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Outbreak of Lung Injury Associated with E-cigarette Product Use or Vaping: Information for Clinicians

Clinician Outreach and Communication Activity (COCA) Webinar

emergency.cdc.gov/coca

September 19, 2019

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- If you are a patient, please refer your questions to your healthcare provider.

At the conclusion of the session, participants will be able to accomplish the following:

1. Provide e-cigarette and vaping terminology;
2. Summarize frequent clinical, laboratory, radiographic, and pathologic findings and outcomes among cases; and
3. Discuss CDC recommendations for clinicians.

Today's Presenter

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Centers for Disease Control and Prevention

Outbreak of Lung Injury Associated with E-cigarette Product Use or Vaping

Information for Clinicians

CDC 2019 Lung Injury Response

Updated as of September 17, 2019

Overview

- **Background**
- **E-cigarette or vaping products**
- **Clinical Features**
  Frequent Clinical, Laboratory, Radiographic, and Pathologic Findings and Outcomes
- **CDC Recommendations for Clinicians**
  History, Diagnosis, Clinical Management, Evaluation of Pathologic Specimens at CDC, Autopsy, What to Tell Patients, Case Reporting to Public Health Authorities, Additional Resources
- **Limitations and Knowledge Gaps**

Background

- As of September 17, 2019, 530 cases of lung injury associated with the use of e-cigarette products or vaping have been reported to CDC
  - data updated weekly at CDC's outbreak website
  - 38 states, 1 U.S. territory; 7 deaths have been confirmed
- No specific etiology has been identified, but all patients have reported using e-cigarette products, or vaping
  - Most have reported using products containing THC
  - Many have reported using THC and nicotine; some only nicotine
- CDC issued recommendations for clinicians, public health officials, and the public through its health advisory network (HAN) on August 30, 2019
- Initial clinical experience summarized in recent publications in *Morbidity & Mortality Weekly Report (MMWR)* and *New England Journal of Medicine (NEJM)*

Patient Exposures in the Lung Injury Outbreak

- All have reported use of e-cigarette products, or vaping, within 90 days of illness
  - Most have reported using cannabinoids such as Δ-9-tetrahydrocannabinol (THC) or cannabidiol (CBD)
  - Some have reported nicotine use alone
- No single device type has been reported consistently (though device types have not yet been well-characterized)
- No single e-cigarette product or substance (including cannabis products) has been reported consistently

CDC Confirmed Case Definition (September 18, 2019)

- 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

- Absence of pulmonary infection 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)

CDC Probable Case Definition (September 18, 2019)

- 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 ***OR*** **Minimum criteria** to rule out pulmonary infection not met (testing not performed) and clinical team** believes this infection is not the sole cause of the underlying lung injury

AND

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

**Clinical team caring for the patient.

Patient Exposures in the Lung Injury Outbreak

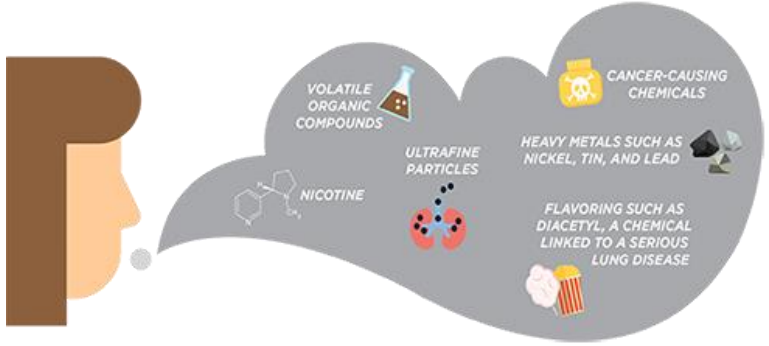
- Series of 53 cases from Illinois and Wisconsin*
  - All had history of e-cigarette use and related products
  - 41 extensively interviewed
    - 61% reported nicotine use; 80% reported THC use; 7% reported CBD use
    - 37% reported THC use alone; 17% reported nicotine use alone
    - 44% reporting both nicotine and THC product use
    - Various brands and flavors
  - Among patients with additional data, 94% used within week before symptom onset; 88% reported daily use

* Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

E-cigarette or Vaping Products

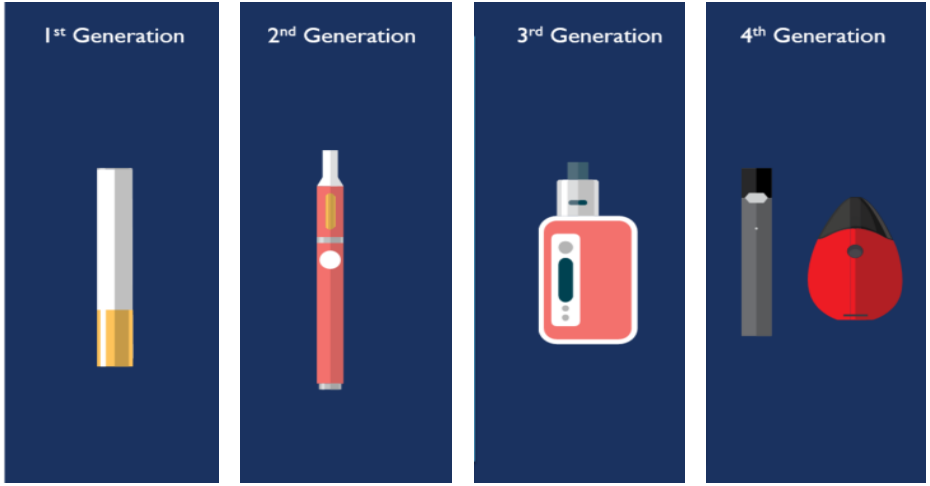
E-cigarette or Vaping Products: The Basics

- E-cigarette products include devices, liquids, flavorings, refill pods, and cartridges
- Devices heat liquid to produce an aerosol that is inhaled by the user
- E-cigarette **aerosol** can contain harmful or potentially harmful substances
  - Nicotine
  - Heavy metals (e.g., lead, nickel, tin)
  - Volatile organic compounds
  - Ultrafine particles
  - Cancer-causing chemicals
  - Flavoring (e.g., diacetyl)



E-cigarette Products: Devices

- Devices vary in shape, size, type, and manufacturer
- Common names
  - E-cigs
  - Vapes
  - E-hookahs
  - Vape pens
  - Mods
  - Tanks
  - Electronic nicotine delivery systems



Disposable e-cigarettes | **E-cigarettes with prefilled pods** | **Tanks or Mods (refillable)** | **Pod Mods (prefilled pods; nicotine salts)**

E-cigarette Products: Liquids, Cartridges, and Pods

- E-cigarette **liquid** can contain
  - Nicotine
  - Flavorings
  - Propylene glycol and vegetable glycerin used in varying proportions as carriers
  - Other chemicals also present
  - Cannabinoids: Δ-9-tetrahydrocannabinol (THC), cannabidiol (CBD), butane hash oil (BHO)
  - Other substances
- E-cigarette liquid types
  - Commercial refillable e-liquid
  - Commercial non-refillable e-liquid
  - Homemade or street sources

E-cigarette Products: Behaviors

- Hacking: modifying device in a way not intended by the manufacturer
  - Refilling single-use cartridges (e.g., with homemade or illicit substances)
  - Dripping: dropping liquid directly onto device heating coil to attain higher compound concentrations in the aerosol

- Dabbing: superheating substances containing high concentrations of THC or other cannabinoids (e.g., budder, BHO, 710, CBD)

Clinical Features:

Frequent Clinical, Laboratory, Radiographic, and Pathologic Findings and Outcomes

Information Sources on Clinical Features

- Anecdotal and verified reports from health departments
- Formal and informal discussions between CDC, clinicians, and medical professional societies
- Recent publications in *Morbidity and Mortality Weekly Report* and *New England Journal of Medicine* (published September 6, 2019)
  - Schier JG, et al. Severe Pulmonary Disease Associated with Electronic-Cigarette–Product Use — Interim Guidance. *MMWR* 2019;68(36).
  - Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019.
  - Davidson K, et al. Outbreak of e-cigarette-associated acute lipoid pneumonia—North Carolina, July–August 2019. *MMWR* 2019;68(36).
  - Maddock S, et al. Pulmonary lipid-laden macrophages and vaping. NEJM 2019.
  - Henry TS, et al. Imaging of vaping-associated lung disease. *NEJM* 2019

