
An Air Embolism Detection Device for Use with a Non-Occlusive Arterial Pumphead

William A. Vivian, Klint H. Stander, and R. Glade Smith

Utah Valley Regional Medical Center and West, Inc.
Provo, UT

Keywords: air emboli, detection; pump, vortex; technique, safety; device

Abstract

(J. Extra-Corpor. Technol. 19[4]: p. 406-407 Winter 1988). A clinical evaluation of an air-bubble detector system used in conjunction with a non-occlusive pumphead is described in this report. The detector system was originally designed for occlusive roller pumpheads. A non-occlusive pump system can now be integrated with an existing rollerhead pump setup to accomplish the same desired effect, that is, automatic shutoff of the non-occlusive arterial pumphead if air is detected. The system is designed to produce an audible alarm when a bolus of air enters the bypass circuit. This system can be operated in a manual or automatic mode for arterial pump shutoff. This system has been judged effective in our clinical setting.

Introduction

One of the greatest risks to the patient on cardiopulmonary bypass is the threat of air embolism.^{1,2} The Sarns Air-Bubble Detector System^a is a device designed to detect the presence of macroscopic air within a segment of bloodfilled, flexible, clear polyvinyl chloride (PVC) tubing. Since May 1982, this unit has been used in every clinical operation at our institution. We have now incorporated this device into our circuit to be used in conjunction with a Centrimed non-occlusive pumphead,^a a Sarns 7000 pump console,^a and a Terumo venous reservoir bag and membrane oxygenator.^b

Direct communications to: William A. Vivian, 640 East 13th Ave., Salt Lake City, UT 84103

a Sarns, Inc., Ann Arbor, MI 48106

b Terumo Corp., Tokyo, Japan

Materials and Methods

The three major parts of the Sarns Air-Bubble Detector system are the control unit, the sensor unit, and the interconnecting cable. The control unit houses the warning lights, controls, and audio alarm. The sensor unit may accept a segment of PVC tubing with a $\frac{3}{8}$ inch I.D. and a $\frac{3}{32}$ inch wall. A pediatric sensor is also available for $\frac{1}{4}$ inch I.D. and a $\frac{1}{16}$ inch wall. There are several limitations to the system such as bubble size (1cc or larger), effective hematocrit range (above 7%), and incidences of false alarms.²

When a light source located within the sensor unit stimulates the photocell receptor, electrical impulses traverse the cord coil to the control unit, triggering the alarm lamp and the audio alarm. The interconnecting cable electrically connects the control unit to the pump console. In the event of electrical stimulation from the sensor unit, the system has been modified to shut off the pumpheads, both occlusive rollerheads and the non-occlusive arterial pumphead. In order to accomplish this, the power cord from the Centrimed pump console is connected to the #5 power supply of the Sarns 7000 modular pump. (Figure 1). When air is detected by the Air Bubble Detector, the control unit automatically shuts off all four roller pumpheads, and also shuts off the power supply to the #5 pumphead which in turn shuts off the non-occlusive Centrimed pumphead via its control unit.

Discussion

There are two systems that can be utilized with the non-occlusive arterial pumphead. The first is an automatic shut-off variation. This is where the non-occlusive Centrimed system is directly connected to the

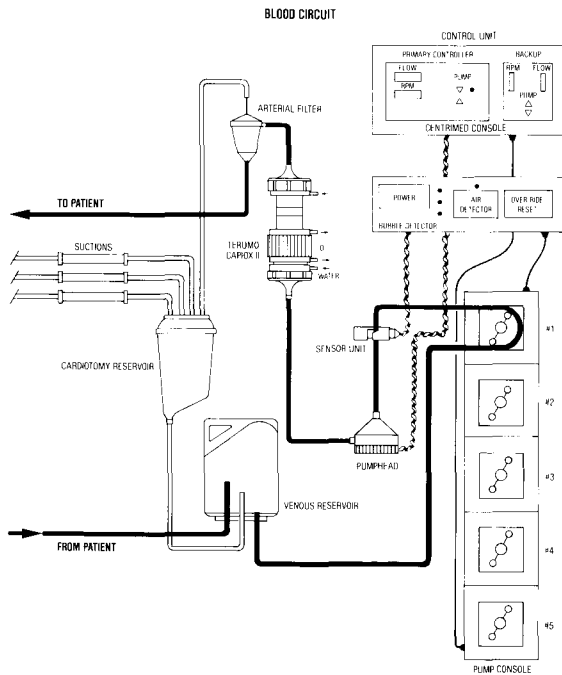


Figure 1: Roller pumphead #1 may be used as a backup pump if the non-occlusive Centrimed pumphead fails. In this schematic, it is unoccluded.

Sarns Modular Pump via the #5 pump power supply, and when the audible alarm is heard from the bubble detector (meaning that air has been detected), both occlusive and non-occlusive pumpheads are shut off. The perfusionist can then take the appropriate steps to evacuate the air emboli. Both the arterial and venous lines should be clamped to prevent exsanguination of the patient in this situation.

The other system available to the perfusionist is a manual type shut-off where the Centrimed pump sys-

tem is not connected in any manner to the Sarns modular pump. When the audible alarm is heard from the bubble detector, it simply means that air has been detected. The non-occlusive pump will continue to operate in this mode, even though all occlusive rollerheads will be shut-off automatically. We highly recommend an arterial line filter be used with either of these systems for added safety.

Summary

The Sarns Air-Bubble Detector System can now be utilized with a non-occlusive arterial pumphead. The system will produce an audible alarm when a bolus of air enters the bypass circuit to protect the patient from a catastrophic event. The system can be wired for automatic shut-off of the non-occlusive pumphead when air is detected. The system can also be used in the manual mode whereby the perfusionist takes the responsibility of shutting off the non-occlusive arterial pumphead. We recommend the automatic mode shut-off in order to stop the non-occlusive arterial pumphead when air is detected. One can then take the necessary steps to evacuate the emboli. We feel that the necessity for an air detection device used in conjunction with a non-occlusive pumphead be determined by the perfusion staff.

References

1. Stoney, W.S., Alford, W.C. Jr., Burrus, G.R., Glassford, D.M. Jr., Thomas, C.S. Jr.: Air Embolism and other Accidents using Pump Oxygenators. *Ann Thorac. Surg.* 29 (4):336, 1980.
2. Vivian, W.A., Malloy, K.P., Hackett, J.E., Clark, D.K., Reed, C.C.: Clinical Evaluation of an Air Embolism Detection Device. *Cardiovascular Diseases, Bulletin of the Texas Heart Institute.* 7 (4):425, 1980.