

**VALI
&
EVALI**

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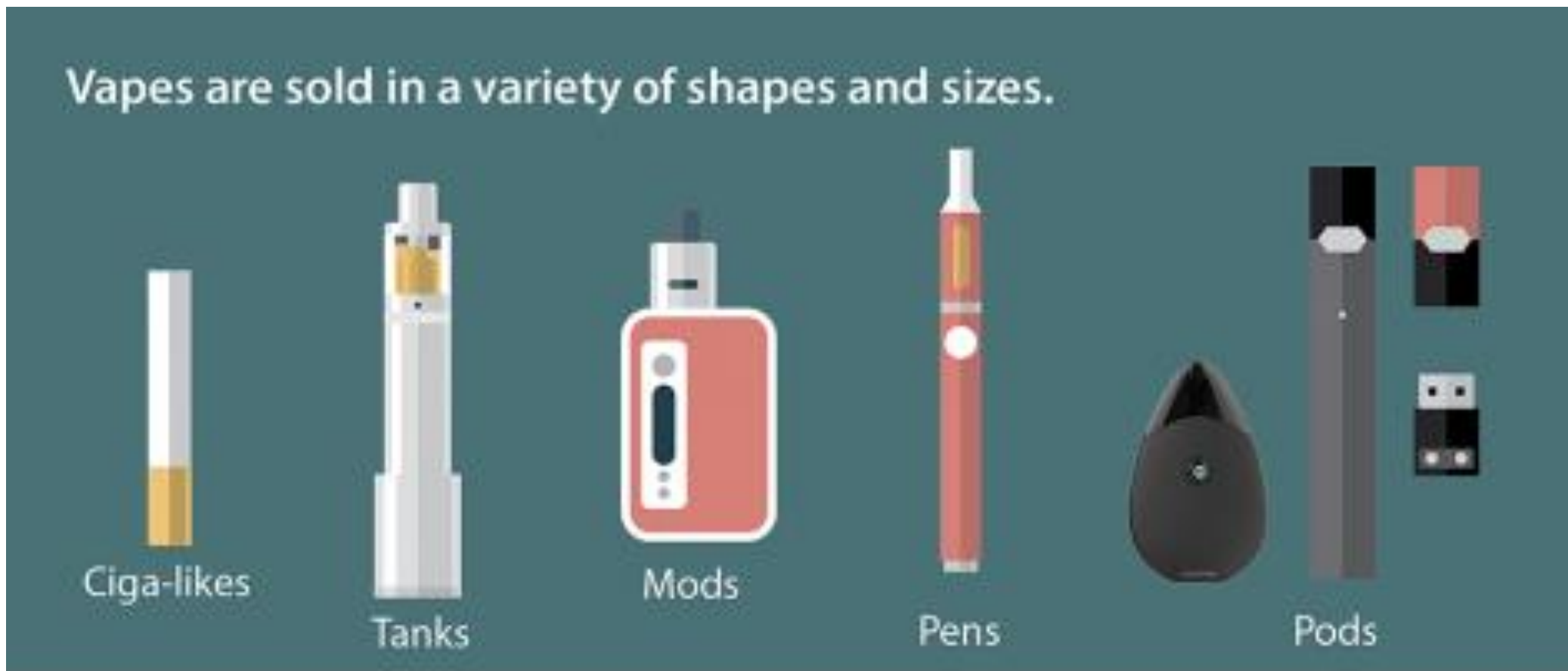
Disclosures

- None

Objectives

- Review of vaping products
- Pathophysiology of vaping-induced lung injury
- Types of lung injury
- Symptoms and diagnosis
- Treatment
- Outcomes

