It can be concluded from the results of this study that, in rabbits, the technique using an egg membrane and Thomas sutures gives the best results, in that more clear grafts were obtained. However, in this method and in that using a conformer, there was more evidence of inflammation and more eyes lost.

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THE DEFENCE RESEARCH MEDICAL LABORATORIES: THEIR CHARACTER AND OPPORTUNITIES*

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THE DEFENCE RESEARCH BOARD is supporting two kinds of research of medical interest, both essential to defence. The field of medicine related to the prevention and treatment of sickness and injury is the only field most of us consider when medical research is discussed. The other kinds of research relate to the fit man in his task; his effectiveness for his duties as judged by his educational background, his training, the problems caused by environmental factors and hazards affecting his performance, the assessment of his task with a view to better methods of work, better protective clothing, better food and better tools.‡

This second type of medical research calls for many scientific disciplines and a thorough understanding of job requirements if these large responsibilities are to be properly discharged. Partnership and responsibility for much of this broad field is shared with engineers, psychologists, physicists, chemists, and others. It is in this field of medical research that the Defence Research Medical Laboratories are engaged, on behalf of the three armed forces.

During World War II Canada's excellent record in this field of research is well known. The wartime National Research Council Associate Committees on Medical Research gave a tremendous impetus to medical research in each of the three services and as the record now reveals, also to medical research in Canada. There was an early and firm grasp of the need for studies on environmental factors and equipment as these affected the fit man, and for studies of his performance in assigned tasks. There was no hesitation in entering fields in which medical men and their colleagues are not characteristically involved, if such entry was going to meet the larger, broader challenges posed by burgeoning environmental and occupational problems. The result was medical partnership or leadership in protective clothing, in the design of better

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‡The strict definition of the adjective "medical" does not include these fields. For want of a more accurate term, "medical" is used, I feel, quite properly. The long range objective of medical and allied research worker should include the betterment of man's ability to work and live in his environment. This could be called the logical step beyond preventive medicine.

oxygen equipment, in emergency kits, in intercommunication problems, and so forth.

The volume of research activity of this type was, as might be expected, greatest in the field of aviation medicine. For the first time Canada had to train large numbers of men for highly specialized tasks. To fit them for these specialized tasks, to equip and train them to use personal equipment, a considerable amount of research and development was required. The activities of the R.C.A.F. Clinical Investigation Unit under Dr. G. E. Hall's direction are well known to many of you, together with other important activities sponsored by the R.C.A.F. A highly productive team was directed by Dr. C. H. Best on behalf of Naval medical research. Army medical research investigators working under Dr. Hurst Brown tended to be more concerned with clinical problems, though much valuable work in this field of occupational medicine was accomplished by them.

Since World War II, the R.C.A.F., in large part through the good offices and hard work of Dr. W. R. Franks, Air Commodore Corbet, and W/C Brown, kept active the facilities for aviation medical research, and consolidated in one establishment—the Institute of Aviation Medicine—aviation medical research, medical selection, medical indoctrination, medical statistics, and an active program of development.

Since these activities reflect considerable credit on the organizers and workers concerned, why should Canada not have continued on that separate service basis? The basic answer lies in the reasons for the existence of the Defence Research Board and its Defence Scientific Service. In a nation the size of Canada, the size of each of the armed forces is such that separate, first class research programs in each field for many of the branches of each service would be expensive, and would make it more difficult or even impossible to secure high grade scientific talent for all. The yields of research almost always have applications beyond a single field. Research on protective clothing is bound to include such problems as durability, water vapour and air permeability of fabrics, and the provision of adequate insulation with minimum bulk. These considerations are of the most direct concern to all three of the armed forces. It would be illogical to set up clothing research laboratories for each of the armed forces in Canada, when most of the results obtained would almost inevitably be of at least some use to all three of the services. The same argument applies to the development of packaged rations, the assessment of noise and intercommunication problems, the understanding of toxic hazards and of means to deal with them, the basic methods for selection and training of recruits, studies of instructional technique, and so on for practically the whole field of research as applied to the man in the armed forces. Even more important is the difficulty of getting a first rate team together and justifying adequate equipment unless this is to be done on a tri-service basis.

