Atrial Fibrillation During an Exploration Class Mission

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Have no financial relationships to disclose

The authors will not discuss off-label use and/or investigational use in this presentation
Outline

1. Background
2. Causes of Atrial Fibrillation
3. Mission to Mars
4. Medical Resources
5. Distant Medical Management
6. Mission Summary
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1. Background
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After a several month journey, the 7-member crew is preparing to enter a low Mars orbit.

You, the flight surgeon, have just received the mission commander’s video message supplemented with the crew’s biometrics & health status.

The message, delayed by the 20 min transmission lag, confirms the “return to duty” criteria for mission specialist (M.C.)
M.C., a 51-yo mission scientist had presented 2 months earlier via a “store & forward” PMC with the chief complaint of Cardiac Palpitations.

M.C. indicated feeling a strange “fluttering” & “pressure” in his chest during these bouts.

Three episodes, lasting ~3hr & terminating with bed rest, were diagnosed as Paroxysmal Atrial Fibrillation (PAF).
Medical Background

M.C.’s cardiac exam 30 days before mission take-off indicated:
- CAD risk factors
- Cardiac Ca^{2+} score
- Significant ectopy during Holter
Medical Background

- M.C.'s cardiac exam 30 days before mission take-off indicated:
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  - cardiac Ca\textsuperscript{2+} score
  - significant ectopy during Holter

- EKG obtained during all three PAF episodes revealed AF with:
  - ventricular rate of \(\sim 150\) bpm
  - narrow complex QRS
  - ST- or T-wave abnormalities
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- Ø cardiac Ca²⁺ score
Medical Background

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- Significant ectopy during Holter

EKG obtained during all three PAF episodes revealed:
- AF with:
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  - Narrow complex QRS
  - ST- or T-wave abnormalities

M.C. indicated having an URTI 3 weeks before the first bout of PAF, in which pseudo-ephedrine was used and a slight hand tremor was noted.
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Medical Background
AF & the Astronaut Corps

- Since 1950’s, 17 cases of AF have been diagnosed amongst 317 active & retired astronauts (~5%)
- Since the 2001, 5 astronauts underwent RFA treatment for atrial arrhythmias
- Of significance is the younger age (~40s) in which these arrhythmias are detected (vs >60 years)
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AF & the Astronaut Corps

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* Since 2001, 5 astronauts underwent RFA treatment for atrial arrhythmias

* Of significance is the younger age (~40s) in which these arrhythmias are detected (vs >60 years)

* Due to: better health surveillance? higher vagal tone? random chance? gravitational-flux induced?
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Terrestrial Mechanisms of Atrial Fibrillation

- Structural Heart Disease
- Pericarditis
- Metabolic Disturbances
- Ectopic Beats
- Myocardial Stretch
- Idiopathic
Mission Question 1:
What Caused M.C.’s AF?

- CO poisoning (a)
- Cardiomyopathy (b)
- Iatrogenic (c)
- Idiopathic AF (lone AF) (d)
- Myocardial infarction (e)
- Pericarditis (f)
- Post-viral thyrotoxicosis (g)
- Pulmonary embolism (h)
- Structural (i)
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Continuation of Mission

The space vehicle is preparing to fire its engines to enter a parking orbit around Mars.

Any chance of returning to Earth in less than 1 year is impossible.
Mission Question 2: At this point you decide to...

a) continue mission, watchful waiting, EKG when symptomatic

b) Abort mission due to poor prognosis & risk of thromboembolic event

c) continue mission, start ASA daily with bi-monthly EKG follow-up exams

d) continue mission, start a β-blocker for possible thyrotoxic disease
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The Mission at Home

The last few weeks have been a harrowing experience for you as the mission Flight Surgeon.
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  • abort mission, sling-shot burn around Mars and return to Earth within 6 months.
The Mission at Home

The last few weeks have been a harrowing experience for you as the mission Flight Surgeon.

