Supplementary Material 1

Study Information Sheet for Survey Participants

Study Title:
Combining Point of Care Ultrasound and Medical Simulation to Provide Medical Students a Systematic Approach to Dyspnea and Volume Status Assessment

Principal Investigator:
Helen M. Shields, M.D.

The Harvard Medical School Internal Medicine Sub-Internship Clerkship at Brigham and Women's Hospital is implementing the addition of a Simulation/Point of Care Ultrasound workshop from January to September 2023. This is a quality improvement medical education research study aimed at evaluating the effectiveness in helping you understand and diagnose the physiology of shortness of breath and your skills in volume status assessment. The purpose of this study is to determine if there are practical benefits to third year medical students to utilizing simulation in combination with bedside ultrasonography to improve the diagnosis of patients with dyspnea and their volume status assessment.

This study is being designed and implemented as part of the Brigham and Women's Medical Education Fellowship.

You are being identified as a potential study participant because you will be enrolled in the Internal Medicine Sub-Internship Clerkship between January and September 2023. Your participation is voluntary and will take place in the form of completion of a set of quality improvement study surveys and an additional session in hands-on ultrasound practice. We anticipate that 50 participants will complete these surveys and additional ultrasound training. Your survey responses will be anonymous, and no identifying data will be collected. The pre-intervention and post-intervention paper surveys and will each take no more than ten minutes to complete. You may decline participation or discontinue participation at any time with no consequences. There will be no remuneration for participation.

These survey findings will remain anonymous. We intend to present and publish these findings through reporting data only in the aggregate. Your responses are confidential, and responses cannot be traced back to any individuals. Data will not be included in any formal competency evaluation, influence your clerkship evaluations, submitted to medical student leadership, or included in your medical school portfolio. There are no foreseeable risks and discomforts anticipated by your completion of study survey material aside from potential discomfort from not knowing answers to particular questions.

This study is a quality improvement study which focuses on improving your assessment of volume status through jugular venous pressure examination and ultrasound.

If you have any questions or concerns regarding the study, please contact the Principal Investigator, Dr. Helen M. Shields at hmshields@bwh.harvard.edu or 617-678-6077.

If you would like to speak to someone not involved in the research about your rights as a research subject, or any concerns or complaints you may have about the research, contact the Mass General Brigham Human Research Committee at (857) 282-1900.

Sincerely,
Helen M. Shields, MD
hmshields@bwh.harvard.edu
Cell: 617-678-6077

Supplementary Material 2
Knowledge and Confidence Pre-Survey

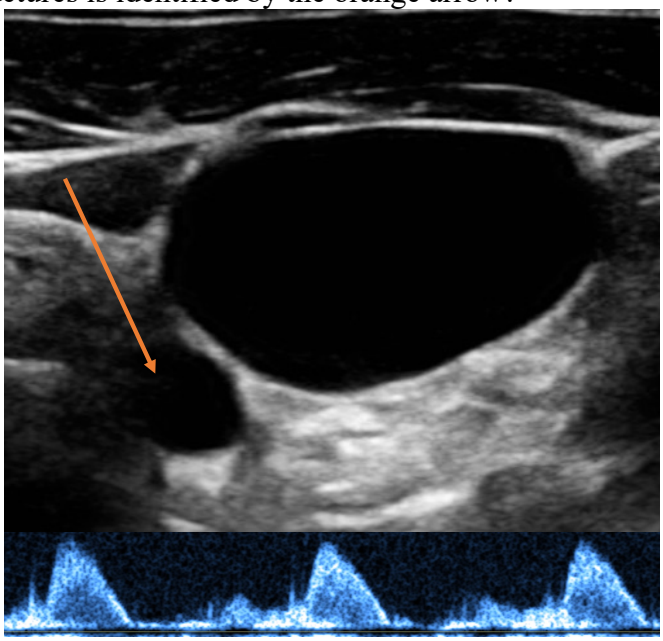
Dear Participant:

Thank you for participating in our STRATUS Dyspnea Workshop. Your feedback is incredibly valuable to us as we continue to improve this educational experience. Survey completion is entirely voluntary. Your responses will remain anonymous, and your opinions are confidential. Participation is voluntary and you can opt out at any time. Non-participation will have no bearing on your standing within the medical school or in the sub-internship clerkship.