The fields of research related to the fit man at his task could each be represented by a separate research laboratory. It is more logical however, to bring them into association in one establishment. The Defence Research Medical Laboratories in effect is a collection of laboratories, each profiting by a single administrative service, by the sharing of large expensive items of equipment and most important of all, each deriving benefit from the partnership of other scientific disciplines in other sections. At the same time, each section is largely responsible for developing its own sphere of usefulness and its own scientific relationship, assisted by the administrative service in DRML and by co-ordination staff work in the Defence Research Board headquarters. It is a common occurrence in our laboratories that scientists of several sections discuss some problem in which each of the sections represented has an interest. Thus, while each section operates in practise as a scientific unit, it benefits by the sharing of administrative services, special facilities and the "ready to hand" advice of competent scientists in other fields. This arrangement is not unlike that of a clinic operated by a staff of specialists covering the whole field of clinical medicine. The laboratories, by analogy, comprise a clinic for the study of problems related to the fit man in his job.

The laboratories.—A brief description of the character of each section will help in understanding the nature of the laboratories.

The administrative services are located on the compound of the R.C.A.F. Station, Toronto, in close relationship to the R.C.A.F. Institute of Aviation Medicine. A good deal of sharing of facilities goes on, and many functions are performed by each establishment on behalf of the other. This overlapping is also present in the research and development projects of mutual

interest with benefit to both. While the establishments are administratively distinct, functionally there is a considerable degree of sharing of tasks and responsibilities.

The scientific sections at present are badly scattered. The toxicology section is located in Ottawa; the workshops and human resources sections are at Downsview, seven miles from the R.C.A.F. Station Toronto; the food laboratories are about one and a half miles west from Avenue Road on Bathurst Street; and the remaining sections are located in four buildings in the compound of the R.C.A.F. Station Toronto. Some relief from the present wide dispersal of facilities will result from the move next summer into the building now being constructed at Downsview, north of Toronto.

The group working on physiological problems includes a team working on *high altitude* projects, such as the effect of altitude on peripheral circulation, the improvement of research tools for studies in aviation medicine and basic research necessary to the use of such apparatus, and the provision of advice on physical and mathematical problems to other sections in the laboratories. Their chief tool is the decompression chamber. There are many problems in the field of *acceleration and safety equipment.* The human centrifuge is being used for the assessment of tolerances to increased forces of gravity as judged by blackout of aircrew in various stages in training, and with varying amount of flying experience. Other physiology teams are assessing various *bodily reactions to cold,* the effects of cold on joint movement, the possible usefulness of ascorbic acid in resistance to cold through tests on humans, the problem of *load carrying* by the infantryman, and other such problems. For these studies, in addition to regular laboratory facilities there is a tropical room, and a large cold chamber containing a decompression chamber. Temperatures as low as –60° F. can be attained.

Recent D.R.M.L.–I.A.M. studies on motion sickness have revealed an important new slant on its cause and prevention. These studies make use of a mechanically powered swing, and an unusual turntable.

The study of the efficient production and transmission of the spoken word and of its intelligibility at the receiving end is the task of the *Sonics* section. The obvious difficulties in making oneself intelligible in a noisy atmosphere and the difficulties of verbal communications in such atmospheres are common, and often critical in nature, where speed and accuracy may be indispensable.

Nearly everyone is a self-styled expert on clothing and on food, and those working as genuine experts in these fields therefore have to be particularly able.

The staff in the *clothing research* section is examining the principles of clothing, its functional properties, and the properties of materials which may be used in clothes. For example, this section is making a fundamental study on the water vapour transmission characteristics of textiles. It is also concerned with the best design of protective clothing for severe cold—both for the Army, and for the R.C.A.F. While the facilities now in the laboratories are extremely limited, an arrangement with the Ontario Research Foundation provides necessary laboratory space until quarters in the new building can be occupied.

While the *food section's* principal objective is the provision of necessary research and development for improvement of service food requirements, its actual function has been confined to the development of packaged rations. This calls for close working relationships with food and packaging firms and the provision of laboratory facilities to study products submitted by them. The effects of storage on foods at different temperatures must be known, and whether the food, as it may be delivered to the consumer in the armed forces, will be acceptable. Accordingly, the section is deeply involved in ration trials, and is almost constantly making acceptability studies in its taste-testing laboratory.

