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DAVID E. GOLDMAN, *Captain*, Medical Service Corps, United States Navy

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I. INTRODUCTION

D. E. Goldman

The material presented in this volume represents an attempt to provide the scientific and military communities with a panoramic view of the research activities of the Naval Medical Research Institute (NMRI) over its first 20 years of existence. These activities have dealt with a wide variety of basic and applied problems and have been related to many facets of naval medicine. They have involved many scientific, clinical, and technical areas and have also involved collaboration with other laboratories, field installations, and fleet units. Complete coverage of the work done is impossible, partly because over the years there have been changes in emphasis and turnover of personnel and partly because of the difficulty in following a problem from its laboratory aspects through to its application in the field. Some areas of research have, therefore, been reviewed in some detail; others have been chronicled and still others merely listed. Certain areas have had to be omitted for one reason or another. The material is largely in the form of scientific reviews, but distributed throughout are examples of applied research and of the development of procedures for preventive and therapeutic medicine in relation to field and hospital situations.

A short historical note is in order. The Naval Medical Research Institute was commissioned in October 1942 with an initial staff of 13 officers and 50 enlisted men. The staff grew to about 200 as wartime activities expanded and was at the time almost entirely military. The work was largely concerned with the development and testing of devices and methods to be used by the fleet. Extensive studies were carried out on protective clothing, desalination of sea water, aviation oxygen equipment, insect repellents and other means of insect control, physiological effects of tropical environment, and the effects of immersion in cold

water. Vaccines, night vision, body armor, nutrition, oral hygiene, tropical diseases, and parasites were investigated. Shortly after the end of the war, NMRI participated in the Bikini atomic bomb tests and has since contributed largely to the knowledge of the biological effects of radiation. Growth in this field eventually led to the formation of a new laboratory (Armed Forces Radiobiology Research Institute) to handle some of the applications of radiobiology.

In 1945 the physical plant was approximately doubled in size and later a modern completely equipped animal laboratory was added. Another section was added to the laboratory in 1957.

After the end of World War II there was a rapid shrinkage in the size of the Armed Forces and many of the investigators returned to civilian life. Much of the Institute's program, however, was retained although with a shift in emphasis from development and testing to research. A civilian component was gradually added to the staff and in recent years, the total staff has remained more or less evenly distributed between military and civil service personnel, with an average of 40 to 50 at the professional level.

The function of an active medical research laboratory in a military organization warrants some discussion. Among the many problems faced by the Navy is the maintenance of the health and effectiveness of its personnel. Traditionally, the Medical Department has cared for the sick and wounded and has advised on ways and means of avoiding illness. As the scope and complexity of military operations have continued to expand, the extent and complexity of the health problems have increased to the point where specialized knowledge is now required to solve them. Thus, the need for research has continued to increase and there are now a number of active laboratories within the

Medical Department whose primary mission is the solving of as many of these health problems as time, skill, and facilities will permit. Some of these problems are common to all mankind, or at least to such of mankind as may happen to be involved in certain situations. Some of the problems are either peculiar to Navy operations or are so likely to occur in Navy operations that the Navy must deal with them independently of any general interest and importance which they may have.

Of the several research installations of the Medical Department, the Naval Medical Research Institute has the most broad interests and deals with the most basic aspects of naval medical problems. One of its persistent activities is, in fact, the investigation of those research areas which underlie most directly the practical problems faced in naval medicine. These problems are at least as much preventive as therapeutic. Although the traditional activity of the medical profession has been in the area of cure, it is obviously more efficient to prevent when at all possible. In any case, both prevention and cure require an understanding of cause, and the search for this understanding is what is often meant by basic research. The results of basic research can then be used to provide practical means for the solution of important problems. Progress is through a stage of applied research in which specific information is sought, to development work where the end product may be a device but in a medical context is most often a procedure or set of working rules.

To accomplish its mission the Naval Medical Research Institute requires trained scientists and physicians, people who not only carry out competent research but who also are able to relate their research to Navy problems. The overall process is not a direct or simple one. Rarely is it possible to analyze a problem, carry out the needed research, and apply it to the field problem all in one sequential chain. Biomedical problems have a stubborn habit of being complex and interdisciplinary. It is characteristic of research activities that the results of one study may be very useful in an area outside that of the worker's immediate interest. For example, work on muscle cells has proved to be valuable in the study of fatigue. Research on the neurophysiology of the brain stem may help solve difficult problems in submarine medicine. Examples could be multiplied. What is important is that, especially in biomedical work, the extensive interactions of scientific activities belie the notion that mission oriented research must be directly related to the end product.

Proper analysis of a problem involves expert judg-

ment as to the selection of an approach, effectiveness of equipment, evaluation of data, and often the education of the consumer in the use of the solution. Clearly, high caliber personnel are needed: imaginative, forceful, and expert. The accommodation of such people in a military laboratory requires maximum use of their scientific judgment and in order to maintain such an expert staff, personnel turnover must be kept at a low level. It is totally impractical to hire people for specific duties, let them go at the termination of a particular study, and then try to find new people for new work. The best procedure which has been found is to select highly competent and imaginative scientists whose interests lie within the major fields of interest of the Navy, to support them, and to encourage their cooperation. To the extent that they respond by turning out useful work in the general areas of relevance, the formula is a success. It applies equally whether the scientists are civilian or military.

In the chapters which follow, a number of the more active areas of the Institute's work are covered in greater or lesser detail. At the end of the volume is a bibliography of the Institute's publications which is believed to be nearly complete. Those who are interested in the Institute's work will find a perusal of that bibliography illuminating. Considerable work has been done, for example, in areas such as submarine medicine, including the preparation of decompression tables, tolerance to atmospheric carbon dioxide, oxygen and nitrogen toxicity. In the area of shipboard medicine, as such, one will find references to work on motion sickness, protection against sunburn, and problems in hygiene and toxicology. A particularly active area has been that of experimental surgery, in which there has been considerable work related to the development of open heart surgery and vascular prostheses. This research has also contributed to the establishment of a tissue bank at the naval hospital in Bethesda. Nearly 400 senior authors have been associated with the preparation of approximately 1,800 reports ranging all the way from short technical notes through extensive research reports and reviews. Much of the material has appeared in the scientific literature.

No apology is made for the obvious gaps in coverage of work in the summaries which follow. No one individual or group has had sufficient continuity to have complete perspective of the problems and of NMRI's contributions in problem areas. The failure to develop senior scientists with such perspective will be particularly noted in such areas as underwater physiology and clinically oriented research. It is in such areas that the bibliography will be most useful.