Frequent Clinical Symptoms

- Most patients have been young and otherwise healthy
- Report gradual onset of various symptoms over days to weeks
  - Respiratory (cough, chest pain, shortness of breath)
  - Gastrointestinal (GI) (abdominal pain, nausea, vomiting, diarrhea)
  - Systemic symptoms (fatigue, fever, weight loss)
- GI symptoms sometimes precede respiratory symptoms
  - Tend to resolve quickly after admission
  - Evaluation for GI-related illness unrevealing
- Almost all published cases have been hospitalized
  - Many with ≥1 antecedent evaluation in ambulatory settings

Frequent Presenting Signs upon Hospital Admission

- Fever
- Tachycardia
- Tachypnea
- Hypoxemia (even in patients without respiratory symptoms upon presentation)
  - One of 53 patients in the recently published 53-case series in *New England Journal of Medicine** did not report respiratory symptoms, but had oxygen saturation of 91% on room air on admission

* Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Frequent Laboratory and Radiographic Findings

- Laboratory
  - Serum leukocytosis with neutrophil predominance
  - Elevated serum markers of inflammation (e.g., ESR, CRP)
  - Transient, mild elevation in serum transaminases
- Chest imaging
  - Abnormal findings may or may not be present on initial imaging, but develop eventually
  - Bilateral opacities on plain radiograph or ground-glass opacities on chest computed tomography (CT), often with sub-pleural sparing
- Imaging of abdomen/pelvis usually unremarkable except for bilateral opacities in cuts of lower lung fields included on CT

Clinical Course

- Initial therapies focused on presumed infectious etiologies
  - Empiric antibiotics with or without steroids
  - Observation with supportive therapy other than antibiotics or steroids
- Many patients have experienced sub-acute or acute hypoxemic respiratory failure requiring supplemental oxygenation and at times ventilatory support, including with intubation and mechanical ventilation or extracorporeal membrane oxygenation
- Patients who did not respond to antibiotics alone have tended to respond to systemic corticosteroids (either alone or concurrent with antibiotics)

Frequently Performed Diagnostic Evaluations

- Appropriate extensive evaluations for infectious etiologies often completed without an identified cause
- Use of pulmonary function testing has been highly variable, mostly depending upon institutional practices
- Some patients evaluated for lung injury with bronchoscopy with bronchoalveolar lavage or lung biopsy (either transbronchial or surgical via video-assisted thoracoscopic surgery [VATS] or thoracotomy)
  - Additional patients considered for these procedures but were too ill
  - Roles and frequencies of biopsy methods remain unknown

Evaluation of Pathologic Specimens

- Both routine histopathologic and special evaluations of specimens have been performed
- Routine processing of tissues includes the application of alcohol, which removes lipids
- Therefore, as a special evaluation, lipid-staining (e.g., Oil Red O, Sudan Black) has been performed on fresh tissues and bronchoalveolar lavage fluid

Spectrum of Clinical and Pathologic Diagnoses

- Acute lung injury and adult respiratory distress syndrome (ARDS)
- Diffuse alveolar damage
- Lipoid pneumonia
- Acute necrotizing pneumonitis
- Organizing pneumonia with lipid-laden macrophages
- Non-specific inflammation
- Hypersensitivity pneumonitis
- Eosinophilic pneumonia

Outcomes

- Specialists in pulmonary medicine, critical care, infectious diseases, pathology, or toxicology frequently involved in patients' care
- Despite illness severity, most patients have survived to hospital discharge
  - Most patients have been young and healthy pre-illness
  - Some patients who have not recovered to pre-illness pulmonary function at time of discharge, demonstrated improvement during post-hospitalization evaluation
  - Other patients still had reduced pulmonary function during post-hospitalization evaluation
  - 7 patients died in the hospital (as of September 17, 2019)

Recommendations for Clinicians

Recommendations for Clinicians: Overview

- History
- Diagnosis
- Clinical Management
- Evaluation of Pathologic Specimens at CDC
- Autopsy
- What to Tell Patients
- Case Reporting to Public Health Authorities

- **CDC will provide updates as more information becomes available**

Recommendations for Clinicians: History

- Ask patients who report e-cigarette product use, or vaping, within the last 90 days about signs and symptoms of respiratory illness

- Ask patients who present with signs and symptoms of respiratory illness about e-cigarette use, or vaping, within the last 90 days

