NEW TYPE OF "JACKET" RESPIRATOR FOR THE TREATMENT OF POLIOMYELITIS

BY

AUBREY F. BURSTALL, D.Sc., M.I.Mech.E.*Professor of Engineering, University of Melbourne*

When an epidemic of poliomyelitis, in which the nerves of the respiratory muscles were severely attacked, occurred in Victoria in 1937 I was called upon to assist in the local manufacture of respirators, which were required quickly and in large numbers. At the beginning of the outbreak, in May, there were two cabinet type respirators in Victoria—one at the Queen's Memorial Hospital for Infectious Diseases at Fairfield, manufactured by the Drinker Company, and the other at the Children's Hospital, Melbourne, built by the Acme Vacuum Cleaner Company with the collaboration of a hospital at Toronto. The latter respirator was purchased in Canada for the Children's Hospital by Dame Jean Macnamara in 1935, with a view to its being reproduced if an epidemic made it necessary.

FIG. 1.—Jacket respirator being fitted.

A modified pulsator valve was devised, the centrifugal fan and valve being used in preference to the Drinker arrangement. By this means it is possible to couple up a large number of respirators to one mechanically operated unit. The usual number was six respirators of the cabinet type connected to one fan and pulsator unit. Thirty-five of these pulsator units, to operate nearly 200 cabinets, were constructed in Victoria in 1937 for use all over Australia.

The epidemic was almost over before it occurred to me that a simplified type of respirator, in which only the chest was included, might be equally effective and would certainly have many advantages over the cabinet type, particularly in nursing and for splinting the arms. This simpler type, termed the "jacket respirator," was

built at Christmas, 1937, in the Engineering Laboratory of the University of Melbourne, and was demonstrated to a number of medical practitioners on January 27, 1938. A week later one of these jacket respirators was put into use at the Children's Hospital, Melbourne, and at the

FIG. 2.—Jacket respirator, back view, showing metal "lugs."

FIG. 3.—Jacket respirator on patient and attached to pulsating mechanism.

time of writing (August, 1938) it has been in use continuously ever since. Some weeks later a similar apparatus was built for and used in the Queen's Hospital for Infectious Diseases at Fairfield, and others have been supplied to hospitals in Victoria and South Australia. One has also been supplied to Dr. Andrew Topping of the London County Council, at whose suggestion the present paper has been prepared. It was thought that a description would be of interest to members of the medical profession (see Figs. 1, 2, 3).

Description of the Apparatus

The apparatus consists of an aluminium cuirass made in one piece, which is hammered out to the shape of the thorax. It encloses the trunk of the patient from the

neck down to the waist-line, and is connected to the pulsating mechanism by means of a one-inch flexible hose. It can be connected to a cabinet type respirator. The capacity of a cuirass is so small that a large number of them may be operated from one cabinet type respirator by drilling a hole in the cabinet and connecting a hose to it. Inside the cuirass is a sponge rubber vest, one inch thick, with holes for the arms, neck, and waist. The openings in the cuirass have a beaded edge and are closed to the body by soft sheet rubber jointing pieces, which are held to the cuirass by being lifted over the beaded edge. This resembles somewhat the method by which a glass jam-jar is covered with a parchment lid. Rubber rings may also be added to prevent the sheet from working off the beaded edge. The cuirass is provided with four metal lugs for the attachment of the arm splints, as shown in the illustration. The whole of the metalwork can be sterilized. It weighs only 6 lb. for a patient aged 10. It is thought that three sizes of cuirass will provide for patients ranging from the age of 3 years up to medium-sized adults.

For the legs and trunk the modified double Thomas splint frame (Macnamara, 1932), minus the arm supports, is fitted to the patient, the upper portion going up inside the aluminium cuirass and the waist-joint being made over the two longitudinal members of the frame.

The time taken for two persons to dress a sick patient completely in the new respirator is seven minutes without splints and ten to twelve minutes with splints. This respirator is therefore not as suitable for the treatment of emergency cases as the Drinker type, because more joints have to be made, and there is more delay in getting the patient into the respirator.