Vaping products



Vaping products



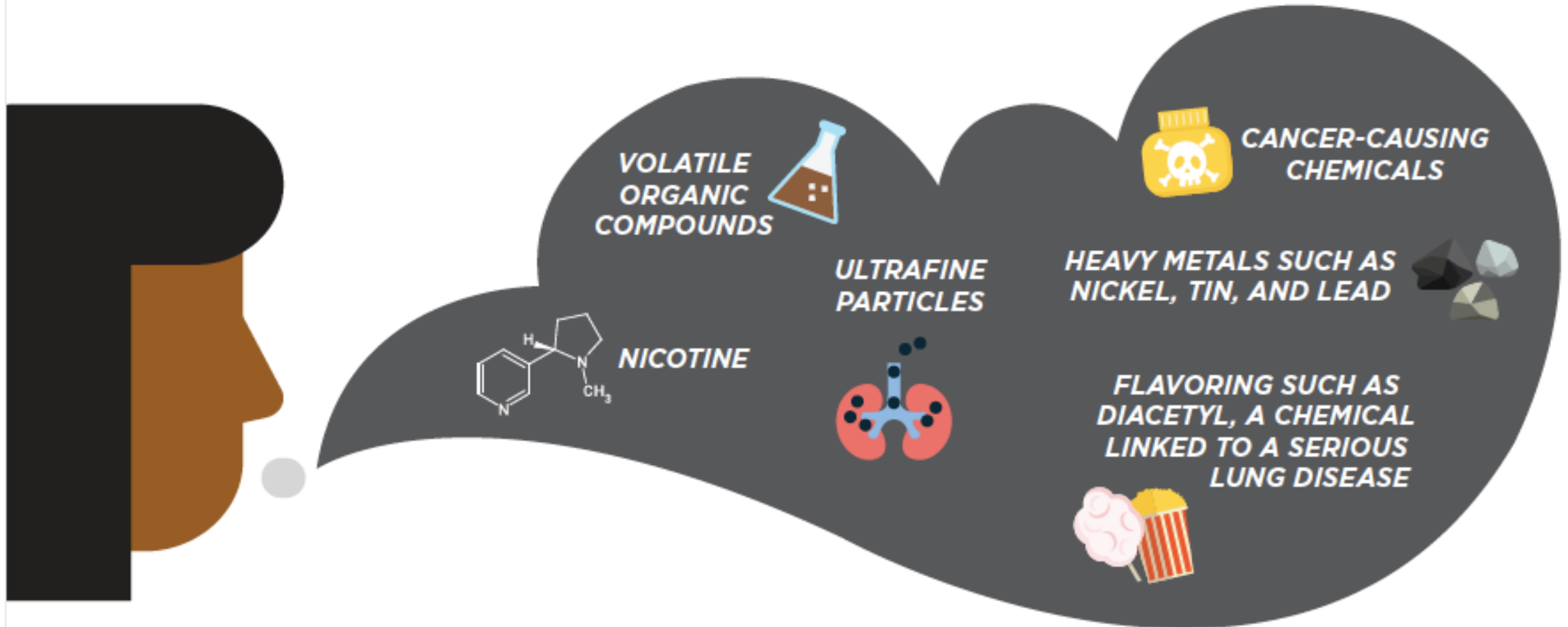


ED





What is being inhaled?



Pathophysiology

- inflammation, edema of airways with epithelial sloughing, alveolar inflammation, and hypoxemia
- symptoms ranging from minor respiratory tract discomfort to acute airway injury and damage to the parenchyma with pneumonitis, alveolar edema, respiratory failure, and death

Epidemiology

- As of Feb 2020, there have been a reported 2807 cases of hospitalized EVALI cases or deaths.
 - All 50 states, D.C., and 2 territories (PR, US VI)
 - 68 deaths confirmed
 - 15% of cases were <18 years old
- There was a sharp increase of EVALI cases in 2019, when the number of cases peaked in Sept 2019.
 - Since then, there has been a steady decline of cases

CDC Definition

Probable Cases

- Using an e-cigarette ("vaping") or dabbing* in 90 days prior to symptom onset

AND

- Pulmonary infiltrate, such as opacities, on plain film chest radiograph or ground-glass opacities on chest CT

AND

- Infection identified via culture or PCR, but clinical team** believes this infection is not the sole cause of the underlying lung injury.
Minimum criteria to rule out pulmonary infection (e.g., culture performed) and clinical team** believes this is the sole cause of the underlying lung injury.

- No evidence in medical record of alternative plausible diagnoses (e.g., cardiac, rheumatologic, or neoplastic process)

- **Clinical team caring for the patient

Confirmed Cases

- Using an e-cigarette ("vaping") or dabbing* in 90 days prior to symptom onset

AND

- Pulmonary infiltrate, such as opacities, on plain film chest radiograph or ground-glass opacities on chest CT

- Infection identified via culture or PCR on initial work-up.

Minimum criteria are:

- A negative respiratory viral panel **and**
- A negative influenza PCR or rapid test, if local epidemiology supports influenza testing; **and**
- All other clinically-indicated respiratory ID testing (e.g., urine Antigen for *Streptococcus pneumoniae* and *Legionella*, sputum culture if productive cough, bronchoalveolar lavage (BAL) culture if done, blood culture, HIV-related opportunistic respiratory infections if appropriate) are negative

AND

- No evidence in medical record of alternative plausible diagnoses (e.g., cardiac, rheumatologic, or neoplastic process)

DIAGNOSIS OF EXCLUSION

What types of lung injury is occurring?

- Various pneumonitis patterns
 - acute eosinophilic pneumonia
 - organizing pneumonia
 - lipoid pneumonia
 - diffuse alveolar damage and acute respiratory distress syndrome (ARDS)
 - diffuse alveolar hemorrhage
 - hypersensitivity pneumonitis
 - respiratory bronchiolitis-associated interstitial lung disease
 - peribronchiolar granulomatous pneumonitis
 - rare giant-cell interstitial pneumonitis

Causes of EVALI

- *NEJM* 2020; 382: 697-705.
 - 48 of 51 EVALI patients had vitamin E acetate in their BAL
 - Coconut oil & limonene was identified in 1 EVALI patient
- *NEJM* 2020; 382: 960-962.
 - seven groups of potentially toxic compounds: nicotine, carbonyls, volatile organic compounds (such as benzene and toluene), particles, trace metal elements according to flavor, bacterial endotoxins, and fungal glucans.
 - Two flavorants (diacetyl and 2,3-pentanediol) have been shown to perturb gene expression pathways related to cilia and cytoskeletal processes in normal human bronchial epithelial cells