- If e-cigarette product use is suspected as a possible etiology of a patient's respiratory illness, obtain a detailed history about e-cigarette product use, or vaping

Recommendations for Clinicians: History (Cont'd)—

e-cigarette product use

- Substances used: nicotine, cannabinoids (e.g., marijuana, THC, THC concentrates, CBD, CBD oil, synthetic cannabinoids [e.g., K2 or spice], hash oil, Dank vapes), flavors, or other substances

- Substance sources: commercially refillable e-liquids (e.g., bottles, cartridges, or pods), commercial non-refillable e-liquids, homemade or street sources

Recommendations for Clinicians: History (Cont'd)—
e-cigarette product use

- Devices used: manufacturer; brand name; product name; model; serial number of the product, device, or e-liquid; if the device can be customized by the user; and any product modifications by the user (e.g., exposure of the atomizer or heating coil)
  - Where the devices were purchased
  - Method of use: aerosolization, dabbing, dripping, or re-use of old cartridges or pods with homemade or commercially bought e-liquids
  - Sharing e-cigarette products (devices, liquids, refill pods, or cartridges) with others (to identify other cases)

Recommendations for Clinicians: Diagnosis

- Consider all possible causes of illness (e.g., infectious, rheumatologic, neoplastic) in patients reporting respiratory with or without GI symptoms and e-cigarette product use
- Consider consultation with specialists (pulmonary, infectious disease, critical care, medical toxicology, pathology) as clinically indicated
- Lipoid pneumonia associated with inhalation of lipids in aerosols generated by e-cigarettes, or vaping, has been reported based on the detection of lipid-laden alveolar macrophages obtained by bronchoalveolar lavage and lipid staining (e.g., Oil Red O, Sudan Black)
  - The decision about whether to perform bronchoalveolar lavage, with or without bronchoscopy, should be based on the overall clinical picture

Recommendations for Clinicians: Diagnosis (Cont'd)

- Lung biopsies have been performed on some patients
  - The decision about whether to perform biopsy (whether transbronchial or surgical) should be based on the overall clinical picture.
  - If a lung biopsy is obtained, consider lipid-staining during pathologic examination.* Because routine tissue processing involves the application of alcohols, which remove lipids, lipid-staining is best performed on fresh tissue.
  - Before the procedure consider consultation with pulmonary, critical care, pathology, or other specialties to inform any evaluation plan
  - However, conducting routine tissue processing and histopathologic evaluation is still important.

*** Additional information on lipid-staining is available at: https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease/healthcare-providers/index.html.**

Recommendations for Clinicians: Diagnosis (Cont'd)

- Contact public health officials as needed for technical assistance with laboratory testing, including for guidance regarding whether to retain specimens, storage instructions in the event of long-term storage, and collection of specimens for indications other than clinical care

- If retaining of specimens is anticipated, contact your facility's laboratory since routine practice might result in discarding of specimens before desired

Recommendations for Clinicians: Clinical Management

- Decisions regarding outpatient versus inpatient management should be based on individual clinical circumstances

- Evaluate and treat as appropriate for other possible causes of illness (e.g., infectious, rheumatologic, neoplastic)

- Consider consultation with specialists (pulmonary, infectious disease, critical care, medical toxicology)

Recommendations for Clinicians: Clinical Management (Cont'd)

- Clinical improvement of patients with lung injury associated with e-cigarette use, or vaping, has been reported with the use of corticosteroids
  - Dosing, route of administration, duration, and timing have varied
  - The decision to use corticosteroids should be made on a case-by-case basis based on risks and benefits and the likelihood of other etiologies

- Patients who have received treatment for lung injury related to e-cigarette product use, or vaping, should undergo follow-up evaluation as clinically indicated to monitor pulmonary function

Recommendations for Clinicians: Evaluation of Pathologic Specimens at CDC*

- If feasible, submission of formalin-fixed (wet) lung tissues is encouraged
- CDC's Infectious Disease Pathology Branch can perform lipid-staining on formalin-fixed (wet) lung tissues using osmium tetroxide before routine tissue processing and paraffin embedding
  - However, lipid staining cannot be performed on formalin-fixed, paraffin-embedded lung tissue blocks, because they have undergone processing that removes lipids
- CDC's Infectious Disease Pathology Branch will also review tissue histopathology and perform additional testing, including testing for possible infectious etiologies

*** Additional information on lipid-staining is available at: https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease/healthcare-providers/index.html.**

Recommendations for Clinicians: Evaluation of Pathologic Specimens at CDC* (Cont'd)

- Please first report any possible cases of lung injury associated with e-cigarette product use, or vaping, to your state, territorial, tribal, or local health department

- Pre-approval is required prior to submission of any tissue specimens. For pre-approval, health departments should contact pathology@cdc.gov and VapingAssocIllness@cdc.gov.