Completion of this survey will be taken as your consent to participate in this quality improvement study.

1) Which of the following physical examination signs are consistent with volume overload?
   a) Lower Extremity Edema
   b) Elevated Jugular Venous Pressure
   c) Five-pound weight gain
   d) Basilar Crackles on pulmonary auscultation
   e) All of the above

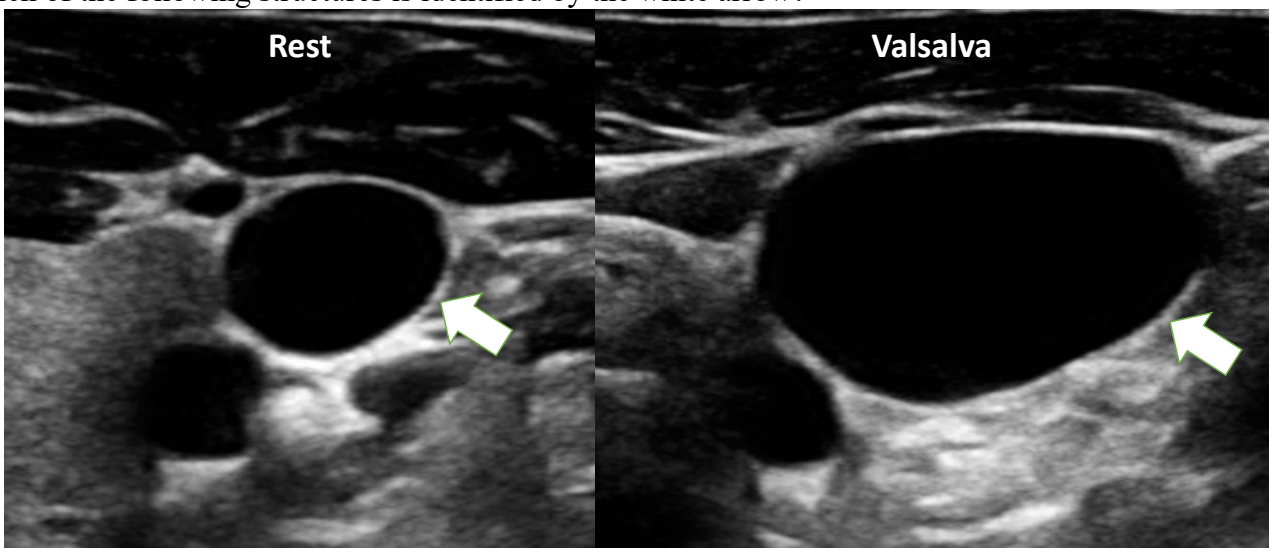
2) Which of the following structures is identified by the orange arrow?



   a) Carotid Artery
   b) Internal Jugular Vein
   c) Vagus Nerve
   d) Sternocleidomastoid Muscle
   e) Thyroid Gland

3) You identify the jugular vein meniscus at 4 centimeters above the sternal angle on a patient lying at a 30-degree angle. What is their approximate central venous pressure?
   a) 4 cm H2O
   b) 6 cm H2O
   c) 9 cm H2O
   d) Not enough information

4) Which of the following structures is identified by the white arrow?



a) Carotid Artery
b) Internal Jugular Vein
c) Vagus Nerve
d) Sternocleidomastoid Muscle
e) Thyroid Gland

5) Each of the following are ultrasound features of jugular vein except:
a) Compressibility with manual pressure
b) Round, thick muscular wall
c) Continuous, low amplitude doppler waveform
d) Increase in diameter with Valsalva maneuver or when lying flat

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6) I feel confident in my understanding of the different etiologies leading to dyspnea
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

7) I feel confident in conducting a systematic clinical examination of a patient with dyspnea
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