Vitamin E Acetate

Aliphatic tail of
Vit. E acetate
penetrates
layer of
surfactant



Aligns
molecule in
parallel with
phospholipids



Phosphatidylcholine
s undergo transition
from liquid to
crystalline phase



Surfactant
looses ability to
maintain
surface tension

Article

Clinical Features of E-cigarette, or Vaping, Product Use–Associated Lung Injury in Teenagers

Devika R. Rao, Kendra L. Maple, Amy Dettori, Folashade Afolabi, Jenny K.R. Francis, Maddy Artunduaga, Tiffany J. Lieu, Kim Aldy, Dazhe James Cao, Stephanie Hsu, Sing Yi Feng and Vineeta Mittal

Pediatrics July 2020, 146 (1) e20194104; DOI: <https://doi.org/10.1542/peds.2019-4104>

- Symptoms
 - Respiratory (69%)
 - Cough
 - Shortness of breath
 - Chest pain
 - Gastrointestinal (85%)
 - Nausea
 - Vomiting

Pulmonary Illness Related to E-Cigarette Use in Illinois and Wisconsin — Final Report

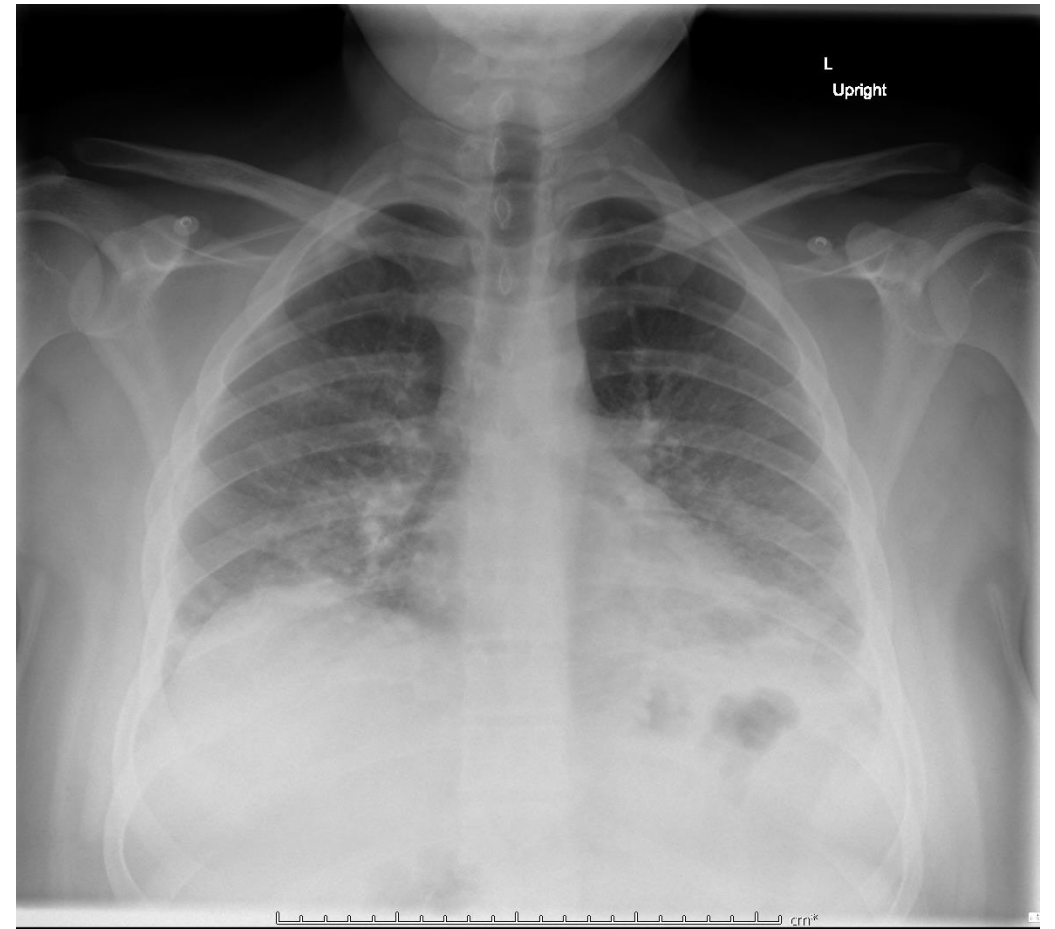
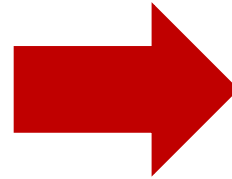
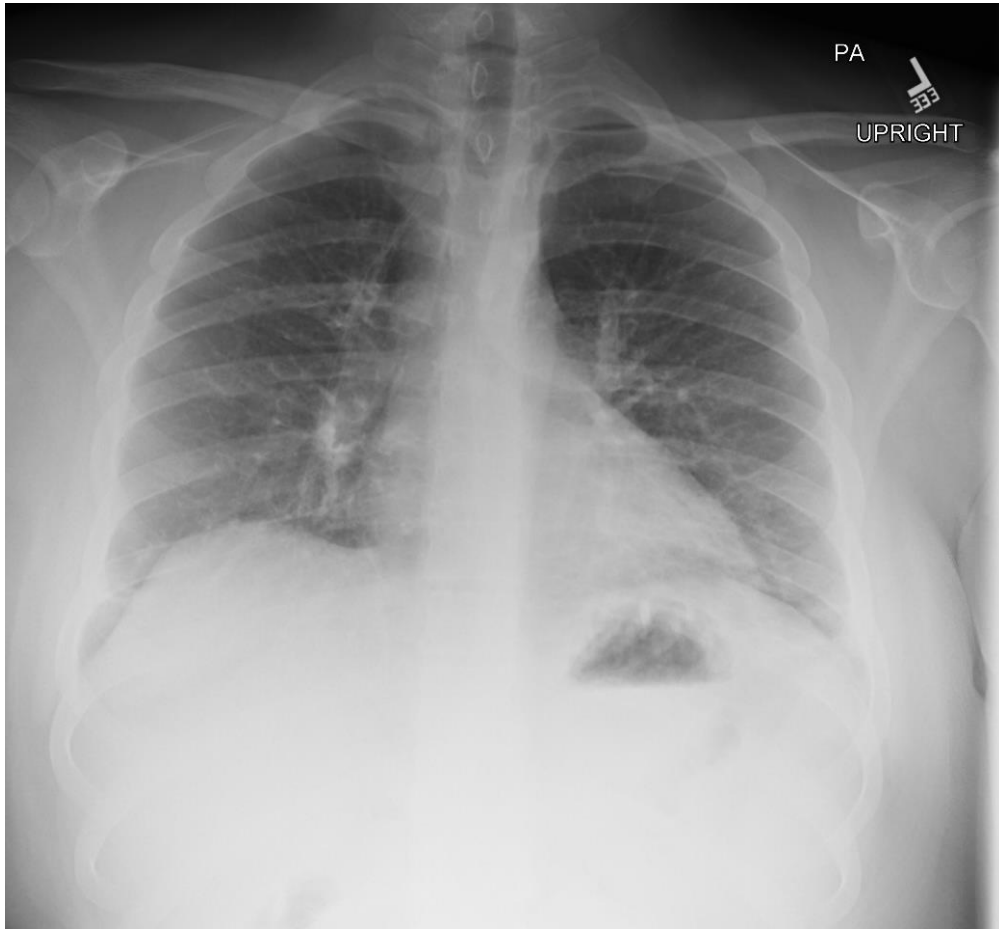
Jennifer E. Layden, M.D., Ph.D., Isaac Ghinai, M.B., B.S., Ian Pray, Ph.D., Anne Kimball, M.D., Mark Layer, M.D., Mark W. Tenforde, M.D., Ph.D., Livia Navon, M.S., Brooke Hoots, Ph.D., Phillip P. Salvatore, Ph.D., Megan Elderbrook, M.P.H., Thomas Haupt, M.S., Jeffrey Kanne, M.D., et al.

