Clinical Decision Support Tools

Intelligent Focused Assessment with Sonography for Trauma: Automated Identification of Pneumothorax, Hemothorax, and Abdominal Hemorrhage Caused by Blast or Other Trauma

Researchers at the U.S. Army Institute of Surgical Research, Fort Sam Houston (USAISR; San Antonio, Texas) have successfully completed the Intelligent Focused Assessment with Sonography for Trauma (iFAST) project. This project focused on automated detection and diagnosis abdominal hemorrhages with ultrasound imagery obtained near the four Focused Assessment by Ultrasound for Trauma (FAST) exam points, i.e., near the spleen, kidneys and in the pelvic area. The iFAST is exclusively licensed to Cherokee Nation Diagnostic Innovations and is the subject of an international patent application (*Grisell et al. 2015*). USAISR is collaborating with General Electric Healthcare under a cooperative research and development agreement to implement the iFAST.

Collaborations continue with the National Aeronautical and Space Administration and with General Electric Healthcare, toward the firming up of concept of operation for hardware for prolonged field care and in long space expeditions. The USAISR researchers continue to seek opportunities to collaborate in such areas as: improved probe designs, portable ultrasonic tomography, and three- and four-dimensional ultrasound, aiming for near real-time software to process these data. They also continue to interview experienced field medics, emergency medical service workers, and Special Operations Forces personnel, when available, to define an operational concept for austere conditions and with indefinite transport delays.

In prior years the project was largely successful in developing algorithms for detection of pneumothorax (air in the cavity between lungs and chest wall) and hemothorax (blood in this cavity) (*Summers et al. 2016*). They have successfully developed algorithms to recognize blood and fluid pools in the abdomen and now their work extends the current state of the art in determining minimum detectable volumes. Briefly, two hypotheses were put forward and tested by the last phase of this research:

1. Hemorrhage prediction and volume measurement accuracy can be significantly increased with intelligent video image processing in near real time
2. Such software can considerably improve the prediction of tissue damages to lungs and abdominal organs caused by trauma injuries.

The goal is accuracy at about the skill levels of interns with occasional practice in emergency departments (EDs) such that their skills did not depreciate materially. However, the literature varied by an order of magnitude concerning the minimum detectable volumes at the various abdominal collection areas.

The recognition software was successfully developed for regions of the body routinely examined for

blood by FAST as normally performed in hospital EDs, but now considered feasible for relatively untrained military and civilian field medics. They showed that:

- Very small lung and abdominal hemorrhages can be detected and measured during the golden window (after injury when many lives can be saved).
- With automated detection and an intelligent tutor to guide the medic, especially the untrained personnel, the system will increase the chances of saving a trauma victim and prevent long-term damage.
- iFAST can be a key medical tool for forward battlefield conditions likely in Role I and Role II-IIb.
- Selectivity and sensitivity detection of abdominal hemorrhage is near expert levels.
- Volume measurement is just about at the level of human perception.
- Cues can be helpful regarding imaging quality, especially to novice users (*Summers et al. 2017*)

In conclusion, the iFAST is a key medical tool for forward battlefield conditions to detect very small lung and abdominal hemorrhages caused by blast or other trauma (Figures 1, 2, & 3).

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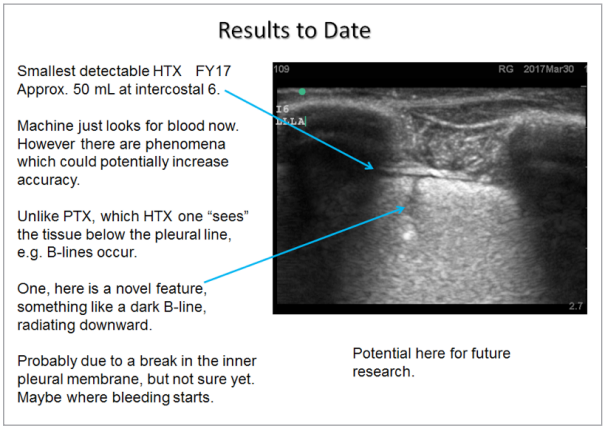

FIGURE 1: Result for hemothorax. A minimum detectable volume. Interestingly, a rather new phenomenon, a dark linear feature was observed below the pleural line (dark line at upper blue arrow). (Figure used with permission from the authors)

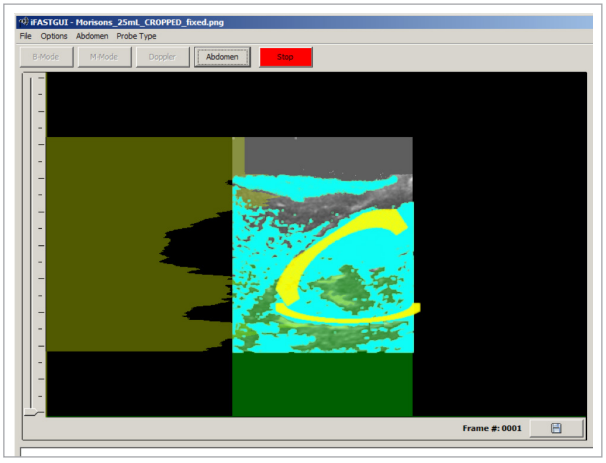

FIGURE 2: Abdominal Hemorrhage: First, two model components (yellow) fitted to a right kidney image. (Figure used with permission from the authors)

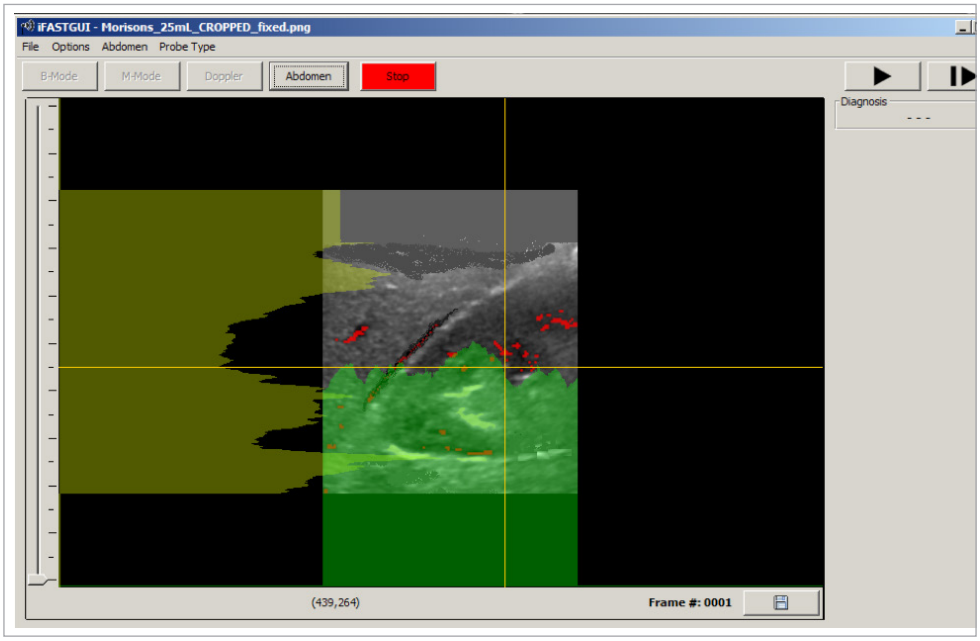

FIGURE 3: Then the hemorrhage is narrowed to a search near the border located by the previous modelling. (Figure used with permission from the authors)

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