8) I feel confident in identifying the jugular venous pressure using my physical examination without ultrasound
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

9) I feel confident recognizing ultrasound images of the jugular vein
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

10) I feel confident in obtaining images of the jugular vein using bedside ultrasound
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

11) I feel confident using Color and Pulse Wave Doppler to distinguish the jugular vein from the carotid artery
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

12) Jugular vein ultrasound adds confidence to my physical examination of a patient's jugular venous pressure
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

13) Could you identify a patient for whom jugular venous pressure ultrasound could be helpful?
Yes *No*

Supplementary Material 3
Knowledge and Confidence Post-Survey

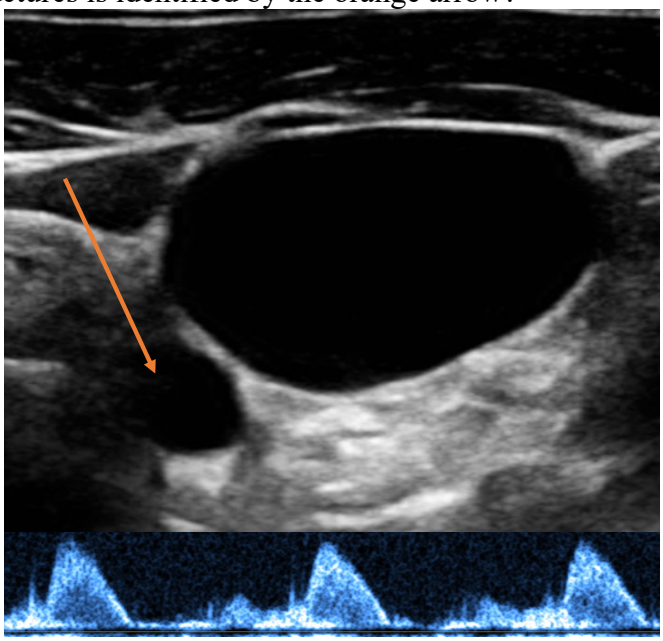
Dear Participant:

Thank you for participating in our STRATUS Dyspnea Workshop. Your feedback is incredibly valuable to us as we continue to improve this educational experience. Survey completion is entirely voluntary. Your responses will remain anonymous, and your opinions are confidential. Participation is voluntary and you can opt out at any time. Non-participation will have no bearing on your standing within the medical school or in the sub-internship clerkship.

Completion of this survey will be taken as your consent to participate in this quality improvement study.

1) Which of the following physical examination signs are consistent with volume overload?
   f) Lower Extremity Edema
   g) Elevated Jugular Venous Pressure
   h) Five-pound weight gain
   i) Basilar Crackles on pulmonary auscultation
   j) All of the above

2) Which of the following structures is identified by the orange arrow?



   f) Carotid Artery
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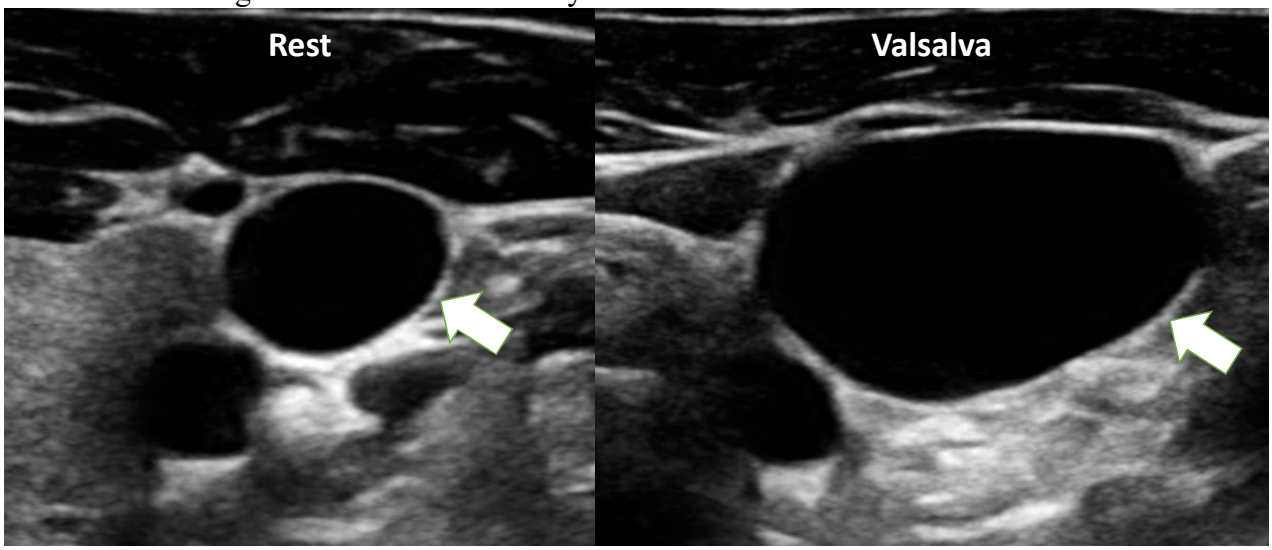
   i) Sternocleidomastoid Muscle
   j) Thyroid Gland

