Updates in Pulmonary Medicine

Lillie Morgan, MD
Cleveland Clinic, Respiratory Institute
Agenda

• Updates in Asthma

• Updates in COPD

• Vaping Induced Lung Injury
ASTHMA: New in 2019
Step 1 treatment is for patients with symptoms <twice/month and no risk factors for exacerbations

Previously, no controller was recommended for Step 1, i.e. SABA-only treatment was ‘preferred’
**Box 3-5A**

**Adults & adolescents 12+ years**

**Personalized asthma management:**
Assess, Adjust, Review response

**Asthma medication options:**
Adjust treatment up and down for individual patient needs

**PREFERRED CONTROLLER**
to prevent exacerbations and control symptoms

**PREFERRED RELIEVER**
Other reliever option

**STEP 1**
- As-needed low dose ICS-formoterol *
- Low dose ICS taken whenever SABA is taken

**STEP 2**
- Daily low dose inhaled corticosteroid (ICS), or as-needed low dose ICS-formoterol *
- Leukotriene receptor antagonist (LTRA), or low dose ICS taken whenever SABA taken †

**STEP 3**
- Low dose ICS-LABA
- Medium dose ICS, or low dose ICS+LTRA #

**STEP 4**
- Medium dose ICS-LABA
- High dose ICS, add-on tiotropium, or add-on LTRA #

**STEP 5**
- High dose ICS-LABA

- Refer for phenotypic assessment ± add-on therapy, e.g. tiotropium, anti-IgE, anti-IL5/5R, anti-IL4R

- Add low dose OCS, but consider side-effects

- Consider adding HDM SLIT for sensitized patients with allergic rhinitis and FEV >70% predicted

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Background to changes in 2019 - the risks of ‘mild’ asthma

- Patients with apparently mild asthma are at risk of serious adverse events
  - 30–37% of adults with acute asthma had symptoms less than weekly in previous 3 months (Dusser, Allergy 2007)
  - 16% of patients with near-fatal asthma
  - 15–20% of adults dying of asthma
- Exacerbation triggers are variable (viruses, pollens, pollution, poor adherence)
- Inhaled SABA has been first-line treatment for asthma for 50 years
  - This dates from an era when asthma was thought to be a disease of bronchoconstriction
  - Patient satisfaction with, and reliance on, SABA treatment is reinforced by its rapid relief of symptoms, its prominence in ED and hospital management of exacerbations, and low cost
  - Patients commonly believe that “My reliever gives me control over my asthma”, so they often don’t see the need for additional treatment
Background to changes in 2019 - the risks of SABA-only treatment

• Regular or frequent use of SABA is associated with adverse effects
  • β-receptor downregulation, decreased bronchoprotection, rebound hyperresponsiveness, decreased bronchodilator response (Hancox, Respir Med 2000)
  • Increased allergic response, and increased eosinophilic airway inflammation (Aldridge, AJRCCM 2000)

• Higher use of SABA is associated with adverse clinical outcomes
  • Dispensing of ≥3 canisters per year (average 1.7 puffs/day) is associated with higher risk of emergency department presentations (Stanford, AAAl 2012)
  • Dispensing of ≥12 canisters per year is associated with higher risk of death (Suissa, AJRCCM 1994)

**Primary End point**: Demonstrate PRN use of Bud-Form is superior to PRN terbutaline measured by weeks of well-controlled asthma.

**Secondary End points**: Show non-inferiority of Bud-Form used PRN vs daily in weeks of well-controlled asthma and rates and time to first exacerbation.

**Inclusion**: Age >12, GINA level 2 treatment, established dg asthma, Pre-BD FEV1 >60%, post BD FEV1 >80%.

**Exclusion**: Recent worsening, use of steroids, pregnancy, ANY comorbidity or physical sign that in the opinion of the investigator put the patient at risk. Any hx of severe, life threatening exacerbation, >10 pack year smokers.
**SYGMA 1**

Exacerbations were defined as worsening sx leading to oral glucocorticoids for ≥3 days, ED or hospitalization.

