SURGE: Smart Ultrasound Remote Guidance Experiment Preliminary Findings

NASA-JSC / Wyle
Aerospace Medicine Clerkship

Dr. Sean Peterson
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Presentation outline

- Ultrasound in space
- SURGE introduction
- SURGE design
- Results
- Next steps

SURGE

Team members

- Scott Dulchavsky (PI)
- Victor Hurst
- Kathleen Garcia
- Ashot Sargsyan
- Doug Ebert
- David Ham
- Mary Carvalho
- Sean Peterson

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- Part of Phase 3 of the Bracelet Investigation Grant
- Henry Ford/NSBRI

Why SURGE?

- Exploration-class missions lead to longer communication delays with mission control
- May not always have communication capability to stream real-time ultrasound images
- SURGE explores use of a “just-in-time” learning tool, called OPEL = On-Board Proficiency Enhancer Light as an aid to a hypothetical crew medical officer working autonomously

SURGE outline

- Inexperienced ultrasound operators
- Autonomous operation
- Investigate necessary requirements to collect useful ultrasound images
  - Level of experience
  - Amount of training
  - Human factors
- Compare to real-time, remote guidance with a communication time delay relating to a lunar mission (5 seconds)

Participants

- No formal ultrasound training
- Less than 2 hours total time using an ultrasound machine
- Mix of medical and non-medical individuals
  - Physicians
  - Biomedical engineers
  - Administrative duties
  - 1 physician astronaut

Study design – 3 groups

A — Remote Guidance

B — Autonomous OPEL

C — Remote Guidance & OPEL

OPEL refers to On-orbit proficiency enhancer light, a computer-based learning tool

Comparison metrics

Fracture assessment

- Task completion time
- Correctly diagnose fractured limb
- Confidence in diagnosis
- Image quality

FAST abdomen assessment

- Task completion time
- Image quality

Post-experiment questionnaire

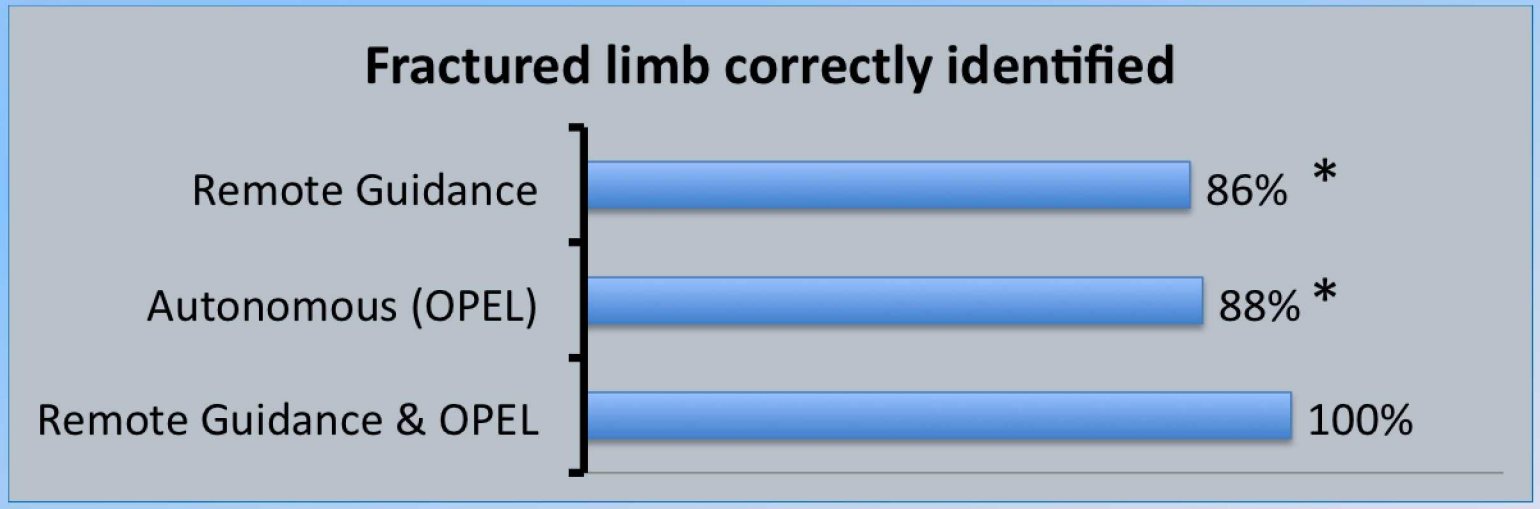
- Assessment of training, cue card, computer-based training, remote guidance, difficulty & frustration