*** Additional information on lipid-staining is available at: https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease/healthcare-providers/index.html.**

Recommendations for Clinicians: Autopsy

- In the event of a fatal outcome, autopsies can be considered
  - Collection of fresh lung tissue for staining of lipids, formalin-fixed (wet) lung tissue, and submission of lung and other tissues for routine tissue processing, paraffin-embedding, and evaluation of histopathology should be considered
  - Infectious disease testing, including postmortem microbiology and molecular testing, should also be considered if indicated by patient history or autopsy findings

- Contact public health officials as needed for technical assistance with laboratory testing

Recommendations for Clinicians: What to Tell Patients

- Regardless of the ongoing investigation, e-cigarette products should not be used by
  - Youth and young adults
  - Pregnant women
  - Adults who do not currently use tobacco products
- Regardless of the ongoing investigation, anyone who uses e-cigarette products should
  - Not buy these products off the street (e.g., e-cigarette products with THC, other cannabinoids)
  - Not modify e-cigarette products or add any substances to these products that are not intended by the manufacturer
  - Monitor yourself for symptoms (e.g., abdominal pain, nausea, vomiting, diarrhea, cough, shortness of breath, chest pain)
  - Promptly seek medical attention if you have concerns about your health

Recommendations for Clinicians: What to Tell Patients

- For adults trying to quit tobacco product use, including e-cigarettes
  - Use evidence-based treatments, including counseling from a healthcare provider and FDA-approved medications
- During the current investigation of lung injury associated with e-cigarettes, or vaping, if you are concerned about these specific health risks
  - Consider refraining from using e-cigarette or vaping products
  - If you are an adult who uses e-cigarettes because you have quit cigarette smoking, do not return to smoking cigarettes
  - If you continue to use e-cigarettes, carefully monitor yourself for symptoms and see a healthcare provider right away if you have symptoms like those reported in this outbreak

Recommendations for Clinicians: What to Tell Patients (Cont'd)

- If you are concerned about harmful effects from e-cigarette products, call your local poison control center at: 1-800-222-1222

- Submit detailed reports of any unexpected tobacco or e-cigarette-related health or product issues to the FDA via the online Safety Reporting Portal: https://www.safetyreporting.hhs.govexternal icon

Recommendations for Clinicians: Case Reporting to Public Health Authorities

- Report cases of lung injury of unclear etiology and a history of e-cigarette product use, or vaping, within the past 90 days to your state or local health department
  - Reporting of cases may help CDC and state health departments determine the cause or causes of these pulmonary illnesses

- Determine if any remaining product, including devices and liquids, are available for testing
  - Coordinate testing with the local or state health departments

Recommendations for Clinicians: Additional Resources

- CDC will provide updates as more information becomes available

- CDC website with updates for the ongoing investigation of lung injury associated with e-cigarette products use, or vaping: https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html

Limitations and Knowledge Gaps

Limitations and Knowledge Gaps

- Information sources have included both confirmed and unconfirmed reports and small case series
  - Anecdotal data can generate hypotheses but alone are insufficient; clinical information to support range of diagnoses has been lacking
  - As of September 17, 2019, of 530 reported cases, <20% have been described in published literature; representativeness of published cases is unknown
- Outbreak surveillance case definitions are intended for public health data collection purposes and not intended for use as a clinical diagnostic tool or replacement for individual clinical judgment
  - No diagnostic criteria exist

Limitations and Knowledge Gaps (Cont'd)

- Most cases have been severe illness resulting in hospitalization, but true spectrum of illnesses (including less severe illness) could be unrecognized

- Investigations in affected states have been ongoing, but national efforts to coordinate, centralize, and standardize data collection efforts have been underway since August 16, 2019

- No systematic data yet for exposure (including products, quantities, sources) or clinical information

Limitations and Knowledge Gaps (Cont'd)

