment on these days. (This was something they never did at any other time and is not generally recommended.)

Thus the extramural evaluations were atypical working situations more akin to state board clinical examinations for dentists. Although the sample sizes were admittedly modest, the statistical techniques used to interpret the data are generally considered robust enough to deal with such small samples. They included employing quality points to reflect degrees of acceptability, converting these to mean scores and standard deviations, and then examining the results for statistical significance using the t-test. It is not appropriate to compare the extramural evaluations to the intramural for significance because of the great differences in working conditions.

Before each extramural evaluation, the examiners received a copy of the Evaluator's Manual (appendix 1). How to use its contents and the quality point scale was also discussed with the examiners on the evaluation day before they set to work. Great care was taken to ensure that they remained "blind" to the identity of the operator who had completed a cavity preparation or restoration being assessed. The rated procedures were a combination of those performed by the advanced skills hygienists, others completed by staff dentists, and some done by practicing dentists from the community who volunteered to participate in the study and subject their work to peer-review.

The patients treated on blind evaluation days were not chosen randomly to simulate an average day's case load. Instead, we screened patients in advance and deliberately scheduled a higher proportion of those in need of challenging multisurface restorations. Because staff dentists had already examined the patients and prescribed specific restorative procedures to be performed on specific teeth, diagnosis and treatment planning were not needed on the blind evaluation day. The scheduled patients were randomly assigned to the different types of operators.

The examiners were sequestered from the work area in isolated examining rooms. Before cavity preparation began, they were allowed to examine the patients' carious teeth, study radiographs,
and make predictive notes. The actual procedures were carried out in the rotunda, and then patients were taken back to the examining rooms. At that point the individual examiners made their assessments and dictated their findings to a clerk who recorded the data on a performance evaluation form. Without being asked to do so, examiners sometimes named specific deficiencies; and these were also recorded. Patients were asked not to talk to examiners or reveal in any way who had treated them. No examiner knew the ratings of any other examiner. Judgments of each operative procedure made by one examiner were entirely independent of those made by others.

Assessments of quality made soon after a restoration is finished cannot take into consideration imperceptible technical differences—such as improper manipulation of materials—that might later undermine the fillings' integrity. The same can be said about the dentist-placed restorations done during the blind evaluations. However, a fairly large number of patients in the study were re-examined during recall visits, and fillings placed by hygienists showed no unusual failure rate. Although clinical data concerning the subsequent integrity of these restorations was not recorded, radiographic evidence confirmed the fact that most were acceptable.

For supplementary qualitative evidence, it seemed more useful to conduct a nonclinical assessment of an explicitly objective criterion: the absence or presence of any overhanging restoration margins detectable in posttreatment bitewing radiographs of a large sample of the patients enrolled in Project Rotunda. Because even small overhangs, whose silhouettes can be seen and measured in the X rays, are deemed potentially harmful, this criterion is commonly used to audit the quality of restorative services.

The radiographs studied at Forsyth were taken at different time intervals, some as much as a year after treatment during a recall visit. But since posttreatment radiographs were not routinely obtained until the project neared its forced conclusion, many of the radiographs were taken soon after treatment on the patient's last visit for restoration polishing. The time variations have little or no effect on the findings, however, because it is highly unlikely that
significant overhang development occurs through a slow lateral "creeping" of restorative materials.

The fact that it was arbitrarily decided not to charge any fees for therapy rendered by experimental type of personnel influenced the procedures followed in surveying patient acceptance of restorative care provided. There is no denying that patients who volunteer to receive care that is free may be biased toward finding it acceptable or giving it a favorable rating. Our study did not attempt to investigate this point. However, patients who were treated by expanded duty dental hygienists at the University of Iowa College of Dentistry paid the usual clinic fees and rated the hygienists' services as preferable to those of senior dental students (Sisty and Henderson, 1974). The findings of the Iowa study led us to believe that patients' acceptance of care in Project Rotunda was not unduly influenced because services were provided at no charge.

Project Rotunda patients were asked but not required to fill out questionnaires about their satisfaction or complaints at two different stages in their participation in the experiment. They could be anonymous if they chose. One questionnaire concerned the patient's feelings about each visit before the last one during a course of therapy. The other was presented on the last day of a course of therapy and concerned the whole course of treatment.

Daily visit questionnaires (fig. 5.1) were given by the hygienists to all patients during the first five months of clinical care delivery, including the internship period. Answering was probably not viewed by patients as voluntary since they planned to return for more free treatment and might jeopardize that prospect by refusing to answer. There were no refusals. By February 1973, after about two thousand of these questionnaires had been filled in with highly consistent answers, collection of daily questionnaires was halted; it seemed that more data would be merely repetitive.

By contrast, answering the final questionnaire (fig. 5.2) given to every patient at the end of a course of therapy was entirely voluntary. Patients had received all the dental treatments they currently needed (sometimes including both restorative and other work done by staff dentists) and could, if they wished, fill out the form anonymously in the waiting room and give it to a clerk. This survey
VISIT EVALUATION FORM

Date ____________

Name ___________________________ ID ______ Visit No. ______

We are asking your cooperation in order to evaluate the services provided by the Forsyth Research Program in the delivery of oral health care. Please answer the questions as honestly as you can.

1. Would you say your visit today was too long? Yes ___ No ___
   If yes, do you feel that the dentist tried to do too much?
   ________________________________
   ________________________________

2. Were you uncomfortable today during treatment? Yes ___ No ___
   If yes, how so?
   ________________________________
   ________________________________

3. Would you be satisfied to have same people treat you again? Yes ___ No ___
   If no, why not?
   ________________________________
   ________________________________

4. Did anything happen to you today that you did not like? Yes ___ No ___
   If so, what?
   ________________________________
   ________________________________
   ________________________________
   ________________________________

Other Comments: ________________________________
   ________________________________
   ________________________________
   ________________________________
   ________________________________

FORSYTH DENTAL CENTER

Figure 5.1  Visit Evaluation Form, Forsyth Dental Center.
**EVALUATION OF RESULTS / 75**

**FINAL EVALUATION FORM**

Name ________________________ Date ______________ Code No. ________

We are asking your cooperation in order to evaluate the services provided by the Forsyth Research Program in the delivery of oral health care. Please answer the questions as honestly as you can. Your answers are confidential.

1. In general, how do you feel about the dental care you received? Circle one number for each of the following categories.

<table>
<thead>
<tr>
<th>Category:</th>
<th>Very Satisfied</th>
<th>Satisfied</th>
<th>Neutral</th>
<th>Dissatisfied</th>
<th>Very Dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required for visits</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Comfort during treatment</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Operator explanation of treatment</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Operator interest in you as a person</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Competence of operator</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Quality of treatment received</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Do you feel comfortable having a female perform the dental treatment you received here?
   (Check one) Yes _____ No _____

3. Would you feel comfortable having a male perform the dental treatment you received here?
   (Check one) Yes _____ No _____ No opinion _____

4. Would you prefer having a male or female perform the dental treatment you received here?
   (Check one) Male _____ Female _____ No preference _____

   If you need more dental treatment, would you choose the same team to do your dental work?
   (Check one) Yes _____ Why? ____________________________
   No _____ Why not? _________________________________

5. What type of therapist did most for your treatment?
   Dental Assistant ______
   Dental Student ______
   Dental Nurse ______
   Dental Hygienist ______
   Dentist ______
   Don't Know ______

6. Any other comments?

---

**FORSYTH DENTAL CENTER**

Figure 5.2  *Final Evaluation Form, Forsyth Dental Center.*
seemed to present an ideal opportunity for expressing any negative reactions or comments that might have been withheld earlier. Perhaps because no pressure was applied to make patients fill out the form, only some 1,200 (45 percent) of the 2,668 enrolled in the study chose to answer all of the five questions on the one-page questionnaire. Thus the responding patients selected themselves rather than being chosen randomly or on any other basis. Despite the differing circumstances of the two patient acceptance surveys, the data presented later in this chapter show that highly positive responses were elicited by both questionnaires.

**RESULTS OF THE FIRST BLIND EXTRAMURAL EVALUATION**

A blind extramural assessment, held primarily to try out the evaluative procedures, took place in March 1973 shortly after the advanced skills hygienists completed their three-month clinical internship and began participating in studies of care delivery. It cannot be emphasized too strongly that the hygienists had never before relied entirely on their own clinical judgment and worked without close supervision and review provided by staff dentists.

Three members of the special liaison committee served as the examiners. The rated work by hygienists included ten one-surface and sixteen multiple-surface cavity preparations to be restored with amalgam (table 5.1). Two hygienist-performed amalgam restorations were not evaluated for lack of time. In addition, two preparations restored with composite materials by hygienists were both rated as acceptable in mean quality point scores, but the number of these procedures was too small to be significant and is not included here.

For this first trial evaluation, we deliberately included a minimum of dentist-performed work—just two cavity preparations and two amalgam restorations done by staff dentists. We could therefore correctly inform the examiners that they were blindly judging work done by both hygienists and dentists, but we were mainly interested in obtaining evaluative data on the hygienists. Because the procedures carried out by dentists were so few, no statistically valid comparisons could be made between the group mean scores of the dentists and of the hygienists as was done later in the second and third blind evaluations. In this first assessment, all the dentists'
Table 5.1  *Project Rotunda: first blind extramural evaluation*

<table>
<thead>
<tr>
<th>Surface</th>
<th>Tooth</th>
<th>Preparation</th>
<th>Cavity preparation</th>
<th>Amalgam restoration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Score</td>
<td>Correction</td>
</tr>
<tr>
<td>Single</td>
<td>2-5</td>
<td>O</td>
<td>11.7</td>
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<tr>
<td></td>
<td>1-5</td>
<td>O</td>
<td>6.7¹</td>
<td>Caries</td>
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<td>2-4</td>
<td>O</td>
<td>11.3</td>
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<td>1-5</td>
<td>O</td>
<td>9.7</td>
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<td>1-6</td>
<td>OL</td>
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<td></td>
<td>1-6</td>
<td>OL</td>
<td>8.0¹</td>
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<td></td>
<td>2-6</td>
<td>MOL</td>
<td>10.3</td>
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<tr>
<td>Mean</td>
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<td>9.8</td>
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<tr>
<td>S.D.</td>
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<td>1.6</td>
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<tr>
<td>Multiple</td>
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<td>DO</td>
<td>11.3</td>
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<td>DO</td>
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<td>MOD</td>
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<td>MODL</td>
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<td>S.D.</td>
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</tbody>
</table>

All

|       |       |             | 10.0  |           | 11.6  |           |
|       |       |             | 1.2   |           | 2.0   |           |

1. Mean score below acceptable minimum but correctable.
2. Special preparation, minimum acceptable score for restoration was 6.
cavity preparations and fillings received mean quality point scores in the acceptable range.

Table 5.1 summarizes the examiners' blind ratings of the hygienists' work. For twenty-six cavity preparations, the group mean quality point score was 10.0—above the 9.0 beginning of the acceptable range. Taken individually, five of the preparations (19.2 percent) received less-than-acceptable mean scores but all were correctable by simple procedures. Specific defects in need of correction were pointed out for only two of these preparations and each by only one of the three examiners—in one case unacceptable internal form, and in the other, unacceptable caries removal. The other examiners did not report these defects.

Two of the amalgam restorations placed by hygienists in the twenty-six cavity preparations were not evaluated by all examiners and are not included in table 5.1. The group mean quality point score for eight single-surface restorations and one multisurface restoration (MOL) that fit into the same quality point category (because it had no opposing tooth and did not need to be judged for the occlusion criterion) was 10.7, with a score of 9 or better signifying acceptable. And for fifteen multisurface restorations, the group mean quality point score was 12.2, with 12 or better indicating acceptable. Taken individually, one single-surface filling (4.1 percent) and four multisurface fillings (16.6 percent) among the twenty-four completed restorations received less-than-acceptable mean scores, but all scored high in the simple-to-correct range. Three of the hygienists' single-surface restorations received perfect scores.

The only specific restoration defects recorded by the examiners were four instances of inadequate contact points, only one of which occurred in a filling that received a less-than-acceptable mean quality point score. The other three restorations received acceptable mean quality point scores despite their challenged contact points. The cited deficiencies in both the cavity preparations and the restorations were not all found by the same person but were noted by different examiners. That subtle quality judgments varied somewhat is not surprising, but it was interesting that whenever one examiner identified a specific defect the other two examiners made no record of it.
RESULTS OF THE SECOND BLIND EXTRAMURAL EVALUATION

In June 1973 a second blind assessment was conducted under the same rules and conditions as the first. Despite considerable notice and efforts to accommodate their schedules, only two of the four members of the special liaison committee acted as examiners. For this evaluation, several outside practicing dentists joined the staff dentists in performing procedures for comparison. As in the previous evaluation, examiners were completely blind to the identity of the operator who performed the work being evaluated.

As detailed in Table 5.2, the advanced skills hygienists performed nineteen cavity preparations, the dentists fifteen. The group mean scores (Table 5.3) for all preparations were 10.2 quality points for the hygienists and 10.6 quality points for the dentists, with a score of 9 or better representing acceptable. Taken individually, three hygienist-performed preparations (15.8 percent) and one dentist-performed preparation (6.7 percent) received mean quality point scores below acceptable but in the simple-to-correct range (Table 5.3). However, the t-test (Table 5.3) showed that there was no significant difference between the performance of cavity preparations of each group of operators.

Specific deficiencies were recorded for ten of the nineteen hygienist-performed cavity preparations and four of the fifteen dentist-performed preparations (Table 5.2). Thus many more deviations from the acceptable were listed than were reflected in the mean quality point scores. Similar disparities between the number of adverse comments and the awarded quality point scores occurred in the evaluations of restorations that were placed by the different operators. One of the two examiners consistently awarded lower scores than the other and was the source of most of the criticisms.

