HemoCue ISS Tech Demo

Results and Lessons Learned

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thank you!

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Overview

- HemoCue experiment summary
- Results of ISS Tech Demo
- Lessons Learned / Contributors to Success
- Generalizable Lessons for other payload developers / PI Teams

HemoCue® White Blood Cell Analyzer

Successfully flown during ISS Increment 64

White blood cells (WBC) are among the most common clinical biomarkers

HemoCue® measures total WBC count and 5-part differential in whole blood samples

An *in situ* medical capability for blood analysis could provide an important tool for meeting the medical diagnosis needs of crewmembers during long-duration and exploration missions beyond low earth orbit

HemoCue® WBC Diff Analyzer
Uses an optical camera to count WBC's that have been stained with a reagent in the microcuvettes inserted into the device (Red blood cells are lysed). Microcuvettes are disposed of after use.

Microcuvettes

Control Solutions
Low, Normal, High WBC counts (known quantities)

HemoCue® swabs

ExMC HemoCue ISS Flight Experiment

ISS Increment 64 Flight Engineer Mike Hopkins working with HemoCue in the ISS Portable Glovebag (IPGB) – December 2020

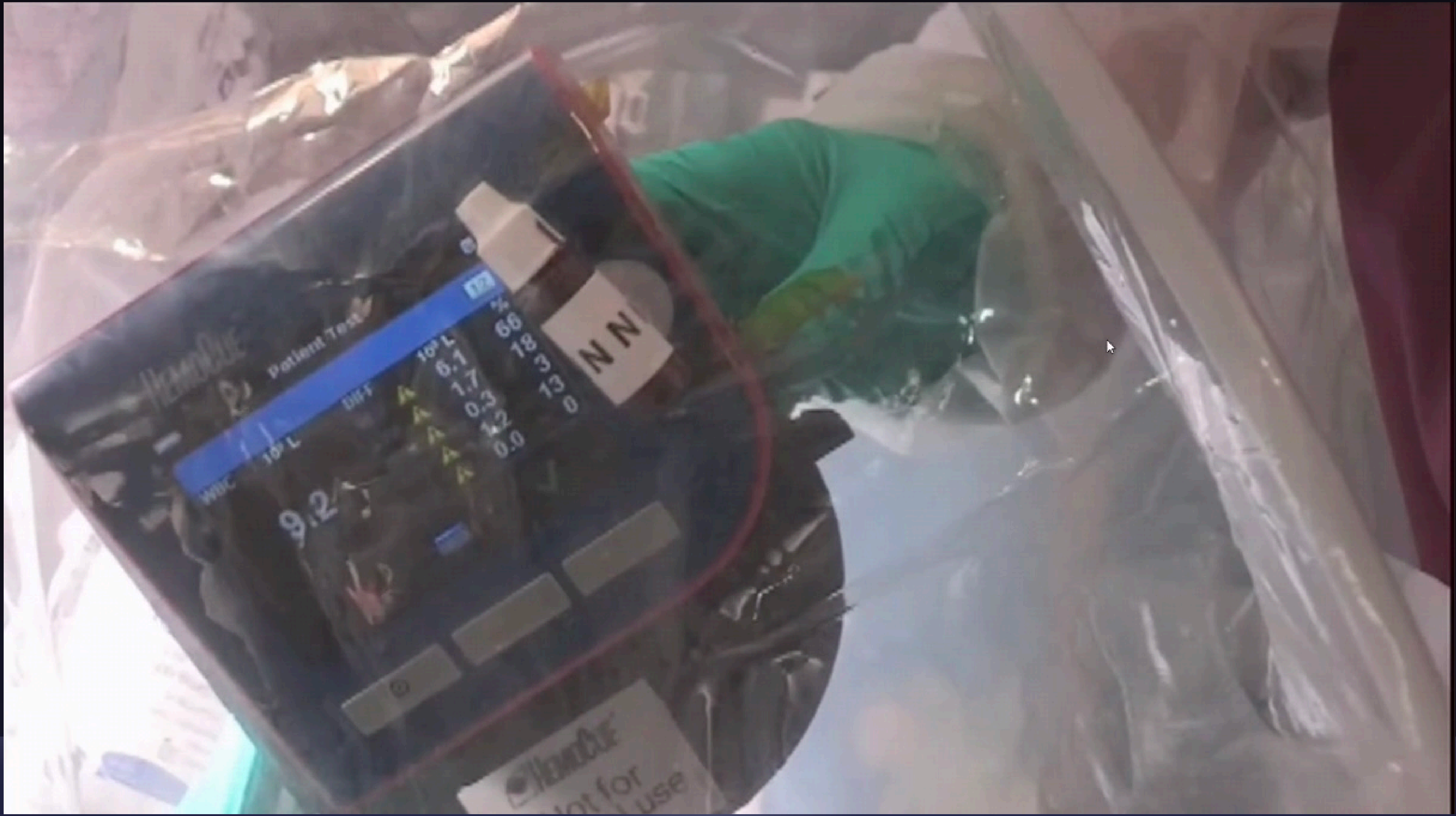
ISS Increment 64 Flight Engineer Kate Rubins with HemoCue in the Maintenance Work Area of the Harmony Module (Node 2) – January 2021

