

Management of E-CIGARETTE OR VAPING PRODUCT USE-ASSOCIATED LUNG INJURY (EVALI)



Published by:

Malaysian Health Technology Assessment Section (MaHTAS)
Medical Development Division, Ministry of Health Malaysia
Level 4, Block E1, Precinct 1
Federal Government Administrative Centre 62590
Putrajaya, Malaysia

Copyright

The copyright owner of this publication is MaHTAS. Content may be reproduced in any number of copies and in any format or medium provided that a copyright acknowledgement to MaHTAS is included and the content is not changed, not sold, nor used to promote or endorse any product or service, and not used in an inappropriate or misleading context.

e-ISBN: 978-967-2887-10-2

Available on the following websites:

<http://www.moh.gov.my>

<http://www.acadmed.org.my>

Also available as an app for Android and IOS platform: MyMaHTAS

STATEMENT OF INTENT

These clinical practice guidelines (CPG) are meant to be guides for clinical practice, based on the best available evidence at the time of development. Adherence to these guidelines may not necessarily guarantee the best outcome in every case. Every healthcare provider is responsible for the management of his/her unique patient based on the clinical picture presented by the patient and the management options available locally.

UPDATING THE CPG

These guidelines were issued in 2021 and will be reviewed in a minimum period of four years (2025) or sooner if new evidence becomes available. When it is due for updating, the Chairman of the CPG or National Advisor of the related specialty will be informed about it. A discussion will be done on the need for a revision including the scope of the revised CPG. A multidisciplinary team will be formed and the latest systematic review methodology used by MaHTAS will be employed.

Every care is taken to ensure that this publication is correct in every detail at the time of publication. However, in the event of errors or omissions, corrections will be published in the web version of this document, which is the definitive version at all times. This version can be found on the websites mentioned above.

TABLE OF CONTENTS

No.	Title	Page
	Levels of Evidence and Formulation of Recommendation	i
	Key Recommendations	ii
	Guidelines Development and Objectives	iii
	Development Group	vi
	Review Committee	vii
	External Reviewers	viii
	Algorithm on Management of E-Cigarette or Vaping Product Use-Associated Lung Injury (EVALI)	xi
1.	INTRODUCTION	1
2.	DIAGNOSIS	3
	2.1 Clinical Presentation	3
	2.2 History of E-Cig or Vaping Product Use for Patients with Suspected EVALI	3
	2.3 Laboratory Investigation	4
	2.4 Imaging	5
	2.5 Bronchoscopy	6
	2.6 Case Definitions	7
3.	AETIOLOGY/CHEMICAL PROFILING	9
4.	DIFFERENTIAL DIAGNOSIS	11
5.	TREATMENT	12
6.	REFERRAL/FOLLOW-UP	15
	6.1 Indications for Referral/Admission	15
	6.2 Management in Emergency Department/ Primary Care Facility	15
	6.3 Discharge from Hospital Admission	16
7.	IMPLEMENTING THE GUIDELINES	18
	7.1 Facilitating and Limiting Factors	18
	7.2 Potential Resource Implications	18
8.	REFERENCES	20
	Appendix 1 Example of Search Strategy	22
	Appendix 2 Clinical Questions	24
	Appendix 3 Types of Vaping Products in Malaysia	25
	Appendix 4 Imaging Features in EVALI	27
	Appendix 5 EVALI Patient Follow-Up Checklist	29

TABLE OF CONTENTS

No.	Title	Page
	List of Abbreviations	30
	Acknowledgement	30
	Disclosure Statement	30
	Source of Funding	30

LEVELS OF EVIDENCE

Level	Study design
I	Evidence from at least one properly randomised controlled trial
II-1	Evidence obtained from well-designed controlled trials without randomisation
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one centre or group
II-3	Evidence from multiple time series with or without intervention; dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence
III	Opinions of respected authorities based on clinical experience; descriptive studies and case reports; or reports of expert committees

SOURCE: US / CANADIAN PREVENTIVE SERVICES TASK FORCE 2001

FORMULATION OF RECOMMENDATION

In line with new development in CPG methodology, the CPG Unit of MaHTAS is adapting **Grading Recommendations, Assessment, Development and Evaluation (GRADE)** in its work process. The quality of each retrieved evidence and its effect size are carefully assessed/reviewed by the CPG Development Group. In formulating the recommendations, overall balances of the following aspects are considered in determining the strength of the recommendations:-

- overall quality of evidence
- balance of benefits versus harms
- values and preferences
- resource implications
- equity, feasibility and acceptability

KEY RECOMMENDATIONS

The following recommendations are highlighted by the CPG Development Group as the key recommendations that answer the main questions addressed in the CPG and should be prioritised for implementation.

a. Diagnosis

- Relevant laboratory investigations should be done to rule out other probable diagnoses before diagnosis of e-cigarette or vaping product use-associated lung injury (EVALI) can be made.
- Chest X-ray should be done in all suspected EVALI cases.
 - Computed tomography scan of the chest should be performed if chest X-ray is normal.
- Bronchoscopy may be performed if clinically indicated to exclude alternative diagnosis and not to confirm EVALI.
- The diagnosis of EVALI should be made based on case definitions as outlined by the United States Centers for Disease Control and Prevention.

b. Treatment

- For patients suspected or confirmed of diagnosis of EVALI, these treatments may be initiated:
 - supplemental oxygen
 - antibiotics when there is diagnostic uncertainty
 - systemic corticosteroids based on the severity of the illness

c. Referral/Follow-up

- A physician should be consulted for any case suspected of EVALI at the emergency department or primary care facility.
- Patients with EVALI should only be discharged when they fulfil the discharge criteria.
 - Upon discharge, hospital prescription should be given.
 - Follow-up should be done by the treating physician.

GUIDELINES DEVELOPMENT AND OBJECTIVES

GUIDELINES DEVELOPMENT

The members of the Development Group (DG) for these Clinical Practice Guidelines (CPG) were from the Ministry of Health (MoH) and the Ministry of Higher Education. There was active involvement from a multidisciplinary Review Committee (RC) during the process of the CPG development.

This is the first edition of an evidence-based CPG on the Management of E-Cigarette or Vaping Product Use-Associated Lung Injury (EVALI). Literature search was carried out using the following electronic databases: mainly Medline via Ovid and Cochrane Database of Systemic Reviews and others e.g. Pubmed and Centers for Disease Control and Prevention (refer to **Appendix 1** for **Example of Search Strategy**). The search was limited to literature published on humans and in English. In addition, the reference lists of all retrieved literature and guidelines were searched to further identify relevant studies. Experts in the field were also contacted to identify further studies. All searches were conducted from 27 August 2020 to 1 September 2020. Literature searches were repeated for all clinical questions at the end of the CPG development process, allowing any relevant papers published before 28 February 2021 to be included. Future CPG updates will consider evidence published after this cut-off date. The details of the search strategy can be obtained upon request from the CPG Secretariat.

There was no relevant evidence-based CPG used as a reference in developing the MoH CPG on EVALI. A total of seven clinical questions were developed under three sections (diagnosis, treatment and referral/follow-up). Members of the DG were assigned individual questions within the sections (refer to **Appendix 2** for **Clinical Questions**). The DG members met 12 times throughout the development of these guidelines. All literature retrieved were appraised by at least two DG members using Critical Appraisal Skill Programme checklist when applicable, presented in evidence tables and further discussed in DG meetings. All statements and recommendations subsequently formulated were agreed upon by both the DG and RC. Where evidence was insufficient, the recommendations were made by consensus of the DG and RC. There were only a few published articles on EVALI and all were of low level evidence. This CPG was developed largely based on the findings of reviews and observational studies, with local practices taken into consideration.

The literature used in these guidelines were graded using the US/ Canadian Preventive Services Task Force Level of Evidence (2001), while the grading of recommendation was done using the principles of

GRADE as much as possible (refer to the preceding page). The writing of the CPG strictly follows the requirement of Appraisal of Guidelines for Research and Evaluation (AGREE) II.