You have organized an international aerospace cardiology expert panel to decide:

• abort mission, sling-shot burn around Mars and return to Earth within 6 months

• continuing with the Mars landing and subsequent 1-year surface endeavour
The Mission at Home
Crew Supplies

* Adequate ASA for the whole mission
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Crew Supplies

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* Insufficient anti-coagulation, rate control & rhythm control medications for one astronaut
The Mission at Home
Crew Supplies

* Adequate ASA for the whole mission

* Insufficient anti-coagulation, rate-control & rhythm control medications for one astronaut

* An Automatic External Defibrillator (AED) device
Mission Question 3: Inquest

In your testimony to the international experts’ conference, you state that:

a. ASA is just as effective as warfarin for anticoagulation
b. the risks and difficulty monitoring warfarin therapy outweigh the stroke risk reduction
c. low-molecular weight heparin is not effective in treating thromboembolic risks associated with AF
d. Immediate electrical cardioversion would preclude the need for anticoagulation
The Mission at Home
Inquest

At the experts’ panel, you present an extensive pre-mission risk/benefit study analysis:

- long-duration mission profile
- age and excellent health of crew
- risk of lone AF and subsequent crew member impact, including fatal stroke

Conclusions:
- impact & risk of warfarin therapy > ASA therapy

At time of mission planning, newer direct thrombin inhibitors not yet vetted
Mission Question 3: Inquest

In your testimony to the international experts’ conference, you state that:

a. ASA is just as effective as warfarin for anti-coagulation
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Continuation of Mission

* Their Mars surface mission proceeded uneventfully until ~1 year after landing when M.C. noticed 24 hours of persistent palpitations, just 3 days before scheduled lift-off & return.
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Holter confirmed: **AF** - rapid ventricular response

165 bpm

pressure 90/50 mmHg
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Holter confirmed: **AF** - rapid ventricular response
165 bpm
pressure **90/50 mmHg**

M.C. notes feeling uncomfortable, but denies chest pressure or dyspnea.
Mission Question 4:

At this point, you would recommend:

- **a** Nothing, M.C. can be expected to spontaneously convert to NSR in the next 24 hours
- **b** Rate control and reassess
- **c** Rate control and initiate immediate chemical cardioversion
- **d** Immediate electrical cardioversion due to hypotension
Mission Question 4:

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- Nothing, M.C. can be expected to spontaneously convert to NSR in the next 24 hours
- **Rate control** and reassess
- **Rate control** and initiate immediate chemical cardioversion
- Immediate **electrical** cardioversion due to hypotension
Mission Question 4:

Rate control first choice, AF can ↓ ventricular filling by ~20%
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* $\text{Ca}^{2+}$ channel blocker vs β-blocker, side-effects

* Spontaneous conversion common <24 hours (~67%)
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* Rate control first choice, AF can ↓ ventricular filling by ~20%

* Ca²⁺ channel blocker vs β-blocker, side-effects

* Spontaneous conversion common <24 hours (~67%)

* Electrical cardioversion only when symptomatic
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Crew member M.C. continued to take ASA and was acutely rate controlled with Ca\textsuperscript{2+} CB
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Of interest was his conversion back to NSR during the 4 minutes of 3G_x loading during lift off from the Martian surface.
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Of interest was his conversion back to NSR during the 4 minutes of 3G\textsubscript{x} loading during lift off from the Martian surface

M.C. remained in NSR for the duration of the journey back to Earth and the mission was completed successfully
This case was to acquaint the audience with the tremendous challenges that face the flight surgeon and medical team when supporting a space mission.
Summary

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Limited crew training time, medical hardware & pharmaceuticals manifested dictate aggressive 1° & 2° prevention strategies to protect a multi-billion dollar asset like the ISS or a mission to the Moon or Mars.
Acknowledgements

- Dept. Anaesthesia
- Memorial University
- Wyle Life Sciences
- NASA - JSC
- CSA
- Jillian Pashley