

# Virtual Autopsy Experience: A COVID-19 Era Adaptation of a Required Medical School Pathology Curriculum Component



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- The COVID-19 pandemic forced an abrupt transition of most pre-clinical medical education session from in-person events to largely online delivery alternatives, requiring the rapid implementation of alternative sources of delivery of course content to students.
- In the setting of the expanding COVID-19 pandemic in late March of 2020, it was uncertain whether the required autopsy experience would remain as a part of the second-year medical student curriculum.
- In this required experience, in the past, groups of 6-8 students participated in an autopsy, subsequently reviewed the glass slides generated from sampling of selected organs with a pathologist, and generated a report.
- This experience had taken place during the M1-M2 school years

- In previous years, based on course evaluations, this experience had been highly-valued among BSOM students, considered one of the defining experiences in the BSOM pathology curriculum.

## Class of 2022 - Block 4 Course Feedback

I loved the autopsy experience--it's an experience that I would not have sought out independently, and I think I learned a lot about a process that I'll likely not see again.

The autopsy experience was excellent and very well executed. It was great experience and should be continued in the manner that is set up

I loved the autopsy portion for pathology.

The autopsy experience is unique in that it allows us to incorporate the majority of things you learn in the foundational years into one experience.

I did like the autopsy experience because it was a way to quickly introduce a specialty that isn't often considered and how to apply our pathology knowledge.

I enjoyed the autopsy experience and having to do the group report.

The autopsy experience was great and really added to my learning experience.

The autopsy experience was cool and I felt like I learned a lot.

- The goals of this study included implementation and evaluation of a required virtual autopsy experience as an alternative to an in-person autopsy experience for pre-clinical medical students.

## ■ Objectives of Autopsy Experience

### ■ Describe and Demonstrate Goals / Purpose of Autopsy Examination

- When is autopsy useful vs. essential
- Distinguish of hospital and forensic autopsy

### ■ Name and Describe the Purpose of the Various Phases of an Autopsy

#### ■ Autopsy +/- X-rays (e.g. infant, gun shot wound, etc.)

- External: Post-mortem changes (e.g. rigor); evaluation for traumatic injury, intravenous drug use, etc.
- Internal : Review normal anatomy on non-embalmed individual and evaluate for abnormalities

#### ■ Toxicologic Specimen Sampling and Data Review, if Performed

- Review and demonstrate specimens gathered for toxicology examination
- When is toxicologic examination performed

#### ■ Microscopic Review of Selected Samples of Various Organs

- Review normal histology of organs
- Demonstrate pathologic changes identified in decedent (e.g. pneumonia, asthma scar, chronic myocardial infarct)

#### ■ Death Certification

- Cause of Death determination
- Manner of Death determination

## ■ Can these objectives be met with a virtual autopsy?

- Second-year medical students were assigned to one of ten groups to attend a mandatory virtual autopsy experiences, including:
  - **Viewing of an autopsy**
  - **Microscopic review of histologic preparations** of organs sampled at autopsy with discussion of the cause and manner of the decedent's death
  - **Generation of a group report** along with a **self-directed learning exercise** conducted by each student
- Autopsy and microscopic sessions were streamed using secure WebEx sessions.
- The virtual autopsy employed a Logitech C930e webcam and a Revolabs wireless microphone.
- The virtual microscopic session employed a Philips IntelliSite digital imaging platform.
- As a **control**, a group of **nine students** volunteered to **also attend an in-person autopsy** and **multi-headed microscope histology session** with appropriate safety precautions deployed including the use of surgical masks and, in the autopsy room, face shields.
- A SurveyMonkey.com survey of students was administered following the autopsy experience.

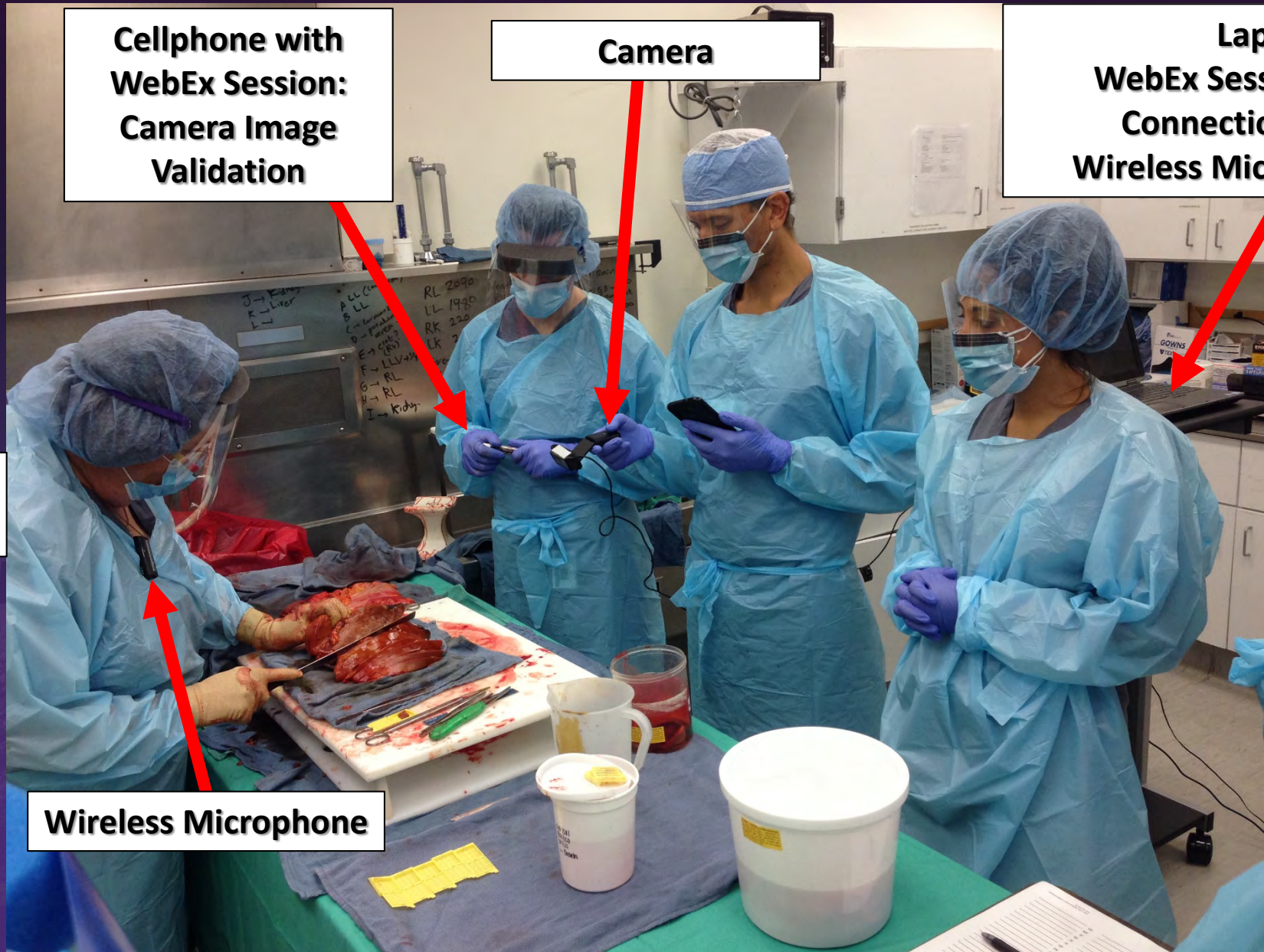
- All **80 students** participated in the mandatory virtual sessions:  
6 total sessions ... 10 groups distributed amongst the sessions