Upon completion, the draft of the CPG was reviewed by external reviewers. It was also posted on the MoH Malaysia official website for feedback from any interested parties. The draft was finally presented to the Technical Advisory Committee for CPG, and the Health Technology Assessment and Clinical Practice Guidelines Council MoH Malaysia for review and approval. Details on the CPG development methodology by MaHTAS can be obtained from the Manual on Development and Implementation of Evidence-based Clinical Practice Guidelines published in 2015 (available at http://www.moh.gov.my/moh/resources/CPG_MANUAL_MAHTAS.pdf?mid=634).

OBJECTIVES

The objective of this CPG is to provide evidence-based recommendations on the management of EVALI on the following aspects:

- a) diagnosis
- b) treatment
- c) referral and follow-up

CLINICAL QUESTIONS

Refer to **Appendix 2**

TARGET POPULATION

Inclusion Criteria

- All vape and e-cigarette users

TARGET GROUP/USERS

This document is intended to guide health professionals and relevant stakeholders in primary and secondary/tertiary care in the management of EVALI, including:

- i. doctors
- ii. allied health professionals
- iii. trainees and medical students
- iv. policymakers
- v. patients and their advocates
- vi. professional societies

HEALTHCARE SETTINGS

Primary and secondary/tertiary care settings

DEVELOPMENT GROUP

Chairperson

Dr. Nurhayati Mohd Marzuki
Director & Consultant Respiratory Physician
Institut Perubatan Respiratori
Kuala Lumpur

Members (in alphabetical order)

Dr. Azahirafairud Abdul Rahim
Acute Internal Medicine Specialist
Hospital Kuala Lumpur, Kuala Lumpur

Dr. Noorul Afidza Muhammad
Respiratory Physician
Hospital Serdang, Selangor

Dr. Bushra Johari
Lecturer & Clinical Radiologist
Universiti Teknologi MARA, Selangor

Dr. Noriah Othman
Pathologist
Hospital Serdang, Selangor

Dr. Fazlina Mohamed Yusoff
Family Medicine Specialist
Klinik Kesihatan Anika, Selangor

Dr. Norliana Ismail
Public Health Physician &
Senior Principal Assistant Director
Disease Control Division, MoH, Putrajaya

Dr. Mohd Afiq Mohd Nor
Emergency Physician
Pusat Perubatan Universiti Malaya
Kuala Lumpur

Ms. Sulastris Samsudin
Head, Prevention Education Unit &
Pharmacist, Pusat Racun Negara
Universiti Sains Malaysia, Pulau Pinang

Dr. Mohd. Aminuddin Mohd. Yusof
Head, Clinical Practice Guidelines Unit
MoH, Putrajaya

Datin Dr. Zuhanis Abdul Hamid
Thoracic Radiologist
Institut Kanser Negara, Putrajaya

Dr. Noorliza Mohamad Noordin
Director & Consultant Public Health
Physician
National Public Health Laboratory
Selangor

REVIEW COMMITTEE

The draft guidelines were reviewed by a panel of experts from both public and private sectors. They were asked to comment primarily on the comprehensiveness and accuracy of the interpretation of evidence supporting the recommendations in the guidelines.

Chairperson

Dr. Irfhan Ali Hyder Ali
Consultant Respiratory Physician
Hospital Pulau Pinang, Pulau Pinang

Members (in alphabetical order)

Dr. Chin Pek Woon Head of Department & Consultant Physician Hospital Enche' Besar Hajjah Khalsom Johor	Dr. Mohammad Hanafiah Kream Consultant Radiologist Sunway Medical Centre, Selangor
Associate Professor Dr. Farizah Mohd Hairi Lecturer & Public Health Physician Universiti Malaya, Kuala Lumpur	Dr. Nazrila Hairizan Nasir Deputy Director (Primary Health) Family Health Development Division MoH, Putrajaya
Dr. Hidayah Shafie Emergency Physician Hospital Kuala Lumpur, Kuala Lumpur	Dr. Nor Aryana Hassan Public Health Specialist & Head Tobacco Control & FCTC Sector, Disease Control Division, MoH, Putrajaya
Dr. Izzuna Mudla Mohamed Ghazali Deputy Director & Public Health Physician Malaysian Health Technology Assessment Section, MoH, Putrajaya	Dr. Norsiah Ali Consultant Family Medicine Specialist & Addiction Medicine Specialist Klinik Kesihatan Masjid Tanah, Melaka
Dr. Leong Yin Hui Lecturer Pusat Racun Negara Universiti Sains Malaysia, Pulau Pinang	Dr. Nurahan Maning Consultant Microbiologist Hospital Raja Perempuan Zainab II, Kelantan
Associate Professor Dr. Mohamad Haniki Nik Mohamed Lecturer & Clinical Pharmacist Universiti Islam Antarabangsa Malaysia Pahang	Associate Professor Dr. Pang Yong Kek President Malaysian Thoracic Society

EXTERNAL REVIEWERS (in alphabetical order)

The following external reviewers provided feedback on the draft:

Dr. Adi Osman
Senior Consultant Emergency Physician & ED Critical Care
Hospital Raja Perempuan Bainun, Perak

Professor Dr. Harmy Mohamed Yusoff
Dean of Medical Faculty & Consultant Family Medicine Specialist
Universiti Sultan Zainal Abidin, Terengganu

Dr. Henry D. Tazelaar
Consultant & Geraldine Colby Zeiler Professor of Cytopathology
Department of Laboratory Medicine & Pathology, Mayo Clinic Alix College of
Medicine, Mayo Clinic
Arizona, United States of America

Dr. Mustafa Kamal Razak
Consultant Respiratory Physician
KPJ Penang Specialist Hospital, Pulau Pinang

Dr. Noorasyikin Mohamed Arifin
Internal Medicine Specialist
Hospital Labuan, Labuan

Associate Prof. Dr. Omar Mihat
Lecturer & Consultant Public Health Physician
Universiti Islam Antarabangsa Sultan Abdul Halim Muad'zam Shah, Kedah

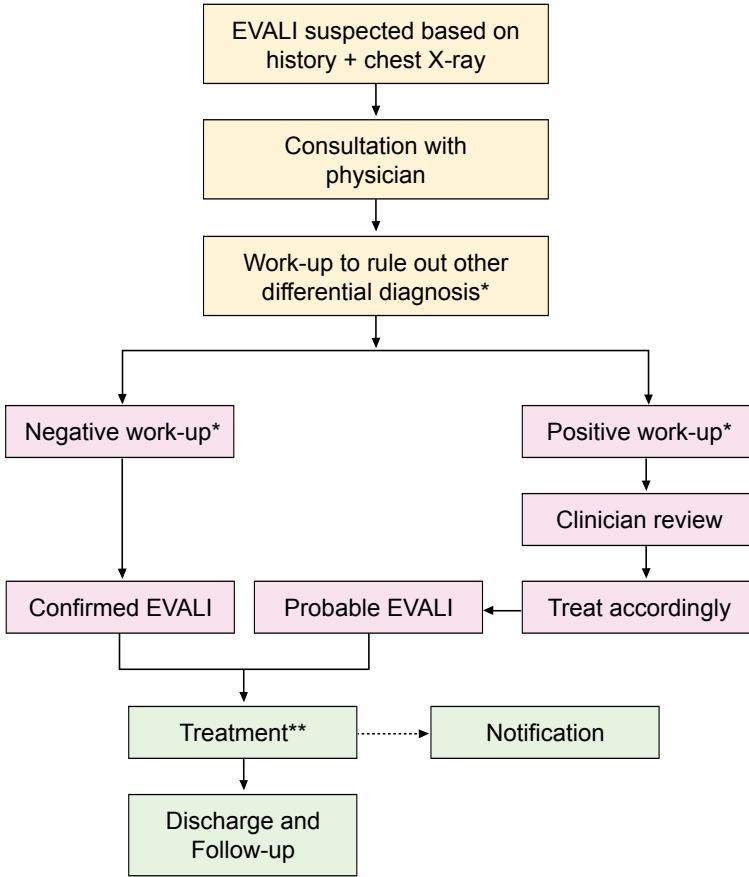
Dr. Raj Kumar a/l S. Maharajah
General Practitioner, Klinik Lingam, Selangor
President, Medical Practitioners Coalition Association of Malaysia (MPCAM)

