Venous Air Embolism Case Study and a Discussion on Clinical Cognitive Bias

Martine Gould BSN, RN
SMU Nurse Anesthesia Resident

Disclaimers

I have no sponsorships, disclaimers, or conflicts of interest

Objectives

- Review a specific laparoscopic gynecology case and the events surrounding an intraoperative code
- Review laparoscopic surgery and common complications seen by anesthesia
- Review venous air emboli and their pathophysiology
- Discuss clinical bias and heuristics in diagnosis and decision making

Case Study- Background and Induction

Background

- 60 year old female scheduled for a laparoscopic hysterectomy for adnexal mass
- Otherwise healthy patient with a remote history of skin cancer
- Pre-op labs and EKG within normal limits
- No anesthetic complications in the past aside from PONV after one surgery

Induction

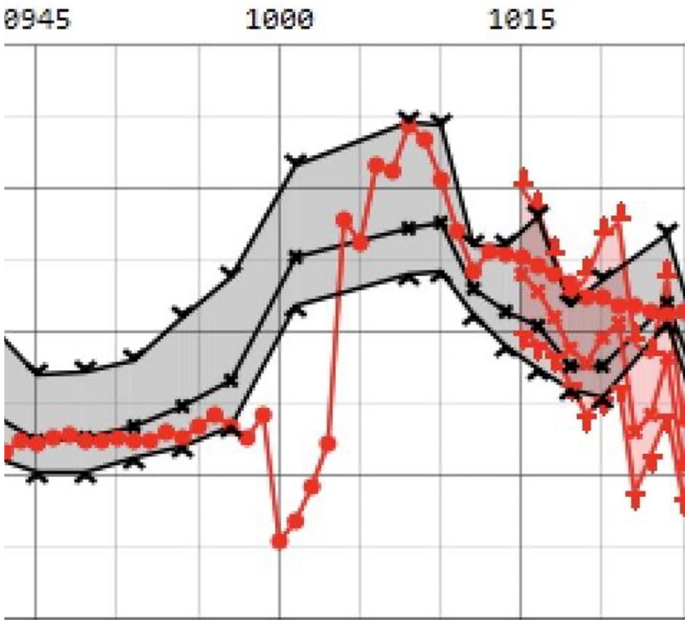
- Uncomplicated induction of anesthesia
- Intubated with oral ETT, OG placed to suction, 18G PIV placed
- Adequate ventilation noted after induction, during positioning and prep

Case Study- Procedure Start and Cardiac Arrest

0959:
First trochar placed after incision, abdomen insufflated with CO2, surgeon notes bleeding on video and suggests converting to open procedure

1000:
Bradycardia began (started in 70s, heart rate dropped progressively to the 20s), 0.4mg atropine given, HR increased to the 60s
EtCO2 dropped from mid-30s to high teens
Called rapid response for immediate anesthesia assistance
Began hand ventilation
Surgeon converted to open procedure

1001:
Anesthesia responded (at least three additional providers)
EtCO2 declined to 8-10 and then eventually to 0 while still hand ventilating with appropriate volumes, ETT was still in correct place
Pulse check confirmed no pulse, CPR and ACLS initiated
Surgeon with open abdomen and hand tamponade on major vessels
Massive transfusion protocol initiated



Case Study- ACLS, Post-Cardiac Arrest, and Transfer

1002-1004:
ACLS continued, pads placed on patient while in PEA
1 gram of epinephrine administered
Additional PIV placements x3
ROSC noted on next pulse check with increased EtCO2 to the teens and then to the 20s

1004-1200:
MTP in place via Belmont and hot line
Arterial line and central line placed
Blood pressure support and medications administered as needed
Vascular surgery in OR for assessment and repair of major vessels, ultimately noting an injury to the IVC resulting in ligation of the vessel
Labs sent, multiple ABGs analyzed

