

## Simulation Patient Design (December 2022) Case of Splenic Artery Aneurysm Rupture

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### Introduction

Splenic artery aneurysm (SAA) is a rare and insidious occurrence, albeit with potential to cause massive blood loss. The visceral artery most prone to true aneurysm formation is the splenic artery, accounting for approximately 60% of all visceral aneurysms.<sup>1,2</sup> Due to its rare occurrence, it may be misdiagnosed and/or mismanaged, especially in an obstetric context, with potentially devastating outcomes. Due to their frequently asymptomatic nature, the prevalence of true splenic artery aneurysms has been unclear.<sup>3,4</sup> The clearest estimate may be gleaned from 3,600 nonselective angiograms, showing an incidental finding of splenic artery aneurysms in 0.78% of the patients.<sup>5</sup>

Specific to splenic artery aneurysms is a 4:1 female-to-male predominance.<sup>1</sup> Interestingly, these aneurysms occur most commonly in women with multiple pregnancies, as shown by the Mayo Clinic experience, with mean number of pregnancies at 3.5.<sup>6</sup> Pregnancy as a risk factor likely relates to structural weakening from the hormonal changes and increased wall stress from portal congestion. The propensity for aneurysm formation in these patients is likely from a combination of medial hyperplasia and elastic lamina fragmentation.<sup>5</sup> Other associated conditions include medial fibrodysplasia, Idiopathic Thrombocytopenic Purpura, hematologic malignancies,  $\alpha$ -1 antitrypsin deficiency, and systemic hypertension.<sup>6</sup> For patients who present with acute symptoms referable to their aneurysm, a majority demonstrate frank rupture, characterized by abdominal/chest pain followed 6 to 96 hours later by hemodynamic instability.<sup>7</sup> The delay in onset of rapid blood loss is thought secondary to the “double rupture phenomenon,” resulting from initial tamponade of the bleeding within the lesser omental sac followed later by frank intraperitoneal hemorrhage with potentially lethal consequences.<sup>6</sup>

Treatment wise, long-standing dogma dictates that unruptured aneurysms greater than 2.0 cm in good-risk patients be repaired.<sup>8</sup> A more recent approach by Stanley et al<sup>9</sup> states that predicated on a 2% rupture risk and a 25% mortality risk of patients presenting with acute rupture, they recommend repair when elective intervention carries a mortality less than a 0.5%. Of note, maternal mortality during SAA rupture in pregnant women maybe 50-70% especially in 3rd trimester and fetal mortality maybe up to 95%, thus establishing early diagnosis could be lifesaving for mother and baby.<sup>10</sup> Treatment is contingent on presentation - an electively discovered SAA may be managed with endovascular or surgical methods whereas a ruptured SAA is going to very likely need emergent surgical exploration +/- vascular embolization and massive transfusion unless caught early. In pregnancy a ruptured SAA will almost assuredly require Cesarean section Laparotomy with or without Splenectomy / Spleno-Pancreatectomy and concurrent Splenic artery Ligation.<sup>11</sup>

**Educational Rationale:** To teach team skills in managing Splenic Artery Rupture

**Target Audiences:** Nursing, OB, Anesthesiology, OR personnel

**Learning Objectives:** As per Accreditation Council for Graduate Medical Education (ACGME) Core Competencies

Upon completion of this simulation (including the debrief) learners will be able to:

- *Medical knowledge:* Recognize clinical signs and symptoms, and describe treatment options for Splenic Artery Aneurysm (SAA) Rupture during pregnancy

- *Patient care*: Understand risk factors that predispose patients to SAA Rupture in order to prioritize management strategies
- *Practice-based learning and improvement*: Identify the setting, equipment, and medications necessary to manage an obstetric patient who develops SAA Rupture including sequelae such as uncontrolled massive obstetric hemorrhage, shock, and coagulopathy
- *Interpersonal and communication skills*: Assign roles such as a team leader who will coordinate the team to provide optimal care to the patient and maintain ongoing communication about the evolution of the clinical situation among the providers
- *Professionalism*: Understand and demonstrate mutual respect for team members
- *Systems-based practice*: Ensure all resuscitation equipment, medications, and protocols are readily identifiable and available in delivery locations including airway management, anesthesia induction/emergency medications, vascular access, massive transfusion; include identification of barriers within the hospital system such as staffing (including non-OB staff like General / trauma surgery, Interventional Radiology), medications and equipment/protocols

#### **Questions to ask after the scenario:**

1. What was the differential diagnosis initially?
2. What are the management considerations for splenic artery aneurysm rupture?
3. Was the emergency response appropriately activated?
4. Did each member of the response team have well-defined roles?
5. Were the next steps for management clearly outlined by the care team?
6. Were there any barriers or system issues identified when caring for the patient?
7. Were opportunities for improvement(s) identified during the scenario?