Professor Dr. Seth Kligerman
Division Chief of Cardiothoracic Radiology
Department of Radiology, University of California
San Diego, United States of America

Dr. Tie Siew Teck
Consultant Respiratory Physician
Hospital Umum Sarawak, Sarawak

Dr. Wong Chee Kuan
Head, Division of Respiratory Medicine & Consultant Respiratory Physician
Pusat Perubatan Universiti Malaya, Kuala Lumpur

ALGORITHM ON MANAGEMENT OF E-CIGARETTE OR VAPING PRODUCT USE-ASSOCIATED LUNG INJURY (EVALI)



*Refer to **Subchapter 2.6** on **Case Definitions**

**May require admission

1. INTRODUCTION

Electronic cigarette or e-cigarette (e-cig) is a handheld device equipped with aerosol generator, battery and solution storage area. Its purpose is delivery of nicotine or other chemicals via aerosolisation.¹ It was invented in 2003 and since then marketed worldwide.² It is believed that e-cig entered the Malaysian market in mid-2000s and gained popularity in 2010s.

The first local study in 2016 showed an estimated figure of 600,000 e-cig users.³ The number had increased to 1.1 million as reported in the Malaysian National Health and Morbidity Survey 2019 with the highest prevalence among those aged 20 to 24.⁴ In addition, the Tobacco and E-Cigarette Survey Among Malaysian Adolescents (TECMA) 2016 reported 300,000 e-cig users among Malaysian youth aged 10 to 19. The highest prevalence was among those in the age group 16 to 19.⁵ In 2018, a cross-sectional study among secondary school students ever used of any smoking products in the last 30 days in Kuala Lumpur showed a prevalence of 73% of e-cig users.⁶

The Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems reported that exposure to nicotine and toxicants from the aerosolisation of e-cig ingredients was dependent on usage and characteristics of the device which influenced the variability of potentially toxic substances emitted.⁷

Inhalation of e-cig aerosol could potentially cause:²

- adverse effects due to acute administration of nicotine, flavourants, chemicals, other particulates
- accidental overdose of nicotine
- developmental effects on the brain from nicotine exposure
- uptake of subsequent illicit drug use
- gateway to conventional cigarettes and dual use of both types of cigarettes
- negative psychosocial health
- battery explosion

Health Effects of E-Cigarette Use Among U.S. Youth and Young Adults reported that delivery of nicotine from e-cig was in doses range from negligible to larger than conventional cigarettes, while its second-hand nicotine exposure was comparable to conventional cigarettes.²

E-cig can induce negative cardiovascular effects through various mechanisms e.g. oxidative stress, inflammation, DNA damage, arterial stiffness and, altered haemodynamics and platelet activity.⁸ Daily e-cig use is associated with increased odds of having myocardial infarction (OR=1.79, 95% CI 1.20 to 2.66).⁹ E-cig aerosol exposure is

also associated with respiratory symptoms in healthy individuals and increased symptoms of patients with asthma, cystic fibrosis and chronic obstructive pulmonary disease.¹⁰

In July 2019, a large case series of pulmonary illnesses were reported in Illinois and Wisconsin, United States of America (USA). These were patients with history of e-cig use within 90 days of the onset of symptoms and had pulmonary infiltrate on imaging with no other contributable cause of the illness. They were termed as E-cigarette or Vaping Product Use-Associated Lung Injury (EVALI).^{11, level III}

A total of 2,807 cases of EVALI with 68 deaths were reported to the Centers for Disease Control and Prevention, USA until 18 February 2020. Laboratory data suggested a strong link between vitamin E acetate and the outbreak of the disease in the country.¹² In addition, analysis of THC-containing cartridges e-liquid and vapour had shown the presence of potential toxicants e.g. solvent-derived hydrocarbons, silicon conjugated compounds, etc.¹³

Based on experience of CPG DG, several cases of probable EVALI had been highlighted among the clinicians in Malaysia. However, the number of cases maybe underreported due to lack of awareness. The development of this first evidence-based CPG on the Management of EVALI is timely with the emergence of this novel medical condition. It will guide the healthcare providers locally on the best practice in the management of EVALI.

2. DIAGNOSIS

2.1 Clinical Presentation

EVALI is a disease that may be missed due to lack of awareness among healthcare providers. In a nationwide study based on cases reported to Centers for Disease Control (CDC) and Prevention of USA, there were patients who initially presented to outpatient setting with EVALI-related symptoms but not admitted. From this cohort, out of those who were later admitted, 46% were fatal while 21% were non-fatal. The risk of mortality was higher among patients with co-morbidities i.e. respiratory disease, cardiac disease, mental health condition and obesity.^{14, level III}

Although CDC case definition stated 90 days, evidence showed that patients used e-cig up to the onset of illness and seek medical attention acutely soon after symptoms appeared.^{15, level III}

Symptoms commonly presented in EVALI are:^{11, level III; 16 - 17, level III}

- respiratory symptoms
 - shortness of breath
 - cough
 - chest pain
- gastrointestinal symptoms
 - nausea
 - vomiting
 - diarrhoea
 - abdominal pain
- constitutional symptom
 - fever

Signs of EVALI that commonly observed are:^{11, level III; 16 - 17, level III}

- hypoxia
- tachycardia
- tachypnoea

2.2 History of e-Cig or Vaping Product Use for Patients with Suspected EVALI

Patients presented with EVALI symptoms should be asked on the use of e-cig or vaping products.

Healthcare providers should employ non-judgemental, open-ended and private questioning sessions with patients.^{18, level III} Confidentiality should be practised according to local guidelines.

- Questions on e-cig or vaping product use in patients with suspected EVALI:^{18 - 20, level III}
 - e-cig use
 - time of last use
 - duration
 - method (aerosol, dabbing or dripping)
 - frequency
 - concomitant smoking products use or substances abuse
 - devices and e-liquids
 - product brand name
 - delivery system (open or closed - refer to **Appendix 3 on Types of Vaping Products in Malaysia**)
 - types of substances use (tetrahydrocannabinol/THC, cannabis, nicotine, modified products, additional substances)
 - product source

2.3 Laboratory Investigation

EVALI is a diagnosis of exclusion. Thus, laboratory investigations need to be done to rule out other probable diagnosis.

There were no laboratory abnormalities specific for the diagnosis of EVALI. Several observational studies showed that most EVALI patients had elevated inflammatory markers. The patients had leucocytosis with neutrophil predominance and, high erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and procalcitonin. There was also mild elevation of liver enzymes.^{11, level III; 14, level III; 16, level III; 21, level III}

In a cross-sectional study, none of the EVALI patients had a microbiologically-confirmed infectious pneumonia. Additional inflammatory serologies (antinuclear antibody, antiglomerular basement membrane and antineutrophil cytoplasmic antibodies) were also negative.^{17, level III}

- Laboratory investigations for EVALI work-up will include:
 - full blood count
 - ESR
 - CRP
 - culture and sensitivity study - blood, sputum, urine
 - urinalysis
 - respiratory panel for influenza and other possible infectious pathogens
 - autoimmune screening
- In local setting, tuberculosis and coronavirus disease (COVID-19) work-up has to be done.

Recommendation 1

- Relevant laboratory investigations* should be done to rule out other probable diagnoses before diagnosis of e-cigarette or vaping product use-associated lung injury can be made.

*Refer to the yellow box above.

2.4 Imaging

- Abnormal chest imaging, either chest X-ray (CXR) or computed tomography (CT) scan, is mandatory for the diagnosis of EVALI.
- While CXR is often abnormal in EVALI cases, a normal CXR does not exclude the diagnosis. In the setting of a normal CXR in a high clinical suspicion of EVALI, a CT scan should be performed to better assess for lung injury.