Preparedness against possible enemy use of gas is necessary, and a considerable problem now that the new, much more toxic nerve gases developed by the Germans have become potential weapons. A thorough understanding of the mechanism of action of these and other possible agents will provide better avenues for the prevention and rational treatment of casualties. This type of activity and the assessment of other possible toxic hazards, which may be encountered anywhere in the armed forces is the concern of the *toxicology section.* A typical question is, what are the hazards to men in tents from burning leaded gasoline in pressure operated stoves? This section has a close working relationship with the Defence Research Chemical

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Laboratories in Ottawa and is equipped with up-to-date facilities for the investigation of these types of problems.

The *personnel research* section is concerned with the best means of conserving and utilizing manpower. This calls for study of the principles and practice of selection and training, and leads to larger problems in manpower allocation.

The *applied experimental psychology* section, on the other hand, is studying the best means of utilizing human capacities, and this requires a thorough knowledge of the man's capacities for his job, and the study of the job itself so that it may be modified better to suit human capacities and preferences. For example, visual and perceptual problems are being investigated, and a more suitable navigator's compartment has been designed.

An animal colony, a library, and a fine workshop capable of making a wide range of instruments and research apparatuses are available to all sections. By such sharing of common facilities it is possible to provide better services for all sections.

The importance of the work.—The many scientific disciplines and facilities outlined above reflect the diverse functions of the laboratories and a capacity to meet a wide variety of problems. Much more attention must be paid to methods for improving the military man's capacity to stay effectively on the job and for improving the character of his work so that it may be done more easily and more accurately. It is almost lazy thinking to assume that any improvement in military effectiveness always demands a great deal of research and development on better aircraft, guns, radar, asdic or warships. A recent lesson from Korea can be drawn. Russian fighter aircraft have shown a capacity for performance of the highest order and it is clear to us all that in Korea the Russian pilots are at least as well mounted as the United Nations' pilots. Nevertheless the figures for *air to air combat* losses have shown a striking difference in our favour. A ratio of from five to seven Russian losses to one U.N. loss has been credited by the United States Secretary of Defence for Air. While the lessons must be drawn cautiously from such figures we cannot afford to ignore the human factor in explaining such a difference. Better aircrew selection, superior combat training, more attention to personal clothing and equipment, better food on the job, close studies of control mechanisms, protection from noise and better intercommunication, better instrument layouts and seating arrangements, all these mean that the military machine becomes more an extension of its operator's own body and will, and less an apparatus whose complexity is reflected in its control devices.

We must not only be sure that our infantryman who may be called upon to oppose his counterpart in war is as well or better armed and supplied than his opposite number, but also we must see that he is not burdened with excessive or awkwardly placed loads. What he does carry into combat not only should be essential but should also be carried and employed in a fashion fitting his physical and mental capacities. Some recent studies we have made make us certain that our infantryman has not been getting the best "treatment" in these respects.

The provision of protective clothing which will not only keep the man on duty warm in cold and wind but do that in spite of driving rain and spray is one problem which has plagued the Navy and which is not yet satisfactorily solved. Steps have recently been taken by the Navy towards a promising solution in consultation with the laboratories.

A deeper appreciation and application of the principles of improving the performance of fit men may well determine our successful emergence from a closely matched major conflict. The Defence Research Medical Laboratories can assist in fostering these principles in their day to day relationships with the three armed forces, and expressing these principles in the quality and kind of results produced from the investigations. Not least is the fact that most of the work may prove equally or more valuable in civilian life.

In fulfilling these functions Defence Research Medical Laboratories will need the encouragement and support of the medical profession. The traditional function of tending the sick will always call for most of the profession's energies. As preventive medicine advances it can be predicted that more attention of the medical profession can and will be directed towards the improvement of the lot of the fit individual. This is one of the highest services medical research workers can perform. The staff of the Defence Research Medical Laboratories is striving to perform this function now, on behalf of the Armed Forces.