

ONLY THE BARE NECESSITIES: PREPARING FOR EMERGENCY SURGICAL PROCEDURES DURING SPACE EXPLORATION

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INTRODUCTION

- With the prospect of extended space explorations on the horizon, NASA has identified a need for addressing emergency medical procedures during flight.
- This project is a subset of a larger endeavor aimed at providing the instruction and tools necessary for a non-surgically trained team to perform surgery during exploration space flight (specifically an emergency appendectomy).
- The ability to intervene surgically due to injury or illness during space exploration poses several challenges including zero gravity conditions, lack of surgically-trained crew, and limited access to supplies due to weight, space, and power restrictions.
- With these limitations in mind, it is imperative that the flight crew be provided with precise instructions and only the essential surgical tools to perform a procedure. Preparatory steps involved in directing this procedure, including the creation of a photographic catalogue of supplies for the procedure may easily be applied to other medical situations as needed.

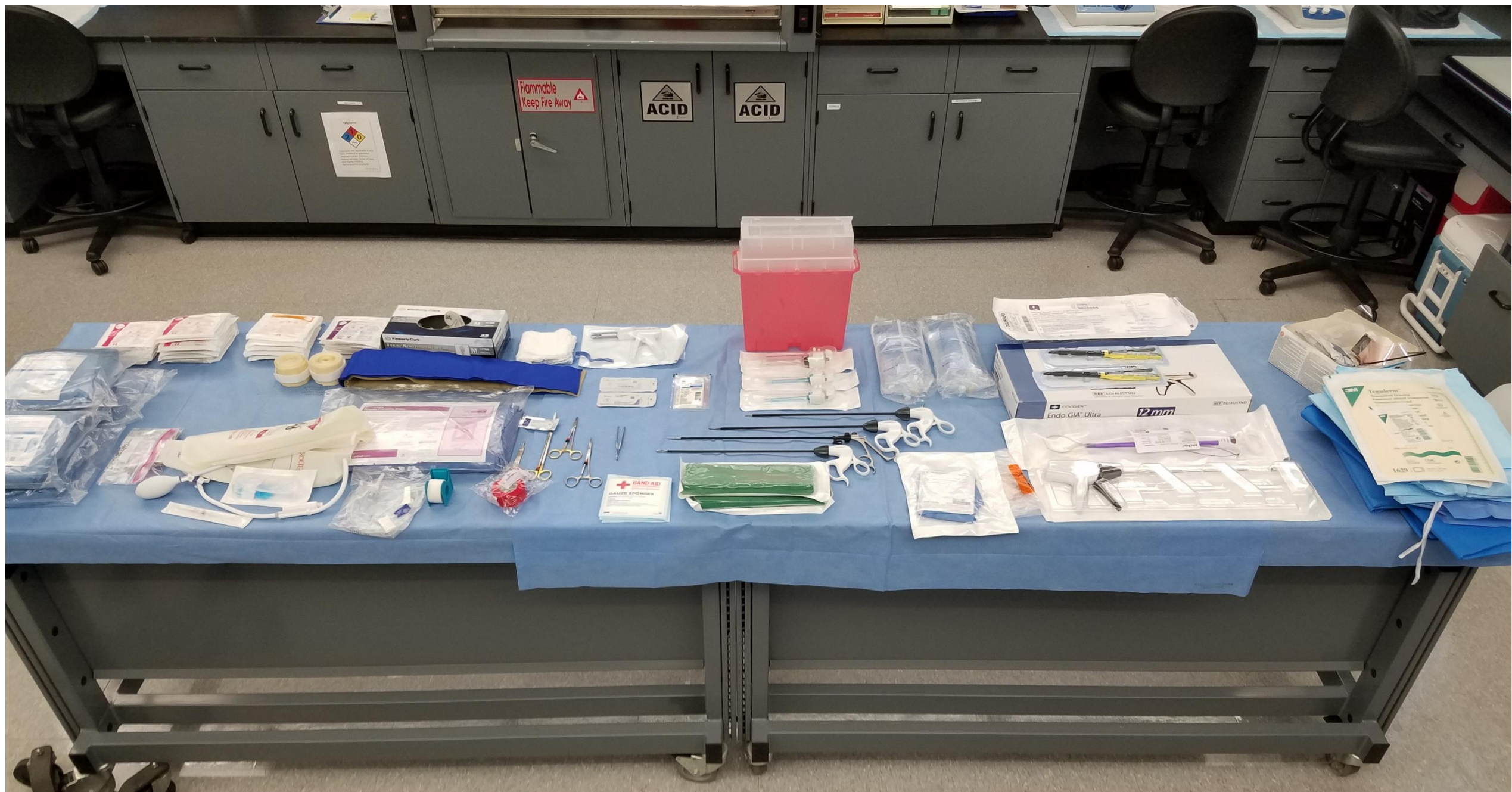


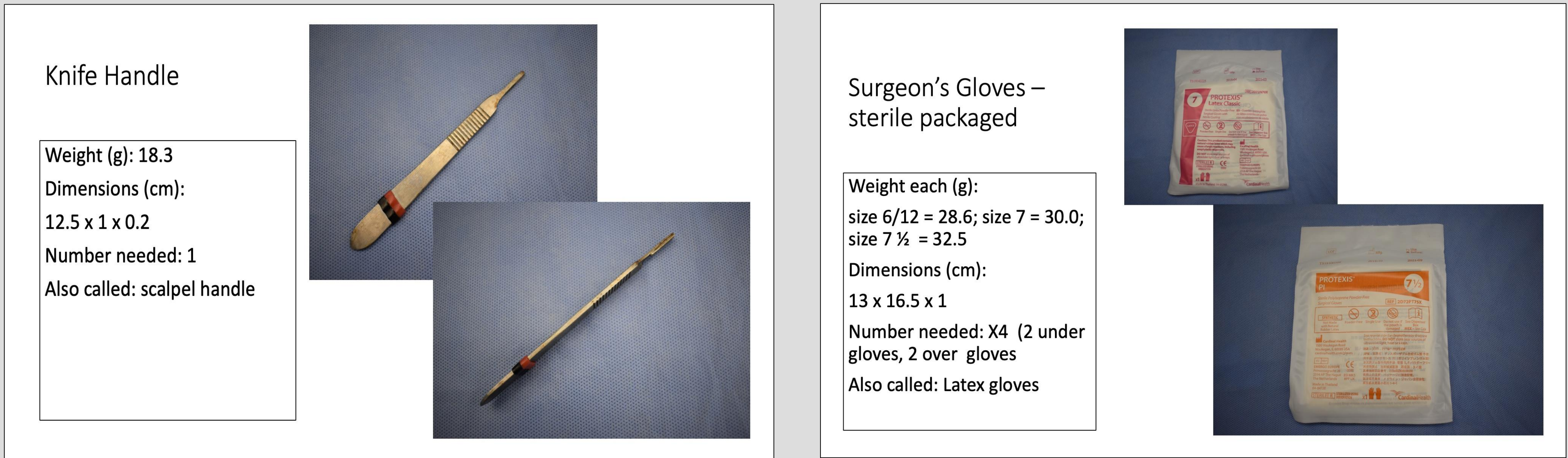
Figure 1: Supplies traditionally required for emergency appendectomy.

OBJECTIVE

To compile a photographic catalogue (including size, weight, and photograph) of all tools necessary to perform an emergency laparoscopic appendectomy during space flight.

This project was approached with the understanding that NASA will ultimately source the needed supplies (as determined by our analysis) from their vendors and will recreate the catalogue with their supplies once acquired, using our example for a reference.

METHODS



Figures 2 and 3: Two examples of catalogue slides showing item name, alternate name, weight, dimensions, number needed, and multi-angled photographs of the item.

- Under the direction of George Pantalos, PhD, and Erica Sutton, MD, a full complement of surgical supplies and equipment was collected and evaluated for necessity (per our previous task analysis).
- Each item was photographed, weighed, measured, and added to an electronic catalog. Included for each item in the catalog was a description of the item, a photograph(s), weight, and dimensions, which would allow for easy identification during an emergency.
- Before simulating the procedure on a fresh cadaver of appropriate height and weight to emulate an astronaut, we asked an experienced surgical technician to review and further reduce the inventory.
- A final inventory was established as the surgeon successfully completed the procedure on the cadaver.

