

Navigating Cannabis and ENDS (Electronic Nicotine Delivery System) Use in Pre- and Post- Transplant Care

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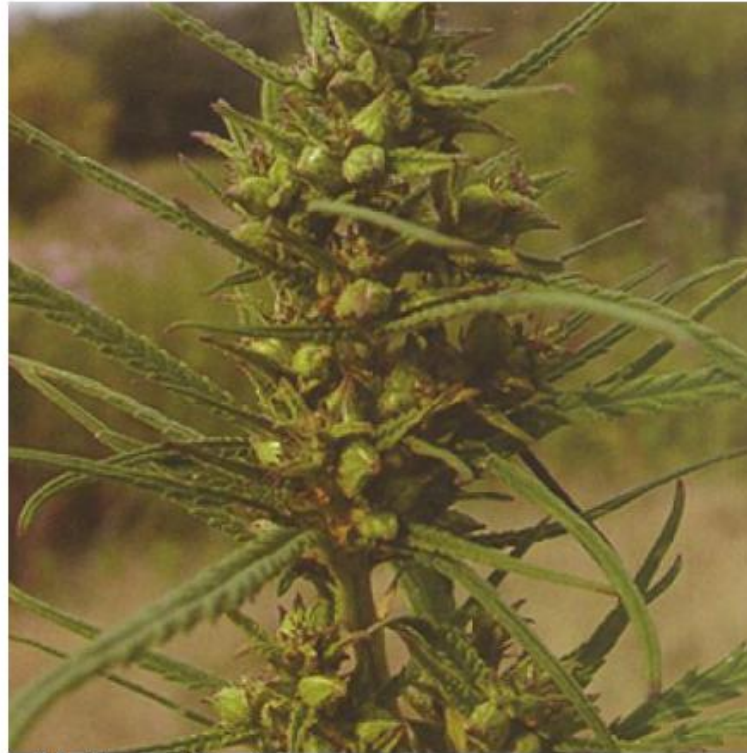
Objective

- ▶ Discuss the origins of cannabis/marijuana.
- ▶ Discuss the chemical properties of cannabis and how it is absorbed.
- ▶ Understand the Endocannabinoid system and its role with cannabis.
- ▶ Identify different strains of marijuana and the challenges they pose.
- ▶ Compare and contrast medicinal and recreational forms of marijuana.
- ▶ Identify side effects of cannabis use physiologically and psychologically.
- ▶ Recognize the risks associated with the use of cannabis in the transplant patient.
- ▶ Identify possible pathogens and potential infections associated with marijuana use.
- ▶ Look at potential risks in using donors that have a history of marijuana use.
- ▶ Understand what vaping/electronic cigarettes are and their delivery systems.
- ▶ Be aware of the physiological effects of vaping and its risk factors in the transplant patient.

Marijuana



Marijuana



Marijuana Plant

Marijuana is the dried leaves, flowers, stems, and seeds from cannabis plant.

Cannabis Also Known as Marijuana

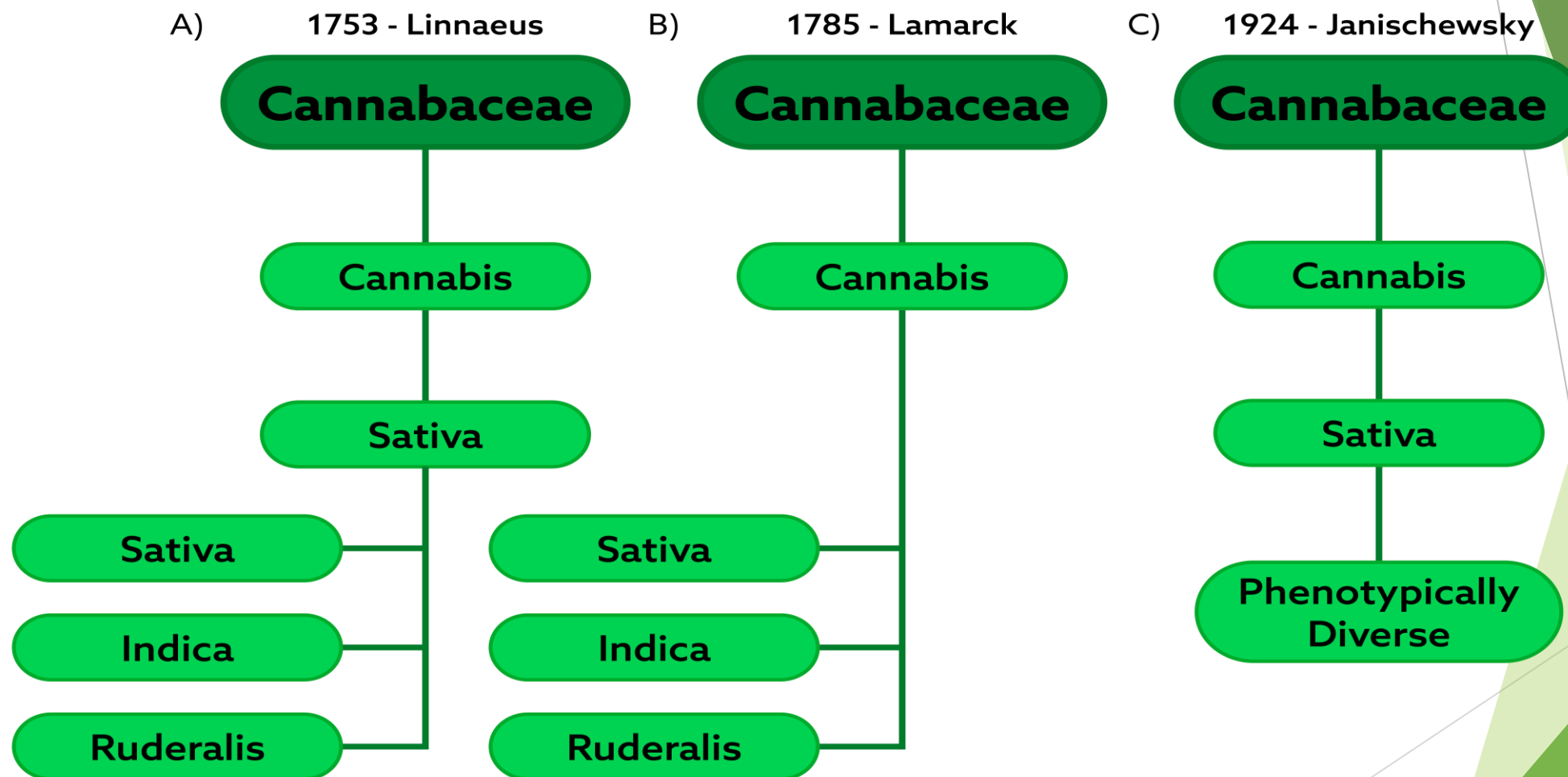
Cannabis used since 500 B.C.

- ▶ Origin – Asia, then spread to Africa, Europe, and the Americas:
 - ▶ Used as an herbal medicine
 - ▶ Used for textiles and rope (hemp)
 - ▶ Used in oils for spiritual use
- ▶ 1850 – U.S. used it for opioid withdrawal, pain, nausea, appetite stimulant.
- ▶ 1851-Classified as medical compound in the U.S. Pharmacopoeia.
- ▶ 1900's –Laws to prohibit marijuana/Criminalization of marijuana.
- ▶ 1930 – Linked crime to marijuana.
- ▶ 1960 – Gained increased popularity-activists, hippies.
- ▶ 1970 – Marijuana placed as schedule 1 drug. Illegal at federal level.
- ▶ 1982 – “Just Say NO” campaign by Nancy Reagan.
- ▶ 1996- Compassionate Use Act-allowing patients to obtain marijuana with physician's script for cancer, AIDS, and pain.
- ▶ 2014 – Colorado is first state to legalize.