Results of Flight Experiment

1) One operations session on ISS was originally planned, to prove out the function of the WBC analyzer in microgravity. Minimum success criteria were not met (9 successful trials (3 repeats runs at each of Low, Normal, and High concentrations of WBC in control solutions). At the end of the first ops session, only 3 out of 13 attempts were successful.

2) PI Team reviewed data and video and considered implications, and in the following days, recreated the erroneous results on the ground. Crew Weekly Summary words were updated with helpful tips and imagery, and a 2nd Ops Session was scheduled.

3) During the 2nd Ops Session, crewmember executed the operations flawlessly. A total of 14 trials were completed successfully out of 20 attempts.


Patient Test
9.2

Results of Flight Experiment

...and, a third session was collaboratively planned and accomplished with the crewmember, to obtain HemoCue WBC 5-part differential on a whole blood (fingerstick) sample successfully

Demonstrated the ability of the HemoCue to operate in microgravity, marking the first time NASA has performed real-time hematology in space

ISS Increment 64 Flight Engineer Kate Rubins with HemoCue performing fingerstick blood draw - January 2021

EXPLORATION MEDICAL CAPABILITY

HemoCue Final Reports and Publications

Lessons Learned

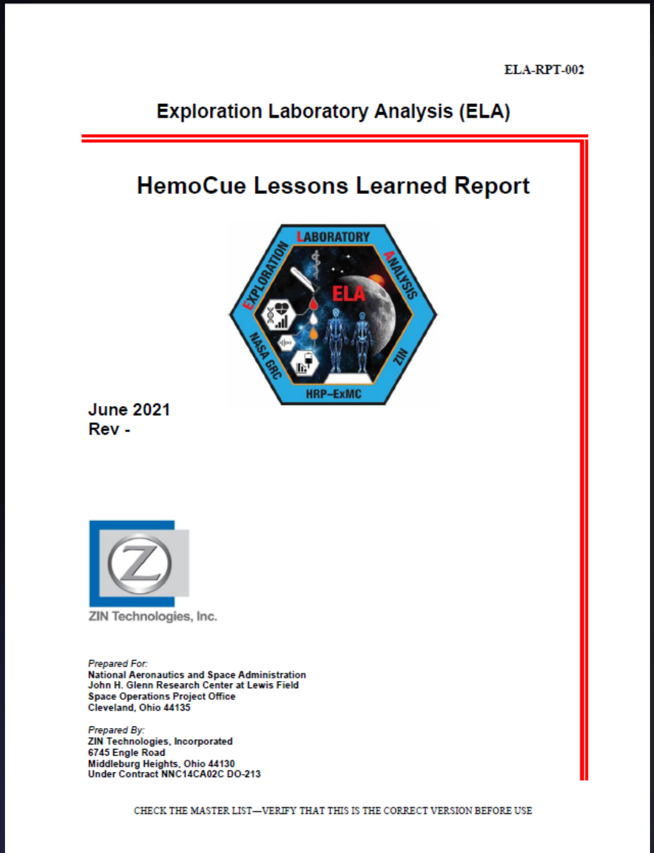
Each Lesson Learned can be thought of in a structural format and includes the following at a minimum:

- What was planned or expected?
- What happened instead of / in addition to what was expected?
- Why did it happen, or what were the factors that contributed to this outcome?
- What were the consequences or results?
- What could be done better next time to improve the outcome (or repeated if outcome was positive)?