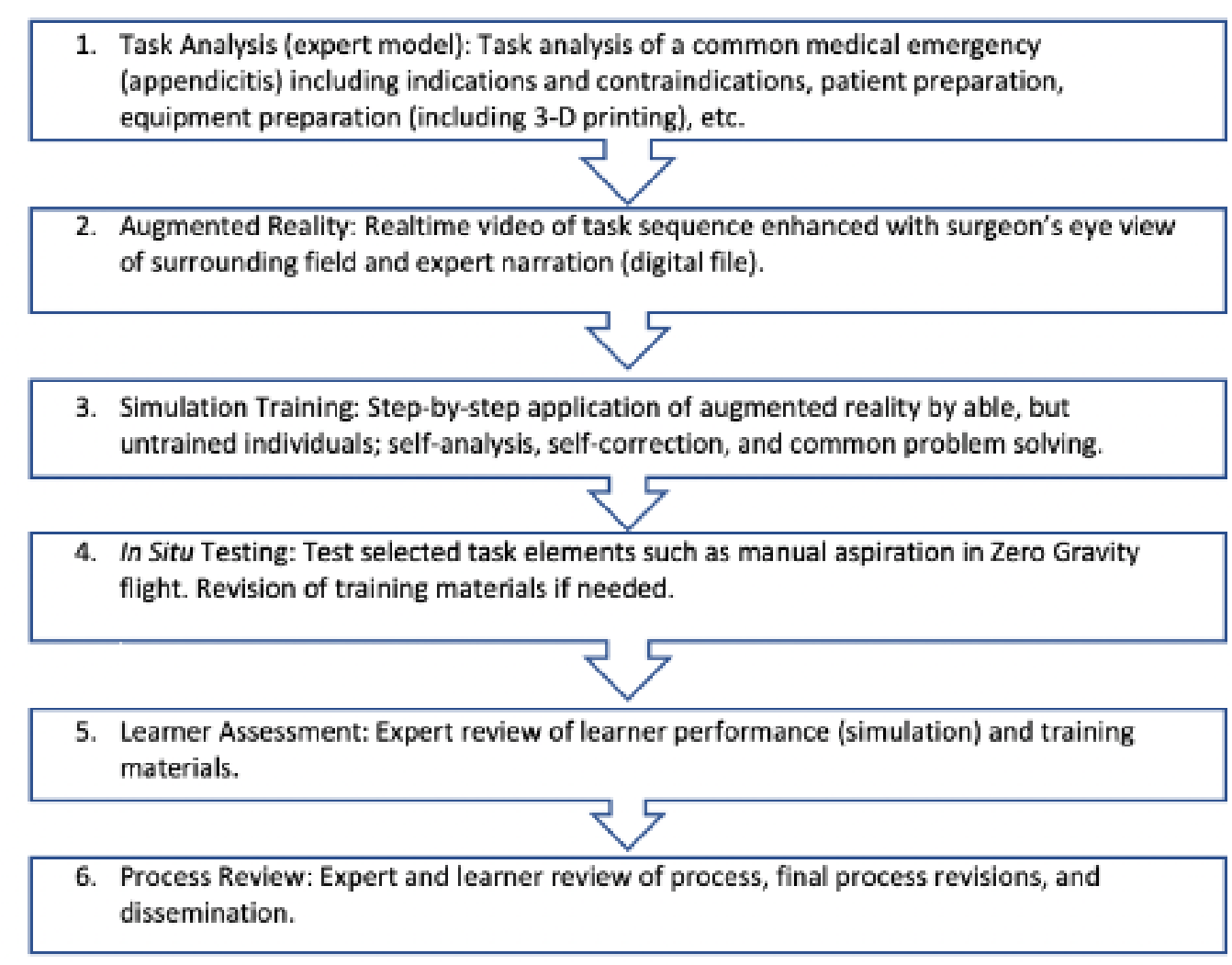


Figure 4: Strategic Model for Space Flight Emergency Surgery Preparedness

RESULTS



Figure 5: Image of all the instruments "tucked" into the instrument holder on the Mayo Stand to be used for the emergency appendectomy.

- Excluding the pharmaceuticals necessary for IV general anesthesia (that research is on-going), we were able to safely replicate a laparoscopic appendectomy in a fresh cadaver using no more than 30 items.
- Identifying this list of "essentials" opens the way for further investigation into which instruments could be 3D printed as needed during flight, which should be selected because they serve multiple uses, and how specific electronic instruments could be modified and miniaturized to make them space worthy.



Figure 6: Dr. Erica Sutton being wired before performing an appendectomy using the task analysis procedure



Figure 7: Four-camera view of the laparoscopic procedure demonstrating the steps in the task analysis as performed by non-surgeons (including the view from the endoscopic video camera, upper left).

CONCLUSIONS

This project demonstrates the critical role of task analysis in preparation for emergency procedures during exploration space flight. Application of this process will enable the development of other job aids for performance of medical procedures in diverse, extreme environments.

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