Cannabis/Marijuana

- ▶ Family “Cannabaceae.”
- ▶ Genus “Cannabis.”
- ▶ Over 1000 strains of cannabis.
- ▶ Two well known Cannabinoids: Cannabidiol (CBD) and Delta-9-Tetrahydrocannabinol (THC).
- ▶ No consensus on how to define its species among taxonomists/botanists.

History of the Taxonomy of Cannabis



Marijuana Species

There are 3 species and over 1000 strains of Cannabis

Cannabis indica

- Annual plant, species of genus cannabis, also called hemp, narrow leaf

Cannabis sativa

- Annual plant, genus cannabis, broad stout leaf

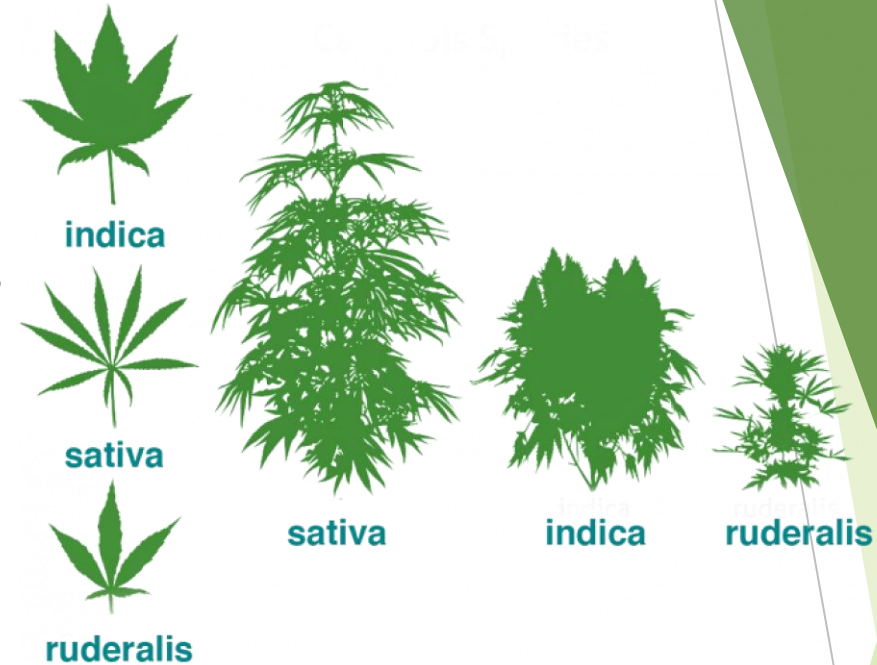
Cannabis ruderalis

- Low THC species

Hybrid

Crossbreed or blend of the above

Active ingredients in strains are THC (tetrahydrocannabinol) and CBD (cannabidiol)



A) 1753 – Carl Linnaeus: Classified Cannabis sativa in Species Plantarum; “sativa” = cultivated.

B) 1785 – Jean-Baptiste Lamarck: Identified Cannabis indica from Indian specimens; smaller, more branched, more psychoactive than European hemp.

C) 1924 – D. E. Janischewsky: Recognized Cannabis ruderalis; small, wild/weedy type with distinct seed abscission zone.

Active Ingredients in Marijuana

Delta-9-Tetrahydrocannabinol (THC) psychoactive

Gives the high feeling

Cannabidiol (CBD) not psychoactive

There are more than 500 chemicals in marijuana and over 125 cannabinoids

- **Cannabinol (CBN)** mild psychoactive
- **Cannabigerol (CBG)**
- **Cannabichromene (CBC)** less psychoactive
- Cannabielsoin (CBE)
- Cannabinodiol (CBND)
- **Tetrahydrocannabinolic Acid (THCA)**
- **Cannabicyclol (CBL)**
- **Cannabitriol (CBT)**
- **Tetrahydrocannabivarin (THCV)**
- **Tetrahydrocannabinolic acid (THCA)**

Chemicals in Cannabis

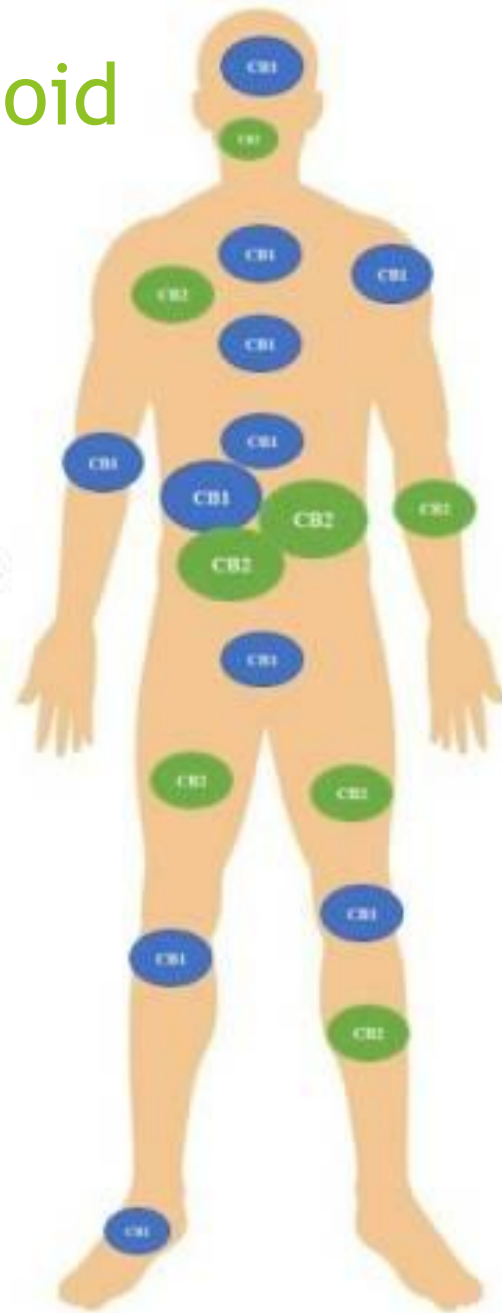
- ▶ **Amino acids**
- ▶ **Nitrogen**
- ▶ **Hydrocarbons**
- ▶ **Terpenes**
- ▶ Monosaccharides
- ▶ Fatty acids
- ▶ Simple Ketones
- ▶ Simple acids
- ▶ Polysaccharides
- ▶ Monosaccharides
- ▶ Proteins, glycoproteins & enzymes
- ▶ **Monoterpenes**
- ▶ **Sesquiterpenes**
- ▶ Flavonoid glycosides
- ▶ Simple esters and lactones
- ▶ Disaccharides
- ▶ Amino-sugars
- ▶ Cyclitols
- ▶ Non-cannabinoid phenols
- ▶ Simple aldehydes
- ▶ Amines
- ▶ Amides

Endocannabinoid System and Marijuana

- ▶ Endocannabinoid system discovered 1990's – named after cannabis sativa.
- ▶ Considered to assist in homeostasis- neuromodulatory effects.
 - ▶ Receptors found in brain and nervous system.
- ▶ 2 receptors activated by endogenous/exogenous molecules:
 - a. CB1 (1988)-Modulates release of neurotransmitters: dopamine, norepinephrine, and serotonin.
 - b. CB2 (1993)-Modulates immune and inflammatory response
- ▶ Endogenous- (endocannabinoid):
 - a. 2-arachidonoylglycerol (2-AG)
 - b. N-arachidonylethanolamine (Anandamide)
- ▶ Exogenous – Marijuana (phytocannabinoid).

