



DIGITAL CLUES AFTER DEATH: A CASE-BASED APPROACH TO THE USE OF PERSONAL DEVICES IN DEATH INVESTIGATION AND MANNER OF DEATH DETERMINATION

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OBJECTIVES

- Describe common personal digital devices and the types of data they may generate.
- Demonstrate how recognition and use of recovered digital data can influence death investigations.
- Explain approaches to data recovery, including regulatory barriers and the need for coordination with state and local officials.

OVERVIEW

1

ELECTRONIC DEVICES

Cell Phone

Smartwatch

Laptop/desktop

Gaming consoles

GPS devices

Airplane black box

Car event data recorder

2

SOFTWARE

Life 360

Snapchat

Facebook

Instagram

Dating applications

Photo-storage applications

3

MEDICAL DEVICES

Glucose monitors/ insulin
pump

Pacemakers

Heart monitor

Vagus Nerve Stimulator

1. ELECTRONIC DEVICES

- Physical devices that electronically collect, store, record, or transmit information
- Used to help reconstruct the circumstances and timeline surrounding a death
- Examples:
 - Cell Phone
 - Smartwatches
 - Laptop/desktop
 - Gaming consoles
 - GPS devices
 - Airplane black box
 - Car event data recorder (EDR)





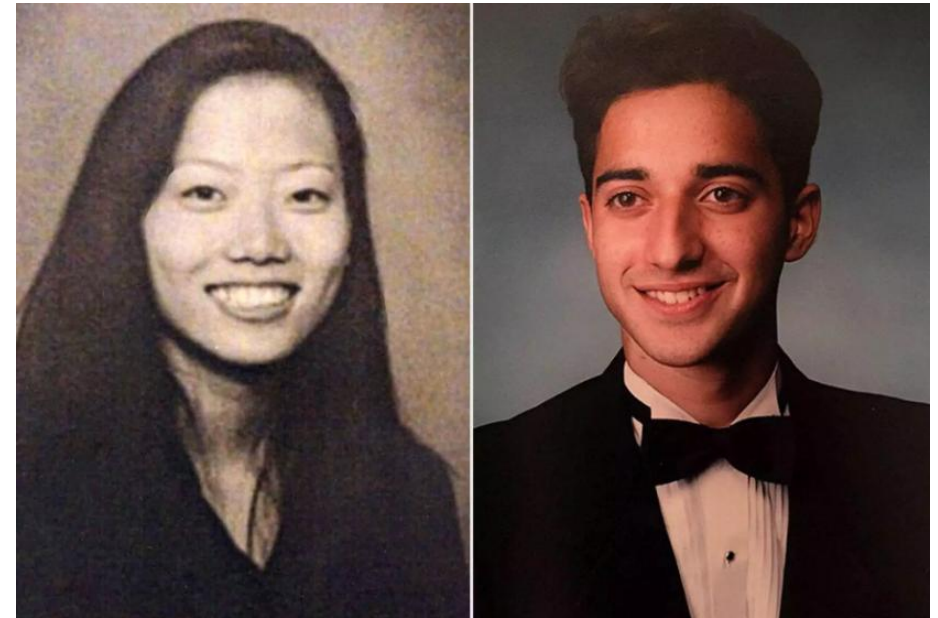
CELL PHONE DATA

Accessing Data via Cellular Network

MURDER OF HAE MIN LEE IN BALTIMORE

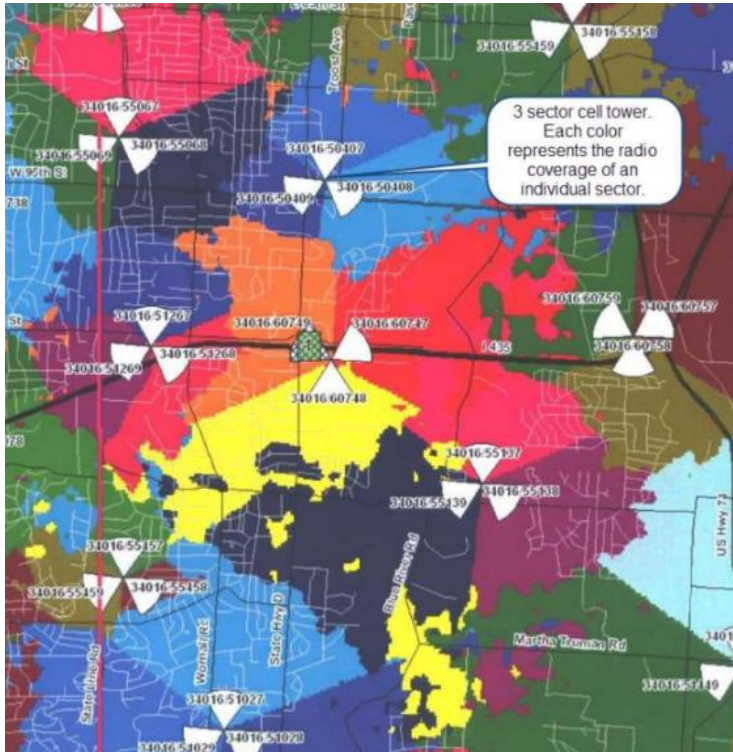
FAMOUS CASE USING CELL TOWER DATA

- On 1/13/1999: 18 year old Hae Min Lee goes missing in Baltimore, Maryland
 - LKA leaving school at 2:15p
 - At 5:00p, she was reported missing by family
- On 2/28/1999, her body was found half buried in Leakin Park and her ex-boyfriend of 8 months (Adnan Syed) was arrested for her murder
 - Cause of death: Manual strangulation
 - Findings included: petechial hemorrhage, multifocal strap muscle hemorrhage, and hyoid bone dislocation
 - Manner of death: Homicide



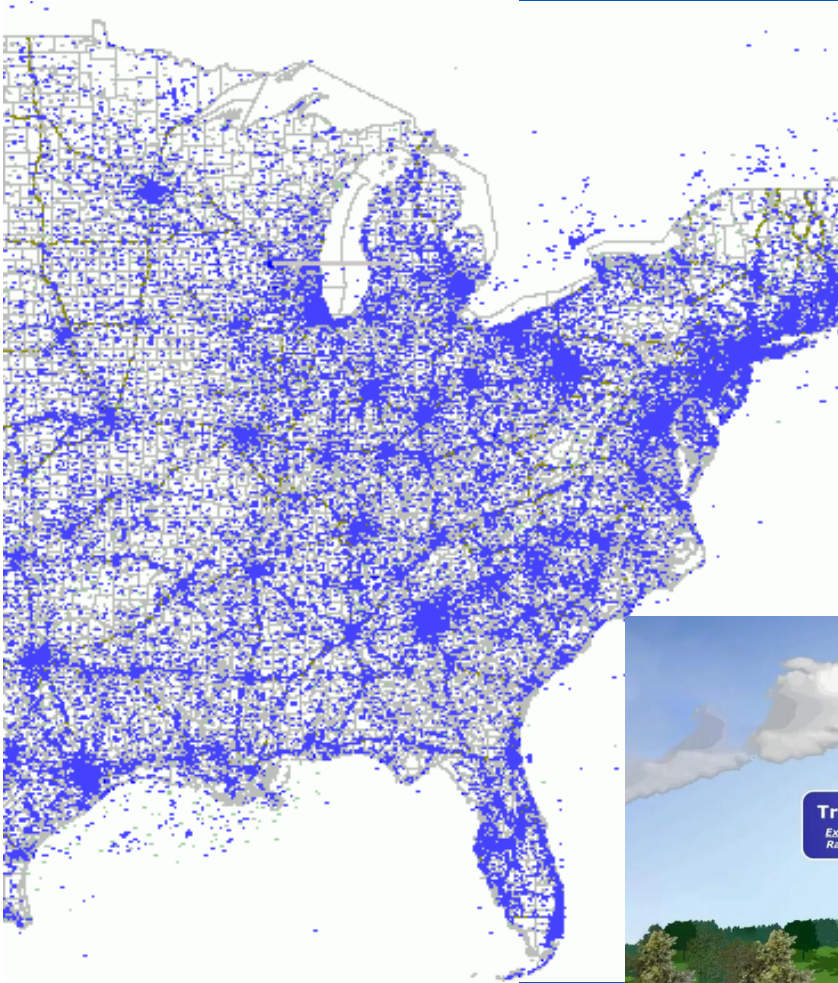
MURDER OF HAE MIN LEE IN BALTIMORE

FAMOUS CASE USING CELL TOWER DATA



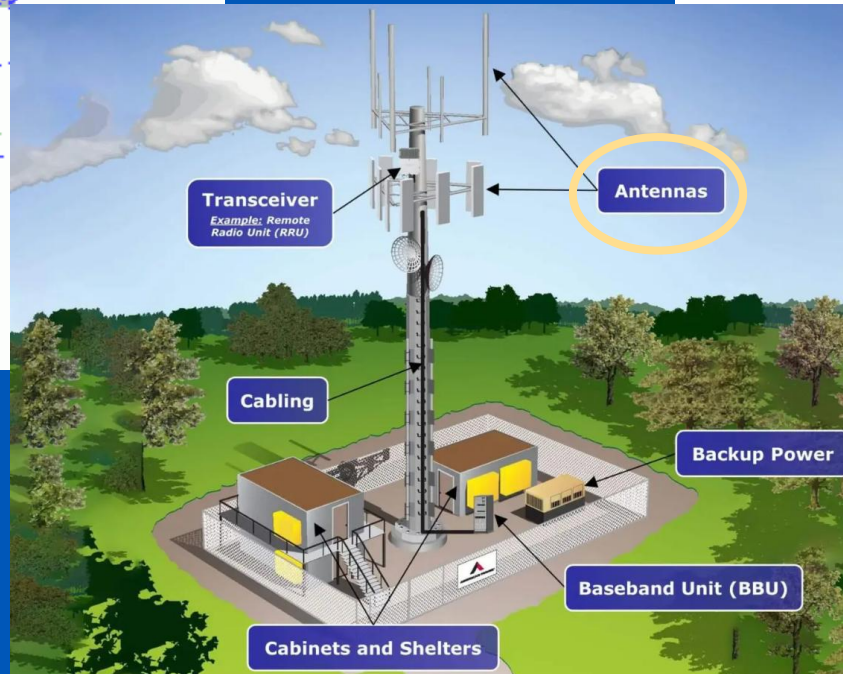
- This case relied heavily on cell phone tower data, There was no physical evidence and conflicting witness accounts
- Cell site data placed Adnan in the park where Hae Min Lee's body was found
- In 06/2000, he was sentenced to life in prison +30 years
- In 2022, he was released from prison via Juvenile Restoration Act (JRA) – minors can petition for reduce sentence after 20 years