- Available data point away from a purely infectious etiology, but this does not exclude the possibility of concurrent processes
  - No decision-making tools to distinguish infection versus non-infection at presentation, so important to rule out and empirically treat infectious etiologies as appropriate, even in patients with exposure history
  - Patterns of illness could change with the approaching respiratory virus season

- Remains unclear whether this is a new syndrome or a newly recognized one previously thought to be pneumonia or pneumonitis of unclear etiology

Limitations and Knowledge Gaps (Cont'd)

- Although most patients have survived to hospital discharge, whether there are post-illness sequelae (e.g., reduced pulmonary function) after hospital discharge is not yet known for most patients
- Age-related differences in illness have not been assessed
  - Outbreak predominantly has affected younger, healthy patients, possibly reflecting different use patterns conferring increased risk compared with older patients
  - Alternatively, diagnosis could be more complicated in adults who are more likely to have chronic lung disease or other medical comorbidities, leading to under-recognition of illness in adults
  - Unclear whether adults have more severe illness more likely to result in death

Limitations and Knowledge Gaps (Cont'd)

- Lipoid pneumonia has been reported in historical and recent case reports and series, but important caveats remain
  - Clinical significance of lipid-laden macrophages remains undetermined—are these markers of disease or markers of exposure?
  - Bronchoalveolar lavage has not been obtained universally on bronchoscope evaluation, and in turn nor has lipid-staining (a non-routine procedure), so frequency of finding is uncertain
  - Characteristics of cellularity of bronchoalveolar lavage fluid are uncertain because they could be altered by antibiotics or steroids and influenced by timing of therapies and interventions
- Autopsy has not been performed for all cases resulting in death, and results have not been reported for all cases when performed

Summary

- CDC's investigation has not yet identified any specific substance or e-cigarette product linked to all cases
  - Most patients have reported using cannabinoids such as THC or CBD
  - Some have reported nicotine use alone
- Most patients have been hospitalized with respiratory illness and received treatment for presumed infectious etiologies; some have responded to steroids with or without antibiotics
- Report possible cases to and coordinate product testing with your health department
- CDC will provide updates as information becomes available

https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease/healthcare-providers/index.html

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Appendix

Review of Recent and Historical Literature

Recent Publications on Pulmonary Disease Associated with E-cigarette Product Use, Or Vaping

Recent Publications with Case Findings

Reference	Number of patients	Brief Description
Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019	53	Summary of clinical characteristics and use of e-cigarette products reported among initial reported cases in Wisconsin and Illinois
Davidson K, et al. Outbreak of e-cigarette-associated acute lipoid pneumonia—North Carolina, July–August 2019. *MMWR* 2019;68(36).	5	Description of patients with lipoid pneumonia diagnosed at 2 hospitals in North Carolina
Maddock S, et al. Pulmonary lipid-laden macrophages and vaping. NEJM 2019.	6	Summary of clinical characteristics and bronchoalveolar lavage findings for patients in Utah
Henry TS, et al. Imaging of vaping-associated lung disease. *NEJM* 2019	19 (+15 in literature)	Review of imaging findings

Comparison of Patients in North Carolina and Illinois/Wisconsin

Patient Characteristics in North Carolina, Illinois, and Wisconsin

Characteristic	NC (n=5)	IL/WI (n=53)
Ages (years)	18–35	16–53 (median:19)
Male	Not reported	44/53 (83%)
Hospitalized	5/5	50/53 (94%)

Reported Symptoms in North Carolina, Illinois, and Wisconsin

Symptom	NC (n=5)	IL/WI (n=53)
Shortness of breath	5/5	46/53 (87%)
Nausea or vomiting	5/5	37/53 (70%)
Abdominal pain or discomfort	5/5	23/53 (43%)
Diarrhea	Not reported	23/53 (43%)
Subjective fever	5/5	43/53 (81%)
Any systemic symptoms*	Not reported	53/53 (100%)

*Subjective fever, chills, weight loss, fatigue or malaise

Presentation Findings in North Carolina, Illinois, and Wisconsin

Finding	NC (n=5)	IL/WI (n=53)
Fever	Not reported	15/51 (29%)
Hypoxemia	5/5 with sat <90% on room air (RA)	20/52 (38%) with sat <95% on RA; 16/52 (31%) with sat <89% on RA
CXR with bilateral infiltrates	5/5 on initial	48/53 (91%) on initial
CT chest with bilateral opacities	5/5 (timing not specified)	48/48 (100%) on initial
Elevated white-cell count	5/5, all with neutrophil predominance; none with eosinophils	45/52 (87%); 34/36 (94%) with neutrophil predominance; none with eosinophils

