DO THE ADVANCES IN DIAGNOSIS REALLY HELP THE AEROMEDICAL EXPERT?

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I have no financial relationships to disclose

The opinions or assertions expressed here in are the private views of the authors and are not to be considered as official or as reflecting the views of the French Military Health Service, or ESAM.
BACKGROUND

What are diagnostic advances?
New technique or new protocol, indication, usefulness, information provided
New syndrome or disease (ERS - 2009)
New consensus (ARVC/D - 2010)

What is the main problem?
Management of investigations

What is the context?
Evidence-based medicine

<table>
<thead>
<tr>
<th>Classes of recommendations</th>
<th>Definition</th>
<th>Suggested wording to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.</td>
<td>Is recommended/is indicated</td>
</tr>
<tr>
<td>Class II</td>
<td>Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure.</td>
<td>Should be considered</td>
</tr>
<tr>
<td>Class IIa</td>
<td>Weight of evidence/opinion is in favour of usefulness/efficacy.</td>
<td>Should be considered</td>
</tr>
<tr>
<td>Class IIb</td>
<td>Usefulness/efficacy is less well established by evidence/opinion.</td>
<td>May be considered</td>
</tr>
<tr>
<td>Class III</td>
<td>Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful.</td>
<td>Is not recommended</td>
</tr>
</tbody>
</table>
In care medicine: evidence-based practice

What benefits for the health?
What risks for the health?
BACKGROUND

In clinical aviation medicine: additional questions

Interesting information to take aeromedical decision?
Possible unsuitable results to consider?
1. IS IT A MEDICAL OR AEROMEDICAL INDICATION?

**DIABETES**

« In asymptomatic patients, routine screening for Coronary Artery Disease is not recommended as it does not improve outcomes as long as atherosclerotic CVD risk factors are treated. »

« Despite abnormal myocardial perfusion imaging in more than one in five patients, cardiac outcomes were essentially equal (and very low) in screened versus unscreened patients. »

« Any benefit of newer noninvasive CAD screening methods, such as computed tomography and angiography, to identify patient subgroups for different treatment strategies remains unproven. »

1. IS IT A MEDICAL OR AEROMEDICAL INDICATION?

RENAL COLIC

In care medicine
Imaging for diagnosis, severity, chance of evacuation

In aviation medicine
Imaging to look for other (renal) kidney stones
1. IS IT A MEDICAL OR AEROMEDICAL INDICATION?

**SARCOIDOSIS**

In pneumonology
Investigations for diagnosis, radiological type, lung function, activity
If asymptomatic:
No screening guidelines for extra-mediastino-pulmonary granulomas

In aviation medicine
Specific screening for pilots

<table>
<thead>
<tr>
<th>Organs</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes</td>
<td>20%</td>
</tr>
<tr>
<td>Skin</td>
<td>20%</td>
</tr>
<tr>
<td>Lymph nodes</td>
<td>20%</td>
</tr>
<tr>
<td>Liver</td>
<td>20%</td>
</tr>
<tr>
<td>Spleen</td>
<td>5-10%</td>
</tr>
<tr>
<td>Nervous system</td>
<td>5-15%</td>
</tr>
<tr>
<td>Heart</td>
<td>5-25%</td>
</tr>
<tr>
<td>ENT</td>
<td>2%</td>
</tr>
<tr>
<td>Kidney</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>&lt; 2%</td>
</tr>
</tbody>
</table>
2. IS IT THE MOST APPROPRIATE CHOICE?

KIDNEY STONES

Efficiency of investigations

<table>
<thead>
<tr>
<th></th>
<th>Plain X-ray</th>
<th>Ultrasound</th>
<th>Helical CT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Se</strong></td>
<td>44-77%</td>
<td>45%</td>
<td>&gt; 96%</td>
</tr>
<tr>
<td><strong>Sp</strong></td>
<td>80-87%</td>
<td>88%</td>
<td>&gt; 95%</td>
</tr>
</tbody>
</table>

Is a « stone free » condition absolutely required?

- Pilot vs non pilot
- Professional vs private
- Multi vs mono or fighter pilot
- Initial vs periodical assessment

Niemann T. AJR Am J Roentgenol 2008
Heidenreich A. Eur Urol 2002
Tamm EP. Radiology 2003
Ray AA. Urology 2010
Türk C. EAU 2015
2. IS IT THE MOST APPROPRIATE CHOICE?