Well controlled weeks were defined by electronic diary data for asthma symptoms, nighttime awakenings, morning PEF, PRN inhaler use*, and additional use of inhaled or oral steroid

<table>
<thead>
<tr>
<th></th>
<th>Terbutaline PRN n=1277</th>
<th>Bud-Form PRN N=1277</th>
<th>Budesonide Maintenance n=1282</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe exacerbations</td>
<td>152 (11.9)</td>
<td>71 (5.6)</td>
<td>78 (6.1)</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>15 (1.2)</td>
<td>6 (0.5)</td>
<td>8 (0.6)</td>
</tr>
<tr>
<td>ED visits</td>
<td>29 (2.3)</td>
<td>7 (0.5)</td>
<td>10 (0.8)</td>
</tr>
<tr>
<td>Mod/Sev exacerbations</td>
<td>274 (21.5)</td>
<td>131 (10.3)</td>
<td>143 (11.2)</td>
</tr>
</tbody>
</table>
Adherence was ~80% for all groups for the twice daily inhaler use.

Median daily dose of glucocorticoid in the bud-form group was 17% of the budesonide maintenance group (metered dose 57µg vs 340µg).

Overall Asthma Quality of Life Questionnaire (AQLQ) Scores were better in the budesonide maintenance group than the PRN group.

3BUD/FOR, budesonide/formoterol; CI, confidence interval; RR, rate ratio.
Novel START

Controlled Trial of Budesonide–Formoterol as Needed for Mild Asthma

Richard Beasley, D.Sc., Mark Holliday, B.Sc., Helen K. Reddel, Ph.D.,
Irene Braithwaite, Ph.D., Stefan Ebmeier, B.M., B.Ch., Robert J. Hancock, M.D.,
Tim Harrison, M.D., Claire Houghton, B.M., B.S., Karen Oldfield, M.B., Ch.B.,
and Mark Weatherall, F.R.A.C.P., for the Novel START Study Team®

**Design:** 52 week, randomized, open-label, parallel group controlled trial. Enrolled 675 pts with mild asthma only treated with PRN SABA.

**Primary End point:** Annualized rate of exacerbations

Urgent care visits, hospitalization, systemic steroids, high use of PRN with >16 actuations of SABA or >8 actuations of Bud-Form over 24 hours

**Secondary End points:** # of exac, time to first exac, ACQ-5 score, treatment failures, FEV1 and FeNO.

**Inclusion:** Age >12 <76, SABA PRN tx only and use 2x/mo but <3x/day

**Exclusion:** Hospitalization in 12 mo, Life threatening asthma, COPD, ILD, >20 pack smoker, CHF, severe CAD, FEV1<50%.
Mean dose of budesonide was 107 µg/day vs 222 µg/day in the PRN vs maintenance group.

Overall adherence to twice-daily budesonide maintenance therapy was 56%.
**Box 3-5A**

**Adults & adolescents 12+ years**

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**STEP 3**
- Low dose ICS-LABA
- Medium dose ICS, or low dose ICS+LTRA *
- High dose ICS, add-on tiotropium, or add-on LTRA #

**STEP 4**
- Low-dose ICS-form is the reliever for patients prescribed bud-form or BDP-form maintenance and reliever therapy
- Medium dose ICS-LABA
- High dose ICS, add-on tiotropium, or add-on LTRA #

**STEP 5**
- High dose ICS-LABA
- Refer for phenotypic assessment
- ± add-on therapy, e.g. tiotropium, anti-IgE, anti-IL5/5R, anti-IL4R

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**Confirmation of diagnosis if necessary**
- Symptom control & modifiable risk factors (including lung function)
- Comorbidities
- Inhaler technique & adherence
- Patient satisfaction

**Treatment of modifiable risk factors & comorbidities**
- Non-pharmacological strategies
- Education & skills training
- Asthma medications

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COPD: Switching Gears

• COPD, an under diagnosed and under-appreciated disease
• Or is it?
COPD: 2019 GOLD updated guidelines
ABCD assessment tool

THE RENEFINED ABCD ASSESSMENT TOOL

Spirometrically Confirmed Diagnosis

Assessment of airflow limitation

Assessment of symptoms/risk of exacerbations

Post-bronchodilator FEV₁/FVC < 0.7

<table>
<thead>
<tr>
<th>Grade</th>
<th>FEV₁ (% predicted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOLD 1</td>
<td>≥ 80</td>
</tr>
<tr>
<td>GOLD 2</td>
<td>50-79</td>
</tr>
<tr>
<td>GOLD 3</td>
<td>30-49</td>
</tr>
<tr>
<td>GOLD 4</td>
<td>&lt; 30</td>
</tr>
</tbody>
</table>

Moderate or Severe Exacerbation History

≥2 or ≥ 1 leading to hospital admission

0 or 1 (not leading to hospital admission)

mMRC 0-1
CAT < 10

mMRC ≥ 2
CAT ≥ 10

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Example

Consider two patients:
- Both patients with FEV$_1$ < 30% of predicted
- Both with CAT scores of 18
- But, one with 0 exacerbations in the past year and the other with 3 exacerbations in the past year.

