



HemoCue ISS Tech Demo

Results and Lessons Learned

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Thank you!

The authors wish to thank both ISS astronauts for their important contributions to making this technical evaluation successful, and also ZIN Technologies, Inc., for payload development; the Exploration Medical Capability Element (ExMC) and Research Operations and Integration (ROI) for their role in selection, funding, and enabling this flight evaluation.

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



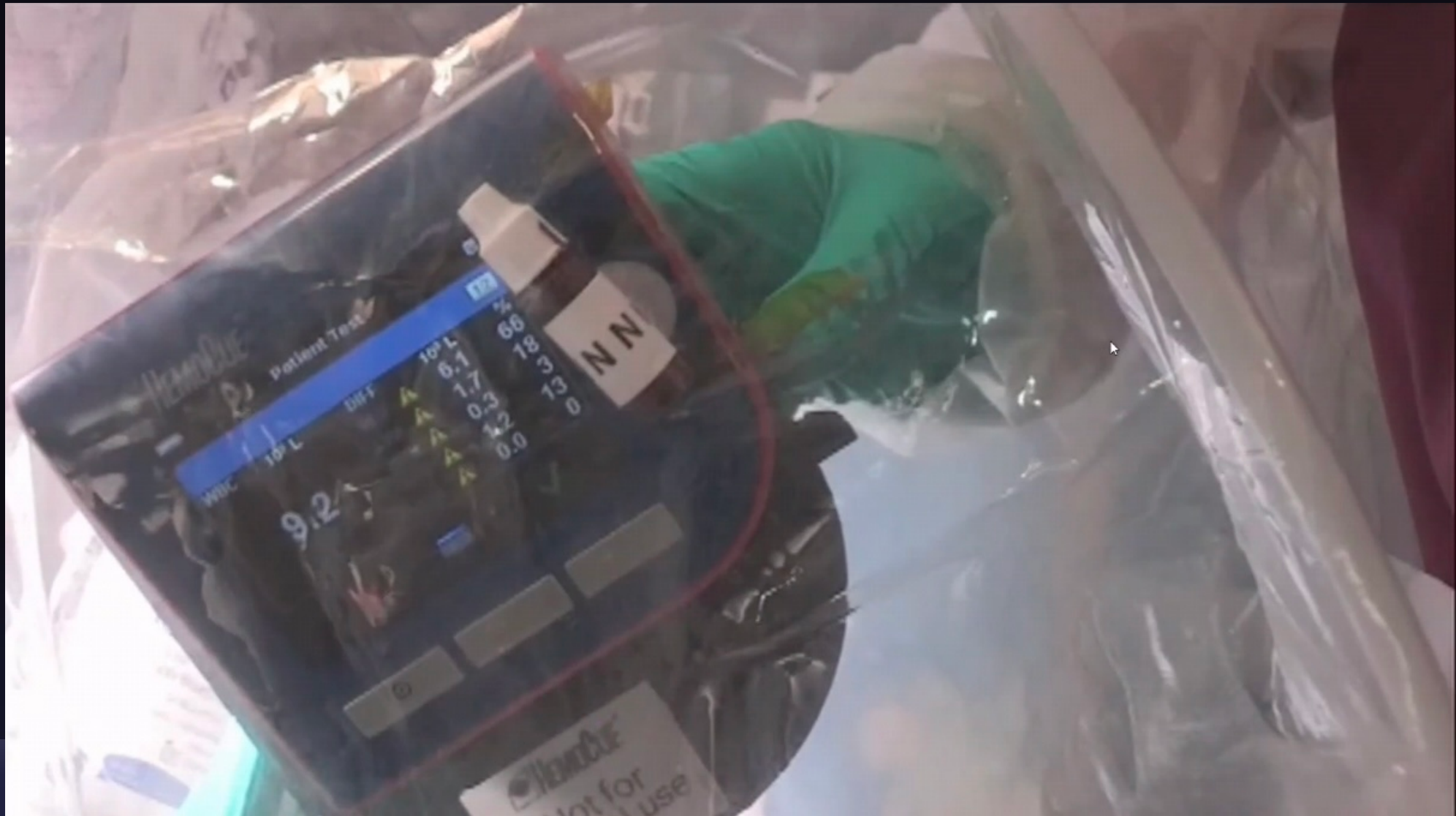
ISS Increment 64 Flight Engineer Mike Hopkins working with HemoCue in the ISS Portable Glovebag (IPGB) – December 2020



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.



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

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April 2021
Rev. –



ZIN Technologies, Inc.

