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Speech, Language, and Psychosocial Aspects of Cleft Lip and Cleft Palate: The State of the Art

Report from the Committee



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REPORT FROM THE COMMITTEE
SPEECH, LANGUAGE, AND PSYCHOSOCIAL ASPECTS
OF CLEFT LIP AND CLEFT PALATE: THE STATE OF THE ART

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Speech, Language,
and Psychosocial Aspects
of Cleft Lip and Cleft Palate:
The State of the Art

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A REPORT ON
SPEECH, LANGUAGE, AND PSYCHOSOCIAL ASPECTS OF
CLEFT LIP AND CLEFT PALATE: THE STATE OF THE ART

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CONTENTS

Preface	
<i>D. C. Spriestersbach</i>	vii
Introduction	1
Anatomical and Physiological Requirements for Speech	
<i>Ralph L. Shelton, Hughlett L. Morris, and Betty Jane McWilliams</i> ...	2
Assessment of Speech	
<i>Hughlett L. Morris, Ralph L. Shelton, and Betty Jane McWilliams</i> ...	19
Instrumentation	
<i>Donald W. Warren</i>	26
Nonsurgical Management of Cleft-Palate Speech Problems	
<i>Ralph L. Shelton, Hughlett L. Morris, and Betty Jane McWilliams</i> ...	34
Language Problems	
<i>Betty Jane McWilliams</i>	41
Psychosocial Considerations	
<i>Betty Jane McWilliams and Robert M. Smith</i>	43
Research Strategies	
<i>Hughlett L. Morris, Betty Jane McWilliams, and Ralph L. Shelton</i> ...	53
References	57
Project Participants	68



P R E F A C E

The National Institute of Dental Research (NIDR) awarded a contract to the American Speech and Hearing Association (ASHA) to prepare a report of the state of the art in clinical research in cleft lip and cleft palate. The ASHA Committee on Clinical Research in Cleft Lip and Cleft Palate: Speech and Psychosocial Aspects was assigned the task of compiling information on the following purposes identified in the contract: (1) review in depth the present status of clinical research on cleft lip and palate and to explore gaps in knowledge, (2) discuss approaches to filling the research gaps, (3) identify areas that need no special research emphasis, and (4) recommend specifically those research areas that need development and stimulate research activity in those areas.

To assess this complex field, a planning committee was appointed. With the exception of the chairman, each committee member was responsible for one of the subcommittees charged to evaluate the following: etiology and pathogenesis, anatomy and physiology, pediatrics and otology, orofacial growth and dentition, surgery, and speech and psychosocial dimensions. Each subcommittee prepared a preliminary assessment of its assigned areas. Drafts of these assessments were circulated to the chairmen and two representatives from each area. A two-day, face-to-face review by the chairmen and representatives from the subcommittees provided the chairmen critical evaluations of their preliminary reports. The chairmen then returned to their subcommittees and prepared final reports.

A summary report entitled "Clinical Research in Cleft Lip and Cleft Palate: The State of the Art" has been published in Volume 10 of *The Cleft Palate Journal* (April, 1973). According to plan, each subcommittee report is to be published in a journal read by those clinicians and researchers working in the area covered by the report. (The status of those reports can be obtained by writing to the appropriate subcommittee chairmen identified in the planning committee.) The material included in this issue of *ASHA Reports* is the work of the subcommittee on the speech and psychosocial aspects of the cleft-palate problem.

While the bulk of the support for this project was supplied directly through the contract between NIDR and ASHA, additional support came indirectly from NIDR through the Joint Committee on Dentistry and Speech Pathology-Audiology. The Joint Committee, established in 1966 with support from NIDR, brought together representatives of the American Speech and Hearing Association and the American Association of Dental Schools to review the common interests and concerns of dentists, speech pathologists and audi-

ologists. Among its objectives were the identification and evaluation of areas of common interest in orofacial anatomy and physiology, growth and development affecting orofacial structure and function, and diagnosis and treatment of orofacial pathologies that affect speech and hearing, mastication, and deglutition. To accomplish its objectives, the Joint Committee presented programs at professional meetings, conducted regional meetings of educators, studied relevant training programs, and created promotional materials that demonstrated and advanced the philosophies of the Committee. One of the most tangible evidences of the Joint Committee's work has been the publication of the reports given at three conferences it organized and sponsored: "Patterns of Orofacial Growth and Development," *ASHA Report Number 6* (March, 1971); "Orofacial Function: Clinical Research in Dentistry and Speech Pathology," *ASHA Report Number 7* (July, 1972); and "Orofacial Anomalies: Clinical and Research Implications," *ASHA Reports Number 8* (August, 1973). It is not an overstatement that the climate and reports created by the Joint Committee contributed to the conviction that it was appropriate and worthwhile to conduct a state-of-the-art review of clinical research in cleft lip and cleft palate. Further, it is appropriate that some of the resources of the Joint Committee should be used to insure that the work of the Subcommittee on Speech and Psychosocial Aspects be made available in view of the massiveness of the report.

Clinical management of patients with cleft lip and palate has improved markedly in the past 20 years. However, large gaps still exist in our understanding of the treatment of persons with clefts. For example, it has become increasingly evident that each part of the masticatory-phonatory-articulatory-auditory system is closely related both developmentally and functionally. Consequently, changing the parameters in any part of the system is likely to change the function of the entire system. Yet, many aspects of these parameters and the restraints within which they operate remain to be delineated. It is clear, therefore, that more research, both basic and applied, is needed before we can be confident that the management regime for a given individual with a cleft is the best we have to offer.

This report concentrates on those aspects of the problem relating to the interactive and communicative behaviors of persons with clefts. A major objective of the complex and costly management scheme for persons with clefts is not only to provide physical and functional integrity of the cleft structures but to provide the motivation and shape the behaviors of those persons so they are able to interact effectively with their noncleft peers. The report that follows is a significant contribution to that goal.

D. C. Spriestersbach, Ph.D.,
CHAIRMAN, PLANNING COMMITTEE

INTRODUCTION

The purpose of this report is to assess the state of our present knowledge regarding the speech, language, and psychosocial status of people with clefts of the lip and palate, to evaluate the research that has contributed to this knowledge, and to define future research needs.

Because there are still serious deficits in our knowledge, there are also limitations in our ability to understand how many different anatomical, physiological, and psychological variables interact with each other to influence communicative and social behavior. A part of the dilemma comes from an inability to ask exactly the right questions and part from methodological barriers to finding answers.

This paper will explore seven aspects of the cleft problem that seem essential in assessing the current status of the art and in setting research priorities for the future. The seven areas are anatomical and physiological requirements for speech, assessment of speech, instrumentation, nonsurgical management of cleft palate speech problems, language problems, psychosocial considerations, and research strategies.

The topics selected are interrelated and information available with reference to one subject is often applicable to another even though the authors may not always be aware of possible relationships that seem apparent to the reader. This document, which attempts to assess the present in terms of history and to look toward future needs, is meant to stimulate the reader to go beyond the manuscript and to think about and act to solve our common problems.

ANATOMICAL AND PHYSIOLOGICAL REQUIREMENTS FOR SPEECH

RALPH L. SHELTON, HUGHLETT L. MORRIS, and BETTY JANE McWILLIAMS

The literature already includes many comprehensive summaries describing the communication skills and problems of individuals with clefts. Since several of these are relatively recent (Westlake and Rutherford, 1966; Spriestersbach and Sherman, 1968; Grabb, Rosenstein, and Bzoch, 1971; Wells, 1971), only a brief review of current information will be included here.

Many individuals with palatal clefts no longer have serious problems with communication. When difficulties do occur, however, they seem most likely to be disorders of consonant articulation and voice quality.

The articulation problems include the loss of oral pressure by escape of air into the nostrils, often exiting at the nares in the form of nasal emission. This is sometimes associated with nares constriction or grimace which results from an almost futile attempt to prevent air loss. Velopharyngeal inadequacy is the major cause of these symptoms, which occur primarily during the production of fricatives, affricates, and plosives. The resulting sounds, even though articulatory movements may be accurate, are nasally distorted. In an attempt to compensate for reduction in oral pressure, some cleft individuals adopt other atypical articulatory behavior, which allows them to use some air pressure before it reaches the critical velopharyngeal port. These compensatory activities result in the substitution of glottal stops for plosives and of pharyngeal for oral fricatives. In addition to articulatory deviations initiated in response to the anatomy and physiology of the valving mechanism, orally determined consonant variations, in no way unique to the cleft population, also occur for the same reasons they exist in the general population. These include inappropriate learning, dental deviations, depressed hearing, and psychosocial factors.

The voice disorder typically associated with cleft palate is hypernasality, a broad, general term descriptive of the vocal abnormalities most commonly accompanying velopharyngeal inadequacy. Recently, some authors have reported that hoarseness and perhaps other laryngeal variations may also be a part of the problem.

In the absence of certain structural and physiological requisites, persons

with velar defects are unlikely to develop normal speech or to improve their speech with therapy.

VELOPHARYNGEAL CLOSURE

In 1968, Morris reported that velopharyngeal closure deficits cause certain classes of errors in consonant articulation. These findings were supported by the work of Arkebauer, Hixon, and Hardy (1967), who demonstrated that production of fricative and stop-plosive sounds is dependent upon oral pressure. Therefore, to the extent that velopharyngeal deficiency restricts oral pressure, interference with pressure sounds should be expected. Since Morris's review, additional studies have supported the conclusion that velopharyngeal closure deficits are related to articulation errors. Scientists and clinicians have continued to wonder, however, whether small velopharyngeal ports are compatible with good speech production and, if so, how large a port can be tolerated. Present information is conflicting.

In 1969, Subtelny et al. studied nasal and nonnasal consonants by simultaneous speech recording, cinefluorographic filming, and measurement of intraoral air pressure and oral and nasal air flow in 10 normal, adult female speakers. The authors concluded that, in vowel-consonant-vowel (VCV) contexts, airtight closure does not always occur and is not necessary for satisfactory production of plosives.

Isshiki, Honjow, and Morimoto (1968) created artificial velopharyngeal incompetence in 11 normal Japanese male adults by inserting polyvinyl tubing into the nasopharynx and studying them with the tube closed and with open ports of 5, 7, 9, and 12 mm in diameter. They interpreted their data to mean "there is no definite point of velopharyngeal dimension where the speech suddenly changes from normal to abnormal." They suggest, however, that "a diameter of 5 mm is the critical size of velopharyngeal dimension for acceptable speech." They noted that their experimental procedure had more influence on plosives than on fricatives, whereas the literature indicates cleft-palate speakers have greater difficulty with fricatives. They speculated that closure requirements might be greater for acquisition of correct articulation than for its maintenance. This is an important issue for future research.

Of additional interest is the diameter of 5 mm. The accuracy of that dimension would undoubtedly relate to the shape of the orifice. For example, if the orifice were oval with greater lateral than a-p dimensions, the sagittal cross section of an opening 0.20 cm² (as described by Warren in the paragraphs that follow) might be closer to 1 mm than to the 5 mm suggested here.

Warren (1967), Warren and Ryon (1967), and Warren, Duany, and Fischer (1969) conducted a series of studies using pressure-flow apparatus for estimating velopharyngeal port area during the production of certain speech sounds. They also used an oronasal analog, a procedure later validated by Lubker (1969). Their work indicates that oral port constriction, nasal

pathway resistance, and respiratory effort, as well as velopharyngeal function, influence speech performance. Nasal pathway resistance is greater in cleft than in normal subjects presumably because nasal deformities and maxillary growth deficits tend to reduce the size of the nasal passage. Nasal emission of air correlates highly with velopharyngeal area when the area ranges from zero to 0.20 cm² ($r = 0.93$). However, in subjects with larger velopharyngeal areas, the correlation is much lower ($r = 0.43$). Warren interpreted his findings to indicate that areas greater than 0.20 cm² are inadequate for normal speech production. This has led clinicians, perhaps erroneously, to conclude that openings of lesser magnitude will probably not seriously affect speech.

Other studies have been directed toward finding explanations for certain variations observed in the velopharyngeal valving phenomenon. Bzoch (1968) used cinefluorography to investigate closure variables in a series of syllables in which /p/ was combined with four different vowels. He observed that velar position was slightly lower for syllables with the vowel /a/ than for syllables with /i/ or /u/. The velopharyngeal port, however, remained closed throughout the production of the syllable sets studied, and Bzoch wondered if port openings sometimes observed in normal speakers may be a function of slow utterance rate.

McWilliams, Musgrave, and Crozier (1968) developed a procedure for using telefluoroscopy to study velopharyngeal closure with patients in cervical extension as well as in the upright position. They observed that hypernasal speakers who appeared to produce velopharyngeal closure in the upright position often demonstrated openings when viewed in extension. The thrust of these findings is that lateral x rays alone may indicate closure that does not really exist and may be misleading to clinicians and researchers. They concluded that velopharyngeal closure is necessary for speech that is not hypernasal.

Hagerty, Hess, and Mylin (1968) reported that some speakers, when their valving mechanisms are poor, may not move the velum during particular speech acts. These observations are crucial because the nonmoving, curtain-like palate may or may not be associated with neuromotor deficits and, thus, may present a variety of management and prognostic problems.

McWilliams and Bradley (1964) point to another possible variation in velopharyngeal closure that must be investigated further. From evaluations of telefluorographic studies, they discussed closure ranging from total blending through partial blending to touch closure. Since lateral x rays, even those which are dynamic in nature, may yield false information relative to the adequacy of closure because they cannot correct for the portion of the valve that cannot be viewed, it is not surprising that they found hypernasality to be more frequently present in the touch-closure group and that this group tended to show loss of contact when the head was extended. It is clear, therefore, that investigators must begin to study the pressure that the palate exerts against the pharyngeal wall and the manner in which varying pressures relate to other measures of velopharyngeal closure and of speech production.

To accomplish this, Knox, Ringel, and Shelton (unpublished) have used a pressure sensing tube positioned between the velum and the posterior wall of the pharynx and have recorded on an oscillograph the pressure produced by contact of the structures during different utterances.

Rate, Consistency, and Timing

Other aspects of velopharyngeal closure which should receive increased attention in the future are the rate of movements, the consistency with which they occur, and their timing in relation to other articulatory events. These seem to relate to the adequacy of speech in ways that may be confused with velopharyngeal closure per se, but which may or may not be associated with anatomical deficiencies of the velum and pharynx.

Tonsils and Adenoids

It is generally accepted that adenoids can contribute to velopharyngeal closure in that an adenoidal pad displaces the posterior pharyngeal wall anteriorly. Because of that displacement, a short, soft palate sometimes effects velopharyngeal closure whereas, otherwise, it could not. Consequently, adenoids are not usually removed from cleft-palate patients except when ear disease is assumed to make it essential.

Many surgeons, speech pathologists, and dentists are reluctant to have even the tonsils removed on the assumption that they may somehow help to prevent nasal escape of air. While there are no known hard data on this subject, it is possible that, in persons wearing prosthetic speech appliances, the tonsils do assist in preventing air escape along the sides of the nasopharyngeal section of the appliance. Subtelny and Koepp-Baker (1956), on the other hand, suggested that removal of hypertrophied tonsils might facilitate oral air passage during phonation thus reducing the likelihood of nasal escape. They also reported that with movement of the soft palate, the tonsils are carried in an upward and backward direction. As Cole (1971) pointed out, we know little about the role of the palatine tonsils in terms of their contribution to palatal function, oral-nasal resonance balance, or tongue behavior. However, hypertrophied tonsils are thought to force anterior displacement of the tongue. Subtelny and Sakuda (1964) presented cephalometric x-ray tracings of a patient before and after removal of his enlarged tonsils. Following removal, the tongue assumed a position closer to the posterior pharyngeal wall. The tongue tip no longer protruded between the incisors, and eruption of the maxillary incisors occurred.