Both would have been labelled **GOLD D** in the prior classification scheme.
With the new proposed scheme, the subject with 3 exacerbations in the past year would be labelled **GOLD grade 4, group D**.
The other patient, who has had no exacerbations, would be classified as **GOLD grade 4, group B**.
Treatment of stable COPD

### INITIAL PHARMACOLOGICAL TREATMENT

<table>
<thead>
<tr>
<th>Group C</th>
<th>LAMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 moderate</td>
<td><em>LAMA or LAMA + LABA</em> or ICS + LABA**&lt;br&gt;**Consider if highly symptomatic (e.g., CAT &gt; 20)&lt;br&gt;*<em>Consider if eos ≥ 300</em></td>
</tr>
<tr>
<td>exacerbations</td>
<td></td>
</tr>
<tr>
<td>or ≥ 1 leading</td>
<td></td>
</tr>
<tr>
<td>to hospitalization</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group A</th>
<th>A Bronchodilator</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 or 1 moderate</td>
<td></td>
</tr>
<tr>
<td>exacerbations</td>
<td>A Long Acting Bronchodilator (LABA or LAMA)</td>
</tr>
<tr>
<td>(not leading to hospital admission)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group D</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mMRC 0-1 CAT</td>
<td>mMRC ≥ 2 CAT ≥ 10</td>
</tr>
<tr>
<td>&lt; 10</td>
<td></td>
</tr>
</tbody>
</table>

**Definition of abbreviations:** eos: blood eosinophil count in cells per microliter; mMRC: modified Medical Research Council dyspnea questionnaire; CAT™: COPD Assessment Test™.
Treatment of stable COPD

Following implementation of therapy, patients should be reassessed for attainment of treatment goals and identification of any barriers for successful treatment (Figure 4.2).

Following review of the patient response to treatment initiation, adjustments in pharmacological treatment may be needed.
FOLLOW-UP PHARMACOLOGICAL TREATMENT

1. IF RESPONSE TO INITIAL TREATMENT IS APPROPRIATE, MAINTAIN IT.
2. IF NOT:
   - Consider the predominant treatable trait to target (dyspnea or exacerbations)
   - Use exacerbation pathway if both exacerbations and dyspnea need to be targeted
   - Place patient in box corresponding to current treatment & follow indications
   - Assess response, adjust and review
   - These recommendations do not depend on the ABCD assessment at diagnosis

• DYSPNEA •
- LABA or LAMA
  - LABA + LAMA
  - LABA + LAMA + ICS
    - Consider switching inhaler device or molecules
    - Investigate (and treat) other causes of dyspnea

• EXACERBATIONS •
- LABA or LAMA
  - LABA + LAMA
    - LABA + ICS
      - Consider if eos < 100
  - LABA + LAMA + ICS
    - Consider if eos ≥ 100
    - Roflumilast
      - FEV1 < 50% & chronic bronchitis
      - In former smokers
    - Azithromycin

** eos = blood eosinophil count (cells/μL)**
* Consider if eos ≥ 300 or eos ≥ 100 AND ≥2 moderate exacerbations / 1 hospitalization
** Consider de-escalation of ICS or switch if pneumonia, inappropriate original indication or lack of response to ICS
IMPACT Trial, NEJM 2018
### Table 2. Trough FEV₁ and St. George’s Respiratory Questionnaire (SGRQ) Total Score (Intention-to-Treat Population).\(^*\)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Triple Therapy (N = 4151)</th>
<th>Fluticasone Furoate–Vilanterol (N = 4134)</th>
<th>Umeclidinium–Vilanterol (N = 2070)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trough FEV₁</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of patients evaluated</td>
<td>3366</td>
<td>3060</td>
<td>1490</td>
</tr>
<tr>
<td>Mean at wk 52 (95% CI) — ml</td>
<td>1274 (1265 to 1282)</td>
<td>1177 (1168 to 1185)</td>
<td>1220 (1208 to 1232)</td>
</tr>
<tr>
<td>Mean change from baseline (95% CI) — ml</td>
<td>94 (86 to 102)</td>
<td>−3 (−12 to 6)</td>
<td>40 (28 to 52)</td>
</tr>
<tr>
<td>Difference between triple therapy and dual-therapy comparator (95% CI) — ml</td>
<td>−</td>
<td>97 (85 to 109)†</td>
<td>54 (39 to 69)†</td>
</tr>
<tr>
<td><strong>SGRQ total score‡</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of patients evaluated</td>
<td>3318</td>
<td>3026</td>
<td>1470</td>
</tr>
<tr>
<td>Mean at wk 52 (95% CI)</td>
<td>45.0 (44.5 to 45.4)</td>
<td>46.8 (46.3 to 47.2)</td>
<td>46.8 (46.1 to 47.4)</td>
</tr>
<tr>
<td>Mean change from baseline (95% CI) — ml</td>
<td>−5.5 (−5.9 to −5.0)</td>
<td>−3.7 (−4.2 to −3.2)</td>
<td>−3.7 (−4.4 to −3.0)</td>
</tr>
<tr>
<td>Difference between triple therapy and dual-therapy comparator (95% CI)</td>
<td>−</td>
<td>−1.8 (−2.4 to −1.1)†</td>
<td>−1.8 (−2.6 to −1.0)†</td>
</tr>
<tr>
<td>Response according to SGRQ total score at wk 52 — no. (%)¶</td>
<td>1723 (42)</td>
<td>1390 (34)</td>
<td>696 (34)</td>
</tr>
<tr>
<td>Odds ratio for triple therapy vs. dual-therapy comparator (95% CI)</td>
<td>−</td>
<td>1.41 (1.29 to 1.55)†</td>
<td>1.41 (1.26 to 1.57)†</td>
</tr>
</tbody>
</table>