In a cross-sectional study involving 98 patients from Illinois and Wisconsin, chest imaging findings were positive in all cases of EVALI. These were based on either CXR or CT scan.^{11, level III}

Findings in CXR of EVALI patients include ground-glass opacities and consolidation which are usually bilateral and almost symmetric in distribution.^{22, level III} The abnormalities are lower lobe predominant or diffuse in most cases with sparing of the heart border and subpleural region. Septal thickening manifesting as Kerley B lines can also be seen.^{23, level III}

Imaging findings of EVALI are better seen on CT scan compared with CXR. The common patterns seen on CT scan are those of acute lung injury (ALI), in the spectrum of diffuse alveolar damage (DAD) and organising pneumonia (OP) with bilateral relatively symmetrical multifocal ground-glass opacities with or without consolidation. Conspicuous lobular and/or subpleural sparing is common as well as sparing around the peribronchovascular interstitium.^{23 - 24, level III} Ill-defined centrilobular nodules, representing foci of airway-centered organising pneumonia on biopsy, are common and usually occur in conjunction with lower lobe or diffuse parenchymal opacity which can mimic the CT findings of acute hypersensitivity pneumonitis. Less commonly, centrilobular nodules may be diffuse with little or no associated ground-glass opacity. Septal thickening is a common finding and in some instances, a crazy paving can occur. Reverse halo or atoll signs are less common but may also be seen.^{24, level III}

Apart from DAD or OP, other less commonly described patterns of ALI in EVALI are diffuse alveolar haemorrhage (DAH) and acute

eosinophilic pneumonia-like pattern (AEP). On CT scan, DAH may be seen as multifocal ground-glass opacities, with or without consolidation and often with poorly defined centrilobular nodules. The AEP-like pattern has findings that overlap with the OP and DAD pattern but is associated with pronounced smooth interlobular septal thickening and pleural effusions secondary to increased vascular permeability.^{24, level III}

Mild and symmetrical hilar and mediastinal lymphadenopathy are common findings of EVALI.^{16, level III; 24, level III} However, necrotic or calcified lymphadenopathy is not a feature. Although uncommon, patients with EVALI can present with pneumomediastinum and/or pneumothorax. Lung cysts/bullae are uncommon early injury but can occur during the reparative phase.^{11, level III; 23, level III} Pulmonary embolism can occur in conjunction with EVALI but is uncommon.^{22, level III}

Refer to **Appendix 4 on Imaging Features in EVALI**.

Recommendation 2

- Chest X-ray should be done in all cases suspected of e-cigarette or vaping product use-associated lung injury.
 - Computed tomography scan of the chest should be performed if chest X-ray is normal.

2.5 Bronchoscopy

There is no clear role of bronchoscopy in the diagnosis of EVALI. Based on current evidence, there is no specific bronchoscopic findings that can confirm the diagnosis of EVALI. Bronchoscopy may be performed to exclude specific suspected alternative diagnosis where non-invasive methods are inadequate. It should be guided by clinical pre-test probabilities of the EVALI.^{15, level III}

Several observational studies showed predominance of macrophages and neutrophils, and scant eosinophils in cytology of bronchoalveolar lavage (BAL) in EVALI patients. Lipid-laden macrophages (LLMs) in BAL had been reported in most EVALI patients as well as asymptomatic persons who were e-cig users. Although LLMs were not specific for EVALI, their absence should prompt reconsideration of diagnosis. A diverse patterns of diffuse lung injury and inflammation were seen in histopathology examination of lung biopsy of EVALI patients, but none were pathognomonic. Thus, cytology and histopathology examination of lung biopsy specimens from bronchoscopy were nonspecific and could not confirm the diagnosis of EVALI.^{15, level III}

Findings of vitamin E acetate in BAL provided direct evidence of its existence at the primary site of injury among EVALI patients.^{25, level III}

Recommendation 3

- Bronchoscopy may be performed if clinically indicated to exclude alternative diagnosis and not to confirm e-cigarette or vaping product use-associated lung injury.

2.6 Case Definitions

The case definitions of EVALI recommended by Centers for Disease Control and Prevention of USA is shown below:²⁶

- 2019 Lung Injury Surveillance Primary Case Definitions:²⁶
 - **Confirmed Case:**
 - Using an e-cig (“vaping”) or dabbing* in 90 days prior to symptom onset
AND
Pulmonary infiltrate, e.g., 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:
 1. A negative respiratory viral panel
AND
 2. A negative influenza polymerase chain reaction (PCR) or rapid test if local epidemiology supports influenza testing
ANDAll other clinically indicated respiratory infectious disease testing (e.g., urine antigen for *Streptococcus pneumoniae* and *Legionella*, sputum culture if productive cough, BAL culture if done, blood culture, human immunodeficiency virus-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).
 - **Probable Case:**
 - Using an e-cig (“vaping”) or dabbing* in 90 days prior to symptom onset
AND
Pulmonary infiltrate, e.g., 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 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).

Footnotes

*Using an electronic device (e.g. electronic nicotine delivery system (ENDS), electronic cigarette, e-cig, vapouriser, vape(s), vape pen, dab pen or other device) or dabbing to inhale substances (e.g. nicotine, marijuana, THC, THC concentrates, cannabidiol (CBD), synthetic cannabinoids, flavourings or other substances)

**Clinical team caring for the patient

Notes: These case definitions are meant for surveillance and not clinical diagnosis. The case definitions are subject to change and will be updated as additional information becomes available if needed.

In USA, confirmed and probable EVALI cases are reported by the clinicians to the local health authorities.^{11, level III; 19, level III}

In our local setting, as EVALI is a new entity with an increasing trend of e-cig use, there is a need to report EVALI cases for surveillance purpose to MoH, Malaysia. The surveillance data can be used to plan for policy and guidance in clinical management.

Recommendation 4

- The diagnosis of e-cigarette or vaping product use-associated lung injury should be made based on case definitions as outlined by United States Centers for Disease Control and Prevention.

3. AETIOLOGY/CHEMICAL PROFILING

E-cig is a device that produces an aerosol by heating a liquid which contains a solvent in one or more flavourings, with or without nicotine (also known as e-liquid). It is composed of an atomiser that uses electrical current from a battery to heat a metal coil. This aerosolises an e-liquid, which is conducted from a reservoir to the coil by a wick. Aerosol from e-cig may contain different chemical composition subject to device type, voltage used and e-liquid content.^{18, level III}

Generally, e-liquid constitutes varying ratios of vegetable glycerin (VG), propylene glycol (PG), nicotine, and flavouring agents. However, some studies detected more than 60 compounds in e-liquid, this includes chemicals which is not stated by the manufacturer.^{27, level III} As e-cig metal components undergo repeated cycles of heating and cooling, traces of toxic metal can leach into the e-liquid and emitted through e-cig aerosol.^{27 - 28, level III}

Chemicals in e-liquid (e.g. PG and VG) and flavouring agent are considered to be “generally recognised as safe (GRAS)” by United States Food and Drug Administration (FDA) for oral consumption but not through inhalation. They will be converted to toxicant when heated during e-cig smoking.^{28, level III}

Recent evidence showed that vitamin E acetate had been detected in a high proportion of THC-containing products associated with EVALI cases.^{29, level III}

Contribution of chemicals of concerns in EVALI cases has been studied. These include chemicals in either THC- or non-THC-containing products. Thus, chemical profiling is important for ongoing surveillance of the potential toxicants that can be associated with EVALI.

