Fluctuation of Fractional Inspired Oxygen Concentration Caused by Misuse of Venti-voice®

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A speaking-aid for patients under mechanical ventilation, Venti-voice® is now used in the increasing number of intensive care units in Japan. Although we found the device very useful for patient care, we would like to point out possible danger of misuse of Venti-voice® for mechanically ventilated patients based on our unusual experience.

Report of a Case

A 53 year old male patient has been put on a ventilator (Servo 900B, Siemens Elema, Sweden) for the treatment of respiratory failure caused by pyothorax and pneumonia. His ventilatory mode was mechanical ventilation with 5 cmH_2O PEEP and fractional inspired oxygen concentration (F_{IO_2}) was 40%. On Oct. 8, 1987. ventilatory mode was changed to intermittent mandatory ventilation without any change in PEEP level or F_{IO_2}.

At the same time, it was decided to use Venti-voice® in an attempt to ease his irritability.

Since each bed has only a single wall outlet for oxygen and one for air in our ICU, and we had misunderstood that the device requires oxygen and air as driving gases, we devided suppling gases using a double outlet connector for oxygen and for air.

Thus oxygen and air was supplied to the device from the same wall outlets to which oxygen and air supply tubings of Servo ventilator had been pinned in (fig. 1). Arterial blood gas analysis (Corning 168 pH-Blood Gas Analyser, Corning Medical, USA) obtained one hour and four hours after the initiation of IMV showed unexpected high Pa_{O_2} which was unproportional to F_{IO_2} (table 1).

Therefore, gas was sampled from the inspiratory tree of the ventilatory circuit and analysed by the blood gas analyser. P_{O_2} of inspired gas was 698 mmHg. Since gas suppling hoses and a oxygen blender seemed without any defect, Venti-voice® which was connected to the same wall outlets in parallel was suspected as an origin of an abnormal happening.

A couple of minutes after disconnecting two gas-suppling hoses to the device from the wall outlets, P_{O_2} of gas sampled from the inspiratory circuit decreased to 290 mmHg which exactly reflected the preset F_{IO_2} of 40%. P_{O_2} of inspired gas rose again to 608 when the hoses of the device were connected again to the same outlets.

It was found gas can flow freely from one gas-suppling hose to the other because two hoses are connected without any diaphragm at the body of the device. Disconnection of IMV circuit did not cause any change in abnormally high inspiratory P_{O_2} while Venti-voice® was connected to the outlets.

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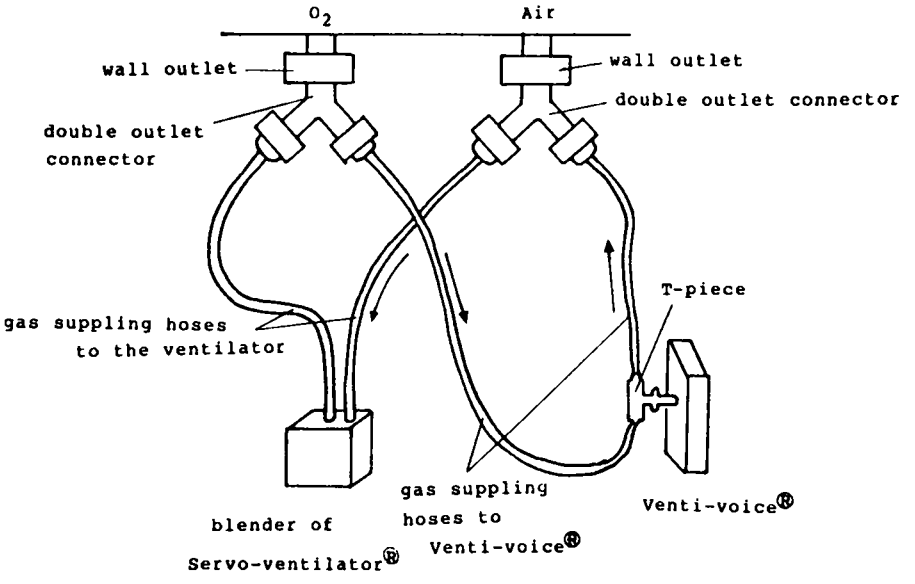

Fig. 1. Connections of Servo-ventilator and Venti-voice® to the wall outlet.

Table 1.

	CPPV ($PEEP_5$)	IMV+$PEEP_5$	IMV+$PEEP_5$	$CPPV_5$
FI_{O_2}	0.4	0.4	0.4	0.4
pH	7.431	7.439	7.464	7.522
P_{O_2}	107	241	276	97
P_{CO_2}	36.7	33.1	31.2	25.7
Venti-voice® connected	no	yes	yes	no

Table 2.