\(^*\) The means presented are least-squares means.

\(^†\) P<0.001.

\(^‡\) Total scores on the SGRQ range from 0 to 100, with lower scores indicating better health-related quality of life.

\(^¶\) A response was defined as a decrease in the SGRQ total score of at least 4 units, as compared with the baseline value.
### Table 3. Adverse Events of Special Interest in the Intention-to-Treat Population.

<table>
<thead>
<tr>
<th>Event</th>
<th>Triple Therapy (N = 4151)</th>
<th>Fluticasone Furoate–Vilanterol (N = 4134)</th>
<th>Umeclidinium–Vilanterol (N = 2070)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Patients (%)</td>
<td>Rate per 1000 Patient-Yr (No. of Events)</td>
<td>No. of Patients (%)</td>
</tr>
<tr>
<td>Anticholinergic syndrome</td>
<td>184 (4)</td>
<td>60.8 (226)</td>
<td>140 (3)</td>
</tr>
<tr>
<td>Asthma or bronchospasm</td>
<td>27 (&lt;1)</td>
<td>7.5 (28)</td>
<td>34 (&lt;1)</td>
</tr>
<tr>
<td>Cardiovascular effects</td>
<td>450 (11)</td>
<td>167.2 (621)</td>
<td>430 (&lt;1)</td>
</tr>
<tr>
<td>Cardiac arrhythmia</td>
<td>153 (4)</td>
<td>50.9 (189)</td>
<td>161 (&lt;1)</td>
</tr>
<tr>
<td>Cardiac failure</td>
<td>138 (3)</td>
<td>42.5 (158)</td>
<td>126 (3)</td>
</tr>
<tr>
<td>CNS hemorrhages and cerebrovascular conditions</td>
<td>41 (&lt;1)</td>
<td>12.1 (45)</td>
<td>28 (&lt;1)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>113 (3)</td>
<td>35.5 (132)</td>
<td>115 (3)</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>80 (2)</td>
<td>26.1 (97)</td>
<td>57 (1)</td>
</tr>
<tr>
<td>Lower respiratory tract infection, excluding pneumonia</td>
<td>200 (5)</td>
<td>63.0 (234)</td>
<td>199 (5)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>317 (8)</td>
<td>95.8 (356)</td>
<td>292 (7)</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>8 (&lt;1)</td>
<td>2.7 (10)</td>
<td>12 (&lt;1)</td>
</tr>
</tbody>
</table>

* Adverse events of special interest are based on an analysis of a group of prespecified adverse events that are associated with the use of inhaled glucocorticoids, long-acting muscarinic antagonists, or long-acting β2-agonists. See Table S15 in the Supplementary Appendix for the full listing of adverse events of special interest. CNS denotes central nervous system.
Analysis of IMPACT, Lancet Resp Med 2019

- Modelled blood eosinophil count as a continuous measure in the overall population and by baseline smoking status to describe the effect of ICS on the rate of on-treatment moderate and severe exacerbations.
Analysis of IMPACT, Lancet Resp Med 2019

- Smoking status matters!
- The beneficial effect on reducing moderate and severe exacerbations observed with ICS-containing treatment was more pronounced in former smokers (RR for triple therapy vs umeclidinium–vilanterol 0.70 [95% CI 0.64–0.77] and fluticasone furoate–vilanterol vs umeclidinium–vilanterol 0.83 [0.75–0.91]) than current smokers (0.86 [0.76–0.98] and 1.01 [0.89–1.15], respectively).