Table 5.3 also demonstrates that the group mean quality point scores for amalgam restorations were well above the acceptable level for both types of operator. With 9 or more quality points equaling acceptable, the hygienists achieved a group mean score of 10.7 points for six one-surface fillings. In terms of multisurface restorations for which 12 or more quality points signified acceptable, the dentists achieved a group mean score of 14.0 points for nine fill-
### Table 5.2  Project Rotunda: second blind extramural evaluation

<table>
<thead>
<tr>
<th>Operator</th>
<th>Surface</th>
<th>Tooth</th>
<th>Preparation</th>
<th>Cavity preparation</th>
<th>Score</th>
<th>Correction</th>
<th>Score</th>
<th>Correction</th>
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<tbody>
<tr>
<td>Advanced</td>
<td>Single</td>
<td>1-6</td>
<td>O</td>
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<td>Caries</td>
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</tbody>
</table>

1. Mean score below acceptable minimum but correctable.
### Table 5.3  
Project Rotunda: statistical comparison of mean quality point scores for advanced skills hygienists (ASH) and dentists at second blind extramural evaluation

<table>
<thead>
<tr>
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<th>N</th>
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</tr>
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<tbody>
<tr>
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<td></td>
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<tr>
<td>ASH</td>
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<td>1.5</td>
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</tr>
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<td>Dentists</td>
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<td>1.2</td>
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<td>1.2</td>
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</tr>
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<td>1.9</td>
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<tr>
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<td>1.8</td>
<td>0.17</td>
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<td></td>
</tr>
<tr>
<td>ASH</td>
<td>19</td>
<td>12.9</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Dentists</td>
<td>15</td>
<td>12.5</td>
<td>2.5</td>
<td>0.54</td>
</tr>
</tbody>
</table>

ings, and the hygienists' group mean score was 13.9 quality points for thirteen fillings. Taken individually (table 5.2), two hygienist-performed restorations (10.5 percent) were scored slightly below the acceptable number of quality points but were correctable by simple procedures. All of the dentists' restorations (table 5.2) were acceptable. Once again, the group mean scores, standard deviations, and t-tests demonstrated that there were no significant differences in quality between restorations completed by the two groups of operators.

The data from the two evaluations in which members of the special liaison committee participated were sent to each committee member for comment or questions. No replies of any kind were received, but nearly a year later, in May 1974, the committee submitted a report to the House of Delegates of the Massachusetts Dental Society that stated: "With close supervision as done at Forsyth, quality can be comparable to that of practicing dentists." The report nevertheless expressed the committee's unanimous opinion
that advanced skills auxiliaries should be opposed as an economic threat to dentists and as personnel who might be employed by the government or third parties to create a lower second level of dentists.

Results of the Third Blind Extramural Evaluation

An assessment by a different group of extramural examiners had not originally been planned but seemed desirable, since the dental societies’ examiners had participated minimally in the evaluations. Subsequently six professors of restorative dentistry—two each from the Harvard, Tufts, and Boston University schools of dental medicine—accepted our invitation to serve as examiners in a third blind evaluation. It was held in March 1974, about a year after the advanced skills hygienists began the care delivery studies. The evaluation was conducted under conditions and rules identical to those of the other blind evaluations. Staff dentists and community practitioners completed cavity preparations and fillings used as comparative material without the examiners knowing which work was dentists’ and which was hygienists’. As they had done just twice before, the hygienists again worked entirely according to their own clinical judgment. As shown in table 5.4, only one (5.9 percent) of the seventeen cavity preparations completed by the hygienists and none completed by dentists failed to receive an acceptable mean quality point score. The group mean score for all cavity preparations (table 5.5) was 10.2 quality points for the hygienists versus 10.0 quality points for the dentists, with the minimum acceptable score beginning at 9.0. When multisurface cavity preparations were compared (table 5.5), those completed by the hygienists received a higher mean quality score and produced a value of $t = 2.14$ which was significant at the 5 percent confidence level. The hygienists also achieved a slightly superior group mean score for single-surface restorations, all of which had an acceptable range starting at 9 points. The hygienists’ group mean score for six such fillings was 10.7 quality points versus 10.5 quality points for three dentist-performed fillings.

For multisurface restorations with an acceptable range starting at 12 points, the hygienists’ eleven fillings received a group mean score of 12.9 quality points and the dentists’ five fillings received a
Table 5.4  Project Rotunda: third blind extramural evaluation

<table>
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<tr>
<th>Operator</th>
<th>Surface</th>
<th>Tooth</th>
<th>Preparation</th>
<th>Cavity preparation</th>
<th>Amalgam restoration</th>
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<td>4-4</td>
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<tr>
<td></td>
<td>4-5</td>
<td>O</td>
<td>11.1</td>
<td>11.6</td>
<td></td>
</tr>
</tbody>
</table>
|               | 1-6     | MO    | 8.4
1 | 11.4    |            |        |            |
| Multiple      | 1-4     | MO    | 10.3        | Depth   | 14.2      |        |            |
|               | 2-4     | MO    | 10.9        |         | 13.4      |        |            |
|               | 4-6     | MO    | 9.8         |         | 10.8
1 | Contour  |        |            |
|               | 4-6     | MOF   | 10.3        | Undercut | 13.2      |        |            |
|               | 3-6     | MODF  | 9.6         |         | 10.4
1 | Occlusion |        |            |
|               | 4-4     | DO    | 10.0        |         | 13.4      |        |            |
|               | 1-5     | DO    | 11.3        |         | 15.4      |        |            |
|               | 1-4     | DO    | 11.5        |         | 12.8      |        |            |
|               | 1-4     | DO    | 10.3        |         | 11.6
1 | Margins |        |            |
|               | 1-5     | DO    | 10.5        |         | 13.0      |        |            |
|               | 2-4     | DO    | 9.1         | Depth   | 13.8      |        |            |
| Dentist       | Single  | 4-4   | O           | 10.8      | 10.8      |        |            |
|               | 4-6     | OF    | 10.1        | 9.6      |            |        |            |
|               | 1-6     | OL    | 10.1        | 11.0    |            |        |            |
| Multiple      | 1-6     | MO    | 9.8         |         | 13.6      | Margins|        |
|               | 3-5     | MOD   | 10.0        | Depth   | 14.6      |        |            |
|               | 1-4     | DO    | 9.1         | Margin  | 12.1      |        |            |
|               | 1-4     | DO    | 9.5         | Depth   | 12.6      |        |            |
|               | 1-5     | DO    | 9.6         |         | 12.2      |        |            |

1. Mean score below acceptable minimum but correctable.

The group mean score of 13.0 quality points, although three hygienist-performed restorations were given individual mean scores just below acceptable in the easy-to-correct range. The closeness of the group mean scores and small standard deviations established once more that qualitative differences in the two groups' performance were statistically non-significant.
Table 5.5  Project Rotunda: statistical comparison of mean quality point scores for advanced skills hygienists (ASH) and dentists at third blind extramural evaluation

<table>
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<td>12.9</td>
<td>1.5</td>
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<td>13.0</td>
<td>1.1</td>
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<td>1.6</td>
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</table>

1. Significant at the 5 percent level.

The Daily Intramural Evaluations

Daily in-house assessments employed the same quality point scale as the blind evaluations but were conducted quite differently. Because of the step-by-step supervision of staff dentists, none of the auxiliary-performed procedures was unacceptable in its final state. Corrections were recommended along the way by the dentists and almost always acceptably executed by the hygienists. As shown in figure 5.3, the occasions when staff dentists had to intervene to make corrections or complete procedures quickly, or both, became rare during the hygienists' internship and fifteen months of care delivery studies. For example, in January 1973, the last month of internship, there were sixty-one interventions in 743 procedures (8.2 percent). In February 1973, the first month of clinical practice, there were fifty-six interventions in 969 procedures (5.8 percent)
Figure 5.3 Dentist intervention to complete restorative procedures. Above each bar is the number of procedures completed during the month. Dentist intervention (vertical axis) is expressed as a percentage of the number of completed restorative procedures. For example, during January 1973, dentists intervened in 8.2 percent, or 61, of the 743 procedures completed.

and in May 1973, there were four interventions in 1,302 procedures or only 0.3 percent.

Out of a total work load during the study of 17,766 procedures undertaken by the hygienists, there were only 224 interventions (1.3 percent) by staff dentists. Of a total of 17,023 hygienist-performed cavity preparations and restorations completed between February 1973 and May 1974, the staff dentists found it necessary to suggest or make corrections in less than 4 percent of the cavity preparations, and less than 2 percent of the restorations required immediate replacement. No cavity preparation was ever rated as totally unacceptable. A few pulp exposures necessitating root canals occurred but none was attributed to improper drilling by a hygienist.
THE BITEWING RADIOGRAPHIC ASSESSMENT FOR OVERHANGS

The findings of this and other published studies of the quality of restorations as judged by overhanging margins are summarized in table 5.6. Dr. Lobene examined posttreatment radiographs taken of 556 patients or 21 percent of all the cases treated in Project Rotunda. This sample was not randomly selected but represented patients who had had posttreatment radiographs at Forsyth. Such radiographs were usually made only when previously treated patients returned on recall visits. The experiment did not last long enough for the majority to return for recall visits. In the last months of the study, however, all patients had had bitewing X rays on their final visit for restoration polishing. The group included patients of various ages with hygienist-placed fillings radiographed at various intervals after placement. Of 556 post-treatment cases examined, 37.4 percent were radiographed at the time of recall visits, six to twelve months after completion. The rest (62.6 percent) were radiographed within a week to a month, at the last appointment for polishing fillings.

In all, 3,745 multisurface restorations were studied for possible overhanging margins. A total of 191 overhangs (5.1 percent) were found in these hygienist-performed restorations. The size of the defect was not considered; the slightest detectable overhang was counted (fig. 5.4). This posttreatment sample was compared to 528 patients examined for overhanging fillings at the outset of the study. In this case, 753 (24.9 percent) overhanging margins were detected by bitewing radiographs in fillings present at the time these patients joined Project Rotunda.

For comparative purposes, only two published studies of overhanging margins in dentist-performed restorations could be found. An early study by Easton (1941) reported an 83.9 percent rate of overhangs in multisurface fillings placed by dentists. More recently, a Harvard thesis by Bailes (1967) found a 29.7 percent overhang rate in such fillings placed by dentists. In this study the subjects were young adult students attending a local college.

LOCAL ANESTHESIA ADMINISTRATION

Although at least nine states have legalized administration of local anesthesia by dental auxiliaries, the dental profession has ex-
Table 5.6  Comparison of quality of compound amalgam restorations

<table>
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<tr>
<th>Year</th>
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<th>Interproximals</th>
<th>Overhangs</th>
<th>Percent</th>
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<td>230</td>
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</tr>
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<td>3,023</td>
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<tr>
<td>1974</td>
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<td>556</td>
<td>3,745</td>
<td>191</td>
<td>5.1</td>
</tr>
</tbody>
</table>

1. Data from Easton (1941).
2. Data from Bailes (1967).
3. Data from Project Rotunda: bitewing radiographs at initial examination.
4. Data from Project Rotunda: bitewing radiographs one to twelve months postoperative.

pressed considerable concern about potential harm to patients. Project Rotunda showed that only nine hours of didactic instruction, demonstrations, and simulated manikin practice were necessary to prepare persons with a dental hygiene background to start performing clinical anesthetic injections under a dentist's supervision. Throughout internship and care delivery studies, all hygienist-performed anesthesia administration attempts were carefully monitored in terms of effectiveness and safety.

The desired duration of insensitivity largely determined which of three anesthetic solutions was used for either infiltration or mandibular block local anesthesia. For short procedures, a 4 percent

Figure 5.4  Bitewing radiographs showing amalgam fillings with overhanging margins (arrows) of varying degrees of severity.
solution of Citanest with epinephrine 1:200,000 was prescribed. For longer procedures, a 2 percent solution of Xylocaine was given with epinephrine 1:100,000 or, for an even more profound effect, 2 percent Xylocaine with epinephrine 1:50,000 was injected. An aspirating syringe was used with a short 27-gauge disposable needle for infiltration anesthesia and with a long needle of the same gauge for mandibular block anesthesia. The amount injected per patient varied from about one-half carpule, containing 1.8 cc of solution, to three carpules.

In general, if the advanced skills hygienists had not produced adequate anesthesia after three attempts, a staff dentist intervened. Each attempt consisted of making several needle insertions to deposit the anesthetic in the appropriate sites for the tooth in question. After a suitable waiting period, success was judged by an evaluation of the signs and symptoms of anesthesia such as numbness, loss of sensation, the absence of pain on probing soft tissue and teeth, and finally by patient comfort at the start of therapy. The ratios of successful infiltration or mandibular block anesthetic administrations on the first attempt to the total number of attempts are expressed as percentages in table 5.7.

In all, 19,849 individual anesthetizations were performed during the hygienists' clinical experience from October 1972 through June 1974. It turned out that the mean percentages of successful first attempts at the two types of anesthesia were approximately the same during internship and clinical care delivery. Monthly averages varied during the study from 95 percent to 98 percent successful first attempts at infiltration and from 78 percent to 95 percent for mandibular block. During the study, 96.7 percent of first attempts at infiltration anesthesia were successful as were 85.7 percent of mandibular block attempts. Overall, 92 percent of all anesthesia were given successfully by the hygienists on the first try. Furthermore, during internship, staff dentists had to intervene in only 2 percent of the cases, and during care delivery studies, in less than 1 percent.

The most important finding, though, was the high degree of safety with which 19,849 attempts at local anesthesia administration were performed by hygienists. No serious consequences resulted from either the infiltration or the mandibular block anesthesia in-
Table 5.7  Project Rotunda: local anesthetics administered by advanced skills hygienists

<table>
<thead>
<tr>
<th>Type</th>
<th>Total attempts</th>
<th>Success on first attempt</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration</td>
<td>11,412</td>
<td>11,030</td>
<td>96.7</td>
</tr>
<tr>
<td>Block</td>
<td>8,437</td>
<td>7,230</td>
<td>85.7</td>
</tr>
<tr>
<td>Total</td>
<td>19,849</td>
<td>18,260</td>
<td>92.0</td>
</tr>
</tbody>
</table>

Injections. There were no episodes of faintness or loss of consciousness, probably because patients were in the supine position at the time of injection. Not a single hematoma was observed or reported. The only untoward effects patients noted in three cases was temporary paresthesia—tingling sensations—the longest of which lasted for twelve hours after injection.

This data indicates that administration of local anesthetics by advanced skills hygienists under the prescription and supervision of dentists is clearly both effective and safe. It is unfortunate that no analogous data on anesthetic administration by dental students or practicing dentists is available for comparison.

Patients' Evaluations of Individual Visits

At the end of each visit the hygienist-dental assistant team gave the patient a questionnaire (fig. 5.1) that asked whether the visit lasted too long, whether the operator tried to do too much, whether the treatment caused discomfort and if so how, whether or not the patient would be satisfied to be treated again by the same personnel, and whether anything had happened that the patient did not like. About two thousand questionnaires were turned in. Less than 2 percent of this patient group, treated from the start of the internship period to February 1973, expressed some dissatisfaction with the explanation the operators had given them about which dental procedures would be carried out during the visit. This gap in communication was easily corrected by discussing the information needs of patients with the teams involved. Since it was the only negative reaction to 2,000 therapy sessions, we decided to stop col-
lecting daily visit data and confine our surveying of patients to requesting an assessment at the end of their series of treatments.