Prepared For:
National Aeronautics and Space
John H. Glenn Research Center
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Middleburg Heights, Ohio 44130
Under Contract NNC14CA02C

June 2021
Rev. –



ZIN Technologies, Inc.

Prepared For:
National Aeronautics and Space Administration
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Space Operations Project Office
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Prepared By:
ZIN Technologies, Incorporated
6745 Engle Road
Middleburg Heights, Ohio 44130
Under Contract NNC14CA02C DO-213

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Life Sciences in Space Research 31 (2021) 29–33

Contents lists available at ScienceDirect

Life Sciences in Space Research

journal homepage: www.elsevier.com/locate/lssr

Spaceflight validation of technology for peripheral blood WBC and differential in a microgravity environment

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ABSTRACT

During long duration orbital space missions, astronauts experience immune system dysregulation. During planned NASA "Artemis" deep space missions the risk of clinical incidence. There is currently minimal clinical laboratory capability about count (WBC) and differential during spaceflight has been an unmet NASA medical and flight validation of a device designed to monitor WBC and differential with generally compatible with microgravity operations. Ground testing for space electromagnetic interference (EMI), and basic evaluation of sample preparation performed aboard the ISS by two astronauts included assessment of three levels blood sample by one of the crewmembers. Flight and ground testing of the same discrepancy between flight and ground data for the differential analysis. However, result of storage length before flight operations, and not due to a microgravity-related regarding crewmember training for technique-sensitive small-volume successful and was the first real-time hematology assessment performed during transits thereby assisting Flight Surgeons and the crew medical officer during 1

1. Introduction

During long duration orbital space missions aboard the International Space Station (ISS), astronauts experience immune system dysregulation. The phenomenon consists of reductions in T cell and NK cell function as well as a persistent mild inflammation (Crucian et al., 2014; Crucian et al., 2015; Bigley et al., 2019). This results in the persistent reactivation of latent herpesviruses (Mebius et al., 2017). Astronauts also experience a degree of adverse clinical events, including infections and atopic dermatitis (Crucian et al., 2016a,b). An analysis of astronaut blood samples returned ambient from ISS indicates that an elevated WBC persists during spaceflight (Kunz et al., 2017). This phenomenon is

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<https://doi.org/10.1016/j.lssr.2021.07.003>
Received 4 June 2021; Received in revised form 9 July 2021; Accepted 12 July 2021
Available online 15 July 2021
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HEMOCUE® ISS FLIGHT EXPERIMENT - RESULTS

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INTRODUCTION

During long duration space missions, astronauts experience immune blood cell count (WBC) can give vital information about the body measure WBC count is currently an unmet need on the International exploration missions. To address this need, the Human Research Capability (ExMC) Element, along with the Research Operations NASA Johnson Space Center Immunology Lab, flew HemoCue® with the ability to measure whole blood WBC count with 5-part d

METHODS

This terrestrial analyzer was launched with blood 'control solution' amounts of WBCs. The original on-orbit test protocol called for the three concentrations of WBCs (Low, Normal and High) and compared expected ranges of WBC counts. After receiving analyzer error m the initial session, the ground team performed additional testing to which resulted in a revision of the procedure for wicking the blood. Two additional on-orbit demonstration sessions were conducted, of the new wicking procedures and a second where a fingerstick sam

RESULTS

During the second on-orbit session, measurements were successful WBC count ranges, providing the first real-time hematology meas third session provided further proof of the technology's ability to environment, with the successful collection and analysis of an act

CONCLUSIONS

Further demonstration details and lessons learned that are general discussed. Others may benefit from this tremendous experience w as planned, but ultimately resulted in greater gain and benefit for

[1] Crucian B.E. et al (2021) Life Sciences in Space Research 31,

NASA TV

Humans in Space

Nov 2, 2021

MORE STORIES

Protecting Astronaut Health with the Prick of a Finger

Fig. 1. A: Astronaut Mike Hopkins performing analysis of control Glovebag; B: Astronaut Kate Rubins with the HemoCue® analyzer 'Node 2' aboard the ISS C: The collection of a fingerstick blood