3) You identify the jugular vein meniscus at 4 centimeters above the sternal angle on a patient lying at a 30-degree angle. What is their approximate central venous pressure?
   e) 4 cm H2O
   f) 6 cm H2O
   g) 9 cm H2O
   h) Not enough information

4) Which of the following structures is identified by the white arrow?



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Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

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Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

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12) Jugular vein ultrasound adds confidence to my physical examination of a patient's jugular venous pressure
Strongly Agree *Agree* *Neither agree nor disagree* *Disagree* *Strongly Disagree*

13) Could you identify a patient for whom jugular venous pressure ultrasound could be helpful?
Yes *No*

STRATUS Dyspnea Workshop Evaluation Survey

Dear Participant:

Thank you for participating in our STRATUS Dyspnea Workshop. Your feedback is incredibly valuable to us as we continue to improve this educational experience. Survey completion is entirely voluntary. Your responses will remain anonymous, and your opinions are confidential. Participation is voluntary and you can opt out at any time. Non-participation will have no bearing on your standing within the medical school or in the sub-internship clerkship.

Completion of this survey will be taken as your consent to participate in this quality improvement study.

1) Please rate your overall experience during the STRATUS Workshop
Excellent *Very Good* *Good* *Fair* *Poor*

2) The STRATUS Workshop was a helpful review of the pathophysiology and differential diagnosis of dyspnea
Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*

3) Please rate the Acute Myocardial Infarction Case Simulation at the STRATUS Workshop
Excellent *Very Good* *Good* *Fair* *Poor*

4) Please rate the STRATUS and in-hospital hands-on jugular venous pressure ultrasound practice
Excellent *Very Good* *Good* *Fair* *Poor*

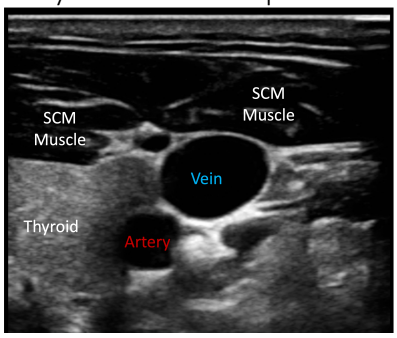
5) If offered, I would attend a similar simulation and ultrasound workshop in the future
Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*

6) Please provide any feedback you have regarding the STRATUS Workshop (optional free text):

Supplementary Material 4 – Estimating Jugular Venous Pressure Using Point of Care Ultrasound

Identifying the Vasculature:

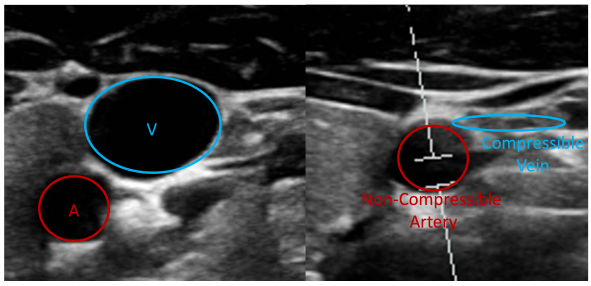
- Orient the **Vascular Probe** using the indicator marker toward the patient's right shoulder
- The Internal Jugular Vein and Carotid Artery are located deep to the Sternocleidomastoid Muscle



- They can be found in an anatomic triangle formed by the two heads of the sternocleidomastoid muscle and the medial portion of the clavicle
- Bring the vessels to the center of the image and optimize the depth

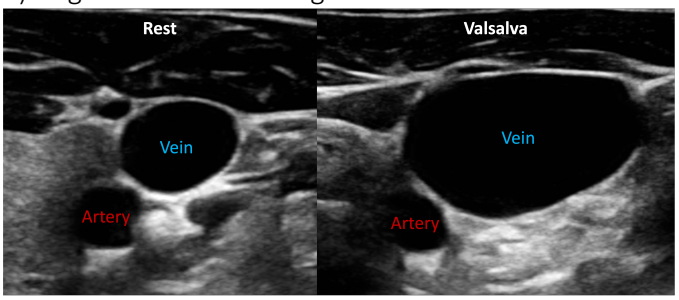
Distinguishing the Vein from the Artery:

1) Check Compressibility



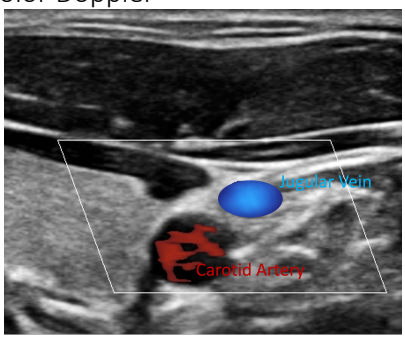
- The Carotid Artery is a thick-walled, pulsatile vessel that is non-compressible to pressure
- In contrast, the Internal Jugular Vein has thinner walls and is easily compressible
- In rare circumstances, the vein may be non-compressible if it contains thrombus

2) Augment Venous Filling



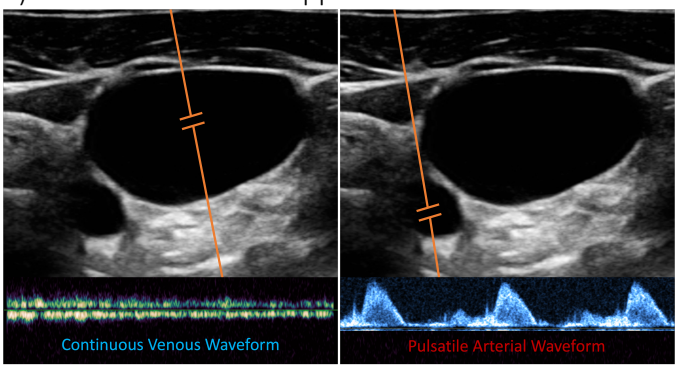
- **The Valsalva maneuver** or **flat positioning** of the patient from an upright position will augment the size of a small jugular vein