**Patients' Final Evaluations of Treatment Series**

A more detailed final questionnaire (fig. 5.2) asked patients to rate six aspects of the care they received on a five-point scale ranging from "very satisfied" down to "very dissatisfied." Five additional questions explored patients' perceptions and preferences about the type and sex of personnel providing them with dental services. Voluntary replies were requested after the patients had their final contact with the hygienist-dental assistant teams at the last of a series of visits. The forms could be filled out anonymously and left with a clerk. Of the 2,668 patients who received full courses of treatment, 1,200 (45 percent) were willing to complete the questionnaire.

As summarized in table 5.8, the responding patients were almost unanimously satisfied with treatment quality (99.1 percent), operator competence (98.6 percent), comfort during therapy (96.0 percent), and duration of visit (96.0 percent). Most of the relatively few patients who did not report satisfaction with all treatment aspects felt neutral rather than dissatisfied. Operator explanation of treatment was the aspect for which the highest dissatisfaction rate (only 1.3 percent) was noted, and all the other potential sources of dissatisfaction were individually noted by less than 1 percent of respondents.

Table 5.9 clearly shows that the responding patients had essentially no preference for receiving dental care from a male operator—which today virtually always means a dentist, since only a small percentage of dentists are female and few auxiliaries are male. A scant 1.5 percent said they were not comfortable being treated by a female operator, and 1.1 percent preferred a male. Many patients (38.9 percent) said they did not know what type of therapist had provided their treatment and 14.8 percent incorrectly identified the type. However, 46.3 percent correctly identified the therapist as a dental hygienist, and 98.8 percent said they would choose the same team to do more of their dental work. Indeed, when it was announced that Project Rotunda would soon be terminated, some ninety patients spontaneously offered to pay "something" if they could continue to receive their dental care from the teams of advanced skills hygienists and dental assistants.
Table 5.8  *Project Rotunda: evaluation of patient satisfaction with dental services provided by advanced skills hygienists*

<table>
<thead>
<tr>
<th>Questionnaire item</th>
<th>Satisfied</th>
<th>No opinion</th>
<th>Dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required for visits</td>
<td>96.0</td>
<td>3.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Comfort during treatment</td>
<td>96.0</td>
<td>3.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Operator explanation of treatment</td>
<td>90.7</td>
<td>7.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Operator interest in you as a person</td>
<td>93.6</td>
<td>5.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Competence of operator</td>
<td>98.6</td>
<td>1.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Quality of treatment received</td>
<td>99.1</td>
<td>0.6</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Table 5.9  *Project Rotunda: summary of patient response to final evaluation questionnaire*¹

Do you feel comfortable having a female perform the dental treatment you received?
Yes: 98.4%  No: 1.5%

Would you prefer having a male or a female perform the dental treatment you received here?
Male: 1.1%  Female: 38.2%  No preference: 60.4%

Would you choose the same team to do more of your dental work?
Yes: 98.8%  No: 1.1%

What type of therapist provided most of your treatment?
- Dental assistant 4.2%
- Dental student 5.2%
- Dental nurse 2.3%
- Dental hygienist 46.3%
- Dentist 3.0%
- Don’t know 38.9%

¹ Based on 1,200 respondents.
CHAPTER 6
APPLICATION OF RESULTS TO SIMULATED CLINICAL PRACTICE

THROUGHOUT THE ADVANCED skills hygienists' clinical experience, productivity data such as the number of patient contact hours, anesthetics attempted, restored tooth surfaces, preventive treatments, and assigned dollar values of rendered services were recorded daily and summarized monthly. These studies encompassed the hygienists' 1,684 hours of patient contact during the internship period lasting from October 1972 through January 1973, and 10,561 hours of patient contact during the clinical practice period lasting from February 1973 through May 1974. During the long practice stage, profiles of the supervising dentists' activities were determined when they were directing the work of various numbers of auxiliary teams and the most effective dentist-auxiliary ratios were identified. Care delivery took place both in a clinic format and in several simulated private practice configurations. The solo-private practice simulations yielded average hourly productivity data from which yearly gross and net incomes were projected.

Procedure

As noted earlier, all patients received free treatment. Therefore, the income that could have been generated if they had been billed for delivered services was calculated using the dollar charges for specific dental procedures (table 6.1) listed in the 1974 Massachusetts welfare fee schedule and the 1972 schedule of usual fees for New England dentists (Professional Budget Plan, 1973). Since the 1972 survey did not include usual endodontic charges in Massachusetts, a small number of Boston endodontists were surveyed to establish endodontic fees. These are probably somewhat higher than
## Table 6.1  Sources of fees for dental services used to calculate income

<table>
<thead>
<tr>
<th>Service Description</th>
<th>Welfare 1974</th>
<th>Usual 1972</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examination and charting</td>
<td>$ 8.00</td>
<td>—</td>
</tr>
<tr>
<td>Full mouth radiographs — 14 films or panoramic radiograph</td>
<td>16.00</td>
<td>$18.00</td>
</tr>
<tr>
<td>Prophylaxis only</td>
<td>8.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Topical fluoride with prophylaxis</td>
<td>15.00</td>
<td>—</td>
</tr>
<tr>
<td>Amalgam — one surface</td>
<td>7.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Amalgam — two surfaces</td>
<td>11.00</td>
<td>13.00</td>
</tr>
<tr>
<td>Amalgam — three surfaces</td>
<td>16.00</td>
<td>21.00</td>
</tr>
<tr>
<td>Composite resin — one surface</td>
<td>10.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Maximum multiple surfaces — same tooth</td>
<td>20.00</td>
<td>22.00</td>
</tr>
<tr>
<td>Fractured anterior tooth with pins</td>
<td>32.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Filling with pins — per pin</td>
<td>4.00</td>
<td>—</td>
</tr>
<tr>
<td>Endodontics — single root</td>
<td>62.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Endodontics — double roots</td>
<td>90.00</td>
<td>200.00</td>
</tr>
<tr>
<td>Endodontics — triple roots</td>
<td>135.00</td>
<td>250.00</td>
</tr>
</tbody>
</table>

1. Data from Massachusetts Department of Public Welfare (1974).
2. Data from Professional Budget Plan (1973).
3. Data not available for Massachusetts. Therefore, the welfare fee was used as the usual fee for these services. This has the effect of underestimating the usual income as reported in this study.
4. Data not available for Massachusetts. Usual fees based on a survey of a small number of private practitioners specializing in endodontics.

the fees general practitioners would charge for endodontics. However, the welfare fees for endodontics are actual.

Projected yearly incomes of dentists working in simulated solo practices with advanced skills hygienists were computed using the average working hours and expenses of New England dentists listed in the American Dental Association’s survey of dental practice (Moen, Loewy, and Poetsch, 1972). Although newer information may now exist, the above three sources were the most reliable, pertinent, and recent information available when the study was conducted.

To avoid possible confusion, some definitions and work arrangements adopted for Project Rotunda should be explained. We con-
sidered that most of the hygienists' care delivery was taking place in a large clinic-type practice such as might be associated with a dental school or a public health facility. Usually, several staff dentists were present to maintain direct supervision over the hygienist-dental assistant teams. In the clinic format, these dentists provided no patient care themselves, except on the very rare occasions when it was necessary for a dentist to intervene, advise or assist the hygienist in completing the procedure.

Supervising dentists were responsible for carrying out at least three examinations on each patient receiving restorative therapy from an auxiliary team for the first time. The hygienist first conducted a preliminary examination and charted any detected dental problems. Then a staff dentist made definitive diagnoses of all oral pathology and drew up a treatment plan based on the charting, radiographs, his confirming examination, and the patient's past medical and dental history. The priorities for treatment were determined and the hygienist was given a prescription for the work to be done on one or more visits, including the local anesthetic to be used, the teeth to be restored and the restorative material to be inserted. Each completed cavity preparation was examined and evaluated by a dentist before work continued. Completed restorations were also assessed for quality by the dentist before the patient was dismissed. The dentist might furthermore have been called upon at any time during the therapy to judge its progress, give advice on succeeding steps, or take over the procedure if intervention was warranted. Quality points awarded by the dentist and the time required for each phase of the therapy were recorded on a performance evaluation sheet for each restoration.

Overseeing the restorative work of the ten hygienist-assistant teams without making them wait for guidance or a go-ahead kept the two or three supervising dentists busy almost all the time. They obviously had only a few brief intervals in which they might have treated patients of their own. It should be noted that diagnoses by the dentists revealed that some patients needed nonrestorative therapy such as pulp capping, root canals, extractions, and crown and bridge work, even though the initial screening had eliminated most cases requiring these extensive sophisticated treatments. These more complex treatments were provided by staff dentists.
Some of the patients with nonrestorative problems as well as those with cavities provided the clinical material for a second type of practice. In a variety of configurations, staff dentists not only supervised the restorative work of auxiliaries but also delivered services themselves to a separate group of patients whose needs often included the more sophisticated procedures. These situations were considered to simulate solo private practices, in that productivity data were gathered on the total number of procedures performed by one dentist who was treating his own patients and by the auxiliary team or teams which he was concurrently supervising. Mean incomes per hour for the dentist and auxiliary teams were calculated from the welfare and usual fee schedules cited in table 6.1. These simulated solo private practices were cost accounted to derive the yearly gross and net incomes they would have generated had they worked the same number of hours as the average New England solo private practice dentist, had similar expenses, and received either welfare or usual fees from patients.

It goes without saying that our simulated private practices could not mirror the real world where actual fees and costs could be better apportioned to the dentist and auxiliary teams. Nor were they intended to duplicate any average or typical form of general solo practice. In fact, the mix of services performed by individual dentists while supervising teams was deliberately made quite variable instead of uniform. As a result, some of our data was gathered on supervising dentists whose mix of performed services was close to the typical general practitioner's 60 percent to 70 percent restorative dentistry and 30 percent to 40 percent other procedures. But we also obtained data representing the income extremes that might occur when supervising dentists themselves work almost exclusively on restorations or conversely concentrate on other sophisticated high-income dental procedures.

The private practice simulations were of limited duration because we expected to conduct studies of auxiliary teams working with dentists in real extramural private practice settings. A total of 145 hours of patient contact time, the equivalent of 3.5 work weeks for a dentist, was distributed among the different configurations. Because of the differing mixes of dentist-delivered care and unavoidable technical variables, such as the location of diseased teeth
in the jaws, our data on the dentists' hourly incomes merely suggest possible ranges. There was a fairly broad range between individual dentists' mean hourly incomes which seemed to result directly from nearly opposite mixes of care. On the other hand, the hygienist-dental assistant teams were quite consistent in their income-producing potential with a narrow range regardless of whether they were doing restorations in the clinic format with several supervising dentists or in solo private practice simulations when the supervising dentist was treating patients and even overseeing one or more auxiliary teams.

The efficient and productive use of auxiliary teams in a program to deliver complete primary dentistry, from administration of anesthesia through finishing of inserted fillings, is obviously predicated upon a large case load of patients in need of their services as well as those provided by their supervising dentist. One of the major premises on which the Forsyth experiment was based is that the demand for dental services will greatly increase in the near future as a result of new payment mechanisms. However, management and scheduling patients to keep all personnel occupied has been cited as a potential problem. In Project Rotunda, we found that judicious overbooking of patients and close coordination of auxiliary and dentist activities were required to maintain a steady flow of appropriate patients and smooth delivery of care. However, this did not necessitate hiring a special manager. One appointment clerk was able to handle all the scheduling, which entailed recording appointments for fourteen different operators.

**Dentist's Time Allocation**

The time usage studies, always conducted under standardized conditions, first focused on the activities and free periods of a single dentist given ten auxiliary teams to supervise (table 6.2). It took only a few days to discover that the supervisory responsibilities of checking each patient at least twice (treatment planning was usually completed on the first visit) did not allow the dentist enough free time to treat his own patients. The dentist's time in supervising ten teams ranged from 28 percent to 62 percent with a mean of only 48 percent available for doing clinical work himself. As shown in table 6.2, the demands of evaluating all therapy and providing guidance
Table 6.2  *Project Rotunda: Allocation of dentist's time when supervising advanced skills hygienist (ASH)-dental assistant (DA) teams*

<table>
<thead>
<tr>
<th>Dentist/ASH-DA Ratio</th>
<th>Percent of dentist time in ASH-DA supervision Range</th>
<th>Mean</th>
<th>Times per hour ASH used dentist help Range</th>
<th>Mean</th>
<th>Times dentist had patient contact &gt; 10 mins.</th>
<th>Mean contact time &gt; 10 mins.</th>
<th>Dentist total productive time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:10</td>
<td>28-62</td>
<td>48</td>
<td>10-21</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1:5</td>
<td>24-54</td>
<td>41</td>
<td>9-13</td>
<td>10</td>
<td>5</td>
<td>13</td>
<td>65</td>
</tr>
<tr>
<td>1:3</td>
<td>5-39</td>
<td>19</td>
<td>3-5</td>
<td>4</td>
<td>6</td>
<td>22</td>
<td>132</td>
</tr>
<tr>
<td>1:2</td>
<td>8-21</td>
<td>12</td>
<td>4-6</td>
<td>5</td>
<td>7</td>
<td>19</td>
<td>133</td>
</tr>
<tr>
<td>1:1</td>
<td>3-13</td>
<td>6</td>
<td>2-5</td>
<td>3</td>
<td>7</td>
<td>19</td>
<td>133</td>
</tr>
</tbody>
</table>

1. Time in minutes per three-hour clinic session.
for ten teams left the dentist with a block of free time that exceeded ten minutes, only once in a three-hour (180 minutes) clinic session. The dentist generally was unoccupied with team interaction for only three or four minutes at a stretch. Furthermore, when he was engaged in providing direct help to a hygienist, teams often had to wait as long as ten minutes before they could proceed with their work. The 1-to-10 configuration was quickly abandoned. Doing nothing but supervising auxiliaries in routine restorative service proved difficult for the staff dentists to tolerate for more than several days at a time. Among other reasons, dentist boredom would apparently militate against large restorative "assembly line" practices with one dentist supervising many auxiliary teams full time.

