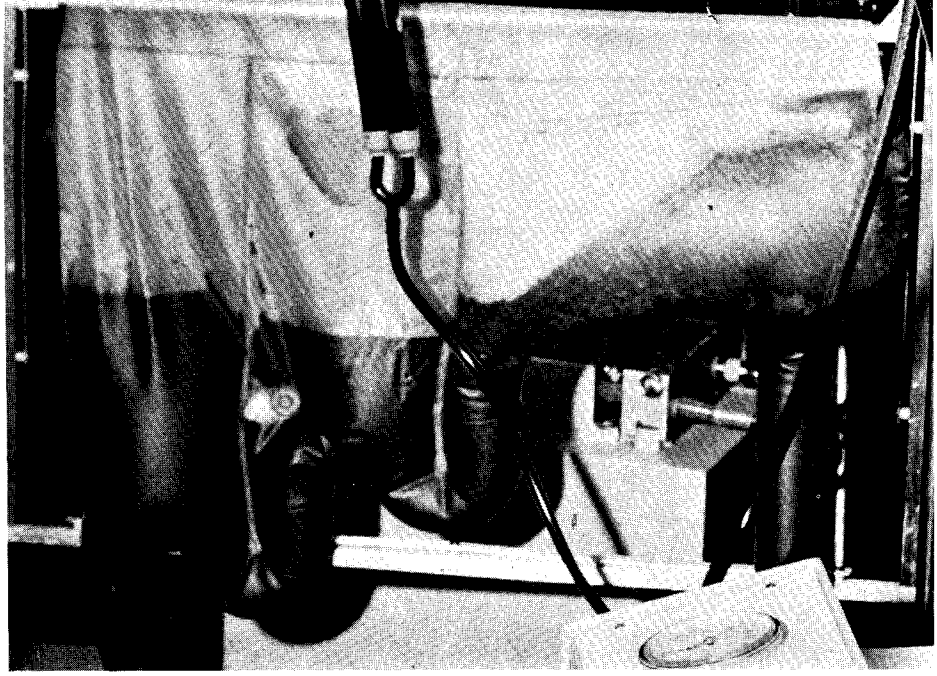

The Rygg Oxygenator in use during open heart surgery. The defoaming sponge must be pushed over the venous reservoir so that the blood will course through it and not under it.

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A Plastic Oxygenator In Use
At Toronto General Hospital

THE Rygg-Kyvsgaard plastic oxygenator was designed in Europe in 1956 by Drs. Rygg and Kyvsgaard of Denmark. We, at the Toronto General Hospital, were interested in such a plastic disposable bubble oxygenator for use at our hospital. A traveling fellow who saw this oxygenator in use in Europe, brought back the equipment and a description of its use; it appeared to be a good oxygenator for use in emergencies because of ease of setting-up, low prime capacity for a limited blood supply and also for use in hemodilution. The performance record of this oxygenator seemed to be as good as any other available at that time. We have been quite happy with it.

The oxygenator is supplied sterile, along with five plastic connectors enclosed in an outer plastic bag. The suction collection reservoir is also supplied as a sterile unit. It has two gas escape ports; a defoaming sponge and also a filter. It is connected to the venous reservoir via a ⅜″ I.D. line and one of the plastic connectors.