3) Utilize Color Doppler



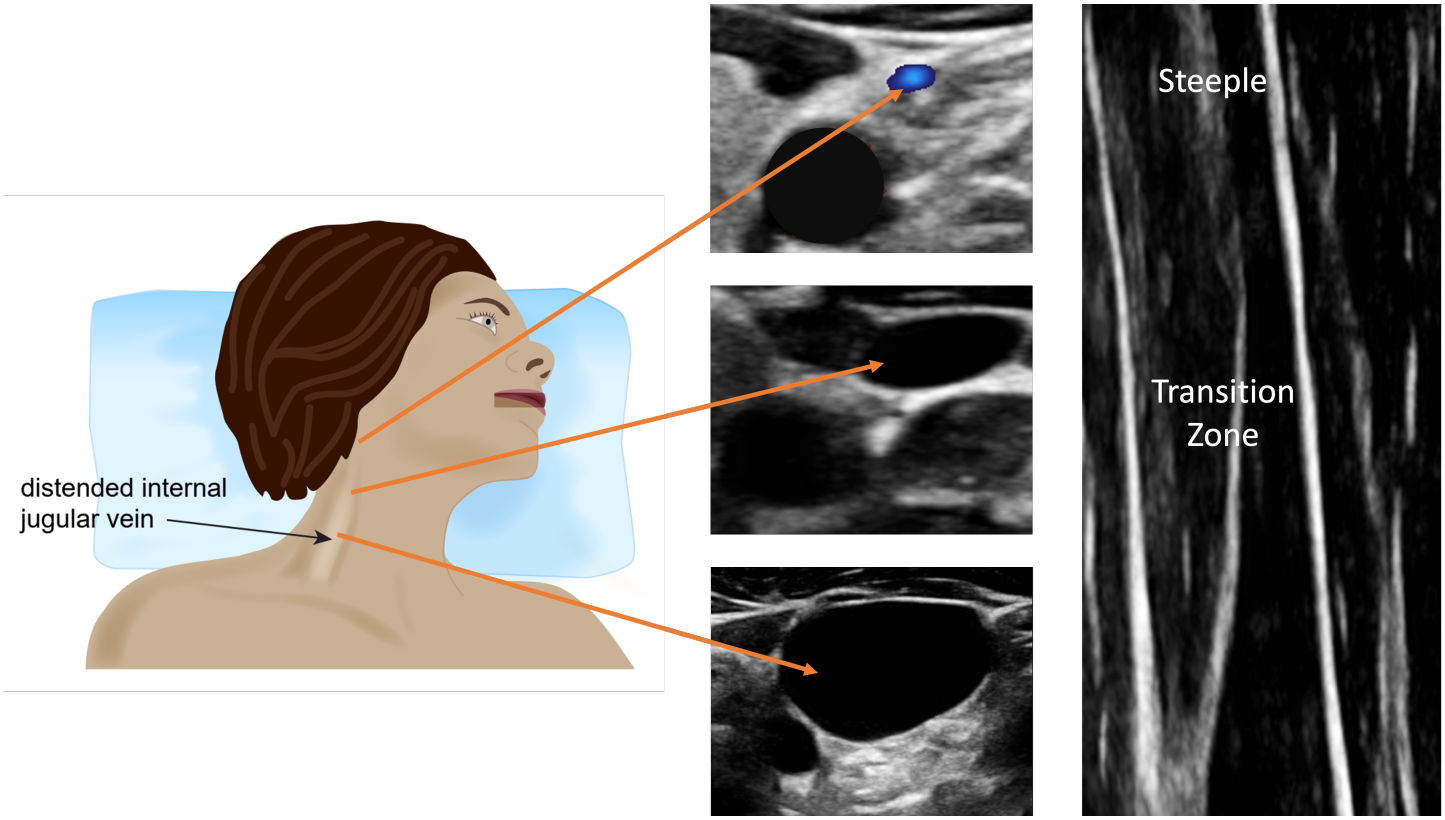
- Using **color doppler**:
  - The artery has pulsatile, arterial flow
  - In contrast, the jugular vein will have a continuous flow pattern

4) Utilize Pulse Wave Doppler



- **Pulse wave doppler** can distinguish an arterial from venous waveform
- In certain circumstances (severe volume overload, tricuspid regurgitation), the venous wave form may have more pulsatility and variation than expected. However, the degree of pulsatility and flow velocities will be lower than the carotid artery

Estimating the Jugular Venous Pressure – Semi-Quantitative



- Lay the patient in bed with their head elevated at a 30-to-45-degree angle
- Scan vertically up the neck until a **transition zone** is seen in the jugular vein from a large vessel to a small, collapsed vessel (middle images)
- This transition zone is the height of the jugular venous pressure column. The location of the transition zone can be confirmed in a longitudinal view (far right images)
- Use this point to measure the vertical height of the Jugular Venous Pressure from the sternal angle
- This vertical height in cm plus 5 cm (the average distance of the sternal angle from the right atrium) is the estimated Jugular Venous Pressure

Supplementary Material 5

Study Information Sheet for Ultrasound Patient Volunteers

Study Title:
Combining Point of Care Ultrasound and Medical Simulation to Provide Medical Students a Systematic Approach to Acute Dyspnea and Volume Status Assessment

Principal Investigator:
Helen M. Shields, M.D.