LEFT BUNDLE BRANCH BLOCK

Coronary artery calcium score
   Interesting to better define the absolute CV risk

Coronary angiography
   Appropriate if high-risk patient

Computed Tomography
   Interesting if low-risk patient (good negative predictive value)

MRI
   Many information provided: LVEF, LV Volume, ischaemia, late enhancement
The AME should use the literature study to observe the advantages and drawbacks of a new technique or protocol and to decide its place in the daily practice of aeromedical expertise.
3. IS AN IMPACT ON AEROMEDICAL DECISION EXPECTED?

HEAD TRAUMA

If unclear information on anamnesis and medical report
- Duration of loss of consciousness or amnesia?
- Results of initial CT?

Brain MRI to screen for hemosiderin sediment
- If positive: severe head trauma
  - higher epileptic risk
  - new decision-process (delay, EEG, multipilot...)

3. IS AN IMPACT ON AEROMEDICAL DECISION EXPECTED?

ATRIAL FIBRILLATION

CHA₂DS₂-Vasc = 0: a new category of patients and pilots

- Very low thrombo-embolic risk
- No anticoagulant therapy
- A more «open» aeromedical decision

**Table:**

<table>
<thead>
<tr>
<th>CHA₂DS₂-VASc Score</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>C Congestive Heart Failure/LV Dysfunction</td>
<td>1</td>
</tr>
<tr>
<td>H Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>A Age ≥ 75 Years</td>
<td>2</td>
</tr>
<tr>
<td>D Diabetes Mellitus</td>
<td>1</td>
</tr>
<tr>
<td>S Stroke (TIA/TE)</td>
<td>2</td>
</tr>
<tr>
<td>V Vascular Disease[a]</td>
<td>1</td>
</tr>
<tr>
<td>A Age 65-74 Years</td>
<td>1</td>
</tr>
<tr>
<td>S Sex (female)</td>
<td>1</td>
</tr>
</tbody>
</table>

**Annual Stroke Risk**

- 1 point = 1.3%
- 2 points = 2.2%
- 3 points = 3.2%
- 4 points = 4.0%
- 5 points = 6.7%
- 6 points = 9.8%
- 7 points = 9.6% (small sample size)
- 8 points = 6.7% (small sample size)
- 9 points = 15.2%
3. IS AN IMPACT ON AEROMEDICAL DECISION EXPECTED?

PREMATURE VENTRICULAR BEATS

20-yo Class 1 applicant, asymptomatic, no family history

PVB on ECG (LBBB morphology, unusual axis)
Holter : 6,000/d
Echo : normal
Exercise test : negative, persistent PVB
Late potential by SAECG : positive for 3 parameters
New ECG : doubtful Epsilon wave
But MRI : normal
3. IS AN IMPACT ON AEROMEDICAL DECISION EXPECTED?

PREMATURE VENTRICULAR BEATS

20-yo Class 1 applicant, asymptomatic, no family history

<table>
<thead>
<tr>
<th>Major Criteria</th>
<th>Minor Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 minor criteria or 1 major + 1 minor criteria</td>
<td>Possible or borderline diagnosis</td>
</tr>
</tbody>
</table>

A not so good long-term prognosis

→ Unfit, decision by licencing Authority (favourable opinion)

The AME should check the impact on aeromedical decision

If no impact expected: useful investigation?
  appropriate tool?

But some investigations may be prescribed during expertise for prevention only
  = AME as a role of GP
4. SHOULD THE RESULTS BE CALLED INTO QUESTION?

CARDIAC MRI

45-yo Class 1 airline pilot, asymptomatic, low CV risk

Dec 2014: LBBB
- Echo: LVEF 53%, LV no dilated
- Coronary CT: normal

Jan 2016: MRI asked by cardiologist
- No ischaemia, LVEF 43%, a/hypokinesia 3/17 segments, late enhancement
- Diagnosis of CAD with necrosis sequela, medical treatment...
4. SHOULD THE RESULTS BE CALLED INTO QUESTION?