The next ratio studied was one dentist supervising five auxiliary teams. Table 6.2, which averages the experience of four dentists, shows that a dentist in this configuration used only 41 percent of his time for team supervision and had 59 percent of it free for potential clinical work. However, the mean number of times he had more than ten consecutive free minutes was only five, averaging thirteen minutes each. Intervals of at least this length were needed to provide meaningful patient services. Thus the dentist had only sixty-five minutes in a three-hour (180 minutes) clinic session, or 36 percent of his time, available in clinically useful blocks. Team supervision averaged thirty interactions lasting 3.8 minutes each. These data support the conclusion that supervision of five auxiliary teams does not leave the dentist with enough long stretches of free time to perform anything but the simpler phases of restorative dentistry. More important, the frequent interruptions would probably be unacceptable to both the operator and the patient.

We therefore reduced the ratio to one dentist supervising three auxiliary teams and found that he then could deliver definitive treatment to his own potential patients while adequately overseeing the teams. As table 6.2 indicates, the averages for four dentists working in the 1-to-3 configuration resulted in six free periods of twenty-two minutes each in 180-minute clinic sessions. Team supervision required only 19 percent of a dentist's time in the form of twelve interactions lasting an average of 4.0 minutes each. With long uninterrupted periods making up 81 percent of the clinic session, the dentist could have provided more sophisticated services
than just simple restorations. The findings tend to support the conclusion that a solo private practitioner should probably supervise no more than three auxiliary teams in order to make good clinical use of his own free time as well as provide complete monitoring of the quality of restorative care delivered by the hygienist-dental assistant teams.

Having found what appears to be the maximum number of auxiliary teams that a dentist in private practice should try to supervise, other ratios of one dentist to two teams and one dentist to one team were investigated. It seems logical that these ratios are the ones most likely to be adopted in real world practices. When given two teams to supervise, the dentist on the average devoted just 12 percent of a three-hour clinic session to team interaction. Table 6.2 demonstrates that of the 133 minutes available for uninterrupted treatment, seven episodes averaged 19 minutes each. However, this average does not show that the dentist’s time frequently exceeded 30 minutes. As might be expected, the free-time blocks were longer when a dentist supervised only one auxiliary team. Interaction with one team (table 6.2) required a mere 6 percent of the dentist’s time. What is not shown, however, is that potential intervals for clinical work exceeding 40 minutes became available during a 180-minute clinic session.

The above profiles of dentists’ time allocations to team supervision and patient treatment are relevant to professional policy and the promulgation of regulations. In the private sector, it would seem appropriate that a limit be set on the number of advanced skills hygienist-dental assistant teams a single dentist should be allowed to employ and direct. Based on our data, the maximum number would be three. However, two teams might be a more acceptable limit, since a legal precedent already exists in Massachusetts and at least nine other states restricting to two the number of physician’s assistants that a physician may supervise at any given time (Opp, 1975). Some states limit the number of hygienists a dentist may employ.

**Productivity and Projected Incomes of the Auxiliary Teams**

In the fifteen months of clinical care delivery from February 1973 through May 1974 (with August 1973 off for vacation), the auxilia-
ry teams amassed a total of 10,561.6 patient contact hours—or a mean of 1,056 hours per advanced skills hygienist. Almost all of this service was provided in the clinic format using at least two supervising dentists. Dentists’ time studies and private practice simulations were interspersed periodically but recorded separately. The extensive clinic-format work experience was primarily intended to find out whether consistent long-term patterns would show up in the teams’ performance data (table 6.3).

There were many more variables, of course, than could be controlled or accounted for in our data retrieval. There was some predictable variation, for instance, in the working speed of individual hygienists. Also on any given day the teams were assigned different mixes of services that could include exposing radiographs, performing oral examinations, carrying out prophylactic treatments, and applying topical fluoride or sealants as well as performing many complete units of restorative dentistry. Total working times per day likewise varied among the teams.

The data in table 6.3 is based upon the number of filled tooth surfaces by types of filling materials which vary in difficulty and time consumption. The actual assigned charges for all performed work including the different types of restorations were entered into the data bank according to the welfare fee schedule (table 6.1), but not according to the usual fee schedule for New England private practitioners. An approximation of the latter fees for restorations was obtained by multiplying the number of filled surfaces by $9.00. The figure represents the average New England usual charge for any restored surface. It was derived by adding the charges for the different filling materials listed in table 6.1 for the number of different possible surfaces to be restored. This produced an average per surface cost of $8.50 which was rounded off to $9.00. This figure of $9.00 per surface was used to determine usual hourly income as reported in table 6.3.

The individual hygienists varied in speed but showed an individual consistency in the average hourly gross income their work could have generated. The range by welfare fees was $20.75 to $28.71 with an overall mean of $25.96 for restorative services and mean hourly rate of $26.31 when preventive services are included. Usual fees for New England dentists produce an hourly income
Table 6.3  Project Rotunda: productivity and income of advanced skills hygienist-dental assistant teams (clinical practice, February 1973-May 1974)

<table>
<thead>
<tr>
<th>Month</th>
<th>Clinic days</th>
<th>Clinic hours</th>
<th>Contact hours(^1)</th>
<th>Income-welfare fee</th>
<th>Income-usual fee</th>
<th>Income per hour(^6)</th>
<th>Percent of contact time(^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Exam(^2) Rest.(^3) Total(^4)</td>
<td>Exam(^2) Rest.(^3) Total(^4)</td>
<td>Welfare(^5) Usual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb.</td>
<td>19</td>
<td>1,140</td>
<td>678.9</td>
<td>$2,376 $11,714 $14,090</td>
<td>$2,772 $18,288 $21,060</td>
<td>$20.75 $31.02</td>
<td>60</td>
</tr>
<tr>
<td>Mar.</td>
<td>18</td>
<td>1,080</td>
<td>680.3</td>
<td>3,264 12,286 15,550</td>
<td>3,808 19,719 23,527</td>
<td>22.86 34.58</td>
<td>63</td>
</tr>
<tr>
<td>Apr.</td>
<td>21</td>
<td>1,260</td>
<td>619.4</td>
<td>2,088 12,407 14,495</td>
<td>2,436 19,800 22,236</td>
<td>23.40 35.90</td>
<td>49</td>
</tr>
<tr>
<td>May</td>
<td>21</td>
<td>1,260</td>
<td>745.8</td>
<td>3,864 16,250 20,114</td>
<td>4,508 24,543 29,051</td>
<td>26.97 38.95</td>
<td>59</td>
</tr>
<tr>
<td>June</td>
<td>18</td>
<td>1,080</td>
<td>674.0</td>
<td>4,656 12,864 17,520</td>
<td>5,432 20,025 25,457</td>
<td>26.15 37.77</td>
<td>62</td>
</tr>
<tr>
<td>July</td>
<td>20</td>
<td>1,200</td>
<td>830.4</td>
<td>5,232 18,588 23,820</td>
<td>6,104 28,593 34,597</td>
<td>28.69 41.66</td>
<td>69</td>
</tr>
<tr>
<td>Sept.</td>
<td>19</td>
<td>1,140</td>
<td>743.3</td>
<td>7,848 13,491 21,339</td>
<td>9,156 22,059 31,215</td>
<td>28.71 41.99</td>
<td>65</td>
</tr>
<tr>
<td>Oct.</td>
<td>21</td>
<td>1,260</td>
<td>861.9</td>
<td>4,944 17,141 22,085</td>
<td>5,768 28,278 34,046</td>
<td>25.62 39.50</td>
<td>68</td>
</tr>
<tr>
<td>Nov.</td>
<td>16</td>
<td>960</td>
<td>636.8</td>
<td>4,176 12,449 16,625</td>
<td>4,872 19,899 24,771</td>
<td>26.11 38.90</td>
<td>66</td>
</tr>
<tr>
<td>Dec.</td>
<td>14</td>
<td>840</td>
<td>508.8</td>
<td>3,048 10,251 13,299</td>
<td>3,556 16,191 19,747</td>
<td>26.13 38.81</td>
<td>61</td>
</tr>
<tr>
<td>1974</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.</td>
<td>20</td>
<td>1,200</td>
<td>649.5</td>
<td>4,896 12,982 17,878</td>
<td>5,712 20,574 26,286</td>
<td>27.52 40.47</td>
<td>54</td>
</tr>
<tr>
<td>Feb.</td>
<td>19</td>
<td>1,140</td>
<td>700.6</td>
<td>4,944 13,665 18,609</td>
<td>5,768 21,789 27,557</td>
<td>26.56 39.33</td>
<td>61</td>
</tr>
<tr>
<td>Mar.</td>
<td>21</td>
<td>1,260</td>
<td>774.4</td>
<td>5,976 14,324 20,300</td>
<td>6,972 22,932 29,904</td>
<td>26.21 38.61</td>
<td>61</td>
</tr>
<tr>
<td>Apr.</td>
<td>22</td>
<td>1,320</td>
<td>801.9</td>
<td>6,072 15,709 21,781</td>
<td>7,084 25,092 32,176</td>
<td>27.16 40.12</td>
<td>61</td>
</tr>
<tr>
<td>May</td>
<td>22</td>
<td>1,320</td>
<td>655.6</td>
<td>1,680 14,941 16,621</td>
<td>1,960 23,220 25,180</td>
<td>25.35 38.40</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>291</td>
<td>17,460</td>
<td>10,561.6</td>
<td>65,064 209,062 274,126</td>
<td>75,908 331,002 406,910</td>
<td>25.96 38.52</td>
<td>50</td>
</tr>
</tbody>
</table>

1. Direct patient services.
2. Includes charting, radiographs, and prophylaxis.
3. Restorative services; amalgam or composite resin fillings.
4. Does not include preventive treatments.
6. Mean hourly incomes and contact times.
which ranges from $31.02 to $41.99 with a mean of $38.52 and a mean hourly income of $39.12 when preventive service fees are added to the restorative and examination fees. Using these mean hourly incomes for clinic type practices, it is possible to project a mean yearly gross income for each dental hygienist-dental assistant team if we make certain assumptions: (a) the auxiliary team's weekly chair time is 61 percent of 40 hours, or 24.4 hours per week; (b) the auxiliary team works 47 weeks per year. The average team's work could gross $30,174 by welfare fees or $44,862 by usual fees. Of the rest of the advanced skills hygienists' time, approximately 20 percent was spent in record keeping, making appointments and other administrative duties. About 19 percent of the teams' clinic time was nonproductive and included broken appointments. This is comparable to the average New England dentist's workweek, 16 percent of which is not spent chairside delivering care.

**Productivity and Projected Incomes: Dentists Working with Teams**

As a result of the studies of dentists' time usage supervising different numbers of auxiliaries, it was decided to simulate private practices in which a dentist treated his own patients and supervised either one or two auxiliary teams. The 1:1 and 1:2 ratios seemed the least disruptive to a dentist's own care delivery and also the most likely combinations to be adopted when such auxiliaries are permitted to enter regular practice.

Simulations using the 1:1 and 1:2 ratios were alternated at intervals so that the personnel did not have a chance to grow accustomed to or prefer one combination over the other. All the advanced skills hygienists and their assistants took part in the simulations and worked at different times with different dentists. Thus, the effect of differences in their individual speed was distributed throughout the productivity and income data. The auxiliaries performed the same mix of services as they did in cliniclike practice—primarily restorations with some examinations, radiography, prophylaxes, and topical treatments. The dentists provided treatment for their own patients with a varied mix of restorations, pulp capping, extractions, endodontics, and crown and bridge work.

Table 6.4 summarizes data gathered when dentists took part in a
<table>
<thead>
<tr>
<th>% dentist income by service</th>
<th>Dentist income per hour</th>
<th>ASH-DA team income per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welfare</td>
<td>Mean</td>
</tr>
<tr>
<td>Restorative</td>
<td>Other\textsuperscript{1}</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>29 (4, 6)</td>
<td>32-35</td>
</tr>
<tr>
<td>12</td>
<td>88 (3, 5)</td>
<td>40-46</td>
</tr>
<tr>
<td>91</td>
<td>9 (3, 4)</td>
<td>22-34</td>
</tr>
<tr>
<td>64</td>
<td>36</td>
<td>20-46</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Service codes: (3) temporary, (4) extraction, (5) endodontics, (6) crown-bridge.
simulated private practice configuration of one dentist supervising one auxiliary team. This sample provided a total of forty-six patient contact hours by the dentists with their own patients while each supervised one auxiliary team delivering care. The individual dentists' contact hours took place during several therapy sessions. The dentists' mix of services is reported as a percentage of their projected income derived by performing restorations or other services. The averages for all the dentists' own work resulted in an income mix of 64 percent from restorations and 36 percent from other procedures, and a mean hourly income of $32 calculated on the basis of welfare fees or $45 by usual New England fees. The wide range from the highest to the lowest dental income clearly reflects the varying service mixes provided by the dentists and is of greater significance than the averages. The dentist who received 98 percent of his income from fillings and 2 percent from extractions had one of the lowest hourly incomes—a mean of $25 by welfare fees or $30 by usual fees. The mean hourly income of the single team of auxiliaries supervised by each dentist can also be found in table 6.4. The auxiliary teams' average hourly income of $24 by welfare fees or $30 by usual fees is almost the same as the hourly incomes of the dentists who did little else beside restorations. Conversely, the dentist who received only 12 percent of his income from restorations and 88 percent from pulp capping and endodontics, had the highest hourly earnings—$44 by welfare fees or $80 by usual fees.

The ranges of projected incomes in the one dentist to one team configuration point to an important conclusion. The auxiliary teams had a fairly small range in their hourly incomes, calculated by the two fee schedules—a maximum difference in their hourly mean of no more than $20. However, the much larger ranges for dentists—as much as $55—indicate that the most economically favorable type of practice using advanced skills hygienists entails delegating virtually all restorations to the auxiliaries and having the dentist perform other more sophisticated, and lucrative, services that require superior training and skills.

In the other simulated private practice configuration, staff dentists each treated their own patients while supervising two auxiliary teams. The dentists spent a total of 100 contact hours treating their own and supervising each auxiliary team's patients. As shown in table 6.5, the averages for the dentists included a service mix in
<table>
<thead>
<tr>
<th>% dentist income by service</th>
<th>Dentist income per hour</th>
<th>ASH-DA team income per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welfare</td>
<td>Usual</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Restorative Other(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>47 (4, 5, 6)</td>
<td>32-108</td>
</tr>
<tr>
<td>8</td>
<td>92 (5, 6)</td>
<td>49-73</td>
</tr>
<tr>
<td>54</td>
<td>45 (4, 6)</td>
<td>32-54</td>
</tr>
<tr>
<td>53</td>
<td>47 (3, 4)</td>
<td>28-108</td>
</tr>
</tbody>
</table>

1. Service codes: (3) temporary, (4) extraction, (5) endodontics, (6) crown-bridge.
which 53 percent of their projected income came from performing restorative dentistry and 47 percent from more expensive services, and their mean hourly income was $48 by welfare fees or $70 by usual fees.