Surgical removal of tonsils may occasionally be necessary for medical reasons. These cases should be studied and carefully documented both before and after surgery so that definitive information can be obtained.

In 1956, Subtelny and Koepp-Baker questioned what might happen in cleft-palate children as the palate descended with growth and the adenoid tissue atrophied. They speculated that altered movements of the palate and pharynx might compensate for the gradual reduction in the adenoidal mass.

Others have wondered about the effects of adenoid atrophy on velopharyngeal closure, but the question remains unanswered. The authors of this report are unable to cite cases where speech has deteriorated over time as adenoids have receded. They can, however, cite many cases where surgical removal of the adenoidal mass has resulted in creating or intensifying speech problems. Research in this important area is long overdue. Until data are accumulated, the removal of adenoids should rarely, if ever, be undertaken.

Other Variables Related to Velopharyngeal Closure

Recently, McKerns and Bzoch (1970) used cinefluorography to compare normal men and women with reference to several palatal measures. The principal measurement, made from film frames taken during palatal elevation, was an angle created by the posterior nasal spine, the superior point of contact between the elevated palate and the posterior wall of the pharynx, and the inferior point of the uvula. The authors found that the basic orientation of velum to pharynx in males represents an acute angle, whereas that of females more nearly approximates a right angle. Velar length and the height of elevation are greater in males than in females, whereas the amount of contact is less. The inferior point of contact is usually above the palatal plane in males while this is not the case in females. Sex-associated variations such as these suggest that male-female dimensions should be incorporated into future research designs.

Kent and Moll (1969) and Berti (1971) discussed contextual influences on velopharyngeal function. These relationships have been of interest for some time, but the focus has been primarily on vowels. These authors showed that the velopharyngeal mechanism may function differently for voiced and voiceless stop consonants. More studies of this type, though difficult, might shed new light on the differential behavior of the palate in normals and in subjects with clefts.

Osborne, Pruzansky, and Koepp-Baker (1971) found that among persons with congenital velopharyngeal incompetence, pharyngeal depth was greater in those with cervical anomalies than in those free of such defects. Subtelny et al. (1970), in a study of pharyngeal flaps, noted shorter pharyngeal dimensions were associated with less severe nasality. Calnan (1971a) also discussed the congenitally large or capacious pharynx in relation to normal palate length and mobility. Cervical anomalies and variations in the depth of the pharynx undoubtedly influence velopharyngeal closure for speech. Investigations directed toward these structures and their relationship to each other might provide information useful in diagnosis and treatment planning.

Movement of the Lateral Pharyngeal Walls

Recently, movements of the lateral pharyngeal walls have been studied during speech both by ultrasound and by cineradiographic procedures. These

movements seem to relate to palatal function and to play a significant role in the achievement of velopharyngeal seal. Kelsey, Minifie, and Hixon (1969) described in detail the instrumentation and techniques involved in ultrasound studies of lateral pharyngeal wall movements in three adult males. Their findings suggest that the dynamic articulatory gestures within the pharynx vary systematically as a function of vowel height. The greatest inward movement of the lateral pharyngeal wall was found to occur during the production of low vowels. Little movement occurred during the production of high vowels. This is of particular interest when it is remembered that cleft speakers tend to experience their greatest difficulty on high vowels.

Kelsey, Crummy, and Schulman (1969) used both cineradiographic and ultrasonic procedures in their study of lateral pharyngeal wall movements. The data reported indicate good agreement between the two measures. Amount of movement was thought to be related to speaker effort and to intensity level. In the ultrasonic studies, the transducer picked up movements 4 cm below the level of the velum. The authors took measurements from the x-ray film at the level of the ultrasound transducer and also 1 cm above and below that level. "The results of these additional measurements indicate that the amount of the motion does not depend sensitively on the level of measurement." This finding should help to simplify procedures using these technologies.

Skolnick (1970) developed a baseview technique using telefluoroscopy for studying velopharyngeal closure. The technique permits the viewing of the velopharyngeal valve as it functions. He described movements of the lateral wall at the level of the velum in several persons and also made observations of the closed port during normal speech. Skolnick, McCall, and Barnes (1973) have described velopharyngeal closure as involving sphincteric action. This baseview technique may well be one of the major research and clinical tools developed in recent years. This will be discussed in greater depth in the section on instrumentation.

Hypothetical Explanations of Velar Function

On the basis of research and theory in speech production, Moll and Shriner (1967) developed the following hypothesis:

... velar positions during speech might be explained by assuming only two modes of velar activity at the muscular level. In terms of this hypothesis, one muscular contraction mode would be applied to elevate the velum and close the velopharyngeal port during all non-nasal sounds. The second mode, resulting in little velar elevation, would be applied during such units as nasal consonants or utterance breaks. The intermediate velar positions which are observed in speech may then be accounted for by considering the timing with which the two modes are applied and the inherent restraints of the mechanical system on which the muscular contractions are acting.

To test their hypothesis, Moll and Shriner cinefluorographically studied two

normal, adult males during sustained production of nasal consonants and vowels. They found that:

. . . velar position attained on a nasal consonant or in a vowel adjacent to a nasal is influenced by the durational characteristics of the speech sample. As the sound units and the breaks between syllables become shorter, the time available for raising or lowering the velum decreases and . . . the velum 'undershoots' the position that it would attain if enough time were available.

Thus, their observations tended to support their hypothesis.

Lubker (1968) used simultaneous electromyography and cinefluorography to test the Moll-Shriner hypothesis further. He studied high and low front and back vowels and the nasal consonant /m/ in five normal, adult males. He found that muscular activity in the palate varied systematically and significantly when palatal position showed significant variation. There was greater palatal elevation and more electromyographic activity for high vowels than for low vowels both in context and in the detached state. Measures of velar movement, velar height, and velopharyngeal gap correlated moderately with measures of tongue height. Lubker speculated, however, that while the findings did not support the Moll-Shriner hypothesis, the signals commanding the muscles to fire might be organized in a manner compatible with their hypothesis.

Fritzell (1969) also conducted extensive electromyographic-cineradiographic studies of the velopharyngeal muscles during speech. His results agreed with Lubker. He concluded that:

. . . variations in velar elevation during speech, which also occur during prolonged velopharyngeal closure as observed by researchers using cineradiography, is determined by variations in the degree of velar muscle activity and not by variations in timing and movements of adjacent structures as hypothesized by Moll and Shriner.

Moll and Daniloff (1971) studied palatal coarticulation in four young, adult males by means of cinefluorography at a film speed of 150 frames per second. They observed "extensive anticipatory coarticulation of velar movement toward velopharyngeal opening . . . on all vowels." For nasal-consonant and nasal-consonant-nasal (NCN) sequences, velar movement toward closure for the consonant was observed during all plosive and fricative consonants. However, in nasal-vowel-consonant (NVC) sequences, where the consonant was either /l/ or /w/, closure was not always obtained on the consonant. Their major finding was that:

. . . in sequences in which a nasal consonant is preceded by one or two vowel sounds, the velar-opening gesture for the nasal is initiated near the beginning of primary articulatory movement toward the first vowel in the sequence. Further, the presence of a word boundary within the sequence does not affect the relative timing of the velar gesture.

Moll and Daniloff (1971) state that their findings are not compatible with the viewpoint of Kozhevnikov and Chistovich (1965) to the effect that the syllable is the basic unit of articulation. The results are compatible, however, with Henke's (1966) articulation model which uses a string of phone-sized

segments and a look-ahead mechanism for scanning future units. Use of this model would specify that the palate close on nonnasal consonants and open on nasal consonants. Velar position for vowels would be unspecified, and palatal function during a vowel would be determined by future elements in the sequence. Although Moll and Daniloff (1971) do not discuss their results in terms of the Moll-Shriner (1967) theory, their binary predictions are consistent with that conceptualization of palatal function although the authors state that a binary specification system is not necessary to their position.

Shelton, Harris, Sholes, and Dooley (1970) also used electromyography (EMG) in their attempt to teach normal adults to elevate their palates on a scale from one (little movement) through seven (maximum movement). Judges' ratings of the movements correlated with EMG peak and duration (r s ranged from 0.48 to 0.77), but application of information analysis procedures to the data indicated that the "speaker operates as if he could divide the palate elevation continuum into slightly less than two categories. . . ."

The variations in palatal activity as assessed by EMG suggest that modifications in the Moll-Shriner (1967) hypothesis will emerge as new information becomes available. Undoubtedly, broader knowledge about palatal behavior will prove pertinent to answering questions relative to the demands for velopharyngeal closure in speech free from the stigmata of valvular insufficiency.

Compensation for Velopharyngeal Closure Deficits

Several recent investigations have sought to explore phenomena that may be compensatory for poor velopharyngeal closure. Compensation implies an attempt to counterbalance some defect of structure or function. It is not always easy to differentiate between such efforts and behavior that is determined by atypical conditions. Decisions regarding this distinction are, therefore, basic in future research.

Carpenter and Morris (1968) studied Passavant's pad cinefluorographically in six subjects with surgically repaired palatal clefts under a variety of speaking conditions. They reported that the soft palate and Passavant's pad assumed a phonatory position, which was maintained throughout utterance except for phrasing interruptions, and that the pad was not influenced by the task. They concluded that the pad functions as an addition to the closure mechanism in persons with repaired clefts, does not disturb the closure process, is probably the result of learned behavior, and may indicate some positive feedback or reinforcement process. They felt, too, that the pad should not be studied in isolation from other structures contributing to velopharyngeal closure.

Curtis (1968) suggested the nasal speaker may expend a greater amount of energy to maintain a given intensity level because of the energy absorption that accompanies nasalization. This compensatory behavior would increase subglottal pressure and tend to raise vocal frequency. Tarlow and Saxman (1970) tested this theory by comparing fundamental frequency during

speech in cleft and noncleft children. The mean fundamental frequency for the cleft subjects was 251.7 Hz (standard deviation = 2.7) compared with 241.5 Hz (standard deviation = 3) for the noncleft children, a difference that was not statistically significant. The cleft subjects had more upward and downward inflection changes than did the noncleft subjects, but the amplitude of the inflection changes was greater for the noncleft children. Tarlow and Saxman suggested that the greater number of inflection changes may be related to length of talking time and may reflect a taxing of the respiratory and phonatory systems.

Rampp and Counihan (1970) also studied fundamental frequency. They investigated vowel production at varying intensities in normal and cleft adults who presented Hunter manometer ratios of 0.75 or less. While the groups did not differ significantly in fundamental frequency, "significant interactions among groups, sexes, and vowels suggested that differences in the mean *f* [fundamental frequency] of individual vowels exist between normal and cleft palate groups and that these differences vary as a function of speaker sex within each group." The female cleft subjects were 26 and 17 Hz lower in fundamental frequency for the vowels /i/ and /u/ than were the normal females. The authors speculated that their cleft-palate subjects may have used greater vocal effort to produce the desired intensities than did the normal subjects. At equal effort, the cleft speakers might have been even lower in pitch. Thus, some variables operating in persons with closure deficiencies may tend to increase fundamental frequency while others tend to decrease it. However, these phenomena do not show up in group comparisons on the single variable of fundamental frequency. Relationships between fundamental frequency and other speaking phenomena obviously require additional study.

Warren and Mackler (1968) observed that the duration of oral port constriction during articulation of voiceless consonants is increased in cleft-palate persons with good closure as compared to those with poor closure. Normal speakers used shorter voiceless consonant duration than did either of the two cleft-palate groups. Oral port constriction was greatest for voiceless fricative consonants. The authors hypothesized that cleft-palate speakers with good speech extend the duration of oral port constriction to provide additional acoustic cues, thus increasing intelligibility. The speaker with poor closure does not use this compensatory phenomenon probably because it would be accompanied by an increase in audible nasal escape of air.

Rolnick and Hoops (1971) studied plosive duration spectrographically in 20 obturated subjects. Duration was increased upon removal of the prostheses; and, in comparison with normals, the subjects produced either extra vertical striations preceding the spike or drawnout aspiration following the spike. These portrayals were thought to represent frication generated by nasal air escape. Their results were not compared with those of Warren and Mackler (1968). Variation in subject and measurement procedures might account for differences. Work of this type should be replicated in well-defined populations.

Lass and Noll (1970) compared rate characteristics in normal and cleft adult speakers. Cleft and noncleft speakers differed in oral reading and impromptu speaking rates and in performance on rate alternation tasks. The direction of the differences, however, varied with the task and measure. The cleft group exhibited greater variability and a wider range of performance than did the noncleft group. These findings, probably not clinically useful at this time, are relevant to future research.

McWilliams, Bluestone, and Musgrave (1969) and McWilliams, Lavorato, and Bluestone (1973) laryngoscoped a group of cleft-palate children with hoarse voices. Most of the children had vocal cord nodules or other laryngeal pathology. In addition, they usually had some evidence of borderline velopharyngeal valving mechanisms. The authors suggested that, in attempting to compensate for closure deficits, the children had abused their vocal mechanisms. Speech therapy could conceivably encourage this unwanted compensation. Lowry et al. (1974) did not find nodules in their population sample, but they specified neither hoarseness nor valving ability.

Marks, Barker, and Tardy (1971) also looked at relationships among cephalometric x-ray studies of velopharyngeal closure, voice quality ratings, and findings from laryngoscopic examinations in subjects from age six years, five months through 19 years, four months. Thirty-four percent of the subjects were judged to have laryngeal voice quality deviations. The incidence of laryngeal pathology was said to be high. Voice quality ratings and closure indices were not significantly correlated. However, the lack of relationship reported may have been a function of methodology since the cephalometric x ray is at least suspect for this kind of investigation.

Relationships among laryngeal pathology, velopharyngeal closure deficits, and various training procedures require further study. If borderline closure deficits contribute to laryngeal abuse, they probably do so in interaction with additional variables, which remain to be specified.

Clinicians and researchers alike have long recognized that velopharyngeal insufficiency seems to be accompanied by aberrant tongue behaviors. These appear indicative of compensatory efforts, but frequently seem to intensify rather than minimize the initial problem.

Palatographic data reported by Shohara (1942) indicated that obturation was followed by more nearly normal lingual contacts during production of certain speech sounds. Other studies have shown speakers sometimes compensate for velopharyngeal closure deficiencies by using lingual adjustments. Brooks, Shelton, and Youngstrom (1965, 1966) reviewed literature in this area and concluded that some speakers with velopharyngeal incompetency probably use the tongue to support the palate. This seems most likely to occur in speech contexts where the tongue is normally retracted or retracted and elevated. It would appear that persons who use tongue elevation and retraction articulate more poorly than do persons who do not use those movements. Speech clinicians may inadvertently encourage such aberrant movements when they attempt to alter articulation in persons with incompetent closure.

Various writers have published data or interpretations of data pertaining to relationships between lingual movements or positions and velopharyngeal closure. Wada et al. (1970) devised a cinefluorographic technique for the study of relationships between palatal and lingual positions and movements. Falk and Kopp (1968) compared nasality ratings and cephalometric x-ray measures in cleft-palate and normal children. Statistically significant relationships were found between certain tongue positions and nasality ratings for the sounds /v/, /ð/, and /z/. Oral cavity dimensions for all sounds were significantly greater for the normal than for the cleft group. However, these findings do little to explain the origins of tongue elevation and retraction as compensations for poor velopharyngeal closure.

Lubker (1968) correlated tongue height with measures of velar movement, velar height, and velopharyngeal opening derived from cinefluoroscopic studies done during isolated vowel and syllable production. Correlations obtained were only moderate (0.45 to 0.61), and the correlations with velopharyngeal opening were negative.