In a nationwide study of hospitalised EVALI patients in USA, the self-reported substance use in e-cig were 53% on both THC- and nicotine-containing product, 33% exclusive THC-containing product and 14% exclusive nicotine-containing product.^{30, level III}

A small study on EVALI patients in Minnesota tested selected products because of available product volume and features that physically differentiated the cartridges showed that vitamin E acetate was the most common compound detected in THC-containing product. Issues faced in doing chemical profiling in the study include:^{29, level III}

- poor cooperation of the patients in providing product for testing
- insufficient amount of material to be tested
- toxicant of concern did not cover flavouring agents

In a systematic review of case reports on e-cig-related illness and injury, 56% of patients who had respiratory symptoms reported using CBD/THC. Another 40% of patients used unknown/unspecified liquid while 3% used nicotine. Further scientific research was warranted to study on the causal role of each of the e-liquid ingredients, their thermolysis byproducts, potential interactions and additive effects.^{31, level III}

Toxicology testing has been recommended to assess aetiologies of lung diseases instigated by substances of abuse. This need to done with proper patient consent.^{18, level III}

- Potential toxicants in e-liquid include PG, VG, flavouring agents, vitamin E acetate, CBD, THC and nicotine.
- More strong evidence is warranted before proper chemical profiling can be recommended in cases of EVALI.

4. DIFFERENTIAL DIAGNOSIS

The most common differential diagnoses of EVALI are infectious pneumonia and other inflammatory lung diseases due to its flu-like illness as listed below:^{15, level III}

- infectious pneumonia -
 - bacterial
 - fungal
 - viral
 - pneumocystis jirovecii
- diffuse parenchymal lung diseases -
 - acute hypersensitivity pneumonitis
 - acute eosinophilic pneumonia
 - organising pneumonia
 - cellular non-specific interstitial pneumonia
- other diffuse lung diseases -
 - acute respiratory distress syndrome
 - diffuse alveolar haemorrhage

- Testing or empirical treatment for usual infectious pneumonia based on the probability of the illness is recommended.
- Probability of alternative diagnosis increases when either:
 - absence of typical demographic and clinical features of EVALI
 - presence of atypical presentations
 - presence of predisposition for other illness
- EVALI can be considered a leading or provisional diagnosis if none other illness is probable based on the above evaluation.^{15, level III}

5. TREATMENT

The treatment of EVALI is symptomatic based on the presenting symptoms which can be respiratory, gastrointestinal or constitutional in nature.

For respiratory symptoms, the following are done:

- **Oxygenation**

Ensure adequate oxygenation via nasal cannula, non-invasive or invasive ventilation. In a cross-sectional study of 36 patients in Pittsburgh, 64% patients required supplemental oxygen therapy during admission with 20% on mechanical ventilation.^{32, level III}

- **Antimicrobials**

In a multicentre cross-sectional study involving 60 patients, 90% of EVALI patients were given antibiotics due to overlapping presentation and diagnostic uncertainty.^{17, level III} As community-acquired pneumonia is a more common cause for hypoxaemic respiratory failure, antibiotics are strongly recommended with sequential de-escalation if no evidence of pulmonary or bloodstream infection is found.^{21, level III}

Antibiotics coverage are recommended to be given empirically for at least 48 hours if history is unclear, if patient is intubated or has severe hypoxaemia despite supplemental oxygen.^{16, level III}

Alternative diagnosis of concomitant EVALI with infections may be considered when laboratory evidences of infections are positive but in whom clinicians feel that microbiologic diagnoses alone are incompatible with the clinical course or severity of the illness.^{32, level III}

• Treatment with empiric antimicrobials, including antivirals, should be considered in accordance with established local guidelines and microbiology pattern.^{20, level III}

- **Corticosteroids**

A multicentre cross-sectional study showed a rapid improvement within days in 95% of EVALI patients received corticosteroids therapy. The initial corticosteroids dosing and duration of therapy varied with severity of illness at presentation. Patients admitted to the intensive care unit (ICU) were given higher doses and longer courses of corticosteroids while outpatients had short bursts of oral corticosteroids.^{17, level III}

In a narrative review, systemic corticosteroids and antibiotics were started immediately in severe cases. Majority of patients showed excellent response (either in clinical, radiological or pulmonary function) to methylprednisolone.^{21, level III}

In less severe cases, infections were ruled out prior to initiation of corticosteroids.^{21, level III} Oral prednisolone had also been administered in less severe hospitalised cases and outpatients.^{17, level III}

Most patients responded within a week of treatment. Thus, corticosteroids should be tapered down based on clinical improvement. There were no established guidelines on the duration of steroids in EVALI, but given good response and unfavourable side effects of corticosteroids, it was recommended no longer than two weeks.^{21, level III}

- Documented corticosteroids treatment in EVALI are:^{17, level III}
 - initial daily dose for:
 - intravenous methylprednisolone is 125 mg/day (IQR 120 - 240)
 - oral prednisolone is 40 mg/day (IQR 40 - 60)
 - duration before tapering dose or stopping: 2 days (IQR 1 - 4)
 - total duration of therapy: 11 days (IQR 6 - 18)

*There is no evidence on the use of hydrocortisone, dexamethasone and inhaled corticosteroids in EVALI.

Treatment of gastrointestinal or constitutional symptoms are treated accordingly based on severity of the symptoms.

Recommendation 5

- In patients suspected or confirmed of diagnosis of e-cigarette or vaping product use-associated lung injury, these treatments may be initiated:
 - supplemental oxygen
 - antibiotics when there is diagnostic uncertainty
 - systemic corticosteroids based on the severity of the illness

Tobacco cessation

- Smoking of tobacco and tobacco products (cigarette, electronic cigarette/vape, shisha, pipe, cigar etc.) can lead to various non-communicable diseases (NCDs). Worldwide, more than eight million people die every year because of this habit.³³
- Hence, the decision to integrate smoking treatment with NCDs is important to reduce the prevalence of NCDs and their complications. This decision was made during the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) Steering Committee Meeting in December 2019 chaired by the Honourable Health Minister of Malaysia.

- The treatment for smoking should be initiated by the treating doctor based on the assessment and treatment of tobacco use disorder as in **Table 1**. Details on this can be found in the CPG on Treatment of Tobacco Use Disorder 2016, available at: https://www.moh.gov.my/moh/resources/Penerbitan/CPG/Respiratory/CPG_TobaccoDisorder.pdf

Table 1. Assessment and treatment of tobacco use disorder

ASSESSMENT AND TREATMENT	
1.	Ask and document smoking status for all patients.
2.	Provide brief advice on quit smoking at every visit to all smokers.
3.	Assess level of nicotine addiction using Modified Fagerström Test for Cigarette Dependence Questionnaire (COMPULSORY) and verify smoking status using carbon monoxide breath analyser (IF AVAILABLE).
4.	Offer pharmacotherapy to all smokers who are attempting to quit, unless contraindicated.
5.	If selected, use nicotine replacement therapy (NRT) for at least eight to twelve weeks, whereas varenicline should be used for at least twelve weeks.
6.	Combination therapy (e.g. two NRTs, a non-NRT, e.g. bupropion with an NRT) is better than monotherapy in smoking cessation treatment and may be most useful for those smokers at highest risk of relapse.
7.	Use smoking cessation medications with caution in special populations (e.g. children and adolescents, pregnant, breastfeeding women, psychiatric and substance abuse disorder patients).
8.	Arrange a minimum of six to eight face to face follow-up sessions for smoking cessation interventions in six months through counselling support team (health education officer, pharmacists or any officer trained for quit smoking services).

6. REFERRAL/FOLLOW-UP

6.1 Indications for Referral/Admission

In view of the challenges in the diagnosis of EVALI, a diagnostic pathway to evaluate patients with suspected EVALI should be considered. This is due to the lack of a specific features for this clinical syndrome. If the history and imaging are suspicious for EVALI, patients should be admitted for thorough infectious and autoimmune work-up.^{16, level III}

In local setting, history and chest X-ray are sufficient as initial work-up at primary care level on suspected EVALI cases.