Image quality metric

- Ultimately, captured ultrasound images will be reviewed and rated by two blinded and independent expert radiologists
- Preliminary assessment performed by un-blinded, non-expert, yet FAST certified family medicine physician
- Not validated
- Rating identical for both the fracture assessment and the FAST abdomen assessment
  - Each view assigned a rating
    - "1" if diagnostic
    - "0" if non-diagnostic
  - Ratings from 4 views summed to give an "Image Quality" rating out of four

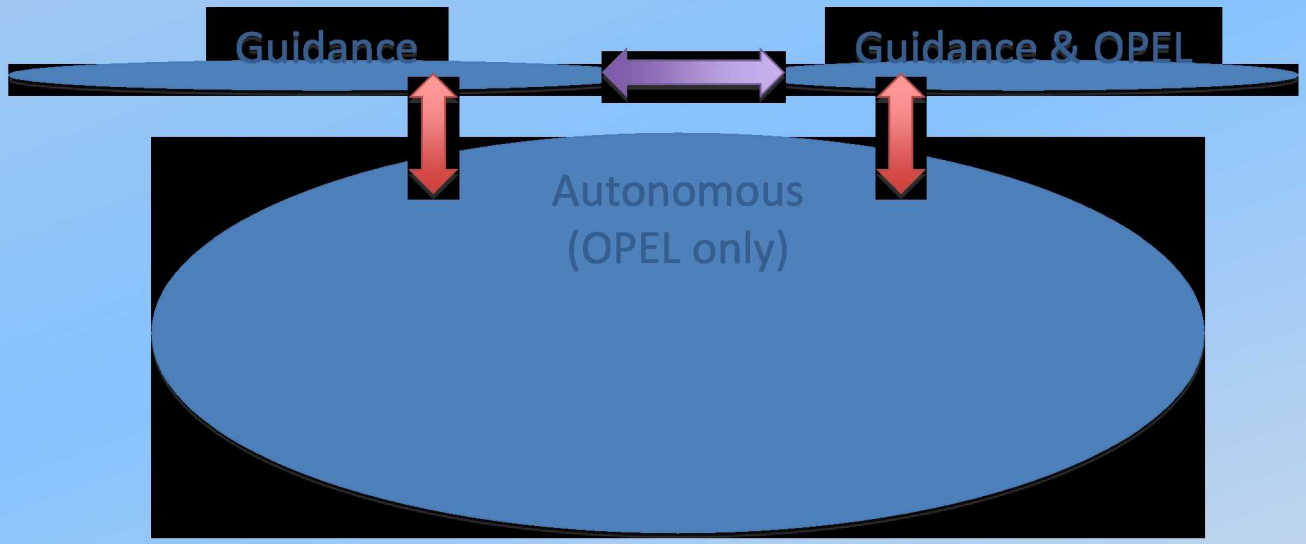
What did we find?

