A PRIMER ON LIMB PROSTHETICS

ABOUT THE AUTHOR

A. Bennett Wilson Jr. is a mechanical engineer who joined the staff of the National Academy of Sciences in 1949 to assist in the development and coordination of a nationwide research and development program in artificial limbs. He served as Executive Director of the Committee on Prosthetics Research and Development of the NAS, as the program came to be known, from 1960-1975. He is a founding member and fellow of the International Society for Prosthetics and Orthotics and also a founding member of Technical Committee 168 (Limb Prosthetics and Orthotics of the International Standards Organization). Mr. Wilson was involved in initiation of current education programs in prosthetics and orthotics and in the introduction of many new devices and techniques in the field of physical rehabilitation.

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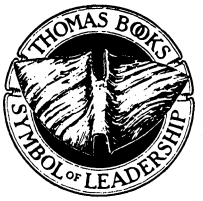

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FOREWORD

The purpose of this book is stated clearly in the Preface and amply fulfilled by the author. Through a long and honored association with the field of prosthetics and orthotics, Ben Wilson has worked to shape events and to better the lot of the patients served. This vantage point has given him the opportunity to observe events and developments. He has shared the results with the reader in a clear and lucid style.

The intended audience should find this book of tremendous assistance in understanding a field that is oftentimes portrayed in a confused and sensationalized fashion by the popular media and frequently glossed over in most professional courses of study. Such an understanding of prosthetics should be of value in mutual communication and in serving the needs of the patients involved. This can be of the greatest benefit to everyone, particularly in an era when changes in health care funding and management place ever-greater demands on the people in the system for more cooperation and better communication

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PREFACE

This purpose of this small volume is to provide entry level prosthetists, physical therapists, occupational therapists, physiatrists, orthopaedic surgeons, rehabilitation counselors, medical administrators and others with a basic knowledge of the current state of the art in providing amputees with artificial limbs. The field of prosthetics, like other technical fields, changes through the years, sometimes rapidly, but usually gradually. The information in this book is as current as possible. Trends are noted where applicable, but mention of any current fads have been avoided in order not to risk misleading the reader. References are provided for those who desire to extend their education in the field.

The nomenclature for amputation levels and limb prostheses that has been adopted by the International Standards Organization in recent years is used throughout the text.

Over the past decade it has become fashionable in the U.S. to use the term "residual limb" exclusively in place of "stump," because, it is claimed, patients are repelled by the word "stump." This might be so in the current atmosphere of super sensitivity and "political correctness", but the use of "residual limb" in place of "stump" is ambiguous since the term "residual limb," taken literally, refers to an intact contralateral limb rather than the residual, or remaining, *part* of an amputated limb. A synonym for "stump" would be quite acceptable, provided that it was not awkward to use and did not allow for confusion in communication. It should be noted also that "residual limb" has not been adopted by the International Standards Organization in their effort to develop a nomenclature that is unambiguous, although a serious search was made for an appropriate substitute for "stump."

For these reasons we have made no effort to avoid the use of the word "stump." This book is intended for clinicians, not patients. Clinicians who wish to avoid the use of "stump" in oral communication with patients can partially overcome the problem of ambiguity by

pointing to the stump and referring to it as "limb," "leg," "arm," "affected side," or the like.

Many people have supported this endeavor, but I want especially to express my appreciation to Charles Pritham who carefully reviewed the entire manuscript for accuracy and clarity and and made many useful suggestions, and John Michael who helped in the same way with the sections on feet and knees. I am grateful to all of the manufacturers who graciously assisted in the development of the illustrations, and to Michael Payne Thomas for his encouragement and assistance throughout the process.

A.Bennett Wilson, Jr.

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INTRODUCTION

Loss of limb has been a problem as long as man has been in existence. Even some prehistoric individuals must have survived crushing injuries resulting in amputation, and certainly some children were born with deformed limbs, with effect equivalent to amputation. In 1958, the Smithsonian Institution reported the discovery of a skull dating back to about 45,000 years of a person who, it was deduced, must have been an arm amputee because of the way his teeth had been used to compensate for lack of an upper limb. Leg amputees must have compensated partly for loss of function by the use of crude crutches and, in some instances, by the use of a peg leg fashioned from a forked stick or a tree branch

The earliest known record of a prosthesis being used by man is in Herodotus' *History*, written about 480 B.C., in which he reports that a Persian soldier by the name of Hegesistratus escaped from imprisonment in stocks by cutting off part of his foot, and that it was replaced later with a wooden prosthesis. Although the history of the development of amputation surgery and artificial limbs is a fascinating subject, it will not be treated here since it has been covered in detail elsewhere (1,41,60,61) and is readily available to the interested reader.

THE AMPUTEE

Generally, with proper care, the individual who has lost part or all of a limb can return to a useful and virtually normal life. Amputees can be found in nearly every occupation. This is not to say that every amputee enjoys unlimited opportunity, but when the proper surgical techniques are employed and when the best methods and devices are used in providing the artificial limb, or prosthesis, the amputee without other complicating disabilities can participate in most of his or her previous activities.

The key to successful rehabilitation is in the hands of the surgeon, the physiatrist (doctor of physical medicine and rehabilitation), the therapists, the prosthetist, and often the vocational rehabilitation specialist, but the degree of success is necessarily limited by the characteristics of the amputation stump. Today, every healthy stump, regardless of the level of amputation, can be fitted successfully and, in general, the lower the level of the amputation, the more functional is the stump, and thus, the individual with his prosthesis.

CAUSES OF AMPUTATION

Amputation may be the result of an accident, or it may be a lifesaving measure to arrest a disease or infection. A small but significant percentage of individuals are born without a limb or limbs or with defective limbs that either require amputation or treatment as if they were true amputees.

Accidents

In some accidents, part or all of the limb may be removed completely because of the accident itself. In other cases, the limb may be

crushed to such an extent that it is impossible to restore blood supply sufficient for healing. Sometimes, broken bones cannot be made to heal, and amputation is necessary. Accidents that cause a disruption in the nervous system and paralysis in a limb may also be cause for amputation, even though the limb itself is not injured. The object of amputation in such a case is to improve function by substituting an artificial limb for a completely useless, though otherwise healthy member. Amputation of paralyzed limbs is not performed very often, but has in some cases, proven to be very beneficial. Accidents involving automobiles, farm machinery, and firearms seem to account for most traumatic amputations. Frostbite, electrical burns, and the misuse of power tools also account for many amputations.

Improved medical and surgical procedures introduced in recent years have resulted in the preservation of many limbs that would have been amputated in earlier times. Newer methods of vessel and nerve suturing make it possible to save limbs that would have had to be amputated some years ago. Highly qualified surgical teams have demonstrated that it is possible to replace a completely severed limb when ideal circumstances are present.

Disease

Diseases that may make amputation necessary fall into one of three main categories:

1. Vascular, or circulatory, disorders
2. Cancer
3. Infection

The diseases that cause circulatory problems most often are arteriosclerosis, or hardening of the arteries, diabetes mellitus, and Buerger's disease. In these cases, not enough blood is circulated through the limb to permit body cells to replace themselves, and unless the limb or part of it is removed, the patient cannot be expected to live very long. In nearly all of these cases, the leg is affected because it is the member of the body farthest from the heart, and thus the blood pressure in the leg is less than in any other part of the body. Vascular disorders are, of course, much more prevalent among older persons. Considerable research is being undertaken to determine the causes of vascular disorders so that amputation for these reasons may at least be reduced if not eliminated; however, at the present time, vas-