Evaluating ACLS algorithms for the International Space Station (ISS) – a paradigm revisited

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Overview

• History
• Background
• Current vs. Revised Algorithm
• Evaluation
• Findings
• Revised Algorithm: Short & Long Versions
• Conclusion – How the choice was made
• Challenges with implementation
History

• Emergency medical capabilities aboard the International Space Station (ISS) were developed in the late 1990’s to help astronaut crew medical officers (CMOs) resuscitate a crewmember.

• Two ISS crewmembers are designated as CMOs for each mission and are trained in emergency procedures including Advanced Cardiac Life Support (ACLS).

• ISS CMOs are typically not physicians and ISS crews rarely have an on-board physician.
Background

• The ISS may have communication gaps of up to 45 minutes during each orbit and therefore it is imperative to have medical protocols, including an effective ACLS algorithm, that can be reliably autonomously executed during flight.

• The aim of this project was to compare the effectiveness of the current ACLS algorithm with an improved algorithm having a new navigation format.
Current ACLS Algorithm

CHeCS

Patient Unconscious and Unresponsive

1. Patient breathing?
   - Yes
   - No

2. Restrain patient on CPR kit.
   - Unload Defibrillator, ALS, RSP.

3. Head tilt or chin lift?
   - Give head tilts.
   - Do breaths go in?
   - Yes
   - No

4. Position head.
   - Attempt two breaths.
   - Do breaths go in?
   - Yes
   - No

5. Check Pulse.
   - Pulse present?
   - Yes
   - No

   - Position patient on CMR.
   - Attaching large Defibrilator pads to patient.
   - Turn knob”R” to Defibr. Analysis.
   - Press ANALYZE.

7. Shock Attempted?
   - Yes
   - No

8. Check Energy 20 J.
   - Press CHARGE.
   - Call “Cleveland.”
   - Press DISCHARGE (two orange buttons).
   - Wait 5 seconds.
   - Press ANALYZE.

9. Shock attempted?
   - Yes
   - No

10. Check Energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

11. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

12. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

13. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

14. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

15. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

16. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

17. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.

18. Check energy 300 J.
    - Press CHARGE.
    - Call “Cleveland.”
    - Press DISCHARGE (two orange buttons).
    - Wait 5 seconds.
    - Press ANALYZE.
Current ACLS Algorithm

1. Patient Unconscious and Unresponsive
   - Check Pupils; note presence
   - Yes: Go to 13
   - No: Go to 2

2. Restrain patient on CMRI
   - Unload Defibrillator, ALS, RSP

3. Head lift or chin lift
   - Give two breaths
   - Do breaths go in?
   - Yes: Go to 10
   - No: Go to 7

4. Reposition head
   - Attempt two breaths
   - Do breaths go in?
   - Yes: Go to 10
   - No: Go to 7

5. Restrain patient on CMRI
   - Glue five chest thrusts
   - Try Magill forceps
   - Layngoscope (ALS, Artery, Subcut., 13, 14, 15, 16, 17)
   - Reposition head
   - Attempt two breaths
   - Do breaths go in?
   - Yes: Go to 10
   - No: Go to 7

6. ILMA inserted?
   - Yes: Go to 13
   - No: Go to 7

7. Has airway clearing been attempted three times?
   - Yes: Go to 10
   - No: Go to 7

8. Check Energy 200 J.
   - Press CHARGE
   - Call "CLEAR"
   - Press DISCHARGE (two orange buttons)
   - Wait 5 seconds
   - Press ANALYZE
   - Shock advised?
   - Yes: Go to 13
   - No: Go to 7

11. 11.

14. Check Energy 300 J.
   - Press CHARGE
   - Call "CLEAR"
   - Press DISCHARGE (two orange buttons)
   - Wait 5 seconds
   - Press ANALYZE
   - Shock advised?
   - Yes: Go to 13
   - No: Go to 7

18. Check Energy 300 J.
   - Press CHARGE
   - Call "CLEAR"
   - Press DISCHARGE (two orange buttons)
   - Pulse present?
   - Yes: Go to 13
   - No: Go to 7
Current ACLS Algorithm

• Originally adapted to the ISS Malfunction ('Mal') format
• Latest revision was 10 Aug 06
• 3 pages in length
Revised ACLS Algorithm

1. Assess for safety hazards
2. Relocate victim to LAB
3. Restrain victim on CMRS
4. Assess breathing status

Extra Crewmember begin CPR

Is victim breathing?