In a radiographic study of nasality, Dickson (1969) divided subjects into three groups representing three degrees of nasality. Measures of the distance between the tongue and the posterior wall of the pharynx and of the distance between the tongue and the hard palate were smallest in nonnasal subjects and greatest in the most nasal subjects. "The most nasal subjects tended to have a lower, more anteriorly placed tongue and to be more variable on most of the physical measures obtained than the least nasal subjects."

Studies of lingual adjustments and their relation to velopharyngeal closure do not agree. It seems likely that more than one class of lingual compensation is available to a speaker and that combinations of several variables probably determine whether or not a speaker will use lingual compensatory movements and, if he does, which movements he will adopt.

Basic studies of tongue physiology are necessary prerequisites to meaningful exploration of lingual compensatory behavior. From extensive cinefluorographic and spectrographic studies of one normal speaker, Perkell (1969) postulated that vowel articulation is accomplished principally by extrinsic tongue musculature which controls tongue position. In consonant production, the tongue seems to be carried to position by the extrinsic musculature. However, the occlusions or constrictions required then seem to be performed by the intrinsic muscles of the tongue. Perkell suggests that different classes of sensory feedback are presumably involved in vowel and consonant production. However, sensory feedback mechanisms are also poorly understood, and another essential area for research is delineated.

Harris (1971) used EMG to study the action of extrinsic musculature in the control of tongue position in speech. Harris (1970) also reviewed what is known about the function of the tongue and other structures in articulation. Basic laboratory research directed toward these structures and their function is needed since so little information is available. The issue of compensatory behavior remains unclear and conclusions regarding it largely speculative.

PHYSIOLOGICAL CORRELATES OF NASALITY

Certain research efforts into the important question of hypernasality have attempted to identify oropharyngeal phenomena other than velopharyngeal closure associated with hypernasality. As Moll (1968) and Morris (1968) both point out, particular attention has been paid to discovering the relationships between ratings of nasality and velopharyngeal closure as revealed by various types of x rays, spectrographs, air flow apparatus, and sound pressure level equipment. These same devices have been used in the constant search for other physiological correlates to the problem of hypernasality.

While there is evidence, as noted in the previous section, that tongue position for different vowels influences the perception of hypernasality, that nasality is related to pitch and vocal intensity, and that nasality differs in cleft and noncleft speakers, both Moll and Morris have provided ample evidence to support the contention that the structural and physiological correlates of nasality are not well understood. Since the appearance of their reviews, additional work has been carried out in these important areas.

Acoustical Phenomena

A study by Carney and Morris (1971) and essays concerning the acoustics of nasality (Curtis, 1968, 1970; Schwartz, 1968, 1971) have increased our appreciation for the complexity of the relationship between the perception of nasality and physiological variables involved in its production. Carney and Morris collected nasality ratings on vowel-plosive combinations and related them to cinefluorographic evidence of velar, pharyngeal, and oral constriction, and to measurements of incisor opening. None of these measurements was systematically related to hypernasality, and hypernasality was sometimes heard in persons who appeared to achieve velopharyngeal closure. However, the cinefluoroscopic studies were taken in sagittal view and the authors point out that velopharyngeal ports may actually have existed. While Bjork (1961) reported, as might be expected, that lateral and transverse measures of closure correlate highly, it does seem probable that baseview cinefluorography will help to extend our present knowledge.

Another problem is that hypernasality appears to be a phenomenon of many subtypes. Perhaps studies to date have not been sufficiently concerned with first delineating the dimensions of these variations and then seeking physiological correlates. An attempt in this direction was made by Carney and Sherman (1971) who used equal appearing interval scaling to study nasality in different contexts as produced by nasal speakers, half with clefts and half without. Nasality ratings were obtained for vowels in isolation, in consonant-vowel-consonant (CVC) syllables, and for the same CVC syllables in a connected speech passage. Comparison of the two groups confirmed previous findings that noncleft nasal speakers are rated more nasal on low than on high vowels, whereas the reverse is true for nasal speakers with clefts. Nasality was also rated as more severe in the cleft group. Relationships

between nasality ratings for isolated vowels and syllables were significantly correlated with ratings of nasality in connected speech only for the cleft speakers. Sherman (1970a) presented strong evidence supporting the contention that there is a definite, although moderate tendency for defectiveness of articulation and nasality to be functionally related in the speech of children with cleft palate. This suggests again that hypernasality is probably not a single entity.

Schwartz (1971) noted that the spectral phenomena associated with nasal coupling may manifest laryngeal components. That is, reduction in the intensity of the first formant, presence of one or more antiresonances within the spectrum, presence of extra resonances, and shift in the center frequency of the formants may result from coupling of the oro- and nasopharynxes but may also be produced on the laryngeal level. Schwartz (1971) added, "In all probability, source-spectrum characteristics and formant-frequency variations interact with the nasal-coupling effects to produce the eventual spectra of nasalized vowels." The interaction between source and resonator has been reviewed and studied by Wada et al. (1970).

Curtis (1970) suggests nasality is such a complex problem that it may be illogical to get a high correlation between it and any single physiological parameter. On the other hand, these speculations fail to explain the immediate and dramatic changes from hypernasal to normal voice quality frequently obtained with pharyngeal flaps or pharyngoplasties.

Current information on the acoustics of nasality indicates that it probably involves interaction among various components of the vocal tract and that it often cannot be explained by velopharyngeal coupling alone. On the other hand, velopharyngeal coupling may constitute the basis of the difficulty with other aspects of the total problem occurring as secondary phenomena. Researchers are only now beginning to seek explanations in this important area.

Nasal Airway

Little direct work has been carried out on the influence of the highly variable nasal airway upon speech. As noted earlier, Warren et al. (1969) have reported that nasal pathway resistance is greater in cleft than in normal subjects probably because nasal deformities and restricted maxillary growth combine to reduce the size of the nasal passages. McWilliams and Musgrave (1971) suggested that, while nasal emission usually accompanies hypernasality, it is not invariably seen because of nasal abnormalities of varying degrees of severity. They noted further that these airway problems serve to alter the resulting speech sound in ways that can be subjectively described. For example, in cases of severe nasal obstruction, the air stream associated with the consonant /s/ may enter the nasopharynx at an incompetent velopharyngeal port but be trapped or only partially emitted at the point of nasal obstruction. The obstruction may be bilateral or unilateral; it may create a

complete or a partial blockage. It is probable that there is a critical point in the relationship between the size of the airway and the volume of the air stream at which nasal consonants lose part of their nasal characteristics but such sounds as sibilants retain a nasal component. These conditions within the nasal airway can result in what, clinically, appears to be a combination of hypo- and hypernasality, cul-de-sac resonance, or nasal turbulence. Nasal airway problems appear to affect both voice quality and articulation. These aspects of the speech of persons with velopharyngeal inadequacy require systematic investigation.

Dentition

Morris (1968) pointed out that many children with defective dental relationships are able to articulate correctly. For this reason, he concluded that we could not reasonably expect to find a relationship between dentition and speech for the cleft-palate population in general even though defective dentition might, in individual instances, be of etiological importance as a cause of defective articulation. There is still inadequate and often conflicting evidence available about the relationships between articulation and oral structure and function.

Subtelny, Mestre, and Subtelny (1964) found that subjects with Class II, Division I malocclusion, who articulated /s/ correctly, positioned their tongues differently from normals. Two-thirds of the normal speakers with good occlusion produced /s/ with the tongue tip elevated above the lower incisors. As a group, subjects with malocclusion but good /s/ production did not differ from the normal subjects in regard to vertical position of the tongue tip. They did, however, retrace the tongue relative to the maxillary incisors. Most subjects with malocclusion and /s/ articulation errors protruded the tongue tip beyond the lower incisors so that it tended to approach the lingual surfaces of the upper incisors. Subtelny and Sakuda (1964) and Subtelny (1970) have developed and supported the hypothesis that tongue function is influenced by oral structure.

Some investigations have supported this position whereas others have not. Stansell (1970), using cephalometrics, reported that sigmatism training reduced dental overjet. In 1968, Jensen conducted a study similar to the 1964 report by Subtelny and Sakuda except that Jensen used cinefluorography rather than cephalometric x rays. Among 19 subjects with Class II, Division I malocclusion and who produced an acceptable /s/, 79% placed the tip of the tongue against the lingual surfaces of the lower incisors while the lower lip approximated the lingual surface of the upper incisors. The remaining 21% placed the tongue tip against the lingual surfaces of the upper incisors and consequently anterior to the lower incisors. The two studies are contradictory with regard to tongue placement for satisfactory /s/ production in persons with Class II, Division I malocclusion. Perhaps the two groups of subjects differed with respect to such variables as speech training. Weinberg (1968)

conducted a study of similar design except that his subjects presented normal molar occlusion but missing upper central incisors. He found that perceptually satisfactory production of the /s/ by these children involved positioning the tongue tip in relation to the mandibular incisors.

If dental conditions do influence tongue function, children with various types of malocclusions would be expected to have an increased incidence of articulation errors. This theory is supported by the literature (Snow, 1961; Bankson and Byrne, 1962) although most children with dentition problems do articulate satisfactorily. However, as Bankson and Byrne have indicated, the impact of dental problems may be greater for speech-sound acquisition than for its maintenance.

Pendergast, Dickey, and Soder (1969) provided additional evidence that dentition may influence articulation. They used a multiple regression procedure to identify variables which might help to predict the spontaneous correction of frontal lisps. Open bite was among the cluster of characteristics present at the end of second grade in children who retained the protrusion lisp at the end of third grade. Open bite did not appear in predictive clusters identified at other ages.

Research pertinent to dental-speech relationships, including those in persons with palatal clefts, has recently been reviewed by Starr (1971). The data he assessed indicated that dentition interacts with other variables, including age, in its effect on speech. The multivariant nature of these relationships and the difficulty in finding satisfactory numbers of subjects within specified subgroups of the cleft-palate population have made it harder to identify the role of dental variables in speech. Starr concluded that articulation errors are more likely to occur in persons with more than one dentition problem but that certain single factors seem more likely than others to influence articulation. These include anomalous dental-arch relationships (especially when the maxillary arch is narrower than the mandibular arch), open bite, missing central incisors, and "... conditions that restrict relationships between the tongue and the lower incisors."

Shelton, Knox, Elbert, and Johnson (1970) discussed a study by Marks (1968) that indicated that the incidence of tongue thrust, still a controversial issue, is especially high in children with cleft palate. Arguments concerning tongue thrust as a cause of speech disorders and malocclusions may actually have diverted attention from dental-speech relationships in well-defined subject groups. If tongue protrusion during speech represents an adjustment to oral environment, we would predict a higher frequency of interdental articulation in cleft-palate speakers with narrow maxillary arches than in similar persons with wider arches. On the other hand, children with complete clefts frequently have missing lateral incisors and some maxillary collapse. McWilliams (unpublished) has observed a high incidence of lateral lisps in children with unilateral clefts. The tongue deviation usually relates to space created by maxillary collapse or missing dentition in the line of the cleft. This is the most common speech problem at the Cleft Palate Center, Univer-

sity of Pittsburgh. It is possible that this type of articulatory deviation becomes most obvious after velopharyngeal valving problems are essentially solved. In those with poor closure, the difficulty may be obscured because the listener responds primarily to nasal elements in sibilant production. Hopefully, collaborative research involving the surgeon, dentist, and speech pathologist will find ways to prevent or minimize maxillary arch and dental deviations and to assess their relevance to speech more effectively.

Several investigators are photocopying dental study models to measure dental arch phenomena in cleft-palate subjects (Huddart, MacCauley, and Davis, 1969; Huddart and Orth, 1970). Stockli (1971) used this procedure to compare maxillary arch phenomena in cleft subjects who had undergone early maxillary orthodontia and bone grafting with subjects who had not. Mazaheri et al. (1971) used procedures similar to Stockli's to describe maxillary arch form changes in groups of cleft subjects. These methodologies, together with other technologies, should be applied in studies of the relationships of dental variables to speech variables in carefully specified groups of subjects under a variety of treatment conditions. Cole (1971) has discussed the importance of work of this kind.

Considering the large number and possible combinations of dental, environmental, subject, and unknown variables that can interact to influence speech, it is obvious that important speech-dentition relationships remain to be uncovered. Use of various subject groups, including the cleft-palate subgroups, should contribute to the process. The literature at this time does not contain conclusive information pertaining to maxillary arch variables, tongue-pharynx size relationships, and dentition measures as they relate to articulatory acquisition or improvement with speech therapy. The authors are in accord, on the basis of clinical experience, that speech clinicians sometimes undertake correction of articulation problems in cleft-palate speakers with other oral problems when they already use correct speaking patterns. Clinicians need information which will help them with prognostication.

CONCLUSIONS

There is a vast literature relating to anatomical and physiological requirements for speech, but there is also a vast amount of conflict in the findings. For too long, speech has been studied as hundreds of isolated phenomena instead of as a coordinated, well-integrated system. The result is that laboratory and research efforts, while they have extended the body of knowledge and provided direction for future research, have often had only limited clinical applicability.

Out of the confusion, however, certain trends can be detected. One has serious implications for patient care right now. The present authors would end this part of the discussion by taking a firm position on the issue of velopharyngeal closure. Studies suggesting that velopharyngeal closure is not essential to normal speech fail to account for the fact that the normally function-

ing mechanism does demonstrate ability to achieve complete closure under certain conditions. Those who would argue in this direction cannot present irrefutable evidence to support their position. Present information strongly suggests that Morris (1968) was accurate when he wrote, "Velopharyngeal closure must be achievable for the production of consonants in connected speech." We recommend that cleft-palate teams strive to provide their patients with mechanisms capable of accomplishing velopharyngeal closure. While small ports may be compatible with normal speech production under certain undefined circumstances, present procedures do not permit the identification of the critical port size for a given individual. Even if this were possible, the surgeon should still attempt to create an unquestionably competent mechanism. He is less likely to surpass his margin for error if closure is his goal.

ASSESSMENT OF SPEECH

HUGHLETT L. MORRIS, RALPH L. SHELTON, and BETTY JANE McWILLIAMS

There have been many research and clinical reports about the diagnosis of cleft-palate speech problems over the past 20 years. This material is well summarized in Spriestersbach and Sherman (1968), Grabb, Rosenstein, and Bzoch (1971), and Wells (1971).

Yet, there remains a need to review the material from a somewhat different point of view and to integrate it with other clinical and research requirements. Further clarification of problems of assessment is of prime concern to professional people faced with clinical decision making. Differences of opinion arise because of variations within the cleft population and because of variability in procedures available for evaluation and in the criteria for interpretation. This seems to be a matter of almost universal concern and requires careful consideration here. Without question, communication among clinicians and treatment-research centers would be facilitated if standardization of assessment procedures were accomplished. However, it will probably never be possible to identify a single measurement technique or set of techniques which can be applied blindly. The element of choice will remain, and the selection of the measuring instrument must depend ultimately upon the purpose of the measurement. In addition, clinical judgment is essential in any assessment protocol, and it is unlikely that it can ever be replaced. Research needs in the area of assessment are great, and they relate to a magnitude of problems.

DESCRIBING SPEECH SKILLS

The necessity here is to understand the nature of speech problems encountered by people with clefts in contrast to normal speakers. The clinician must describe speech accurately, determine the magnitude of the deviation, prognosticate, and plan treatment.

Among the techniques used for diagnosing speech problems are articulation and intelligibility testing, and ratings of articulation, intelligibility, general defectiveness, and severity of voice quality deviations such as hypernasality or hoarseness. Psychological scaling and clinical judgments have both been used.