ABOUT CELLULAR NETWORKS

- Cellular networks are made up of tens of thousands of cell towers.
- Carrier: Sprint, Verizon, T-mobile, AT&T and US Cellular, etc.
- Cellular towers have antennas emitting radio signals in different directions
- A cell phone that is powered on and has service, will stay connected to their carrier's network

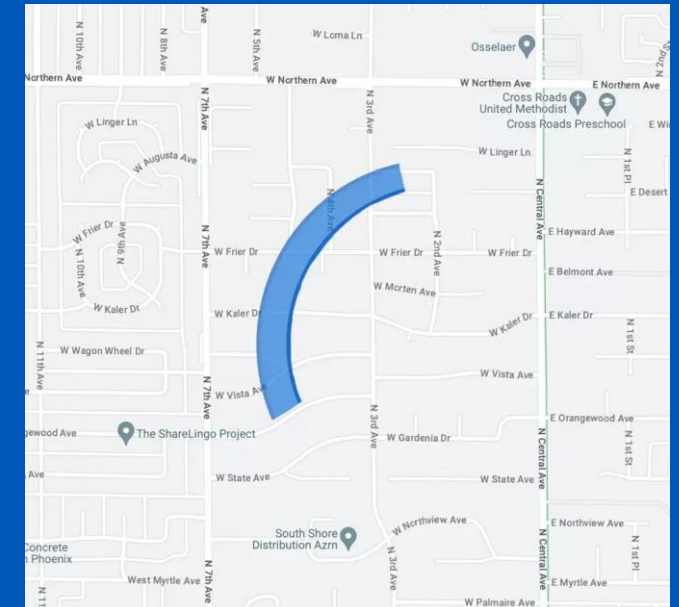
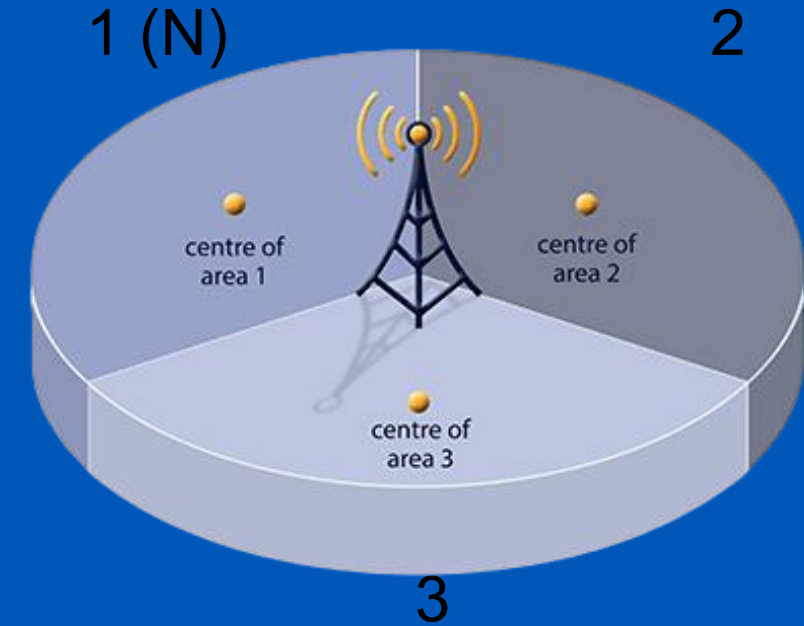


ABOUT CELLULAR DATA

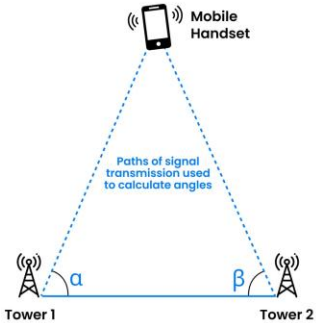
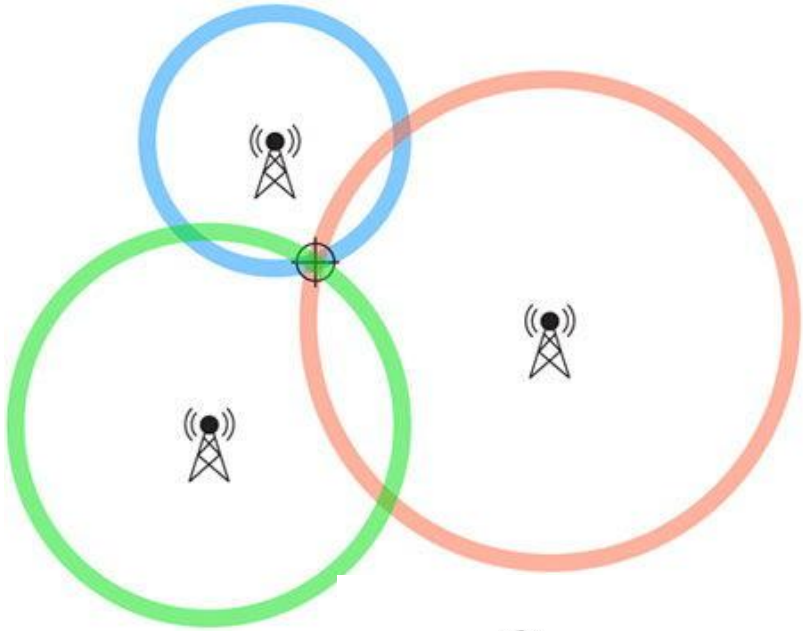
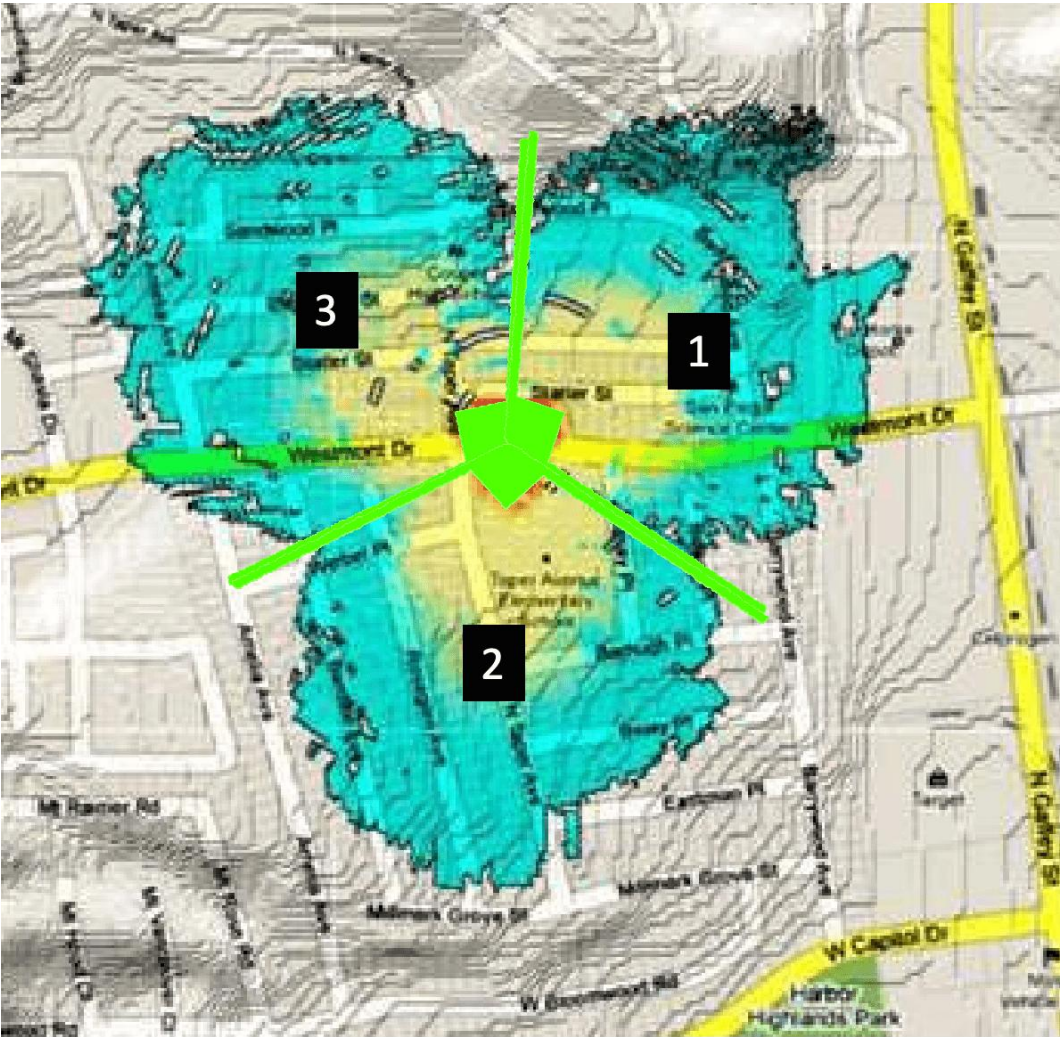
- All of that information is recorded in the carrier's database = cell phone mapping records
- These records can be used to determine:
 - General location of where a phone call or text message was placed (not accurate)
 - Date and time of the call or text
 - Called numbers
 - Duration of the phone call
 - Latitude and longitude of the tower's location.