Subjects were able to correctly identify fractured limb



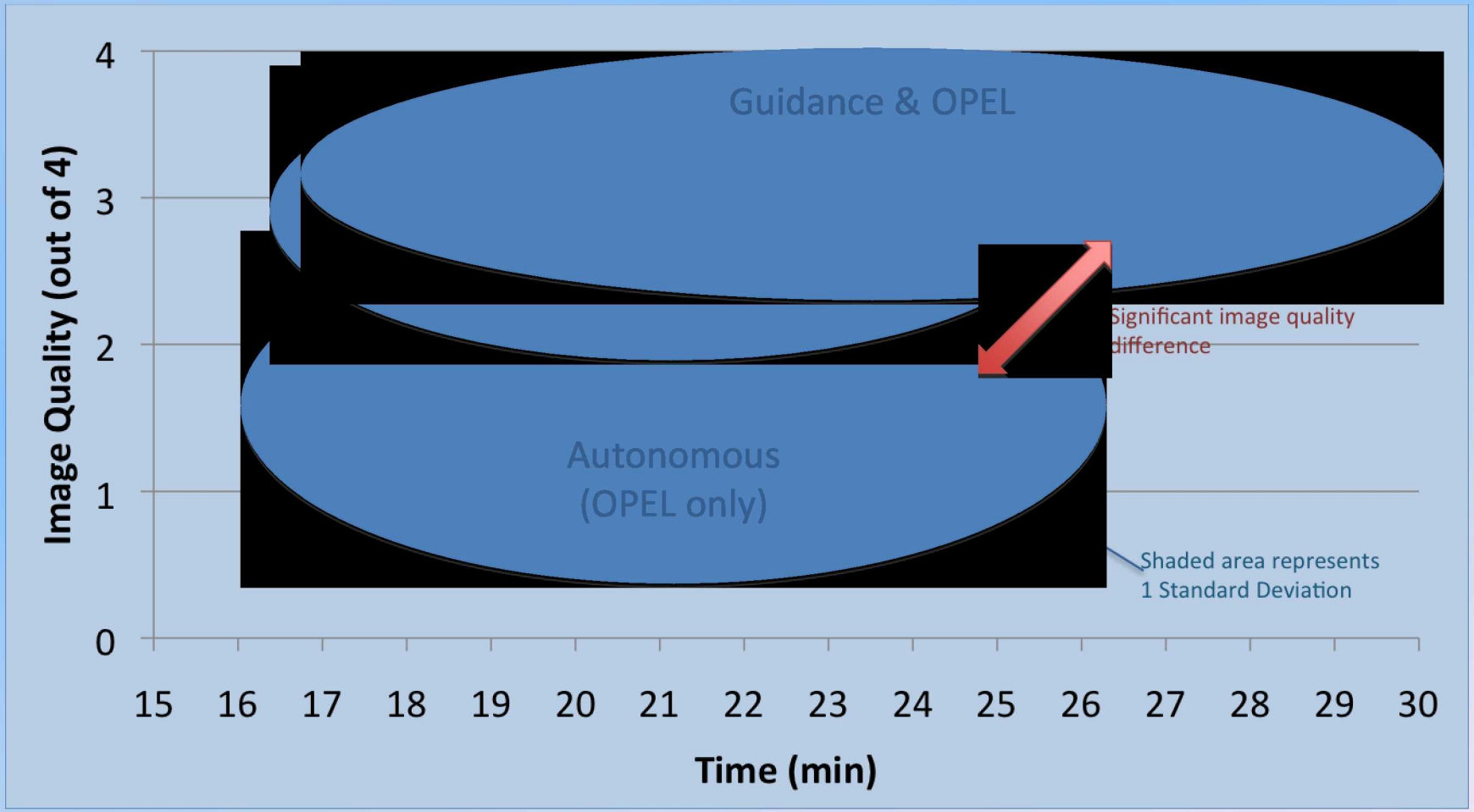
* 2 out 22 subjects identified a fracture, but in the wrong limb

Guidance improved image quality for fracture assessment



OPEL refers to On-orbit proficiency enhancer light, a computer-based learning tool
Analyzed using ANOVA: Tukey's Honest Significant Difference (HSD) Test

