EDITORIAL

Infant Pulmonary Function Testing: An Upcoming Modality for Evaluation of Respiratory Disorders

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Pulmonary function tests (PFTs) are used in adults and in children over six years of age to assist with monitoring a variety of lung conditions, and in some cases to aid diagnosis. The majority of available tests require the subject to perform complex respiratory maneuvers such as deep inspirations, forced expirations, or breath-holds. Such respiratory gymnastics are not possible for subjects younger than six years age. Respiratory physiologists divide this younger cohort into two groups: infants - who for this indication are defined as subjects less than two years age; and preschool children - who for this indication are defined as those aged between 3 to 6 years.The distinction is based upon the methodological approach to obtaining measurement. Succinctly, PFTs in infancy are obtained when the subject is asleep and the operator controls any necessary maneuvers. PFTs in the preschool years are obtained by a mixture of incentive techniques and distraction techniques, depending on the test being performed.

Infant pulmonary function testing (IPFT) has been performed by specialist centres for more than 40 years. Progress initially was slow, as individual tests are very time consuming, require two operators, and testing equipment had to be hand designed and built. Great progress was made, mainly due to the perseverance and dedication of a small number of committed physiologists. By the 1990s, laboratories had access to commercially produced IPFT equipment, and testing was being performed for clinical indications as well as for research. The progress has been such that a recent American Thoracic Society workshop report concentrated upon the clinical application of these measurements rather than simply upon the methodology [1].

All biomedical measurements need to meet certain criteria before they can be used in clinical practice. There need to be standardized procedures or approaches for equipment, staffing, data collection, data interpretation, and quality control. There needs to be adequate information on the variability of the measure, and crucially, reference ranges for normal values that are relevant to the local population. With regard to the last of these, in this issue of *Indian Pediatrics*, Kumar and colleagues [2] present data from repeated IPFT measurements in healthy children tested at their center between 2012 and 2017. The data presented here represent an extraordinary achievement. The authors have collected six-monthly data for three different IPFT modalities from birth to 36 months age in 281 healthy children. The three modalities are tidal breathing flow-volume loop (TBFVL), rapid thoracoabdominal compression (RTC), and raised volume RTC (RVRTC). The authors have generated centile curves using the LMS method, and gender-specific data.

The strengths of the study [2] are a prospective birth cohort design, excellent follow-up, and adherence to American Thoracic Society/European Respiratory Society criteria for IPFT testing [3,4]. The study does not have any funding from the manufacturers of the equipment. The limitations include being a single-center study from Northern India and lack of analysis by ethnicity. More importantly, and presumably unavoidably, the three modalities presented are not necessarily the three most useful to clinical care. TBFVL measurements are relatively easy to collect, but the data do not discriminate well between health and disease, and the test is now rarely used internationally. The RTC test is best considered a methodological precursor to the RVRTC test and has therefore been almost completely supplanted by the latter. At the same time the authors were unable to provide any data on infant plethysmography, multi-breath washout, or forced oscillation. That said, the RVRTC test – sometimes termed infant spirometry – is probably the single most widely used IPFT internationally, and the data presented here will be of great value to pediatric pulmonologists in India, and also to the wider international community.

What next for this area? At present the international consensus is that IPFT has rather limited clinical application. Some European and North American cystic fibrosis centers use IPFT (usually RVRTC plus multi-breath washout) as part of their clinical monitoring [5,6]. Even here, it is recognized that abnormalities can be very minor. Some centers with specialism in childhood interstitial lung diseases will use limited IPFT measurements in their practice. However, it should be noted that at present there are no commercially available systems for measurement of transfer factor in infants. With the current evidence, IPFT does not appear to be of value in the monitoring of chronic lung disease of prematurity or recurrent wheeze [1].

In our opinion, there is greater potential in the field of pediatric pulmonology research. It should not be forgotten that a ground-breaking IPFT study from the Institute of Child Health in London first identified the impact of maternal antenatal smoking upon infant lung development [7]. The effect of airborne pollution upon lung health is becoming a public health emergency, nowhere more so than in India. As pediatricians, we have a duty to determine whether airborne pollution is damaging the lungs of our youngest citizens. Perhaps the work of Kumar, *et al.* [2] can assist us with the next stage of this research.

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REFERENCES

1. Rosenfeld M, Allen J, Arets BH, Aurora P, Beydon N, Calogero C, *et al*. An Official American Thoracic Society Workshop Report:Optimal Lung Function Tests for Monitoring Cystic Fibrosis, Bronchopulmonary Dysplasia, and Recurrent Wheezing in Children Less Than 6 Years of Age. Ann Am Thorac Soc. 2013;10:S1-S11.
2. Kumar P, Mukhherjee A, Pandey S, Jat KR, Lodha R, Kabra SK. Normative data of infant pulmonary function testing: A prospective birth cohort study from India. Indian Pediatr. 2020; 57:25-33.
3. Bates JHT, Schmalisch G, Filbrun D, Stocks J. Tidal breath analysis for infant pulmonary function testing. Eur Respir J. 2000;16:1180-92.
4. Sly PD, Tepper R, Henschen M, Gappa M, Stocks J. Tidal Forced Expirations. ERS/ATS Task Force on Standards for Infant Respiratory Function Testing. European Respiratory Society/American Thoracic Society. Eur Respir J. 2000;16:741-48.
5. Matecki S, Kent L, de Boeck K, Le Bourgeois M, Zielen S, Braggion, *et al*. Is the raised volume rapid thoracic compression technique ready for use in clinical trials in infants with cystic fibrosis? J Cyst Fibros. 2016;15:10-20.
6. Kent L, Reix P, Innes JA, Zielen S, Le Bourgeois M, Braggion C, *et al*. Lung clearance index: evidence for use in clinical trials in cystic fibrosis. J Cyst Fibros. 2014;13: 123-38.
7. Hoo AF, Henschen M, Dezateux C, Costeloe K, Stocks J. Respiratory function among preterm infants whose mothers smoked during pregnancy. Am J Respir Crit Care Med. 1998;158:700-5.