![Graph showing baseline blood eosinophil count vs rate ratios (95% CI).](image)
Non-Pharmacological Treatment

- Education and self-management
- Physical activity
- Pulmonary rehabilitation programs
- Exercise training
- Self-management education
- End of life and palliative care
- Nutritional support
- Vaccination
- Oxygen therapy
- Lung Cancer Screening

© 2017 Global Initiative for Chronic Obstructive Lung Disease
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Overview of various therapies used to treat patients with COPD and emphysema worldwide. Note that all therapies are not approved for clinical care in all countries. Additionally, the effects of BLVR on survival or other long term outcomes or comparison to LVRS are unknown.

**Advanced COPD**

- Emphysema predominant phenotype with severe hyperinflation
  - Large bulla
    - Bullectomy
  - Heterogeneous emphysema
    - No large bulla
  - Homogeneous emphysema
    - Lung transplant

- Not candidate for bullectomy, BLVR or LVRS

Definition of Abbreviations: BLVR, Bronchoscopic Lung Volume Reduction; EBV, endobronchial Valve; LVRS, Lung volume reduction surgery; LVRC, Lung volume reduction coil; VA, Vapor ablation

*at some but not all centers

FIGURE 4.5
New Devices

**Zephyr® Valve vs. Medical Management (Control)**
Patients with Complete Fissure & Lobar Occlusion

Lung Function
- Forced Expiratory Volume (FEV1)

Quality of Life
- St. George Respiratory Questionnaire (SGRQ)

Exercise Tolerance
- 6 Minute Walk Distance (6MWD)

The EMPROVE Trial - Spiration® Valve System for Single Lobe Treatment of Severe Emphysema
Vaping Induced Lung Injury
Clinical Presentation

Median duration of symptoms pre hospital = 6 days
30% initially diagnosed with a mild pneumonia and discharged home with oral antibiotic (e.g. azithromycin)

Presenting symptoms (Layden 2019):
• 98% respiratory sx (dyspnea 87%; chest pain 55%; cough 83%; hemoptysis 11%)
• 81% had GI sx *initial* (nausea 70%, vomiting, diarrhea abdominal pain).
• 100% of patients had some constitutional symptom (fever > chills > weight loss > fatigue/malaise)
• Upper respiratory symptoms (e.g. rhinorrhea, sneezing, or congestion) *don't* seem to be a component of the illness
<table>
<thead>
<tr>
<th>Hypersensitivity pneumonitis (HP)</th>
<th>Acute or chronic presentation + exp his</th>
<th>Acute: B GGO and poorly defined nodules Chronic: reticular fibrotic pattern honeycomb change and traction bronchiectasis</th>
<th>↑↑ Lymph, ↑ Neut “Foamy” cytoplasm Mast cells Plasma cells Extreme lymphocytosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIP</td>
<td>Acute onset of dyspnea</td>
<td>Diffuse, bilateral ground-glass attenuation with patchy airspace consolidation</td>
<td>↑↑ Neut Prominent neutrophilia Diffuse consolidation on CXR</td>
</tr>
<tr>
<td>Lipoid PNA</td>
<td>History of mineral, vegetable, or animal oils (?constipation)</td>
<td>Extensive ground-glass opacities or consolidation with attenuation values between fat and water (&lt;30 HU)</td>
<td>Oily layer on surface of BAL fluid Lipid-laden macrophages Vacuoles in Mac that stain positive for lipid</td>
</tr>
<tr>
<td>Organizing PNA/Acute lung injury</td>
<td>Fleeting infiltrates</td>
<td>Bilateral infiltrates with peripheral or perilobular consolidation, GGO, atoll or reverse halo</td>
<td></td>
</tr>
<tr>
<td>Giant Cell interstitial PNA</td>
<td>Fibrotic lung disease caused by hard metals (tungsten, cobalt)</td>
<td>GGO and reticulation, traction bronchiectasis (UIP/NSIP/OP)</td>
<td></td>
</tr>
<tr>
<td>Eosinophilic pneumonia (EP)</td>
<td>Diffuse CXR infiltrates Bilateral</td>
<td>Peripheral subpleural airspace consolidation</td>
<td>↑↑ Eos Eos% &gt; 25%</td>
</tr>
</tbody>
</table>

Henry NEJM 2019
Radiographic Presentation

Imaging from a series of six patients in Utah. Substantial variation between patients is possible.

