Cultural Article

Venturi mask is the pioneer of High-Flow Oxygen Therapy Concepts

Citation: Manici M., Bambi S., Lucchini A. "Venturi mask is the pioneer of High-Flow Oxygen Therapy Concepts" (2022) *infermieristica journal* 1(1): 7-9. DOI: 10.36253/if-1668

Received: May 25, 2022

Revised: June 10, 2022

Just accepted online: June 20, 2022

Published: June 29, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Matteo Manici[1], Stefano Bambi[2], Alberto Lucchini[3]

[1]RN, MSN, Post-Operative Intensive Care Unit, University Hospital of Parma, Italy
[2]RN, MSN, PhD, Associate Professor, Health Sciences Department, University of Florence, Italy
[3]RN, Head Nurse, General Intensive Care Unit, Emergency Department - ASST Monza - San Gerardo Hospital, University of Milano-Bicocca, Italy

Abstract: Oxygen therapy should be carefully considered and monitored because, like any other medication, it can cause harm to patients if misused. This paper focuses on the distinction between low-flow and high-flow oxygen therapy. A discussion about the Venturi system for oxygen administration is carried on, given that some authors include it in the low-flow devices group despite its characteristics to deliver high-flow therapy.

Keywords: Oxygen, Therapy, High-Flow, Low-Flow, System, Nursing

Oxygen delivery is probably one the most frequently administered medication by nurses worldwide. Oxygen was discovered by Joseph Priestly in the late 18th century and has been used as a treatment for patients with acute and chronic respiratory failure until nowadays[1]. Its use should be carefully considered. Like any other medication, it may cause harm to patients if misused. In clinical practice, a common debate between two currents of thought has been going on until today: "you can't administer too much oxygen" versus "oxygen won't hurt"[2]. Recently healthcare professionals tended to titrate oxygen administration to avoid the side effects of both hypoxaemia and hypoxemia in emergency and intensive care settings field[3,4]. Indeed, the risks related to hypoxaemia are widely known. On the contrary, complications related to excessive oxygenation seem to have a low priority for healthcare professionals[5].

Oxygen can be administered through low flow – delivering "pure" oxygen until 30 L/min – or mixed with ambient or compressed air providing high flows from 30 to 80 L/min and over, using many different interfaces.

Recently, Miller and colleagues[6] have proposed

standardisation of High-Flow Oxygen Therapy Concepts. The authors organised the mess of the several terminology changes introduced with the extensive employment of oxygen therapy through high flow nasal treatment during the last years. Many trade terms refer to those oxygen delivery modes. They include high-velocity nasal insufflation (Hi-VNI—Vapotherm, Exeter, New Hampshire), high-flow nasal insufflation (HFNI), high-flow nasal oxygenation, Optiflow (Fisher and Paykel, Irvine, California), transnasal humidified rapid-insufflation ventilatory exchange, heated high-flow nasal cannula, heated humidified high-flow nasal cannula, and high-flow nasal cannula[6]. HFN therapy provides optimal humidification and other benefits affecting physiologic mechanisms: physiological dead space washout with improved carbon dioxide (CO_2) levels, decreased respiratory rate, positive end-expiratory pressure, increased tidal volume, and end-expiratory volume[7]. The authors suggest High Flow Nasal Insufflation (HFNI) as a more appropriate terminology to better describe this mode of "noninvasive high-flow respiratory support"[6].

Unlike the conventional oxygen therapy modalities, HFNI can deliver heated and humidified gas with very high-flow rates that can approximate the patients' inspiratory demand while maintaining an adjustable oxygen inspiratory fraction (FiO_2)[6]. If gas flow rate exceeds their inspiratory peak flow (PIF), patients can inhale a stable mix of air-oxygen flow. Under normal conditions, PIF is about 20-30 l/min, and during increased effort or acute distress, spontaneous inspiratory until 45 litres per minute or greater field[8,9].

However, some doubts emerge because Miller and colleagues' classification of 6 includes Venturi mask among low-flow oxygen supports that do not meet inspiratory demand. Venturi Mask is a conventional oxygen therapy device developed about 1960 by Earl James Moran Campbell. He applied to the medical field the Venturi effect – known since the late 18th century – creating an oxygen delivery face mask capable of administering an air/oxygen mix through high flow rates and, at the same time simultaneously, preventing CO_2 retention[10]. The Venturi face-mask face mask receives oxygen at a specific rate, flowing into the show through a narrow tube. The oxygen flow rate increases by passing through the thin tube called the Venturi valve, and consequently, the downstream pressure decreases. The Venturi valve includes a side orifice that aspirates room air because of the decreased pressure within the lumen of the valve. In this fashion, the oxygen flow is mixed with the room air before reaching the patient at a constant and predictable rate.

Product data sheets and many independent studies about the effectiveness of Venturi masks usually do not report data about the final flow reached by this device. However, the basic concept of the Venturi mask developed by Campbell indicates that this system works as "air at a high flow-rate with controlled oxygen enrichment" generating a flow rate ranging from 30 to 80 L/min[11]. Flow rate performances can also vary according to the manufacturers' characteristics of the Venturi valves. For example, in Intersurgical EcoLiteTM mask kits with a Venturi valve (Intersurgical LTD, UK), when the oxygen flow through the Venturi valve is settled at 15 L/min with the FiO_2 35% valve, delivers a total gas flow of 84 L/min; the flow decreases to 60 L/min with the FiO_2 40%, and 30 L/min with the FiO_2 60%.

On these bases, we propose to maintain the Venturi Mask inside the conceptual framework of "high-flow" oxygenation systems, especially when settled to a middle-low FiO_2 setting (<50%), because FiO_2 is inversely proportional to flow. In addition, many Venturi systems are usually employed to generate high flow rates to adequately supply to set up HFCI or Continuous Positive Airway Pressure (CPAP) devices (when a PEEP valve is added to the exit hub of an interface or an expiratory branch of a dual-limb breathing circuit.

We hope that the COVID-19 world pandemic era could offer a way to rethink the education on oxygen therapy methods in academic and professional settings with the aim to perform a conscientious oxygen administration, titration and monitoring by nurses (and all the other healthcare professionals).

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