Editorial

ERS International Congress 2017: preview of the "innovation in diagnosing and monitoring respiratory disease" symposium from the allied respiratory professionals assembly

Jana De Brandt[1], Laurie Smith[2,3]

[1]REVAL - Rehabilitation Research Center, BIOMED - Biomedical Research Institute, Faculty of Medicine and Life Sciences, Hasselt University, Diepenbeek, Belgium; [2]POLARIS, Academic Radiology, University of Sheffield, Sheffield, UK; [3]Sheffield Children's Hospital NHS Foundation Trust, Sheffield, UK

Correspondence to: Jana De Brandt. Campus Diepenbeek, Hasselt University, Agoralaan Building A, 3590 Diepenbeek, Belgium.
Email: jana.debrandt@uhasselt.be.

Submitted Nov 19, 2017. Accepted for publication Nov 20, 2017.
doi: 10.21037/jtd.2017.12.96
View this article at: http://dx.doi.org/10.21037/jtd.2017.12.96

Introduction

The symposium on "*innovation in diagnosing and monitoring respiratory disease*" was organised by ERS Assembly 9, which represents allied respiratory professionals (lung function technologists, physiotherapists and nurses), at the ERS International Conference in Milan [Session 542, Wednesday 13th of September at Beige (South) room from 10:45–12:45]. This session focuses on new technologies that aim to diagnose respiratory disease early and to reduce the burden of lung disease. These technologies aim to enable professionals to provide care closer to home. Four experts and one patient were invited to provide insight into these research developments, with a focus on the technology used and critical appraisal of e-health solutions.

Many interesting and novel findings will be presented during the conference, which are too numerous to be covered by this preview. We hope this preview raises the interest of the readers of the *Journal of Thoracic Diseases* towards ERS activities and look forward to welcoming its readers at future ERS International Congress.

Tele-health technologies in asthma

By Kay Boycott—Chief executive, Asthma UK

Respiratory disease costs the EU more than €380 billion a year. With a global asthma population that is due to grow to 400 million by 2025, there will be increasing pressure on healthcare systems and health care professionals. This could lead to poor outcomes and experiences for people with asthma.

The public are increasingly used to carrying around devices such as smart phones and a drive must be made to ensure we take advantage of this technology to develop improved monitoring and diagnostic tools. Initial research suggests a willingness among the asthma population to carry a connected device. This is in parallel with the increasing investment in technology within care settings and digitisation of care pathways. There is therefore a major opportunity for people with asthma, healthcare professionals and health systems to use data from these devices over the coming decade to improve asthma outcomes. During the symposium, priorities for innovation, the end use requirements and current innovation landscape in new technologies which are supporting better asthma care, will be explored.

The symposium will discuss the main unmet need in research as identified through the European Asthma Research and Innovation Partnership (EARIP) and the need to take into account high risk populations when designing a trial. It will touch on segmentation led on by Asthma UK using Experian demographic data, combined with UK health data sets to build a segmentation and methods to achieve self-management.

It will also discuss the broader landscape of connected devices for asthma and the future research potential generated by the data collected by these devices. This will look at Asthma UK's two reports on connected devices

(Connected Asthma and Smart Asthma) and how rapid the research and development arena look around this area. It will also focus on the vast data opportunities and care pathway improvements created by connected devices. With the widespread roll out of connected devices we can collect better data which will enable us to drive deeper phenotyping.

Lung volume technologies: a futuristic 3-dimensional (3D) method

By Dr. James Dodd—Consultant and honorary senior lecturer in Respiratory Medicine at North Bristol NHS Trust, UK

There is an increasing interest in technologies that may enable remote monitoring of long term conditions in the home environment (1,2). The current gold standard physiological measure of lung function is spirometry; this requires the subject to co-ordinate a full inhalation followed by a forced exhalation into a flow or volume measuring device, which produces a graphical representation of the relationship between exhaled flow and volume. Spirometry however has limitations and can be expensive, requiring specialist equipment and training to perform and interpret and can be difficult to perform for some patients (for example the very young, frail, or cognitively impaired). Spirometry also gives limited physiological insight into lung disease. A novel approach to respiratory function assessment, which has the potential to improve the quality of disease monitoring, is non-contact measurements of respiratory motion.

Non-contact measurement of lung volumes has previously been explored. These include structured light (3-5), accelerometers (6), optoelectronic plethysmography (7,8), and impedance pneumography (9). These novel technologies could also be used for real-time home monitoring of long term conditions, supporting self-management and preventing adverse health events such as hospitalizations.

