EXPERIMENTAL PRESSURE COMPARISON OF COMMERCIAL CPAP DEVICES: PRELIMINARY INVESTIGATION OF TARGET PERFORMANCE

Margherita De Luca (1,2), Andrea Formaggio (1,2), Giovanni Putame (1,2), Simone Borrelli (1,2), Alberto L. Audenino (1,2) and Mara Terzini (1,2)

1. Department of Mechanical and Aerospace Engineering, Politecnico di Torino, Torino (Italy)
2. Polito^{BIO}Med Lab, Politecnico di Torino, Torino (Italy)

Introduction

CPAP (continuous positive airway pressure) therapy improves the treatment of patients with obstructive sleep apnoea syndrome and is widely used to treat patients with hypoxemic respiratory failure to avoid the necessity of intensive care. The traditional CPAP devices work in an open configuration with some disadvantages such as high daily oxygen consumption, viral air contamination and high noise [1]. An alternative solution lies in an innovative system able to deliver CPAP therapy with a closed-loop breathing circuit [2]. The aim of this study is to analyse the pressure performance of commercial devices able to deliver CPAP therapy according to their normal use configuration and evaluate performance variations when the devices were tested under the normal usage configurations of the innovative closed-loop concept.

Methods

Two devices able to deliver CPAP therapy were tested: AirSense 10, ResMed (AS) and iSleep, Breas Medical (iS). Devices were tested in four configurations: in an open circuit with a full-face mask as an interface (MOP – standard configuration) or an helmet (HOP); in a closed-loop circuit with a full-face mask (MCL) or an helmet (HCL). The CPAP devices were connected via a circuit to a lung simulator (TestChest V3, Organis Gmbh) and a flow analyser (FlowAnalyser Pro, IMT Analytics), and the therapy was delivered to a head phantom through the patient interface. All tests were performed using CPAP levels at 5, 7.5 and 10 cmH_2O, simulating different conditions normally treated with CPAP therapy: a healthy subject (typical for obstructive sleep apnoea patient), a post-surgery patient and an acute respiratory distress syndrome (ARDS) patient. Thirty-six tests were performed in total, measuring the pressure at the patient connection port. Parameters for pressure performance evaluation are shown in Figure 1.

Results

The maximum deviation of P_{mean} (i.e., mean static pressure measured with the patient in apnoea) from the set CPAP level is 18% in the MCL configuration with iS. Differences between expiratory and inspiratory peaks (ΔP), results smaller with AS in all the tested configurations (Figure 2). Compared to a mask interface, using a helmet reduces pressure fluctuations. Minimum oscillations are obtained with AS at a CPAP level of 5 cmH_2O (ΔP = 3 cmH_2O in HOP with ARDS patient). Closing the breathing circuit always produces a ΔP increase.

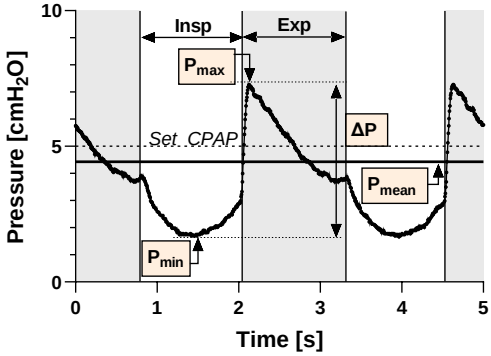

Figure 1: Pressure performance parameters depicted on a post-surgery patient (CPAP 5 cmH_2O).

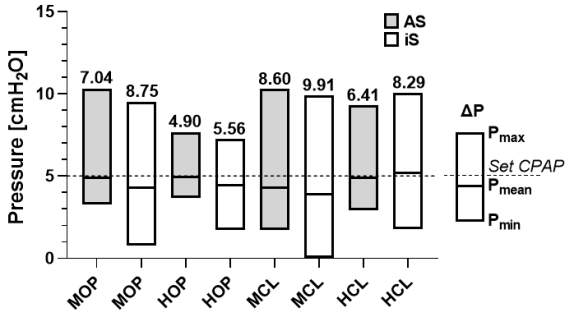

Figure 2: Performance comparison in all configurations for post-surgery patient (CPAP 5 cmH_2O).

Discussion

Initial findings indicate that AS device is more effective in maintaining P_{mean}, particularly when used in its standard configuration (MOP), likely due to a better-performing pressure control. Furthermore, the use of a helmet interface instead of a mask helps in stabilizing pressure fluctuations due to its larger internal volume. While closing the breathing circuit can solve issues related to oxygen consumption and viral load dispersion, it can also lead to increased pressure instability, possibly because the exhaled gas is retained within the circuit.

References

1. Lucchini et al. Dimens Crit Care Nurs, 9(4):194-202,2020
2. Cavaglià et al. Artif. Organs, 45(7):754-761, 2021

Acknowledgements

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