CELL PHONE MAPPING RECORDS

- Some of the information on the spreadsheet:
 - Which cell tower the phone "pings"
 - What side of the tower or antenna the phone "pings"
 - Timing advance: how long it takes for a signal to travel to and from the cell phone to tower
 - A reported accuracy of 10 meters.
 - Signals radiate in a circle so the phone can be within a 10 meter wide arc

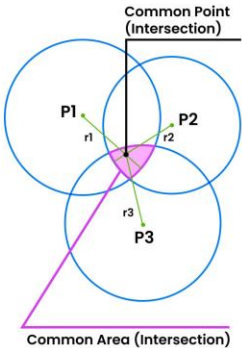


CELL TOWER TRIANGULATION



Triangulation

Tower-1 and Tower-2 – base stations receiving the signal
 α and β – angles of arrival of the signal from the mobile device
Mobile Handset – the device being located



Trilateration

P1, P2, P3 – locations of the nearest towers
Radii $r1$, $r2$, $r3$ – distances to the mobile device based on signal strength or time of arrival
Common Area (Intersection) – estimated position of the mobile device

*by heylocat.mobi

ABOUT CELLULAR DATA

For law enforcement this is useful to track mobile device locations and reconstruct timelines

- LE identifies the cell phone carrier and gives them with a warrant
- Cell phone carriers only keep this information for about 7 days, so LE with also put a hold on these records



Cell phone carrier gives LE a spreadsheet of information

Some LE agencies purchase software to process and organize this spreadsheet information

- Easier to read
- Reduces misinterpretation
- However it is expensive

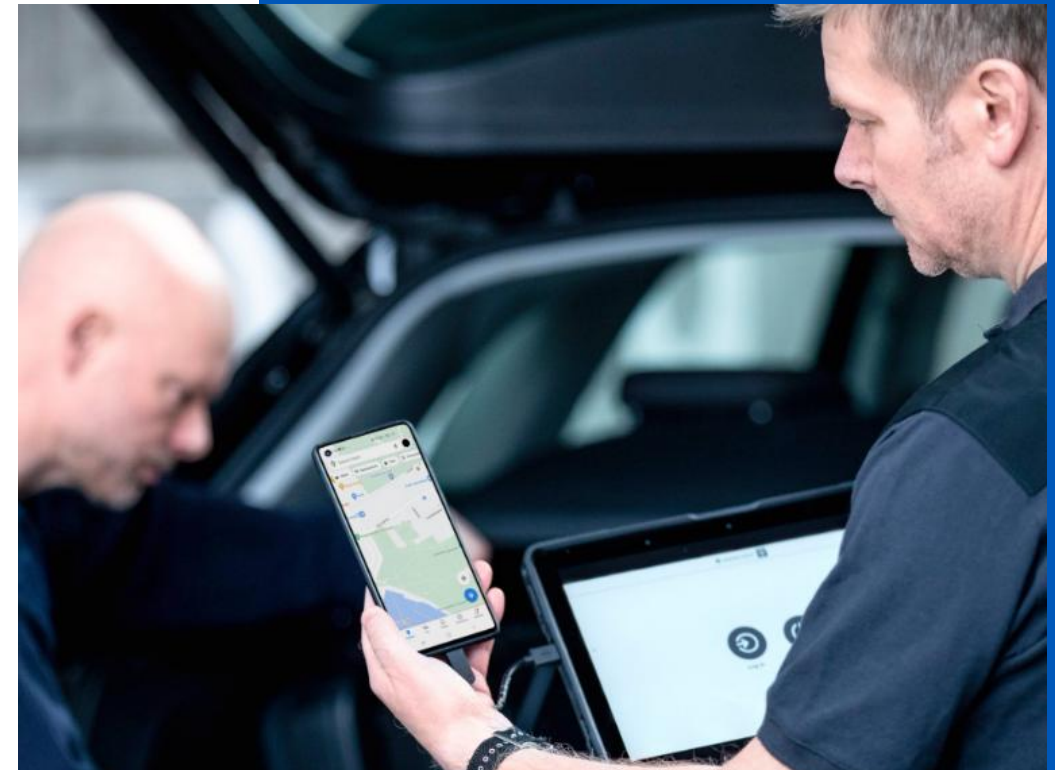


CELL PHONE DATA

Accessing Data via Physical Cell Phone

LAW ENFORCEMENT HAS THE PHONE...NOW WHAT?

- Some law enforcement agencies have software that extract a copy of the data from the devices
 - Text messages
 - Google searches
 - Notes
 - Applications used such as Facebook and snapchat –
 - Exact GPS locations
- Ideally, LE would have the phone passcode
 - Software may be used to access a locked phone





CASE EXAMPLES

Cell Phone Data

CASE EXAMPLE #1

- An older boy arrived home from work
- Goes to his bedroom at 2230
- The next morning, father sees that his room is empty at 0730 His father assumed he already left for school.
- At 0815, the father enters the garage and notices his truck and ATV running. He also notices a hose running from the exhaust pipe of the ATV to the rear window of the truck.
- The boy is unresponsive in the truck. The father and EMS perform CPR. He was pronounced dead at 0918.



CASE #1 AUTOPSY

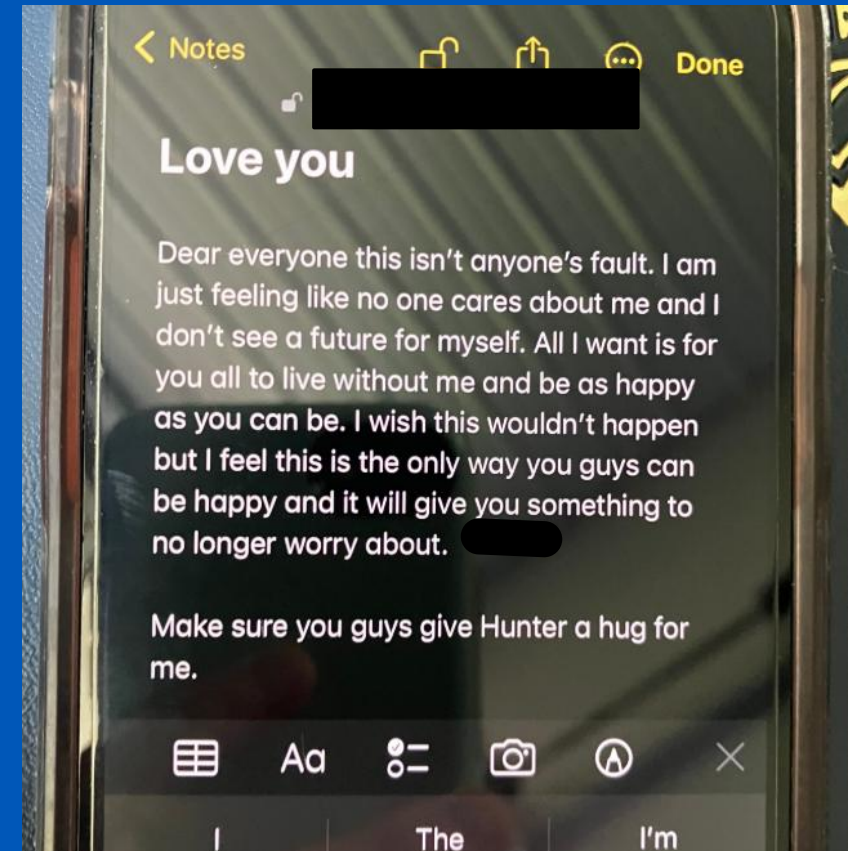
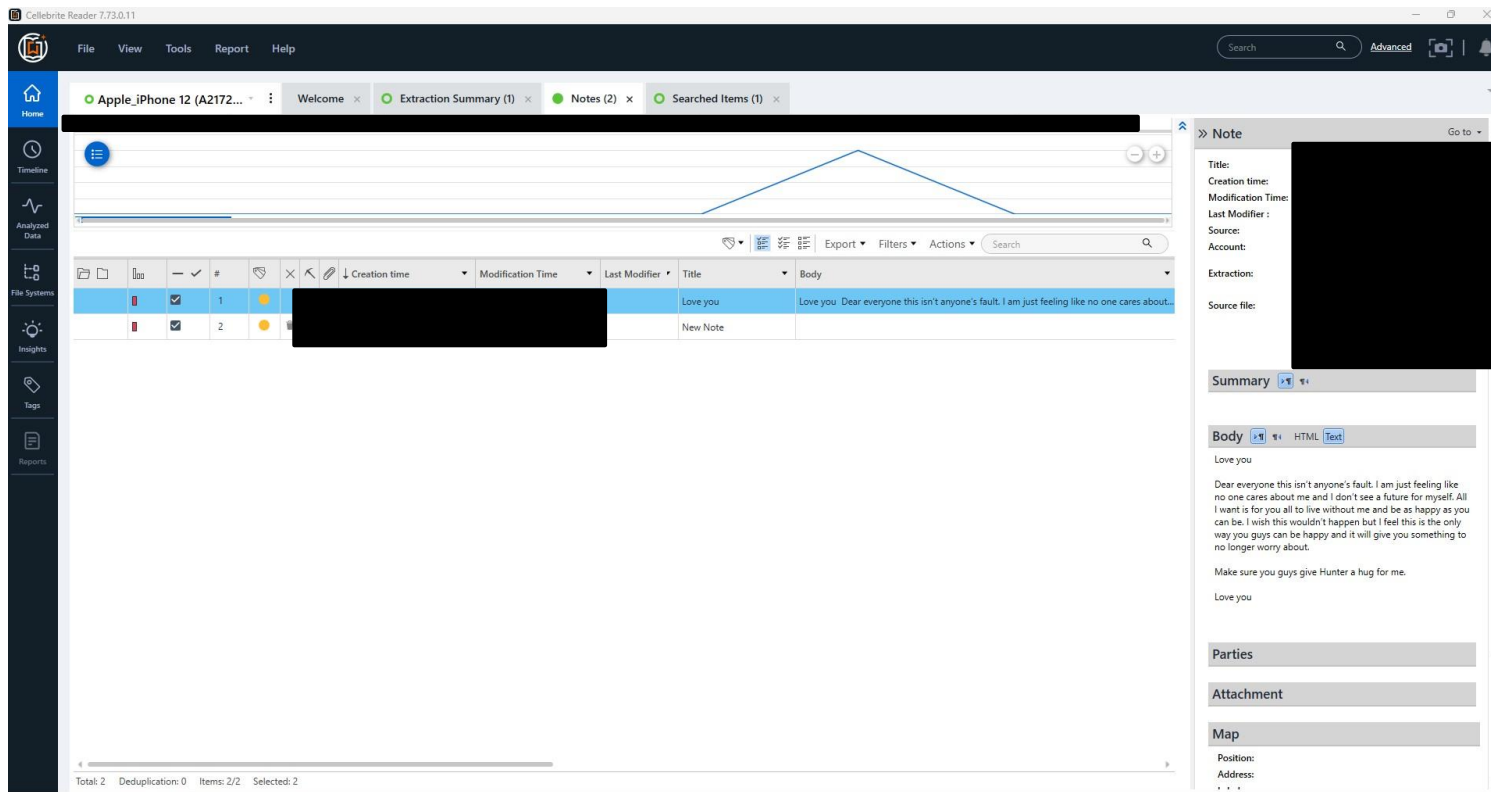
- Cause of death: Carbon monoxide intoxication
- Manner of death: Suicide