In addition to home monitoring, other possible applications include; population screening for lung disease, respiratory gating for radiological imaging techniques [such as magnetic resonance imaging (MRI)] and patient-ventilator synchronization for non-invasive or invasive mechanical ventilation. Some of these techniques assessed to date have been costly and their role in day to day practice remains to be defined.

Recent technological advances have reduced the cost of time-of-flight cameras, which measure 3D movement in real-time, from which motion can be detected to within 0.1 mm (10). This is achieved through calculation of multiple distances between the camera, the object of interest and a virtual plane a specified distance from the camera, using Light Imaging, Detection, And Ranging (LIDAR) technology. This is a detection system which works on the principle of radar, but uses light from a laser.

Data will be presented from a developmental study designed with engineers as part of the EPSRC SPHERE project (http://www.irc-sphere.ac.uk/) who are developing sensors for the home to diagnose and help manage health and wellbeing conditions. The technology aims to aid early diagnosis, lifestyle change and the ability of patients to live at home.

This preliminary assessment of a low cost, "off-the-shelf" game console camera to estimate chest volume changes during spirometry, suggests it can accurately track respiratory rate and motion. Currently this technology is limited by the need to generate a scaling factor for each subject in order to convert the estimated volume change in the model to assess accurate air flow. Positive predictive value for obstructive spirometry was 0.833, however the negative predictive value was 0.685. This technique may still have potential, if further refined, as a method of screening for respiratory disease.

Other approaches to remote chest volume change estimation have included optoelectronic plethysmography, which utilise slight-based tracking of multiple markers placed on the body. This technology has demonstrated similarly close correlation with spirometry in 10 healthy subjects with normal lung function (8), however this was limited by the requirement for multiple chest wall markers.

Structured light plethysmography is the most progressed of remote lung function assessment techniques. Initially developed in the 1980s, commercially available devices are now available such as the Thora3Di (PneumaCare, Cambridge, UK). These rely on the projection of a grid pattern of light recorded by two cameras from which volume changes are estimated. Studies published in abstract form have been from healthy subjects with normal lung function, showing good correlation with spirometry and acceptable variability by Bland-Altman analysis (11).

During the symposium the potential of 3D chest wall motion tracking in respiratory medicine will be summarized. In the short to medium term, this technique could be used to remotely monitor respiratory rate, screen for abnormal spirometry or assist patient/ventilator synchronization.

As clinicians we understand that individual patient's reasons for admission to hospital and deterioration in health are complex—projects such as SPHERE are working to capture and understand this complexity and use it to support the patient and healthcare workers to improve disease outcomes. However, it is vital that clinicians engage with engineers, healthcare administrators, computer scientists and others to ensure that we focus on important clinical problems.

Biomarker technologies: 4-dimensional (4D) approach

By Prof. Dr. Peter Sterk—Professor of Pathophysiology and Phenotyping of Asthma and COPD at the Faculty of Medicine of the University of Amsterdam, The Netherlands

Biomarkers can be useful in the diagnosis, phenotyping and monitoring of patients with respiratory diseases. In particular, this holds for chronic diseases, such as asthma or COPD, and for severe lung diseases such as lung cancer and interstitial lung diseases. Thus far, singular biomarkers or combinations of those have mostly been used to complement clinical markers for these purposes. For example, in asthma, eosinophil counts in blood or sputum and exhaled nitric oxide (FeNO) are increasingly used in the subtyping of the disease. This is most relevant for therapeutic choices, in this case regarding inhaled steroids and the new biological treatments such as anti-IL-5 (12).

Recently, technologies have evolved to measure multiple biomarker at once and to express the results in a so-called biomarker fingerprint or signature. This has the advantage of taking the benefit of composite, biological information. These high throughput assessments are based on 'omics' technologies that allow the measurements of thousands of molecular markers at once. Examples are genomics at the DNA level, transcriptomics at the RNA level, proteomics for proteins, and metabolomics for metabolites (13). This can be performed from blood, sputum, urine and even exhaled breath. When coupled to pattern recognition algorithms, these technologies are delivering molecular fingerprints or signatures of individual patients. In this way transcriptomic analysis in blood has led to novel subtyping of patients with asthma or COPD (14). The advantage of such novel phenotyping of patients is that this is more closely related to biological mechanisms, which provides insight into more individual targeted interventions.

Breathomics is the quickest and least invasive 'omics' technology, since it provides a molecular fingerprint of exhaled air, by electronic nose (eNose) or gas chromatography/mass spectrometry (GC/MS). The latter is the standard analytical chemistry technique in the lab, whereas eNoses are making use of cross-reactive sensors that can give pseudo real-time results at point of care when linked to a cloud-based database (www.breathcloud.org). This technology is now delivering increasingly accurate diagnosis and phenotyping in various lung diseases (15).