If comparisons are to be made with normal speakers, then an articulation test for which normative data are available (such as the Templin-Darley

Test, 1969) is a reasonable choice. On the other hand, ratings of any aspect of cleft-palate speech can be compared with those of normal speakers simply by using normal speech samples in study designs. However, the application of various speech rating techniques to cleft problems has probably resulted in greater misunderstanding than any other single issue.

Clinical ratings or judgments are made in a clinical setting and are usually based on observations made by the clinician. The number of observations varies depending on the problem. A clinical judgment represents an attempt to summarize the findings of several evaluations which the clinician deems necessary. There is evidence that, when the clinical judgment is made on a dichotomous basis, the judgment can be made reliably (Morris, in preparation). On the other hand, when judgments are made for the purpose of assessing relative status and when they use a multipoint scale, they may not be so reliable (Philips and Bzoch, 1969).

If the purpose of the assessment is to ascertain the extent of the problem and if the assessment is to be made of connected speech, it seems preferable to use psychological scaling procedures rather than clinical judgments. In general, the procedure for obtaining psychological scale values involves asking perhaps 20 listeners to evaluate a series of tape-recorded samples of connected speech and to assign to each sample a number indicating its relative position on a scale. Many different scales can be used, some with greater reliability than others. However, for speech ratings, the common trend is for 5, 7, or 9 equal-appearing interval scales to be selected. Training in the use of the scales is essential, and reliability can be improved in that way. Generally, some method of determining the reliability of the judges is used.

Individual ratings can be compiled for statistical management. For more technical information regarding scaling, see Sherman (1954), Counihan and Cullinan (1970), Fletcher and Bishop (1970), and Sherman (1970b). Other approaches are to be found in Prather (1960) and Van Demark (1964).

Clinical judgments, no matter how expertly arrived at, do not meet the requirements for psychological scaling. The speech sample may vary in length among subjects. Only one listener is involved, and he rarely makes judgments consecutively. Rather, he makes them whenever and wherever the situation demands. Such intermittent use of his "yardstick" may result in unreliable ratings. However, there are precautionary steps which the speech clinician can take to insure that clinical judgments reach a somewhat higher degree of reliability. These include making judgments from tape-recorded samples rather than in the live clinical context (although that may also be desirable and necessary) referring frequently to a training tape for purposes of keeping the criteria for judgment firmly in mind. Even with these precautions, however, psychological scaling procedures appear preferable at least for research use.

Clinical judgments continue to be used in the clinical setting by the speech pathologist, surgeon, dentist, and other team members. There is a great need, therefore, for research designed to provide information for specifying the bases for clinical judgments and for executing those judgments with

greater reliability. We need simple, valid, reliable clinical methods of assessment which will not be as complicated and time consuming as are the more formal scaling methods.

ASSESSING THE RESULTS OF CLEFT-PALATE PHYSICAL MANAGEMENT

Much confusion has surrounded the objectives of and procedures for assessing the results of cleft-palate physical management and for evaluating the techniques themselves. This confusion arises partially out of the imprecise and unclear language used by many speech pathologists and partially out of failure to establish necessary research priorities.

A major consideration in this area is the use of speech as an index to the success or failure of specific procedures for the repair or management of palatal clefts, recognizing again that speech can be affected by other variables of combinations thereof.

The whole issue of evaluating the effects on speech of various surgical procedures becomes a primary future research target when it is remembered that limited though the data are, an educated guess is that approximately 25% of the cleft-palate population demonstrates some degree of residual velopharyngeal incompetence with its associated speech problems. There is obviously variation in the figures reported. Braithwaite's (1964) percentage of "success" is much higher than that, and there are some indications that the V-Y procedure may yield better results than any other procedure studied to date. On the other hand, it may also be true that the failure incidence runs to astronomical proportions in certain situations which have not been and perhaps cannot be systematically investigated.

There has been surprisingly little research about the effectiveness of various primary surgical procedures. While some critical reviews of the literature are available (Grabb et al., 1971; Morris, in preparation), it is appropriate to include here some of the available information.

Table 1 is a summary of the various research projects reported since 1960. We can conclude from these data that research into the effectiveness of surgical procedures remains limited. Few patient series have been studied, and methodological limitations are serious. There has been bias in the selection of subjects for study, use of questionable assessment techniques, inappropriate control of the other variables that can influence surgical results, and too little attention to developmental patterns over a time dimension.

The most important element in this aspect of assessment is, of course, the evaluation of velopharyngeal competence during speech. The reasons are obvious. The primary purpose of initial surgical management of a palatal cleft, secondary surgical procedures such as pharyngeal flap or pharyngeal implant, and primary and secondary prosthetic appliances is to provide the patient with the physiological ability to separate the mouth from the nose during speech, or, in short, to provide him with velopharyngeal competence. These physical management procedures for cleft and associated palatal prob-

TABLE I. Literature review: speech results of cleft-palate surgery, 1960 to 1971.

Reference	N	Age at Surgery	Procedure	Criterion	Success Rate	Comments
Greene (1960)	153	1 yr	V-Y	normal speech or lateral articulation	86.7% (LP, unilateral) 79.5% (LP, bilateral) 35.5% (PO)	Surgery by several surgeons. Author doubts validity of PO results. Evaluations by two speech pathologists.
McWilliams (1960)	45	16.4 mos (mean)	some modification of the Veau	excellent or good speech	81%	Surgery by eight surgeons. Author (a speech pathologist) did all evaluations.
Braithwaite (1964) and Morley (1970)	360	varies (65% between 12 and 24 mos)	V-Y	nasopharyngeal closure	95.8%	Evaluations (probably) done by several speech pathologists.
Trauner and Trauner (1967)	264	?	V-Y	no rhinolalia aperta	86%	Little information about the sample or who did the evaluations. Age at surgery not recorded.
Battle (1967)	413	before 2 years	V-Y	good speech	83% ("short" postalveolar) 83% (LP, unilateral) 74% ("long" postalveolar) 70% (LP, bilateral) overall results, all cleft types: 77%	Details about evaluation procedures are vague. Not all subjects evaluated by speech pathologist.

TABLE I. (Cont.)

Reference	N	Age at Surgery	Procedure	Criterion	Success Rate	Comments
Millard, Batstone, Heycock, Bensen (1970) (partial results: only primary surgery reported here)	59	?	palatal island flap	normal speech or slight nasal escape	79.6%	Apparently all evaluations done by a speech pathologist. Age at surgery not reported.
McEivitt (1971) partial results: stage results only:	97 233 36	?	Langenbeck V-Y "setback"	no persistent rhinolalia	57% 87% 72% overall results, all surgical procedures, all cleft types: 77%	Criteria for deciding which patient got which procedure are not given. Age at surgery not reported.
Lindsay (1971)	66 45	? ?	Langenbeck Dorrance pushback	acceptable speech-no influence of the cleft palate	61% 42%	Details about evaluation procedures are vague. Criteria for deciding which patient got which procedure are not given. Age at surgery not reported.
Cahan (1971b)	245	13.4 mos (mean)	V-Y	no (nasal) escape of air	64.1%	All surgery done by one surgeon.
Morris (in preparation)	101	29.2 mos (mean)	V-Y, modified by Demjen	velopharyngeal competence	71.2%	Questions about randomness of sample. An additional 28% had minor v-p problems not requiring secondary management. Author (a speech pathologist) did all evaluations. All surgery performed by one surgeon.

lems are not designed to remedy aspects of speech, voice, or language unrelated to velopharyngeal function.

While velopharyngeal incompetence is a major hazard to speech production in ways that can be specified, there are other hazards which may be equally devastating but that have very different origins. Therefore, statements about the general adequacy of speech are not meaningful if the effects of physical management are in question. If the speech of the cleft-palate patient is normal, we have reason to think that the physical management has been successful. On the other hand, if speech is not normal, we cannot say anything about the adequacy of physical management until we know the nature of the speech problem. For example, if the speech task involves the consonant /s/, the relevant judgment to be made in this context has to do only with whether the air stream is orally or nasally channeled. Judgments restricted to the correctness of the sound are inappropriate since /s/ may be incorrect as the result of dental deviations, hearing loss, developmental immaturity of various types, faulty learning, or factors of unknown origin. Thus, if the results of physical management are judged on that basis alone, the success rates may be grossly underestimated.

Another source of confusion in assessing the results of physical management is that, although there are many useful procedures for evaluating velopharyngeal competency during speech, no single method is wholly satisfactory. The normal articulation of fricatives, affricates, and plosives requires oral emission of air. The nasal emission of air during their production indicates a deficiency in velopharyngeal valving, and hypernasal voice quality also indicates a velopharyngeal problem (Morris, 1968). However, particularly in marginal cases, the extent of nasality on vowels can be heavily influenced by the nature of adjacent consonants. Thus, it is possible, within limits, to collect evidence from the speech pattern to support or reject the presence of valving problems. However, unless these speech characteristics are severe, they seldom provide all the information necessary for a valid decision. It is desirable, therefore, to use certain instrumentation to augment the more subjectively determined speech data. To be most meaningful, however, the measures selected should be applied in relationship to the speech act. There is overwhelming evidence indicating that velopharyngeal behavior during speech differs from the behavior found in such nonspeech tasks as blowing, sucking, and swallowing (Bloemer, 1953; Ashley et al., 1961; McWilliams and Bradley, 1965; Moll, 1965; Flowers and Morris, unpublished).

Instrumentation appropriate to the task of assessing velopharyngeal closure is discussed in detail later in this report. Whatever method or methods are selected, however, there are four major requirements for a satisfactory method for the assessment of velopharyngeal competence for either clinical or research purposes. They are:

1. The method must reveal the presence or absence of an opening between the nasal and oral cavities during speech.

2. The method must provide reliable information about the size of any velopharyngeal opening which is present during dynamic speech.
3. The method should provide information about the location in space where the observation is made.
4. The method must have inter- and intrasubject reliability.

Since no single method of assessment meets all of these criteria, none can be relied upon without qualification. The best solution appears to be the use of a combination of methods. Precisely which combination is most efficient is yet to be determined.

In discussing assessment with emphasis upon velopharyngeal closure, other oral conditions such as dentition, alveolar arches, palatal vault, and oral cavity size must not be completely ignored. These are also frequently affected by the physical management of cleft palate (Starr, 1971). While the resulting deviations may not be unique to the cleft population, they may occur with greater frequency in persons with clefts and thus constitute relatively greater hazards. Future research must systematically investigate the influence of physical management upon these dimensions and, in turn, their ultimate influence upon the speech result. However, it will also be essential to view the potential outcomes according to a hierarchy of relevance in the life of the patient and to order them appropriately in assessing management results.

OTHER ASPECTS OF ASSESSMENT

In addition to the evaluation of velopharyngeal closure and its effects upon speech, other parameters of the speech patterns of individuals with clefts must be evaluated. These have been discussed earlier in this report, but they are appropriate for inclusion here as well. They include articulation, inflection, timing and duration, vocal quality and pitch, and variations in resonance characteristics. It is imperative that methods be found for evaluating these aspects of speech with greater objectivity than is now possible and that attention be given to learning about these speech parameters as they are influenced by such variables as extent of initial deformity, age, hearing, intelligence, socioeconomic status, psychosocial factors, and structural or functional variations.

INSTRUMENTATION

DONALD W. WARREN

Objective measurements of speech are required to assess adequately the effects of cleft palate. This has led to the adaptation of a number of instruments for analyzing the vocal process. This section will deal primarily with those instruments that have had the most profound impact on research and clinical efforts in cleft palate. These include radiologic techniques such as cephalometrics and cineradiography and aerodynamic techniques such as pressure and airflow devices. Additionally, such tools as electromyography, ultrasound, and tonar, although still in the developmental stages in cleft-palate research, will be discussed briefly.

Many other instruments have been developed for diagnosing palatal function, but our current state of knowledge has been achieved primarily through research efforts with the stated technologies. It should be noted that excellent detailed reviews of assessment techniques have been published recently in *ASHA Reports Number 5* by Lubker (1970), Harris (1970), and Bzoch (1970).

RADIOLOGIC TECHNIQUES

Cephalometric Studies

Cephalometric radiographs played an important role in cleft-palate research in the 1950s. Standardized studies of the pharynx and velum during growth provided data for comparison with cleft-palate subjects (King, 1952; Brader, 1957; Subtelny, 1957; Graber, Bzoch, and Aoba, 1959; Ricketts, 1954). Information on site of velopharyngeal closure and changes with age had immediate clinical application. Subtelny and Koepp-Baker (1956) examined the role of adenoid tissue in palatal closure and their disclosures led to a more conservative approach to adenoidectomy.

Cephalometric techniques for estimating palatal function provide information despite the static nature of the process (Hagerty and Hoffmeister, 1954; Calnan, 1955). However, the limitations of the technique should be carefully delineated in the future. Abnormal articulation patterns have also been identified (Hixon, 1949; Buck, 1953) and later confirmed by cineradiographic techniques (Shelton, Brooks, and Youngstrom, 1964; Brooks, Shelton, and Youngstrom, 1965).

The introduction of laminagraphy improved the analysis process by providing measurements in a selected plane rather than from a projection of all planes. Subtelny and Subtelny (1959) and Hagerty and Hill (1960) used this technique to study articulatory structures in normal and cleft subjects. Subtelny (1956) reported that the overall maxillary dimensions and the velum are smaller in cleft-palate individuals.

In the present state of the art, cephalometry continues to be an extremely valuable tool for assessing structural abnormalities and for providing accurate longitudinal data on craniofacial growth and development.

Cineradiography

The limitations of static radiographs were overcome to some degree with the introduction of cineradiography. Although Carrell (1952) was the first to introduce the technique in speech research, Berry and Hofmann (1956) and Moll (1960) used image intensification to provide acceptable radiation levels for research purposes. The early studies provided such details as ideal filming rates, most effective processing procedures, techniques for combining sound on film and methods of tracing and analyzing data (Bjork, 1961; Bjork and Nylen, 1961; Warren and Hofmann, 1961; Shelton et al., 1963; Bjork and Nylen, 1963). Further modifications were reported by Sparrow, Brogdon, and Bzoch (1964) and Bzoch (1968). McWilliams and Bradley (1964) developed a rating scale for reducing telerradiographic data obtained from their video system.

Cineradiographic studies have provided information on the relationship between velar length and depth of the nasopharynx (Warren and Hofmann, 1961; Mazaheri, Millard, and Erickson, 1964; Williams and Bzoch, 1966), the palatal plane and site of velar closure (Warren and Hofmann, 1961; Bjork and Nylen, 1963), as well as velopharyngeal closure patterns (Bzoch, 1968).

Abnormal lingual movements have been reported by Shelton, Brooks, and Youngstrom (1964); Brooks, Shelton, and Youngstrom (1965); and Williams (1969). Blackfield et al. (1962) studied subjects with velopharyngeal incompetency without cleft palate and provided evidence of such anatomic abnormalities as short hard and soft palates, deep pharynx, and inadequate palatal movements.

Recently, Skolnick (1970) reported a significant methodological advance in telefluoroscopy. He described a new approach for assessing palatal closure using lateral and base projections. The base projection, by showing the *port en face*, demonstrates both the movement of the lateral pharyngeal walls and lateral edges of the velum. This means that procedures such as the posterior pharyngeal flap could be viewed and analyzed radiographically. As noted earlier, however, the approach does not provide information concerning the location of the valve being viewed. This is a limitation that will require work in the future. Telerradiography has a distinct advantage over cineradiography in that it requires about one-quarter to one-half the skin roentgen dosage of

16 mm pulse cine at 30 frames per second. The question of radiation dosage is extremely pertinent at this time, however, since there is real concern among many investigators over the ethics of exposing individuals to radiation for research purposes alone.