Carbon Monoxide, B (Autopsy)

Test	Result Name	Value
Carbon Monoxide, B (Autopsy)	Carbon Monoxide, B	67
	Tube type	Red
	Tube ID	A
	collection site	Femoral

CASE #1 FURTHER INVESTIGATION

- The decedent's phone is accessed on scene with passcode.
- Law enforcement also obtained his phone for data extraction.
- Found a suicide note timestamped at 0220



▼	Source	▼	Search Results
	Safari		

Go to ▾

Timestamp:	4:58:02 AM(UTC-5)
Source:	Safari
Value:	how long does it take to fill up your garage with co2
Search Results:	
Searched In:	
Origin:	Unknown
Account:	
Service Identifier:	
Extraction:	Advanced Logical
Manually decoded:	False
Source file:	

Go to ▾

Timestamp: [REDACTED]
Source: Safari
Value: how long does it take to fill up your garage with co2

Searched In:

Origin: Unknown

Account:

Service Identifier:

Extraction: Advanced Logical

Manually decoded: False

Source file:

Map

Position:
Map Address:

Labels : Evidence

Description :

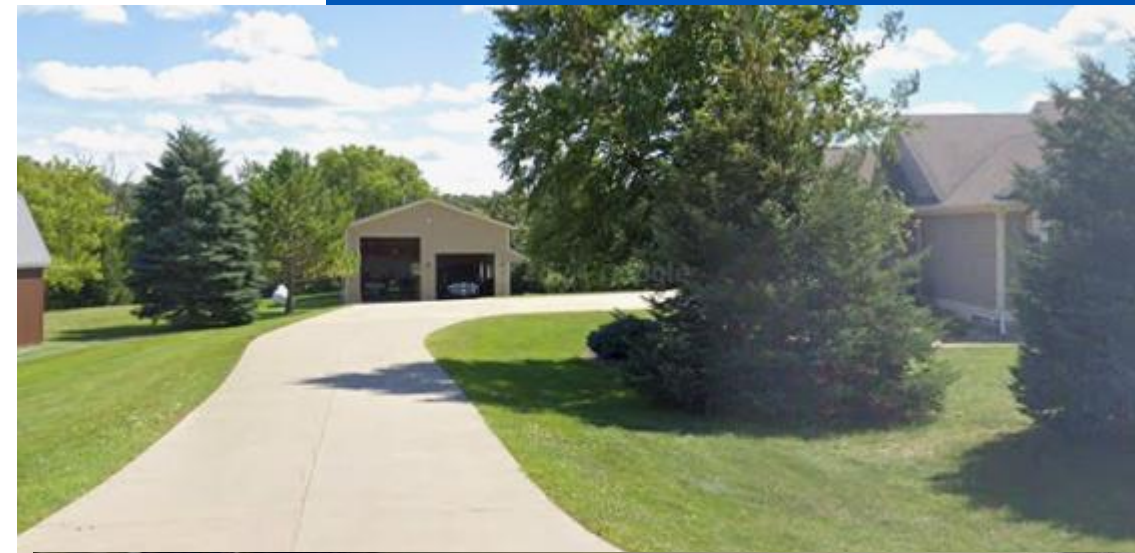
Source

Go to ▾

Title:	how long does it take to fill up your garage with co2 - Google Search
Last Visited:	
URL:	https://www.google.com/search?q=how+long+does+it+take+to+fill+up+your+garage+with+co2&ie=UTF-8&qoe=UTF-8&hl=en-us&client=safari
Visits:	1
Account:	

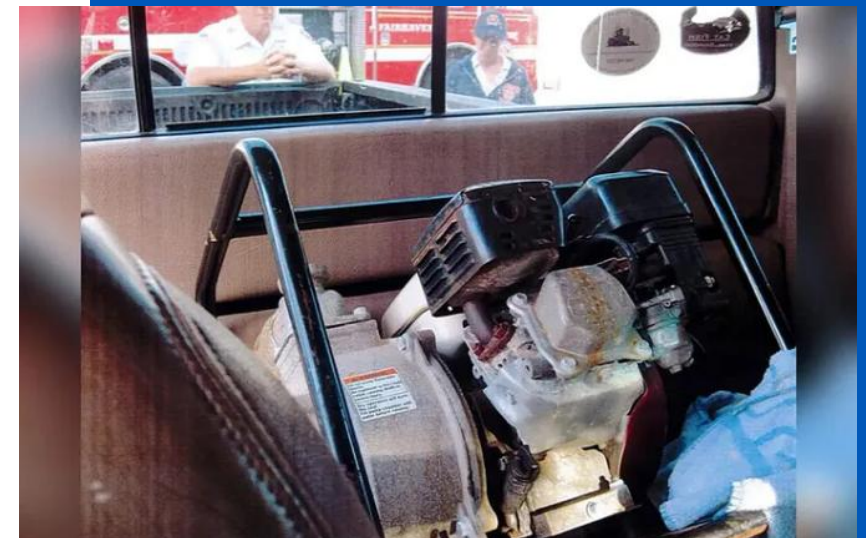
- Tracking his steps on his iphone shows:
 - At 0445, he moves up one floor (presumably from his downstairs bedroom to the main floor)
 - At 0502, he takes approximately 113 steps (78 meters) (presumably from the house to the garage)
 - At 0521, he takes approximately 7 steps (5.25 meters). Presumably him in preparing his suicide attempt

These are his last known movements by his phone.



FAMOUS CASE CONSIDERATION

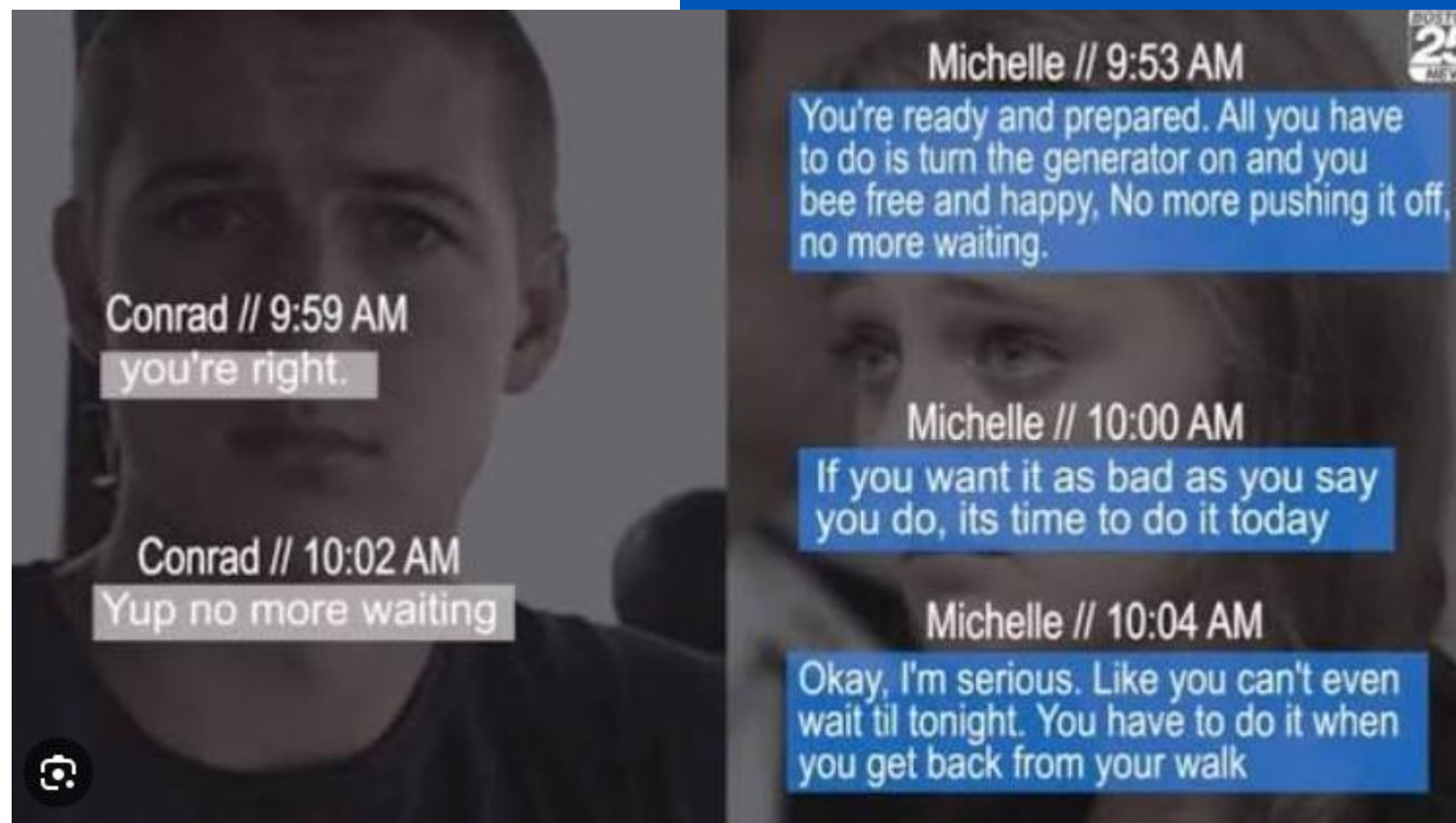
- On July 12, 2014, Conrad Roy III was found deceased in his truck parked at a local business parking lot in Fairhaven, Massachusetts
- There was a gasoline powered water pump in the back of his truck
- Death Certificate
 - Cause of Death: Carbon monoxide poisoning
 - Manner of Death: Suicide