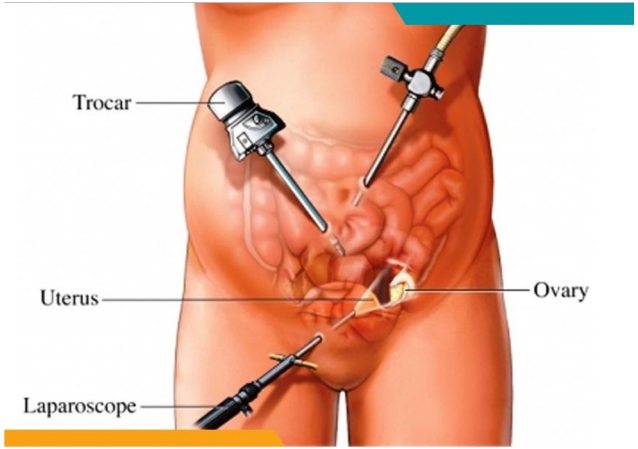
1200-1330:
Patient stabilized on minimal pressors
Transfusions stopped after a total of 6 units of PRBCs, 7 units of FFP, 2 units of platelets
Abdomen closed

1330:
Transfer to ICU intubated on minimal pressor support and a propofol infusion

Following Day:
patient extubated and off pressors, remained in ICU for pulse checks

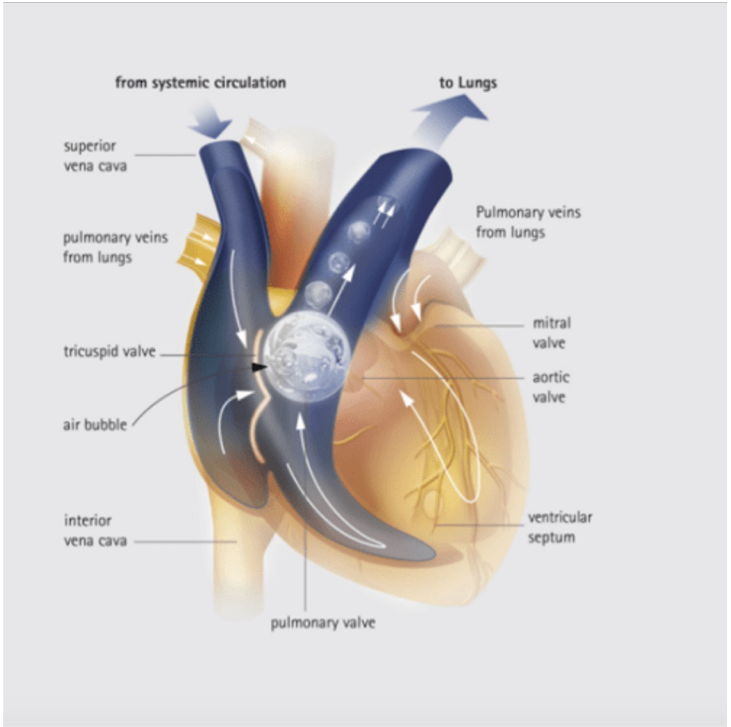
Complications of Laparoscopic Surgery

- **Complications rates** for laparoscopic gynecology surgeries are 0.6-14.6%, 0.02% result in a fatality
  - Up to ½ of complications occur at the time of abdominal access
- **Risk factors for complications**: prior surgery, complexity of surgery, patient comorbidities, surgeon learning curve
- **Most common complications**
  - Vascular injury
  - Bowel and urinary tract injury
  - Surgical site complications
  - Complications related to pneumoperitoneum: pneumothorax, cardiac arrhythmias, CO2 retention, CO2 air embolus