Three Parts

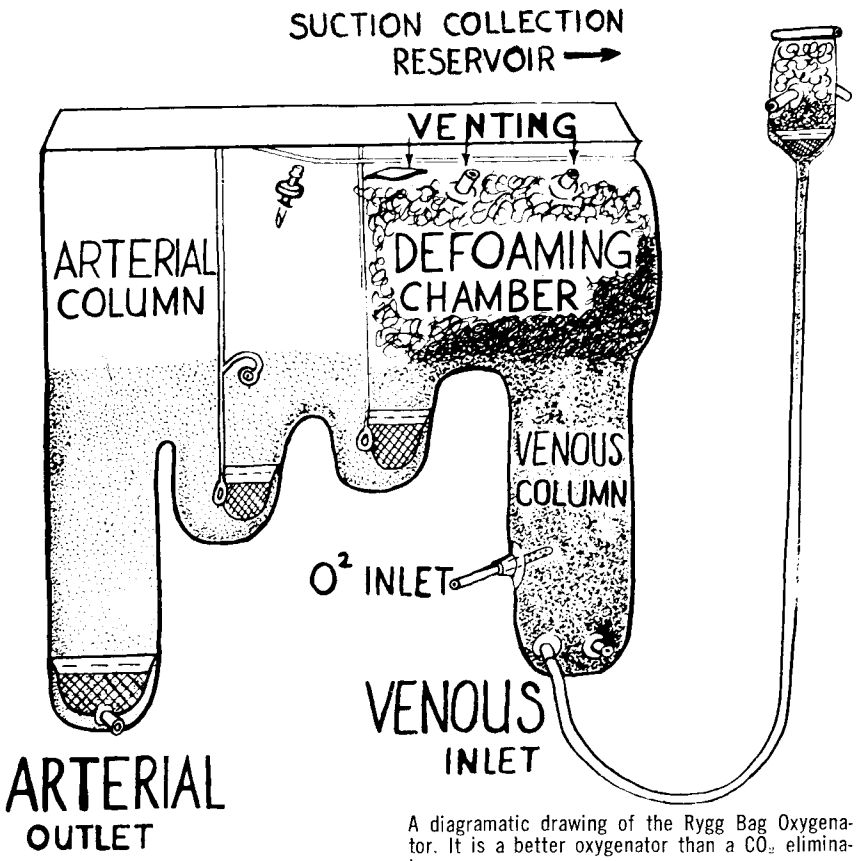
The oxygenator is made up of three parts: the venous reservoir, the defoaming chamber with two vents for elimination of CO_2 and the arterial reservoir. Between the defoaming chamber and the arterial reservoir there is a fine mesh screen, together with two more in the arterial reservoir. The venous reservoir has three inlets—one for venous return, one for cardiotomy return and one containing the oxygen diffuser.

The defoaming chamber has a sponge made up of nylon filament wound into a large ball and sprayed with a defoaming agent. During the run it is necessary to keep this sponge over the venous reservoir in order that the blood will course through it rather than below it or froth out the vents. This may be done by simply pushing it over the venous reservoir at various times during the run, or securing it by means of blocks and c. clamps along the upper edge forcing the sponge down over the venous reservoir. One hole or even two should be cut in the upper part of the defoaming chamber for additional release of CO_2. According to experiments done by Dr. Rygg et al, the CO_2 elimination ability is inferior to the oxygenating capacity of the oxygenator, therefore the oxygenating capacity of the reservoir is governed by the PCO_2 of the venous blood. We have found that if we stay on partial bypass for a few minutes longer than usual once the pump run is started, that we can get rid of some CO_2 via the lungs and thereby assist the oxygenator.

The optimum flow of O_2 to the venous reservoir is eight L/min. If there is a shift of the PH to the left and an increased PCO_2 then naturally the efficiency of the oxygenation of the blood is diminished, which must be corrected by cutting one or two holes in the upper part of the defoaming chamber in the left upper corner.

Used Since Early '66

This oxygenator has been in use at the Toronto General Hospital since early in 1966. Since that time we have used it on approximately 75 patients with pump runs varying from 16 min. for an ASD to 3½ hours for a double



A diagramatic drawing of the Rygg Bag Oxygenator. It is a better oxygenator than a CO_2 eliminator.

valve procedure. Every type of open-heart surgery has been done using this oxygenator. Mostly this oxygenator has been selected for:

(1) pump runs up to one hour such as ASD's, mitral valve replacements

(2) where there has been a problem procuring blood and

(3) for emergency pump surgery. We have done some aortic valve replacements and they have gone well on the Rygg bag.