- *NEJM* 2020; 382: 903-916.
 - 98 confirmed cases
 - Symptoms
 - Respiratory (97%)
 - Gastrointestinal
 - Constitutional (100%)
 - Median duration of symptoms 6 days, 71% presenting within 7 days of onset
 - 66% of hospitalized patients had been seen in an outpatient setting prior
 - 45% had been treated as an outpatient with abx

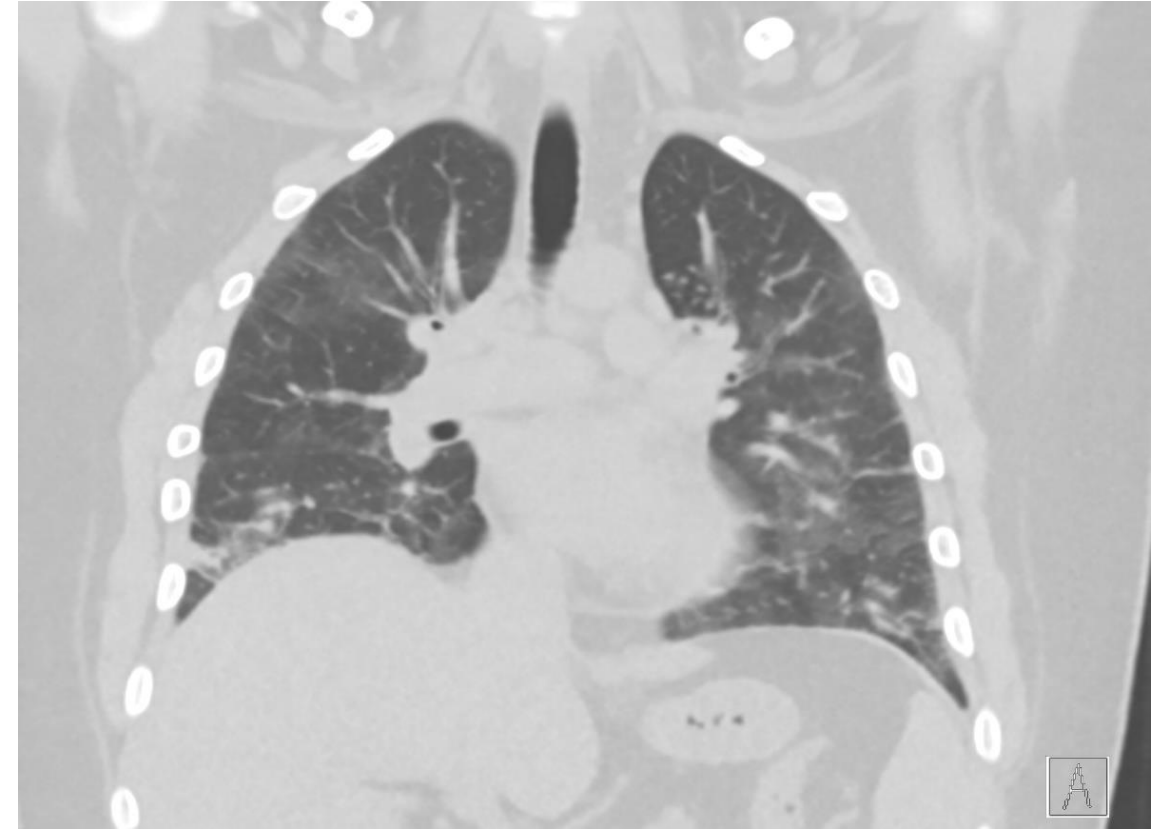
Diagnosis (of exclusion)

