CHASING THE ECIG DRAGON:
HOW THE PUBLIC HEALTH THREAT BECAME A CRIMINAL JUSTICE PROBLEM

Michelle R. Peace, Ph.D.
Associate Professor
Department of Forensic Science
Virginia Commonwealth University

LEARNING OBJECTIVES

Describe
- The public health phenomena of e-cigs
Describe
- How e-cigs work and how they evolved
Describe
- The impact to criminal justice and forensic science
NIJ STATEMENT AND FINANCIAL DISCLOSURE

• Through the Looking Glass: Abuse of the Evolving Electronic Cigarette and the Impact of Vaping Ethanol in the Evaluation of Impairment

• Characterization and Abuse of Electronic Cigarettes: The Efficacy of “Personal Vaporizers” as an Illicit Drug Delivery System

• Chasing the E-cigarette Dragon: Characterizing the Evolution and Impact of Design and Content

are supported by Award Nos. 2014-R2-CX-K010 and 2016-DN-BX-0150 and 2018-75-CX-0036, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this publication/program/exhibition are those of the author(s) and do not necessarily reflect those of the Department of Justice.

• No funding was obtained from any manufacturer of any product used in this study.

What Some People Think When Ecigs are Mentioned
What I Think About When Ecigs are Mentioned

E-CIGARETTE HISTORY

• First models developed in 1927 and 1965

• Modern e-cigarette developed in 2003 by Hon Lik

• Spread to Europe by 2006
  • United States in 2007

http://herb.co/2015/11/11/the-history-of-vaporizing/
E-CIGS ON THE MARKET

First Generation – “Ciga-like”
- looks like real cigarettes
- simplest make-up (battery, coil, and filling)
- low single voltage
- can contain a cartomizer
- appeal to visual users trying to quit traditional cigarettes

Second Generation – “Mid-size”
- looks like a pen
- larger than cigalikes and are more customizable
- commonly called a clearomizer
- rechargeable battery and refillable tank decreases cost

E-CIGS ON THE MARKET

Third Generation – “Advanced Personal Vaporizers”
- stronger batteries and various settings
- rebuildable atomizer
- smoked by advanced vapers because of the endless modification possibilities

Fourth Generation – “Alternative Vaping Products”
- Liquid with particulates
- Non-liquid vaping material
E-CIGS ON THE MARKET

Fifth Generation?

- Heat Not Burn
- Salt Vapors

ELECTRONIC CIGARETTES

https://vapeonwattreviews.files.wordpress.com/2014/07/kanger-aerotank-mega-mini-2.jpg
http://america.aljazeera.com/content/dam/aljami/images/shows/innovation/kepisodes/111-ecigfoodology/ECigs-HowTheyWork2.gif
E-LIQUID COMPONENTS

- Propylene Glycol (PG)
- Vegetable Glycerin (VG)
- Flavorants
- Active ingredients
  - Nicotine
  - Drugs Other Than Nicotine (DOTNs)
    - Natural products/plant materials
    - Non-Traditional Pharmaceuticals
    - Scheduled Drugs
    - Designer Drugs

HEALTH IMPACTS

- Addiction/Cessation
- Long-term Studies
- Oral cavity and lung tissue
  - PG:VG Byproducts
  - Flavorants
- Passive Inhalation

Berry, et.al. E-cigarette initiation and associated changes in smoking cessation and reduction: the Population Assessment of Tobacco and Health Study, 2013-2015, Tobacco Control, March 2018
Lemer, et.al. Vapors Produced by Electronic Cigarettes and E-Juices with Flavorings Induce Toxicity, Oxidative Stress, and Inflammatory Response in Lung Epithelial Cells and in Mouse Lung. PLoS One. 2015;10(2)
Tzoriti, et.al. Passive Exposure to e-cigarette emissions: Immediate Respiratory Effects, Tobacco Prev Cess Ma 2018
• May, 2016: FDA ruled that the manufacture, packaging, import, labeling, advertising, promotion, sale and distribution will be regulated