The most striking finding was that when dentists supervised two auxiliary teams, rather than one, their mean hourly income increased considerably. To be sure, their average service mix had shifted to include a smaller percentage of restorative services and a greater percentage of the other high-income procedures. But the shift does not account for all of the individual dentists' increased mean hourly earnings. For example, one dentist received 99 percent of his mean hourly income (versus 98 percent in the 1:1 study; see table 6.4) from restorations, yet in the 1:2 study, his hourly income increased $13 by welfare fees or $18 by usual fees over the 1:1 study findings. The average hourly income of the auxiliary teams (table 6.5) also increased $3 by both welfare and usual fees over the findings of the 1:1 study. This is not considered a significant difference. It is also interesting to note the consistency of the productivity and income of the auxiliary teams in different work settings. In a clinic setting and the simulated practices 1:1 and 1:2, the teams’ mean hourly income ranged from $24 to $27 for welfare fees and $30 to $33 for usual fees.

It is worth stressing again that the 1:2 study was conducted at the same time as the 1:1 study. Still unexplained is the unexpected increase in individual productivity between 1:1 and 1:2. The varying types and locations of oral pathology, mix of service performed, and combinations of people do not seem to account in full for the seeming inconsistency, although they may have contributed to it. We are more inclined to suspect a Hawthorne effect, arising from the psychological interaction between members of the larger practice units, which increased productivity. Perhaps the dentists supervising more auxiliaries and seeing more completed work were subconsciously motivated to work harder and so increased their own productivity. Also, competition may have spurred the auxiliary teams.

Cost Accounting and Profits of Auxiliary Team Simulated Practices

The American Dental Association's 1971 survey of dental practice reported the average dentist's working hours per week and per
year. In conjunction with the productivity data for dentists and auxiliary teams (tables 6.4 and 6.5) these figures were used to calculate the potential gross annual income of a dentist in a solo practice setting supervising one and two auxiliary teams. Private practice dentists in New England worked an average of 40.9 hours per week and spent 34.4 hours (84.1 percent) of their time in direct patient contact. The dentists worked 47.2 weeks per year and were on vacation 3.6 weeks. The rest of the year was used in sick days and attending meetings. The dentist’s chair time is equivalent to the patient contact time as used in this report. The mean patient contact time for the teams was 61 percent of the workweek (table 6.3). Comparative data follows:

<table>
<thead>
<tr>
<th></th>
<th>40.9 hrs.</th>
<th>34.4 hrs.</th>
<th>2.4 hrs./wk.</th>
<th>32.0 hrs./wk.</th>
<th>29.6 hrs./wk.</th>
<th>24.9 hrs./wk.</th>
<th>47.2 wks.</th>
<th>1,510.4 hrs.</th>
<th>1,397.1 hrs.</th>
<th>1,175.2 hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workweek, average New England dentist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dentist’s chair time—84 percent of 40.9 hours</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dentist’s supervision time per auxiliary team—7 percent of 34.4 hours (table 6.2)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dentist’s time with own patients, directing one auxiliary team</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dentist’s time with own patients, directing two auxiliary teams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary team chair time—61 percent of 40.9 hrs. (table 6.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice’s work year (minus vacation, illness and other absences)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dentist’s yearly time with own patients, directing one team</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dentist’s yearly time with own patients, directing two teams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary team’s yearly time with patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adding the earnings of the personnel in the two practice configurations provides the following total: the gross annual income generated by a dentist treating his own patients and by the one auxiliary team he supervises could be $76,515 by welfare fees or $103,197 by usual fees (table 6.6). The gross annual income generated by a dentist treating his own patients and by the two auxiliary teams he supervises could be $130,473 by welfare fees or $175,300 by usual fees.
Table 6.6  Project Rotunda: Estimated gross income for one dentist delivering care while supervising one auxiliary team

<table>
<thead>
<tr>
<th>Income per hour</th>
<th>Income per year¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welfare</td>
</tr>
<tr>
<td>Dentist</td>
<td>$32</td>
</tr>
<tr>
<td>Auxiliary team</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
</tr>
</tbody>
</table>

1. Based on data from table 6.4.

(table 6.7) if the dentist had a service mix like the averages in table 6.5 of 53 percent restorative fees and 47 percent fees for the more expensive services. An idea of the greater potential gross income of a practice with two auxiliary teams in which the dentist performs complex services almost exclusively can be gained from data (table 6.5) showing a dentist who derived 92 percent of his income from costly procedures and whose mean hourly earnings were $55 by welfare fees and $112 by usual fees. The gross annual income of this dentist and his teams could be $140,252 by welfare fees and $233,979 by usual fees.

The cost accounting of the two experimental practices described must also analyze the expenses generated by the teams providing care under the supervision of the dentist. The salaries of auxiliaries (hygienist and dental assistant), laboratory charges, rent, utilities, and dental supplies are the major overhead items. These, of course, can vary widely depending upon the characteristics, type (general or specialized), and location of the dental practice. Therefore, in calculating the professional expenses associated with these experimental private practice models, certain assumptions were made regarding auxiliaries' salaries and other overhead items. Data in the ADA 1971 Survey of Dental Practice was also used for cost accounting the experimental solo private practices.

Salaries are the largest item of overhead in actual practices. In these experimental practices, the salaries of the advanced skills hygienists and the dental assistants also were very important. The
Table 6.7  Project Rotunda: Estimated gross income for one dentist delivering care while supervising two auxiliary teams

<table>
<thead>
<tr>
<th></th>
<th>Income per hour</th>
<th>Income per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welfare</td>
<td>Usual</td>
</tr>
<tr>
<td>Dentist</td>
<td>$48</td>
<td>$70</td>
</tr>
<tr>
<td>Auxiliary team 1</td>
<td>27</td>
<td>33</td>
</tr>
<tr>
<td>Auxiliary team 2</td>
<td>27</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>102</td>
<td>136</td>
</tr>
</tbody>
</table>

1. Based on data from table 6.5.

1971 survey reported the mean monthly income of full-time auxiliaries in New England as $633 for a conventional hygienist and $406 for a dental assistant. Based on these figures, annual salaries were $7,596 for a conventional hygienist and $4,872 for a dental assistant. Since the advanced skills hygienist (ASH) would assume greater responsibility for patient care and could generate greater income, this person logically should receive a larger salary than a conventional hygienist. For purposes of determining expenses in the experimental practices detailed in tables 6.6 and 6.7, an acceptable salary for a full-time ASH was estimated at $12,000 per year; the full-time salary of the dental assistant member of the team, $6,000 per year.

Calculation of expenses to estimate the potential net income for each experimental practice studied is based on the professional expenses of independent dentists, expressed as a percentage of gross income (Moen, Loewy and Poetsch, 1972). (For convenience, the data for the New England region is reproduced in table 6.8.) Estimated expenses for the auxiliary teams in the experimental private practices are included in table 6.8 so direct comparisons to the professional expenses of the dentist can be made. Since the auxiliary teams' salaries are deducted from dentists' income, salaries are not shown as a percentage of gross income in table 6.8. Auxiliary teams did not provide prosthetic services so it is appropriate to delete dental laboratory charges from their estimated operating expenses.
Table 6.8  Professional expenses of dentists and estimated expenses of ASH-DA teams in experimental practices as a percentage of gross income

<table>
<thead>
<tr>
<th>Item</th>
<th>Dentist's % of gross(^1)</th>
<th>ASH-DA teams' % of gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>15.8</td>
<td>-</td>
</tr>
<tr>
<td>Dental laboratory charges</td>
<td>9.1</td>
<td>-</td>
</tr>
<tr>
<td>Office rent and utilities</td>
<td>6.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Dental supplies</td>
<td>6.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Depreciation: equipment</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Fringe benefits</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>All other expenses</td>
<td>7.3</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>46.8</td>
<td>12.2</td>
</tr>
</tbody>
</table>

1. From the ADA 1971 Survey of Dental Practice; data for New England.

A dentist adding one auxiliary (ASH-DA) team to his practice would need to add at least one complete operatory. According to the 1971 survey, 47 percent of independent dentists reported that they had two chairs and 29 percent three chairs. Adding one ASH-DA team to either of these practices would increase office rent and utilities 25 percent to 30 percent. Therefore, rent and utilities for auxiliary teams were generously adjusted to half that of the dentist (3 percent). Based on the actual cost of dental supplies in the experimental practices, the auxiliary team's expenses for dental supplies was estimated at 3 percent of the gross. Finally, a fair estimation of other expenses for the ASH-DA teams was set at half that of the dentist or 3.7 percent (table 6.8). These expense estimates are probably somewhat larger than would be anticipated in actual practices; but they seem to be the most reasonable approximations that could be made based on the data available for actual practice expenses.

The auxiliary team's contribution to estimated expenses and potential net income of the experimental practice of one dentist providing care and supervising one ASH-DA team is shown in table 6.9. In this experimental practice, the auxiliary team's contribution to the calculated net income of the practice was $8,082 by welfare fees and $15,128 by usual fees. This was an income after salaries and expenses of 28.7 percent of the total gross income by welfare
Table 6.9 Estimates of annual expenses and potential net income produced by auxiliary teams in experimental solo private practice simulations (one dentist supervising one ASH-DA team)\(^1\)

<table>
<thead>
<tr>
<th></th>
<th>Welfare</th>
<th>Usual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total gross income—one team</td>
<td>$28,183(^2)</td>
<td>$35,229(^2)</td>
</tr>
<tr>
<td>Total salaries—one team</td>
<td>18,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Gross income after salaries</td>
<td>10,183</td>
<td>17,229</td>
</tr>
<tr>
<td>Expenses: 12.2% of gross income by usual fees(^3)</td>
<td>2,101</td>
<td>2,101</td>
</tr>
<tr>
<td>Net taxable income</td>
<td>8,082</td>
<td>15,128</td>
</tr>
<tr>
<td>Net income as % of total gross</td>
<td>28.7</td>
<td>42.9</td>
</tr>
</tbody>
</table>

1. Annual salary for advanced skills hygienist, $12,000; annual salary for dental assistant, $6,000.
2. Data from table 6.6.
3. A change from one fee schedule to the other would not change the professional expenses as summarized in table 6.8. Therefore, the higher expense figure derived from usual fees was used in this calculation.

fees and 42.9 percent by usual fees. It is important to recall that the dentist’s time required for direct supervision and monitoring of the auxiliary team is only 7 percent of his chair time or 2.4 hours per week.

The experimental practice consisting of one dentist working and supervising two auxiliary teams (table 6.10) showed a calculated potential net income contribution to the practice by the auxiliary teams of $22,349 by welfare fees and $36,441 by usual fees. This was an income of 35.2 percent of the total gross income by welfare fees and 47.0 percent by usual fees. Supervision of two teams required 14 percent of the dentist’s work time or 4.8 hours per week.

This analysis of the possible expenses and net income of these experimental private practices and the calculated projections of gross incomes, whether by welfare or usual fees, support the conclusion that it is economically feasible for the private practice dentist to employ advanced skills hygienist-dental assistant teams to provide high-quality restorative dental services while keeping consumer costs to a reasonable level.

What is needed now is a true field test of this system in actual
Table 6.10  Estimates of annual expenses and potential net income produced by auxiliary teams in experimental solo private practice simulations (one dentist supervising two ASH-DA teams)\(^1\)

<table>
<thead>
<tr>
<th></th>
<th>Welfare</th>
<th>Usual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total gross income—two teams</td>
<td>$63,412(^2)</td>
<td>$77,504(^2)</td>
</tr>
<tr>
<td>Total salaries—two teams</td>
<td>36,000</td>
<td>36,000</td>
</tr>
<tr>
<td>Gross income after salaries</td>
<td>27,412</td>
<td>41,504</td>
</tr>
<tr>
<td>Expenses: 12.2% of gross income by usual fees(^3)</td>
<td>5,063</td>
<td>5,063</td>
</tr>
<tr>
<td>Net taxable income</td>
<td>22,349</td>
<td>36,441</td>
</tr>
<tr>
<td>Net income as % of total gross</td>
<td>35.2</td>
<td>47.0</td>
</tr>
</tbody>
</table>

1. Annual salary of advanced skills hygienist, $12,000; annual salary of dental assistant, $6,000.
2. Data from table 6.7.
3. A change from one fee schedule to another would not change the professional expenses of the auxiliary team as summarized in table 6.8. Therefore, the higher expense figure derived from usual fees was used in this calculation.

private practice so that analysis of the use of this type of auxiliary team for the delivery of cost-effective care can be based on real numbers, not on projections and calculations.
CHAPTER 7

Summary and Conclusions

THE PUBLIC AND the dental profession are both concerned in regard to present and future systems of dental care. Dental educators are concerned with the adequacy of the didactic and clinical curriculum for training dentists and dental auxiliaries. Practitioners share these concerns with educators. However, they are also concerned with the quality of dental care provided by practicing dentists and expanded function auxiliaries. The productivity, income, patient acceptance and increased costs of using these auxiliaries in private practices are other important concerns. This study of new duties for dental hygienists and the data from a limited series of experiments using advanced skills hygienists addresses these concerns.

Findings and conclusions of the Forsyth Experiment:

Education

A curriculum using task analysis and a "need to know" reduced the time required to teach and demonstrate proficiency in performing selected restorative procedures by half, without any loss in quality.

By the end of the clinical practice period, twenty-five weeks after the start of training, the hourly productivity of the hygienist-dental assistant teams closely approached that of the dentist, while maintaining the high quality of the completed work.

Spending $2,300 for twenty-five weeks additional training, compared to about $50,000 needed to educate dentists, makes training hygienists to take over selected restorative dental procedures economically attractive.
QUALITY

Based on blind evaluations by teams of independent extramural evaluators, the advanced skills hygienists were found to perform restorative dentistry equal in quality to that done by practicing dentists working under the same restraints of quality control.

Routine daily intramural monitoring of quality during the fifteen months of experimental clinical practice showed that the staff dentist rarely had to intervene to make corrections or complete a procedure. This occurred in only 1.3 percent of the procedures.