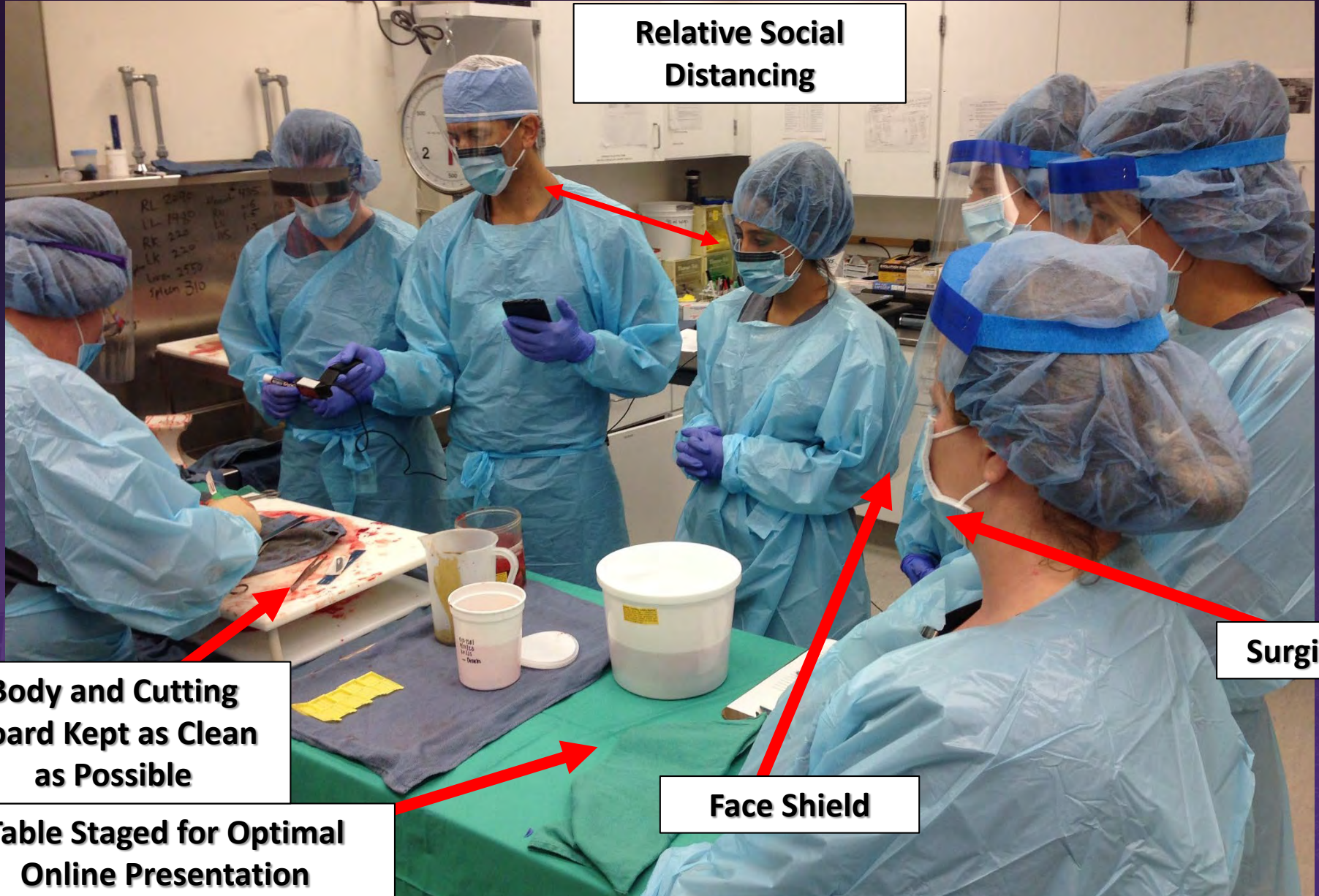
**Autopsy  
Phase**

**Slide Review Phase:  
Following Week**

**Report Phase:  
Due ~30 Days after Autopsy**

- The **control group** participated in the first virtual autopsy and histology sessions and attended a subsequent autopsy and histology sessions in person.