- Complete blood cell count with differential
- Sputum culture (can order induced sputum in children aged ≥ 13 years old or endotracheal tube culture if intubated)
- Respiratory viral panel
- HIV
- Blood culture
- High-resolution chest CT scan without contrast or CT angiography of the chest if pulmonary embolus is suspected (eg, teenager is on oral contraception)
- Electrolytes, liver function tests, serum urea nitrogen, creatinine
- Erythrocyte sedimentation rate and/or C-reactive protein
- Urine drug screen (especially important if vaping use > 3 months, as elicited on history)
- Consider flexible bronchoscopy with BAL, viral and bacterial culture, fungal culture, cytology
- Consider rheumatologic workup
- PFTs: spirometry, lung volumes (TLC), DLCO
- 6MWT when patient is stable

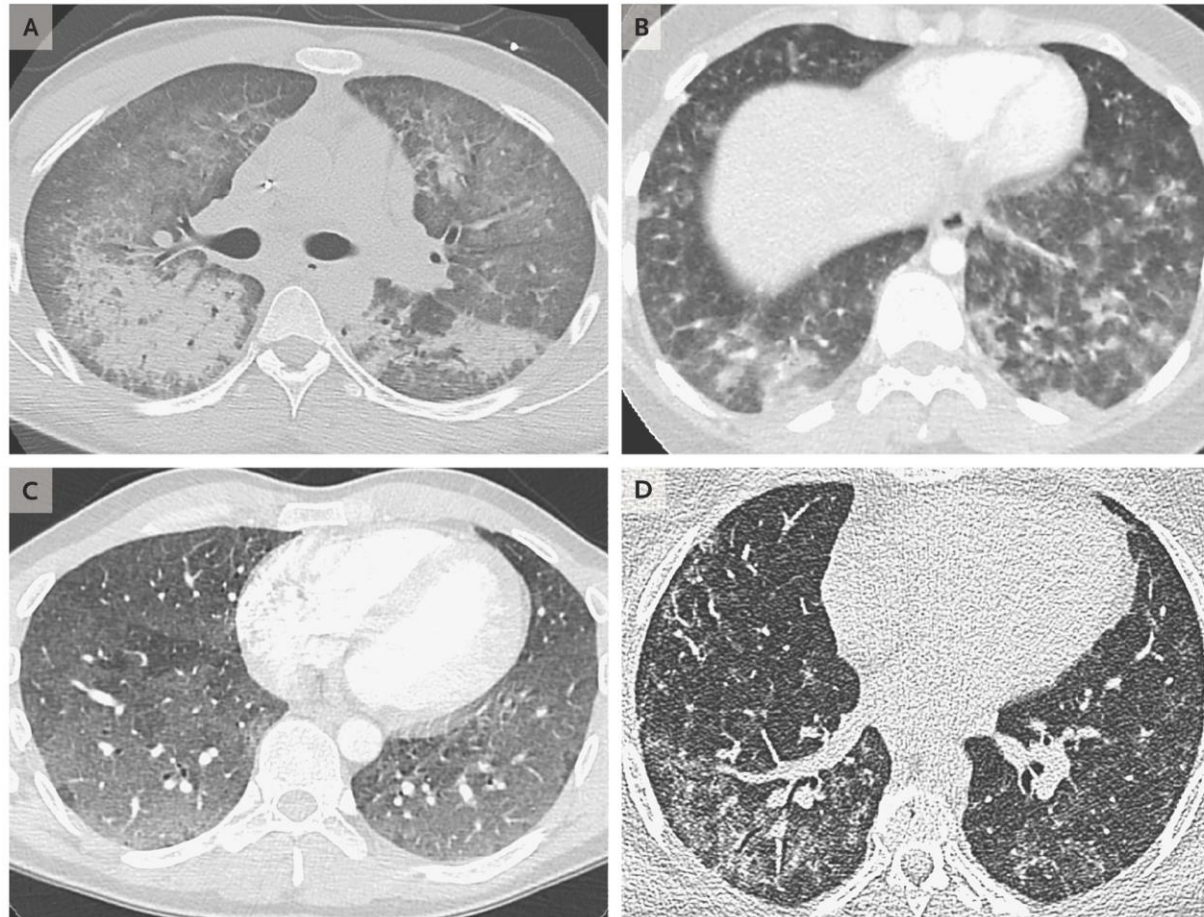
CXR



CT-correlate

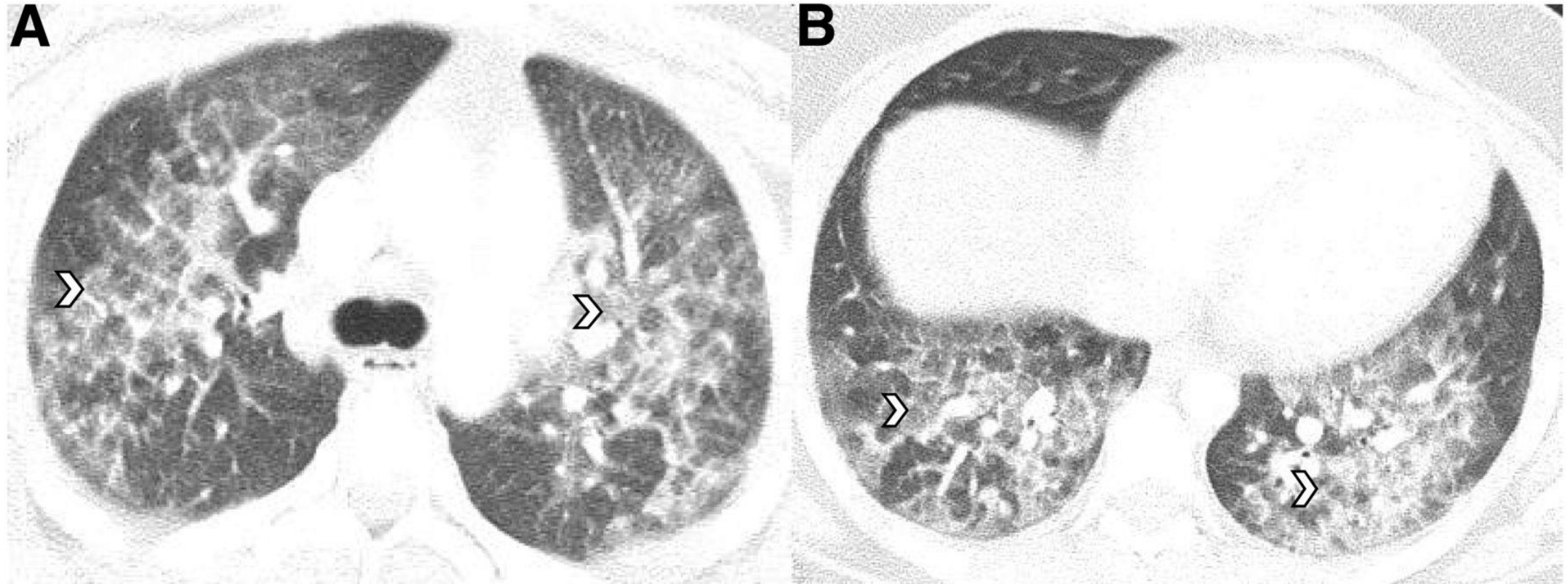


Diagnosis



NEJM 2019; 381:1486-1487.

Diagnosis



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Treatment

- 1) Treatment with systemic glucocorticoids^b
- 2) PFTs before and after steroids if possible: spirometry, TLC, DLCO, 6MWT when patient is stable
- 3) Consult psychiatry if concerns for chemical dependency
- 4) Consult child life and social work
- 5) Discharge with steroid taper per pulmonology (longer taper if bronchiolitis obliterans are seen on transbronchial biopsy specimen, if biopsy was done)