Evaluating the quality of restorative services involved using posttreatment radiographs to detect the presence of overhanging margins; 5.1 percent not previously detected in hygienist-completed restorations were found. Pretreatment radiographs made on this sample of patients at their initial Project Rotunda entry examination showed 24.9 percent overhanging margins. This compares with a finding of 29.7 percent found in an independent study of young adults reported in 1967.

Monitoring of the administration of infiltration and block local anesthesia throughout the study showed that 96.7 percent of first attempts at infiltration anesthesia were successful, as were 85.7 percent of mandibular block attempts. During the entire study 92 percent of all anesthetics were given successfully by hygienists on the first try. In a total of 19,849 anesthetics attempted by hygienists, there were only three minor short-term adverse reactions. In the delivery-of-care studies, the need for dentist intervention occurred in less than 1 percent of the cases.

ACCEPTABILITY OF AUXILIARIES

Of a total of 2,980 patients screened and examined for admission, only 312 (10.5 percent) were not accepted because their oral diseases were so severe that they could not significantly benefit from the hygienist-dental assistant team's services.

Of the 2,668 patients who received a full course of treatment 45 percent volunteered their opinions on whether they were satisfied with treatment.
Of 1,200 volunteered opinions, 98.6 percent were favorable concerning the operator's competence and 99.1 percent were satisfied with the quality of treatment. Only 46.3 percent correctly identified the therapist as a dental hygienist. Of this group, 98.8 percent said that they would choose the same teams again. Only 1.1 percent stated a preference for treatment by a male rather than a female.

Allocation of a Solo Dentist's Time
Supervising Auxiliaries

One dentist could supervise the activities of all ten hygienist-dental assistant teams provided the dentist was not required to perform diagnosis, treatment planning, or any other direct patient service. Dentists reported they were bored after several days of only supervising auxiliaries and not rendering direct patient services.

One dentist supervising five hygienist-dental assistant teams had 59 percent of his time free for direct patient services. However, he reported only five useful blocks of uninterrupted time during a three-hour work period.

One dentist supervising three hygienist-dental assistant teams had 81 percent of his time for direct patient services with six useful blocks of uninterrupted working time per three hours of clinic time.

One dentist supervising two hygienist-dental assistant teams needed only 12 percent of his time to supervise the auxiliary teams and had 88 percent of his time for patient treatment. He had seven blocks of time averaging nineteen minutes each for direct patient service. When supervising only one auxiliary team, 94 percent of the dentist's time was available for patient service and the average number and length of blocks of uninterrupted time were the same as when he supervised two auxiliary teams. In the 1:1 ratio, the dentist had many work periods exceeding forty minutes.

Productivity, Projected Income and Expenses

The advanced skills hygienist-dental assistant teams provided services directly to patients on an average of 61 percent of
their worktime regardless of the ratio of dentist-to-auxiliary teams.
The patient's chair time with the auxiliary team averaged forty-five minutes per visit.
Appropriate supervision of auxiliaries took the following percentages of a dentist's worktime: one team 6 percent, two teams 12 percent, three teams 19 percent.
Total productive time for a dentist to provide direct patient services while supervising one, two, or three teams was almost constant at 73 percent of a three-hour work period.
The gross mean hourly income calculated on the basis of welfare fees generated by a single hygienist-dental assistant team was $25.96 for restorative services ($26.31 including preventive services). On the basis of usual fees, mean hourly income was $38.52 for restorative services ($39.12 including preventive services). These hourly incomes project an average team's gross annual income of $30,174 (welfare fees) and $44,862 (usual fees).
The gross hourly income of a solo dentist providing care while supervising one hygienist-assistant team ranged from $20 to $46 (welfare fees) and $25 to $91 (usual fees). The mean hourly incomes were $32 and $45.
The gross hourly income of a solo dentist providing care and supervising two hygienist-assistant teams ranged from $28 to $108 (welfare fees) and $34 to $138 (usual fees). The mean hourly incomes were $48 and $70.
One team working with one dentist had a mean hourly income of $24 (welfare) and $30 (usual) fees. Two teams working with one dentist each had a mean hourly income of $27 and $33 respectively.
On the basis of this measured sample of actual services rendered while operating experimental solo private practice simulations consisting of one dentist and one team, the calculated annual net of the gross income to the practice after expenses was 28.7 percent and 42.9 percent by welfare and usual fees. For the practices which used one dentist and two auxiliary teams, the calculated annual net of the gross income to the practice after expenses was 35.2 percent and 47.0 percent by welfare and usual fees.
A number of conclusions and recommendations have been made, based on the data and findings of this experiment. However, as has been carefully stated, these statements are predicated upon certain assumptions, projections and extrapolation of data to reflect what might occur in actual solo private practices. These conclusions are tentatively presented:

1. The advanced skills hygienist working under the direct supervision of the dentist provided services of high quality, equal to those of dentists working under the same conditions of peer-review.
2. Appropriately supervised hygienist-assistant teams provided restorations of higher quality than that generally provided by dentists not working under some form of quality control or peer-review.
3. Advanced skills hygienists working under the direction of and upon prescription of a dentist administered local anesthetics safely and effectively.
4. Almost all of the patients aged five to thirty-five were drawn from a caries-susceptible population; thus they were found to benefit from the services provided by the advanced skills hygienist. This showed that the auxiliary could be useful and have a positive economic effect on a solo practice or clinic providing care for a large number of caries-susceptible people.
5. Patients expressed satisfaction with the dental services provided by the auxiliary teams.
6. Some dentists practicing in a solo setting can probably supervise as many as three auxiliary teams, but in order to assure the highest quality care, a solo dentist should not be permitted to supervise more than two hygienist-assistant teams.
7. Training advanced skills hygienists who can provide 60 percent to 70 percent of the services of the dentist makes better economic sense than continuing to increase the number of new dentists.
8. The solo private practice dentist using hygienist-assistant teams to provide restorative care could not only charge lower fees but increase his net income.
IN LOOKING BACK on Project Rotunda and ahead to its implications for dental care delivery in the United States, Forsyth’s demonstration of improved cost effectiveness with no loss of quality in auxiliary-rendered restorative dental services puts this nation’s principles to a test. In a freely competitive society on the verge of extending basic health benefits to all citizens through some form of national health insurance, the scientifically proven utility of expanded function dental auxiliaries should be quickly accepted by the private sector. The alternative is government control, which would not only force adoption of such auxiliaries but also do away with the main incentive for progress, productivity, and quality—the freedom to innovate and compete. Either way, increasing employment of expanded function auxiliaries seems inevitable. Self-defeating opposition merely slows the pace somewhat and causes temporary reverses. The events that grew out of Project Rotunda are illustrative.

LEGAL CHALLENGE UPHELD

Forsyth’s investigation of the clinical usefulness of advanced skills hygienists was forced to cease in June 1974, at the end of the project’s first phase, instead of being extended, as planned, into a variety of community practice situations to obtain “real world” data on productivity, costs, and dividends for dentists and patients. The profession’s policy that led us to embark on the study was a resolution favoring research on expanded function auxiliaries passed in 1970 by the House of Delegates of the Massachusetts Dental Society. Both the society and the Board of Dental Examiners raised no objections to Forsyth’s fully communicated plans to carry
out such a study involving clinical performance of restorative dentistry by specially trained auxiliaries under close dental supervision. Therefore, we proceeded without seeking a specific enabling change in the Dental Practice Act of Massachusetts.

No problems arose between 1970 and 1973. Then rumors persisted that a small group of dentists was urging the Board of Dental Examiners to close down the project, although the board at first seemed to ignore the pressure. In October 1973, however, the board notified Forsyth that a hearing would be held to review the project's justifiability. On this occasion, testimony favorable to the research program was presented by officers of the Massachusetts Dental Society as well as representatives of Forsyth. The only negative testimony challenging the project's legality came from a spokesman for the protesting group.

Initially, the board seemed satisfied with Forsyth's presentation and gave informal assurances to that effect. But after a short while, the examiners reversed themselves and voted unanimously that drilling of teeth by hygienists was a direct violation of the Dental Practice Act of Massachusetts. The board then submitted its opinion and a transcript of the hearing testimony to the Massachusetts attorney general's office for a ruling and action.

In March 1974 a verdict was rendered by an assistant attorney general, who stated: "While hygienists may properly assist dentists in any phase of operative or surgical procedures"—the provision in the practice act on which Forsyth based the auxiliaries' closely supervised clinical work—"the Dental Practice Act clearly does not contemplate that their assistance embrace procedures constituting the practice of dentistry." He concluded that drilling teeth is deemed in the act to be undertaking the practice of dentistry, and the legislature had not exempted research from this provision.

Forsyth was confronted with two choices. One was to fight the ruling in court and try to keep the research going through legal maneuvers. The other was to seek a compromise in which Forsyth would agree to suspend its study of expanded duties at the end of the intramural phase in June 1974 and not attempt to continue any further clinical research until the practice act was amended. In return the attorney general would allow the experiment to continue through June without taking any legal action. Forsyth chose the latter course.
The future action that remained open to Forsyth was well stated in the last paragraph of the assistant attorney general's ruling: "Our conclusion that the hygienist program at Forsyth violates the Dental Practice Act in no way reflects our view as to the desirability of this result. It may very well be in the public interest to encourage research programs such as Forsyth's hygienist program. However, such a result can only be achieved by appropriate amendments to the Dental Practice Act. The Board of Dental Examiners, the Massachusetts Dental Society, and educational institutions may wish to propose legislation which would permit research programs under strictures that would protect the public."

The impact of the 1974 economic recession on dentistry further increased resistance to Forsyth's efforts to gain support for its findings and for legislative change. In January 1974, when the legal challenge was pending, we decided that as many dentists as possible should be invited to observe the experiment while it was still in operation. Many foreign visitors had viewed the advanced skills hygienists at work, but very few American dentists had done so. Therefore, an invitation to an open house at the project was placed in the program of the dental society's winter meeting. Only three dentists out of the society's total membership came to observe the auxiliaries as they treated patients. A letter with a similar invitation to view the project was subsequently sent to the officers and trustees of the American Dental Association. Neither the officers nor the trustees of the association officially visited the project before it was terminated.

At the next dental society meeting in May 1974, liberal proposals for revising the Dental Practice Act were placed before the House of Delegates, but a general hardening of attitudes toward expanded functions for dental auxiliaries led to their defeat. The economic basis for this opposition was plainly acknowledged in the annual report submitted to the House of Delegates by the Massachusetts Dental Society Forsyth Special Liaison Committee. The report conceded that 'Forsyth has developed a highly effective educational method . . . In a short time, (hygienists) have been trained well to cut Class I through V preparations, insert . . . restorations, and in-
ject local anesthetics . . . With close supervision, as done at Forsyth, quality can be comparable to that of a practicing dentist.” But a 1974 survey showing that 62 percent of Massachusetts dentists could treat more patients than they had at that time was cited as a countervailing factor. Thus, the report concluded: “. . . this committee feels that the training of such auxiliaries might be like opening Pandora’s box . . . that government and third parties might utilize them to create a new, lower level of dentists, perhaps the ‘denturist of teeth.’ This could lead to the archaic two-level form of dentistry . . . a return to the tooth mechanic. We, therefore, wish to unanimously express our opinion that such auxiliaries should not now be trained and the provision for such a category of therapist in the law should be opposed.”

Between May and December 1974, battle lines were drawn over sharply conflicting legislation to change the Dental Practice Act. In May, Forsyth’s director tried and failed to get the Massachusetts Dental Society’s House of Delegates to go on record in favor of academic freedom to pursue research and education. In December 1974 the Board of Dental Examiners introduced its own legislative bill to gain even more control over education than it already possessed and also tried to seize veto power over research through administrative rules and regulations.

These attempts to usurp the research prerogatives of educational institutions mobilized academic leaders to fight back. They organized an unprecedented coalition—including Boston’s three dental schools, consumer representatives, community health centers, hospitals, and several state agencies—to oppose the board’s legislative and administrative incursions. A hearing on the board’s restrictive bill in the spring of 1975 brought out harshly critical testimony, caused the legislation to be redrafted along the lines of a model dental practice act, and showed the cooperating groups that they could mount an effective counterattack against ultraconservative interests in organized dentistry.

Forsyth had meanwhile enlisted the aid of legislative leaders of the Massachusetts House and Senate in what was to become a three-year dialogue of argument and compromise. It resulted in the final passage of a revised dental practice act that was not perfect, by any means, but an improved one that all parties could live with.
Participating in various stages of the dialogue were the officers, board of trustees, and House of Delegates of the Massachusetts Dental Society; the Board of Dental Examiners; the deans of the three dental schools; Forsyth's director and dean; public health officials; and officers of the Massachusetts Dental Hygienists Association and the Massachusetts Dental Assistants Association.

Except for a few slight changes made later by legislators, the key compromises had been hammered out by May 1977. At that time the proposed new practice act was aired before the House of Delegates and a vote was taken on whether to support it. The delegates, who cast their ballots in behalf of the grassroots of Massachusetts dentistry, approved in principle the whole package of changes. During the discussion, the organized opposition, which had dwindled down to a small band of dissident members within the dental society, had an opportunity to present its case but was voted down by the vast majority of delegates.

One of the new law's reforms was the inclusion of a licensed dental hygienist on the eight-member board of dental examiners. To proponents of academic freedom, the most welcome provision was the stipulation that "nothing in . . . rules and regulations adopted thereunder shall prohibit research, including educational research, conducted under the direct supervision of a licensed dentist and done by not-for-profit dental research institutions chartered by the Commonwealth of Massachusetts and by (accredited) dental schools . . . whether such research is performed within or without such institutions; provided, however, if such research involves treatment of dental patients and is to be conducted in the private office of one or more private practices, the Board shall be notified in writing of the intent to conduct such research and the practice or practices shall be selected in consultation with the Board." If this research exemption to the law's limitations on what constitutes the practice had existed during Project Rotunda, the experiment conducted on Forsyth's premises could not have been judged illegal. The plan to continue the study in private practice settings would also have been legally permissible.

Academic freedom is still abridged in terms of routine training of expanded duty auxiliaries in Massachusetts. The new law requires
that “if any accredited educational institution in the Commonwealth . . . wishes to undertake an educational program for dental hygienists or dental assistants which program would involve delegated procedures not in accordance with the existing Rules and Regulations of the Board, such educational institution must petition the Board in writing, detailing the contemplated program, for the Board’s written approval. The program may be undertaken if the Board so approves and shall be subject to periodic review and approval.”

