LUNG FUNCTION IN THE TIME OF COVID-19

AFRIPAEDLF WORKING GROUP MEETING, 1 OCTOBER 2020
DI GRAY
LUNG FUNCTION AND COVID-19 RISK

- Key concern around lung function and infectious risk
  - Aerosolising, especially forced manoeuvres
  - Exposing at risk patients to infectious spaces
South Africa: children 7.6% of laboratory confirmed cases and 2.9% of admissions;
UPDATE: POSITION STATEMENT OF THE SOUTH AFRICAN THORACIC SOCIETY (SATS) ON PULMONARY FUNCTION TESTING (PFT)

The South African Thoracic Society, in line with other international respiratory societies, recommends that pulmonary function testing can be reintroduced where there is a clinical or other substantial indication for testing, provided personnel and subjects are adequately protected from contracting SARS-CoV-2. While it remains the employer’s responsibility to provide pulmonary function technologists and other individuals involved with a safe working environment, SATS recommends the following:

1. There should be an important clinical or other substantial indication (including compensation and research) to perform testing. Deferring testing should be considered where the perceived risk outweighs the benefit.
2. Personnel performing the test should be assessed for risk of severe COVID-19 disease, and high-risk personnel should not be forced to perform PFTs.
4. PFTs may be performed 4 weeks after symptom onset in individuals who had proven or highly likely symptomatic COVID-19, and a negative screen (as per point 3).
5. Testing capacity/volumes should at the present time preferably be escalated to no more than 50% of pre-COVID capacity, to allow for adequate time between subjects to ensure safety in addition to measures to ensure social distancing.
6. The contact time between personnel and subjects should be minimised wherever possible.
Recommendation from ERS Group 9.1 (Respiratory function technologists /Scientists)
Lung function testing during COVID-19 pandemic and beyond

We recommend the following safety measures for lung function testing based on the prevalence of COVID-19 in the community:

<table>
<thead>
<tr>
<th>Pandemic phase</th>
<th>High community prevalence</th>
<th>Level 1 safety recommendations</th>
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</thead>
<tbody>
<tr>
<td>Post Peak phase</td>
<td>Low community prevalence</td>
<td>Level 2 safety recommendations</td>
</tr>
<tr>
<td>Post Pandemic phase</td>
<td>Controlled</td>
<td>Level 3 safety recommendations</td>
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**Recommendations for Pandemic Phase - Level 1 safety**

During high prevalence of the virus in the community, referring personnel must carefully consider the safety of staff, cross-contamination of equipment and therefore restrict referrals to patients requiring urgent / essential tests only for immediate diagnostics of current illness.
**Spirometry (and other Lung Function) Testing during COVID-19 PROTOCOL**

- **Key Messages:**
  - Only tests that will inform key diagnostic or management decisions should be done.
  - No one acutely sick or within 2 weeks of COVID exposure should be tested.
  - Careful attention to strict infection control and PPE; book less patients, space them to avoid clustering and allow time between tests.
  - Tidal breathing measures (oscillometry, FeNO, MBW) are less aerosolising than spirometry and are safer. Consider using where appropriate to your clinical question.
  - Avoid bronchial provocation and exercise testing.

**Strict infection control**

- Screening: at booking and arrival
- Avoid crowding: booking, spacing in waiting room, reduce people in lung function room
- Good ventilation: negative pressure or open windows
- Masks and visors
- Strict hand hygiene
- Equipment and used surfaces: wiped down between testing
- Filters: single use (cf. NDD ultrasonic flow meters need additional filter)
- After test clean and leave room for 15 min
EasyOn PC – inline filter placed behind the spirette

EasyOne Air – inline filter placed behind the spirette

EasyOne Pro / Lab – inline filter placed in front of the spirette
DISCUSSION
ERS 2020: Paediatric Respiratory Physiology Summary

Kathryn Ramsey
University Children’s Hospital Bern, Switzerland
Paediatric Respiratory Physiology sessions

Oral sessions:
- Chronic respiratory diseases and their origins in early life - how physiology meets clinical medicine
- Covid-19 Impact in children with chronic lung conditions
- Live from the clinic (procedure videos) - paediatric procedures and physiology
- New frontiers in CF imaging and lung physiology
- Respiratory physiology and sleep: from neonates to adults

Poster sessions:
- Respiratory physiology and sleep: new approaches to diagnosis and treatment
- Respiratory physiology and sleep: from neonates to adults
- Clinical monitoring and new therapies for cystic fibrosis
Chronic respiratory diseases and their origins in early life: how physiology meets clinical medicine

Elianne Vrijlandt (Netherlands)