Endocannabinoid System

- CB1**
- brain
 - lungs
 - central nervous system
 - vascular system
 - muscles
 - immune system
 - bone marrow
 - pancreas



- CB2**
- spleen
 - liver
 - bones
 - immune system
 - bone marrow
 - pancreas



Endocannabinoids

- Endogenous (anandamide, 2-AG)
- Acts on receptors CB1 and CB2
- Helps to regulate sleep, mood, memory, hunger, metabolism, glycemic control, pain perception, and immune system.

Phytocannabinoids

- Exogenous (cannabis)
- THC, CBD, CBN, CBG
- Activates CB1 and CB2

Synthetic Cannabinoids

- Lab Created
- Medicinal: Marinol
- Spice/K2
- Activates CB1 and CB2

Why is Marijuana Consumed?

Recreationally - mind altering, high feeling, relaxed, increased sensory perception, euphoria



Medicinally - for diseases and their side effects

How is Marijuana Consumed?

Food-Edibles	Candy	Oils
Extracts	Smoked	Inhaled
Vaporized	Medicinal (oral, oromucosal spray, transdermal)	Pills, Capsules, Tinctures

Marijuana and Metabolism

- ▶ Distributed in adipose tissue (lipid soluble): liver, lung ,brain and spleen.
- ▶ Rapidly absorbed in lungs after inhalation.
- ▶ Quickly reaches high concentration in blood after inhalation (6-10min).
- ▶ Takes 60-180 minutes for peak systemic absorption with oral consumption.
- ▶ Half life is 1-13 days depending on frequency of use.
- ▶ Excreted in feces (65%) and urine (20%) although it can be detected in saliva, blood, hair, sweat, and nails.
- ▶ 80-90% is excreted within 5 days.
 - ▶ Chronic use causes accumulation in adipose tissue and can be excreted into the urine for as long as 30 to 60 days from cessation of use.
- ▶ Metabolized in liver by CYP450 enzymes, specifically CYP3A4.

Medicinal Marijuana

Used for many diseases

Cancer	Insomnia
Chronic pain	Multiple sclerosis
Depression	Muscle Spasms
Glaucoma	Nausea/Vomiting
Headaches	Anxiety
Arthritis	Epilepsy
Low appetite	PTSD

Medical Marijuana

- ▶ Sativex (nabiximols) is for neuropathic pain, sleep disturbance, and spasticity in multiple sclerosis.
 - ▶ Currently used in the UK and Canada.
 - ▶ Currently in phase 3 trials in US.
 - ▶ Equal ratio of THC and CBD.
- ▶ Studied and used in cancer patients for pain and nausea, no ongoing trials currently and studies are inconclusive.
- ▶ Synthetic forms are:
 - ▶ Dronabinol (Marinol or Syndros) FDA approved for nausea in chemo patients and anorexia in AIDS.
 - ▶ Nabilone (Cesamet)- FDA approved for refractory chemo induced nausea/vomiting.
- ▶ Cannabidiol - Epidiolex approved for severe forms of epilepsy and seizure disorder like Lennox-Gastaut syndrome, Dravet syndrome, and tuberous sclerosis as of June 2018.

Medical Marijuana and Potential Issues

- ▶ Lack of standard dosing, strength, variability of dose.
- ▶ Bioavailability of inhaled vs oral cannabinoids is different.
- ▶ Inconsistent pharmacokinetics of oral cannabinoids.
- ▶ Difficulty in titration of dose with inhaled forms.
- ▶ Health risks.
- ▶ Pharmaceutical grade product (free of pesticides)?
- ▶ Safe route of administration?
- ▶ Safe concentration levels?
- ▶ Potential for abuse/misuse.
- ▶ Inaccurate labeling by dispensaries with concentrations of CBD, THC, and other chemicals.
- ▶ Drug interactions!
- ▶ Risk of infections/how is it grown?
- ▶ More Research is needed!!!!

Accuracy of Labeling in Dispensaries

- ▶ Study done to evaluate labeling and dispensaries.
- ▶ 107 dried cannabis flowers from dispensaries in Colorado, Oregon and California randomly selected by law enforcement.
- ▶ Acceptance criteria of +/- 20%.
- ▶ Over 70% of evaluated products did not meet the +/- 20% acceptance due to over labeling.
- ▶ THC content claimed to be in product was inflated by 30% (over labeled) in all samples except one. Only one sample was under labeled.

American Cancer Society

- ▶ Small number of studies show effectiveness for nausea in chemo patients.
- ▶ Smoked cannabis, regardless of how it is smoked, can harm lung tissues and contribute to respiratory symptoms such as cough, wheezing, and bronchitis.
- ▶ Cannabis smoke contains many of the cancer-causing substances found in tobacco smoke.
- ▶ Cannabis products have become significantly more potent.
- ▶ Animal studies show it may slow growth of some cancers.
- ▶ “Relying on marijuana alone for treatment for cancer may have serious health consequences.” Cannabis may be used to help manage symptoms.
- ▶ May strains and levels of active compounds which makes it hard to predict outcomes and effects of marijuana.
- ▶ More research needed but because since it’s a “schedule 1” there are restrictions which deter research.
- ▶ American Cancer Society will not take a stand on legalization until more research is done.

Street Names for Marijuana

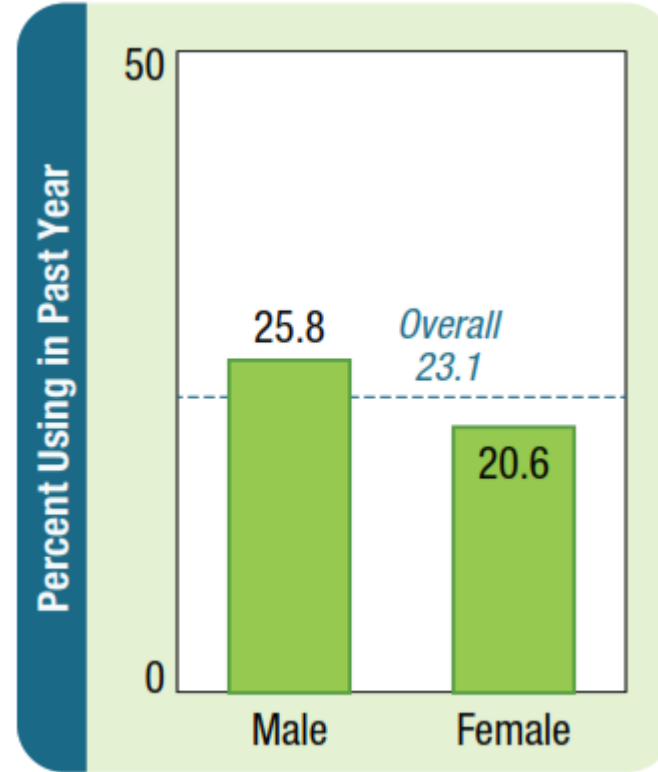
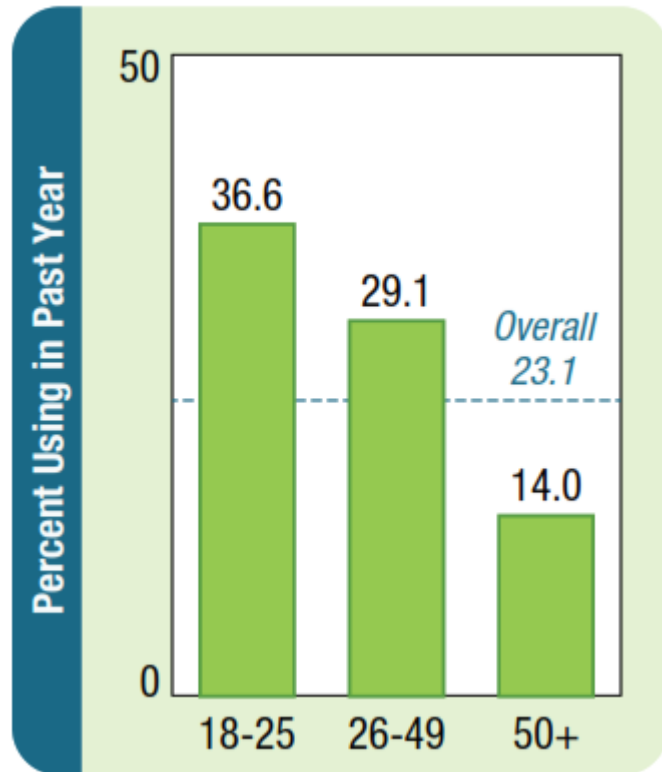
There are ~1200 slang names for marijuana including:

Pot	Joint	Ganja	Reefer	Grass
Stinkweed	Bernie	Mary Jane	Bud	Blue Crush
Dope	Boo	Hay	Black Gold	Maui Wowie
Rope	Bush	Skunk	Northern Lights	Gangster
Panama Gold	Thai stick	Churro	Hashish	Acapulco gold
Texas tea	Jungle Juice	Weed	Crazy Weed	Catnip
Wooz	Flower Tops	Dabs	420	Yerba

Synthetic Marijuana

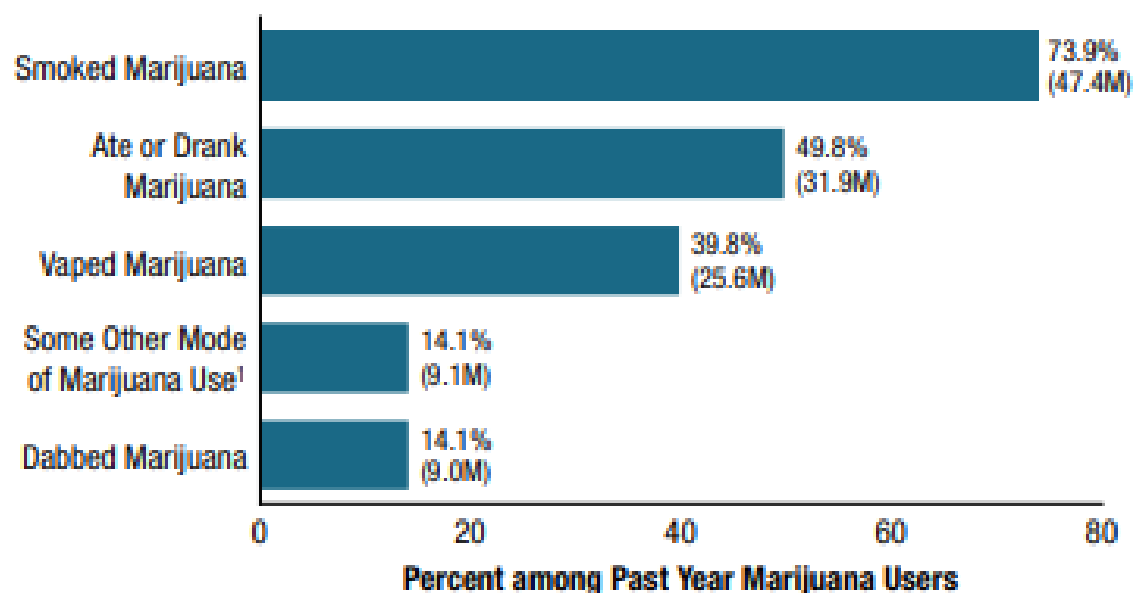
- ▶ K2, Spice, Black Magic, Spike, Demon, Skunk, Ninja, Smoke, Crazy Clown, Serenity, Yucatan, Fire, Scooby Snax, Spike, Mr. Nice Guy, Paradise, Zohai.
- ▶ Produced in laboratory.
- ▶ Sprayed on dried leaves to be smoked or vaporized.
- ▶ Not safe!
- ▶ May effect brain more than traditional marijuana (psychotic effects).
- ▶ Illegal.
- ▶ Act on same brain cell receptors as THC.
- ▶ Addictive.
- ▶ Used for psychoactive properties and sold has “herbal incense” or “potpourri”.
- ▶ Can cause seizure, hallucinations, anxiety, panic, elevated blood pressure/heart rate.

Marijuana Use 2022- 2024



Mode of Marijuana Use 2024

Figure 16. Mode of Past Year Marijuana Use: Among People Aged 12 or Older Who Used Marijuana in the Past Year; 2024



Growing Trends

- ▶ 74% of Americans live in a state where marijuana is legal recreationally or medically.
- ▶ 79% of Americans live in a county with at least one cannabis dispensary.
- ▶ There are nearly 15,000 cannabis dispensaries in the United States.
- ▶ California has far more dispensaries than any state: “3,659”.
- ▶ Oklahoma has the most marijuana dispensaries per capita of any state.
- ▶ 57% of U.S. adults believe marijuana should be legal for recreational and medical use. 32% support legalization for medical use only and 11% do not support legalization at all.
- ▶ Growth in use due to direct marketing and promotion and social media.

Growing Trends

- ▶ THC in marijuana products has steadily increased to 3x the concentration in the last 25 years.
- ▶ Higher THC content=higher effects on brain.
- ▶ There has been an increase in ER pavisits related to marijuana use particularly among youth.

Is Marijuana Legal?? YES and NO!

- ▶ Legal at some state levels – states have rights to make own laws (10th amendment).
- ▶ NOT legal at federal level.
- ▶ Legal – medicinally – in 40 states and District of Columbia.
- ▶ Legal – recreationally – in 25 states and District of Columbia.
- ▶ FDA will support clinical trials to study medical marijuana.
- ▶ FDA has NOT approved use for any indication except:
 - a. Epidiolex – seizures
 - b. Marinol (dronabinol) and Syndros (dronabinol) for anorexia/nausea/vomiting-Chemo/AIDS
 - c. Cesamet (nabilone)-nausea
- ▶ Marijuana is a Schedule 1 controlled substance.
- ▶ More research needed to prove efficacy and safety.
- ▶ Most used illicit drug in U.S.- 42% increase in use over last 10 years.
- ▶ Lots of revenue in marijuana sales.

■ Fully legal ■ Medicinally legal ■ Low-THC cannabis oil (CBD oil) ■ Fully illegal

 USA Facts

Effects of Marijuana on Body

Dry mouth	Increased heart rate
Fatigue	Increased risk of stroke
Dizziness	Increased risk of heart disease
Paranoia	Fear
Addiction	Panic
Attention loss	Anxiety
Memory issues	Increased blood pressure
Learning struggles	Increase appetite
Effects brain development	Delivers harmful substances to body (many also found in tobacco)
Decreased testosterone	Increased prolactin

Effects of Marijuana on Body

- ▶ Impaired short-term memory.
- ▶ Impaired motor coordination.
- ▶ Altered judgement.
- ▶ Paranoia, Anxiety, Depression.
- ▶ Long term= 9% risk of addiction, 17% risk if begun in adolescence, 25-50% risk if daily user.
- ▶ Altered brain development especially if initiated in early adolescence.
- ▶ Can decrease IQ as much as 8 points with initiation at young age and its not reversible .
- ▶ Associated with poor educational outcomes.
- ▶ Chronic bronchitis.
- ▶ Increased risk of myocardial infarction, heart failure, and stroke.