This required approval and review would not apply to education carried out as part of a research program such as Project Rotunda. But it can restrain educational institutions like Forsyth from having an ongoing program in expanded duty training intended to prepare graduates for nonresearch practices which transcend state boundaries.

With research freedom now protected by Massachusetts law, Forsyth is preparing to resume studying the clinical utilization of advanced skills hygienists. Some of the original ten graduates (two of whom have entered dental school) may be utilized in community practice situations, and their impact on care delivery and the economics and management of the practices may be documented to provide “real world” data. A new class of trainees may also be recruited to go through the 25-week advanced skills curriculum and take part in the private practice experiments. Among the many important management factors to be studied is the problem of how to schedule patients to ensure a flow that will keep a dentist and one or two advanced skills hygienist teams efficiently occupied. At the outset of Project Rotunda, we had high cancellation and “no show” rates and found that overbooking was necessary to keep the teams supplied with enough appropriate patients. Out in practice, it remains to be determined whether overbooking is required or whether it tends to bring in too many patients, leading to long waiting times, inability to treat some scheduled patients, and consequent dissatisfaction. We must also determine the existence of a pool of patients demanding care and not receiving it to maximize the benefits to be derived by both the consumer and providers in the private sector.
The National Picture

On a national level, organized dentistry still is maintaining its reactionary unwillingness to endorse the training and practice of expanded duty auxiliaries with adequate control and supervision (Lobene, 1976). But some noteworthy supportive steps are being taken by federal and state government agencies. It seems likely that national resistance will soon abate when organized dentistry recognizes that the issue is eroding its local leadership and credibility and threatening to hasten government intervention.

In 1977 the American Dental Association became, if anything, more negative in its policy toward permitting auxiliaries to perform expanded functions than it had been the year before. In 1976 its House of Delegates had specified that cavity preparation, placement of restorations, and local anesthesia administration are functions that should not be delegated to auxiliaries. The issue was not reexamined in 1977, although the ADA's national policy remained contradictory to the dental laws of some states where auxiliaries are permitted to place fillings and in at least nine other jurisdictions where they are allowed to administer local anesthesia. However, Massachusetts made progress and joined at least fourteen other states that have added hygienist members to their boards of dental examiners.

The same year saw the Federal Trade Commission initiate a potential challenge to the ADA's restrictive influence, on the grounds that it might constitute restraint of trade, now that the practice of dentistry has been classified as a form of commerce. The FTC let it be known that it was mounting a major investigation into how the private sector dispenses dental care and that it had requested the ADA to supply a great amount of data. FTC investigators visited the Forsyth School for Dental Hygienists to gather material on Project Rotunda and to inquire whether ADA policies were interfering with its ability to operate competitively. An affirmative answer was given regarding the school's ability to recruit students competitively with other hygiene schools around the country. The reason is that Forsyth cannot routinely teach expanded functions that are now legally taught and practiced in other jurisdictions, unless Forsyth requests and receives a written dispensation from the board of dental examiners, which is unlikely. Preparing a nation-
wide case will take the FTC investigators several years. When the commission receives their findings and recommendations, it might hold hearings and perhaps even recommend that Congress enact regulatory legislation.

In another move that flouts the ADA's policy, the Veteran Affairs Committee of Congress has directed the Veterans Administration to create civil service positions for expanded function dental auxiliaries and to start using them to increase the efficiency of dental care delivery. Candidates can be either dental hygienists or dental assistants who have received formal training as expanded duty auxiliaries in educational programs such as those found in Washington State, Pennsylvania, and California. These programs teach the placing of restorations and local anesthesia administration but not cutting of tooth tissue. At this time, however, the Veterans Administration does not appear to be planning the use of these auxiliaries for the cutting of hard and soft tissues.

THE YEARS AHEAD

The roles that auxiliaries will play in our future care delivery system clearly anticipate increased performance of expanded functions such as restorative dentistry. The added duties, once they are lawful, will not be reclaimed by dentists—just as physicians have permanently delegated many technical procedures to auxiliaries. Legal implementation, however, will vary according to need and locale. The continuing controversy over delegation is not over the feasibility of training ancillary personnel to carry out operative functions with dentist-like precision but rather over which duties will be legally relinquished by dentists. Much of the resistance stems from dentists' unwillingness to make changes in their work habits and the mix of dental work they are accustomed to doing.

The timing and pace of greatly increased auxiliary performance of expanded duties hinges on Congressional enactment of some form of national health insurance that includes dental care. To hazard a guess, it seems reasonable to predict that a nationwide health insurance program will be enacted within the next decade. If this comes to pass, there will be such a vast increase in the demand for care that existing dental manpower will have to be stretched to the limit by the only swift and economical means available: assigning
routine technical procedures to auxiliaries, who can be quickly trained.

To avoid losing important strengths of the present private care delivery system, the following recommendations are proposed for incorporation into any national health insurance legislation covering dentistry (Lobene, 1975b):

1. Dental care delivery should continue to be provided in all of the current modes—private solo practice, group practice, clinic practice, and institutional practice. As in private enterprise, these different practice modes should compete for patients in terms of service quality, convenience, and fees charged.

2. Children up to the age of seventeen should be given first priority to receive care. Eligibility should be staggered to create an even flow of patients into the care system. Service could be in school clinics, or through private practitioners if parents prefer.

3. In all practice modes, maximum use of auxiliaries is essential if the insurance program is to keep costs as low as possible.

4. A national insurance program should merely supplement the existing methods of payment, which should not be eliminated. Thus government payments from taxation or social security revenue should become a fourth alternative to existing methods—direct fee for service payment by patients to providers, prepayment to a single care-providing institution such as a health maintenance organization, and payment by prepaid insurers including Blue Cross for services received from patient-chosen providers.

5. To lessen the existing maldistribution of dentists and auxiliaries, consideration should be given to granting income tax forgiveness for the first five years of practice in underserved areas. This would induce young dental school graduates to settle in such places, because the large expenses of starting a practice would be subsidized.

6. A national education program should be directed at children and adults to inform them that most dental disease is pre-
ventable and acquaint them with the available methods for preventing it. This effort should begin in the schools and extend into communities and homes.

If diversified modes of practice and payment continue when basic care is guaranteed by the government to those who cannot now afford it, the resulting multilevel system will retain the advantages of free choice and competition. Use of auxiliaries will probably vary with the practice mode (Lobene, 1968). A small segment of the public who are willing to pay the highest cost will receive personalized private attention from a dentist using few, if any, auxiliaries; this will most closely resemble current private practice. Group practices, outpatient hospital clinics, and privately operated clinics owned by unions and large corporations will provide medium-cost dental care for most people; these will use greater numbers and types of auxiliaries per dentist. Many of our future dentists will have been trained in similar facilities such as clinics in outpatient areas of hospitals affiliated with dental schools. And, lastly, public health dentistry financed as inexpensively as possible by government will use relatively few dentists and many auxiliaries to serve people regardless of ability to pay.

The fear that quality differences will result from such varying levels of dentistry will prove unfounded if the profession openly scrutinizes members' work with a minimum of government regulation. For example, state dental societies working closely with boards of examiners might set up systems to review and evaluate dental therapy much as hospital tissue committees and Professional Services Review Organizations audit medical practice. Some dental care plans have already instituted review systems.

Dentists must accept final responsibility for the quality not only of their own performance but also of the auxiliaries working under their direct supervision. Therefore, they must decide which duties can be delegated and which procedures require their own skills and education, such as diagnosis and treatment planning. If this concept gains acceptance, controversies over what functions may legally be performed by auxiliaries will become pointless. Dental practice acts can simply be revised to give the licensed dentist authority to assign to an auxiliary with appropriate training and dem-
onstrated competence those duties which he believes the auxiliary can perform with safety and excellence. Malpractice penalties—along with peer-review and continuing education requirements for relicensing—will ensure that the authority to delegate is properly exercised by a qualified dentist.

Major alterations in practice arrangements and routines will undoubtedly be at least temporarily discomfiting to many dentists. As the Forsyth experiment has shown, merely delegating the placement of restorations has required significant changes in a dentist’s way of working and the flow of patients through his office. Individuals who themselves do not want to change also do not want other dentists to have the economic advantage of delegation of duties, namely the ability to attract more patients at lower fees because the office is more productive.

The cost-benefit superiority of having the typical dentist supervise several auxiliaries who perform a variety of expanded functions will eventually prevail because it is more socially useful, predicts Forsyth’s director (Hein, 1975). In addition, he suggests that new manpower configurations will have the upsetting effect of reducing the need for specialists and increasing the need for generalists who are able to perform the routine procedures of many of today’s specialties. The economic findings of Project Rotunda illustrate this point. The staff dentists who principally performed restorative dentistry while supervising advanced skills hygienists doing the same work earned only a slightly higher gross hourly income than the auxiliaries—because the dentists worked slightly faster. But staff dentists who chiefly did endodontics and fixed prosthodontics earned approximately twice the gross hourly income of the hygienists whose restorative work they supervised.

In the future, group practices may well be able to handle all but the most complicated dental problems without having any specialists on the staff. The staff dentists will be “supergeneralists” who among themselves are able to perform more of the basic clinical procedures of today’s specialties. They will be free to do the harder and better-paying jobs such as root canals, periodontal surgery, and prosthetic work, because all the cavity restorations and other simple procedures will be done by auxiliaries. Only very unusual patients will be referred to the few remaining specialists, who will
probably be working in academic settings or major health centers. The need to make a drastic switch away from the present trend of training and using large numbers of specialists is today one of dentistry's serious controversies. It is likely, however, that the transition will span two or three decades, so the educational system may have time to lessen the strife by emphasizing expanded auxiliary and generalist training rather than specialty programs.

Finally, the most painful issue is the one that addresses the economic implications of delegating restorative dentistry to auxiliaries; the issue is complex and the outcome unpredictable. If the private sector embraces the concept of using auxiliaries, the biggest unanswered question is whether the increased income resulting from enhanced productivity will be voluntarily shared with patients in the form of lower fees. It is certain that the growing consumer movement will not sanction a repeat of the windfall profits dentistry reaped after the introduction of high-speed drills. Fees per restoration were not reduced in the 1950s and 1960s even though productivity increased by a factor of two or three. But today, it would be hard to imagine public interest research groups ignoring another such failure on the part of dentists to pass along savings to patients. Dentistry would be wide open to charges of monopolistic price-fixing. And, there is no doubt that government-financed health insurance would require an adjustment in usual fees for auxiliary work.

From another standpoint, financial discrimination may be a significant but temporary factor in the argument for more delegation in dentistry. Scarrott (1973) has pointed out that almost all auxiliaries are women, who tend to receive lower salaries than men doing similar work. As social change lessens this pay differential, women auxiliaries will command higher wages, and the profit from employing them may not be as great as it is at present.

Unfortunately, no studies have yet been performed in the United States to establish the actual productivity and income increases that would result from employing auxiliaries who possess the broad restorative skills taught in Project Rotunda. The nearest approach to such a study was carried out by Redig and associates (1974), who gathered data in several California private practices where dental assistants placed and finished fillings in dentist-prepared cavities.
The study found that full-time use of one expanded duty dental assistant increased a dentist's net income by 26 percent, and that using two of the auxiliaries full-time raised another dentist's net income by 44 percent. It is reasonable to assume that net profit would have been even higher if the auxiliaries had performed the irreversible duties of anesthesia administration and cavity drilling, as Forsyth's advanced skills hygienists did. Indeed, Forsyth's data supports that conclusion, although it was not obtained under actual extramural private practice conditions.

Based on productivity data of our staff dentists, the scale of usual fees, and cost allocations, our staff dentist supervising one auxiliary team hypothetically increased his yearly net income by as much as 43 percent as a result of the auxiliaries' work; supervising two teams boosted his hypothetical yearly net income by 47 percent. This supports the conclusion that reductions of 10 percent to 25 percent in fees for restorations could presumably be passed on to patients and still give private-sector dentists a respectable profit, motivating them to produce more high-quality care at a reasonable cost to the consumer.
Each criterion for the procedures contained in this manual is to be evaluated and awarded quality points from one to four according to the performance scale for the evaluation of restorative procedures.

**Performance Scale for Evaluation of Restorative Procedures**

<table>
<thead>
<tr>
<th>Quality</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>4</td>
</tr>
<tr>
<td>Acceptable</td>
<td>3</td>
</tr>
<tr>
<td>Not Acceptable</td>
<td>2</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>1</td>
</tr>
<tr>
<td>Not Applicable</td>
<td>0</td>
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</tbody>
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**Criteria for the Evaluation of Rubber Dams**

**Orientation**

Holes should be punched so that the upper edge of the dam is just below the nasal septum and the rubber dam is centered to the midline of the patient’s face. The rubber dam napkin should be centered wrinkle-free beneath the rubber dam so that the patient’s face is protected from the rubber dam and holder.

**Stabilization**

Clamps and ligatures should be placed so that the rubber dam is held securely during operative procedures.
Isolation

The rubber dam must form a seal at the necks of the teeth. The seepage of moisture can be prevented by properly inverting the rubber dam. If a rubber dam is not practical for the procedure or operating conditions, then isolation should be by cotton rolls, saliva ejector and other appropriate means.

Criteria for the Evaluation of Cavity Preparation for Amalgam Restorations

External Outline Form

1. Extend outline into all carious and non-coalesced fissures (extension for prevention).
2. Remove all undermined enamel rods so that enamel is supported by sound dentin.
3. Occlusal outline should be composed of graceful curves.
4. The proximal box outline should allow the passage of an explorer tine through the embrasures when held parallel to and in contact with the cavosurfaces proximally.
5. The gingival cavosurface margin is determined by either breaking contact with proximal surface of the adjacent tooth or by the extent of the caries.

Internal Outline Form

1. The pulpal wall in dentin should be generally parallel to the occlusal plane and approximately 1.5 mm below the main fissure, or central pit. The head of a No. 330 bur can be used to estimate this depth since it is 1.5 mm in length.
2. The minimum depth of the axial wall measured at the gingival-axial line angle should be approximately 1.0 mm which is the diameter of a No. 330 bur.
3. Retention grooves may be placed in dentin at buccal and lingual line angles.
4. The pulpal line angle should be rounded or chamfered.
5. The buccal and lingual walls are generally convergent in an occlusal direction.
6. Pulpal and gingival walls parallel the general plane of occlusion.
7. Buccal and lingual walls of the proximal box are generally at right angles to the axial wall and are slightly convergent in a gingival occlusal direction.
8. Plane gingival cavosurface margin to remove unsupported enamel.