FAMOUS CASE CONSIDERATION

- Law enforcement unlocked his phone and found a text conversation with his girlfriend Michelle Carter
- Text messages going back 1 month before death reveal suicidal ideation and initially Michelle is telling him to get help
- Conversations turn into Michelle trying to convince him and pressure him into committing suicide
- There are also texts and phone calls while he is in his truck committing suicide, and she fails to notify anyone





FAMOUS CASE CONSIDERATION

- In 2015, she was charged with involuntary manslaughter
- Served 11 months before she was released from prison for good behavior
- Death Certificate
 - Cause of Death: Carbon monoxide poisoning
 - Manner of Death: Suicide
- Should manner of death be Homicide or Suicide?
- Does this change what we do in the autopsy suite?



SMARTWATCH

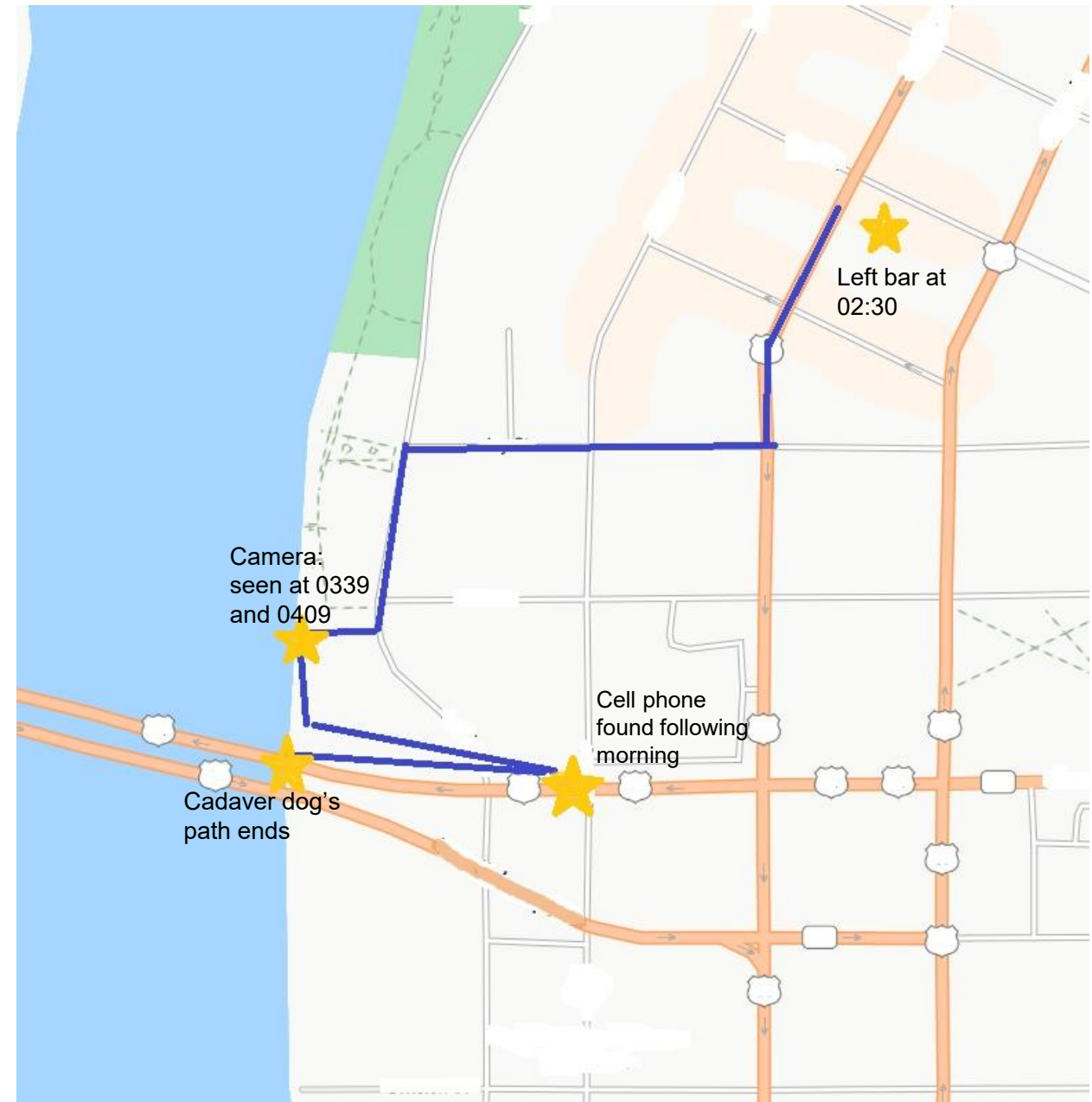
SMARTWATCH

- A tiny device worn on the wrist, typically synced with cell phone and has additional capabilities such as heart rate monitor, GPS tracking (running routes), speed detection, and sleep patterns
- LE accessing data
 - Data can be accessed from the watch
 - However, because the watch syncs with a phone or cloud account and it has Wi-Fi or cell service, the data can be collected from the cell phone or cloud account it syncs to



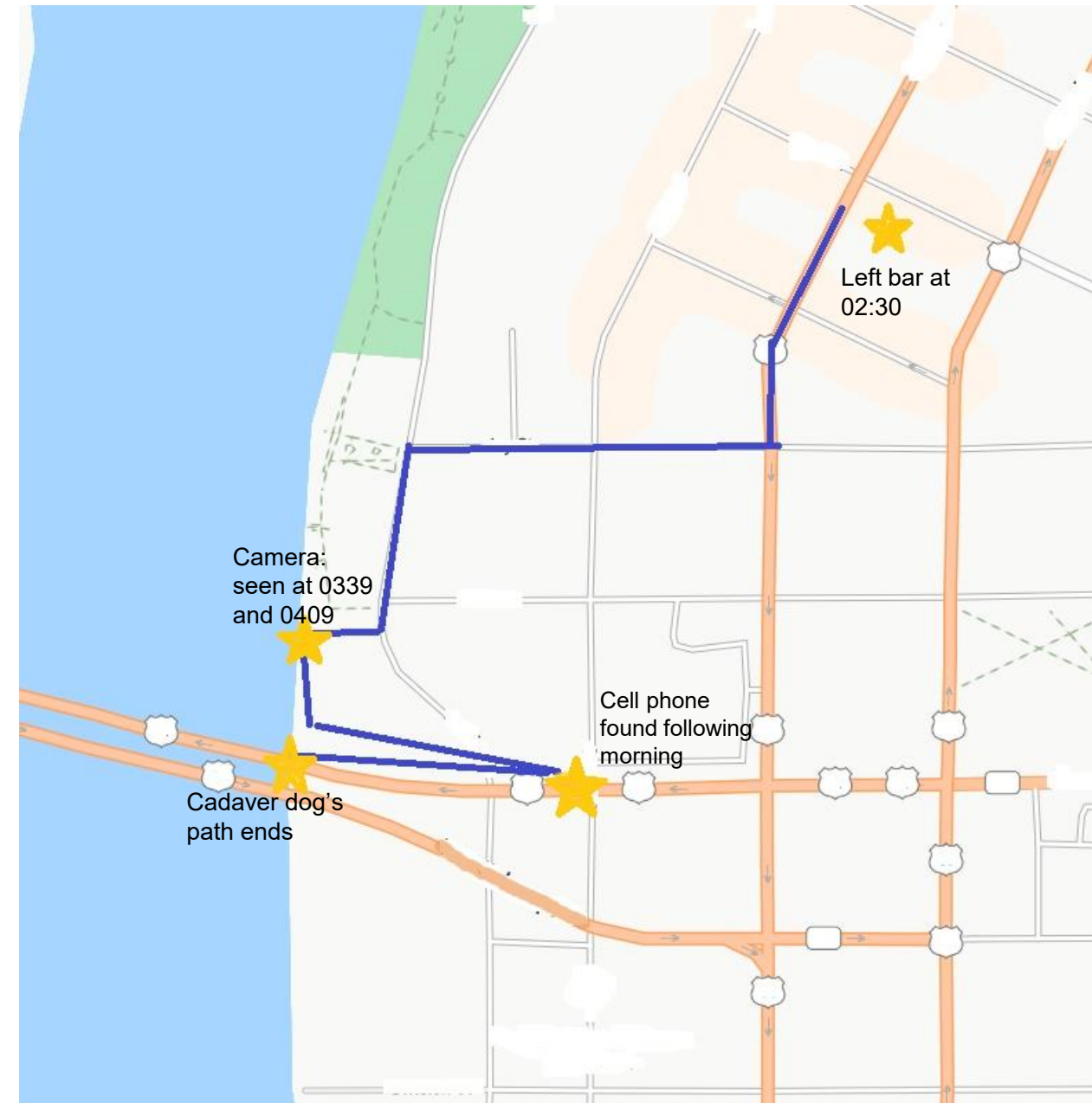
CASE EXAMPLE #2

- A young women visits multiple local bars one night, and walks home alone.
- She is reported missing later that morning, and an active missing person search ensues on land and nearby water
- She is seen on camera leaving the bar at 02:30. She is by herself and looking at her phone
- She leaves the bar at 2:30a, however continued to text a friend until 3:22a when she no longer answers her phone.