Tele- and cineradiography as techniques for studying the speech mechanism are extremely valuable. Improvements in the x-ray image through computer processing or xeroradiography should come in time. Perhaps the most significant problem still requiring a practical solution is the amount of data analysis necessary for quantitative studies. Computer assisted measurements seem to offer the most obvious solution.

AERODYNAMIC TECHNIQUES

The effect of palatal dysfunction on the respiratory aspects of speech was recognized decades ago, and a number of crude devices were developed to provide a gross indication of nasal air escape. These devices included, among others, u-tube manometers, mirrors which recorded nasal fogging, and various blowing devices (Moser, 1942; Buncke, 1959; Chase, 1960; Hess and McDonald, 1960). These clinical tools differentiated the most obvious palatal defects from normal functions but were not dependable in cases of slight to moderate palatal incompetency.

The development of instruments capable of precisely measuring pressure and airflow associated with speech has resulted in improved, objective methods for assessing muscle function as well as providing a more comprehensive understanding of the physiological basis of cleft-palate speech problems.

The basic components of aerodynamic measuring systems are flowmeters, which record volume rates of airflow, and pressure transducers, which record airway pressure within the vocal tract.

Airflow Measurements

Two types of flowmeters have been used, the pneumotachograph and the warm-wire anemometer. The pneumotachograph is the most reliable type of flowmeter and is easily calibrated. In addition, it records both egressive and ingressive airflow. The pneumotachograph often requires the use of a facemask, however, and this may restrict articulatory movements to some degree (Lubker and Moll, 1965).

The warm-wire anemometer does not require the use of a facemask, but it is more difficult to calibrate, is often nonlinear, and, unless modified, does not record flow in both directions.

Flowmeters have been used to estimate velopharyngeal competency under the assumption that nasal airflow is linearly related to palatal function (Quigley et al., 1963; Quigley et al., 1964). However, there is good evidence that this is not so (Warren, 1967; Lubker and Schweiger, 1969). Factors such as respiratory effort and nasal airway resistance influence the volume rate of nasal airflow in individuals with palatal incompetency (Warren and Devereux,

1966; Warren and Ryon, 1967; Warren and Wood, 1969; Warren, Wood, and Bradley, 1969). Indeed, studies have demonstrated that nasal airflow can occur in cases of palatal incompetency when producing nonnasal sounds. Lubker and Moll (1965) have shown that nasal airflow occurs in normal speakers possibly as a result of palatal elevation. Warren (1967) has reported peak airflow rates as high as 150 cc/sec during nonnasal consonant productions in subjects with adequate palatal function.

Pressure Measurements

A number of pressure recording devices have been used to measure airway pressure during speech and associated activities. The oral manometer is a relatively simple, inexpensive clinical tool used to estimate intraoral pressure during sustained blowing or inhaling. Although the instrument can usually differentiate between incompetency and competency, it cannot determine the degree of palatal closure. Morris (1966) has demonstrated a moderate correlation between manometer scores and articulation tests. Weinberg and Shanks (1971) have recently reported that negative manometer ratios more accurately determine mild hypernasality than do positive ratios.

The pressure transducer is a more flexible tool and has been used to record pressures in different parts of the vocal tract. Usually the transducers are connected to catheters placed in the oral or nasal cavities. However, miniature transducers have been developed that can be placed directly in the area to be measured (Koike and Perkins, 1968). This eliminates the need for catheters and the possibility of articulatory interference. There has been a problem of temperature sensitivity with these transducers, but modifications in design can compensate for temperature changes.

Pressure and Airflow Studies

Data obtained from the simultaneous recording of pressure and airflow along the vocal tract have, to some degree, explained the physiological basis of cleft-palate speech problems. For example, palatopharyngeal incompetency has been determined in terms of the respiratory requirements for speech. The findings of Warren (1964), Warren and DuBois (1964), and Warren and Ryon (1967) that an opening larger than 20 mm² results in palatal incompetency has been confirmed by others (Machida, 1967; Lubker, 1969). However, additional investigation is required in this area since velopharyngeal adequacy appears to extend over a continuum. A number of investigators have also provided convincing evidence that articulatory proficiency is related to velopharyngeal opening although not specifically in a linear fashion (Subtelny and Subtelny, 1959; Shelton, Brooks, and Youngstrom, 1964, 1965; Brandt and Morris, 1965; Barnes and Morris, 1967).

Hydraulic equations have been used to measure and compare such parameters as velopharyngeal orifice size, nasal airway resistance, oral port opening, and temporal patterns of consonant production in order to identify the

compensatory adjustments that occur in response to incompetent closure (Warren and DuBois, 1964; Warren, 1964; Warren and Mackler, 1968; Warren, Wood, and Bradley, 1969).

These studies have shown that speech performance depends on a number of complex variables and not just the ability of an individual to achieve adequate velopharyngeal closure. Thus, when closure is inadequate, the level of performance attained by a speaker depends to a great extent on how other speech structures adapt to the incompetency as well as upon the anatomic configuration of the oral and nasal cavities.

It appears that the physiological basis for these adjustments is the need to modify the respiratory requirements of consonant sounds. Thus, cleft-palate speakers have been shown to use larger volumes of air (Warren and Wood, 1969), to have higher nasal airway resistance (Warren, Wood, and Bradley, 1969), and to have more airway turbulence (Williams, 1969) than normals. In addition, the timing of consonant production seems to depend to some degree on adequacy of closure (Warren and Mackler, 1968).

Analog studies of the upper speech mechanism under simulated cleft-palate conditions have demonstrated why speech sounds such as voiceless fricatives require greater respiratory effort and are distorted more frequently than are their voiced counterparts or other consonant types (Warren and Devereux, 1966; Warren and Ryon, 1967).

Although palatal incompetency influences the respiratory requirements of sounds, similarities exist among the cleft and normal populations. Both groups demonstrate identical patterns of voiced-voiceless consonant differences. That is, voiceless consonants are produced with higher pressures, greater airflows, and larger air volumes than corresponding voiced sounds, regardless of the cleft condition.

ELECTROMYOGRAPHY

The minimal use of electromyography in cleft-palate research undoubtedly reflects the technical difficulties associated with the procedure as well as the complexity of the muscle groups comprising the orofacial region. Although the development of the hooked electrode has overcome a number of the disadvantages of the needle and surface electrodes, two basic objections to the technique remain. One is the inability to verify conclusively that the muscle being recorded is, in fact, the muscle being investigated. The other is the inability to determine the precise relationship between electrical activity and muscle contraction. Unfortunately, muscles are often identified by their electromyographic activity, and the resulting data are valid only if this somewhat tenuous assumption of what the activity should be is correct. The advantage of electromyography is that it offers an approach to monitoring the motor commands of the central nervous system.

One of the earliest studies (Broadbent and Swinyard, 1959) demonstrated that the activity of the posterior pharyngeal flap is similar to the activities of

the tensor palatini, levator palatini, and superior constrictor muscles. However, the study was performed while the subjects were swallowing rather than speaking. The authors also reported that the electromyographic activity of the tensor was consistently different from that of the levator. The levator and superior constrictor responses were similar, however.

Li and Lundervold (1958) used concentric needle electrodes in 16 cleft-palate subjects and reported considerable difficulty in differentiating the various muscles. They were able to identify the tensor muscle but reported no difference in its activity and that of other muscle groups.

Cooper (1965) described some pilot studies on palate muscles using surface electrodes. He noted a close relationship between electromyographic activity of the soft palate and velopharyngeal closure. Activity from electrodes placed on the posterior pillars did not relate as well to palatal closure.

Lubker (1968) used bipolar suction electrodes combined with cineradiography and reported that electromyographic activity during speech appeared to vary consistently and was positively correlated with velopharyngeal position. The study also demonstrated more electromyographic activity for high vowels than for low vowels.

The most comprehensive electromyographic study of palatal function was reported in a monograph by Fritzell (1969). He inserted fine monopolar wire electrodes through the nasal cavity into the tensor, levator, and superior constrictor muscles and orally into the palatoglossus and palatopharyngeus muscles. Placement was estimated to be accurate 69% of the time. Fritzell reported that levator activity corresponded closely to speech production and velopharyngeal closure. Levator activity disappeared during the production of nasal sounds. The superior constrictor responded with activity that was similar to the levator while the palatoglossus muscle demonstrated an opposite effect with activity corresponding to lowering of the palate. Palatopharyngeus activity was minimal and, at times, had little relationship to speech. The tensor was active only during swallowing and chewing.

At the present stage of development, electromyography provides some insight into which muscles participate in normal velopharyngeal closure. Data from cleft subjects remain scarce and for justifiable reasons. The difficulty involved in identifying muscles after surgery poses a formidable task to those attempting to establish electromyography as a reliable clinical tool.

SOME OTHER TECHNIQUES

Ultrasound, as a technique in cleft-palate research, is relatively new and is still in the developmental stage. Virtually all the studies have come from the Wisconsin group of Minifie, Kelsey, and their associates. A complete description of the Doppler ultrasound principle is provided by Minifie, Kelsey, and Hixon (1968) and Kelsey, Minifie, and Hixon (1969). In the field of cleft palate, the technique has been applied only to studies of the lateral pharyngeal walls (Minifie et al., 1970).

Thus, in spite of the advantages the technique offers, it does not require the insertion of tubes or wires into the vocal tract nor does it pose a radiation hazard to the subject. Its application seems to be limited. Tissue-air interfaces tend to block the passage of the sound beam and the continuous movement of structures makes the interpretation of data extremely difficult. However, more experience with the approach may help to overcome some of the current problems.

Tonar (Fletcher, 1970) is an instrument designed for measurement and modification of nasality and phonation. The system is voice activated, and it scans the nasal output, locks on to a resonant frequency, and simultaneously tracks resonant frequency and the equivalent frequency band from the oral output. Nasal-to-oral acoustic ratios are generated, and this information is fed to a nasality rating meter. The result is a continuous display of ratios as the person speaks. A goal ratio dial is provided so that attempts to modify speech behavior can be compared to levels set by the clinician. A variable criterion level dial sets the number of consecutive successes required for reinforcement of this behavior. Additional circuitry has been developed to track and display fundamental frequency and vocal intensity. Fletcher (1972) has reported case study information which indicates that Tonar has contributed to reduction of nasality in a few individuals. Also, it appears to have some value in investigating certain voice disorders and for modifying resulting speech behavior.

The panendoscope was described by Taub (1966) as a tubular optical device that may be placed into the mouth for direct visualization of velopharyngeal closure. He stated that integral illumination and the lens system provide a view which may be observed or photographed. Willis and Stutz (1972) used the panendoscope in conjunction with a video recording system, thus providing a means of displaying velopharyngeal movements to the person producing them. Schulz et al. (1973) used the panendoscope to evaluate pharyngeal flaps. Further use and investigation of this and other similar tools is anticipated.

CONCLUSIONS

The diagnosis of cleft-palate speech problems, from the point of view of instrumentation, has matured over the past two decades from an art to a science primarily as a result of the newly developed objective methods of assessment. Indeed, in the present state of the art, many centers involved in treatment and research have combined the different technologies to portray comprehensively how structures function under the stress of cleft palate. This application of research technology has provided a general understanding of the physiological bases of cleft-palate speech.

Two areas of research that have been neglected, however, are the acoustic and perceptual aspects of the speech problem. Certainly, as noted earlier, there have been studies in these areas but, in general, the level of achievement

lags considerably behind the physiological studies. The problem may be a lack of interest by skilled individuals rather than a lack of appropriate instrumentation. A variety of instruments are capable of performing sophisticated acoustical analyses, and it appears likely that the combination of these with presently available physiological tools could provide valuable information on the acoustic and perceptual correlates of abnormal function.

It is evident from the foregoing remarks that the advances in research technology have had practical significance for patient care and have opened up many new avenues for future research. However, in attempting to predict future directions, one must consider the possibility that the development of new research tools and the accumulation of additional data may at some point provide less value for the time and money invested than would other alternative approaches. Specifically, researchers in cleft palate presently study a population of patients that is heterogenous not only in the types of deformities present but also in the quality of care received. Thus, while some patients may be treated in large centers where the caseloads are large enough to provide clinicians with adequate experience, others may be treated by those with substantially less skill, experience, and understanding of the factors involved. This, of course, is a problem of our health care delivery system. However, it is a pertinent consideration if we are to use effectively the sophisticated instruments of research for practical gains in patient care and if future research projects are to be relatively bias free. In planning for the future, it is essential to recognize that, although present instrumentation can provide important data on each patient, our system of health care delivery determines its worth.

NONSURGICAL MANAGEMENT OF CLEFT-PALATE SPEECH PROBLEMS

RALPH L. SHELTON, HUGHLETT L. MORRIS, and BETTY JANE McWILLIAMS

There has been less research about the nonsurgical management of cleft-palate communication problems than there has been in the areas of description, definition of etiological bases, and development of diagnostic procedures. This is not surprising because management investigation is probably the most difficult aspect of clinical research. It obviously cuts across many different areas of care and is plagued by hundreds of known and unknown variables.

VELOPHARYNGEAL CLOSURE

In 1968, Shelton, Hahn, and Morris reviewed literature concerning speech training and therapeutic exercise as they influence velopharyngeal closure. They concluded that no specific evidence could be cited to indicate that motor exercises are of value for increasing velopharyngeal competence or for accomplishing good, automatic articulation. Their discussion and a previous article (Shelton, 1963) cited physical medicine and physical therapy literature as indicating that therapeutic exercise is designed to develop strength, endurance, range of motion, and skill. Shelton et al. (1968) recommended, at least implicitly, that the speech clinician direct his attention to skill.

Nylen (1961) had reported earlier data, which indicated that articulation training can improve the pattern of velopharyngeal closure. In 1964, Blakeley published case studies that suggested that reduction of prosthetic obturator sections can result in an increase in pharyngeal wall movement. A study by Yules and Chase (1969) showed pharyngeal wall movement can be developed and incorporated into speech by a combination of electrical stimulation and training using visual cues. This section reviews recent work which bears on issues surrounding behavioral treatment for the improvement of velopharyngeal closure.

Articulation Training

Little has been done to evaluate the influence of articulation therapy on velopharyngeal closure. Shelton et al. (1969) reported cinefluorographic data, which indicated that a particular program of articulation therapy did not in-

fluence velopharyngeal gap, pattern of velopharyngeal closure, movement of the posterior wall of the pharynx, or relationships between the tongue and atlas or tongue and posterior wall of the pharynx. It would appear that, in the absence of other evidence, the clinician should not expect articulation training to result in improved velopharyngeal closure.

✦ *Speech Appliance Reduction*

Blakeley and Porter (1971) presented a case study of a young boy with palatal paralysis and pharyngeal weakness who underwent speech bulb reduction over a period of three years. During that period, he received some speech therapy. The boy improved his articulation and eliminated hypernasality and nasal escape during speech. The speech bulb was greatly reduced in width and anterior-posterior dimension during treatment, and its use was finally discontinued. The boy continued to speak "well" during posttreatment testing even though lateral head x rays showed a distance of 2.3 mm between palate and posterior pharyngeal wall during phonation of /i/. In evaluating opening size, the limitations of the lateral head x ray for this purpose must be noted. It is possible that different instrumentation might have yielded different results.

Weiss (1971) studied the records of 20 persons who were able to discontinue wearing speech appliances following a program of obturator reduction. He found certain common characteristics among these 20 successful patients. They included excellent cooperation of patient and parent, early enrollment in the obturator reduction program, good palatopharyngeal compensation ability, remedial speech carried out simultaneously with prosthetic therapy, consistency in the wearing of the obturator, and careful case selection.

