

2. Armour JA, Hagerman GR, Randall WC: Arrhythmias produced by local nerve stimulation. *Am J Physiol* 223: 1068-1075, 1972
3. Rogers MC, Abildskov JA, Preston JB: Neurogenic ECG changes: An experimental model. *Crit Care Med* 1: 192-196, 1973
4. Millar K, Abildskov JA: Notched T waves in young persons with central nervous system lesions. *Circulation* 37:595-603, 1968
5. Goldman MR, Rogers EL, Roger MC: Subarachnoid hemorrhage: Association with unusual electrocardiographic changes. *JAMA* 234:957-958, 1975
6. McRae J, Wagner G, Roger MC, et al: Paroxysmal familial ventricular fibrillation. *J Pediatr* 84: 515-519, 1974
7. Moore D: Stellate Ganglion Block. Springfield, Ill., Charles C Thomas, 1954, pp 108-117
8. Randall WC, McNally H, Cowan J, et al: Functional analysis of the cardioaugmentor and cardioaccelerator pathways in the dog. *Am J Physiol* 191: 213-217, 1957
9. Randall WC, Priola DV: *Nervous Control of the Heart*. Edited by Randall WC. Baltimore, Williams and Wilkins, 1965, pp 214-244
10. Yanowitz F, Preston JB, Abildskov JA: Functional distributions of right and left stellate innervation of the ventricles. *Circ Res* 18:416-428, 1966
11. Rogers MC, Abildskov JA, Preston JB: Cardiac effects of stimulation and block of the stellate ganglion. *ANESTHESIOLOGY* 39:525-533, 1973

Anesthesiology  
48:141, 1978

## Accidental Ventilator-induced Hyperventilation

PETER M. WATERMAN, M.D.,\* STANISLAV PAUTLER, M.D.,† R. BRIAN SMITH, M.D.‡

We report below a case in which the patient was accidentally hyperventilated as a result of erosion of a ventilator bellows.

### REPORT OF A CASE

A 53-year-old man weighing 65 kg was brought to the operating room for aortofemoral bypass under general anesthesia. Past history revealed myocardial infarction several years previously, but the patient was not taking any medication at the time of admission.

Preoperative medication included morphine, 10 mg, hydroxyzine, 100 mg, and glycopyrrolate, 0.2 mg, im, 45 minutes prior to induction of anesthesia. In addition to two intravenous lines, a left radial arterial catheter was inserted, as well as a subclavian line for central venous pressure (CVP) monitoring.

The patient received thiampylal, 400 mg, for induction. Tracheal intubation was facilitated by the use of succinylcholine, 100 mg. Anesthesia was maintained with 66 per cent nitrous oxide and supplementary morphine. Neuromuscular block was achieved with *d*-tubocurarine, monitored with a peripheral nerve stimulator.

Approximately 30 minutes into the procedure, an Ohio® anesthesia ventilator was connected to the anesthesia machine. The tidal volume of 650 ml was set at a rate of 10/min. Shortly thereafter, the patient's blood pressure fell from 140/70 to 80/30 torr, while CVP rose from 10 to 20 cm H<sub>2</sub>O. Arterial blood-gas determinations showed pH 7.60, P<sub>CO<sub>2</sub></sub> 17 torr, and P<sub>O<sub>2</sub></sub> 200 torr. A Wright respirometer was then inserted in the expiratory part of the system, and a tidal volume of 1,700 ml was measured. Removal of the ventilator from the system resulted in rapid return of vital signs to previous levels. Repeat blood-gas determinations revealed pH 7.55, P<sub>CO<sub>2</sub></sub> 22 torr, and P<sub>O<sub>2</sub></sub> 115 torr. The operation then proceeded without incident.

\* Assistant Professor of Anesthesiology.

† Associate Professor of Clinical Anesthesiology.

‡ Professor and Vice Chairman.

Received from the Department of Anesthesiology, University Health Center of Pittsburgh, Pittsburgh, Pennsylvania 15261. Accepted for publication August 8, 1977.

Address reprint requests to Dr. Smith: Anesthesiologist-in-Chief, Presbyterian—University Hospital, 230 Lothrop Street, Pittsburgh, Pennsylvania 15213.

Examination of the ventilator revealed numerous small erosions penetrating the wall of the bellows.

### DISCUSSION

The ventilator is similar in method of operation to many other commercially-available ventilators. A concertina-type bellows fills with the gas to be inhaled, which is forced into the lungs by compressed gas (oxygen) on the outside of the bellows. This is accomplished utilizing the fluidic principle. Other ventilators utilizing a series of lightly-loaded spring valves are also commercially available.<sup>1</sup>

In this case, the concertina had holes in it. The compressed gas driving the machine was 100 per cent oxygen at 50 psi; during inhalation, large quantities of oxygen at this high pressure were added to the intended inhaled gas mixture. This resulted in a tidal volume of 1,700 ml, as opposed to the preset tidal volume of 650 ml. A reduction in blood pressure with concomitant increase in CVP and a high airway pressure alerted the anesthesia personnel to the problem, and it was quickly rectified. Fortunately, there was no serious ill effect. However, if the driving gas had been air, the F<sub>I<sub>O<sub>2</sub></sub></sub> could be lower than expected.

The four Ohio® ventilators in our department were examined, and a similar partial erosion of a ventilator bellows was found in a second machine.

It is the intent of this report to alert others to the possibility of this complication and to encourage routine examination of the ventilator, particularly the rubber portions, before use. It is recommended that a respirometer routinely be used to check tidal volume, as opposed to relying upon the ventilator setting.

### REFERENCE

1. Mushin WW, Rendell-Baker L, Thompson PW, et al.: *Automatic Ventilation of the Lungs*. Second edition. Philadelphia, F. A. Davis, 1969, pp 676-688