-Maddock SD et al 2019 NEJM
Imaging from a series of patients in North Carolina. In addition to ground glass opacification, some patients demonstrated nodular ("tree-in-bud") opacities.
**Approach to Possible Vaping-Induced Lung Injury in the Non-Intubated Patient**

**Case Highly Suggestive for Vaping-Induced Lung Injury**
- History of vaping (especially concerning if using THC oils or adulterated liquids)
- Bilateral ground-glass opacities on CT scan *(without* atypical imaging features, such as cavitation or large nodules)
- No immunocompromise
- No exposure to unusual pathogens

**Noninvasive Diagnostic/Therapeutic Approach**

**Noninvasive Diagnostic Evaluation**
- Blood cultures x2
- Sputum gram stain & culture if productive cough
- Urine for legionella & pneumococcus antigens
- Nares PCR for viruses +/- influenza
- Nares PCR for MRSA
- HIV serology
- ESR, C-reactive protein, procalcitonin (if available)

**Empiric Therapy for Pneumonia & VAPI**
- Antibiotics *(e.g. ceftriaxone plus azithromycin)*
- Oxygen support as needed *(e.g. high-flow nasal cannula)*
- Steroid *(e.g. 1 mg/kg prednisone daily)*

**Clinical Improvement**
**Diagnostic Evaluation Unremarkable**

**Further Investigation**
- Consider bronchoscopy
- Additional laboratory studies

**Continue Treatment**
- Gradually wean off steroid
- Discontinue antibiotic *(provided infectious evaluation is negative)*

Possible strategy for suspected vaping-induced lung injury in a patient who doesn’t require intubation. The approach in an intubated patient is similar, but there is generally a lower threshold for bronchoscopy in that context. Please note that this is not based on any high-level evidence *(as such evidence doesn’t exist)*. The extent of workup required is controversial and practice patterns will likely evolve as further information becomes available.

*The Internet Book of Critical Care, by @PulmCrit*
Case

- 38 year old female with PMHx of Pleurisy in 2018, Former smoker 16 pack years, quit age 34 who presents with chest tightness and dyspnea on exertion. Her PCP diagnosed asthma and started her on Dulera. She comes to a pulmonologist after 2 years of therapy with worsening symptoms.

- PFTs
  - Pre BD FEV1 of 1.11 L, 34% increasing to a Post BD FEV1 of 1.33L, 40%
  - FVC 2.66, 67%.
## Summary by Lung Thirds

<table>
<thead>
<tr>
<th></th>
<th>Total Lung</th>
<th>Left Lung</th>
<th>Right Lung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>33 ± 2</td>
<td>79 ± 1</td>
<td>19 ± 2</td>
</tr>
<tr>
<td>Functional</td>
<td>41 ± 2</td>
<td>21 ± 1</td>
<td>23 ± 2</td>
</tr>
<tr>
<td>Persistent</td>
<td>26 ± 1</td>
<td>30 ± 6</td>
<td>45 ± 5</td>
</tr>
</tbody>
</table>

- Normal: Voxels ABOVE -950 HU on inspiration, Voxels ABOVE -856 HU on expiration
- Functional Low Density Area: Voxels ABOVE -950 HU on inspiration, Voxels BELOW -856 HU on expiration
- Persistent Low Density Area: Voxels BELOW -950 HU on inspiration, Voxels BELOW -856 HU on expiration

### Volume (L)

<table>
<thead>
<tr>
<th></th>
<th>Total Lung</th>
<th>Left Lung</th>
<th>Right Lung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspiration</td>
<td>6.3</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Expiration</td>
<td>4.4</td>
<td>2.1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

*The ranges provided with the LDA results are an indication of the accuracy of registration (see user manual for more information). This does not account for additional sources of variation such as slice thickness, image noise, scanner calibration or respiratory phase.

Values on functional assessment report are calculated based on the expiratory image. Values may differ from inspiration assessment report as the persistent low density area represents voxels which are low on both inspiration and expiration and the percentages are calculated based on the expiratory images.
Alpha-1 Anti-Trypsin Deficiency

- PI*ZZ homozygote

- ATS, WHO and GOLD recommend screening all patients with COPD for AATD, regardless of smoking status.
Cleveland Clinic
Every life deserves world class care.