Summarised impact:

- Transgenerational impacts
- *In utero* smoking
- Premature birth / BPD
- Parental smoking
- Viral infections
- Maternal/paternal asthma
- Gene-environment interactions
Chronic respiratory diseases and their origins in early life: how physiology meets clinical medicine

Alexander Möller (Zurich)

ERS survey of Covid-19 in children with respiratory conditions including asthma, cystic fibrosis, and BPD

- March 2020
- 174 centres responded
- 94 centres with cases in 945 children

Emerging data suggests children with respiratory conditions not at increased risk for severe Covid-19 infection

Conclusions

- We were able to collect some data from a large group of children with Covid-19 infection
- Due to the design of the survey the details of the results are limited
- The low numbers of children with the reported conditions admitted to hospital suggest that these children are not at increased risk for severe COVID-19
- These emerging findings may be useful for governments planning for provision of care over the coming months and years
- Still, a sizeable minority of children with BPD and respiratory diseases other than asthma might be at increased risk and may benefit from being shielded.
Sanja Stanojevic (Toronto):

- 64 CF children and 50 healthy controls
- Longitudinal 3 monthly MBW outcomes at preschool (3-4y) and school age (5-10y)
- Mean LCI and LCI slope during preschool years associated with LCI at school age
- Higher rate of hospitalisations associated with higher LCI
- LCI relatively stable during school age years
New frontiers in CF imaging and lung physiology

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Bettina Frauchiger (Bern):

- 71 CF children (907 visits)
- Longitudinal 3 monthly MBW at routine clinical surveillance
- LCI relatively stable in preschool and school-age, increases during adolescence
- Risk factors: aspergillus, pseudomonas, exacerbations, CF related diabetes, ABPA
- Steeper increase in females (mostly explained by higher incidence of risk factors)
Respiratory physiology and sleep: from neonates to adults

**Tonja Bårdsen (Norway):**

- Spirometry outcomes in former pre-terms vs term born controls
- Extremely preterm born subjects
  - GA ≤ 28 wks, BW ≤ 1000g
  - Born in 3 decades (80s, 90s, 00s)
  - N = 30-50 per group
- Worse FEV₁ in pre-terms but improvement over time, especially in BPD
Respiratory physiology and sleep: from neonates to adults

Yasmin Salem (Bern):

• Impact of caesarean section on respiratory outcomes in first year of life
• 580 healthy infants with weekly surveillance (114 CS)
• No impact of C-section delivery on respiratory outcomes:
  ▪ Weekly respiratory symptoms
  ▪ Weekly respiratory rate
  ▪ Lung function at 6 weeks of age

Results // Respiratory symptoms

<table>
<thead>
<tr>
<th>VD: n=459</th>
<th>CS: n=111 (39 with CS planned)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daytime symptoms</strong></td>
<td><strong>Nighttime symptoms</strong></td>
</tr>
</tbody>
</table>

Figure 1. Weeks with respiratory symptoms in the first year of life.
Any day-nighttime symptoms: score > 0. Any severe symptoms: score ≥ 3.

<table>
<thead>
<tr>
<th>Weeks with any respiratory symptoms</th>
<th>Adjusted IRR (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS all</td>
<td>0.82 (0.67 to 0.98)</td>
<td>0.048</td>
</tr>
<tr>
<td>CS planned</td>
<td>0.75 (0.53 to 1.05)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Table 2. Weeks with any respiratory symptoms (symptom score > 0).
* adjusted for: sex, gestational age, birth weight, maternal age, older siblings, child care, atopy of the mother and the educational status of the father.
# from poisson regression model with children born by VD as reference group.
Florian Wyler (Bern):

- 15-20% disagreement in outcomes between Ecomedics and ndd devices
- Due to sensor characteristics rather than algorithms or breathing pattern
- Ecomedics device over-estimates N₂ concentration due to error in O₂ sensor
- Correction is possible but will involve reloading all measurements (hopefully possible in future version of Spiroware – not 3.30)
Further development of SPIROWARE®

In the course of SPIROWARE® 3.3 development, we were informed by the Latzin group (Florian Wyler, Marc Oestreich, Kathryn Ramsey and Philipp Latzin) that the accuracy of our sensors can be further improved beyond the specifications from the manufacturer. We collaborated with them to extensively test the accuracy of the device sensors. Our measurements using a mass spectrometer confirmed the findings of the Latzin group who had used fixed reference gas mixtures. We have then developed an algorithm to correct the sensor signals (Fig. 1). In a first analysis we assumed a linear relationship and have re-analysed 884 N2MBW tests, which showed that the main effect was an offset and slight compression of the LCI scale. Z-scores remained stable on average (Fig. 2). At the moment, it looks like the clinical statement of the LCI remains the same.