**Autopsy  
Phase****Technology****Dr. Karen  
Kelly****Cellphone with  
WebEx Session:  
Camera Image  
Validation****Camera****Laptop:  
WebEx Session; Camera  
Connection via USB;  
Wireless Microphone Base****Wireless Microphone**

**Autopsy  
Phase****Virtual Autopsy  
& Control Group****COVID-19  
Safety  
Precautions****Autopsy Sessions  
Occurred Prior to  
the Availability of  
Vaccination****Precautions  
Comparable to  
Operating Room  
Protocol****Body and Cutting  
Board Kept as Clean  
as Possible****Table Staged for Optimal  
Online Presentation****Relative Social  
Distancing****Surgical Mask****Face Shield**



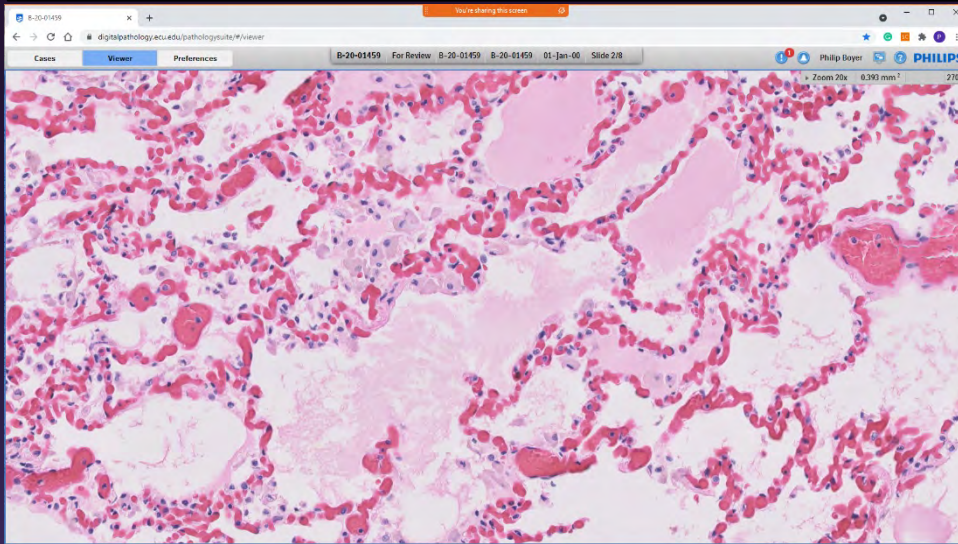
**Slide  
Review  
Phase**

**WebEx  
Session**

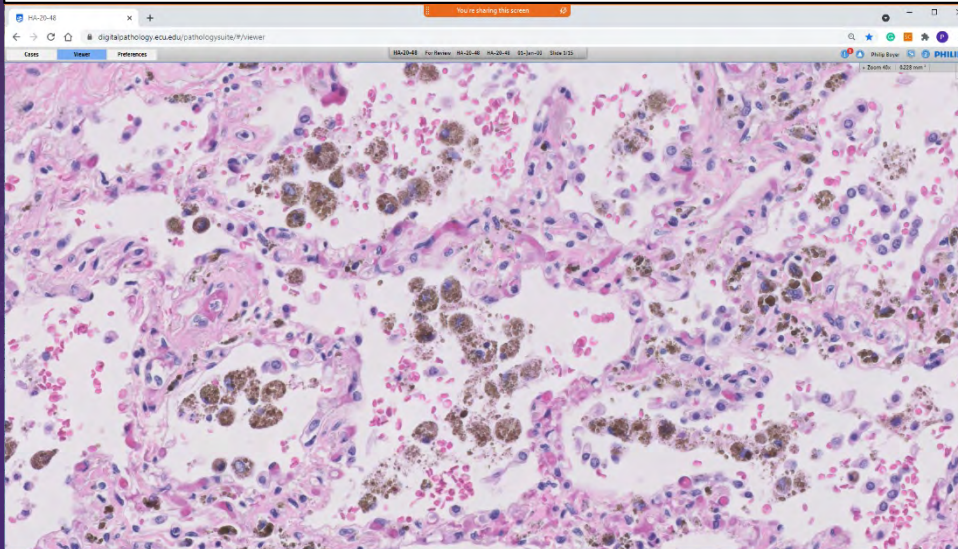
**Digital  
Slides  
Reviewed:  
Philips  
Intellisite**

**Lung  
Disease**

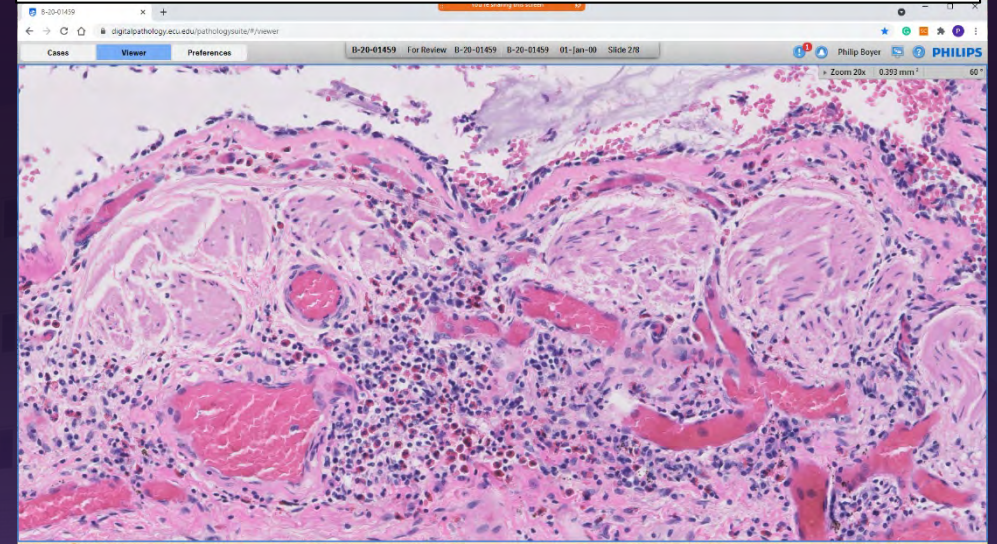
## Acute Congestive Heart Failure & Pulmonary Edema