Merits and Demerits

I wish to emphasize that from the outset it was never contemplated that this apparatus would entirely replace the cabinet type of respirator in a large hospital. The jacket respirator was primarily designed to provide cheaper and better facilities for the treatment of patients who had recovered from the acute stages of the disease.

The special features which characterize this respirator as it was first made are as follows:

1. The main portion is constructed of aluminium.
2. The metal is welded up to form a single piece.
3. The aluminium is hammered out to the shape of the thorax.
4. There are no bolted or screwed joints; all joints between rubber and metal are of the "jampot-cover" type.
5. The arm splints are attached to the cuirass and the rest of the double Thomas splint is used, the upper portion being carried up inside the respirator.
6. The abdomen is not included.
7. The whole apparatus is very simple to use and cheap to construct.

The jacket type of respirator appears to have the following general advantages over the cabinet type:

1. Simplicity of nursing, panning, etc.
2. Limbs can be treated while the patient is in the respirator.
3. Useful but limited movements of hands and arms are possible if the patient is not completely paralysed.
4. There is a wider range of vision for the patient.
5. An ordinary bed can be used.
6. The whole jacket can be sterilized.
7. The initial cost is small.

8. The air capacity is much less.

9. It is easier to maintain the temperature of the extremities.

10. It is particularly valuable when the deltoid muscles are paralysed.

Experience with the jacket respirators which have been used up to the present reveals the following disadvantages:

1. The time taken to install the patient in the respirator is longer than in the cabinet type.

2. At least three sizes of respirator are required.

3. To raise the arms over the head may cause the patient some distress, and in certain cases may make it impossible for this respirator to be used.

4. There are more points where leakages may occur, and more rubber joints to maintain.

Since this type of respirator has been constructed discussion has arisen regarding the advisability of including the diaphragm within the respirator, and the jacket at Fairfield Hospital has been extended to include the diaphragm. This modification has not affected the ease with which the patient can be placed in the respirator, but it has increased the difficulty of attending to the patient's back.

The jacket respirator has other applications—for example, it seems to be suitable for the resuscitation of the apparently drowned. The small air capacity makes it possible for a light hand-operated bellows to be used in conjunction with the respirator. Further experiments towards its development and application for this and other purposes are contemplated.

I wish to record my indebtedness to numerous members of the medical profession in Melbourne for their advice and assistance during the experimental stages of this work, and particularly to Dame Jean Macnamara for her advice and encouragement to make the first jacket respirator; to Dr. V. L. Collins, medical superintendent of the Children's Hospital, Melbourne, who so willingly undertook to give it a trial; to Dr. F. V. Scholes, medical superintendent of the Queen's Hospital for Infectious Diseases, Fairfield, Victoria, and his staff; and to Dr. F. Kingsley Norris for his advice and enthusiasm.

The jacket respirators were constructed in the workshops of the engineering department at the University of Melbourne by Mr. D. Campbell, under my supervision.

REFERENCE

Macnamara, Jean (1932). *British Medical Journal*, 2, 1098.

The tenth International Congress of Military Medicine and Pharmacy will be held in Washington in 1939 from May 7 to May 15. Invitations to participate have been sent to every country by the President of the United States, and already several acceptances have been received. General Charles R. Reynolds, Surgeon-General of the United States Army, will be president of the Congress. The programme has already been tentatively drawn up, and includes discussion of the following questions: (1) Organization and function of the medical services in colonial expeditions. (2) Probable casualties in war and methods of calculation. (3) Practical procedures for anaesthesia and analgesia in war surgery. (4) Organization and function of the military chemico-pharmaceutical service. (5) Emergency treatment and primary apparatus for fractures of the jaw in war. (6) Technical specialization of administrative officers in the medical service. (7) Oxygen therapy and its practical use with troops on active service. Registration is open to all officers of the medical services of the Army, Navy, Air, and Colonial Services, National Guard, Territorial Forces, and public health service, whether active or reserve. Further information may be obtained from the Secretary-General, Colonel Harold W. Jones, at the Army Medical Library, Washington, D.C.