- 6) Discharge with primary care visit within 1–2 days and pulmonology clinic appointment within 2 weeks
- 7) Consider referral to teenager recovery program (addiction treatment program)

Glucocorticoid treatment considerations^b

- High dose (1 g IV daily for 3 doses): moderate-severe disease on CT scan, patients in the ICU, lack of improvement with lower dose
- Moderate dose (500 mg IV daily for 3 doses): moderate disease on CT scan, mild hypoxemia not improving, mild PFT abnormalities, lack of improvement with lower dose
- Low dose (60–300 mg/day IV for 3–5 days): mild disease on CT scan, mild or no hypoxemia, normal PFT and/or normal 6MWT results, concern for coinfection
- Oral dose: (30–40 mg twice daily for 5 days) mild disease on CT scan, no hypoxemia, normal PFT results, minimal respiratory symptoms, concern for coinfection, systemic hypertension

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Treatment

- Supportive care
- Glucocorticoids
- Social support/follow-up

First Double Lung Transplant Patient Injured by Vaping Shares Story to Save Others

January 30, 2020

Henry Ford Health System EVALI Patient Daniel Ament on the Path to Recovery

DETROIT - The teen who had a double lung transplant after a vaping-related injury is sharing his story in hopes to inspire others - particularly teens - to stop vaping and seek alternatives for a healthier and happier life.