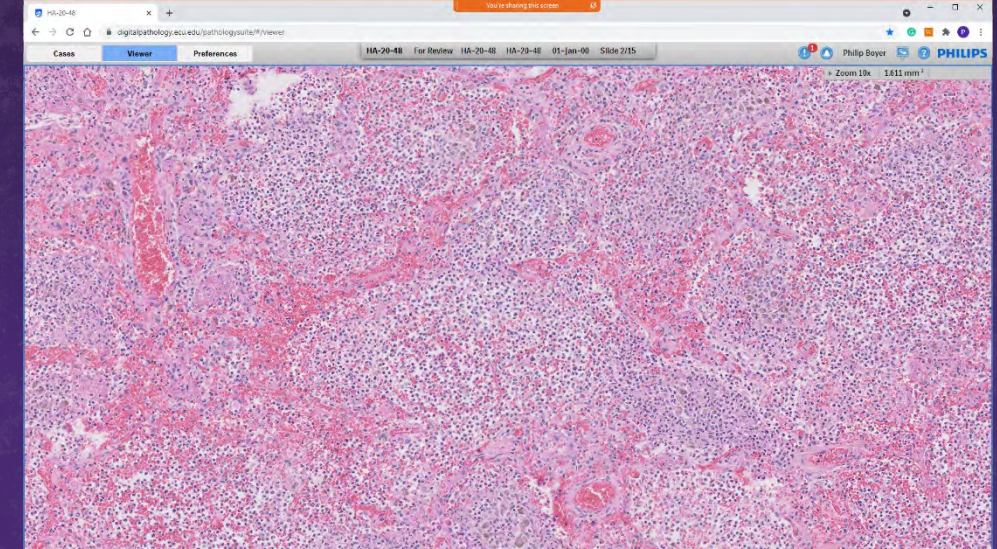
## Chronic Congestive Heart Failure & Heart Failure Cells