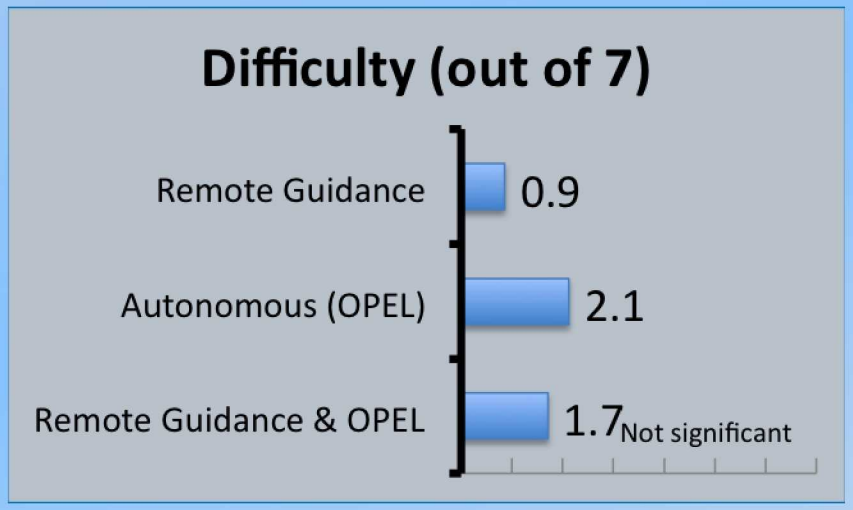
Wide variation on FAST abdomen results

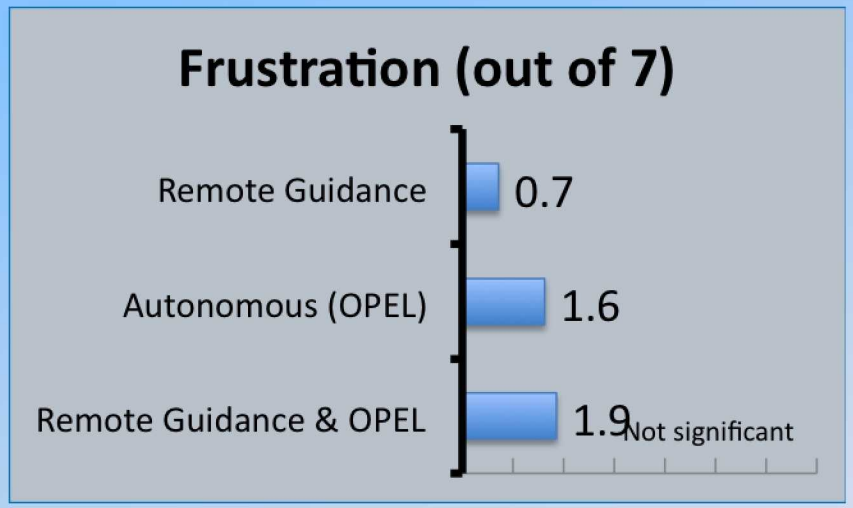


OPEL refers to on-orbit proficiency enhancer light, a computer-based learning tool