EVALI DISCHARGE READINESS CHECKLIST

Use this checklist in addition to institutional checklists and resources to assist with planning towards the safe discharge of patients hospitalized with e-cigarette, or vaping, product use–associated lung injury (EVALI).



CONFIRM PATIENT CLINICAL STABILITY

- Stable oxygenation and exercise tolerance for 24–48 hours prior to planned discharge*
- Stable vital signs, physical exam, resolution of symptoms, and normalized laboratory tests

ENSURE INITIAL FOLLOW-UP, OPTIMALLY WITHIN 48 HOURS

- Confirm outpatient follow up with primary care and/or pulmonology optimally within 48 hours of anticipated discharge

ENSURE APPROPRIATE OUTPATIENT FOLLOW UP

- Confirm outpatient follow up, as indicated by clinical course during hospitalization
 - Primary care:** for all EVALI patients, optimally within 48 hours
 - Pulmonology:** for all EVALI patients, follow up within 2–4 weeks, and at 1–2 months
 - Endocrinology:** for pediatric EVALI patients given steroids, for all EVALI patients at heightened risk of adrenal suppression due to duration or intensity of steroid treatment
 - Cardiology:** for those EVALI patients with history of cardiac pathology
 - Psychiatry:** for those EVALI patients with concurrent anxiety, depression, PTSD, ADHD, previously diagnosed psychiatric illness, or if inpatient psychiatry consultation was required
 - Addiction medicine:** for those EVALI patients with a positive substance use disorder screen
 - Physical therapy:** for those EVALI patients demonstrating any deconditioning
 - Pain management:** for those EVALI patients with a chronic pain syndrome or pain due to comorbidities
- Provide written guidance about signs/symptoms and instructions on finding help, if symptoms recur
- Consider additional measures to optimize outpatient follow up for patients with conditions of high risk for EVALI rehospitalization and death**

OPTIMIZE OUTPATIENT MEDICATION USE & SAFETY

- Complete discharge medication reconciliation with outpatient medications, clinical course
- Complete discharge medication counseling between inpatient pharmacist and patient
- Counsel on signs of adrenal insufficiency if patient was prescribed corticosteroids during hospitalization, and on informing providers about corticosteroid treatment in case of acute injury or illness

CONNECT TO SOCIAL CARE WORKFORCE

- Complete evaluation by social care workforce to identify, record, and address postdischarge support needs
- Complete screening for mental health and substance use disorders
- Connect to community services to address social determinants of health

OFFER AND OPTIMIZE CESSATION SUPPORT

- Complete substance use disorder screening (ASSIST, CRAFFT-N, or institution's preferred tool) with connection to addiction medicine, follow up counseling, and medications when indicated
- Discuss cessation from e-cigarette, or vaping, including documenting a quit plan, and offering evidence-based tobacco product cessation interventions, including behavioral counseling and medications***

*Evans 2019], [Mikosz 2019], Clinical Lung Injury Working Group

**After EVALI admission or if prior home O2 dependence, confirmed stability on low flow O2 with home discharge on supplemental O2 may be indicated.

***Older age, cardiac disease, diabetes, chronic pulmonary disease (including chronic obstructive pulmonary disease and obstructive sleep apnea), or multiple comorbidities.

*** Among patients aged < 18 years, health care professionals can consider the use of interventions that have been shown to increase cigarette smoking cessation among adults, including behavioral interventions. No medications are currently FDA-approved for tobacco product cessation, including e-cigarettes, in children and adolescents.



U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

Discharge

- ✓ Clinically stable for 24-48 hrs prior to d/c
- ✓ Screen for & ensure access to social/mental health/substance use services
- ✓ Complete med rec & edu
- ✓ Ensure outpt follow-up w/in 48 hrs of d/c
- ✓ Follow-up w/pulm w/in 2-4 weeks



Outpatient follow-up evaluation

Within 48 hrs of discharge:

- Confirm respiratory status is stable
- Ensure adherence w/ medication (e.g. tapering of corticosteroids)
- Reinforce importance of abstinence from e-cigarette, or vaping, product use
- Assist w/ coordination of care as indicated (e.g. mental health, substance abuse, PT)

2-4 wks and 1-2 months after discharge: *Pulmonary follow-up*

- Assess pulmonary function & resolution of radiographic findings
- Continue to educate & counsel