## Asthma



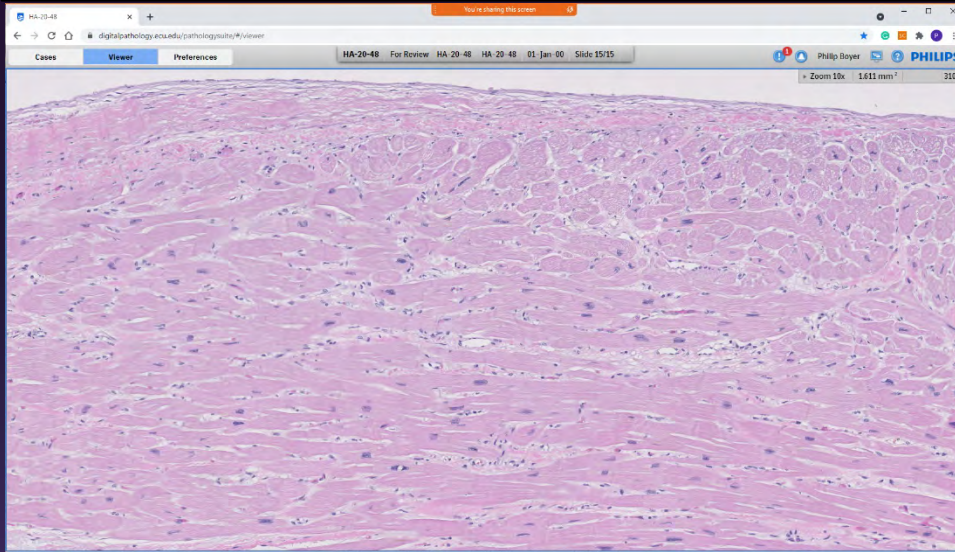
## Acute Bronchopneumonia



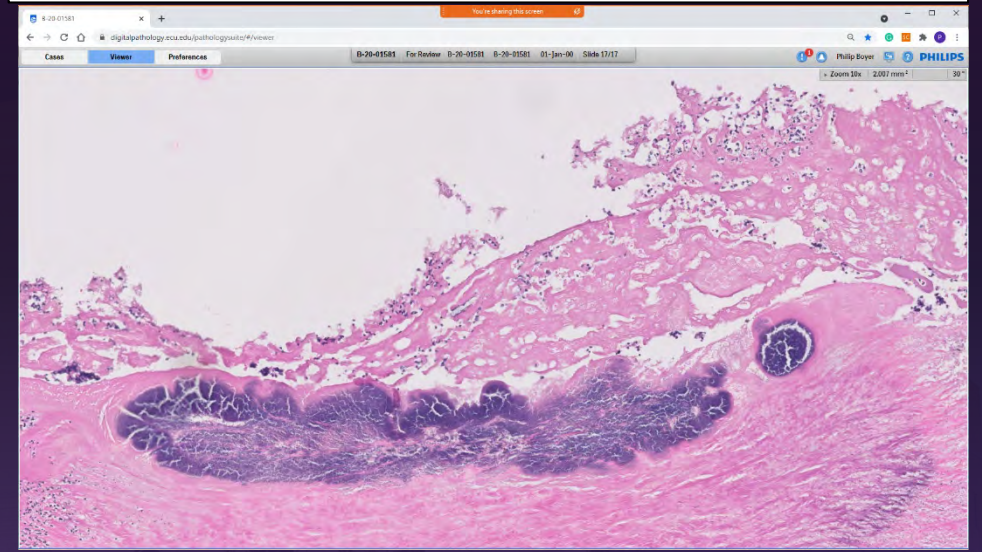
**Slide  
Review  
Phase**

**Heart  
Disease**

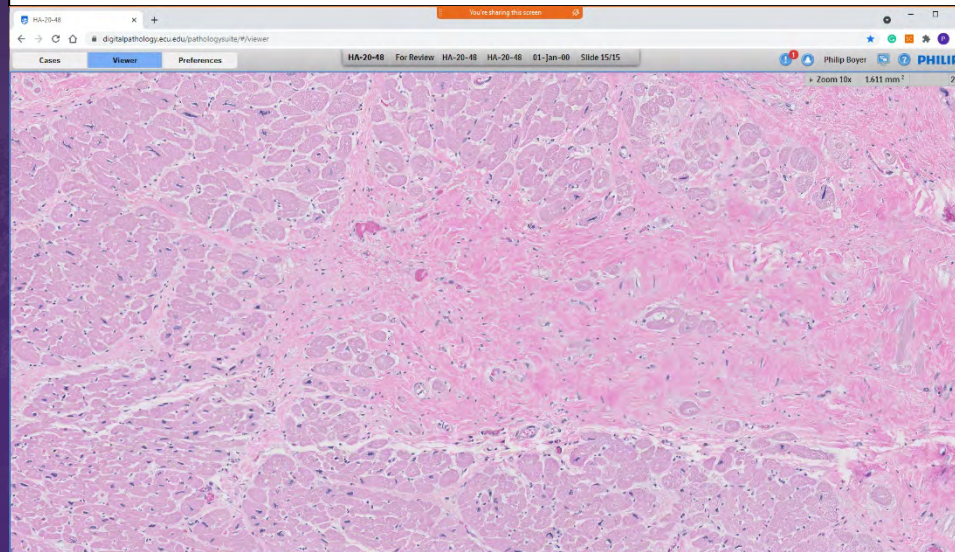
## Left Ventricular Hypertrophy



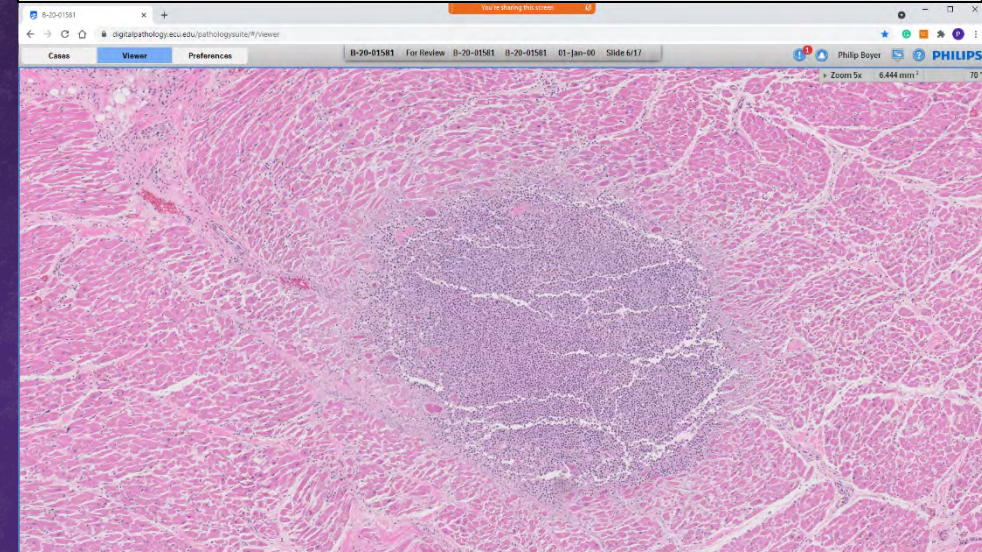
## Intervenous Drug Use: Infected Mitral Vegetation



## Old Myocardial Infarct



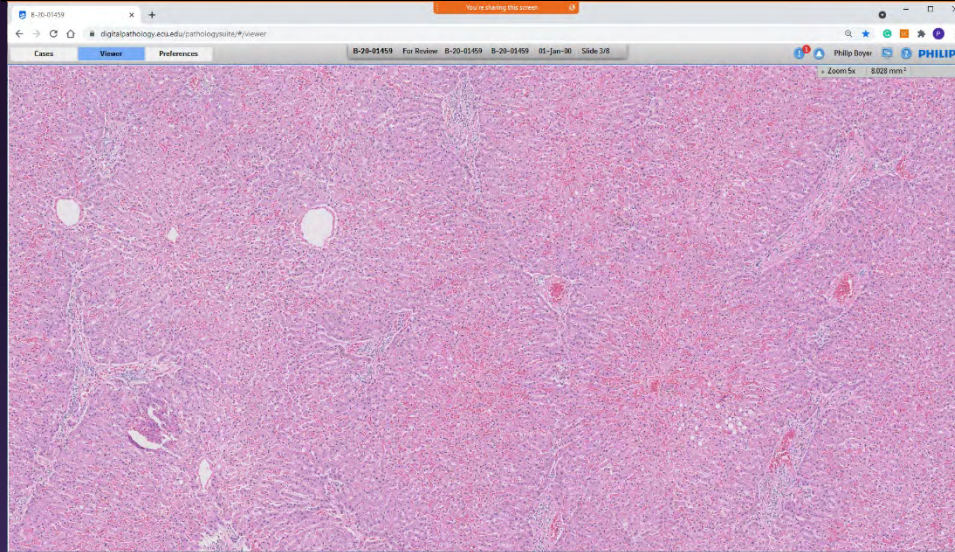
## Intervenous Drug Use: Myocardial Abscess