#### **Assessment Instruments:**

1. Learner Knowledge Assessment form (Appendix 1)
2. Simulation Activity Evaluation form (Appendix 2)

#### **Equipment Needed and Set-up:**

##### **In-situ set-up**

1. Mannequin set-up in L&D triage room using standard admission set-up
2. One 18G IV setup with fluids attached and multiple access ports on the line
3. Standard monitors: Pulse oximetry, blood pressure cuff, and EKG leads available.
4. L&D OR set up for emergent cesarean section in preparation for transfer to the OR.

#### **Simulation Scenario Set-up:**

##### **The case**

Mrs. Abby Bleeter is a 28-year-old G3P2 with a gestational age estimated at 30 weeks. She presents to the Labor and Delivery Triage with complaints of vague but steadily worsening abdominal pain following moving a food container while cooking. On evaluation, she is found to be mildly hypotensive (104/60 mm Hg) and tachycardic (110 bpm). The exam also reveals upper abdominal tenderness. Labs are sent and a tentative diagnosis of abruptio placentae/uterine rupture is entertained with pertinent management initiated. Other history is unremarkable except for a history of ITP.

## Simulation Pre-brief

- Read the scenario and instruct team members on their role during the simulation
- The learners take their places inside and outside of the labor room
- Initial confederate can play the role of patient's partner in L&D triage. Additional confederate needed in the OR to play the role of the general surgeon called in during the cesarean section.

## Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in OB triage complaining of continuous, epigastric/upper abdominal pain.	Patient awake and appropriately responsive in moderate distress.  Heart Rate: 110 bpm BP: 104/60 mm Hg SpO <sub>2</sub> : 96% (room air) Temp: 36.9°	Initial patient evaluation and exam by L&D nurse: <ul style="list-style-type: none"> <li>- Calls OB team to assess the patient</li> <li>- Places an 18G IV</li> <li>- OB team orders labs (CBC, T/S, CMP, coagulation profile, UA)</li> </ul>			
Patient complains of worsening abdominal pain. Fetal heart rate tracing shows episodic late decelerations.	Patient exhibits frank pallor. Abdominal exam reveals significant tenderness and guarding. Patient c/o nausea and dizziness.  Heart Rate: 128 bpm, sinus tachycardia BP: 89/52 mm Hg SpO <sub>2</sub> : 95% (room air)  Pertinent Admission Lab Results Hgb: 7.9 g/dL Platelets: 110 x 10 <sup>9</sup> /L Fibrinogen: 180 mg/dL	OB team initiates management with tentative diagnosis of abruptio placentae vs. uterine rupture. <ul style="list-style-type: none"> <li>- IV fluid bolus</li> <li>- Anesthesia team informed</li> <li>- Blood bank informed</li> <li>- Second peripheral IV line placed</li> <li>- Transfer to OR and prepare for expedient Cesarean delivery (CD)</li> </ul>			
Patient is moved to OR.  Prolonged fetal heart rate deceleration to 60 bpm once in OR.	Patient unable to position for spinal due to intense abdominal pain.  Heart Rate: 137 bpm, sinus tachycardia BP: 89/52 mm Hg SpO <sub>2</sub> : 93% (room air)	Emergent GETA induced using standard RSI with lidocaine, propofol, and succinylcholine and cricoid pressure <ul style="list-style-type: none"> <li>- Antibiotics given</li> <li>- OG tube placed</li> <li>- Fentanyl and midazolam given</li> <li>- Oxytocin prepared</li> </ul>			
Patient in OR s/p emergent GETA. Pfannenstiel incision for CD made.	Patient extremely pale and diaphoretic.  Heart Rate: 150 bpm BP: 74/45 mm Hg	-Stat page to General Surgery -Oxytocin started after delivery <ul style="list-style-type: none"> <li>- Confirm adequacy of uterine tone with obstetricians.</li> </ul> -Emergent additional large bore			