Our goal is to implement an automatic correction, which can be applied during migration of the SPIROWARE® database. However further validation of the modified algorithms is required with a larger dataset.
New Wbreath version available online

Marc Oestreich (Bern):

- Infant MBW signal processing and algorithms in current Wbreath version (3.28.0) unclear
- Large disagreement with new Spiroware setup
- Wbreath outcomes not calculated according to consensus statement

New Wbreath version (3.52.3) uses same algorithms as consensus and Spiroware (available online)

- 15% increase in LCI and 7% decrease in FRC compared to old Wbreath version
Summary of Spirometry data in Africa

R Masekela and Diane Gray
Number of people approached for testing $N=4223$

Total Excluded $N=546$

Reasons for exclusion:
- Failed medical screening questions (130)
- Pulmonary function tests failed quality control (138)
- Current or past smoker (156)
- Data missing (100)
- Z-score greater than +/- 5 (18)
- Excluded due to ethnicity/ age (4)

Included tests $N=3677$
## PAAS 2- Results

### Table 1. Characteristics of the study population (KwaZulu-Natal and Western Cape province, South Africa).

<table>
<thead>
<tr>
<th></th>
<th>Black African (n=2116)</th>
<th>Caucasian (n=343)</th>
<th>Mixed Ethnicity (n=693)</th>
<th>Indian (n=524)</th>
<th>Total (n=3676)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex - Female</strong></td>
<td>1200 (56.6%)</td>
<td>153 (44.6%)</td>
<td>404 (58.3%)</td>
<td>326 (62.2%)</td>
<td>2083 (56.7%)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 25 years</td>
<td>1128 (53.3%)</td>
<td>212 (61.8%)</td>
<td>440 (63.5%)</td>
<td>243 (46.4%)</td>
<td>2023 (55.0%)</td>
</tr>
<tr>
<td>&gt; 25 years</td>
<td>988 (46.7%)</td>
<td>131 (38.2%)</td>
<td>253 (36.5%)</td>
<td>281 (53.6%)</td>
<td>1653 (45.0%)</td>
</tr>
<tr>
<td><strong>Weight for age Z-score</strong></td>
<td>0.04 (0.41)</td>
<td>0.10 (0.66)</td>
<td>0.09 (0.47)</td>
<td>0.12 (0.56)</td>
<td>0.07 (0.48)</td>
</tr>
<tr>
<td><strong>Height for age Z-score</strong></td>
<td>-0.27 (0.84)</td>
<td>0.08 (0.87)</td>
<td>-0.40 (1.12)</td>
<td>-0.25 (0.95)</td>
<td>-0.26 (0.92)</td>
</tr>
<tr>
<td><strong>BMI for age Z-score</strong></td>
<td>0.99 (1.28)</td>
<td>0.71 (1.15)</td>
<td>0.90 (1.034)</td>
<td>1.01 (1.28)</td>
<td>0.95 (1.29)</td>
</tr>
<tr>
<td><strong>Carnic index</strong></td>
<td>0.51 (0.03)</td>
<td>0.52 (0.04)</td>
<td>0.50 (0.03)</td>
<td>0.52 (0.03)</td>
<td>0.51 (0.03)</td>
</tr>
<tr>
<td><strong>Stunting</strong></td>
<td>110 (5.2%)</td>
<td>5 (1.5%)</td>
<td>64 (9.2%)</td>
<td>37 (7.1%)</td>
<td>216 (5.9%)</td>
</tr>
<tr>
<td><strong>Province</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KwaZulu-Natal</td>
<td>1260 (59.6%)</td>
<td>236 (68.8%)</td>
<td>306 (44.2%)</td>
<td>517 (98.7%)</td>
<td>2319 (63.1%)</td>
</tr>
<tr>
<td>Western Cape</td>
<td>856 (40.4%)</td>
<td>107 (31.2%)</td>
<td>387 (55.8%)</td>
<td>7 (1.3%)</td>
<td>1357 (36.9%)</td>
</tr>
</tbody>
</table>
Figure 2. Summary of FEV₁ Z-scores for each ethnic group using each of the GLI reference equations. The equations that resulted in the closest fit to a mean z-score of zero, and a standard deviation of one were selected as best fit.
Figure 3. Summary of FVC Z-scores for each ethnic group using each of the GLI reference equations. The equations that resulted in the closest fit to a mean z-score of zero, and a standard deviation of one were selected as best fit.
Acknowledgements

• Collaborators
  • Sara Jane Nimmo (UK)
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