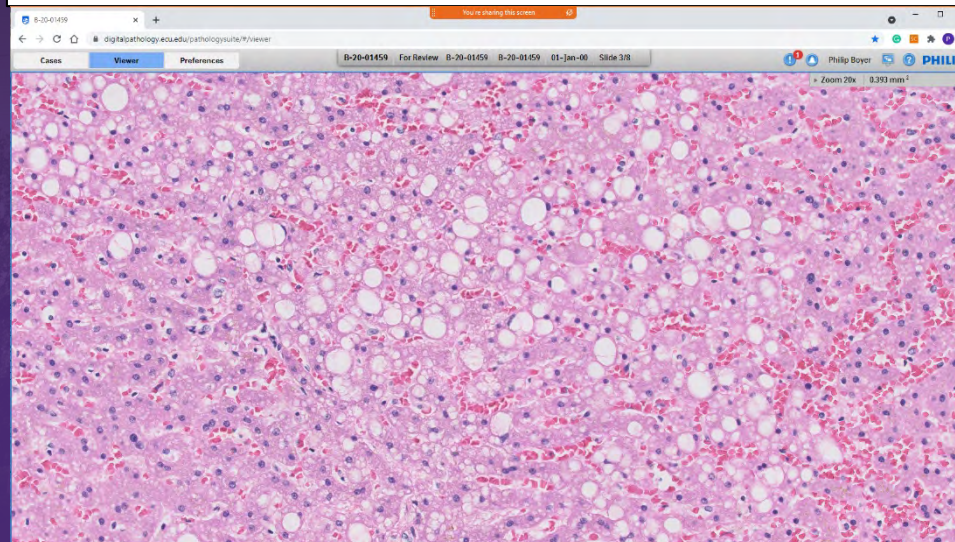
**Slide  
Review  
Phase**

**Liver  
Disease**

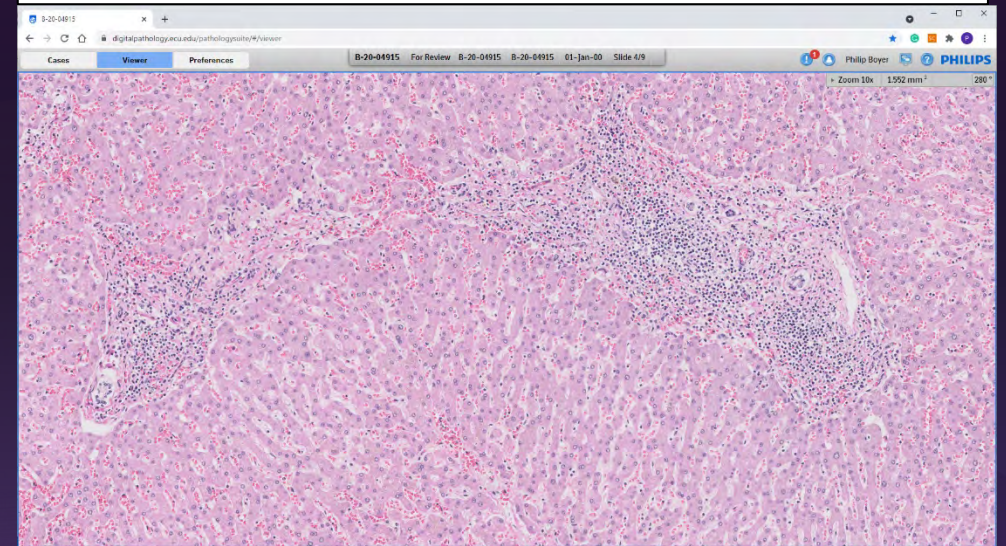
### Central Lobular Congestion in Acute Right Heart Failure



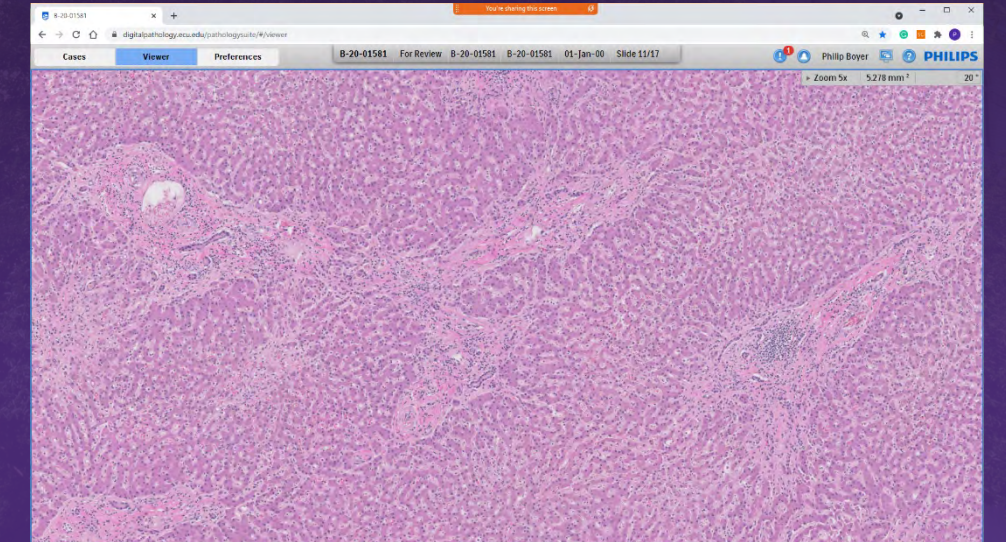
### Steatosis in Man with Heavy Ethanol Use



### IVDA 1: Hepatitis C: Inflammation & Early Bridging Fibrosis



### IVDA 2: Hepatitis C: Inflammation & Advanced Fibrosis



## Report Phase

## Group Report

### Summarizing Key Findings in Autopsy

#### Medical Student Autopsy Report Template

Student Name(S):

Case #:  Date of Autopsy:

Pathologist: Dr. Thomas Sporn

Pathologist's Assistant:

Morgue Technician: Kacey Miner

Hospital Record #:  Patient's Name:

Patient's Age:  Gender:  Race:

#### 1. Clinical Data: Clinical history, social history, problem list, other relevant data:

##### Medical History:

- Slightly obese
- Never smoker according to records (9/22/20)
- Stage III non-small cell lung carcinoma
  - Tx: Chemo & Radiation
- Large R hemisphere hemorrhage
  - Identified on CT
  - DDx: toxic/met/nutritional: anticoagulant effect vs. neoplastic (hemorrhage into a metastasis-not clearly seen on CT)
- Thrombosis of the inferior vena cava (IVC filter placed)
- Thrombus in upper extremity

#### 2. Specific Issues and Questions To Be Addressed by Autopsy: As identified by the treating physicians:

Bulky residual carcinoma in mediastinum and hilar lymph nodes in R lung & adrenal, thrombosis involving entire inferior vena cava and beginning of renal veins

Cannot find primary site because it's been treated. Probably began in hilum of R lung (lung cancer tends to arise more centrally). She was probably a smoker.

Thrombosis of L upper extremity-very uncommon unless there was some kind of hardware placed, this lends evidence that she may have been hypercoagulable secondary to neoplasm.