• E-cigs are nicotine products

• Regulations Include:
  • Child-resistance packaging
  • Nicotine warning statement
  • Ban the sale to minors
  • Require ID to anyone under the age of 26
  • Approval of all products

• Challenges to regulations
  • House of Rep. bills
    • Less Dangerous Products
    • “Deeming Rule”

Original regulations were slated to take effect before end of 2018

• Ecig products on consumer side of the cash register

• Mitigated Risk Strategy

Nicotine Level Chart

- Extra Strong 24mg
- Strong 18mg
- Medium 12mg
- Light 6mg
- No Nicotine

100% = Nicotine dosage in a traditional cigarette

* Any tobacco product use is defined as past 30 days use of electronic cigarettes, cigarettes, cigars, hookahs, smokeless tobacco, pipe tobacco, and/or bidis.
E-LIQUIDS IN POISON CONTROL CENTERS

American Association of Poison Control Centers

E-Cigarette Device and Liquid Nicotine Reported Exposures

Electronic Cigarette and Liquid Nicotine Cases
All ages

- 2013: 1543
- 2014: 4023
- 2015: 3744
- 2016: 2907
- 2017: 2478
- 2018 YTD: 1441

E-CIGARETTES IN THE (SOCIAL)MEDIA

DANGEROUS DRUG TREND
TEENS HIDING DANGEROUS DRUGS IN E-CIGS
AIMS OF ECIG GRANTS

- Develop Analytical Methods
  - Water Trap Sampling
  - SPME Sampling
  - GC-MS
  - Headspace GC-MS
  - LC-MS/MS/MS
  - DART Accu-TOF™ MS
  - SEM-EDX
  - ICP-MS

- Characterize e-cigs
  - Characterize classes of e-cigs
  - Temperature of coil
  - Characterize delivery of drugs
  - Function of voltage
  - Bio-marker Formation

- Characterize e-liquids
  - Nicotine
  - DOTNs: THC, mAMP, Heroin,
    - Pyrolysis products

- Chasing the Dragon
  - THC, CBD, SynCans
  - Ethanol
  - Mytragynine
  - N.P.S.
  - “Health Supplements"

NICOTINE LABEL VS ACTUAL

American Produces Nicotine 6-22 mg/mL

- >10% Diff: 18 of 27
- >20% Diff: 9 of 27
- >30% Diff: 5 of 27

Range: -47% to +39%

Variation from Label Nicotine Concentration (%)
CULTURE / MYTH

Turn the power of the device up in order to get more drug in the cloud.

MODEL DEVELOPMENT
Dose Capture with Nicotine

HEADSPACE FID ANALYSIS
OF 63 E-LIQUIDS

Concentration of Ethanol in % by Weight per Volume
**SOURCE OF ETHANOL**

- Flavors are dissolved in ethanol
- Thin the e-liquid for some devices
- Dissolves Drugs Other Than Nicotine
- Intentional

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**UNKNOWN ISSUES WITH VAPING ETHANOL**

- PBT and EBT Wait Period
- Bypass of the gut – impairment?
- Metabolites of Ethanol in Urine
- Alcohol Addiction Recovery
- Indication of underage drinking
- Defense for DUI cases
USER MODIFICATIONS

• Cloud production important in “vaping” culture

• Modifications to optimize cloud production
  • Power settings (voltage)
  • Coil resistance
  • Wire type
  • PG:VG ratio

• Effect of cloud on illicit substance lung deposition

INHALATION OF AEROSOL
INHALATION vs INJECTION vs INGESTION
INHALATION OF AEROSOL

E-CIGARETTES AND CRIME

• E-cigarettes have become a popular method for abuse of drugs
  • Public “clandestine” use
  • Have become prevalent on drug blogs and YouTube videos

“It’s possible to vape OPIUM eLiquid using all the eCigarette devices...OPIUM contains PG+VG (50:50) and Butyr Fentanyl a novel synthetic opioid research chemical.” –volabs.com