- Hospital admission is highly recommended for patients with:^{20, level III; 34, level III}
 - decreased oxygen saturation (<95% on room air)
 - concurrent illness especially if respiratory distress is present
 - co-morbidities that compromise pulmonary reserve
 - unreliable access to medical care especially ability for follow-up within 24 - 48 hours and promptly in the event of rapidly worsening respiratory symptoms
 - poor social support

Early follow-up within 24 - 48 hours post-discharge is essential due to the considerable degree of rehospitalisation and death among those with co-morbidities.^{34, level III}

6.2 Management in Emergency Department/Primary Care Facility

Determining the need for hospital admission requires careful clinical judgement by the emergency physician due to high risk of rehospitalisation and mortality among the EVALI patients.^{19, level III}

- Criteria appropriate for outpatient management are:^{19, level III}
 - normal oxygen saturation $\geq 95\%$ with no respiratory distress on room air
 - absence of high-risk co-morbidities e.g. chronic obstructive pulmonary disease or congestive cardiac failure
 - availability of support system for outpatient follow-up
 - no significant diagnostic findings on initial emergency department (ED) workup

The plan upon discharge from ED include:^{19, level III}

- i. prescription of a short course oral corticosteroids with tapering dose depending on clinical severity
- ii. prescription of antibiotic/antiviral if warranted

- iii. education on warning signs (refer to yellow box in **Subchapter 6.3**)
- iv. follow-up in 24 - 48 hours

If patient is seen in primary care facility, the same principles as above are applicable.^{34, level III}

In our local setting, for any suspected case of EVALI, a physician should be consulted for further management.

Recommendation 6

- A physician should be consulted for any case suspected of e-cigarette or vaping product use-associated lung injury for confirmation of diagnosis when seen at the emergency department or primary care facility.

6.3 Discharge from Hospital

Due to occurrence of adverse clinical outcomes among EVALI patients shortly after discharge, it is important to ensure that patients are clinically stable for at least 24 - 48 hours before discharge. There should be no clinically significant fluctuation in vital signs and patients should have a good post-hospital care transition.^{34, level III}

- Criteria to determine readiness for hospital discharge include:^{34, level III}
 - patient is clinically stable for 24 - 48 hours before discharge
 - initial outpatient follow-up within 48 hours of discharge
 - instruction on discharge medication and counselling of patient is given
 - screening for mental health, substance use disorders and social support needs is established before discharge
 - counselling and offering e-cigarette and tobacco use cessation intervention, including behavioural intervention and medications have been discussed

It is crucial to determine readiness for hospital discharge among EVALI patients as this can improve their outcomes.^{34, level III} Patients with fatal cases are more likely than those with nonfatal cases to have a history of any respiratory disease, cardiac disease and any mental health condition.^{14, level III} Thus, a holistic approach of discharge plan is essential.^{19, level III}

- Discharge from hospital prescription may include:^{19, level III}
 - prescription of a short course oral corticosteroids with appropriate dosage, duration and tapering
 - prescription of an oral antibiotic or antiviral if necessary
 - follow-up at outpatient clinic within 24 - 48 hours
 - education on strict return-to-ED warnings (development of new or worsening respiratory symptoms, with or without fever)^{20, level III}
 - provision of access to outpatient smoking and vaping cessation facility

In our local setting, since EVALI is not well established, the CPG DG recommends such cases to be followed-up by the treating physician.

Recommendation 7

- Patients with cigarette or vaping product use-associated lung injury should only be discharged when they fulfil the discharge criteria.*
 - Upon discharge, hospital prescription should be given.**
 - Follow-up should be done by the treating physician.

*Refer to preceding yellow box on Criteria to determine readiness for hospital discharge.

**Refer to preceding yellow box on Discharge from hospital prescription.

Refer to **Appendix 5** on **EVALI Patient Follow-Up Checklist**.

Refer to **Algorithm** on **Management of E-Cigarette or Vaping Product Use-Associated Lung Injury (EVALI)**.

7. IMPLEMENTING THE GUIDELINES

The management of EVALI should be guided by evidence-based approach in order to provide quality care to the patients. Several factors may affect the implementation of recommendations in the CPG.

7.1 Facilitating and Limiting Factors

Existing facilitators for application of the recommendations in the CPG include:

- wide dissemination of the CPG (soft- and hardcopies) to healthcare providers
- training and updates on EVALI in relevant scientific and professional meeting, seminar, conference etc.
- public awareness campaigns related to harmful effects of e-cigarette

Existing barriers for application of the recommendations of the CPG are:

- limited awareness and knowledge among healthcare providers on EVALI and its management
- lack of awareness among patients, families/carers and community on EVALI
- no surveillance system on EVALI locally

7.2 Potential Resource Implications

EVALI is a diagnosis of exclusion. Many tests are required to be done prior to confirmation of the diagnosis. Accessibility for imaging facilities especially CT scan is limited. Besides, many laboratory tests necessary to be performed in the work-up for the diagnosis are not easily available.

Chemical profiling is another important factor to be addressed in identifying the probable toxicants in EVALI. However, many issues are faced in doing it which include:

- poor cooperation of patients in providing product for testing
- insufficient amount of material to be tested
- toxicant of concern did not cover flavouring agents

Currently, in local toxicology laboratories, not all toxicants can be tested due to lack of standardised testing methods and high cost involved.

Surveillance system also need to be developed to capture the data on EVALI for policy planning and guidance in clinical management. Furthermore, high level of evidence is required to improve the management of the disease.

The following is proposed as clinical audit indicator for quality management of EVALI:

$$\text{Percentage of chest radiograph done in suspected case of EVALI*} = \frac{\text{Number of chest radiograph done in suspected cases of EVALI in a period}}{\text{Number of suspected cases of EVALI in the same period}} \times 100\%$$

*Target of 100%

Implementation strategies will be developed following the approval of the CPG by MoH which include quick reference, launching of the CPG and, Training Module and training of healthcare providers in using it.

REFERENCES

1. Brown CJ, Cheng JM. Electronic cigarettes: product characterisation and design considerations. *Tob Control*. 2014;23 Suppl 2(Suppl 2):ii4-10
2. National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. *E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General*. Atlanta (GA): Centers for Disease Control and Prevention (US); 2016 (Available at <https://www.ncbi.nlm.nih.gov/books/NBK538680/>)
3. Ab Rahman J, Mohd Yusoff MF, Nik Mohamed MH, et al. The Prevalence of E-Cigarette Use Among Adults in Malaysia. *Asia Pac J Public Health*. 2019;31(7_suppl):9S-21S
4. Institute for Public Health (IPH), National Institutes of Health, Ministry of Health Malaysia. *National Health and Morbidity Survey (NHMS) 2019: Vol. I: NCDs - Non-Communicable Diseases: Risk Factors and other Health Problems*. Bandar Setia Alam: NIH; 2020
5. Institute for Public Health (IPH) and International Islamic University Malaysia. *National E-Cigarette Survey (NECS) 2016: Prevalence, Pattern and Perception Regarding E-Cigarette and Vape Use Among Malaysian Adults*. Kuala Lumpur: IPH; 2017
6. Nur Atikah AH, Wee LH, Nur Zakiah MS, et al. Factors associated with different smoking statuses among Malaysian adolescent smokers: a cross-sectional study. *BMC Public Health*. 2019;19(Suppl 4):579
7. National Academies of Sciences, Engineering and Medicine. *Public health consequences of e-cigarettes*. Washington, DC: The National Academies Press; 2018
8. Buchanan ND, Grimmer JA, Tanwar V, et al. Cardiovascular risk of electronic cigarettes: a review of preclinical and clinical studies. *Cardiovasc Res*. 2020;116(1):40-50
9. Alzahrani T, Pena I, Temesgen N, et al. Association Between Electronic Cigarette Use and Myocardial Infarction. *Am J Prev Med*. 2018;55(4):455-461. Erratum in: *Am J Prev Med*. 2019;57(4):579-584
10. Thirión-Romero I, Pérez-Padilla R, Zabert G, et al. Respiratory Impact of Electronic Cigarettes and "Low-Risk" Tobacco. *Rev Invest Clin*. 2019;71(1):17-27
11. Layden JE, Ghinai I, Pray I, et al. Pulmonary Illness Related to E-Cigarette Use in Illinois and Wisconsin - Final Report. *N Engl J Med*. 2020;382(10):903-916
12. Outbreak of Lung Injury Associated with the Use of E-Cigarette, or Vaping, Products (Available at https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html)
13. Muthumalage T, Friedman MR, McGraw MD, et al. Chemical Constituents Involved in E-Cigarette, or Vaping Product Use-Associated Lung Injury (EVALI). *Toxics*. 2020;8(2):25
14. Werner AK, Koumans EH, Chatham-Stephens K, et al. Hospitalizations and Deaths Associated with EVALI. *N Engl J Med*. 2020;382(17):1589-1598
15. Aberegg SK, et al. Diagnosis of EVALI: General Approach and the Role of Bronchoscopy. *Chest*. 2020;158(2):820-827
16. Kalininskiy A, Bach CT, Nacca NE, et al. E-cigarette, or vaping, product use associated lung injury (EVALI): case series and diagnostic approach. *Lancet Respir Med*. 2019;7(12):1017-1026
17. Blagev DP, Harris D, Dunn AC, et al. Clinical presentation, treatment, and short-term outcomes of lung injury associated with e-cigarettes or vaping: a prospective observational cohort study. *Lancet*. 2019;394(10214):2073-2083
18. Belok SH, Parikh R, Bernardo J, et al. E-cigarette, or vaping, product use-associated lung injury: a review. *Pneumonia (Nathan)*. 2020;12:12
19. Aldy K, Cao DJ, Weaver MM, et al. E-cigarette or vaping product use-associated lung injury (EVALI) features and recognition in the emergency department. *J Am Coll Emerg Physicians Open*. 2020;1(5):1090-1096
20. Jatlaoui TC, Wiltz JL, Kabbani S, et al. Update: Interim Guidance for Health Care Providers for Managing Patients with Suspected E-cigarette, or Vaping, Product Use-Associated Lung Injury - United States, November 2019. *MMWR Morb Mortal Wkly Rep*. 2019;68(46):1081-1086
21. Cherian SV, Kumar A, Estrada-Y-Martin RM. E-Cigarette or Vaping Product-Associated Lung Injury: A Review. *Am J Med*. 2020;133(6):657-663