#### 3. Provisional Findings / Diagnoses after Gross Component of Autopsy:

- General Skin:
  - Area of hyperpigmentation on anterior thorax (result of radiation therapy)
  - Tattoos on the anterior/lateral right and left shoulders
    - Heart tattoo on the lateral R arm
    - Tattoo on right wrist

- Head/Neck: Family requested autopsy exclude head, neck
- Heart:
  - no evidence of coronary atherosclerosis
  - Open coronary arteries
  - chambers and ventricles normal size & shape, no dilation
  - Normal leaflets of valves
  - Structurally normal heart with faint fatty streaks
  - No evidence of thrombus in atrial appendages
- Chest:
  - small hemorrhage L ant thorax
  - increased fluid present bilaterally in pleural spaces- serous, no bleeding present
  - No pericardial metastasis- serosal membrane smooth
  - Firm mass on right side of mediastinum (Around aorta and esophagus)
    - May have originated from the hilum of the R. lung
    - enclosing the arch of the aorta
    - para-aortic, paraesophageal, paratracheal lymph nodes all contain metastasis
  - Right Lung
    - Tumor adherent to medial upper lobe of R lung
    - No tumor mass involving main stem bronchus or upper lobar bronchi
    - Congestion (edematous) but no focal abnormalities
    - Lung exuding clear edema fluid
    - Punctate black discoloration from inhalation of soot, exhaust, etc. (not pathologic) "Anthracosis"
    - Large hilar mass: hilar lymph node metastasis
  - Left Lung
    - Punctate black discoloration from inhalation of soot, exhaust, etc. (not pathologic) "Anthracosis"
    - Patent pulmonary arteries
    - Congestion and edema present but no focal abnormalities
- Abdomen:
  - Appendix present and normal, no enlargement
  - Bowel healthy and pink, no sign of hemorrhage, green tint due to decomp
  - Gall bladder present
  - Filter found from the IVC to catch(filter) clots
    - Thrombus of IVC stopped by filter (just below renal veins)
      - lines of Zahn present (distinguish from post-mortem thrombus)
  - Right Kidney
    - Capsule easy to peel back
    - 152 g
    - cortical pitting (sign of HTN)
    - Normal calyces/renal pelvis
  - Left Kidney
    - capsule easy to peel back

**Report  
Phase****Individual  
Self-  
Directed  
Learning  
Exercise****LCME****Requirement  
that Students  
Participate in  
Such Exercises****→ Position them  
for life-long  
learning****Autopsy Experience****Self-Directed Learning Exercise****Liaison Council for Medical Education (LCME): Element 6.3 Requirements**  
**Components of Self-Directed Learning**

- o **Information Relevant To Learning Needs**: Identify, analyze, and synthesize
- o **Credibility of Information Sources**: Assess
- o **Information Learned**: Share with their peers and supervisors
- o **Feedback**: Receive on information-seeking skills

**Translation**

- o Medical Topic:
  - Reflect on your existing knowledge
  - Search literature / textbooks to improve knowledge
    - Evaluate the credibility of learning materials
  - Describe what you have learned: clearly, succinctly
    - Share it with peers / instructors
  - Receive feedback about information seeking skills from
    - Peers / Instructors

## Report Phase

## Individual Self- Directed Learning Exercise

Focused on any  
topic regarding  
autopsy about  
which the  
student wants to  
learn more

Student 2 (Name):

a. **Topic:** Pulmonary Embolism

b. **Analysis:** I chose this topic because blood disorders are present in my family history, I am interested in its pathogenesis, and I wanted to bolster my knowledge on the topic. This patient was admitted to Vidant for treatment of an inferior vena cava thrombus, for which she underwent a thrombectomy with placement of an IVC filter as well as administered anticoagulation therapy which ultimately led to intracranial hemorrhage and death. Pulmonary embolism (PE) typically originates from a preformed thrombus present in the deep venous system of the lower extremities that dislodges and travels through the venous circulation, to the right heart, and occludes the vasculature in the lungs. Most commonly, PEs arise from thromboses in the veins around the gastrocnemius; however rarely can originate in renal, pelvic, or upper-extremity veins. This patient had an identified PE in the left lower lobe of her lung, and as we discovered when reviewing her past medical history, she had multiple risk factors that put her at risk for this complication. Virchow's triad outlines three factors that put a patient at risk for developing thromboses: hypercoagulability, venous stasis, and endothelial injury. One study outlined 12 risk factors for PE, one of the risk factors listed was present in 94% of patients with this complication. Of those risk factors, Uleceia had the following described in the study: central venous instrumentation in the past 3 months, malignancy (especially lung cancer), and possibly immobilization after her procedure. Malignancy has been identified in 17% of cases of venous thromboembolism, bronchogenic carcinoma being the second most commonly associated comorbidity. Sleep disordered breathing is also an identified risk factor for development of a PE, which may have been likely due to her increased central adiposity. Lastly, autopsy results have found that at least 60% of patients who died in the hospital had a PE present, with the diagnosis missed in 70% of those cases. Although the PE complication was not what ultimately led to her demise, it is not surprising that it was found at autopsy given her risk factors.

c. **Reference(s):** 1. Ouellette, D. R., MD, Harrington, A., MD, & Kamangar, N., MD, FACP, FCCP, FCCM. (2020, September 18). Pulmonary Embolism (PE) (970550792 753519924 Z. Mosenifar MD, FACP, FCCP, Ed.). Retrieved October 07, 2020, from <https://emedicine.medscape.com/article/300901-overview>

d. **Credibility of Reference(s):**

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Annie Harrington, MD Fellow in Pulmonary and Critical Care Medicine, Cedars-Sinai Medical Center and is a member of the following medical societies: [Alpha Omega Alpha](#), [American College of Chest Physicians](#) (**co-author**). Nader Kamangar, MD, FACP, FCCP, FCCM Professor of Clinical Medicine, University of California, Los Angeles, David Geffen School of Medicine; Chief, Division of Pulmonary and Critical Care Medicine, Vice-Chair, Department of Medicine, Olive View-UCLA Medical Center (**coauthor**)

Zab Mosenifar, MD, FACP, FCCP Geri and Richard Brawerman Chair in Pulmonary and Critical Care Medicine, Professor and Executive Vice Chairman, Department of Medicine, Medical Director, Women's Guild Lung Institute, Cedars Sinai Medical Center, University of California, Los Angeles, David Geffen School of Medicine (**Chief Editor**)