“You can get away with vaporizing meth at work this way... some places let you smoke e-cigs inside.” –bluelight.org
E-CIGARETTES AND CRIME

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- Oklahoma Bureau of Narcotics, November 2016
- Philadelphia “Smokeasy” Raid, April 24, 2017

E-CIGARETTES, ABUSE, & CRIME

- Adulterated e-liquids with scheduled drugs
  - THC, CBD, Synthetic Cannabinoids, Novel Psychoactive Substance, etc

- Public “clandestine” use

- Modifying customizable devices to hold non-traditional e-liquids
  - Plant material, resins, etc
  - Drug blogs and Youtube tutorials
E-CIGS POSTMORTEM: ?

- Tooth loss
- Broken neck
- Coma
- Severe burns
- Death

E-CIGS POSTMORTEM: ✓

Death Following Intentional Ingestion of E-liquid

- 24yo female, unresponsive, pulseless
- Intentional suicidal ingestion (suicide note)
  - Partially ingested bottle of whiskey
  - 2 empty 15ml vials of concentrated nicotine (100mg/ml)
  - Prescription meds had appropriate pill counts
- Arrival in ED:
  - BP: 74/53; Pulse: 106bpm; Respiration: 14 breaths/min
  - Pupils fixed and dilated
- Admission to ICU:
  - Myoclonic jerking
  - Absence of corneal, gag, and cough reflexes
  - Anoxic brain injury by MRI
- Toxicology:
  - GC-MS screening: Positive for nicotine, cotinine, and Rx
  - LC-MS3: Plasma nicotine and cotinine >1000ng/ml
- E-liquid bottles were not tested
- Died 3d post-ingestion

Death Following Injection of E-liquid

- 29yo male found unresponsive by family
- History of depression, not taking Rx medications
- Found with a suicide note indicating injection of e-liquid
- Wife claimed he was using e-cigs to stop smoking
- EMS: defibrillated twice, intubated, given atropine, sodium bicarb, and lidocaine
- Hospital: pupils fixed, tonic/clonic seizures, 125 bpm heart
  - Put in therapeutic hypothermia
  - Never regained consciousness
  - Autopsy not performed
- Serum drug screen:
  - Positive for lidocaine, nicotine, cotinine
  - No amphetamines found
  - Serum nicotine/cotinine: 2000/2100 ng/ml
- Product not available for testing

Liberty Reach was created with the true cannabis connoisseur in mind, featuring rare exotic flower strains sourced from around the world for those seeking a one of a kind luxury experience.
The analysis of an electronic cigarette formulation sold under the brand name "Liberty Reach".

Packaging stated that the liquid contained 69.1% THC and 1% CBD.

**THC RESULTS**

DART-MS Spectra at 20 V of the E-cig marijuana formulation.
GC-MS TIC of the E-cig marijuana formulation showing the identification of propylene glycol and the marijuana terpenes.

## THC RESULTS

<table>
<thead>
<tr>
<th>Compound</th>
<th>Advertised Concentration (v/v)</th>
<th>Actual Concentration (v/v)</th>
</tr>
</thead>
<tbody>
<tr>
<td>THC</td>
<td>69.1 %</td>
<td>42.6 %</td>
</tr>
<tr>
<td>CBD</td>
<td>1.0 %</td>
<td>0.5 %</td>
</tr>
<tr>
<td>CBN</td>
<td>Not Advertised</td>
<td>0.36 %</td>
</tr>
<tr>
<td>CBC</td>
<td>Not Advertised</td>
<td>0.72 %</td>
</tr>
<tr>
<td>CBG</td>
<td>Not Advertised</td>
<td>0.64 %</td>
</tr>
<tr>
<td>THCA-A</td>
<td>Not Advertised</td>
<td>5.6 %</td>
</tr>
</tbody>
</table>

HPLC-MS/MS cannabinoid qualitative analysis data (v/v)
The analysis of an electronic cigarette formulations sold under the brand name "Good As Gold".