Lessons Learned

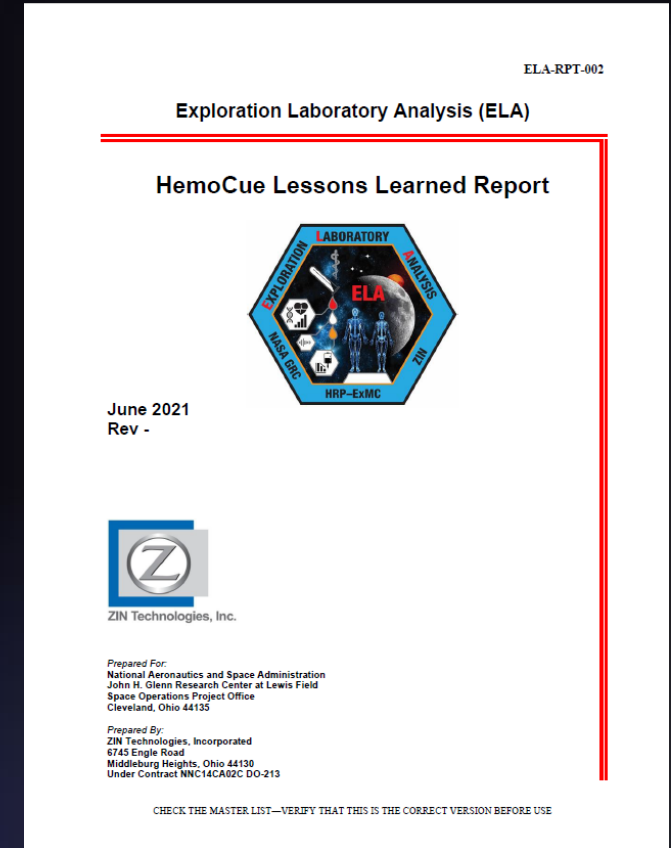
Each Lesson Learned can be thought of in a structural format and includes the following at a minimum:

- 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



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'

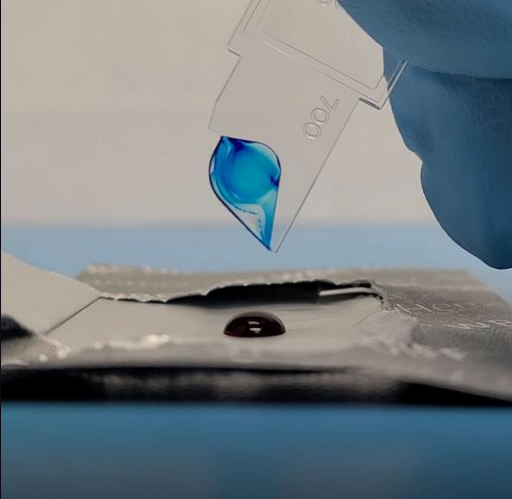
PI Team decided to try holding the cuvette in solution for a longer period of time, in an attempt to fully fill the cuvette

ExMC HemoCue ISS Flight Experiment

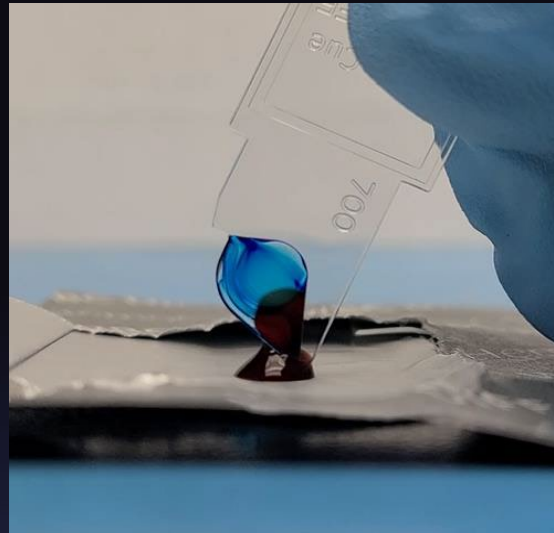


ISS Increment 64 HemoCue Ops session in the GRC Telescience Support Center

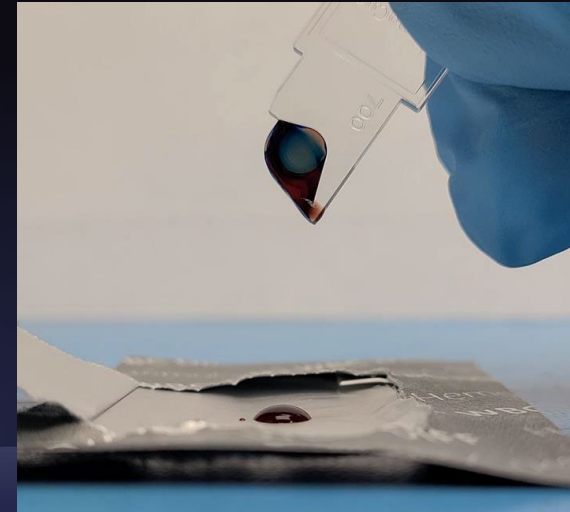
Correct Droplet Size



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