Cannabinoid Hyperemesis Syndrome (CHS)

- ▶ First reported in Australia in 2004.
- ▶ Caused by regular, long term, daily/weekly cannabis use.
- ▶ Symptoms: nausea, vomiting, intense abdominal pain, decreased appetite, retching, weight loss, compulsive hot showers or baths with relief.
- ▶ More prevalent in young adults ages 18-39 years old.
- ▶ Of patients with cannabis use disorder, the prevalence of CHS is up to 32%.
- ▶ From 2017 to 2021, emergency department visits for CHS doubled in the US and Canada and were most common among males aged 16 to 34 years.
- ▶ Affects about 2.75 million people in the US yearly.
- ▶ Risk factors are those with heavy cannabis use (typically daily or multiple times per day) for more than 1 year.
- ▶ Complications: erosion of teeth enamel, dehydration, acute kidney injury, and low blood levels of chloride, potassium, sodium, and bicarbonate.
- ▶ Treatment is cessation of cannabis and supportive care with resolution of symptoms in 2 weeks.

National Center for Drug Abuse Statistics

- ▶ Marijuana use has increased an estimated 65.2% between 2015 and 2024.
- ▶ Rise in popularity of marijuana use is associated with the expanding legalization and more widespread acceptance.
- ▶ 64% of Americans say that regular alcohol use is more harmful than the regular use of marijuana and 63% of the population believe tobacco is more harmful than marijuana.
- ▶ 26% of 12th graders used marijuana at least once in 2025.
- ▶ 44.3% of Americans used marijuana monthly in 2024.
- ▶ Cannabis use highest in 18-25 yrs and in males.
- ▶ In 2024, the percentage of Americans who used marijuana exceeded the percentage of those who used tobacco products by 5.2%.
- ▶ Rates of Substance Use Disorder (SUD) involving marijuana were 3.7 times higher in 2024 than in 2015.
- ▶ It's estimated that 30% of cannabis users have cannabis use disorder.

Cannabis Use Disorder

Diagnostic and Statistical Manual of Mental Disorders, DSM–5, defines cannabis use disorder as the presence of clinically significant impairment in 12 months, manifested by at least 2 of the following:

- ▶ Cannabis is taken in larger amounts or used over a longer period than intended
- ▶ Persistent desire to cut down with unsuccessful attempts
- ▶ Excessive time spent acquiring cannabis, using cannabis, or recovering from its effects
- ▶ Cravings for cannabis use
- ▶ Recurrent use resulting in neglect of social obligations
- ▶ Continued use despite social or interpersonal problems
- ▶ Important social, occupational, or recreational activities foregone to be able to use cannabis
- ▶ Continued use despite social or interpersonal problems
- ▶ Important social, occupational, or recreational activities foregone to be able to use cannabis
- ▶ Continued use despite physical harm
- ▶ Continued use despite physical or psychological problems associated with cannabis use
- ▶ Tolerance
- ▶ Withdrawal symptoms when not using cannabis

Is Marijuana Addictive?

- ▶ Approximately 3 in 10 marijuana users will develop cannabis use disorder.
 - ▶ DSM-5 lists Cannabis Use Disorder.
 - ▶ Cannabis Use Disorder is most prevalent in U.S. after alcohol and nicotine addiction.
- ▶ Approximately 1 in 10 people who use marijuana will become addicted (most severe form of cannabis use disorder).
- ▶ For those who use marijuana before age 18, “1 in 6” will be come addicted.
- ▶ Amount of THS has increased = increased potency.
 - ▶ Cannabis can vary in mixture and thus vary in content; proportion and effects.
- ▶ Long-term or frequent cannabis use has been linked to increased risk of psychosis or schizophrenia in some users.

Marijuana and the Lungs

- ▶ Commonly consumed using pipes, bongs, joints, blunts to inhale or vaporize.
- ▶ Burning of substances releases carcinogens.
- ▶ Second-hand smoke (inhalation of another person's marijuana smoke) can cause serious health problems .
- ▶ Increased risk of aspergillus and other fungal infections.
- ▶ No method of inhalation is safe.
- ▶ Just smoking 1-2 joints/month can increase risk of lung disease.
- ▶ Marijuana smoke causes coughing, increased sputum or phlegm, wheezing, shortness of breath and inflammation of lung tissue. (chronic/acute bronchitis).
- ▶ Since joints, spliffs, and blunts are usually smoked without a filter, the concentration of the particulates in the airways are 4 times higher than when tobacco alone is smoked.
- ▶ Marijuana smoke is hotter and more irritating to the bronchi.
- ▶ Marijuana tends to be inhaled more deeply and prolonged = increased exposure.

American Cancer Society (ACS) and Cancer Action Network (CAN) Position Statement on Cannabis 2026

ACS and CAN supports the prohibition of the smoking or aerosolizing of cannabis and other cannabinoids in public places because the cancer-causing substances found in cannabis smoke pose numerous health hazards to the individual using and others in their presence. Allowing the smoking or aerosolizing of cannabis in public places also undermines the effectiveness of 100% smoke-free laws.

Immune System Marijuana

- ▶ THC – decreases T cell proliferation and cytokine production.
- ▶ CBD-modulates cytokine production and enhances regulatory T cell functions.
- ▶ Reduces ability of T-cells and alveolar macrophages to protect the body from foreign pathogens.
- ▶ ?Benefits/Risks and more research is needed.
 - ▶ Cannabis strain/concentration/dose.
 - ▶ THC concentration vs CBD concentration.
- ▶ Anti-inflammatory effects of CBD could target immune cells and interfere with inflammatory signaling?
- ▶ Could it prevent rejection? Could it increase the risk of infection?

Comparative Effects of THC and CBD on Immune Cells

Immune Cell Type	THC Effect	CBD Effect
T lymphocytes	Suppressive (-)	Modulatory (+)
B lymphocytes	Suppressive (-)	Neutral (+)
Macrophages	Suppressive (-)	Modulatory (+)
Dendritic Cells	Suppressive (-)	Modulatory (+)
Natural Killer Cells	Suppressive (-)	Neutral (+)

Suppressive (-): Inhibits function or reduces activity

Modulatory (+): Adjusts function without complete inhibition

Neutral ±): No significant suppressive effect

Pathogens in Marijuana

Concerns with inhaled marijuana

Risk of bacterial and fungal infections

- Pseudomonas
- Aspergillus
- Streptococcus
- E. coli
- Flavobacterium
- Penicillium
- Cladosporium
- Trichoderma

Common pathogens found in soil in water

- Fusarium, Pythium, Golovinomyces, Botrytis, Hop Latent Viroid

Concern with water left in “bongs” - acts like a humidifier - formation of biotoxins

Of fungal infections 89% are from smoking cannabis and 4% are from edibles

Risk of Bacteria, fungus, and toxin contamination while being grown, processed, or stored

Cannabis and Drug Interactions

THC and CBD competitively inhibit CYP3A4 which is responsible for the metabolism of tacrolimus and many other medications.

THC and CBD are also metabolized by CYP3A4 and CYP2C9.

Tacrolimus is exclusively metabolized by CYP3A4 and CYP3A5.