CARDIAC MRI

45-yo Class 1 airline pilot, asymptomatic, low CV risk

Feb 2016:

2\textsuperscript{nd} look of MRI: possible CAD
  - Coronary angiography: normal
  - Screening for thrombophilia: negative
3\textsuperscript{rd} look of MRI: possible LV non-compaction

Sep 2016: new MRI

LVEF 46%, septal dyskinesia, non-compacted/compacted myocardium ratio < 2.3

\rightarrow Diagnosis of cardiomyopathy not confirmed
4. SHOULD THE RESULTS BE CALLED INTO QUESTION?

Possible results
- Normal EEG
- Variation of normality, physiological figures
- Doubtful EEG
- Abnormal EEG

Interpretation may change depending on the neurology specialist...
- Interesting 2nd look
- Before a 2nd EEG...

EEG

Normal Abnormal
The AME should not be prisoner of the interpretation
   Easier if periodical activity in relation with investigations

A « culture of investigation-practice » in the French military AeMC
   Most of aeromedical experts : first-line cardiac exams
   A few of them : specific techniques as EEG and cardiac MRI
   With activity for aircrews and real patients

Interest of a collective opinion ++
   Easier in AeMC
5. WHAT IS THE BEST DECISION BEFORE THE RESULTS?

A case-by-case decision depending on
The presumed disease or syndrome
The pre-test probability
and
The real job and flying activity

Temporary fit or grounding ++

Decisions may change depending on the evolution of knowledge...
EARLY REPOLARIZATION PATTERN

CONCLUSIONS

An early-repolarization pattern in the inferior leads of a standard electrocardiogram is associated with an increased risk of death from cardiac causes in middle-aged subjects.

CONCLUSIONS

In view of the relatively high prevalence of the early repolarization pattern without ST-segment elevation in apparently healthy subjects (27) as per the new definition, we believe it necessary to state that, pending further research, in the absence of syncope or a strong family history of juvenile sudden cardiac death, the finding of the early repolarization pattern does not merit further investigation, irrespective of ST-segment slope. This paper provides a basis on which future research can be undertaken through shared data and standardized measurements.
6. ARE THERE UNEXPECTED or UNSUITABLE RESULTS?

24-yo fighter student pilot

Recurrent headaches

Brain MRI: pineal gland tumor 15x18x11 mm
  no Gd-enhancement

EEG: normal

Tumor biomarkers: normal

Specialized consultations/opinions: wait and see new imaging

No change on MRI at 3, 6, 12 mo

Vigilance tests: normal

Waiver, transport pilot, regular follow-up
6. ARE THERE UNEXPECTED or UNSUITABLE RESULTS?

31-yo fighter navigator

Acute headache
Brain CT: thalamic lesion
Brain MRI: confirmed, 7 mm long axis
no Gd-enhancement

Specialized consultations/opinions
1st diagnosis: ischaemic stroke
Complete check-up: no aetiology
2nd diagnosis: low or high-grade tumor
MRI at 3, 6 mo: no change... fit to fly
MRI at 12, 24 mo: no change... THE END
### Cranial MRI

**As a Screening Tool:**

**Findings in 1,772 Military Pilot Applicants**

Weber F.

<table>
<thead>
<tr>
<th>Findings (Total n = 1772)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unequivocal normal findings</td>
<td></td>
<td>81.7%</td>
</tr>
<tr>
<td>Variations of the norm and apparently harmless changes</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Arnold Chiari I°</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Cavum septi pellucidi</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Wide basal cisterns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcification of the falx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osseous changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asymmetry of the ventricles</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Dystop cerebellar tonsilles</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Intracranial lipomas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total variations</td>
<td>160</td>
<td>9%</td>
</tr>
<tr>
<td>Findings of unknown significance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arachnoid cysts (14 left middle ... miscellaneous)</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Intracerebral cysts</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Empty sella</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain atrophy</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Cysts of the pineal gland</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>White matter lesions</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Hydrocephalus int.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total findings of unknown significance</td>
<td>148</td>
<td>8.4%</td>
</tr>
<tr>
<td>Evident pathological cases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arteriovenous malformations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cavernoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerebellar tumors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defect after traumatic brain injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total pathological cases</td>
<td>12</td>
<td>0.7%</td>
</tr>
</tbody>
</table>
6. ARE THERE UNEXPECTED or UNSUITABLE RESULTS?