Yes

Go to Page 7

No

Give 2 Rescue breaths

Carotid pulse present?

Yes

DEPLOY DEFIBRILLATOR

a. Unstow defibrillator
b. Check multifunction pads connected to Defibrillator
c. Attach pads to victim's chest (see Figure 1)

Go to Page 2

LOCK - Watch for spontaneous chest rise to see if victim is awake/moving.
LISTEN - for exhalation from mouth/nose
FEEL - Feel for exhalation from mouth/nose
Revised ACLS Algorithm

• Format adopted from ACLS Training Materials produced by the American Heart Association (AHA)

• Generated in Fall 2006 by representatives from the NASA-JSC Flight Surgeon Office and Wyle Laboratories’ Medical Simulation Laboratory Group (MSLWG).

• 9 pages in length
Evaluation Method

• Participants (CMO Analogs; n=8) were given a prebrief detailing expectations of the study (“think out loud”).

• Participants were then given the scenarios and used either the current and revised ACLS algorithms to mitigate the medical issue presented on the Emergency Care Simulator.

• The participants used ISS medical equipment as directed by the algorithms.

• All verbal communication and actions by the participants as well as investigator observations were recorded (audio, video, written questionnaire) during each scenario for subsequent analysis.
Configuration of Equipment
Study Findings

- **7 of 8** participants indicated their preference for using the Revised version of the ACLS Algorithm.
- The content within the Revised ACLS Algorithm received higher scores from participants in regards to being:
  - easier to comprehend,
  - having useful pictures,
  - being easier to navigate,
  - having a more intuitive format.
- Only negative finding for the revised was the length (9 pages).
Revised Format - 2 Versions

• **LONG** - 9 Pages
  – Evaluated by MSLWG
  – Follows full ACLS guidelines from AHA

• **SHORT** - 6 Pages
  – Developed from the **LONG** ACLS Algorithm
  – Focuses on defibrillation and CPR
  – Moves to back of algorithm as an appendix
    • drug administration
    • ILMA Troubleshooting
  – Has Respiratory Assessment being directed by Flight Surgeon
Conclusion

- Discussion with Flight Medicine revolved around choice of long v short version:
  - Are AHA guidelines being formally followed
  - Skill level of the crew in delivering medication vis IV
  - Effectiveness of ET Meds in space
  - Early defibrillation benefits
  - What changes would later need to be made to the algorithm with flying an AED as primary intervention instead of the current Defib.

- Vote in favor of the Short Algorithm
- Next phase implementation
Process Issues - Why this isn't a simple change

• FS agreement and consensus is necessary for the change to occur
• Formal Change Request process is in place that must be followed
• Several NASA Boards approval required before inclusion of new algorithm in the ISS Medical Checklist
• New Algorithm format will require waivers from authorities such as SODF (Mal Format owners)
• Labor intensive change in time of limited resources
• Russian translation required
• Training timeline for crewmembers is 18 months pre-flight
• Update will need to be manifested for flight (hard copy and software update)
Back up slides
## Overall Survey Results

### Questions

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<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>Procedure content is concise</td>
<td>5.89</td>
<td>5.50</td>
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<tr>
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<td>5.33</td>
<td>5.83</td>
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*Very Negative Reaction 1-2, Neutral 3-5, Very Positive Reaction 6-7*
## Algorithm Content Survey

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*Completely Disagree 1-2, Neutral 3-5, Completely Agree 6-7*
# Difficulty Survey

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# Frustration Survey

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*Completely Frustrated 1-2, Neutral 3-5, Not Frustrated at All 6-7*
Clarity Errors

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*Type of Clarity Errors: Absence of Cue, Terminology, Congruence*