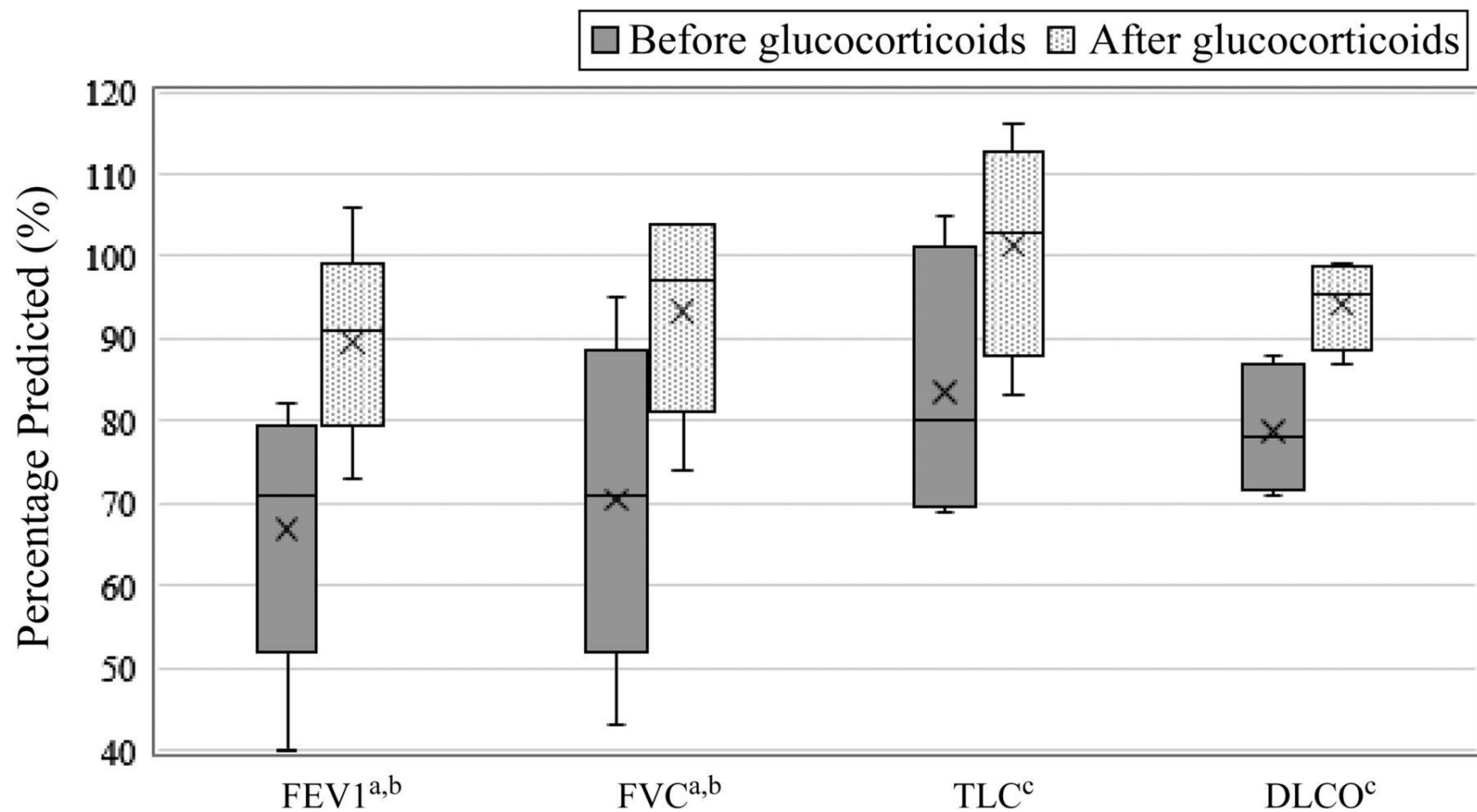
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- All patients reported near-complete recovery
 - 31% supplemental home oxygen
 - Pt on VV-ECMO & trach now decannulated

Outcomes



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Characteristics of Patients Experiencing Rehospitalization or Death After Hospital Discharge

- As of 12/10/2019, 2.7% of EVALI patients required rehospitalization
- Approx. 1 in 7 deaths among EVALI patients occurred after discharge
- At least 25% of rehospitalizations occurred w/in 2 days of discharge
- Median ages of patients:
 - Died 54 yrs
 - Hospitalized 27 yrs
 - Neither 23 yrs

MMWR 2020. 68; 1183-1188.

Characteristics of Patients Experiencing Rehospitalization or Death After Hospital Discharge

- Had more chronic medical conditions
- H/o admission to ICU
- H/o respiratory failure requiring intubation & mechanical ventilation
- No significant difference w/ respect to receipt of corticosteroids, antibiotics, or length of stay

MMWR 2020. 68; 1183-1188.

Review

- Suspicion of vaping product use
- Symptoms: cough, shortness of breath, chest pain, GI, fever
- Diagnosis of exclusion
 - Computed tomography
- Treatment: glucocorticoids & supportive care
- Recovery is possible
 - Long term pulmonary fibrosis

References

- https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html
- *NEJM* 2020; 382: 697-705.
- *NEJM* 2020; 382: 960-962.
- *NEJM* 2020; 382: 903-916.
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