22. Artunduaga M, Rao D, Friedman J, et al. Pediatric Chest Radiographic and CT Findings of Electronic Cigarette or Vaping Product Use-associated Lung Injury (EVALI). *Radiology*. 2020;295(2):430-438
23. Kligerman S, Raptis C, Larsen B, et al. Radiologic, Pathologic, Clinical, and Physiologic Findings of Electronic Cigarette or Vaping Product Use-associated Lung Injury (EVALI): Evolving Knowledge and Remaining Questions. *Radiology*. 2020;294(3):491-505
24. Panse PM, Feller FF, Butt YM, et al. Radiologic and Pathologic Correlation in EVALI. *AJR Am J Roentgenol*. 2020;215(5):1057-1064
25. Blount BC, Karwowski MP, Morel-Espinosa M, Rees J, et al. Evaluation of Bronchoalveolar Lavage Fluid from Patients in an Outbreak of E-cigarette, or Vaping, Product Use-Associated Lung Injury - 10 States, August-October 2019. *MMWR Morb Mortal Wkly Rep*. 2019;68(45):1040-1041. Erratum in: *MMWR Morb Mortal Wkly Rep*. 2020;69(4):116
26. 2019 Lung Injury Surveillance Primary Case Definitions September 18, 2019 (Available at https://www.cdc.gov/tobacco/basic_information/e-cigarettes/assets/2019-Lung-Injury-Surveillance-Case-Definition-508.pdf)
27. Traboulsi H, Cherian M, Abou Rjeili M, et al. Inhalation Toxicology of Vaping Products and Implications for Pulmonary Health. *Int J Mol Sci*. 2020;21(10):3495
28. Chun LF, Moazed F, Calfee CS, et al. Pulmonary toxicity of e-cigarettes. *Am J Physiol Lung Cell Mol Physiol*. 2017;313(2):L193-L20
29. Taylor J, Wiens T, Peterson J, et al. Characteristics of E-cigarette, or Vaping, Products Used by Patients with Associated Lung Injury and Products Seized by Law Enforcement - Minnesota, 2018 and 2019. *MMWR Morb Mortal Wkly Rep*. 2019;68(47):1096-1100
30. Krishnasamy VP, Hallowell BD, Ko JY, et al. Update: Characteristics of a Nationwide Outbreak of E-cigarette, or Vaping, Product Use-Associated Lung Injury - United States, August 2019-January 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(3):90-94
31. Tzortzi A, Kapetanstradaki M, Evangelopoulou V, et al. A Systematic Literature Review of E-Cigarette-Related Illness and Injury: Not Just for the Respiriologist. *Int J Environ Res Public Health*. 2020;17(7):2248
32. Zou RH, Tiberio PJ, Triantafyllou GA, et al. Clinical Characterization of E-Cigarette, or Vaping, Product Use-associated Lung Injury in 36 Patients in Pittsburgh, Pennsylvania. *Am J Respir Crit Care Med*. 2020;201(10):1303-1306
33. Tobacco (Available at <https://www.who.int/news-room/fact-sheets/detail/tobacco>)
34. Evans ME, Twentyman E, Click ES, et al. Update: Interim Guidance for Health Care Professionals Evaluating and Caring for Patients with Suspected E-cigarette, or Vaping, Product Use-Associated Lung Injury and for Reducing the Risk for Rehospitalization and Death Following Hospital Discharge - United States, December 2019. *MMWR Morb Mortal Wkly Rep*. 2020;68(5152):1189-1194

EXAMPLE OF SEARCH STRATEGY

Clinical Question: What are effective and safe treatments in EVALI?

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) <1946 to August 28, 2020>

1. Lung injury/
2. ((lung or pulmonary) adj1 injur*).tw.
3. Acute lung injury/
4. (acute adj2 lung injur*).tw.
5. 1 or 2 or 3 or 4
6. Vaping/
7. vap*.tw.
8. ((electronic cigarette or e cigarette or e cig) adj2 use*).tw.
9. Electronic Nicotine Delivery Systems/
10. (electronic adj1 cigarette*).tw.
11. e cigarette*.tw.
12. e cig*.tw.
13. electronic nicotine delivery system*.tw.
14. 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
15. 5 and 14
16. EVALI.tw.
17. 15 or 16
18. THERAPEUTICS/
19. therap*.tw.
20. treatment*.tw.
21. STEROIDS/
22. steroid*.tw.
23. corticosteroid*.tw.
24. HYDROCORTISONE/
25. hydrocortisone.tw.
26. PREDNISOLONE/
27. prednisolone.tw.
28. METHYLPREDNISOLONE/
29. methylprednisolone.tw.
30. GLUCOCORTICIDS/
31. (glucocorticoid adj1 effect*).tw.
32. glucocorticoid*.tw.
33. CRITICAL CARE/
34. ((critical or intensive) adj1 care).tw.
35. (surgical intensive adj2 care).tw.
36. NONINVASIVE VENTILATION/
37. ((non invasive or non-invasive or noninvasive) adj2 ventilation*).tw.

38. INTUBATION/
39. intubation*.tw.
40. BRONCHODILATOR AGENTS/
41. bronchodilator*.tw.
42. (bronchodilator adj1 (agent* or effect*)).tw.
43. supportive therap*.tw.
44. supportive treatment*.tw.
45. standard therap*.tw.
46. standard treatment*.tw.
47. or/18-46
48. 17 and 47
49. limit 50 to (english language and humans)

Appendix 2

CLINICAL QUESTIONS

Diagnosis

- i. What are the criteria to diagnose EVALI?
 - clinical presentation, laboratory investigations imaging, bronchoscopy
- ii. What is the probable aetiology of EVALI?
 - When is chemical profiling indicated in EVALI?
- iii. What are the differential diagnoses of EVALI?

Treatment




- iv. What are effective and safe treatments in EVALI?



