Risk of Cardiac Rhythm Problems During Spaceflight: Thoughts from the Reviewers

James D. Thomas, MD, FACC, FASE
Director, Center for Heart Valve Disease
Bluhm Cardiovascular Institute
Professor of Medicine, Feinberg School of Medicine, Northwestern University
Chicago, Illinois

Conflicts of interest: GE, Abbott, Edwards (honoraria)
Evidence Report:

Risk of Cardiac Rhythm Problems During Spaceflight

1. How well is the risk understood? What, if any, are the major sources of disagreement in the literature pertaining to this risk?
2. Does the evidence report provide sufficient evidence, as well as sufficient risk context, that the risk is of concern for long-term space missions?
3. Does the evidence report provide evidence that the named gaps are the most critical presented? Are there any additional gaps or aspects of existing gaps that are not addressed for this specific risk?
4. Does the evidence report address relevant interactions among risks?
5. Is the breadth of the cited literature sufficient?

Human Research Program
Human Health Countermeasures Element

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Lyndon B. Johnson Space Center
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How well is the risk understood?
What, if any, are the major sources of disagreement in the literature pertaining to this risk?

• There is concern among the reviewers about viewing risk of arrhythmia monolithically
  – Isolated PACs/PVCs entirely benign
  – Nonsustained VT in a normal heart likewise benign
  – SVT is benign but may need treatment and could impact a mission
  – AF is serious and requires treatment but likely could be managed in flight if meds are available
  – Most worrisome are VT/VF, which could be lethal if subject unmonitored or on EVA

• Arrhythmias may be primary problem but often are just one manifestation of underlying heart disease
Does the evidence report provide sufficient evidence, as well as sufficient risk context, that the risk is of concern for long-term space missions?

- The overall risk of arrhythmias is low but grows with the duration of the mission, the delay in communication with Earth, and difficulty of returning to ground
  - Atherosclerosis/heart disease may develop on a long mission
  - Communications delay would mandate higher training for all in flight as well as autonomous decision support
- Unclear risk of high-energy $\gamma$-rays on coronary disease
  - Further research needed on risk outside Van Allen Belts using ground-based models
  - Balance of screening for lowest risk individuals against losing high-caliber candidates with minimally higher risk
Does the evidence report provide evidence that the named gaps are the most critical presented? Are there any additional gaps or aspects of existing gaps that are not addressed for this specific risk?

- The word “gap” does not appear anywhere in the report
  - There should be a section devoted to this
Does the evidence report address relevant interactions among risks?

• **Risk of arrhythmias grows with exertion**
  – Short runs of SVT, VT, and AF often seen during stress tests
  – Usually self-limiting

• **Risk of arrhythmias grows with electrolyte imbalance**
  – Usually autoregulated but can we check these in flight?

• **Unclear risk of arrhythmias from high-energy γ-rays**
  – Both primary risk and secondary to accelerated atherosclerosis

• **Unclear how much underlying structural heart disease (e.g. valve regurgitation) or atherosclerosis in astronaut candidates is acceptable**
Is the breadth of the cited literature sufficient?

• Very complete on existing reports of arrhythmias in flight
• Could expand on general literature showing benign nature of most of these issues
• Little literature available on impact of high-energy $\gamma$-rays on arrhythmias (and other heart disease)
• There should be more discussion as to specific diagnostic and therapeutic needs in flights
  – Continuous EKG monitoring? Autonomous diagnosis?
  – Diagnostic ultrasound? Autonomous view guidance and interpretation?
  – What medicines should be carried and in what quantities? Enough for short-term use or for duration of mission?
Rather than focus narrowly on arrhythmias, we need a new, overarching cardiovascular risk
The Risk of Accelerating or Precipitating Mission Threatening Cardiovascular Disease Events During Long Duration Spaceflight

• **Risk of an acute coronary event in space**
  – Risk of flying an astronaut with pre-existing but subclinical disease
  – Risk of the spaceflight environment (confinement, radiation, etc.) accelerating or initiating disease

• **Risk of an arrhythmia in space**
  – Risk of atrial fibrillation (in middle aged men and women), including rhythm/rate control and stroke risk
  – Risk of non-life threatening arrhythmias
  – Risk of life-threatening arrhythmias (including QT prolongation in susceptible individuals)

• **Risk of myopericardial disease in space**
  – Mostly this risk would be from radiation

• **Importance of non-human primates to answer some of the basic questions regarding radiation and CV disease**