Cannabis and Drug Interactions Review

- ▶ Literature review done June 2011-June 2022. Two case reports and 1 clinical trial with 6 patients. Tacrolimus and Cannabis showed a probable and moderate interaction. Cannabis can **increase** tacrolimus levels. (Lopera,V. et al.,J. Clin. Med 2022,11, 1154)
- ▶ Case Study of epilepsy patient that recieved tacrolimus for interstitial nephritis and cannabidiol (CBD) as part of a clinical trial. The concomittent use caused a **3 fold increase in tacrolimus levels**. (Leino,A.D., et al., Am J Transplant 2019 Oct;19(10):2944-2948)
- ▶ Case Study 67 year old HSCT for follicular lymphoma. Patient's family was bringing in CBD gummies. Tacrolimus levels were suprathapeutic with peak at "45". Of note he was receiving posaconazole as well. Altered mental status due to **tacrolimus toxicity**. (Hauser, N.,et al., Case Rep Transplant. 2016 Aug 9;2016:4028492)
- ▶ In Vitro Study from February 2025 of 50 donors and compared the effects of CBD with tacrolimus. Showed **statistically significant inhibition of tacrolimus depletion with CBD** . CBD inhibited tacrolimus depletion more strongly in rCYP3A5 enzyme than rCYP3A4 systems.(So,G.C.,et al.,Clin Transl Sci. 2025 Feb 7;18(2):e70152)

Cannabis and Drug Interaction Review

- ▶ Controlled fixed-sequence clinical trial of 12 healthy adults given daily cannabidiol for 2 weeks to achieve steady state and 2 isolated doses of tacrolimus over this time frame. Plasma levels of tacrolimus were obtained at certain time points and demonstrated **3 fold change in tacrolimus levels**. Moderate drug interaction. (So,G.C., et al., *Clinical Pharmacology & Therapeutics*, Vol 117(3), 2025 March).
- ▶ Case Study of 67 year old female kidney recipient. Tacrolimus level increased to “32.7” (**4 fold increase in her typical level**), feeling unwell, and subsequent decline in renal function. It was found that she had started taking Cannabis oil 6 weeks prior. (Singh,A.,et al., *Kidney International Reports*,Volume 8, Issue 3, Supplement, March 2023, Page S392.)
- ▶ Fixed-sequence, open-label, phase 1 trial in 16 healthy volunteers to investigate interaction between CBD and everolimus. **Everolimus increased by 2.5-fold**. (Wray,L.,et al., *Clinical Pharmacology in Drug Development* 2023, 12(9) 911–919.)

Cannabis and Drug Interactions

Medication	Cannabis Interaction	Metabolic Pathway
CNI Tacrolimus Cyclosporine	↑ CNI drug level via CYP3A4 inhibition	CYP3A4 CYP3A4, CYP3A5
mTORi Everolimus Sirolimus	↑ mTORi drug levels via CYP3A4 inhibition	CYP3A4 CYP3A4
Antiproliferative agents Azathioprine MMF ^a /MPA ^a	None	None
Antifungal agents Fluconazole Ketoconazole Itraconazole Posaconazole ^a Voriconazole	↑ THC & CBD drug level via inhibition of CYP2C9 ↑ THC & CBD drug level via inhibition of 3A4 & 2C9 ↑ THC & CBD drug level via inhibition of CYP2C9 ↑ CBD drug level via inhibition of CYP3A4 ↑ CBD drug level via inhibition of CYP3A4	CYP3A4/CYP2C9 (inhibitor) CYP3A4/2C19/2C8, P-gp (inhibitor) CYP3A4, P-gp (inhibitor) CYP3A4 (inhibitor) CYP3A4/2C9/2C19 (inhibitor)
Pneumocystis jiroveci prophylaxis SMX-TMP Dapsone ^a Pentamidine	↑ THC & CBD drug level via inhibition of CYP3A4 & 2C9 2C9 ↑ SMX level via CY2C9 inhibition	CYP2C9 (SMX; substrate) N/A N/A
CAV prophylaxis Statins	↑ Statin exposure through inhibition of CYP3A4 and 2C9	CYP3A4, CYP2C9 (substrate)

Donors and Marijuana

- ▶ Multicenter retrospective study in Philadelphia, Pennsylvania of solid organ transplant recipients from January 2015- June 2016.
- ▶ 394 organ donors (89 recent marijuana use).
- ▶ Of the 394 organ donors, they donated to 658 organ recipients (158 received an organ from a donor with recent marijuana use).
- ▶ No association between donor marijuana use and post transplant infections and graft failure. However, this only evaluated outcomes in the early transplant period.

Donors with Marijuana Exposure

- ▶ Donor Shortage=Increase Wait Time.
- ▶ Limited data available.
- ▶ Already using donors with tobacco smoking history.
- ▶ Many cannabis smokers smoke tobacco as well.
- ▶ Cannabis-greater delivery to lungs.
- ▶ Cannabis associated with increase in airway inflammation and pulmonary infections.
- ▶ Older age + tobacco use+ cannabis use= increased risk.
- ▶ Can we increase donor pool if we use donors with history of cannabis use.

Transplant and Marijuana

- ▶ Some transplant centers will deny a transplant if patient is actively using marijuana-zero tolerance rule or period of abstinence.
- ▶ Individual transplant centers make their own rules for acceptance of recipient with history of marijuana use.
- ▶ Donors are accepted if they have history of marijuana use.
- ▶ Why is the patient using? – coping mechanism?-addiction?
- ▶ Limited studies of interactions between immunosuppressive medications and marijuana.
- ▶ Limited studies of outcomes of use of marijuana post transplant.
- ▶ 22 States have adopted the “Sole Basis Rule”- cannot reject transplant for sole reason based on history of medicinal cannabis use. (Psychology Today 8/16/2025)
- ▶ Is there a difference between a patient who uses medicinal marijuana vs. recreational in the minds of health care providers.

Transplant and Marijuana

- ▶ In April 2016, a 12-question internet-based survey of American Transplantation Society members to study screening and acceptance practices of potential recipients and marijuana use.
- ▶ Surveys were sent to 3321 members of the AST with 225 responses (8%). Two hundred respondents were from the United States (89%) with 21 states represented.
- ▶ 55% of respondents screened all transplant candidates, 20% screened depending on organ, and 20% did not screen at all.
- ▶ Variation in approval: 28% rejected irrespective of organ, 52% varied according to organ, and 4% unknown.

Obstacles in Marijuana Research

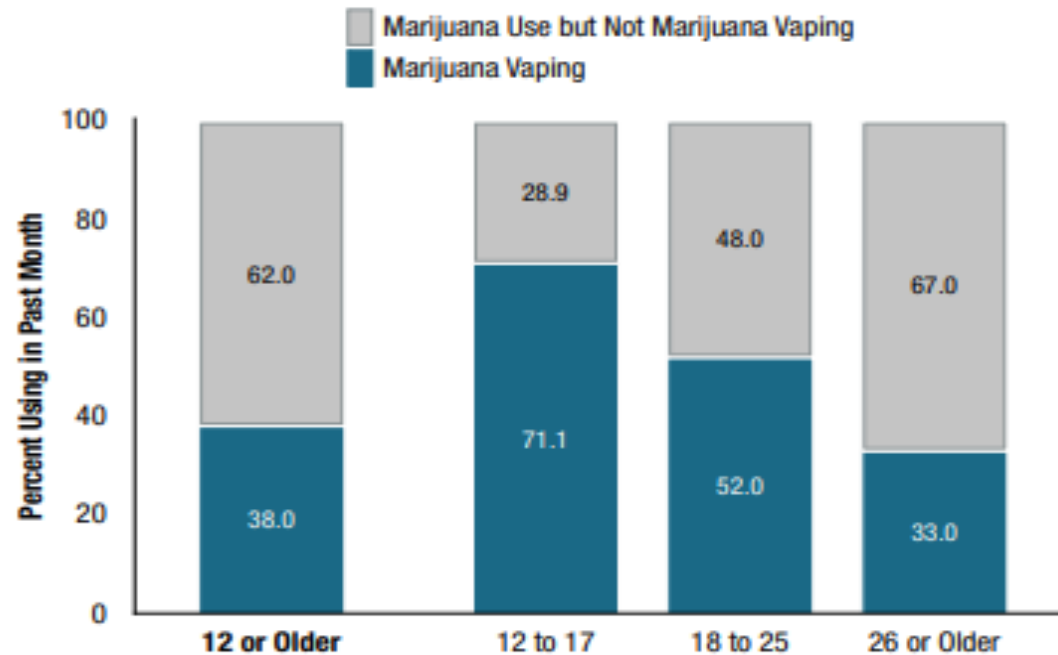
- ▶ Taxes on marijuana are high
- ▶ Price wars
- ▶ Not enough research due to restrictions by FDA
- ▶ Schedule 1 Drug-no accepted medical use thus no NIH funding.
- ▶ Research into harm but not benefits currently.