Lessons Learned

HemoCue project captured nine (9) Lessons Learned in the report:

1. Verify Video Settings Prior to Performing Operations
2. Practice makes perfect and a Picture is Worth a Thousand Words
3. Tool and hardware flow makes operations go smoother
4. Use what is already available on ISS
5. Program the Sleep out of the Analyzer
6. Use of Control Samples
7. Fluid/air separation technique and use of taller dropper bottles
8. COTS Process
9. Success Criteria


ELA-RPT-002

Exploration Laboratory Analysis (ELA)

HemoCue Lessons Learned Report

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Rev -

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CHECK THE MASTER LIST—VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

HemoCue Lessons Learned Report may be found at the NASA Engineering Network site; select GRC for center

https://nen.nasa.gov/web/ll/center

First ISS Ops Session (12.28.20) Results

During first ops session -

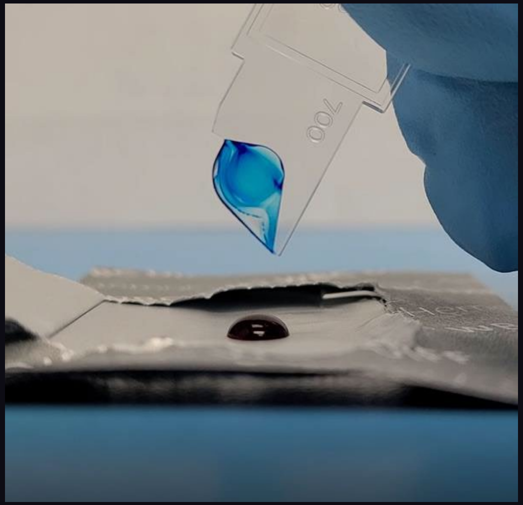
The control solution didn’t appear to wick the same into the cuvette in microgravity as in earth gravity, crewmember reported it appeared to ‘jump around the circle’ (region of analysis) in the cuvette tip, ‘not fill the circle’

PI Team decided to try holding the cuvette in solution for a longer period of time, in an attempt to fully fill the cuvette