Clinical Course in North Carolina, Illinois, and Wisconsin

Finding	NC (n=5)	IL/WI (n=53)
Received empiric antibiotics	5/5	45/50 (90%)
Worsened on antibiotics	5/5	Not reported
Received steroids	5/5	46/50 (92%)
Improved on steroids (with or without antibiotics)	5/5	30/46 (65%)
Negative workup for infectious etiologies	5/5	"Nearly all"

Clinical Course in North Carolina, Illinois, and Wisconsin

Finding	NC (n=5)	IL/WI (n=53)
Required ICU care	3/5	31/53 (58% overall, 62% of hospitalized)
Diagnosed with ARDS	3/5	15/53 (28%)
Required intubation and mechanical ventilation	1/5	17/53 (32% overall, 35% of hospitalized)
Received extracorporeal membrane oxygenation	0/5	2 (1 died)
Survived to discharge	5/5	52/53 (98%)

Comparison of Bronchoalveolar Lavage Findings for Patients in North Carolina, Illinois/Wisconsin, and Utah

Bronchoscopy Alveolar Lavage Findings in North Carolina, Illinois, Wisconsin, and Utah

Characteristic	NC (n=3)	IL/WI (n=24)	UT (n=6)
Lipid staining performed	3/3	Not specified	6/6
Lipid-laden macrophages identified	3/3	7/14 with cell counts reported	6/6
>5% eosinophils*	0/3	0/3	1/6

* Timing of steroids or other interventions not specified.

Review of Imaging Studies for 19 Patients and Review of Literature

Henry TS, et al. Imaging of vaping-associated lung disease. *NEJM* 2019

Review of Imaging Studies (correspondence from Henry, et al.)

- Based on review of imaging for 19 patients and 15 patients reported in literature
- No information provided regarding exposure other than "*all met the case definition of vaping-associated lung injury*"
- Most imaging patterns have basilar-predominant consolidation and ground-glass opacity, often with areas of lobular or subpleural sparing
- Authors noted that fat attenuation (highly suggestive of lipoid pneumonia) has not been frequently observed on CT

Additional Data from Wisconsin and Illinois

Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Experience in Illinois and Wisconsin (n=53 patients)

- Patient demographics
  - Median age 19 years (range: 16–53 years)
  - 83% male
  - 30% with asthma; otherwise no underlying chronic lung disease
- Clinical presentations
  - Median symptom duration before admission 6 days (range: 0–61 days)
  - 94% of patients hospitalized; 72% evaluated as outpatient before admission
  - 45% of those evaluated as outpatients received outpatient antibiotic treatment, however all reported progression of symptoms

Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Illinois and Wisconsin: Clinical Presentation

- Respiratory symptoms (98% of cases)
  - Shortness of breath (87%)
  - No report of upper respiratory symptoms (e.g., rhinorrhea, sneezing, congestion)
- GI symptoms (81% of cases)
  - Nausea (70%)
  - Vomiting (66%)
  - Diarrhea (43%)
- Systemic symptoms (100% of cases)
  - Subjective fever (81%)

Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Illinois and Wisconsin: Clinical Presentation (Cont'd)

- Initial recorded vital signs
  - 64% with tachycardia (range 55–146 BPM)
  - 43% with tachypnea (range: 15–48 breaths/min)
  - 69% with SpO2 <95% on room air
  - 31% with SpO2 <89% on room air
  - 29% with fever
- Initial laboratory findings
  - 87% with leukocytosis (median: 15.9K/ml, range 12.3–18.1K/ml); 94% with neutrophil predominance; no eosinophilia >2%
  - 50% with mild transient transaminase elevations
  - Acute kidney injury reported in 1 patient who responded to intravenous fluid (IVF) hydration

Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Illinois and Wisconsin: Imaging

- 91% with abnormal findings on chest radiograph at presentation
- All 48 patients who had CT chest had abnormal findings
  - Characteristic finding: bilateral ground-glass opacities with subpleural sparing
- All patients had bilateral lung opacities

Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Illinois and Wisconsin: Biopsy Findings