Vaping

- ▶ Introduced in 2007 as an aid for smoking cessation.
- ▶ JUUL entered market 2015.
- ▶ “Perceived” lack of negative side effects.
- ▶ Comes in many enticing flavors.
- ▶ As of 2016 the FDA requires warning statements to be present on vaping products.
- ▶ Anyone younger than 18 may not purchase vaping/e-cigarette products.
- ▶ In 2024, e-cigarettes were the most used tobacco product among middle and high school students in the United States.

Marijuana Use

Figure 12. Type of Past Month Marijuana Use: Among Past Month Marijuana Users Aged 12 or Older; 2024



E-Cigarettes/Vaping (ENDS-Electronic Nicotine Delivery System)

- ▶ Vaping: inhalation of an aerosol using a battery powered device that contains nicotine, CBD or THC.
- ▶ The devices come in many bright colors and flavors.
- ▶ The device could be a:USB flash drive, pen, highlighter, or looks like a toy.
- ▶ Smart vapor-connects to smart phone includes a reward system for vaping.
- ▶ The liquid is referred to as: e-juice, e-liquid, vape juice, or vape liquid.
- ▶ Inhalation turns on heater/Contains a heating element.
- ▶ “The larger the battery the more heat is produced.”
- ▶ More heat = more nicotine released.
- ▶ Nicotine delivery is variable due to device and liquid strength

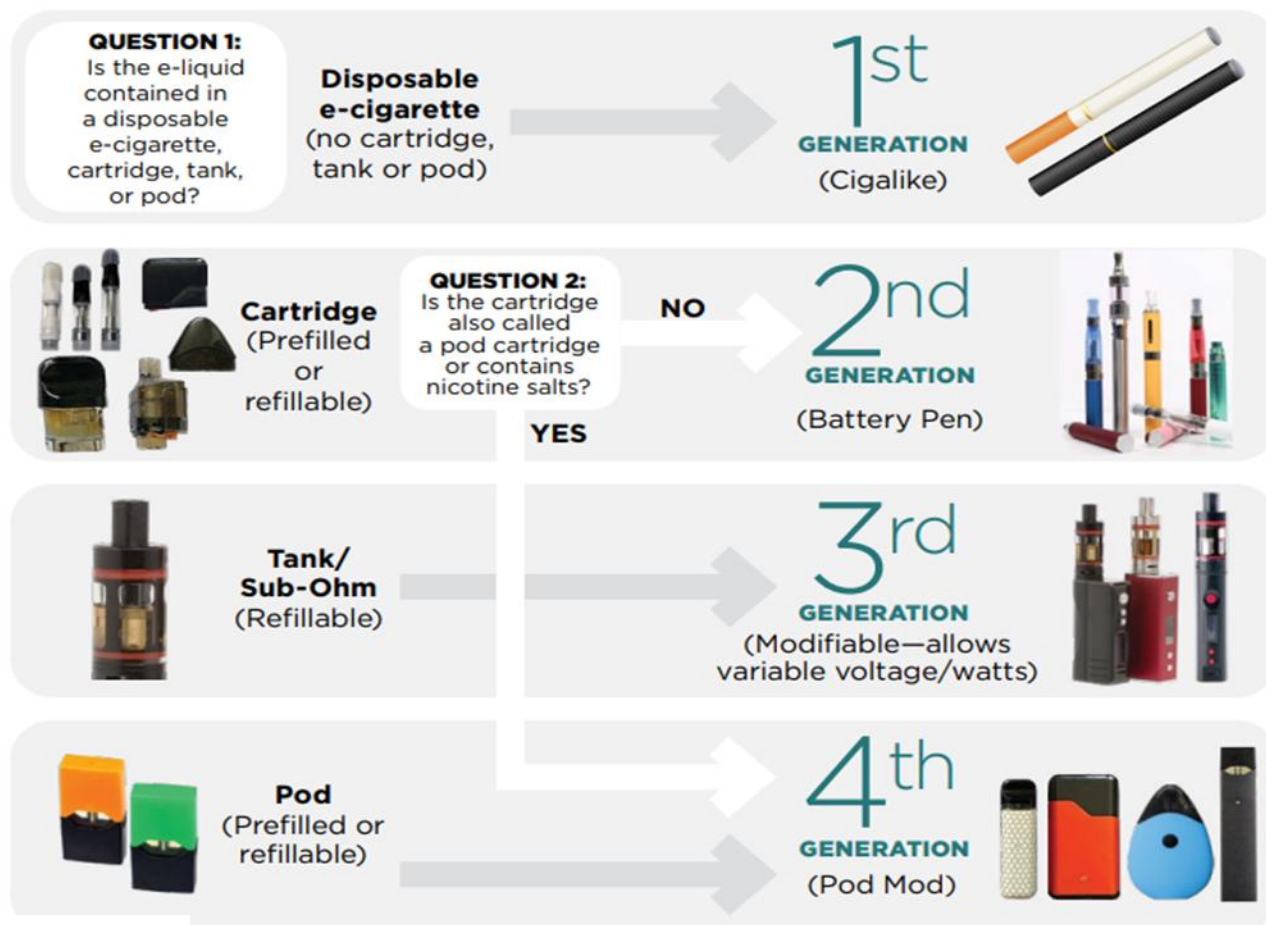
Classifying E-Cigarettes, or Vaping, Products

How to Classify the User's E-Cigarette, or Vaping, Product

For an accessible explanation of schematic below on how to classify e-cigarettes, go to [Appendix, page 25](#).

Important notes:

1. E-liquids can contain nicotine, THC, CBD, flavors, or other solvents.
2. Marijuana herb, hash oil, dab wax are used with vaporizers.



E-Liquid



E-Liquid

- E-liquid is the liquid that is converted into an aerosol by an e-cigarette, or vaping, product. It is typically a mixture of water, food grade flavoring, a choice of nicotine levels, cannabis (THC, CBD), propylene glycol (PG) or vegetable glycerin (VG).
- PG and VG are humectants used in e-liquid to produce aerosols that simulate combustible tobacco cigarette smoke.
- The ratio of PG and VG in the e-liquid can change based on whether flavor (higher levels of PG) or plume (higher levels of VG) is desired.

E-Cigarettes/Vaping

What's in it?