The Harvard Medical School Internal Medicine Sub-Internship Clerkship at Brigham and Women's Hospital is implementing the addition of a Simulation/Point of Care Ultrasound workshop from January to September 2023. This is a quality improvement medical education research study aimed at evaluating the effectiveness of this workshop to provide medical students a systematic approach to shortness of breath, a common clinical scenario they will encounter. The purpose of this study is to determine if there are practical benefits to third year medical students to utilizing simulation in combination with bedside ultrasonography to assess volume status to improve the diagnosis of patients with shortness of breath.

This study is being designed and implemented as part of the Brigham and Women's Medical Education Fellowship.

As a patient at the Brigham and Women's Hospital, you have been identified as a potential volunteer study participant in this quality improvement study. If you agree to participate in this study, you are providing permission to participate in an examination using ultrasound. This examination will be performed by a medical student being directly supervised by a licensed physician investigator of the study staff. This examination includes a visual examination of your neck to assess the venous structures in the area, an examination of your lungs with a stethoscope, and an examination of your legs and lower back to look for swelling. Additionally at the bedside, an ultrasound examination of one side of your neck will be performed. We anticipate that the focused physical examination and ultrasound examination at the bedside will take no more than thirty (30) minutes total to complete.

There will be no renumeration for participation.

Your participation in this study is entirely voluntary, and you may decline to participate or decide to discontinue participation at any time. Participation will not affect your clinical care, and the licensed study staff are not involved in your ongoing clinical care. Your protected health information will remain protected in compliance with the Health Insurance Portability and Accountability Act (HIPAA). Any images obtained in these Point of Care Ultrasound examinations will occur under the supervision of a licensed physician investigator of the study staff, and the images will be evaluated at the time of acquisition. These images will not be saved, and you will not be billed for Point-Of-Care images. The study faculty will ensure your protected health information is protected by compliance with Health Insurance Portability and Accountability Act (HIPAA) protections.

We are required by the Health Insurance Portability and Accountability Act (HIPAA) to protect the privacy of health information obtained for research. This is an abbreviated notice and does not describe all details of this requirement. During this study, identifiable information about you or your health will be collected and shared with the researchers conducting the research. In general, under federal law, identifiable health information is private. However, there are exceptions to this rule. In some cases, others may see your identifiable health information for purposes of research oversight, quality control, public health and safety, or law enforcement. We share your health information only when we must, and we ask anyone who receives it from us to protect your privacy.

There is a minimal risk of discovering abnormal findings on your Point of Care Ultrasound examination. The images from these examinations will be reviewed for quality assurance by a licensed physician investigator of the study staff at the time of acquisition to ensure there are no abnormal findings. If any abnormal findings are discovered, we will ensure you have an appropriate follow-up plan with your team or your Primary Care Physician. The literature supports the fact that Point of Care Ultrasound is safe, does not utilize radiation, and beyond some slight physical pressure from the ultrasound instrument during your examination, we do not anticipate any additional foreseeable risks or discomfort to you as a participant.

If you have any questions or concerns regarding the study, please contact the Principal Investigator, Dr. Helen M. Shields at hmshields@bwh.harvard.edu or 617-678-6077.

If you would like to speak to someone not involved in the research about your rights as a research subject, or any concerns or complaints you may have about the research, contact the Mass General Brigham Human Research Committee at (857) 282-1900.

Sincerely,

Helen M. Shields, MD
Principal Investigator
Email: hmshields@bwh.harvard.edu
Cell: 617-678-6077

Badar Patel, MD
Co-Investigator
Email: bpatel26@bwh.harvard.edu
Cell: 940-300-7756