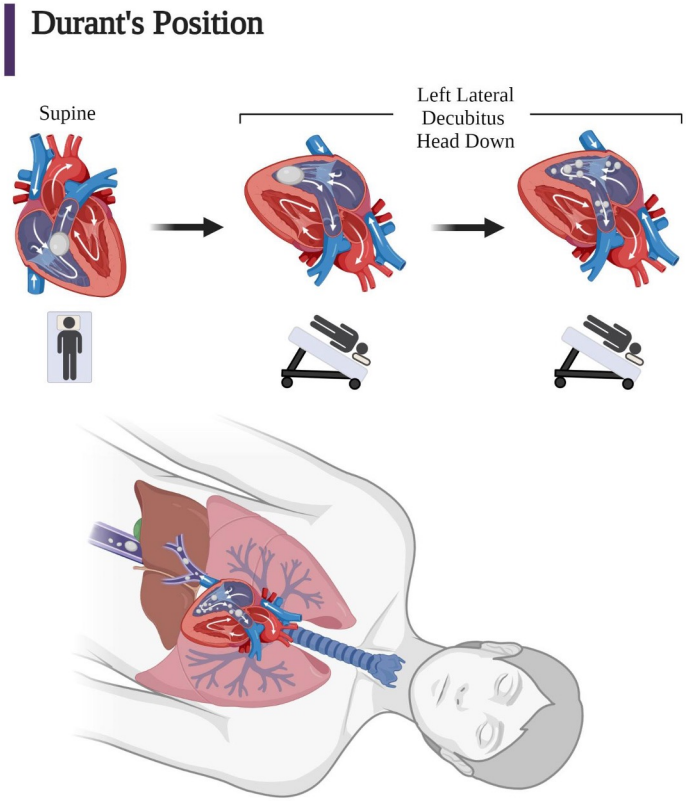
Venous Air Emboli

- **Frequency**: clinically significant emboli occur in 0.001% of laparoscopic surgeries
    - The incidence is likely higher based on TEE studies (6.25-100%)
    - Significant emboli generally related to incorrect placement of veress needle or trochar and insufflation into vessel; mortality is as high as 28%
- **Pathophysiology**: air enters the systemic venous circulation, ultimately traveling to the right ventricle and into pulmonary circulation. VAEs of significant size can block the RVOT, leading to cardiopulmonary collapse.



Venous Air Emboli

- **Clinical Presentation**: sudden decrease in EtCO2 and SpO2, hemodynamic instability, EKG changes, and cardiac arrest
- **Diagnosis**: transesophageal echo is the most sensitive diagnostic tool, precordial doppler (mill wheel murmur), 5-lead EKG, EtCO2
- **Treatment**: dessuflate/stop insufflation, Durant or Trendelenburg position, supportive measures (FiO2 to 100%, hemodynamic support), aspirate via central line, ACLS in the event of cardiac arrest
    - Benefit of CO2: higher blood solubility facilitates rapid resorption into the bloodstream
- **Outcome**: dependent on volume of CO2, rapid identification and treatment



Clinical Bias

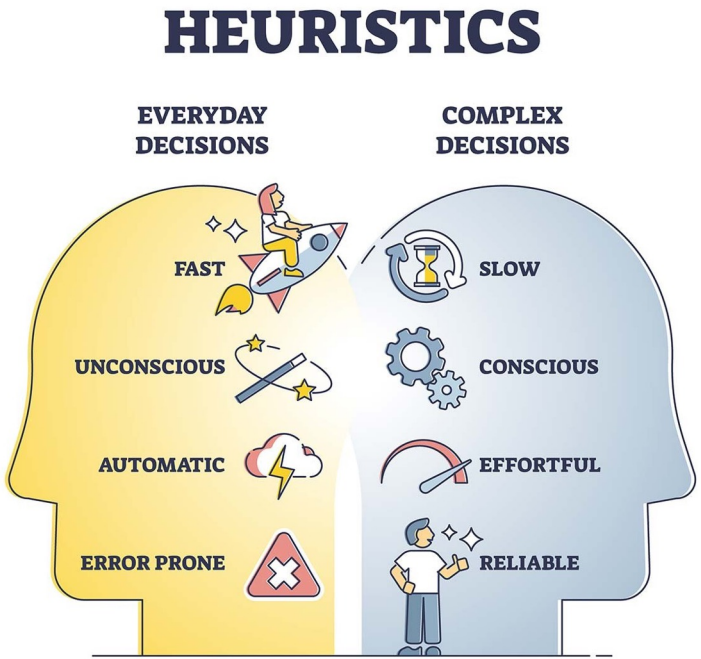
- **Two modes of cognitive processing**
  - System 1: fast, efficient, and intuitive; relies heavily on heuristics and cognitive “shortcuts”
  - System 2: slower, deliberative, and under conscious control
- Neither system is “better”, but they both have their place in diagnostics and medical care
  - Example: driving your own car on familiar roads in good weather vs. driving a rental car in an unfamiliar are in poor weather
  - Experience also plays a role in effectiveness of the two systems
- “inappropriate reliance on heuristics and intuitive thinking in an unfamiliar or complex situation can lead to error and harm” (Balakrishnan & Arjmand, 2018)