- Nicotine
- Carcinogens
- Heavy Metals (nickel, tin, lead)
- Flavorings (diacetyl)
- Volatile Organic Compounds (benzene-car exhaust)
- Ultrafine Particles
- The aerosol often contains a mixture of nicotine, formaldehyde and acrolein

Tobacco vs Marijuana

- ▶ While cigarette smoking has declined the use of e-cigarettes has increased.
 - ▶ Co-use of tobacco/cannabis products has increased 2% per year over the last decade.
 - ▶ Escalating e-cigarette use is associated with increase odds of cannabis vaping in age 18-24 yrs.
- ▶ Prolonged and deeper inhalation with Marijuana.
 - ▶ 5 X carbon monoxide concentration, 4x amount of tar disposition.
- ▶ Carcinogenic:
 - ▶ 50% more benzopyrene.
 - ▶ 75% more benzathracene.
- ▶ Secondhand smoke from tobacco and marijuana causes similar health risks.
- ▶ Smoking Cannabis and tobacco, including e-cigarettes device delivery, can increase exposure to fungal and bacterial contaminants, pesticides, molds, bacteria, metals, and solvents

E-Cigarettes/Vaping

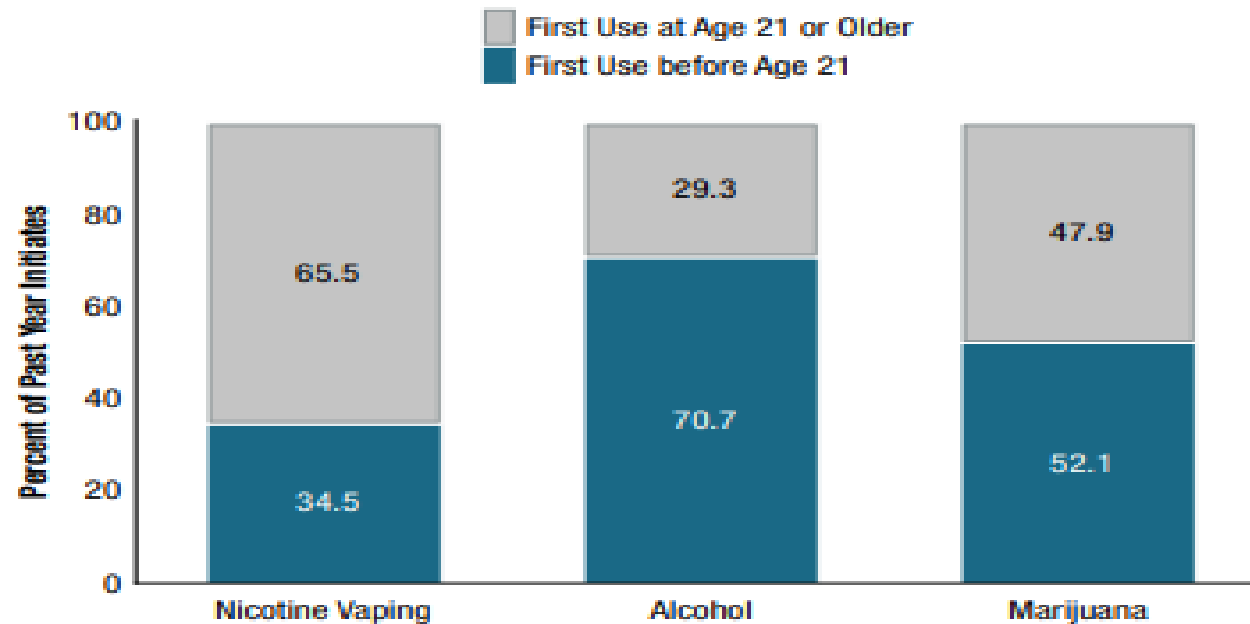
- ▶ Sales between February 2020 and June 2024 increased from 15.7 million to 21.1 million. This is a 34.7% increase in E-cigarette sales.
- ▶ As of June 2024, there were 6,300 different e-cigarette products available in the US.
- ▶ As of June 2024, e-cigarette sales totaled \$488.9 million.

EVALI (E-cigarette Vaping Acute Lung Injury)

- ▶ Discovered around peak of hospitalizations of e-cigarette users in August of 2019. (2807 cases and 68 deaths as of February 18, 2020).
 - ▶ Monitoring ceased with COVID pandemic and identification of Vitamin E Acetate as main cause EVALI.
- ▶ Use of e-cigarette within 90 days of symptoms.
- ▶ Respiratory and GI symptoms:
 - ▶ shortness of breath, fever, cough, vomiting, diarrhea, headache, dizziness, rapid heart rate and chest pain, pulmonary infiltrates on CXR/CT.
- ▶ Majority of cases with EVALI used THC containing e-cigarettes which also had Vitamin E acetate.
- ▶ Associated with **Vitamin E Acetate** found in e-cigarettes.
- ▶ E-cigarettes obtained from friends, family, in-person and on-line dealers.

Substance Initiation and Age

Figure 32. Initiation of Use before Age 21 and at Age 21 or Older: Among People Aged 12 or Older Who Were Past Year Initiates of the Substance; 2024



Donors and Vaping Exposure

- ▶ Study from UT Southwestern to look at outcomes in lung transplant recipients who received organ from donor with history of electronic cigarette/vaping use.
- ▶ Recipients between 2014-2021 evaluated and 29 recipients identified and compared against 28 patients with no donor history of electronic cigarette use.
- ▶ Study looked at hospital length of stay, graft failure, ventilator days, ICU length of stay, FEV1 at 3, 6, and 12 months.
- ▶ No difference was found in short term outcomes between both groups.

Vaping and Transplant

- ▶ No tobacco products are safe.
- ▶ Most e-cigarettes have nicotine which is highly addictive.
- ▶ Vaping can cause inflammation in the lungs.
- ▶ The aerosols contained within vaping devices contain harmful substances.
- ▶ Vaping products target youth.

American Nurses Association

“Professional nursing organizations need to advocate for all nurses and to advance change to improve health and healthcare.” The ANA strongly supports:

- ▶ Scientific review of marijuana's status as a federal Schedule I controlled substance and relisting marijuana as a federal Schedule II controlled substance for purposes of facilitating research.
- ▶ Development of prescribing standards that include indications for use, specific dose, route, expected effect, and possible adverse reactions, as well as indications for stopping a medication.
- ▶ Establishing evidence-based standards for the use of marijuana and related cannabinoids.
- ▶ Protection from criminal or civil penalties for patients using therapeutic marijuana and related cannabinoids as permitted under state laws.
- ▶ Exemption from criminal prosecution, civil liability, or professional sanctioning, such as loss of licensure or credentialing, for healthcare practitioners who discuss treatment alternatives about marijuana or who prescribe, dispense, or administer marijuana in accordance with professional standards and state laws.

American Association of Nurse Practitioners Position Statement

- ▶ The American Association of Nurse Practitioners (AANP) recognized that there is evidence for the therapeutic use of marijuana and related compounds and that practitioners (NP's) are frequently the health care providers patients look to for health care treatments.
- ▶ AANP supports efforts for the continued scientific review of medicinal marijuana and cannabinoid use, the establishment of evidence-based therapeutic recommendations for marijuana and the inclusion of marijuana and cannabinoids in nursing education and continuing education, AANP supports policies that authorize NPs to discuss treatments and treatment alternatives in open and direct dialog with their patients. AANP believes that these conversations are essential to patient care and should be exempt from criminal or professional prosecution, such as loss of licensure.

American Association of Nurse Practitioners, Board of Directors 2025

Summary

- ▶ More research is needed regarding medicinal marijuana and its impact
- ▶ Little data available about effects of marijuana in the post transplant patient
- ▶ Marijuana is harmful to the lungs when inhaled
- ▶ Vaping is harmful to the lungs –*there are no safe tobacco products*
- ▶ There are potential interactions with transplant medications and marijuana, but studies are limited
- ▶ Regular use of marijuana can affect other systems of the body
- ▶ Use of donors with marijuana history can be used as long as tobacco history is also taken into consideration
- ▶ The commercialization of marijuana along with direct-to-consumer advertising in recreational dispensaries, on the internet, and through social media allows self-medication without the involvement of healthcare professionals. (Azcarate,P.M., et al., J Gen Intern Med. 2020 Apr 6;35(7):1979–1986)