The 4D aspect arises when following biomarkers over time. Hence, when monitoring individual patients during the course of their disease. This aspect has not been widely covered yet, but ongoing projects are attempting to capture information about the variability of biomarkers over time, by time series analysis. This aims to discover the 'signal in the noise'. In other words: what previously was considered to be random variability, is now being analyzed in depth (e.g., by detrended fluctuation—or attractor analysis) demonstrating diagnostic or phenotypic signatures or fingerprints in the pattern of variation (16).

Eventually, it can be predicted that powerful pattern recognition of 'omics' and time series data will provide strong, complementary information for early diagnosis, individual phenotyping, and personalized therapy in patients with lung diseases.

Wearable technologies

By Dr. Fabio Pitta—Professor of Respiratory Physiotherapy at the State University of Londrina, Brazil

Objective assessment of physical activity in daily life is a current hot topic in the scientific literature. It can involve patients with respiratory disease and many other populations, including the elderly and individuals with various chronic diseases. A diversity of wearable tools to investigate daily physical activity are available, and a body of literature has emerged concerning the characteristics and limitations of these tools. As an example, pedometers are small and relatively inexpensive motion sensors, which essentially count steps walked and estimate energy expenditure. Similarly, many cell phone apps, with the goal of monitoring steps/day, energy expenditure and daily physical activity, are also available. Accelerometers are motion sensors that have reached a higher degree of technological advance. When compared to pedometers, they are more sensitive, can store data for weeks and can also be remotely controlled. Some accelerometers are able to differentiate the intensity of physical activity performed and the time spent in different activities and body postures (e.g., walking, standing, sitting, lying), and for this reason are also known as "activity monitors". During the symposium characteristics, advantages and limitations of the available monitoring tools available to assess physical activity in subjects with chronic respiratory disease will be discussed.

Furthermore, recent advances in technology have also led to the development of light and small oxygen therapy devices and portable ventilators, which aim to facilitate patients' mobility and ambulation. Understanding different portable devices is of relevance to better understand the association with physical activity impairments due to equipment-related restriction in mobility, adding to the isolated aspects of disease limitation. Stationary home devices have been technologically improved and portable oxygen equipment has been developed, which aims to meet the needs of those patients who present with less daily life limitations or those who intend to be more mobile. However, providing lightweight oxygen may not necessarily change patients' behaviours since there is evidence that these light devices may not increase either oxygen use or activity.

Portable ventilators are useful to provide mechanical ventilation to patients in the home environment. They continue to decrease in size and, alongside the improving technology, results in increased device performance. More recently, a novel, portable, non-invasive open ventilation system (NIOV) was designed for non-invasive ventilation, which is specifically intended to facilitate ambulation and enhance the performance of daily living activities. The device was well tolerated and the addition of supplemental oxygen remarkably prolonged exercise tolerance and improved patient's comfort during activities of daily living. This was accompanied by respiratory muscle unloading and a reduction in dyspnea.

Despite the advantages of using lightweight home oxygen therapy devices and portable ventilators, the daily dependence on equipment may reduce mobility and partially impair patients' physical activity level. The challenge is to circumvent these limitations and continue to advance towards the best possible care for patients with chronic respiratory diseases.

E-health solutions from a patient's perspective

By Annette Brons—Asthma patient, The Netherlands

This presentation is from a stranger in your midst, since I am an asthma patient instead of a physician or scientist. I was asked to tell something about e-health from a patient's perspective as I use several standard e-health solutions.

To start with, I order my medication through my pharmacy's website. This really saves a lot of time and unnecessary pharmacy visits, since I only have to go there once to pick up everything I ordered. If my asthma gets worse and increasing my medication myself does not have the desired effect, I can also contact my lung physician via e-mail. I shortly tell him what's wrong, for how many days, what my peak flow is, whether I have a fever or not, and what I already tried. No later than at the end of the day, but mostly within a few hours, he replies with what I should do. Subsequently, he sends the necessary prescription to the pharmacy. This way of communication is beneficial for both of us by saving us a lot of time.

In addition to these standard e-health solutions, I also use monitoring apps. I check my peak flow regularly and enter these values in an application on my mobile phone. This way, I can see the trend of my peak flow values. Since it is difficult for me to feel whether my asthma worsens, this helps me signal deterioration and it enables me to increase my medication in time. Recently, I also started to use a wearable monitor, which is able to count my steps, measure my heart rate, and track my sleep. Although I loved to play sports, it caused dyspnea the following night frequently. My asthma is very capricious and I therefore find it difficult to know when I am training too hard. Now that I am able to track my heart rate while training, I am more aware of the impact and I can adjust my training to my current physical state.

