**A novel alarm device for CCHS patients ventilated during sleep**

F. Brenna1, A. Carcano2, M. Cavalleri1, F. Morandi3, G. Reni1

1 Bioengineering Laboratory, IRCCS E. Medea, Bosisio Parini (LC), Italy;

2 AISICC, Italian Association for congenital central hypoventilation syndrome, Firenze, Italy;

3 Pediatric Unit, Sacra Famiglia Hospital, Erba (CO), Italy

Email address : francesco.brenna@bp.Lnf.it

A high number of patients affected by Congenital Central Hypoventilation Syndrome (CCHS) is treated with ventilators during sleep together with monitoring of blood oxygen saturation (SpO2) to evaluate the effectiveness of the treatment and to detect critical hypoxia. If SpO2 falls below a threshold, a noisy alarm fires to alert a supervisor (a parent or a caregiver). The supervisor deals with the situation and, if there is no technical problem or false alarm, awakes the subject, because it is observed that CCHS patients usually recover from hypoxia when roused from sleep. During a single night many alarms may occur, causing fractioned sleep to the subject and a lasting state of anxiety in supervisors.

The aim of this work is to build and test a device able to automatically simulate some of the actions usually performed by the supervisor.

In particular:

1. it continuously receives SpO2 readings from a commercial pulse-oxymeter having a proper real-time interface
2. when SpO2 goes critical, it provides a number of multisensory stimulations to the patient
3. it stops the stimulations if SpO2 recovers.

This new device is based on an Android platform, with a LCD display and a touch screen interface. Using the interface it is possible to set various severity conditions. Each condition is defined both by the minimum SpO2 level not to be crossed and by the maximum time SpO2 can remain below the defined minimum level.

When a severity condition is detected, the device operates some appliances to induce a gradual arousal in the patient. Such appliances at present are: an air fan that blows towards patient’s face; a sonic alarm; a vibrating motor that tickles the patient. The intensity and combination of stimuli can be programmed to boost as time goes by, if the condition doesn’t recover. When the maximum allowed time is elapsed without any condition improvement, a remote alarm is fired in the supervisor’s room.

Stimulation is automatically ended if SpO2 returns over the safety threshold. According to literature, this might even happen without completely waking up the patient.

Expected benefits from this new device are:

1. longer sleep periods for patients, as long as stimulations and passive movements prove to be sufficient to recover from hypoxia in some circumstances
2. higher independence for young-adult patients, who could be enabled to autonomously manage most nightly critical situations
3. better quality of life for supervisors, who might feel more confident and involved only when really needed.

The device is designed with standard and open interfaces, in order to host other appliances and more input signals, such as a sleep phase analyzer that could help in choosing the intensity and combination of alarming stimuli for the same severity condition. An experimentation on normal and CCHS subjects is planned in the next months to evaluate and validate the device.