The prime consists of 500 cc's of 2/3 5% gluc. in D.W., 1/3 N. Sal. and from 700 - 1000 cc's of 5% gluc. in D.W. depending on the size of the patient. 25 mgms Heparin are added to each 500 cc's of prime and also two amps of sod. bicarb. (44.6 M Eq/50 cc. Amp.) prior to circulation and filling the lines. 4 units of ACD blood are added via the venous reservoir. The ACD blood by preference is not over 24 hours old and to each unit is added 25 mgms. heparin and 6 cc's calcium chloride. (10 gms/10 cc. Amp). As we go on bypass another two amps of sod. bicarb. are added. A mild hypothermia is used in most cases. (32° C).

Problems encountered:

1. CO_2 elimination may be helped, if an extra opening or two is cut in the defoaming chamber and also leaving the patient on partial bypass for 3-5 minutes.

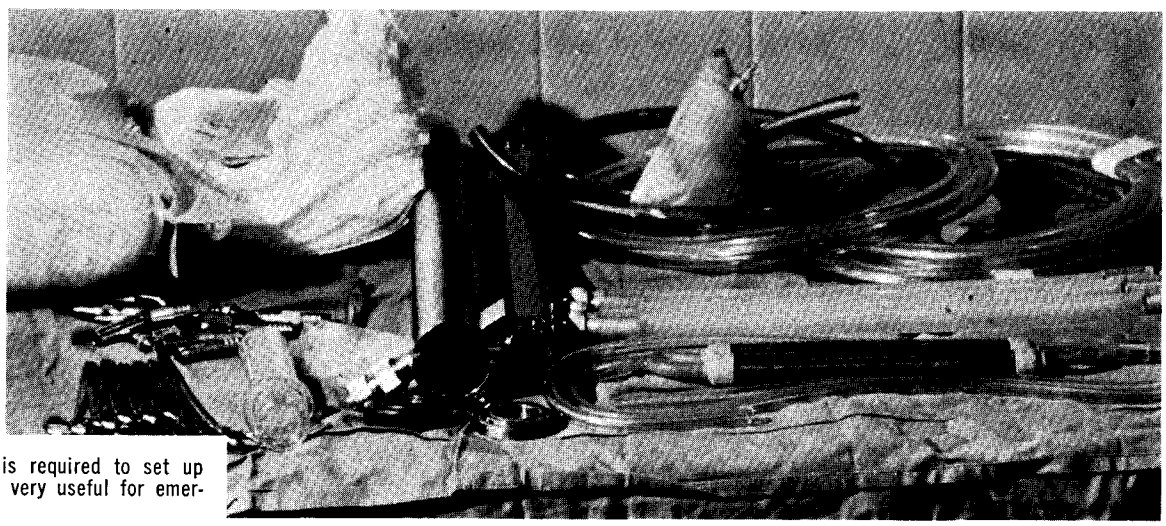
2. At the onset the venous reservoir must not be allowed to collect blood as the pressure from the O_2 line will not bubble a long column of blood into the defoaming chamber. Leave the O_2 at 8 L/min. until the blood has left the chamber then put it at 2 - 3 L/min. or the small holes in the diffuser will clog with RBC.

3. The defoaming sponge must be held over the venous reservoir so that the blood will go through it rather than under it.

4. The 3/8" I.D. Plastic tubing can be more easily put on the plastic connectors if it is cut on a slight slant. The plastic connectors will not pull out of their appointed places if reasonable care is taken.

Summary

The Rygg-Kyvsgaard bag is a more efficient oxygenator than a CO_2 eliminator, but this later situation may be helped if the steps mentioned above are taken. It is advantageous if there is a scarcity of blood because of the fairly low priming volume. It may be employed also with hemodilution. It is easily set up in an emergency. We use this oxygenator for elective cases with pump runs of up to 1 hour and flow rates up to 4½ L/min. We have used it successfully for pump runs of up to 3½ hours.



A minimum of equipment is required to set up the Rygg Oxygenator. It is very useful for emergency open-heart surgery.