Analyzed using ANOVA: Tukey's Honest Significant Difference (HSD) Test

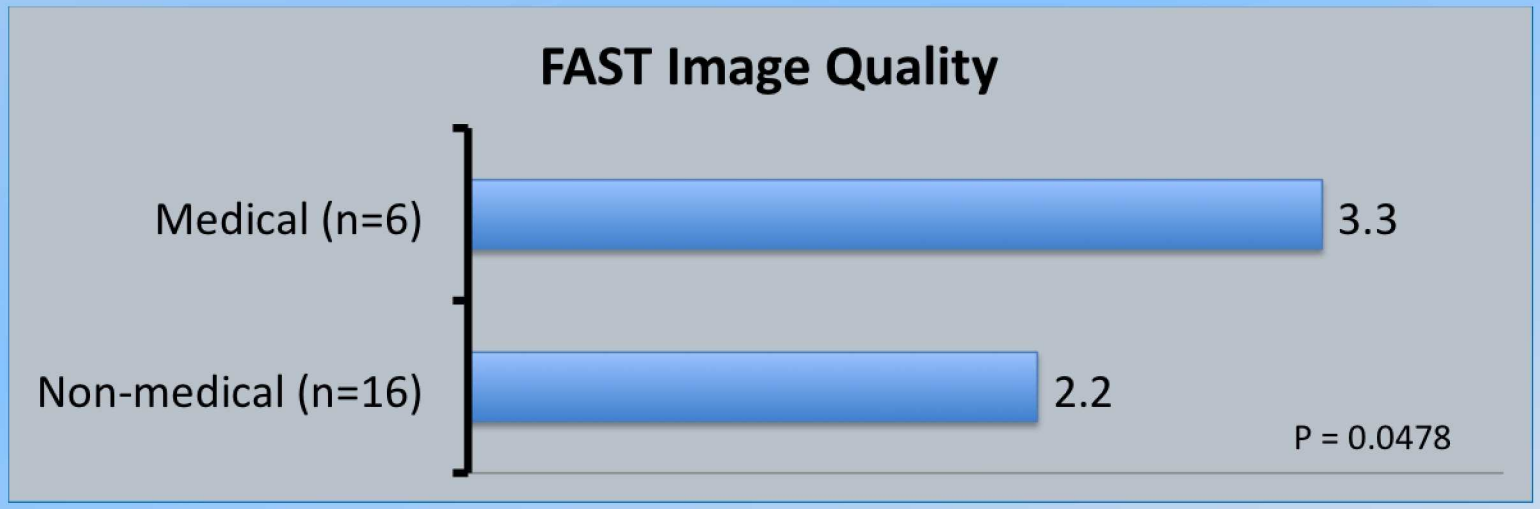
No perceived difference in difficulty or frustration





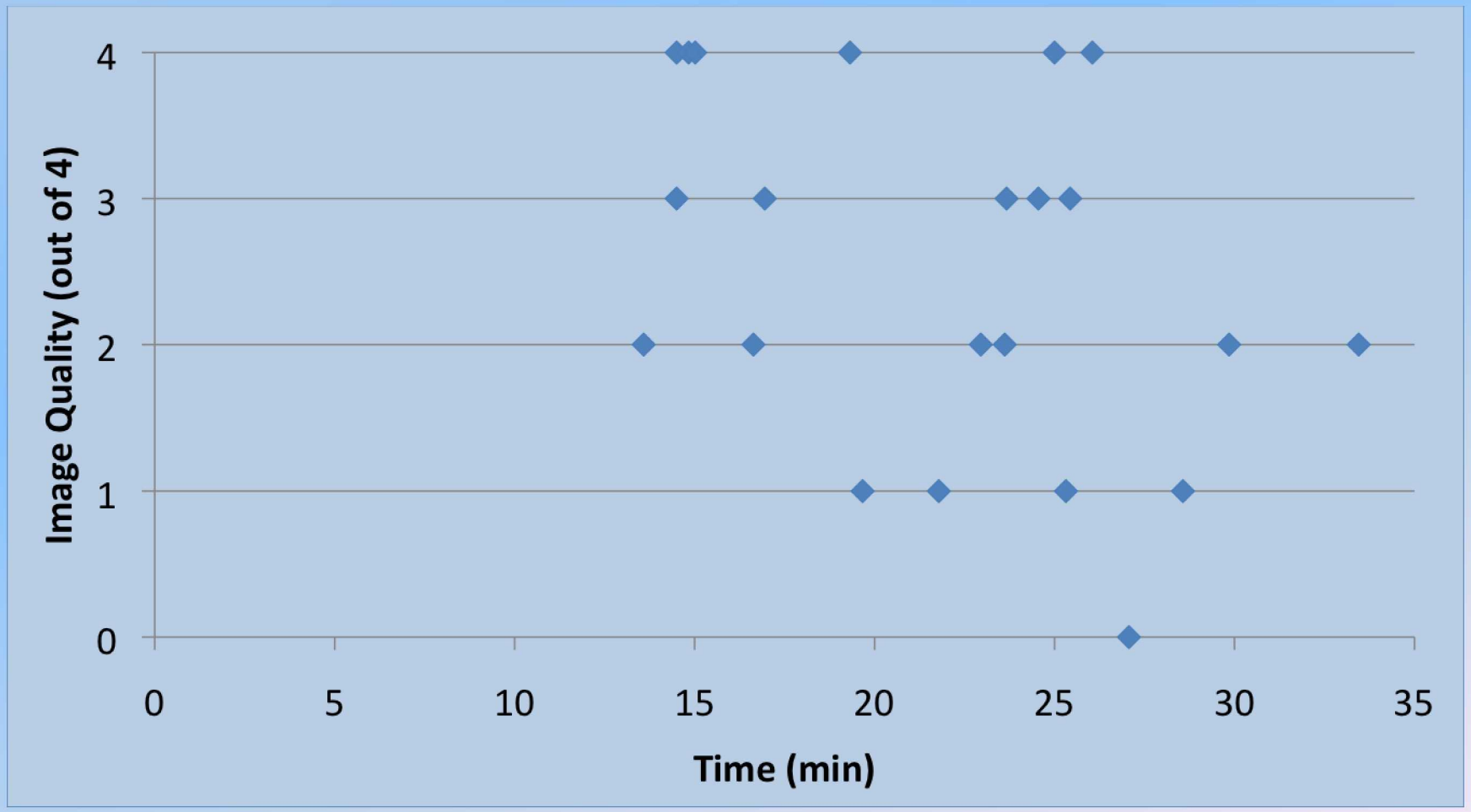
- Initial scales for Difficulty and Frustration were a Likert scale out of 7 with 1 being “very difficult” and 7 being “not difficult at all”
- Graphs above represent 7 minus the average of each group
- None of the differences were significant