Weiss mentions a number of variables, which were studied in his subjects, but no data are reported. Tapes and x rays presented at meetings (Weiss, 1971) suggest his patients have maintained good speech without obturators at least during the testing situation. However, because the reports do not include use of control groups or procedures, the observations reported can provide only hypotheses to be tested in well-controlled studies. Since the treatment is directed toward the development of pharyngeal wall movements, work must be done to determine whether specific classes of patients develop greater pharyngeal movement under a well-specified regimen of bulb reduction than do similar control subjects who do not receive treatment. In addition, it is essential to discover how well any such movements are maintained and under precisely what conditions. Findings of this type generalized to grossly inadequate subjects would undoubtedly be in error, and every precaution must be taken to assure appropriate interpretation of data.

Shelton, Lindquist, Arndt, Elbert, and Youngstrom (1971) studied planned speech bulb reduction in 18 subjects. Lateral cinefluorographic films made before and after reduction indicated only one subject produced forward movement of the lateral pharyngeal wall where no movement was present prior to treatment. Shelton and his associates also looked for evidence of tongue

elevation and retraction in response to the bulb reduction. These unwanted compensations were not observed. They did find, however, that subjects speaking with their reduced bulbs sometimes produced closure by displacing the bulb or by changing cervical posture. Adjustments of this type may reduce the likelihood of a subject's compensating through increased pharyngeal movements.

These authors also discussed the use of speech bulb reduction for diagnostic purposes, an idea compatible with the exploratory clinical use of obturator reduction recommended by Blakeley (1964) and Weiss (1971).

In another study, Shelton, Lindquist, Knox, Wright, Arndt, Elbert, and Youngstrom (1971) designed a speech appliance so that one section or bulb could be removed and replaced by another. This permitted repeated study of three subjects under each condition used in the reduction program. Cine-fluorographic films were made before and after the obturation program while oral and nasal sound pressure levels and nasal air pressure were used as dependent variables. The latter three measures were sensitive to section conditions within an experimental session, but longitudinal comparisons were difficult to interpret because of measurement variability. The x-ray data suggested that one of the subjects developed movement of the posterior pharyngeal wall but only when wearing sections between the original bulb and later smaller sections or no appliance at all. The authors discussed a number of problems that confound the month-to-month observation of the individual undergoing speech bulb manipulation and indicated that, while they had worked to specify subject, treatment, and dependent variables precisely, future studies would have to do even better.

Bulb reduction is sometimes suggested as a method for improving a patient's chances of responding well to a secondary surgical procedure. However, this claim also needs investigation. Evidence must be sought to determine whether the treatment actually results in increased pharyngeal movements, whether movements acquired are maintained after surgery, whether persons who undergo bulb reduction prior to surgery have better speech prognoses than do similar patients who did not have obturator treatment, and in what type of patient changes are most likely to occur. As Shelton, Lindquist, Arndt, Elbert, and Youngstrom (1971) have noted, there is presently no proof that the treatment is effective. The feeling is that it is based largely upon observations that obturators sometimes have to be made smaller after a period of time because of increased movement in adjacent structures. If this happens, the reasons for it are still unclear, and the matter must be explored before clinical faith is placed in the system.

It is clear that investigations into obturator manipulation should continue only if tight experimental designs can be developed. Baseview cinefluorography, fiberoptic bundles, or some other means should be used to visualize closure directly before, during, and after the course of treatment. Research should be planned so that dual treatments such as obturator reduction and speech therapy do not confound the results.

Velopharyngeal Training and Exercise

Work published by Yules and Chase (1969) stimulated studies by Tash et al. (1971). Tash developed and tested a program intended to teach a subject to move his lateral and posterior pharyngeal walls during phonation. The program began with touch cues and progressed through a series of specific steps. Responses were documented by the experimenter and one other observer. Lateral cinefluorographic films were made before and after training, and pre- and posttreatment measures of fundamental frequency, jitter, and nasality were compared. Nasal pressure and oral and nasal sound levels were studied frequently throughout the study. The laryngeal voice observations were included because pilot work had indicated that similar training influenced perceived voice quality.

While the records of observers' counts of number of trials on which subjects produced movement of the lateral or posterior pharyngeal wall indicated that learning had taken place, the other measures were essentially negative. The cinefluorographic films showed little or no movement of the posterior pharyngeal wall. This is another instance where baseview cinefluorography would probably have provided more information. For one subject, the posttreatment cinefluorographic film showed marked elevation of the larynx and occlusion of the entire pharynx as he attempted to produce the pharyngeal wall movements. This may be further evidence of laryngeal compensations for valving deficits. Acoustical voice measures, however, showed no change; and judges could not differentiate between phonation with movements and phonation without movements. Shelton, Knox, Elbert, and Johnson (1970) and Shelton, Harris, Sholes, and Dooley (1970) also trained voluntary palate movements in several normal subjects. Their work, however, was not directed toward evaluation of therapeutic exercise, so there is still no evidence that the movements can be transferred to and integrated with the speech act nor is there information about possible hazards.

Peterson (in press), in a well-described study of palatal response to tactile and percutaneous electrical stimulation, has made a marked contribution in this area. She found no relationship between the degree of tactile stimuli and palatal elevation, and both normal and abnormal subjects showed only sporadic responses to tactile and electrical stimulation. There was marked variability within and among subjects, some showing no response to the stimuli used. This study illustrates once again the highly uncertain nature of velar and pharyngeal behavior.

Other writers have suggested palatal exercise of varying types. Morley (1970) feels that "simple exercises, practiced even for a few minutes daily, increase the rate of progress." Cole (1971) advises specific exercises used in conjunction with evaluational techniques designed to determine what actual progress is being made. It is his contention that, if the exercises are going to prove effective, they will do so within a three-month period.

Lubit and Larsen (1969, 1971) used a device to provide therapeutic

exercise to the palate and posterior wall of the pharynx. An inflatable bag was used to exert pressure against the palate and posterior pharyngeal wall. The authors have presented case materials indicating that patients had improved both their speech and palatopharyngeal closure. However, since no baseline or other control procedures are reported, it is not possible to credit the treatment with the improvement. Some of the differences in x rays could, for example, be attributed to error in the timing of the film exposures. In addition, Maxwell (1971) noted that two of the four subjects described by Lubit and Larson showed velopharyngeal openings during utterance of about 3 mm in sagittal section. Openings of this magnitude appear incompatible with normal articulation and voice, in light of present information. The device is, however, worthy of proper experimental testing in the future. If the procedure, precisely programmed and described, is effective, identification of the phenomena involved would be important along with data regarding the precise characteristics of subjects who can profit from the treatment. Consideration should also be given to the possible development of unwanted side effects.

More recently, Moller et al. (1973) taught a subject to make velar movements as they provided him with information acquired through the use of a transducer placed in contact with his velum. They concluded that, if velopharyngeal closure is to be improved through training, the subject will probably have to be given accurate information about his performance on a trial-by-trial basis. In addition, Powers and Starr (1974) administered therapeutic exercise to four persons thought to have velopharyngeal closure deficits. The treatments, which involved blowing, sucking, swallowing, and gagging, had no influence on ratings of nasality or on velopharyngeal closure as measured from cephalometric x rays of sustained /i/.

Shelton et al. (1968) recommended that speech clinicians rely on the surgeon or dentist to provide adequate mechanisms in patients with velopharyngeal incompetency. Only then would the speech clinician be in a position to work effectively. Since that time, a number of studies have looked at articulation therapy, speech appliance reduction, and palatal training or exercise as ways of developing velopharyngeal closure. To date, these methods are still experimental and essentially unproven. The foregoing recommendations must, therefore, stand until additional experimental work offers more definitive evidence to the contrary and is related to the degree of velopharyngeal incompetency.

ARTICULATION THERAPY

Van Demark (1966) reported that six factors account for the articulation errors found in cleft-palate children between five and 14 years of age. The two most prominent were related to velopharyngeal closure and maturation. Van Demark and Van Demark (1967) compared articulation errors of cleft-palate children achieving velopharyngeal closure and those of children with

functional articulation problems. They found that "when a child with a cleft palate achieves velopharyngeal closure, it is difficult to differentiate his speech from that of a child with a functional articulation disorder. Therapy, then, can be essentially the same for the two groups." This was also suggested by McWilliams (1958), who based her conclusions on the high incidence of inconsistent sound errors in cleft patients. She speculated, however, that sibilant errors appear less likely to yield to such therapy because they tend to occur with such high frequency and to be so highly consistent. Much articulation treatment research has been conducted in recent years. Some of this was reviewed by Wright (1969) and assessed by Bankston (1971). Much remains to be done, however, to determine possible unique parameters in cleft populations and to evaluate the effectiveness of articulation therapy with reference to specific conditions. Speech therapy for cleft-palate patients, however, has been developed largely through clinical experience. Approaches are described in Grabb et al. (1971), but only limited research has been carried out in this area. Chisum et al. (1969) reported that cleft-palate children receiving articulation therapy made greater articulation gains on the sounds taught than did cleft-palate children during a period when no therapy was provided. Presumably, the treatment was responsible for the improvement made.

Van Demark (1971a, b) reported the results of a series of articulation tests administered to cleft-palate subjects before and after articulation therapy. While therapy appeared effective, the thrust of the studies was toward the selection of measures for use in treatment research. The work supported the utility of a sentence articulation test developed earlier (Van Demark, 1964).

In the studies by Chisum et al. (1969) and by Van Demark (1971b), the speech therapy provided was not well defined, and the number of trials was not specified. The various activities were not counterbalanced. Consequently, the best that can be said is that the activities used appeared to result in improved scores on certain measures. We anticipate more precise evaluation of speech treatments for cleft-palate persons in the future. The problem is complicated by difficulty in obtaining large numbers of homogeneous subjects. Use of a single subject, repeated measures, or operant research can be expected to make contributions in this area. Moller et al. (1969) have used this methodology in a study of reduction of facial grimace. After Philips and Harrison (1969a) described articulatory and language skills in preschool children with clefts, Philips (1971) argued for speech therapy for young cleft children suggesting that they profit more from this training than do older children. Universal acceptance of this premise would result in costly services to many children who seem able to develop normally without it. However, since present knowledge makes it difficult to prognosticate with complete accuracy in individual cases, error in the direction of over-training would probably be less damaging than failing to provide needed therapy.

Those who have worked with cleft-palate patients over the years seem to agree that these patients are being served better now than they were 15

years ago. These gains probably reflect improvement in surgical and dental services and better delivery of care. However, speech services have improved too. Knowledge gained from speech science enables the clinician to focus his efforts where they will do the most good. Developments in the behavioral sciences have been applied in the speech clinic. Improvements in measurement and instrumentation have increased understanding of voice and articulation. Indeed, variables previously ignored are now dealt with. The speech pathologist is attempting to devise treatments, based on scientific literature, that should ultimately prove effective. The addition of empirical tests for treatment protocols should increase with time. Our growing understanding of anatomical and physiological limitations to the development of normal speech is leading to better therapeutic decision making. However, there is still truth in the statement that speech therapy is, after all, "only a poorly defined form of treatment that is not appropriate to all individuals who have disorders of communication even in the presence of cleft palate" (McWilliams, 1966).

LANGUAGE PROBLEMS

BETTY JANE McWILLIAMS

The systematic study of many different parameters of the speech profiles of children with cleft palates have led naturally to consideration of their language abilities as compared to those of children who have not experienced the broad ramifications of clefts. A portion of this work has been well reviewed by Shames and Rubin (1971). Smith (1971) also discusses speech and language with particular reference to psychosocial issues.

Spriestersbach, Darley, and Morris (1958) reported a reduction in mean sentence length with retardation in verbal output and vocabulary usage for cleft children. They did not find variations in the structural complexity of sentences. Bzoch (1959) presented evidence to show that more than 50% of his sample had "delayed" speech development. Morris (1962) found that children with clefts were less adequate than were their controls on the Ammons Picture Vocabulary Test, the Vocabulary Subtest of the Wechsler Intelligence Scale for Children, mean sentence length, structural complexity, variety of words, and articulation skills. Smith and McWilliams (1966) reported reduction on measures of creativity even when speech adequacy was not in question and when intelligence was held constant. Shames, Rubin, and Kramer (1966) also noted a significant lag in language usage in preschool children with clefts, but their data suggested that the deficiencies might not hold in older age groups. Smith and McWilliams (1968a, b) showed language deviations as measured by the Illinois Test of Psycholinguistic Abilities in young cleft-palate children. The depression they reported was of a generalized nature, but particular deficits were noted in vocal expression, gestural output, and visual memory. These deficits were not obliterated by increasing age. Ebert, McWilliams, and Woolf (1974) found no deficiencies in tests of written language skills when cleft children were compared with matched controls. Philips and Harrison (1969b) studied 137 children with palatal clefts ranging in age from 18 to 72 months. They found the cleft children reduced in language skills when compared to their controls. However, when they sought explanations for these deficiencies, they were unable to isolate particular variables which seemed causal in nature. These authors wondered if parents' failure to accept early distorted speech attempts might deprive their children of positive reinforcement thus limiting verbal development.

Faircloth and Faircloth (1971) suggest that there are two types of deviant

oral language in cleft children. They suggest that "the child who strives for articulophonetic accuracy reduces sentence length, word length, and sentence complexity." On the other hand, the child who "relies on language structure for intelligibility uses a wider variety of linguistic constructions." These conclusions are based upon 10 case studies, and the data are certainly not conclusive. In fact, the hypotheses would need to be tested across populations of cleft children representing varying degrees of speech proficiency. This is work which should be done, but, until it is, a cautious attitude is recommended. McWilliams (1970) suggested that too little is known about the origins of reduced language skills in children with clefts but that, since the deficits occur throughout the range of mental and speech abilities, we should perhaps be seeking explanations in the child's prelinguistic experiences. This also remains to be undertaken.

Hearing is only one area that must be explored. It is well established that infants and young children with cleft palates frequently have middle-ear disease and accompanying hearing problems of the conductive type (Stool and Randall, 1967; Stool, 1971; Paradise and Bluestone, 1969; Harrison and Philips, 1971). The reported incidence of such problems depends on the standards used to define hearing loss, the age of the children studied, and other variables. In general, the hearing losses demonstrated do not exceed 30 to 40 dB, they fluctuate in severity, and they tend to decrease in frequency after palatal repair and, again, after six to eight years of age. This almost universal problem must be viewed in relationship to other aspects of development, particularly language and general articulation proficiency. Little attention has been paid to this issue even in noncleft children. Holm and Kunze (1969) have initiated this line of inquiry in their comparison of 16 children with histories of fluctuating hearing loss with 16 matched controls on a variety of language and speech measures. Their results showed that the hearing-impaired children were significantly deficient in vocabulary, articulation, receptive and expressive language, grammar and syntax, and auditory memory. Saxman and Bless (1973) compared 60 cleft children and 60 noncleft children, all with normal hearing, on certain language measures and did not find significant differences between groups.

Overall, language skills appear somewhat reduced in children with palatal clefts. However, the deficits found thus far are not of major magnitude. The variations described must be viewed within the context of other parameters of development and must be related to eventual outcome. In short, it would be a mistake, on the basis of present information, to classify children with clefts as having significant language impairment. This is a promising area for investigation and one that should not be neglected in future research.