Clinical Bias- Dual Process Therapy

- Predictable deviations from rational decision making (systemic biases) that lead to error occur more frequently with type 1 processes
- Repetitive utilization of type 2 may allow for eventual processing in type 1 for a given situation (skill acquisition)
- Biases affecting decision making in type 1 processing can be “overridden” by explicit effort to use type 2 processing (debiasing using metacognition)
- Excessive reliance on type 1 processing can override type 2 processing, leading to unexamined decisions
- Decision makers can move rapidly between type 1 and type 2 processes
- There is a tendency to default to type 1 processing when possible

Clinical Heuristics- Background

- **Definition**: the influence of “short-cuts” in clinical decision making
  - Generally positive, but potential for negative outcomes
- Fast, intuitive, and based on cognitive bias vs analytical and thoroughly assessed



Clinical Heuristics- Types

- **Availability**: likelihood based on prior experiences and similar situations
- **Confirmation**: “tunnel-vision” searching for data to support initial hypothesis
- **Representativeness**: diagnosis based on prevalence in population while ignoring atypical presentation
- **Anchoring**: diagnosis based on one specific piece of information without considering other s/sx
- **Bandwagon**: the tendency to side with the majority, particularly the experienced
- **Overconfidence**: too sure of their conclusion to entertain other options, often based on extensive training but can happen to experienced providers
- **Omission**: delaying treatment for some patients and inadequate response to clinical symptoms
- **Aggregate**: deciding that aggregate data does not apply to certain patients, seen increasingly in regulated and standardized healthcare

Heuristics- Countering the Negative Effects

- **Decreasing risks of inaccuracy**:
  - increasing expertise
  - developing clinical reasoning
  - seeking assistance of peers and available tools
- **Essential behaviors and attitudes**:
  - deliberate induction and deduction
  - a willingness to test
  - attitude to openness
  - metareasoning

References

Balakrishnan, K., & Arjmand, E. M. (2019). The impact of cognitive and implicit bias on patient safety and quality. *Otolaryngologic Clinics of North America*, *52*(1), 35–46. https://doi.org/10.1016/j.otc.2018.08.016

Kelley, M. A., Mandel, J., & Finlay, G. (2023, July 7). Air embolism. https://www-uptodate-com.samuelmerritt.idm.oclc.org/contents/air-embolism?search=venous+air+embolism&source=search_result&selectedTitle=1~56&usage_type=default&display_rank=1

Khadilkar, S. V., & Khadilkar, S. S. (2020). Bias in clinical practice. *The Journal of Obstetrics and Gynecology of India*, *70*(1), 1–5. https://doi.org/10.1007/s13224-019-01304-5

Orhurhu, V., Gao, C., & Ku, C. (2022, November 28). *Carbon dioxide embolism*. StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK539885/

Pryor, A., Mann, W., & Bates, A. (2023, June 14). Complications of laparoscopic surgery. https://www-uptodate-com.samuelmerritt.idm.oclc.org/contents/complications-of-laparoscopic-surgery?search=laparoscopic+surgery+complications&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

Whelehan, D. F., Conlon, K. C., & Ridgway, P. F. (2020). Medicine and heuristics: Cognitive biases and medical decision-making. *Irish Journal of Medical Science (1971 -)*, *189*(4), 1477–1484. https://doi.org/10.1007/s11845-020-02235-1