Medically trained subjects obtained better quality FAST images



- No significant difference in FAST task completion times
- No significant difference in either fracture assessment completion times or quality of images

No correlation between FAST ultrasound task completion time and image quality



Great ideas for improvement obtained by post-experiment questionnaire

Overall

- Maintain consistent, plain language
- Reinforce firmer pressure to improve image quality
- Have automatic recognition of internal body structures by ultrasound

Pre-experiment training

- Include a “tour” through the human body showing specific organs
- Describe how to get gel out of bottle by shaking it down to the dispersing end

Cue card

- Add instructions on how to capture a STILL and a VIDEO LOOP
- Include a description of “SWEEP” = tilting probe one way and then the other to visualize an organ or interface
- Change position of A4 to be more posterior in mid-axillary line

Remote guidance

- Limit instructions to 3 steps so as to not get ahead of ultrasound operator
- Provide positive feedback when proper images obtained to aid ultrasound operator confidence
- Share with ultrasound operator what a “positive” scan would show

Many suggestions for improving the FAST component of OPEL

FAST abdomen procedure

- Remove medical language
- Better describe orientation of probe and include pictures of orientation
- Better describe how to locate the kidney
- Describe how to manage with rib shadows
- Better describe procedure to visualize heart from sub-xyphoid approach
- Reset depth setting after each position to avoid missing far-field structures
- Include a “problem-solving” section that describes potential maneuvers to attempt to gain the desired image.
- Embed videos in word document at relevant line items

FAST abdomen video

- Expand video to include more still pictures of the desired views with labels describing the target organs and where “free fluid” would appear
- Better describe how to do a SWEEP or “tilt” to visualize an interface
- Emphasize need to have probe nearly parallel with abdomen and tucked under ribs with firm pressure to visualize heart
- Provide examples of “positive” free fluid ultrasound images in video
- Include a “problem-solving” section that describes potential maneuvers to attempt to gain the desired image (i.e., breath holds, bending knees, rotating probe, panning probe)

Thank you!

- Corrine for providing us with an excellent month at "space camp"
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