PSYCHOSOCIAL CONSIDERATIONS

BETTY JANE McWILLIAMS *and* ROBERT M. SMITH

Several comprehensive reviews of the literature on psychosocial dimensions of the cleft-palate condition, have appeared in recent years (Goodstein, 1960b; Matthews and Ohsberg, 1966; Spriestersbach and Sherman, 1968; McWilliams, 1970; Wirls, 1971; Clifford, 1973). The authors of these reviews express the common concern that extreme differences exist between the conclusions of clinicians and those resulting from empirical work, and that additional data are needed before these differences can be resolved. McWilliams (1970) has described the state of the art in these areas as "unsettled, unsure, and immature." At this point, it is impossible to confirm or deny the hypothesis that cleft-palate individuals, viewed collectively, experience an environment so extraordinary as to result in their becoming psychologically, socially, educationally, or vocationally exceptional. Those who believe that a cleft-palate person can be expected to be deleteriously affected in his psychological and social existence arrive at this conclusion by way of a series of assumptions based on inferences and clinical experience (Brophy, 1909; Baker and Smith, 1939; Ricketts, 1956; Cooper et al., 1960; Epstein, 1965; Johnson and Moeller, 1967). They suggest that it is only logical and natural that a child who experiences early surgery, some measure of cosmetic disfigurement, and sometimes less than normal speech, is a representative of a unique population with a peculiar psychological and social character. It is interesting and highly significant that these speculations are not generated from any systematic theoretical stance, which serves to highlight one of the major gaps in cleft-palate work that has focused on behavioral dimensions.

The 1960s might well be characterized as a time when behavioral specialists who were concerned with cleft-palate individuals gave attention to validating the clinical judgments so characteristic of earlier periods. Representatives from all of the disciplines who were concerned for patients with cleft palates contributed to this movement by behavioral scientists through their acknowledgment of the potential value of including a psychologist as a member of the cleft-palate team and by encouraging the support of more behavioral research in pertinent areas. One of the significant consequences of this movement has been a more rapid acceleration of behaviorally oriented research on the cleft-palate condition than was previously evidenced.

Although it has been only within the past 10 years that most of the sys-

tematic attempts have been made to research the various behavioral nuances of cleft palate, it was fairly early in that period that some disagreement surfaced between previous clinical characterizations of cleft-palate persons and new research findings. Data tended not to support the often involved nomological networks of cause-and-effect explanations that had been generated from clinical impressions.

The fact that clinical judgments and results from research tend not to agree can be interpreted in several ways. First, one can legitimately claim that clinicians have found psychological and social problems among groups of cleft-palate persons because they expected them to be there. In essence, they saw what they expected to see even though the range of maladaptive behaviors, which were observed, may not have been significantly disparate when compared to other populations. Second, the disagreement in conclusions may have resulted from failure to focus on the most pertinent psychosocial variables and from using evaluative devices possessing low validity and reliability. As Wirls (1971) has pointed out, this latter point is a common problem in personality research. Third, there may or may not be a unique pattern of psychological and social characteristics representative of cleft-palate children. Thus, the results of certain landmark studies may have been attributable to chance. Finally, the research designs used may have fostered or contributed to a sufficient magnitude of error to result in false or inconclusive findings.

In the early and middle 1960s, a multitude of studies were initiated on a full range of behavioral dimensions. Of course, the initial thrust of these studies was to try to describe the behavioral parameters of the condition and the environmental factors peculiar to the situation. Following the attainment of valid descriptors, behavioral scientists fully anticipated developing theoretical and empirical models which might permit accurate and reliable predictions of various advantageous and disadvantageous circumstances for the cleft-palate patient. The ultimate goal of this type of effort is to gain enough descriptive data and accurate predictors to begin controlling the environment to permit normal development from psychological and social perspectives. Unfortunately, the information that has emerged has not permitted the wise application of research findings in the clinical setting. In addition, clinicians and researchers disagree with themselves and with each other in most of the areas stressed in behavioral research.

PARENT ATTITUDES

As might be expected, considerable attention has been given to the parents of cleft children and to the assessment of the impact of the cleft in their lives. As McWilliams (1970) noted, the impact will depend upon the parents, how much of a threat a congenital anomaly in their baby is to their own egos, and the extent to which they have access to and can use various psychological coping mechanisms. These vast individual differences may well ex-

plain why studies directed toward the measurement of impact per se have yielded inconclusive information. Yet, clinicians continue to feel that grief (Solnit, 1961; Tisza and Gumpertz, 1962) over the loss of a perfect baby is an emotion almost universally shared by parents of babies with malformations. Associated with this grief, many writers (Wishik, 1951; Kinnis, 1954; MacCollum and Richardson, 1954; McDonald, 1954, 1956, 1959; Lillywhite, 1957, 1958; Thurston, 1959; Spriestersbach, 1961b, 1973; Sleeter, 1965; Irwin and McWilliams, 1973) believe, are negative feelings of varying degrees toward the imperfect baby whom they must nurture and love. In addition, even folklore (Crocker and Crocker, 1970) probably contributes to certain attitudes not always easy to interpret. Studies to date have not been successful in identifying parental responses which seem appropriate to the situation and which fall within normal limits as opposed to those which represent pathological patterns. So many studies have been retrospective in nature that valuable information has probably been unavailable to researchers.

The meager data reported, however, provide some insights that should be helpful in plotting future research strategies. Norval, Larson, and Parshall (1964) suggested, from their comparison of low- and high-stress families, that emotional trauma may be greater for younger than for older parents and for families with fewer children. They agree with Spriestersbach (1961a, 1973) that the extent of the deformity is also a probable factor in the degree of stress experienced with more severe abnormalities being associated with greater parental stress. These findings are supported by Clifford (1969a) who found that parents rate a cleft lip and palate as a more severe problem than they do either cleft lip or cleft palate in isolation as well as by Slutsky (1969) and Spriestersbach (1973).

Most recently, Clifford and Crocker (1971) compared mothers of cleft and noncleft babies on a number of parameters including marital, sexual, and self-satisfaction prior to and following the birth of their babies. There were few real differences in the two groups of women, but the mothers of cleft babies perceived fewer positive and more negative changes in themselves than did the mothers of normal babies. In addition, there was evidence to suggest that having a cleft child is to experience shock and that the degree of shock may relate to the extent of the deformity and to the amount of time that elapses before the mother sees her baby. This study points to the need for investigations carried out at and immediately following birth and for studies that will attempt to assess the role of professional management in these first crucial hours.

There is little doubt but that experiences and feelings in the new-born period help to determine how parents will handle the problems they encounter after the child leaves the hospital and, perhaps, later in his life. Clinicians certainly subscribe to the view that parental attitudes are closely tied to the manner in which the child learns to perceive himself. Backus et al. (1943) went so far as to suggest that "when parents are well adjusted to having a child who has a cleft palate, the child himself will be adjusted and

happy." This is undoubtedly too simplistic a view of the human condition, but it serves to underscore the vital role clinicians consistently believe parents play. Alpert (1959) used a case study to illustrate this important relationship. MacGregor et al. (1953) reported that "the single most important factor in the genesis of maladjustment in cases of facial deformity in childhood is parental behavior influenced by 'other' life aspects." Bleiberg and Leubling (1970) have shown parental attitudes probably do directly influence the manner in which they carry out recommendations made by cleft-palate care centers.

Again, the clinical feeling is that parental attitudes are significant in the lives of children with clefts, and some clinicians persist in their belief that the parents of cleft children constitute a high-risk group so far as negative attitudes and adjustment patterns are concerned. However, this has never been demonstrated, and it remains an area of discomfort for both clinicians and researchers. Goodstein (1960a, b) studied mothers and fathers of cleft and noncleft children by means of the Minnesota Multiphasic Personality Inventory (MMPI). The parents of cleft children tended to show somewhat more anxiety than did their controls and the parents of older children with clefts seemed more poorly adjusted than the parents of younger children. It is possible that the parents' anxiety levels paralleled those of their children and that older children with clefts experience greater life problems than do younger children. This latter area has a high priority for future research. On the other hand, it may be that children are now receiving better care than formerly. Perhaps the parents of these younger children will never experience the feelings of anxiety reported by the parents Goodstein studied 13 years ago.

It is not possible from information now available about the parents of children with clefts to determine what the influence of the cleft condition has been in their lives. Neither is it possible to state with certainty how the attitudes of parents have influenced the lives of their children. Goodstein (1968) concludes his consideration of this topic with the statement that "present evidence suggests that most of these parents, despite the presence in the children of a rather obvious physical disability, are generally well adjusted and able to provide adequate support for their developing children." McWilliams (1970), on the other hand, from a review of essentially the same publications, concluded that efforts to understand the problems of parents have been somewhat naive and that there has been a tendency to forget or to ignore the dynamics of the parents as people operating within a social structure and with historic roots which predate the birth of a defective child. It is, therefore, unrealistic to expect that disfigured offspring will be accepted and assimilated into their lives according to a measurable and predictable response scheme. So far as parents are concerned, they must be viewed as people with common, uncommon problems in a sometimes hostile and repressive environment. In short, the facial disfigurement becomes a condition of stress with which they deal as effectively or ineffectively as they handle stress

in general and this problem in particular. Perhaps studies of child rearing practices, parent-child interaction, and child-sibling relationships viewed from a behavioral stance would help to answer today's questions, which are not basically different from those posed 10 years ago.

THE INFANT WITH A CLEFT

An infant with cleft palate probably experiences many traumatic events early in life which are poorly understood both in terms of the precise nature of these events and in terms of their life implications. Still in question is the role of the parents as they seek to provide comfort, relief, and support in the presence of less than satisfactory feeding experiences; the discomfort related to ear disease or its treatment; often frequent and massive clinical invasion; early hospitalization; and unpredictable responses from family, friends, and curious strangers. Certainly the parent as a person, his child rearing practices, and the attitudes previously discussed will be of relevance here, but the child himself will also play a major role. Perhaps relatively poor parents can provide enough nurture for a sturdy baby who does not encounter developmental problems. On the other hand, even strong, supportive parents interacting with a difficult baby may encounter problems almost beyond the scope of their powers—problems that could end disastrously for families less well endowed. We know essentially nothing about these very early experiences and their influence upon future growth and development. Retrospective studies have failed to provide information useful in modifying clinical practice. We still do not know much about feeding problems and how they can best be overcome. We have not even considered age of surgery in the light of parental and infant behavioral responses. We do not know whether parents whose concern is for themselves rather than for their baby actually behave differently from parents whose anxiety is first for their infant. Clinically, we cannot always tell the difference. This is an area of investigation that must be developed in the years to come. It is worth the investment in time, money, and creative, innovative programming to look carefully at these early months in an effort to learn how we may best minimize the effects of the handicap.

PATIENT ATTITUDES

Information about the adjustment patterns of children, adolescents, and adults with clefts has not been significantly expanded since the publication of the comprehensive reviews referred to earlier. The bulk of the studies undertaken (Birch, 1952; Sidney and Matthews, 1956; Goodstein, 1961; Clifford, 1967, 1969b) do not support the often repeated clinical contention that cleft patients suffer from psychological distress more frequently and more intensely than do their noncleft peers. The summed impressions from this body of literature led Goodstein (1968) to say:

Indeed the informal observational impression suggests that the typical adult with

cleft palate is happily married, gainfully employed, and a generally, useful, contributing member of society.

In spite of evidence like that noted above, clinicians continue to be aware that individuals with clefts often fail to conform to the happy picture that seems to emerge from Goodstein's findings. Certainly, the astute clinician will be aware of the need for psychosocial assessment as a part of clinical management and will take steps to assure that this aspect of care is available. In addition, the researcher will continue to seek answers in this area, perhaps using innovative designs and looking to cleft subgroups for more highly refined information.

Tisza, Irwin, and Zabarenko (1969) used an innovative approach when they evaluated the dramatic play of young cleft children. They found that the children expressed fantasies of unusual depth and intensity involving oral aggression and incorporation. In addition, the children seemed to fear maternal rejection and recognized that even submission to surgery did not guarantee acceptance. The children also appeared to suffer conflict between active-aggressive and passive wishes. On the other hand, they repeatedly demonstrated their ability to act out painful experiences and then "cross the bridge back to reality." In other words, these authors see cleft children as having come to terms with their life situations but, nevertheless, retaining the scars of conflict. It would not be surprising if such children, on more superficial personality tests or attitudinal scales, appeared much like other children. This possibility points up the need for better tools of assessment.

McWilliams and Musgrave (1966) compared cleft children with completely normal speech, cleft children with normal voice quality but with articulation disorders, and cleft children with hypernasality and related speech problems on a number of behavioral characteristics. The children with normal speech had significantly fewer behavior problems than the group who spoke poorly but had no hypernasality. Bad temper and enuresis were typical of the latter group, and the presence of bad temper was usually associated with a significantly increased number of other behavior problems. These results suggest that research designs must begin to consider subsamples within the cleft population and that studying the total group may obscure differences and lead to false conclusions.

Wirls and Plotkin (1971) have contributed the most recent information on this subject. They compared 32 cleft-palate only and 34 cleft-lip and cleft-palate children between the ages of seven and 14 with an equal number of noncleft siblings within the same age range on several projective techniques. These included the Draw a Person, the Kahn Test of Symbol Arrangement, the Thematic Apperception Test (TAT), and the Rorschach. In most cases, significant differences were either not found or could have been accounted for by chance. However, on the TAT, there were three significant differences at the 0.02 level, all of them between the palate-only group and their siblings. The palate-only group significantly more often projected themselves into the story; perceived characters as neglectful, rejecting, or hateful; and told more

negative stories. The major value of this work is the authors' careful discussion of factors which might have influenced their results. For example, they speculate about the influence of a cleft child upon the family patterns of interaction and about the possibility that the siblings may not be typical of other children. While they largely reject these ideas, they nevertheless raise relevant issues which should be investigated in the future.

A careful appraisal of what we now know about the attitudes and personality characteristics of children and adults with clefts suggests that we are not much further along in our understanding than we were when clinically oriented articles, based upon observation and experience, constituted the major portion of the literature. Research in this area has been plagued by problems of sampling, subgroup classification, inadequate controls, measuring instruments too gross for the task, and lack of appropriate normative information. In addition, we have passed through an era when it seemed necessary to test people and then look for differences in their response patterns as compared to those of noncleft individuals. It would, perhaps, be more fruitful in the future to worry less about such allusive concepts as self-image, attitudes, and feelings which are difficult, at best, to assess and address ourselves instead to observations of behavior which can be quantified and compared within and among different groups.

INTELLIGENCE

Many studies over a number of years (Billig, 1951; Irwin and Means, 1954; Munson and May, 1955; Illingsworth and Bush, 1956; Goodstein, 1961; Lewis, 1961; Drillien, Ingram, and Wilkinson, 1966) have strongly suggested that cleft children, as a group, tend to have mean IQs somewhat lower than the population mean. However, none of the studies has suggested that intelligence is a problem of major magnitude. Rather, there has seemed to be a slight displacement of mean and median IQ toward the lower end of average for the population. Few studies have attempted to look at mental development in cleft children as a function of age, type of cleft, success or failure of physical management, and other variables of a similar nature. The few studies that have made such attempts have arrived at rather different interpretations of data.

Ruess (1965) compared 49 children with clefts with their nearest-age noncleft siblings. While the cleft children were significantly lower in verbal and full-scale WISC IQs than their siblings, there were no real differences between the two groups in performance IQs, reading and spelling skills, figure drawings, and school progress. This study suggests that cleft children, at least those in this study, may have increased difficulty handling the verbal demands of the WISC and indicates a need to learn why and under what circumstances such problems occur.

McWilliams and Musgrave (1966) studied 168 children with clefts divided into three groups on the basis of speech adequacy. Children with normal

speech and those with normal voice quality accompanied by consonant articulation errors were comparable with mean Binet IQs of 109 and 108, respectively, and mean WISC IQs of 104 and 105, respectively. However, children with hypernasal speech had a mean Binet IQ of only 97, a statistically significant difference. While differences on the WISC fell short of significance, the trend was the same.