CASE EXAMPLE #2

- At 0339, she is again seen on camera heading towards the waterfront
- At 0409, she is seen on camera leaving the waterfront and heading south.
- 1 day after being reported as missing, her cell phone is found on top of a sign. That ends her digital trail
- That same day cadaver dogs were used to track her scent. They followed the path as seen on camera, but then end along the waterfront under a bridge.



CASE EXAMPLE #2

Three days later, she was found floating in the river by a fisherman.

Approximately 6 miles from where she is LKA

She was officially pronounced dead and was transported to the medical examiner's office for an autopsy

Autopsy findings were significant for:

- Moderate decompositional changes (bloating, marbling, skin slippage)
- Hemorrhagic watery fluid in bilateral sinuses, 3 mL
- Bilateral sphenoid hemorrhage
- No evidence of acute trauma
- No evidence of pathologic disease, grossly

CASE EXAMPLE #2

- What is the cause of death?
 - Drowning?
 - Can she swim? If yes, why was she unable to swim to shore?
 - Intoxicated? Trauma? Unconscious?
 - Did she die before entering the water? Or after?
- What is the manner of death?
 - Natural?
 - Accident?
 - Suicide?
 - Homicide?
 - Undetermined?



CASE EXAMPLE #2

- Final movements with apple watch data
 - 4:16a: begins crossing the bridge
 - 4:16a: A car crossing the bridge does not recall seeing her
 - 4:16a-4:27a: no movement
 - 4:27:43-4:27:51: less than 1 second, she moves approximately 55 feet-Last data
 - 4:46a: A man running across the bridge does no see her
- Bridge height is approximately 65 feet
- Heart rate noted from 7:22a-7:41a (44-46 BPM): water flow interferes with the optical sensor's ability to measure blood volume.



CASE EXAMPLE #2

.16-.19%	Very drunk – Strong state of depression, nausea, disorientation, dizziness, increased motor impairment, blurred vision, judgment further impaired
.20-.24%	Dazed and confused – Gross disorientation to time and place, increased nausea and vomiting, may need assistance to stand or walk, impervious to pain, blackout likely

- Toxicology Blood 193 mg/dL
- Cause of death
 - Drowning
- Manner of death
 - Natural?: No evidence of natural disease
 - Homicide?: No evidence of foul play after extensive investigation. She was alone.
 - Suicide?: No suicidal ideation, no depression, no suicide note, or personal history circumstances to indicate it was
 - Accident

2. SOFTWARE

- Digital programs, applications, and online platforms that collect, store, process, or transmit information
- Helpful in establishing a timeline, provide context around a death, identifying patterns of behavior, and corroborate other investigative findings
- Examples:
 - Life 360
 - Snapchat
 - Facebook
 - Instagram
 - Dating applications
 - Photo-storage applications

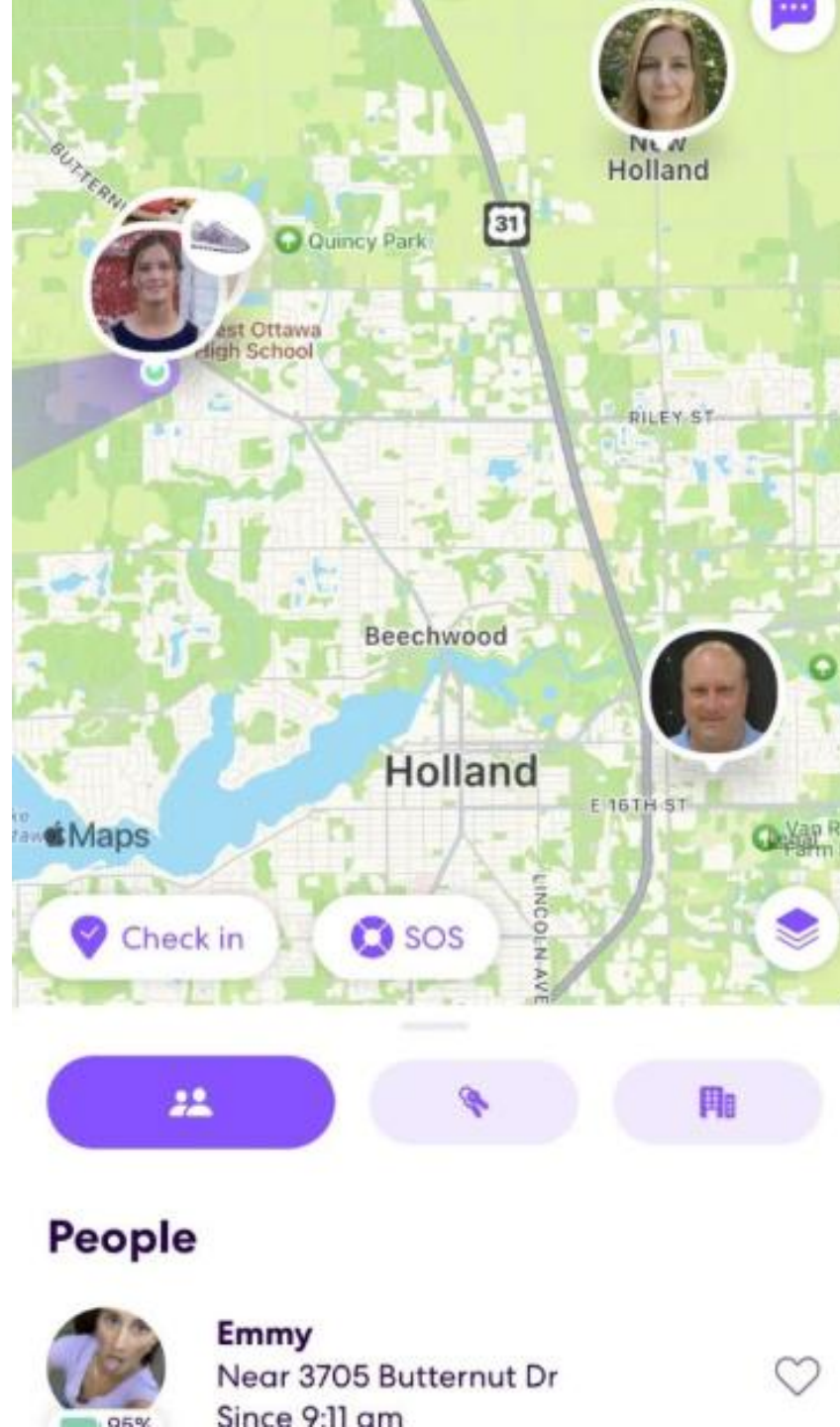




LIFE 360

LIFE 360

- Life 360, an app with a location-sharing feature so that friends and family can share their real-time location and movements with one another
- Has crash detection features, roadside assistance and emergency dispatch



- Uses GPS tracking, so provides an exact location.
 - Latitude / longitude
 - Can access historical data as well
- Law enforcement usually accessed Life 360 information from a friend's/family member's phone in the decedent's private circle

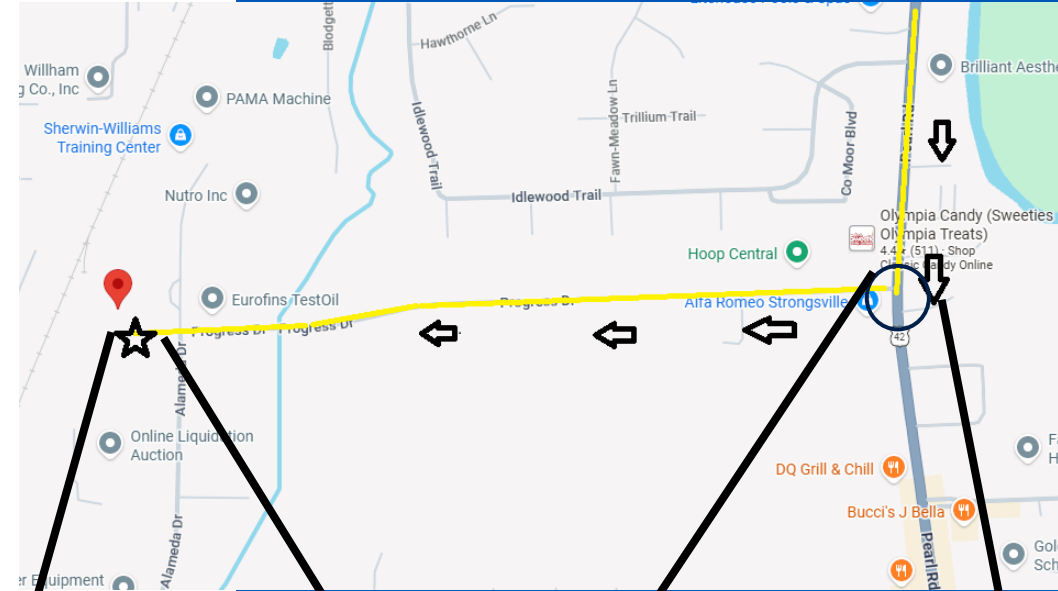
FAMOUS CASE: MACKENZIE SHIRILLA MURDER



[Hell On Wheels: Mackenzie Shirilla's Double Murder Crash](#)

FAMOUS CASE: MACKENZIE SHIRILLA MURDER

- On July 31, 2022
 - Mackenzie Shirilla, Dominic Russo, and Davion Flanagan leave a friend's home at 5:30a
 - At 05:34: CCTV slow turn onto Progress Dr
 - Car travels at high speeds along Progress Dr (Speed limit is 35 mph, car was moving at least 90 mph)
 - At 05:36: Vehicle crashes into a building
 - At 06:15, 9-1-1 is called.
- Dominic Russo and Davion Flanagan are pronounced dead on scene
- Mackenzie survives with broken bones
- Initially, the collision is investigated as a possible accident or vehicle malfunction



FAMOUS CASE: MACKENZIE SHIRILLA MURDER

- Friends of Dom and Davion came forward to share information from Life 360.
 - Life 360 shows Shirilla driving towards the building at over 90 mph with no hard braking until the car hit the building
 - One high-speed alert and one hard-braking alert
 - Show Dom traveling from 5:30a-5:36a and that they were moving at 90 miles per hour
- Investigation revealed frequent conflicts between the couple
- An incident 2 weeks prior where Shirilla was driving erratically. She was overheard saying “I’m going to wreck this car right now”
- An auto expert was able to confirm that the car was in perfect working condition



FAMOUS CASE: MACKENZIE SHIRILLA MURDER

- The car's Event Data Recorder (EDR) showed:
 - Accelerator pedal was 100% engaged before crash
 - At no point was the brake pressed before the crash
- Crash reconstruction concluded:
 - Car speed was approximately 97 mph
 - Vehicle was gaining speed before leaving the roadway
- Shirilla was charged and found guilty. She was sentenced to life in prison and is eligible for parole in 15 years.
- Death Certificate
 - Cause of Death: Multiple blunt force injuries
 - Manner of Death: Homicide

Initially, MOD was accident based on initial police investigation that it was an accident. The DC was amended based on new information for the investigation.