All of these e-health solutions have improved my quality of life. However, I have also tried several promising solutions that regrettably turned out to be less useful. In general and in my opinion, the following five aspects seem to be important for an e-health solution to be used regularly: accessibility, time consumption, costs, privacy, and individual adjustment. The e-health solution should be accessible, easy to use and easy to find, especially considering a large proportion of people with lung conditions are relatively old and may not have that much experience with the technology. Furthermore, to use a solution regularly it should become a habit, which will only be the case if it does not take too much time. Moreover, healthcare costs are already high and should therefore be not too expensive. However, in order for companies to keep costs low, patients often 'pay' to share their data to keep the e-health applications free of charge. Data collection is indeed important for improving e-health solutions, but confidentiality has to be guaranteed. Lastly, it is important that the e-health solution can be adapted to patients' individual situation, since each patient has their own wishes and needs.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. De San Miguel K, Smith J, Lewin G. Telehealth remote monitoring for community-dwelling older adults with chronic obstructive pulmonary disease. Telemed J E Health 2013;19:652-7.
2. Chatwin M, Hawkins G, Panicchia L, et al. Randomised crossover trial of telemonitoring in chronic respiratory patients (TeleCRAFT trial). Thorax 2016;71:305-11.
3. Morgan MD, Gourlay AR, Denison DM. An optical method of studying the shape and movement of the chest wall in recumbent patients. Thorax 1984;39:101-6.
4. Lau E, Brand D, Wareham RJ, et al. Comparison of Forced Expiratory Volumes Measured with Structured Light Plethysmography (SLP) and Spirometry. British Thoracic Society Winter Meeting, London, 2009.
5. Aoki H, Miyazaki M, Nakamura H, et al. "Non-contact respiration measurement using structured light 3-D sensor, in Paper presented at: SICE Annual Conference (SICE). Akita, 2012.
6. Reich AR, McHenry MA. Estimating respiratory volumes from rib cage and abdominal displacements during ventilatory and speech activities. J Speech Hear Res 1990;33:467-75.
7. Cala SJ, Kenyon CM, Ferrigno G, et al. Chest wall and lung volume estimation by optical reflectance motion analysis. J Appl Physiol (1985) 1996;81:2680-9.
8. Aliverti A, Dellaca R, Pelosi P, et al. Compartmental analysis of breathing in the supine and prone positions by optoelectronic plethysmography. Ann Biomed Eng 2001;29:60-70.
9. Sackner JD, Nixon AJ, Davis B, et al. Non-invasive measurement of ventilation during exercise using a respiratory inductive plethysmograph. I. Am Rev Respir Dis 1980;122:867-71.
10. Penne J, Schaller C, Hornegger J, et al. Robust real-time 3D respiratory motion detection using time-of-flight cameras. Int J Comp Assist Radiolo Surg 2008;3:427-31.
11. Lau E, Brand D, Wareham RJ, et al. "Forced expiratory flow and volume measured with structured light plethysmography and spirometry". American Thoracic Society International Conference. New Orleans, 2010.
12. Agusti A, Bel E, Thomas M, et al. Treatable traits: toward precision medicine of chronic airway diseases. Eur Respir J 2016;47:410-9.
13. Wheelock CE, Goss VM, Balgoma D, et al. Application of 'omics technologies to biomarker discovery in inflammatory lung diseases. Eur Respir J 2013;42:802-25.
14. Bigler J, Boedigheimer M, Schofield JP, et al. A Severe Asthma Disease Signature from Gene Expression Profiling of Peripheral Blood from U-BIOPRED Cohorts. Am J Respir Crit Care Med 2017;195:1311-20.
15. Bos LD, Sterk PJ, Fowler SJ. Breathomics in the setting of asthma and chronic obstructive pulmonary disease. J Allergy Clin Immunol 2016;138:970-6.
16. Thamrin C, Frey U, Kaminsky DA, et al. Systems Biology and Clinical Practice in Respiratory Medicine. The Twain Shall Meet. Am J Respir Crit Care Med 2016;194:1053-61.

Cite this article as: De Brandt J, Smith L. ERS International Congress 2017: preview of the "innovation in diagnosing and monitoring respiratory disease" symposium from the allied respiratory professionals assembly. J Thorac Dis 2017;9(12):4942-4946. doi: 10.21037/jtd.2017.12.96