CapnoBase:
Signal database and tools to collect, share and annotate respiratory signals

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Background and Objective

The development of reliable and robust algorithms for the processing of biomedical signals in the operating room requires a series of high resolution signals recorded under different and known conditions. For algorithm tuning and validation, large datasets containing annotated clinical scenarios are required. These scenarios can be difficult to obtain, especially in the case of rare respiratory events recorded during anesthesia (e.g. rising end-tidal carbon dioxide (EtCO2) associated with malignant hyperthermia or anaphylaxis). The collection and annotation of data is very time consuming. In addition the comparative performance of an algorithm can only be assessed using a benchmark dataset. There is currently no public benchmarking dataset for respiratory signal analysis available. *CapnoBase* is a collaborative research project designed to provide easy to use research tools and a database of annotated respiratory signals including a benchmark dataset.

Methods

Following institutional ethics approval, an in vivo data set was recorded and extracted from 59 routine pediatric surgeries at the British Columbia Children's Hospital and 35 routine adult surgeries from St. Paul's Hospital, Vancouver using the S/5 Collect (Datex-Ohmeda, Inc. Madison, WI) recording software. Data sets included CO2 gas concentration (pCO2), gas flow and pressure signals from ventilated and spontaneously breathing subjects. Segments of 2 minutes each were extracted from the cases. All signals were recorded at 25 Hz. Another simulated data set was generated with a mathematical computer model of the human cardio-respiratory system (Tang, Y. et al.). To simulate different ventilated patient conditions, parameters such as ventilation rate, inspiratory/expiratory ratio, change in metabolic rate, increased pulmonary shunt, and increased dead space were modified in the model. We developed Matlab GUI (MathWorks, Inc. Natick, MA) software tools to evaluate, align and annotate the respiratory signals. The pCO2 and flow signals were aligned and the EtCO2, inspiratory pCO2, and the start of inspiration and expiration for each breath were annotated. Each segment was evaluated independently by two anesthesiologists to identify the trend in the signal, special clinical events and for the quality of the individual capnogram shapes.

Results

An initial set of 50 simulated and 190 in vivo segments of at least 2 minutes in length were rated and included in the database. The cases contain observable events such as cardiac oscillations, apnea, hypo- and hyperventilation, rebreathing, change to spontaneous breathing and change in tidal volume or respiratory rate. Fifty in vivo cases were selected to build a benchmark data set.

Conclusion

A web platform (www.capnobase.org) to foster collaboration between researchers developing algorithms for respiratory signal analysis has been developed. Participation of other researchers is keenly anticipated. The benchmark datasets will allow for comparative performance analysis of a range of different algorithms. The complete database and the evaluation tools are available for students and the wider research community.

References

Tang, Y., Turner, M.J. & Baker, A.B. Effects of alveolar dead-space, shunt and V/Q distribution on respiratory dead-space measurements. *British journal of anaesthesia* **95**, 538-48 (2005).