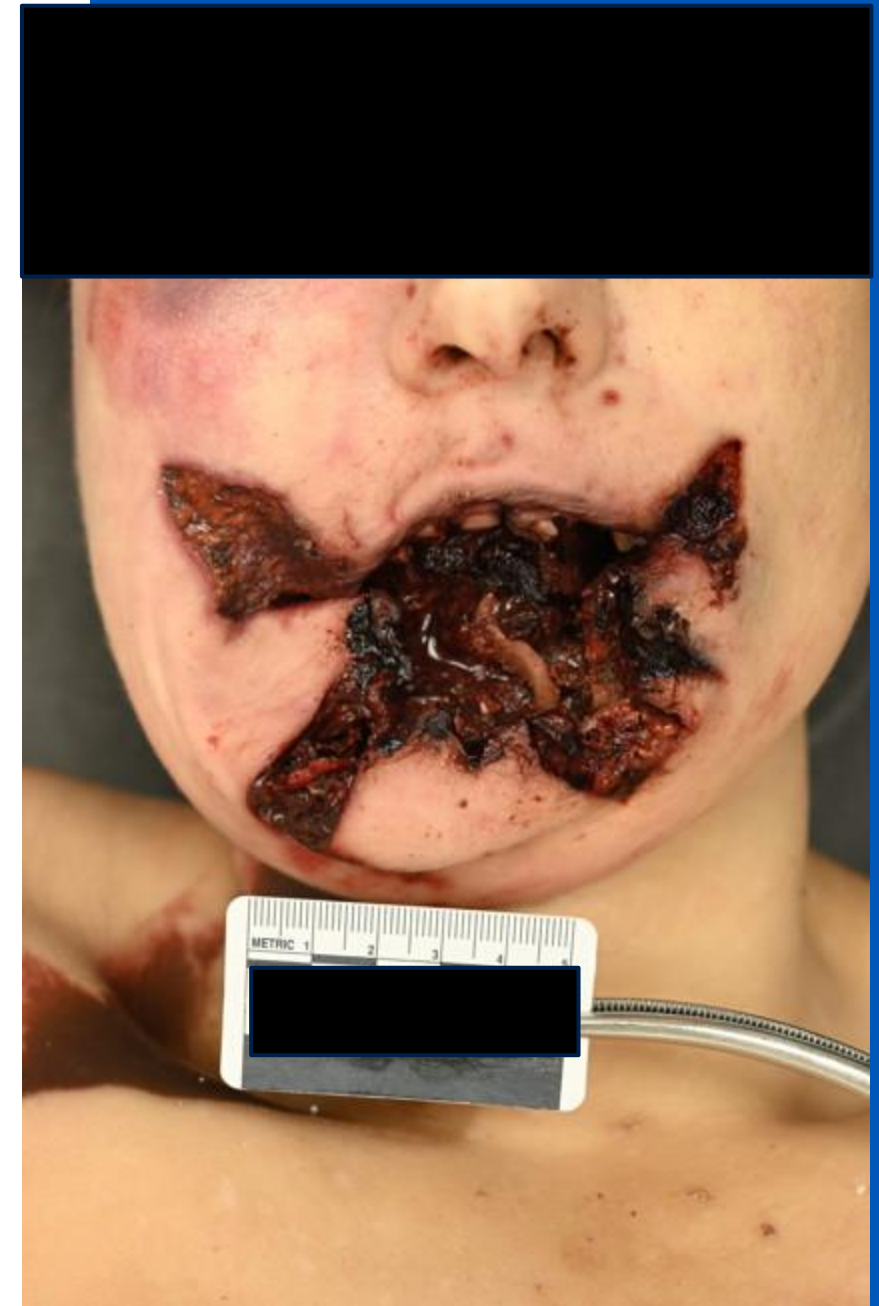
CASE EXAMPLE #3

- A young woman is found deceased at a highway overpass, with a gunshot wound to the mouth
- Met up with her ex-boyfriend the previous night and had not heard from her since.
- Found her with Life 360
- No gun is found on scene.



CASE EXAMPLE #3 - AUTOPSY

- Intraoral gunshot wound with extensive mandible and maxillofacial fractures and intraoral soot deposition. No exit wound.
- Dislocation and fracture of C1-C2
- Right sphenoid bone fracture
- Trajectory is front-to-back, slightly right-to-left, and slightly upwards
- Death Certificate
 - Cause of death: Intraoral gunshot wound of the head
 - Manner of death.....
 - Suicide?
 - Homicide?



CASE EXAMPLE #3: INVESTIGATION

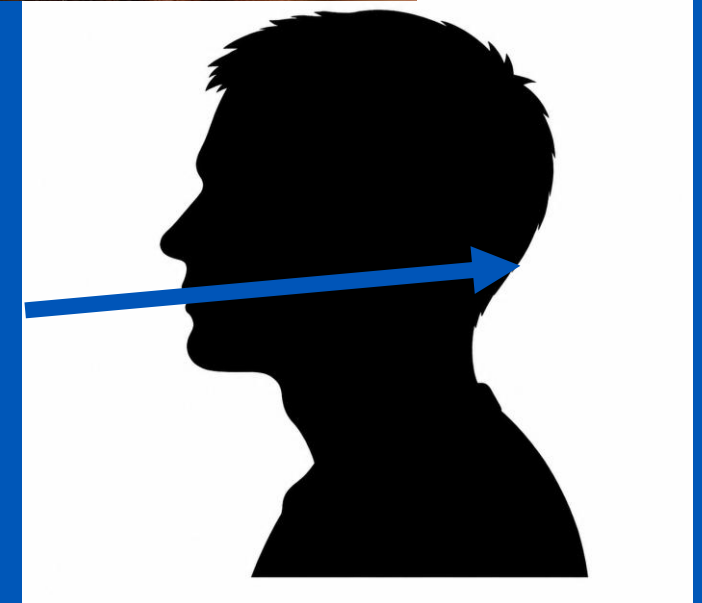
- A friend drops her off at a park
- Gas station CCTV shows them both entering and leaving the gas station from 2134-2139.
 - Ex-boyfriend pulls a gun case from his backpack
 - Acting aggressive towards her in the footage, shoving her head, throwing things at her, and talk aggressively
- Both are seen walking out of camera's view towards the highway overpass
- Life 360 shows her at the highway overpass at 2154
- At 2239, the ex-boyfriend reappears of video footage without the decedent

CASE EXAMPLE #3

- Ex-boyfriend's explanation
 - Gun belonged to the decedent
 - She did not arrive to the gas station with a gun, she found it on the railroad tracks
 - They were walking and arguing when she said "I want to shoot something"
 - Argued for another hour she grabbed the gun by the barrel, slammed it into the rocks, and the gun went off
 - She was unresponsive so he ran away in a panic and left the gun on scene
 - He never touched the gun

CASE EXAMPLE #3 - AUTOPSY

- Multiple blunt force injuries: nose deformity with multiple abrasions of the head and neck not associated with the gunshot wound
- Trajectory is front-to-back, slightly right-to-left, and slightly upwards
- Death Certificate
 - Cause of death: Intraoral gunshot wound of the head
 - Manner of Death: Homicide
- Conviction combined surveillance video, [REDACTED] injuries, the autopsy, the ex-boyfriend's behavior, and his statement
- Multiple source confirmed ex-boyfriend owned a gun, but he claimed to not own a gun and had extensive knowledge regarding the gun used.



3. MEDICAL DEVICES

- Electronic medical devices that monitor, record, or regulate physiological functions and may retain information about a person's health, treatment, body activity, and identity
- Examples:
 - Glucose monitors/ insulin pump
 - Pacemakers
 - Heart monitor
 - Vagus Nerve Stimulator



FAMOUS CASE: PACEMAKER

- On October 9, 2000, 72-year-old David Crawford, was found dead outside his home
- Multiple injuries to the head, most likely caused by axe.
- Burglary gone wrong.
- Believed he died between 4a-7:30a
- Pacemaker at autopsy was quickly interrogated
 - Went to bed shortly after 10p
 - At 4:46a, he woke up
 - At 4:54a, his heart was beating over 100 bpm (assault)
 - At 5:04: his heart beat slows (end of assault)
 - At 5:34, his heart stops beating



