Clinical Medicine 2019 Vol 19, No 2: s94

Smart capnometry: Personalising the diagnosis and management of respiratory disease

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Aims

To develop a connected, portable, point-of-care medical device (capnometer) for the diagnosis, monitoring and management of acute and chronic cardiorespiratory diseases at home and in primary and secondary care environments, facilitating timely, evidence-based treatment interventions and optimisation of treatment pathways.

Methods

This device has been designed and developed as a personal lung function monitor for adults and children with breathlessness caused by cardiorespiratory pathologies. Patients breathe normally (inhalation and exhalation) into a handheld device for a short period of time (<60 s). The device uses a unique carbon dioxide (CO_2) sensor to measure the absorption of CO_2 in the infrared spectrum, from which the CO_2 concentration is calculated. Data collected by the device can be displayed on the device (for the patient) and uploaded onto a database to facilitate further analysis and shared decision making by healthcare professionals.

Results

The device reproducibly captures the exhaled CO_2 concentration in normal tidal breathing on a breath-by-breath basis with very high speed and precision. By analysing changes in the shape of the exhaled CO_2 signal, information (metrics) has been extracted to quantify the performance of the lungs, in health and disease. The shape of the CO_2 profile, and the metrics derived from this shape, collected from clinical trials, have been used to diagnose and monitor a wide range of acute and chronic respiratory pathologies including infection, COPD, asthma, cystic fibrosis and respiratory failure in motor neurone disease and heart failure. In addition to diagnosis, the capnometer provides a tool for quantifying the efficacy of treatment interventions on a personalised basis. Data collected by the device, stored on a database accessible by healthcare professionals, is facilitating remote patient monitoring and early identification of deteriorating respiratory health, allowing timely treatment interventions which prevent further deterioration and unnecessary expensive hospitalisation.

Conclusion

Currently, with the absence of appropriately sensitive and specific respiratory disease metrics, large cohorts of chronic and acute pathologies are managed through scheduled clinic/hospital reviews and acute hospital attendances/admissions. By identifying the capnographic signatures of chronic respiratory pathologies and their exacerbations, intelligent point-of-care devices can be deployed, providing patients with a tool to monitor and take ownership of their respiratory health. Specifically, tidal breathing capnometry is achievable by patients of all ages. Such an arrangement provides patients, carers and parents with reassurance, trend data to monitor stability, and early warning mechanisms to facilitate timely treatment interventions and avoid deterioration and expensive hospitalisation. ■

Conflict of interest statement

Dr John Altrip works for the NHS as an accident and emergency registrar (Pilgrim Hospital, Boston), a clinical fellow (Respiratory Support and Sleep Centre, Papworth Hospital, Cambridge) and holds an NHS England Clinical Entrepreneur Fellowship. He is also the co-founder and medical director of Cambridge Respiratory Innovations Ltd (www.criltd.co.uk).

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