	Inspiration	Expiration
Pressure at O_2 outlet	4.5	4.5
Pressure at air outlet	4.2	4.5
		kg/cm^2

Measurement of supplied pressure of oxygen or air was performed at each wall outlet while the ventilator was working. Slight fluctuation between 4.5–4.2 kg/cm^2 was noticed at the air outlet while oxygen pressure was constant at 4.5 kg/cm^2 (table 2).

From these findings, we blieve that oxygen was pressed into the air suppling hose of Venti-voice® from the oxygen suppling hose when pressure of air fell below that of oxygen. Oxygen in the air suppling hose to the Venti-voice® reached to the oxygen blender of the ventilator via the double outlet connector and air suppling hose to the ventilator, thus raising FI_{O_2} much higher than pre-set level (see arrows in fig. 1).

Discussion

Venti-voice® is designed to supply white noise as a gas flow into oral cavity or naso-pharynx for phonation while patients are on mechanical ventilation or CPAP. Therefore, gas flow from the device has nothing to do with inspiratory gases that patients actually breathe. In the situation we reported, however, it was shown that simultaneous use of a ventilator and Venti-

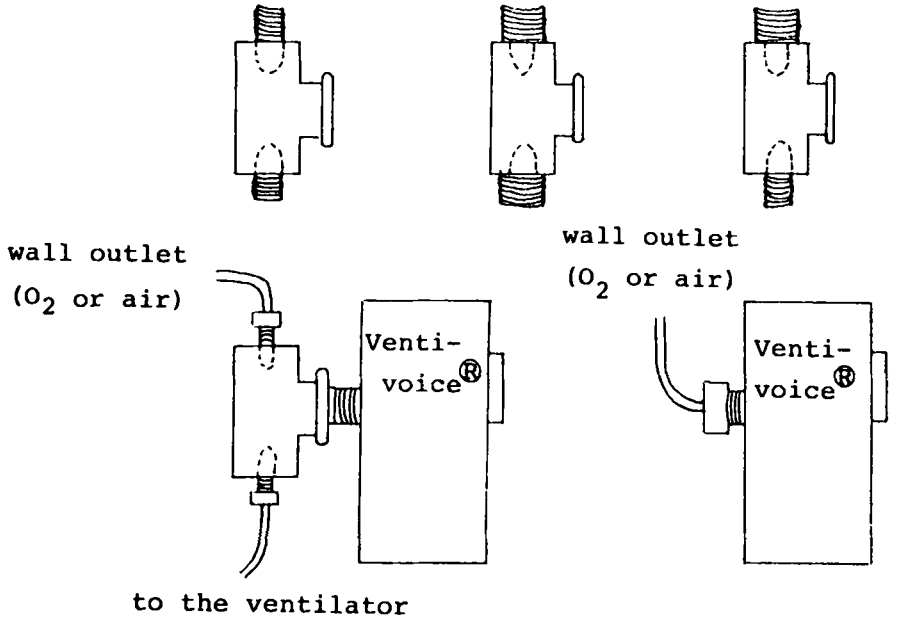

Fig. 2. T-pieces and how to use Venti-voice®.

T-pieces for air (upper left) and for oxygen (upper middle) which can be taken into 3 pieces. A wrongly mounted T-piece is shown at upper right which can be connected to air on one side and to oxygen on the other.

Correct way of using Venti-voice® is putting the device between a wall outlet and a ventilator using a T-piece for either oxygen or air (lower left), or driving the device with single gas-supply hose from other outlet without using a T-piece.

voice® might cause unexpected change in fractional inspired oxygen concentration.

In our case, fortunately, oxygen was forced into the air-supply tubing due to the pressure difference resulting in an elevation of F_{IO_2}. If a pressure of air-supply tubing is higher than that of oxygen-supply tubing, disastrous hypoxemia can occur due to unexpected decrease in F_{IO_2}.

Retrospective analysis revealed that the accident was caused by two mistakes. First, connecting T-piece to get driving gas for the device from a gas suppling hose to the ventilator was supplied with a wrong part from an agency. Furthermore we supplied air and oxygen to the device through this wrongly constructed T-piece, although the device is designed to be drived by air or oxygen and not by their combination. The cause of the first mistake was wrong reconstruction of original T-piece by a misunderstood engineer. We found that two T-pieces, one for oxygen and one for air, are supplied in a purchased set of the device, and the T-piece was easily taken into 3 pieces and reconstructed in a wrong shape by attaching a part of one to the other (fig. 2). We recommend that the T-piece should be supplied in a shape which can not be taken into pieces. The second mistake was solely attributed to our misunderstanding. The divice can be drived by either oxygen or air without using a T-piece, and a T-piece is needed only when driving gas for the divece is taken from a gas suppling hose to the ventilator (fig. 2). It is a mandatory requirement of users to read directions carefully when using a new equipment, and we have no excuse for this respect. However, from the viewpoint to decrease accidents due to misunderstanding, we think that manuals for each medical instrument which are translated into Japanese should be supplied to users at the time of purchase.

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