Removal of Carious Dentin

1. All carious dentin should be removed.
Criteria for the Evaluation of Cavity Preparation for Composite Resin Restorations

External Outline Form
1. This is determined by the extent of caries and the need for adequate access to place restorations.
2. Cavosurface margins are not extended and enamel may be preserved to maintain a contact point.
3. The walls of the cavosurfaces are generally parallel to the enamel rods.
4. No bevels are placed at the cavosurface margins.

Internal Outline Form
1. Axial wall is generally parallel to the long axis of the tooth and in dentin.
2. Retention grooves are placed in the dentin in the gingivalaxial and incisoaxial line angles without undermining the incisal angle.
3. Gingival and incisal walls should converge toward the lingual cavity opening.

Removal of Carious Dentin
1. All carious dentin should be removed.

Criteria for the Evaluation of Matrix Bands

1. Adaptation
A. The band should be firmly wedged against the length of the gingival margin.
B. The band should be closely adapted to the proximal margins.
C. The band should be contoured as nearly as possible to conform to the original proximal surface.
D. The contact area should be placed so as to reproduce the contact of the original proximal surface.
E. The band should extend at least 2 mm above the height of the proposed marginal ridge.

2. Stability
Wedges and clamps must be placed so that the band will not be displaced during condensation of restorative materials. Bands and wedges should be stabilized and reinforced with compound where necessary.

3. Tissue Integrity
Whenever possible all precautions must be taken to prevent trauma to the supporting tissues during the placement and stabilization of matrix bands.
Criteria for the Evaluation of Finished Amalgam Restorations

Contour
Should conform closely to the original contour of the proximal surface.

Contact
Should be tight enough to prevent vertical and horizontal food impaction and pass dental floss with a definite resistance. The location and areas of the proximal contact will be determined by the morphology of the tooth and tooth alignment.

Margins
Should blend with the adjacent enamel so that the margins are imperceptible to the tine of an explorer passed over the surface of the enamel and restoration. No overhangs or excess flash should cover margins.

Occlusion
The vertical stops areas and the intensity of the contact during occlusion as determined by the use of articulating paper should be the same as other teeth. During closure the restoration should not interfere with the occlusion of other teeth. The remaining cuspal planes and grooves should serve as a guide to carving. The marginal ridge and triangular fossa should be carved to approximate the anatomy of the natural tooth. Excessive carving of the occlusal anatomy does not serve any functional purpose.

Finish
The polished surfaces should be free of grooves, scratches, pits, gross irregularities and smooth with a high metallic luster visible in all accessible areas.

Criteria for the Evaluation of Finished Plastic Restorations

Contour
Should conform to the original anatomy of the tooth with the marginal ridge continuous with that of the existing ridge.

Contact
Should be tight enough to prevent the impaction of food and pass dental floss with a definite resistance. The location and area of the contact will be determined by tooth morphology, alignment and degree of eruption.

Margins
Should blend with the adjacent enamel so that margins are imperceptible to the tine of an explorer passed over the surface of the enamel and the restoration.
Occlusion

The contact area and the intensity of the tooth contact during occlusion should be the same as other teeth. During closure the restoration should not interfere with the occlusion of other teeth.

Finish

The surface should be smooth, dense and free of scratches or pits and should blend in shade with the restored tooth.
APPENDIX 2

SUMMARY OF KEY EVENTS

January 1965 Forsyth trustees approve proposal for a new study of expanding the duties of dental hygienists.

1965-1970 Professional relations campaign.


June 1971 Operations grant awarded to fund the study.

September 1971 Trainee candidates and staff dentists selected for carrying out the program.

February 1972 Construction of the Rotunda completed.

March 1, 1972 Ten dental hygienists begin didactic and preclinical instruction in restorative dentistry.

July 28, 1972 Trainees complete the objectives of preclinical training and demonstrate proficiency in manikin performance of advanced skills.

September 1, 1972 Hygienists and certified chairside dental assistants begin training in four-handed dentistry.

October 15, 1972 Ten teams of advanced skills hygienists and dental assistants working under the direct supervision of staff dentists begin the internship phase of clinical practice. Individual team productivity measured through January 1973.

March 2, 1973 Teams complete internship phase and begin baseline experiment in the delivery of care.

March 1973 First blind evaluation by the Massachusetts Dental Society-Forsyth Liaison Committee examiners of the quality of restorative procedures performed by hygienists and dentists.

138
Simulated private practice experiments are begun to determine the most effective combination of dentists, advanced skills hygienists, and dental assistants.

Data gathered on quality, productivity, hypothetical earnings, and costs of delivered care.

Second blind quality evaluation conducted by liaison committee.

Third blind quality evaluation conducted by professors of restorative dentistry from Boston dental schools.

Project Rotunda terminated as a result of an opinion of the Massachusetts Attorney General's Office and pressure from the board of dental examiners.

Experiments with team configurations and simulated private practices completed but other planned studies could not be carried out.

The Governor of the Commonwealth of Massachusetts signed into law a recodification of the Dental Practice Act which provides for freedom of research.


INDEX

"Advanced skills hygienists" (ASH): aim in training, 10-11; cost of educating, 55; data collection regarding, 54, 55-57; productivity data, 92, 115-116; salaries of, 108-109; standard set for, 67; on state boards of dental examiners, 122, 124; supervision of (during training), 70-71, 76. See also Auxiliaries; Education; Evaluation; Productivity; Supervision of auxiliaries; Trainees

American Dental Association (ADA), 120; and auxiliaries, policy on, 8, 124-125; Council on Dental Education, 5, 46; House of Delegates, 8, 20; 1971 survey by, 93, 106, 108

Anesthetics (local) administered by auxiliaries, 1, 9, 32, 35, 130; acceptance of, 7, 8, 11, 33; as controversial issue, 13-14, 86-87, 124; instruction in, 50; ratio of successful (to number attempted), 16, 88-89, 114, 117; in UK and New Zealand programs, 17, 23, 26

Australia: dental care programs in, 22, 25-27

Auxiliaries: acceptance of, by dentists and ADA, 7-8, 24, 124-125; acceptance of, by patients/public, 6-7, 24, 30, 33, 35, 39-43 passim, 114-115, 117; delegation to, of restorative dentistry (as issue), 9-12, 44, 129-130; economic implications in use of, 35, 37, 38, 42, 82, 104, 109-112, 117, 128, 129-130; group practice and, 5, 128; quality of work of, 18-19, 23, 24, 30-42 passim, 81, 114, 117; restrictions on, 22; value recognized, 2, 4; women as, 22, 129. See also “Advanced skills hygienists” (ASH); Anesthetics (local) administered by auxiliaries; Evaluation; Productivity; Supervision of auxiliaries; Trainees

Auxiliary training programs: Australia, 25-27; Canada, 28-30, 36, 41; New Zealand, 17-19, 21, 25-27, 47, 49; opposition to (U.S.), 2, 14, 45, 46; Singapore, 20, 21-22; United Kingdom, 23-24, 27, 47, 49-50, 51; United States, 1, 5, 10, 12, 16, 19, 31-39, 42. See also Project Rotunda

Bitewing radiographs, 72, 86

Boston University, 70, 82

Brunei, 20

Canada: dental care programs in, 22, 27-31, 34, 35, 40-41; Royal Canadian Dental Corps, 36, 47, 49

Career paths, 10-11, 34-35, 36

Caries prevention, 6, 11, 23, 28

Children’s Bureau, U.S., 2, 19

Colby, Ira, 45

Cost(s): of care, 5, 9, 29, 30, 54-55, 111, 130; of clinics, 25; of training, 9, 10, 65-66, 113

Cost accounting: methods, 54; and profits, 106-112. See also Income; Productivity

Cox, Norman K., 17

Curriculum (Forsyth plan), 113; development of, 47-54; modifications, 60-61

147
Curriculum (general): Australia, 26; Canada, 28, 30; Singapore, 21; United Kingdom, 26, 28, 30, 49-50; U.S., 5, 10, 31-32, 34, 37-38

Dalhousie University (Halifax, N.S.), 40

Dental hygienists, see "Advanced skills hygienists" (ASH); Auxiliaries

Dental laws, 39. See also Massachusetts

Dental Manpower Development Center (Louisville, Kentucky), 38, 47

Dentist intervention, see Supervision of auxiliaries; Trainees

Education: academic potential and, 11; costs of, 9, 10, 65-66, 113. See also Auxiliary training programs; Curriculum; Trainees

Evaluation: blind extramural, 70, 76-83, 114, 138, 139; daily intramural, 84-85, 114; and Evaluator’s Manual, 68, 71, 133-137; by patients, 89-91; of restorative work by auxiliaries, 18, 23, 24, 29-30, 31, 32, 34, 36-42 passim; of trainees, criteria for, 54, 55, 57, 62, 67-76, 133-137

Federal Trade Commission (FTC), 124-125

Fluoridation: and fluoride application, 10, 23, 27, 100; importance of, 7

Fones, Alfred C., 16

Forsyth, James Bennett, 2

Forsyth Dental Center, 1-3; first experiment by, 19-20; rationale for study by, 9, 11-12, 44. See also Project Rotunda

Forsyth Dental Infirmary for Children, 2, 17, 19

Forsyth School for Dental Hygienists, 10

Ghana, 21

Greene, John, 4

Group practice, 4-5, 128

Harvard University, 70, 82

Hein, John W., 11-12, 45

Hong Kong, 20

Howard University College of Dentistry, 31, 32


Indoor Health Service (U.S.), 37-38

Indonesia, 21

Insurance plans, 6; and national health insurance legislation recommendations, 126-127

Kells, C. Edmund, 16

Licensing, 10, 20

Lobene, R. R., 24, 45, 86

Malaya, 21

Malaysia, 20, 21, 22

Malpractice suits, 5, 128

Massachusetts: Board of Dental Examiners, 19, 45, 118-122, 139; Dental Assistants Association, 122; Dental Hygienists Association, 122; dental laws, 19-20, 46, 99; Dental Practice Act, 15, 46, 119-122, 139; Dental Society, 19-20, 45-46, 69, 81, 118-121, 138; Department of Public Health, 19; opposition in, to Forsyth study, 2, 14, 46

Medex programs, 6

Medicaid, 45

National Health Service (UK), 22. See also Socialized dentistry

Naval Dental Research Institute, 47

Naval Training Center, U.S. (Great Lakes, Illinois), 35-36

New Cross School, see United Kingdom

New Zealand: dental care programs in, 1, 17-19, 20-21, 22, 25-27, 47, 49

Ontario Dental Association, 40

Papua-New Guinea, 20

Paraprofessionals, see Auxiliaries

Patients: acceptance by, of auxiliaries, 6-7, 24, 30, 33, 35, 39-43 passim, 114-115, 117; acceptance by,
of free care (Project Rotunda), 73, 76, 90, 91; evaluation of trainees by, 89-91; recruitment and characteristics of, 58-59, 114
Pennsylvania Dental Practice Act, 39
Philadelphia Department of Public Health, 39
Prepaid plans, 5, 6
Prince Edward Island dental manpower study, 40. See also Canada
Productivity: data (trainee), 92; dentist, auxiliaries and, 9, 24-25, 35-40 passim, 42, 54, 95, 102, 104, 106, 116, 130; hygienist-dentist compared, 65, 113
Project Rotunda, 47, 54, 55, 59, 61, 124, 138; design of, 47, 49; evaluation of, 67-91; goal of, 67; implications of, 118, 128, 129; patient response to, 73, 76, 90, 91; pre- and posttreatment radiographs from, 72, 86, 114; termination of, 118-119, 122, 139; work arrangements, 93-97, 123
Public Health Service, U.S., 4; Division of Manpower Education, 52; studies by, 37-38
Quality assessment, see Evaluation
Quality of work, see Auxiliaries; Supervision of auxiliaries
Restorative dentistry: decline of need for, 5-6; delegation of, to auxiliaries (as issue), 9-12, 44, 129-130; quality assessment of, 67; trainee finishing times for, compared, 64; two basic phases of, 1. See also Evaluation
Royal Canadian Dental Corps, see Canada
Singapore: dental care programs in, 20, 21-22
Socialized dentistry, 11, 17, 20, 22
Specialization: value of, questioned, 5, 128-129
Sri Lanka, 20
Supervision of auxiliaries, 1, 22, 35, 38, 130; and employment ratio, 24, 27, 29, 31, 35, 36, 39, 102, 104, 106, 115, 116, 117; limited, 18, 21, 23, 26-27, 29, 30-31; and responsibility for performance and quality, 42, 81, 94-95, 117, 127; vs. specialization, 5, 128-129; and time allocation, 96-99, 102, 104, 106-107, 111, 115, 116; during training, 70-71, 76
Tasmania, 25
TEAM (Training in Expanded Auxiliary Management) clinic, 33-34
Temple University School of Dentistry, 39
Thailand, 21
Time allocation, see Supervision of auxiliaries
Trainees: intervention in procedures of, 84-85, 88, 94, 114; selection of, 57-58, 138. See also Education; Evaluation
Tufts University, 70, 82
United Kingdom, 21, 22-27; New Cross School, 23-24, 47, 49-50, 51
U.S. Army Dental Corps, 7
U.S. Naval Training Center (Great Lakes, Illinois), 35-36; and Naval Dental Research Institute, 47
University of Alabama School of Dentistry, 36-37, 49, 51
University of Iowa College of Dentistry, 31-32, 33, 73
University of Kentucky College of Dentistry, 32, 34-35
University of Minnesota School of Dentistry, 33, 38-39
University of Oklahoma, 11
University of the Pacific School of Dentistry (San Francisco), 42
University of Toronto, 41
Veterans Administration, 125
World Health Organization, 21
Yukon Project, 27-28
Zambia, 21
ment, assessing the quality of performance, and assuring the patient’s well-being.

The Forsyth experiment yielded information on the competence of auxiliaries trained in this fashion, on patient acceptance, on the efficiency of various patterns of practice, and on the potential economic effects of delivering care in this way. The results of the study are bound to stir controversy, but they cannot be ignored by anyone who cares about a major problem in health care.

Ralph R. Lobene, who directed the Forsyth experiment, is Dean of the Forsyth School for Dental Hygienists and Professor of Dentistry and Allied Health. Alix Kerr, his collaborator on this volume, is a professional writer with wide experience in health topics.

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