In a more recent study (Paradise et al., 1972), preschool children who had had active ear care from birth did not show reduction in mental functioning as measured by the Stanford-Binet. In fact, the mean IQ was displaced toward the high end of the population mean. This study suggests that the mild intellectual depression heretofore reported as characteristic of children with clefts may in reality reflect other variables which influence mental functioning within limits. Future investigations should seek explanations for differences which may exist between well-described and specific cleft and noncleft groups rather than continue the descriptive types of studies characteristic of the past.

SCHOOL PROGRESS

As noted in the section on intelligence, Ruess (1965) failed to find differences in cleft children and their siblings in reading and spelling skills and school progress. Demb and Ruess (1967) reported that the high school dropout rate for 64 cleft subjects was 25% but that it was 42% for their siblings. McWilliams and Paradise (1973), however, found that when cleft and noncleft siblings drop out of high school, the cleft subjects do so earlier. However, at the upper end of the educational continuum, there appeared to be no difference between groups. Thus far, no studies have attempted to assess actual school behavior throughout the grade range in an effort to describe differences that may exist, where they occur, how they change with time, and what the eventual outcome is. We do not know, for example, whether young children with clefts, thought to be somewhat immature socially (Goodstein, 1961), experience special problems in early school adjustment, achievement, and progress. Neither do we know very much about the adolescent in his educational milieu. School issues are undoubtedly not a unique area for investigation but may constitute part of a larger concern for information about adjustment to and within various social structures. In addition, it is probable that the person with a cleft takes his place in school, and ultimately in society, according to some scheme that should be predictable because of his physical defect. For example, the average person with a cleft probably does better in life than does the average spastic quadriplegic. On the other hand, he may do less well in some ways than does the average individual with no handicap, and he may or may not be similar in certain respects to the average diabetic, cardiac patient, or asthmatic. However, we know very little about this kind of ordering within the school structure, or, indeed, within society. These may well be corrective measures that should be applied to certain of our educational and social systems. Exactly what problems cleft individuals experience in society

must be defined before programs of change are planned. We have alluded to the need for research in relationship to specific problems of adolescents and adults. Actually, the status of this group of cleft subjects is largely unexplored in all areas.

ADOLESCENT AND ADULT PROBLEMS

Some clinicians continue to feel that adolescents and young adults with clefts are less mature in social interaction with their peers than in self-help, responsibility at home, freedom to move about the community, or driving a car. There is a suspicion that they do not date as early or as frequently as their peers (Van Demark and Van Demark, 1970), that they probably marry later (McWilliams and Paradise, 1973), that they may cling longer to organized activity such as church groups, that they may be less verbal with their peers than their peers are with each other, that they may have somewhat different friendship patterns, and that they may be somewhat less "avant-garde" and less likely to take chances with new and untried behavior than are many other young people. Van Demark and Van Demark (1970) also felt that their subjects tended to be observers of life rather than participants and that they had somewhat unrealistic vocational goals. However, such impressions are not shared equally among clinicians and researchers, and no one can attest to their accuracy. Neither can anyone say with certainty what the eventual employment and economic outcome is for cleft patients. Are people with clefts found in top managerial posts? If they are, does it matter what kind of speech they have or how they look? How do professional schools look upon accepting students with clefts? Do any apply? If they do, does anyone care about their appearance or speech? What income levels are reached by people with clefts? When they marry, how prolific are they and why? Are they worried about poor genes? What are their marital weaknesses and strengths? What illnesses do they suffer in adult life and how do they respond to them? Are they really any more or less contented than their peers? How do they view the cleft, and what role do they think it plays in their lives?

SOCIAL ISSUES

McWilliams (1970) reviewed literature relating to social attitudes toward individuals with facial disfigurement. Such information is limited, and there is little or nothing relating to the cleft population who may suffer from facial disfigurement, disorders of communication, both, or neither of these conditions. Thus far, most research efforts have been directed primarily to the person with a cleft. Little attention has been paid to the society in which he must move. It is just possible that society may create pressures which it then minimizes and denies so that the person with a cleft, or handicapped people in general, experience the subtle and not so subtle forms of discrimination which majorities practice against minorities. It is time for research to be directed toward

social groups and structures to assess their impact on the lives of people who do not conform easily and comfortably to the master plan and to the subpatterns which society has decreed for its members. If the person with a cleft is required to cope with malattitudes such as prejudice, ridicule, pity, and, more particularly, the overt behaviors likely to accompany these attitudes, the clinician is failing in his responsibility if he does not present an accurate picture of the real world but leaves the ultimate outcome to chance, thus joining society in a massive denial of truth and helping to increase isolation and despair for the patient. Information in this vitally important area must be expanded.

Without question, future research on the behavioral aspects of cleft palate must be designed to deal effectively with problems of validity. Continuing to conduct research that is faulty in design and lacking in the basic rudiments of proper scientific methodology not only renders the results questionable but may serve to mislead the professional community into believing that cleft-palate individuals are or are not of a certain character when, in fact, the evidence for such conclusions is insufficient. The use of statistical tools cannot overcome the problems that are the natural result of weak experimental designs. Behavioral research is difficult, time-consuming, and seemingly almost impossible to design so that population samples are appropriate, biases in samples are known, and variables that make a difference are controlled. However, these precautions must be taken to assure that new and better methods for answering questions are sought and then cast into sound experimental designs.

It is crucial that future research in the psychology and sociology of cleft palate be directed toward (1) determining the behavioral characteristics of the various populations of cleft-palate children, adolescents, and adults and (2) providing a detailed portrait of the environmental correlates of whatever unique behaviors may be discovered. This latter point is important because it focuses upon phenomena that are observable. Information of this type would help to dispel our present dilemma of having many possible explanations which defy empirical validation and which in no way lead to the development or rearrangement of medical and behavioral programs of management.

Wirts (1971) has commented that research attention needs to be directed toward the reasons that investigators have not found many differences between cleft and non-cleft subjects as well as toward further investigations of differences which may exist. Not until we have the courage to admit that we still know very little, have faulty methodologies, and cannot afford to go on asking the same old questions will we be able to direct our research toward more fruitful investigations.

RESEARCH STRATEGIES

HUGHLETT L. MORRIS, BETTY JANE McWILLIAMS, *and* RALPH L. SHELTON

One major purpose of this report is to facilitate the delineation and design of future research projects. Many times throughout this discussion reference has been made to the need for more rigorous studies and for attention to the details of research design. It seems appropriate, therefore, to include here some comments about research requirements as we see them.

There are several characteristics of the so-called cleft-palate problem that cause particular difficulty in design development. Some of these are characteristics of the cleft-palate population; others relate to the nature of the sample and to the kind of problem to be investigated. This concept is certainly not new (Spriestersbach, Moll, and Morris, 1961, 1964), but the implications for research design are so important that it bears repeating here. There are crucial differences with respect to communication skills and psychosocial well-being among cleft-palate subgroups categorized according to cleft type, extent of other craniofacial impairment, type of management, age of management, age of examination, cultural heritage, physiological requisites for speech, and a multitude of environmental factors. The heterogeneity of the cleft-palate population makes it necessary to look for interactions among variables before any cause-and-effect relationships can be specified. For example, to assess the relationship between a certain surgical procedure and the resulting velopharyngeal competence, the variable of age at surgery should be controlled, or at least examined, for optimal interpretation of results.

On the other hand, it would be ridiculous to generalize about results achieved through a particular surgical procedure in the hands of a single surgeon who uses it to repair only simple clefts while patients with more severe problems are treated with obturators. In the same way, relating dental status of cleft-palate speakers to adequacy of sibilant production is almost impossible unless only speakers with velopharyngeal competence are used. This latter criterion is difficult to meet when one remembers the uncertainty existing relative to adequacy and the unique problems posed by those patients who seem to have borderline velopharyngeal competence. This discussion is directed, of course, toward a consideration of population and sample.

The incidence of cleft lip and palate is about one in every 500 to 800 births, depending upon the study quoted. This means that research about the birth defect can be undertaken only in relatively large health science centers,

which serve large patient populations. This factor, combined with the problem of heterogeneity, frequently makes it difficult for the researcher in a small center to conduct research. On the other hand, large centers may be limited by the high levels of patient care which they were created to provide. One center probably cannot, alone, have a sufficiently representative case load to make generalizations. For example, one of the authors of this report has not heard glottal stops with enough frequency to consider them at all characteristic of the cleft-palate condition or to have access to a study population. Psychosocial studies, given such biases, become difficult to interpret and may be meaningless except for one specific situation. This kind of sample bias may point also to the obvious fact that cleft children are being subjected to care ranging from most to least expert and that serious studies in the delivery of services must be undertaken.

Population and *sample* are used here in the statistical sense. The population is the larger group about whom generalizations are to be made. The sample is the group of subjects drawn from the population for study. Drillien et al. (1966) present an excellent discussion of population and population samples in cleft-palate research. Another example of such coverage is Morris (in preparation).

Careful attention must be given to the specification of population and sample because of the great heterogeneity in the total group. Control of this heterogeneity is essential to producing data which can be interpreted accurately and generalized appropriately. Spriestersbach et al. (1961, 1964) have presented examples of subgroups that might be considered.

Another important issue in the selection of subjects is the need for a selection process that will assure that subjects with good results and those with poor results will be included in the sample. One method for counteracting a bias of this sort is to study a series of patients. Another is to ask a disinterested person to select the sample randomly or even to conduct the entire evaluational project. Previous investigations have frequently ignored this kind of rigor in research design, and this cannot be condoned in the future.

THE INFLUENCE OF MATURATION AND TREATMENT ON THE "CLEFT-PALATE PROBLEM"

Like many health problems that affect children, the status of the cleft-palate disorder frequently changes with maturation and clearly changes with treatment. Research designed to study the impact of the birth defect on the individual in terms of speech or psychosocial parameters must be formulated in such a way that longitudinal aspects of the disorder can be accounted for. In a sense, because there is such variation in the scope of the problem over the period of years from birth to adulthood, all research observations should be accompanied by information which identifies the status of the patient along the maturation and treatment continua. For example, the effects of cleft-lip surgery cannot be fully evaluated until the patient is a young adult; cleft-

palate surgery cannot be assessed accurately until the patient is seven or eight years of age; and the final, overall outcome cannot be determined until the patient has taken his place in society and has begun to function as a total human being.

SOME SUGGESTED METHODOLOGIES

The problems referred to above call for the consideration of some specific research methodologies in addition to the usual kinds of project designs. While no one of the methods described below is satisfactory for all research questions, each has some distinct advantages.

Data Banks

Arrangements for the centralized storage of data with convenient retrieval procedures have been considered and used in conducting research programs in many fields. The data bank has the clear advantage of allowing researchers to pool data over time and population samples so that an appropriate number of subjects or other units for study can be accumulated for a specific project. This kind of procedure is particularly appealing in the case of cleft-palate research because of the relative infrequency of the defect and because of the heterogeneity of the population.

There are many problems in establishing such data collections, however, and to date few such efforts seem totally successful. Major problems have to do with specifying the observations to be stored so that the data will be useful for a variety of purposes. Related to that requirement is the additional one that there must be sufficient specificity in the observations so that appropriate subgroups of the population can be identified for study. In addition, the observations must be reliable over time and among data "bankers."

Although there are no easy solutions to these and other problems in connection with data banks, several guidelines can be suggested for establishing such data collections which may enhance their usefulness.

1. Data banks may be more productive if they are mission-oriented rather than open-ended. Creating a data bank that is only a repository for a number of observations and assuming that the data will eventually be useful for answering a variety of unidentified questions is not recommended. A better approach is to design a data bank for one purpose or set of related purposes that are formulated at the initiation of the project.
2. For maximal usefulness and reliability of the data, the observations to be stored should be descriptive or documental in nature, not evaluative or judgmental. Descriptive data can be used for a greater variety of purposes and can have greater reliability than data involving judgments about specific phenomena. For example, high fidelity tape recordings of articulation test responses are preferable to information about articulation test scores. Also, edited tape-recorded samples of connected speech (from which psy-

chological scale values of various aspects of speech can be derived) are preferable to clinical judgments of articulation defectiveness, hypernasality, and so on. Also, copies of cephalograms are preferable to specific measures of velopharyngeal opening or clinical judgments of velopharyngeal status. This is true even though such measurements and judgments must eventually be made.

3. Considerable attention must be given to the methods used for making the observations to be stored in a data bank. For example, if instrumentation is involved, the same instrument should be used throughout the project, or if different instruments are used, they should be calibrated carefully. In the same way, procedures not requiring instrumentation must be specified carefully. All contributors to the data bank must agree to use the same procedures, and a system must be established for monitoring the use of the standardized procedures.
4. Procedures for storing the data, methods for retrieving the data, and a system for establishing a protocol for using the data must be established clearly before the data bank is initiated. Experience has shown that, with few exceptions, clinical records are not maintained with the rigor required for the collection of data to be used in research. Maintaining a detailed and somewhat separate record-keeping system for the data bank is expensive even for only one institution. If more than one institution is involved, federal financial support would surely be needed.

Small Sample Research

Many questions can be researched meaningfully using small numbers of subjects. In general, these questions concern the relationships between variables under specific conditions. With some exceptions, these are not questions of what is typical of the cleft-palate population. Instead, specific, well-delineated, structured questions are asked. An example might be, "What patterns of lingual movement and posture do selected subjects with velopharyngeal incompetence use during specific speech tasks?" and "How do those patterns differ from those of normal subjects selected by a highly specific set of criteria?" This line of attack has special relevance in the evaluation of various therapeutic procedures administered to carefully selected subjects demonstrating precise and well-defined clinical characteristics.

Longitudinal Studies

Some aspects of the cleft-palate problem can be studied more effectively by observation of the subjects over a period of years rather than by so-called cross-sectional or time-limited studies. For such research missions, longitudinal projects are needed. In essence, longitudinal projects probably require the use of a data bank established for a single group of patients. Hence, the prior discussion about data banks is relevant here. One important consideration in conducting a longitudinal study is the need to secure the cooperation of a

sufficient number of patients over the required period of time. Without commitment on the part of patients and their families, the data will be sketchy and uneven in quantity and quality and the results difficult to interpret. Collaborative projects planned and executed by several institutions working jointly would help to assure subject numbers and might aid in the identification of hidden variables and bias in particular samples.

CONCLUSIONS

Cleft-palate research carried out during the past 25 years has often been of a descriptive nature. This is understandable when it is remembered that the work was executed by concerned clinicians who sought to establish the parameters of the problem and thus to influence patient care. There can be little doubt about the success of their efforts. The cleft patient is no longer destined at birth to speak poorly, to suffer from severe facial deformity, to be subjected to countless surgical procedures which often rendered his situation increasingly hopeless, and to suffer from associated problems which went unattended. Research has increased substantially his chances for normal speech, minimized the risks of facial disfigurement, reduced significantly the number of surgical procedures while improving their quality, and offered him help with related health hazards. However, if further progress is to be made, it must be recognized that the research approaches of the past are no longer appropriate and that new directions and methodologies must be developed. The future demands projects that are both well defined and mission-oriented but that seek also to discover the ways in which many variables act together to influence the clinical results. This kind of research is difficult and demanding. First, the right questions must be asked. Then, projects must be designed so that resulting data are meaningful and can be appropriately interpreted, generalized, and applied. The future will be a demanding time for researchers in cleft palate. However, if the challenges can be met with imagination, creativity, and solid insights derived from the past, it should also be a time of rapid informational expansion and of increasingly better care and outcome for the person with cleft palate.

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