54-yo businessman and Class 1 pilot (1,300 f.h.)

Cough
Chest X-ray: big aorta?
Thoracic CT: No
  but possible dissection of the superior mesenteric artery
Abdominal CT: confirmed, artery a little dilated
  no other vascular abnormality, no thrombus

Specialized consultation/opinion: periodical echography advised
6. ARE THERE UNEXPECTED or UNSUITABLE RESULTS?

54-yr businessman and Class 1 pilot (1,300 f.h.)

What about *Spontaneous dissection of the superior mesenteric artery*?
- Rare
- 2 symptomatic forms: acute and chronic mesenteric ischaemia
- Symptoms when associated lesions
- Treatment required if symptoms only

**Literature study**: limited information

What decision for this pilot?
- ➡️ for a fighter pilot?
The AME should be aware that some results may change the situation

Not to be surprised of strange interpretations or conclusions

Not to be surprised of unsuitable results

To imagine the unlikely results is part of the AME’s job...
CONCLUSION

Diagnostic advances

Respect of the main principles for the use of investigations

Solution of aviation medicine problems

New questions

Hindsight about the case report

Hindsight about the medical knowledge

Help for the AME
Additional slides...
2. IS IT THE MOST APPROPRIATE CHOICE?

**SLEEP APNOEA SYNDROME**

Respiratory polygraphy
- Easy, rapid, ambulatory exam for initial screening

Polysomnography
- Better for diagnosis and severity (EEG)
- Sleep disorders
- Restless-leg syndrome
- But in sleep-specialized centers only...
4. SHOULD THE RESULTS BE CALLED INTO QUESTION?

CARDIAC IMAGING

36-yo fighter pilot, asymptomatic
14,000 PVB/d

COMPUTED TOMOGRAPHY
LV and coronary arteries: N
RV: dilated?

MRI
LV: N
RV: not dilated, apical fat tissue signal
regional dyskinesia?

ISOTOPIC VENTRICULOGRAPHY
RV: N
LV: septal hypokinesia

STRESS SCINTIGRAPHY
multiple and diffuse defects
« compatible with artefacts »

MRI N°2
LV: N
RV: aspecific signal, no dyskinesia
PREVALENCE OF J WAVE AND EARLY REPOLARIZATION PATTERN IN A LARGE POPULATION OF AIRCREW MEMBERS

E Perrier (1), S Bisconle (1), D Permal (1), O Manen (1), J Derache (1), D Dubourdieu (1), AP Hornez (1), JF Liviez (1), V Martel (1), P Heno (1),

1 Aeromedical Center - RIA PERCY - 92414 CLAMART
2 Aerospace and cardiology department - RIA PERCY - 92414 CLAMART

RESULTS

From 09/01/2009 to 08/31/2010, we analysed 826 standard resting 12 leads ECG of AM (77.2 % male, mean age male: 36.8 +/- 10.2 yo, mean age female: 30.5 +/- 8.7 yo).
- 30.5 % - military aircrew
  (404 fighter pilots including deployed aviators)
- 69.5 % - civilian aircrew

Inferior leads: 60.6 % (N = 152 / 251 = 65.7 %)
Lateral leads: 34.2 % (N = 86 / 251 = 33.4 %)
Both leads: 5.2 % (N = 13)

Prevalence of ER was 2.84 %
n = 251 (231 male = 92.3 %, 20 female = 7.9 %)

Slurring pattern: 63 %
n = 158 / 210 (slurring + notching = 83.6 %)

Notching pattern: 16 %
n = 41 / 93 (slurring + notching = 36.6 %)

Both pattern: 21 % (n = 52)

J elevation > 1.5 mm: 123 (48.6 %)
J elevation 1.5-2 mm: 72 (28.7 %)
J elevation 2-2.5 mm: 40 (15.9 %)
J elevation ≥ 2.5 mm: 12 (4.8 %)
7. ARE THERE LIMITS FOR DIAGNOSTIC ADVANCES?

Radiation exposure
Main problem of CT, advantage of MRI

Cost
Pet-scan...
Not a real problem in such a population

Invasive procedure
In theory not possible if the aeromedical decision is the only justification...