Packaging stated that the eliquids contained either 0 or 12 mg of Kratom.

**KRATOM Results**

King Kratom (0 mg)

- Mitragynine
- 7-hydroxymitragynine
- Nicotine

DART-MS Analysis of undiluted Kratom e-liquids at 20V
Buzz-Juice Results

DART-MS Spectra at 20 V of the Bee-Juice E-liquid.
CBD CASE

When a Pharmacy Student Walks Into...
• A “friend” bought this CBD product...

100% Natural CBD Extracts
We are dedicated to producing the finest and purest CBD extracts while never compromising on quality.

CBD CASE RESULTS

BENEFIT OF CBD HERBAL DROPS

Pain Relief
Reducing swelling & insets, Stomach muscle spasms, Reduced nausea and diarrhea.

Promotes Health
Promotes brain & nervous system growth. Nourishes heart health, 76% or more bacterial growth.

Well Being
Helps against anxiety, reduces muscle tension. Stresses All, body growth, mental and growth is immune system cells.

How to Use
As needed. Drop one pump under the head & insides for a glass.

Quality Test our Products
Every batch of extract is lab-tested to ensure a consistent product, and to determine the correct purity in our products, we carefully examine the entire process, from growth to manufacturing and to distribution.
OPIOID CASES

ARMED FORCES

15 incidents
- 9 incidents were batteries exploding
ECIGS & FORENSIC TOXICOLOGY

**Analytical Scheme:**
- DART-MS
- GC-MS or LC-MSMS
- SPME-DARTMS
- SPME-GCMS

- Forensic Urine Drug Test Results
- THC
- Blue Lotus Flower (nuciferine)
- Kratom (mitragynine)
- Bee Juice (MDMB-Fubinaca)
- CBD (5F-ADB Fubinaca)
- Opioids
- Armed Forces

You can make any kind of daft statement when you live in a world of stupid. Take Lindsay David Johnson for example. Johnson lives in Hawaii and builds the frames of houses. Nothing stupid here so far except, as a smoker, he didn’t have any cigarettes so he borrowed a friend’s vape kit. Again, not stupid at all – we know that vaping offers a great way out of smoking. Certainly a better idea than the ones Johnson made in order to be “found guilty of abuse of family or household members, criminal property damage in the fourth degree and unauthorized control of a propelled vehicle.”

Those decisions meant that he faced regular drug testing and blamed the presence of methamphetamine in his system on his friends’ eliquid. But can it even do that, asked the judge? “I don’t know. It could have been none of the ways. I don’t know why, ma’am. I’m more confused in this situation than anybody.” If in doubt – blame the ecig.
• Laboratoy for Forensic Tox Research (LFTR) Team:
  - Haley Mulder
  - Jesse Patterson
  - Tyson Baird
  - Lori McLean
  - Karen Butler
  - Joseph Stone
  - Shelle Butler
  - Kaitlyn Brooks
  - Ivy Blue
  - Rose Krakowiak
  - Laura McNew
  - Jimmy Stewart
  - Alex Dupont
  - Kaitlyn Forsythe
  - Jasmyne Royals
  - Mika Smith
  - Jonathan Tomko
  - Kimberly Karin
  - Jasmine Povlick
  - Grace Connolly
  - Erica Sales

• Virginia Commonwealth University
  - Joseph Turner, Ph.D., Chemistry
  - Justin Poklis, B.S., D-ABFT-FT, Pharm/Tox
  - Alphonse Poklis, Ph.D., F-ABFT, Pathology
  - Matt Halquist, Ph.D., Pharmaceutics
  - Michael Hindle, Ph.D., Pharmaceutics
  - Carl Wolf, Ph.D., Clinical Toxicology

To watch a group of bees is to see a frenzy of different interests coalesce into a single, clear thought.
– Jason Castro, Scientific American

QUESTIONS?
Michelle Peace, Ph.D.
mrpeace@vcu.edu
804-828-8420