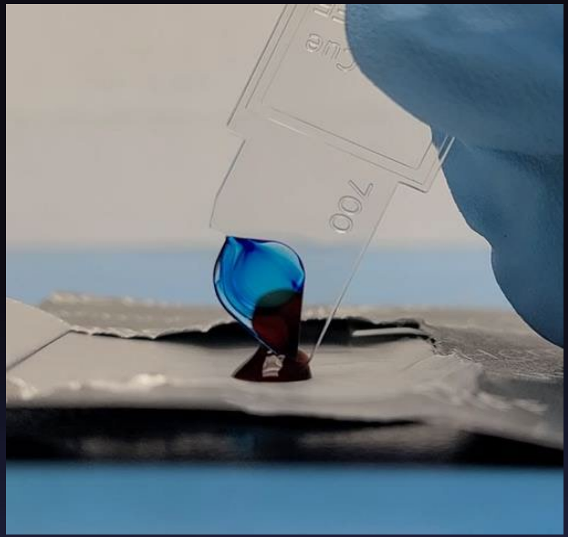
ExMC HemoCue ISS Flight Experiment

ISS Increment 64 HemoCue Ops session in the GRC Telescience Support Center

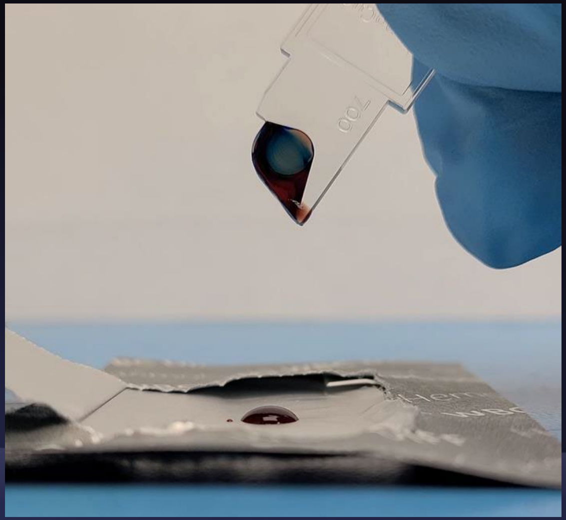
Correct Droplet Size



Proper Approach Angle



Good Fill

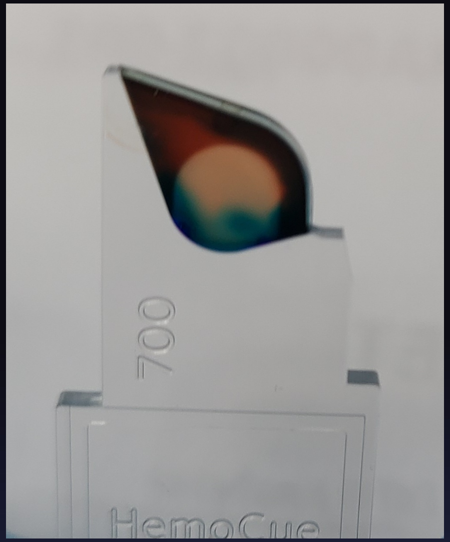


Variations in Technique Used to Fill the Cuvette

Optimal Fill
(High Probability of Success)

- 1 touch fill method
- Short fill time (~ 1 sec.)
- No bubbles
- Medium blue circle
- Dark maroon edge

Not Ideal Fill
(May Produce Error Message)



- Multi-touch fill method
- Extended fill time (> 10 sec.)
- No bubbles
- Half light pink circle
- Half medium blue circle
- Dark maroon edge

Not Acceptable Fill
(Skip Analysis, Discard Old Cuvette, & Use a New Cuvette)

- Multi-touch fill method
- Extended fill time (> 10 sec.)
- 1 Unwanted bubble
- Half light pink circle
- Half medium blue circle
- Dark maroon edge

Generalizable Lessons Learned

When developing Crew Procedures and planning experiment

- Use items already on ISS where possible (HemoCue used ISS Portable Glove Bag (IPGB), Kapton tape, Ziploc bags, gauze pads, BZK wipes, and Alkaline C batteries)

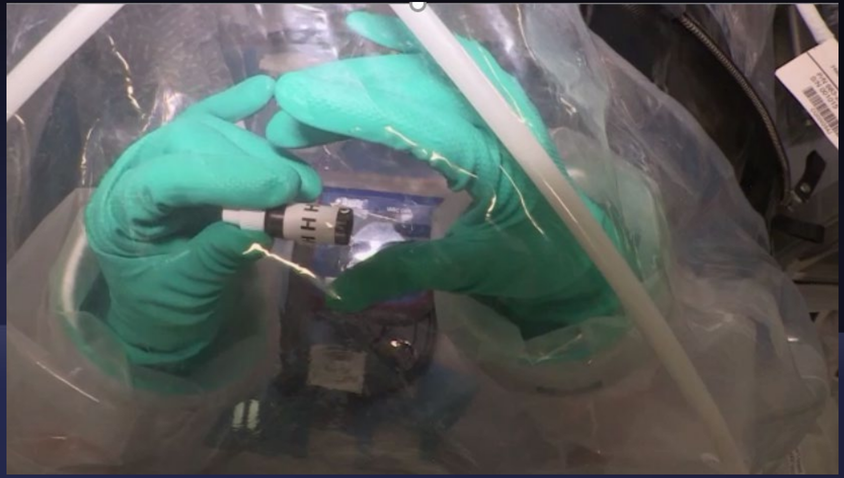
- Pay attention to and communicate the variety of outcomes realizable – not just nominal, but **illustrate *off-nominal* outcomes as appropriate in Crew Procedures (photos, videos)**

- Plan for **practice** session(s) during ops– allows PI Team to determine where more instruction may be needed (Set-up, Operations, Stow → Set-Up, *Practice*, Operations, Stow)

→ Increasing Crew Autonomy

Generalizable Lessons Learned

- Workspace organization / practical considerations
  - Plan for restraining loose items – consider especially subassemblies, disassembly of components, not just assemblies (e.g, bottles/bottle caps)
    - Velcro
    - Gray tape 'doughnuts' to hold down loose items
  - If visual confirmation required, do not cover viewing area with label



Generalizable Lessons Learned

- **System was *tolerant* to 'failure' and gave allowance to 'try again'**

  - we had *excellent support* at all levels including leadership (ExMC, ROI, ISS Program, Crew, PI Team)

  - we had a dedicated team with diverse talents and perspectives
    - *great communication*
    - *curiosity and humility*

Thank You