Student 3 (Name):

a. **Topic:** Metastasis of Lung Cancer

b. **Analysis:** I chose to delve deeper into research pertaining to metastasis of lung cancer. Lung cancer is particularly interesting as it is one of the most common types of cancer and affects a large proportion of the population. If detected early enough, it may save a patient's life. Often times, about 85 percent of the time, patients with lung cancer have an extensive smoking history. Our patient had no smoking history, yet she had cancer which has progressed to Stage III. Although she was receiving chemotherapy and radiation for her tumor, the tumor could have progressed to Stage IV. Patients with lung cancer often do not present until late in their course; usually during Stage IV once metastasis has occurred. Metastasis can occur via two routes, via the blood and via the lymphatic system. Metastasis through the blood vessels typically results in setting in distant locations more rapidly than metastasis through the lymphatics. In primary cancers of the lung, certain tissues are preferentially selected including the brain, liver, bone and adrenal glands in which metastasis can occur. Tumor cells can migrate via single cell or small cell cluster movement. Tumor cells have established mechanisms which allow them to survive in circulation and extravasate to establish a metastatic focus. Extravasation typically occurs in venules due to the decreased blood flow in these areas. In order for tumor cells to survive, they must establish a relationship with the surrounding microenvironment. These cells must secrete vascular endothelial growth factors or communicate with macrophages to release growth factors to induce blood vessel formation. Hypoxia also plays a role in the development and growth of cancer cells. Lack of oxygen typically induces apoptosis. As tumor cells grow larger, some portions of the mass do not receive an adequate oxygen supply. Tumor cells avoid death by upregulating HIF1a which leads to the formation of more blood vessels. Although much research has gone into lung cancer and metastasis, metastasis is a complicated process that involves numerous factors which are not all understood.

c. **Reference(s):**

Popper, H. H. (2016). Progression and metastasis of lung cancer. *Cancer and Metastasis Reviews*, 35(1), 75-91. doi:10.1007/s10555-016-9618-0

d. **Credibility of Reference(s):** Helmut Popper is a Medical Doctor and a professor of Pathology at the Medical University of Graz in Austria. His primary research article on the metastasis of lung cancer was peer-reviewed and published in the *Cancer and Metastasis Reviews* scholarly journal in 2016. The article was written for physicians and those with a scientific background as there are many scientific terms which may make the article difficult to understand by the general public. I accessed the article through restricted login on the Laupus Library website utilizing the PubMed database.

Student 4 (Name):

a. **Topic:** IVC Thrombectomy

b. **Analysis:**

This patient initially came to Vidant Medical Center for treatment of an IVC thrombus, therefore I wanted to learn more about IVC thrombi as well as thrombectomy procedures. This patient's metastatic brain bleed was precipitated by treatment she received in preparation for this procedure. IVC thrombectomy is an invasive procedure that may require a caval venotomy and creation of an arteriovenous fistula. Due to the nature of this procedure and the availability of

## ■ Objectives of Autopsy Experience

### ■ Describe and Demonstrate Goals / Purpose of Autopsy Examination

- When is autopsy useful vs. essential
- Distinguish of hospital and forensic autopsy

### ■ Name and Describe the Purpose and Phases of Autopsy

- Autopsy +/- X-rays (e.g. i... and, etc.)
  - External: Post-mortem (e.g. bruising, lacerations, tattoos, etc.); evaluate intravenous drug use, etc.
  - Internal: ... on non-... abnormalities

### ■ Toxicology Sampling and Demonstration of Toxicology

- Microscopic Examination of Tissues and Organs
  - ... identified in decedent (e.g. pneumonia, asthma scar, chronic myocardial infarct)

### ■ Cause of Death determination

## ■ Can the Objectives be met with a virtual autopsy?

**Objectives Met**

**Able to Conduct All Phases of Autopsy Virtually**

## ■ Technical

### ■ WebEx

- WebEx updated software frequently early in pandemic (competing with Zoom)
- Some **functionality changed from session to session** → challenges optimally sharing primary screen

### ■ Camera (Logitech C930e):

- **Quality: Outstanding** – with auto-focusing and auto-light metering
- **Positioning: Took time to optimize**
  - Adjusted positioning during Autopsies 1-2 to optimize view for remote students
  - External Examination of Body: Stationary
  - Evisceration and Organ Sectioning: Hand-Held; Validation of field on computer or cell phone

### ■ Microphone, Wireless X1 (Revolabs Solo):

- On gown of prosector: Outstanding sound quality with noise cancellation (e.g. for bone saw use)
- However, students could not hear comments by others in the autopsy room
- → **Need second microphone**



## ■ Trial Run Useful but Insufficient

- While a trial run of hardware (camera, microphone using laptop computer) and communication software (WebEx) was essential to initial problem shooting, it **did not uncover all possible impediments to success**

## ■ Control Group: N = 9 Students → Essential

### ■ Incorporation of Control Group was **Critical to Success**

- Participated in first autopsy and microscopy sessions
- Provided **essential feedback** to **fine tune all elements and nuances of the experience**

## ■ Fewer Autopsies by Combining Groups: 6 vs. 12 Total Autopsies

### ■ Combining several groups (normally limited to 6-8 students) allowed for fewer total autopsy sessions without diminishing experience

- More students could participate in particularly good, **high-yield autopsy cases**, mixed **hospital cases** (e.g. cancer patient with hypercoagulability) and **forensic cases** (e.g. IV drug abuse patient with hepatitis C and early cirrhosis, dementia patient who drowned)

- **Virtual Autopsy Pros:**

- Met **COVID-19** restrictions and safeguards during early part of pandemic
- Provided the **convenience** of viewing the session from home
- Provided **close-up view** of all elements of the autopsy ... vs. straining to see when part of a group

- **Virtual Autopsy Cons:**

- Possibility of **breach of patient confidentiality** given the streaming nature of the autopsy

- **Virtual Microscopic Session Pros:**

- Opportunity to view digitized glass slides **without the usual barriers and impediments** of focusing eye-pieces and visualizing the images on a **multi-headed microscope**

- **Virtual Microscopic Session Cons:**

- Pathologists needed to **acquire skill set** for using virtual slide software effectively to demonstrate specific findings vs. using glass slides at microscope

- **Virtual Sessions, Autopsy and Microscopic Session Cons:**

- **Communication barriers** inherent to virtual sessions where students' microphones are muted to optimize sound quality were present
  - Inhibited asking questions: Pathologists and Students
- **Potential for distraction** by social media

- Formal survey of students ongoing
- 2021-2022 Plans
  - Preliminary Indication: **M2 Block 4 instruction** will be largely undertaken **virtually**
  - Autopsy Experience: **Students will be given option:**
    - In-Person
    - Virtual
    - Both

# Acknowledgements



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