Referral and follow-up

- v. What are the indications for referral/hospitalisation of EVALI patients?
- vi. What are the discharge criteria for EVALI patients?
 - outpatient and inpatient
- vii. What are the discharge plans for EVALI patients?
 - outpatient and inpatient

Appendix 3

TYPES OF VAPING PRODUCTS IN MALAYSIA

Type of e-cig delivery system	Description	Picture
<p>Open System</p>	<ul style="list-style-type: none"> • Features a prominent chamber (tank) • Refillable - users can open and fill the tank with their choice of e-liquid • Allows users to modify their devices • Also known as “tanks,” “e-vapors” and “mods” • Locally also known as vape 	<p>Device:</p>  <p>E-liquid:</p> 
	<p>Other examples of open system design</p>	

<p>Closed System</p> <ul style="list-style-type: none"> • Uses tanks, which come ready-filled with e-liquid • Disposable or reloadable with prefilled cartridges • Does not allow users to fill their devices and add other chemicals • Also known as pods 	<ul style="list-style-type: none"> • Uses tanks, which come ready-filled with e-liquid • Disposable or reloadable with prefilled cartridges • Does not allow users to fill their devices and add other chemicals • Also known as pods 	
	<p>Other examples of closed system design</p>	
	<p>Other examples of closed system design</p>	

IMAGING FEATURES IN EVALI

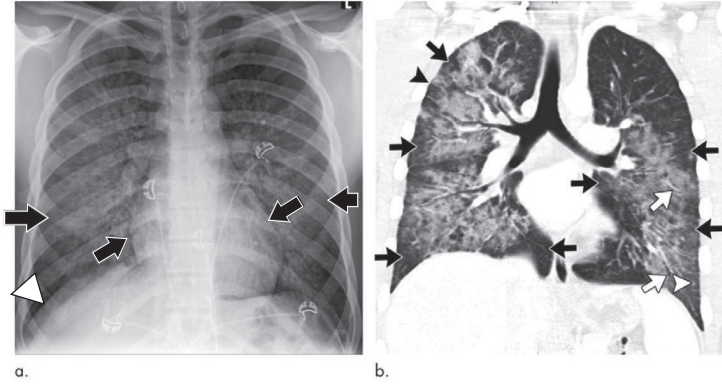


Figure 1

- a. Chest radiograph shows infiltrates with sparing of subpleural region (black arrows) and interlobular septal thickening (white arrowhead).
- b. Corresponding CT image shows perihilar predominant ground-glass opacity with prominent sparing of subpleural interstitium both peripherally and centrally (black arrows) with intermixed areas of lobular sparing. In addition, there is sparing of peribronchovascular interstitium (white arrows). Septal thickening (black arrowhead) and scattered centrilobular nodules (white arrowhead) are present.

Source: Kligerman S, Raptis C, Larsen B, et al. Radiologic, Pathologic, Clinical, and Physiologic Findings of Electronic Cigarette or Vaping Product Use-associated Lung Injury (EVALI): Evolving Knowledge and Remaining Questions. *Radiology*. 2020;294(3):491-505

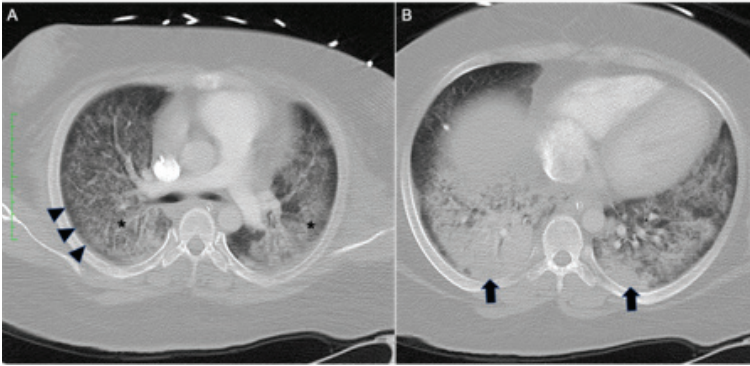


Figure II

Axial CT scan in lung window:

A - Presence of bilateral ground glass opacities (asterisks) with subpleural sparing at the upper lobes (black arrowheads).

B - Bilateral lung consolidation at the lower lobes (black arrows).

Source: Radiology Department, Hospital Umum Sarawak, Kuching, Sarawak

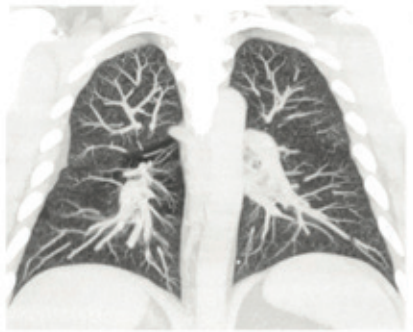


Figure III

Coronal maximum intensity projection image showing diffuse centrilobular nodularity.

Source: Kligerman S, Raptis C, Larsen B, et al. Radiologic, Pathologic, Clinical, and Physiologic Findings of Electronic Cigarette or Vaping Product Use-associated Lung Injury (EVALI): Evolving Knowledge and Remaining Questions. *Radiology*. 2020;294(3):491-505

Appendix 5

EVALI PATIENT FOLLOW-UP CHECKLIST

The following should be done on EVALI patients on follow-up:	
Activity	Comment
a. At 48 hours follow-up:	
• Continue education about EVALI	
• Assess and encourage adherence with medication regimens	
• Ask about side effects of treatment	
• Reinforce the importance of abstinence from e-cig product use	
• Facilitate referrals to other providers or services indicated by patients' medical history or conditions	
• Provide relevant resources on social, mental health and substance use disorder	
b. At 1 - 2 months follow-up	
• Repeat all the steps at 48 hours follow-up	
• Do spirometry	
• Do chest X-ray	

LIST OF ABBREVIATIONS

AEP	acute eosinophilic pneumonia
ALI	acute lung injury
BAL	bronchoalveolar lavage
CBD	cannabidiol
CDC	Centers for Disease Control
CPG(s)	clinical practice guidelines
CRP	C-reactive protein
CT	computed tomography
CXR	chest X-ray
DAD	diffuse alveolar damage
DAH	diffuse alveolar haemorrhage
DG	development group
e-cig	electronic cigarette
ED	emergency department
ESR	erythrocyte sedimentation rate
EVALI	E-Cigarette or Vaping Product Use-Associated Lung Injury
GRADE	Grading Recommendations, Assessment, Development and Evaluation
ICU	intensive care unit
IQR	interquartile range
LLMs	lipid-laden macrophages
MaHTAS	Malaysian Health Technology Assessment Section
mg	milligram
MoH	Ministry of Health
OP	organising pneumonia
PCR	polymerase chain reaction
PG	propylene glycol
RC	review committee
THC	tetrahydrocannabinol
US(A)	United States (of America)
VG	vegetable glycerin

ACKNOWLEDGEMENT

The DG members of these guidelines would like to express their gratitude and appreciation to the following for their contributions:

- Panel of external reviewers who reviewed the draft
- Technical Advisory Committee of CPG for their valuable input and feedback
- Health Technology Assessment and Clinical Practice Guidelines Council for approval of the CPG
- Ms. Rosnani Abdul Latip and Mr. Wan Mohd Nor Fakarudin Wan Abdullah on retrieval of evidence
- Dr. Sri Rao Siva and Dr. Nur Hanani Mat Daud on CPG development
- Dr. Muhamad Hairul Nizam Abd Hamid on the design of CPG cover
- All those who have contributed directly or indirectly to the development of the CPG

DISCLOSURE STATEMENT

The panel members of both DG and RC had completed disclosure forms. None held shares in pharmaceutical firms or acts as consultants to such firms. Details are available upon request from the CPG Secretariat.

SOURCE OF FUNDING

The development of the CPG on Management of E-Cigarette or Vaping Product Use-Associated Lung Injury (EVALI) was supported financially in its entirety by the MoH Malaysia.

**MALAYSIAN HEALTH TECHNOLOGY
ASSESSMENT SECTION**

Medical Development Division
Ministry of Health Malaysia
Level 4, Block E1, Precinct 1
62590 Putrajaya, Malaysia

e ISBN 978-967-2887-10-2



9 7 8 9 6 7 2 8 8 7 1 0 2