- 3 patients underwent lung biopsy
  - 2 patients transbronchial only, 1 patient also had open lung biopsy
  - 2 on antibiotics/corticosteroids , 1 on neither before biopsy
  - Lipid staining not performed
  - Findings: mild and non-specific damage, acute diffuse alveolar damage and foamy macrophages suggesting inhalation toxin exposure, interstitial and peri-bronchiolar granulomatous pneumonitis

Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019

Dosing of Corticosteroids in Recent Outbreak Reports

Publication	Dosages and medications
Davidson K, et al. Outbreak of e-cigarette-associated acute lipoid pneumonia—North Carolina, July–August 2019. *MMWR* 2019;68(36).	5/5 patients received intravenous methylprednisone (120 mg–500 mg daily); all discharged home on taper of oral prednisone (dose and duration not specified)
Maddock S, et al. Pulmonary lipid-laden macrophages and vaping. NEJM 2019.	2/6 patients received "high-dose glucocorticoids" (dose, duration, and discharge regimen not specified); 2 other patients received "short-course of prednisone" before hospitalization (dose and duration not specified)
Layden J, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—preliminary report. *NEJM* 2019	"majority of patients have received prolonged courses" of systemic glucocorticoid therapy

To Ask a Question

- **Using the Webinar System**
  - Click on the **Q&A** button in the Zoom webinar system.
  - Type your question in the **Q&A** box.
  - Submit your question.
  - Please do not submit a question using the chat button.
- **For media questions, please contact CDC Media Relations at 404-639-3286 or send an email to media@cdc.gov.**
- **If you are a patient, please refer your questions to your healthcare provider.**

Today's webinar will soon be available to view on demand

When: A few days after today's live webinar

What: Video with closed captioning

Where: On the COCA Call webpage at:
https://emergency.cdc.gov/coca/calls/2019/callinfo_091919.asp

Upcoming COCA Call

Topic: 2019–2020 Recommendations for Influenza Prevention and Treatment in Children: An Update for Pediatric Providers

Date: Thursday, September 26, 2019

Time: 2:00-3:00 p.m. ET

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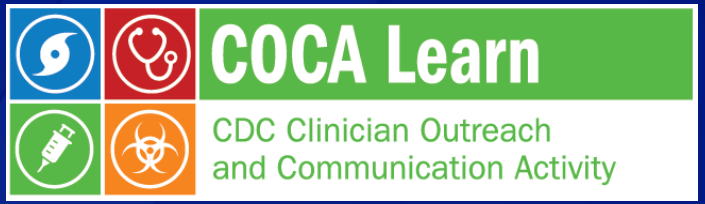

Monthly newsletter that provides information on CDC training opportunities, conference and training resources, the COCA Partner Spotlight, and the Clinician Corner.

As-needed messages that provide specific, immediate action clinicians should take. Contains comprehensive CDC guidance so clinicians can easily follow recommended actions.

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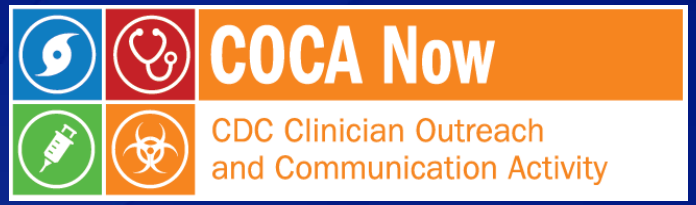

Informs clinicians of new CDC resources and guidance related to emergency preparedness and response. This email is sent as soon as possible after CDC publishes new content.

CDC's primary method of sharing information about urgent public health incidents with public information officers; federal, state, territorial, and local public health practitioners; clinicians; and public health laboratories.

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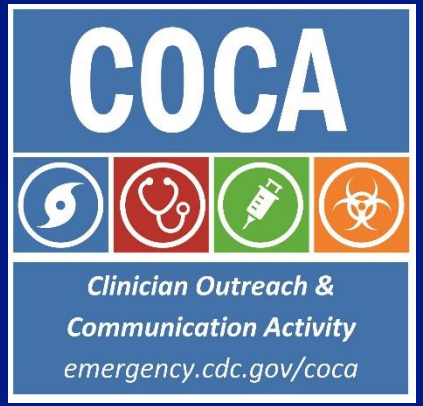

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