<p>Pre-term viable infant delivered with APGARS of 2/6/8.</p>	<p>SpO<sub>2</sub>: 93% (FIO<sub>2</sub> 1.0)</p> <p>OB states uterus/placenta, tubes, and ovaries as normal and indicates an extrauterine source of bleeding.</p>	<p>vascular access obtained</p> <ul style="list-style-type: none"> <li>- Consider CVL vs RIC line placement</li> <li>- Arterial line placed and arterial blood gas sent</li> <li>- Rapid infuser set up to deliver massive transfusion</li> <li>- Fast blood ordered. Transfuse 2 units when available</li> <li>- Vasopressor boluses and infusion as indicated. Start infusion of phenylephrine.</li> </ul>			
<p>General surgeon points to splenic artery aneurysm rupture as the source of the bleeding.</p>	<p>QBL= 3.5 L per L&amp;D nurse</p> <p>Heart Rate: 165 bpm</p> <p>BP: 70/50 mm Hg</p> <p>SpO<sub>2</sub>: 94% (FIO<sub>2</sub> 1.0)</p> <p>Results of repeat labs in OR after 1 unit of prbc:</p> <p>Hgb: 5.4 g/dL</p> <p>Platelets: 70 x 10<sup>9</sup>/L</p> <p>Fibrinogen: 90 mg/dL</p> <p>INR: 1.7</p>	<ul style="list-style-type: none"> <li>-Continue resuscitation with packed red blood cells. Prepare and transfuse additional 2 units s/p Hgb of 5.4 g/dL.</li> <li>-Call for 2 units of FFP, 1 unit cryoprecipitate, and 1 unit platelets.</li> <li>-Consider sending ROTEM/TEG (based on availability), platelet count, and fibrinogen level.</li> <li>-Vasopressors continued as indicated.</li> <li>-Active warming continued.</li> <li>-Replete Calcium.</li> </ul>			
<p>Surgeon secures relative hemostasis but still feels there is "oozing".</p>	<p>QBL= 4.3 L per L&amp;D nurse</p> <p>After 2-3 units of prbc:</p> <p>Heart Rate: 150 bpm</p> <p>BP: 86/62 mm Hg</p> <p>SpO<sub>2</sub>: 96% (FIO<sub>2</sub> 1.0)</p>	<ul style="list-style-type: none"> <li>-Interventional radiology notified to determine if patient is candidate for embolization.</li> <li>-Surgeon makes the decision to place abdominal packing and Abthera in effort to provide tamponade effect.</li> <li>-Planned return for staged removal of abdominal packing/re-exploration for definitive repair.</li> <li>-Inform ICU team of impending transfer of critical patient.</li> </ul>			
<p>Patient is prepared for ICU transfer</p>	<p>Heart Rate: 142 bpm</p> <p>BP: 94/60 mm Hg</p> <p>SpO<sub>2</sub>: 98% (Intubated)</p>	<ul style="list-style-type: none"> <li>-Vasopressor infusion and resuscitation continued.</li> <li>-Patient on phenylephrine infusion with consideration of adding second vasopressor if needed</li> <li>-Patient transferred to ICU, intubated and on propofol or dexmedetomidine infusion for sedation.</li> <li>-Family updated on patient's condition and ICU transfer.</li> </ul>			

## Appendix 1

### Learner Knowledge Assessment Labor and Delivery Multidisciplinary Team Simulation

Name of simulation: \_\_\_\_\_

Date: \_\_\_\_\_

OB Nursing Anes

Each item has two components. The “Before the simulation” column (left side) examines your perspective at the beginning of the simulation. The “End of Simulation” column (right side) is to evaluate your perspective at the completion of the simulation.