FAMOUS CASE: PACEMAKER

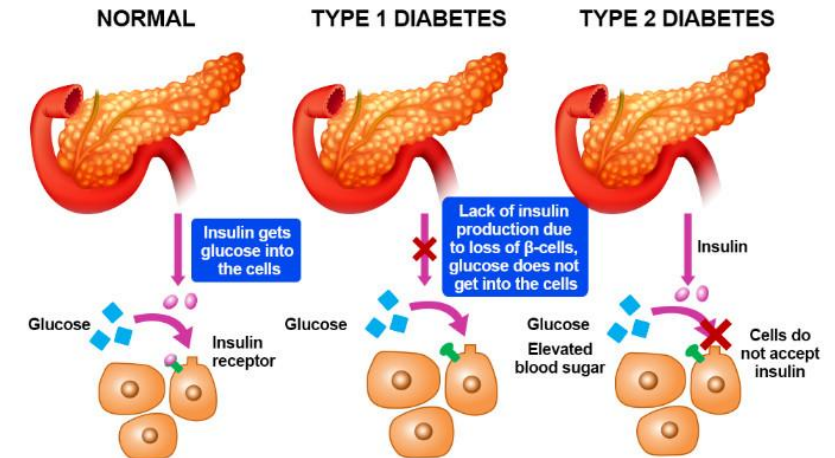
- Two suspects in the cases, cousins:
 - Darcy McClain: Claims someone stole an axe from his home, lives alone, was asleep at time of murder
 - Ivan Jones (19 years old): Claimed he was asleep from 1a-6a and lives with sister.
- Ivan's sister, last saw him at 3a and was awoken at 6a to him taking a shower. His clothes were freshly bleached and there was physical evidence connecting him to the crime scene
- The timeline was critical in comparing against the suspect's alibi
- 1st time pacemaker data was used in a murder trial
- Ivan John Jones was sentenced to 20 years in prison



INSULIN PUMP

ABOUT DIABETES

- Type 1 diabetes: autoimmune destruction of pancreatic beta-cells resulting in insulin deficiency
- Type 2 diabetes: body can produce insulin, but the cells do not respond to it the way they should
- Glucose is a major source of energy for central nervous system, particularly the brain, and muscles, so when the body is not making enough insulin to break down glucose, the body will start to break down fat and eventually muscle as fuel.
 - Acetoacetate and beta-hydroxybutyrate are by-products of fat metabolism and are also acid ions.
 - Increase in acid ions = drop in pH and subsequent (keto)acidosis.
- Ketone bodies include 3 molecules: acetoacetate, beta-hydroxybutyrate, and acetone.



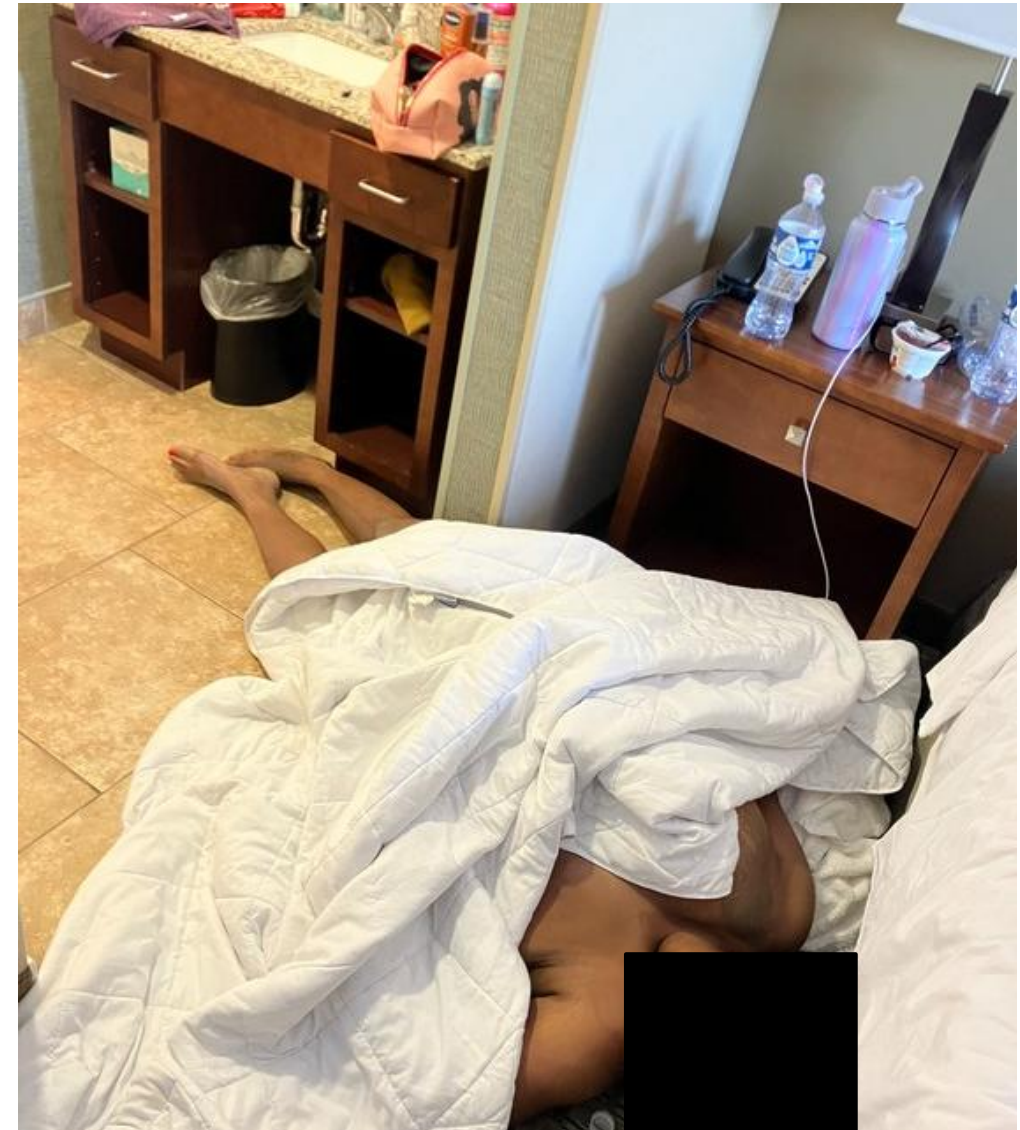
TYPES OF GLUCOSE MONITORS

- **Blood glucose meters (BGMs):** pricking finger with lancet and then applying the drop of blood to a test strip and inserting into a digital meter
- **Continuous glucose monitors (CGMs):** a small sensor worn on the arm or belly with a tiny filament inserted just under the skin. Glucose is measured in the interstitial fluid and data is sent via Bluetooth to a receiver or smartphone. These record data continuously. Sends alerts to phone or receiver to alert hyper- or hypoglycemic events and rapid drops in glucose levels
- **Flash glucose monitors (FGM):** Form of CGM. A sensor is placed under the skin like CGMs, but do not have real-time alerts. User has to scan the sensor with their smartphone / reader to view their glucose data.



CASE EXAMPLE #4

- A young women checked into a hotel for a 1-month stay
- Per the mother, during a recent phone conversation, she said that her blood sugar was very low.
- The following day, she did not arrive for her first shift at work. Her employer called 9-1-1 for a welfare check.
- First responders arrived to her locked hotel room. Upon making entry, they found her noticeably deceased on the bedroom floor.
- Past medical history: Type 1 diabetes mellitus



CASE EXAMPLE #4

- Scene: There were no illicit drugs or alcohol found on scene. However, the scene did have a strong smell of alcohol. The bathroom floor was covered in urine. The glucose monitor had multiple readings in the 300s mg/dL.

10:17 a



1:20 p



5:33 p



5:52 p



9:07 p



CASE EXAMPLE #4

- Preliminary Autopsy
 - Wischnewsky spots
 - Quick tox: positive for alcohol
- Vitreous

Chemistry Tests

Bld Urea Nitrog(BUN), S	77	H	mg/dL	6 - 21
Chloride, S	124	H	mmol/L	98 - 107
Beta-Hydroxybutyrate, S	13.8	H	mmol/L	<0.4
Potassium, S	12.8	CH	mmol/L	3.6 - 5.2

CHEMISTRY

Sodium, S	153	H	mmol/L	135 - 145
Glucose, Random, S	641	CH	mg/dL	70 - 140

Toxicology

Acetone, B	37	CH	mg/dL
Acetone, U	51	CH	mg/dL



Death Certificate

**Cause of Death: Diabetic
Ketoacidosis**

Manner of Death: Natural

CASE EXAMPLE #5

- Older woman with a history of type 2 diabetes mellitus (insulin dependent), hypertension and depression
- Recent substantial financial loss due to telephone scam
- Texted scammer that she intended to commit suicide via insulin overdose
- Husband found her the next morning asleep on the couch, but unable to arouse her and called 9-1-1
- Arrived to hospital unresponsive with neurologic symptoms. Hypertensive and tachycardic until she became severely encephalopathic.

CASE EXAMPLE #5

- Husband found her cell phone on the bag of insulin and alcohol which appeared untouched, and found the messages indicating self harm
- Remained comatose with altered mental status and seizures. Brain biopsy was reactive without etiology despite extensive work-up. Full toxicology with drug and heavy metals was negative.
- Transitioned to comfort cares
- Pronounced death almost 4 months after incident
- Autopsy
 - Neuroexam consistent with hypoglycemic injury, but not specific
 - Findings consistent with clinical





CASE EXAMPLE #5

- Medtronic was contacted
- CGM and insulin pump showed:
 - 3:00a-4:00a: she administers a 15.2 unit insulin bolus for 31 g of carbohydrates- her glucose was 265 mg/dL at that time
 - Continuous glucose monitor values progressively decline, reaching 40 mg/dL between 7:30a and 8:00a
 - Insulin delivery was suspended at approximately 6:45a
 - After 8:00a, to continuous glucose monitor data is available

CASE EXAMPLE #5

- Death Certificate
 - Cause of death: Complications of insulin toxicity
 - Manner of death: Suicide
- Based on circumstances, suspicious from her clinical team, the over administration is interpreted as intentional
- Lesson's learned
 - Consult endocrinologist or identify a diabetic within your team with extensive insulin pump knowledge
 - Never shy away from reaching out to a manufacturer

SUMMARY

1

ELECTRONIC DEVICES

Cell Phone
Smartwatch

2

SOFTWARE

Life 360

3

MEDICAL DEVICES

Pacemakers
Glucose monitors/ insulin
pump



SPECIAL THANK YOU!

Dr. Andrew Layman, MD
All of our medical examiner's
Office of Decedent Affairs
Autopsy Technicians
Fellow Pathologists' Assistants
Our local first responders



QUESTIONS