#### 1. How would you rate your knowledge of risk factors for Splenic Artery Rupture?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none				Knowledgeable			Little/none				Knowledgeable		

#### 2. How would you rate your knowledge of differential diagnosis of Splenic Artery Rupture ?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none				Knowledgeable			Little/none				Knowledgeable		

#### 3. How would you rate your knowledge of signs and symptoms of Splenic Artery Rupture?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none				Knowledgeable			Little/none				Knowledgeable		

#### 4. How would you rate your knowledge of delivery planning for Splenic Artery Rupture?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none				Knowledgeable			Little/none				Knowledgeable		

#### 5. How would you rate your overall confidence when confronted with Splenic Artery Rupture causing massive obstetric hemorrhage and coagulopathy?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none				Knowledgeable			Little/none				Knowledgeable		

## Appendix 2

### Simulation Activity Evaluation

DATE OF SIMULATION: \_\_\_\_\_

OCCUPATION: Consultant PG Yr 1 2 3 4    STUDENT    NURSE    MIDWIFE    OTHER

SPECIALTY: \_\_\_\_\_ YEARS IN PRACTICE: \_\_\_\_\_

Please rate the following aspects of this training program using the scale listed below:

1 = Poor      2 = Suboptimal      3 = Adequate      4 = Good      5 = Excellent

Use "N/A" if you did not experience or otherwise cannot rate an item

#### **INTRODUCTORY MATERIALS**

Orientation to the simulator	1	2	3	4	5	N/A
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#### **PHYSICAL SPACE**

Realism of the simulator space	1	2	3	4	5	N/A
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#### **EQUIPMENT**

Satisfaction with the mannequin	1	2	3	4	5	N/A
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#### **SCENARIOS**

Realism of the scenarios	1	2	3	4	5	N/A
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Ability of the scenarios to test technical skills	1	2	3	4	5	N/A
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Ability of the scenarios to test behavioral skills	1	2	3	4	5	N/A
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Overall quality of the debriefings	1	2	3	4	5	N/A
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#### **DID YOU FIND THIS USEFUL?**

To improve your clinical practice?	1	2	3	4	5	N/A
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To improve your teamwork skills?	1	2	3	4	5	N/A
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To improve your VERBAL communication?	1	2	3	4	5	N/A
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To improve your NONVERBAL communication?	1	2	3	4	5	N/A
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#### **FACULTY**

Quality of instructors	1	2	3	4	5	N/A
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Simulation as a teaching method	1	2	3	4	5	N/A
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#### **COMMENTS/SUGGESTIONS:**

## References:

1. Abbas MA, Stone WM, Fowl RJ, et al: Splenic artery aneurysms: Two decades experience at Mayo clinic. *Ann Vasc Surg* 16:442-449, 2002
2. Stanley JC, Thompson NW, Fry WJ: Splanchnic artery aneurysms. *Arch Surg* 101:689-697, 1970
3. Moore SW, Guida PM, Schumacher HW: Splenic artery aneurysm. *Bull Soc Int Chir* 29:210-218, 1970
4. Bedford PD, Lodge B: Aneurysm of the splenic artery. *Gut* 1:312-320, 1960
5. Stanley JC, Fry WJ: Pathogenesis and clinical significance of splenic artery aneurysms. *Surgery* 76:898-909, 1974
6. Berceci, Scott A. "Hepatic and Splenic Artery Aneurysms." *Seminars in Vascular Surgery*, vol. 18, no. 4, 2005, pp. 196–201.
7. de Perrot M, Buhler L, Deleaval J, et al: Management of true aneurysms of the splenic artery. *Am J Surg* 175:466-468, 1998
8. Trastek VF, Pairolero PC, Joyce JW, et al: Splenic artery aneurysms. *Surgery* 91:694-699, 1982
9. Stanley JC, Wakefield, TW, Graham LM, et al: Clinical importance and management of splanchnic aneurysms. *J Vasc Surg* 3:836-840, 1985
10. Gourgiotis, S, et al. "Spontaneous Rupture of Splenic Artery Aneurysm in Pregnancy: A Case Report." *Advances in Medical Sciences*, vol. 53, no. 2, 2008, pp. 341–3., <https://doi.org/10.2478/v10039-008-0016-x>.
11. M. de Perrot, L. Buhler, J. Deleaval, B. Borisch, G. Mentha, P. Morel: Management of true aneurysms of the splenic artery *Am J Surg*, 175 (1998), pp. 466-468