Aviation Cardiology

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ICAO European Regional Civil Aviation Medicine Seminar/Workshop
București
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The applicant shall not possess any abnormality of the heart, congenital or acquired, which is likely to interfere with the safe exercise of the applicant’s licence and rating privileges.
ICAO Annex 1

- SARPs mention
  - CABG, angioplasty, MI
  - Abnormal cardiac rhythms
  - Routine resting ECGs
  - Blood pressure and drugs to lower it
  - Functional & structural abnormalities

- Guidance found in Manual of Civil Aviation Medicine (Doc 8984)
Cardiovascular Incapacitations

- International Air Transport Association Study (1988)
- Sudden incapacitations in 36000 airline pilots over 10 years
- Acute MI leading cause (10 of 26)
Cardiovascular Incapacitations

- Evans and Radcliffe 2004 study on incapacitation

- Incapacitating Event = ‘Incapacitation with symptoms that, if they had occurred in-flight, would have resulted in an inability to act as flight crew for at least 10 minutes’

- Cardiovascular conditions accounted for 44% of the events
Cardiovascular Disease Trends

- Decline in CAD noted since 1970s in Western countries
- From 1992 to 2002 UK CAD death rates fell 44% for people under 65yr
  - 50% fall in men & women aged 55-64yr
  - 35% fall in men aged 35-44yr
  - 32% fall in women aged 35-44yr
(British Heart Foundation)

- 58% of CAD mortality decline in UK during 1980s & 90s attributable to reductions in major risk factors
Causes for Decrease in CAD Mortality

- Smoking reduction in UK (also BP & cholesterol management)

- Reducing cholesterol in USA (also BP & smoking reduction)

- UK data from Unal B et al, Circulation 2004
- USA data from Ford ES et el, NEJM 2007
Death rates from CHD for people aged under 65, 1970-2003, England

Data are 3 year moving averages plotted against middle year.

Changes in death rates from CHD, men and women aged 35-74, between 1990 and 2000, selected countries

Cardiovascular Disease Risk Assessment

- Currently limited operations in pilots over 60yrs & enhanced risk assessment in over 65yrs

- Study awaiting publication
  - Suggests that a significant number of UK pilots under age 65yr have a high absolute risk of CVD
  - May require more comprehensive risk assessment and aggressive risk factor management
ICAO

- November 2009 - Revised Annex 1 Standards and Recommended Practices

- Recommendation – to increase emphasis on health education and prevention of ill health
Cardiovascular Risk Factors

- Age
- Sex
- Family history
- Smoking
- Hypertension
- Diabetes
- Hyperlipidaemia
- Obesity
Sex

UK Annual CVS Mortality Rate 2007

- Men
- Women

Age

%
• completely avoidable!
• cessation produces a rapid decline in risk
• particularly high risk of CAD in the young
• risk factor for so many diseases
Survival from age 35yr among smokers and non-smokers among UK male doctors

Fig 3 Survival from age 35 for continuing cigarette smokers and lifelong non-smokers among UK male doctors born 1900-1930, with percentages alive at each decade of age.

Smoking

- Cessation is extremely beneficial for all age groups, and the earlier smokers quit, the closer will their chances of survival resemble that of never smokers.

From Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years’ observations on male British doctors. *BMJ* 2004;328(7455) :1519
Blood Pressure and Stroke Risk

MacMahon et al - Lancet 1990;335:765-74
(combined results of 9 observational studies - 420,000 subjects)
Lifestyle measures for BP reduction

- British Hypertension Society Guidelines management of hypertension:
  - weight reduction
  - reduced salt intake
  - limited alcohol consumption
  - aerobic exercise
  - reduced total fat and saturated fat intake
  - increased fruit and vegetable consumption

Are all effective in lowering blood pressure

- Alone or in combination these interventions can reduce the need for drug therapy and enhance the effect of antihypertensive agents
Hypertension

- Throughout middle & old age, usual BP is strongly and directly related to vascular (and overall) mortality, without any evidence of threshold down to at least 115/75mmHg.
  - Prospective Studies Collaboration, Lancet 2002

- BP lowering drugs reduce the risk of CHD events and stroke in people with a history of vascular disease and in those with high BP

- The effect of BP lowering drugs in reducing disease is entirely due to BP reduction (special extra effect of B Blockers)

- Proportional reduction in CHD events and stroke for a given reduction in BP, an approximate halving of risk for each 10mmHg diastolic reduction (same in people without high BP)
  - Law et al, BMJ 2009
Diabetes

- Evidence for:
  - Effects of Type 2 Diabetes develops 5-10yr prediagnosis
  - Hyperinsulinaemia associated with insulin resistance
  - Increase in blood pressure and triglycerides
  - Start of microvascular disease
  - Pre-dates rises in blood glucose

- Action on this limited by lack of cost effective population screening
Diabetes

- Better diet
- Increased physical activity
- Modest weight loss

-> could reduce development of Type 2 DM in high risk middle aged adults by 58%

Finnish Diabetes Prevention Study, Finland
Diabetes Prevention Programme, USA
Diabetes

- Decrease in life expectancy at time of diagnosis
  - Life expectancy decreases 8yr if diagnosed age 50yr

- CV risk in type 2 diabetic is same as aged matched individual who has had an MI

- ‘Window of Opportunity’ after diagnosis
  - Acting early after diagnosis to gain tight control can have a significant impact on future outcome
  - May be unable to change outcome if good control is delayed, even with later good control

- Aim for HbA1c 7.5%
  - Currie C et al, Lancet 2010
Hyperlipidaemia

- Air Force/Texas Coronary Atherosclerosis Prevention Study
- Primary prevention study
- Symptom free subjects with average cholesterol 5.5 mmol/l
- Randomised to statin vs. placebo
- Results:
  - Reduction all end-points 37%
  - Reduction fatal/non-fatal MI 40%
  - Reduction CABG/PTCA 33%
- Statins - remarkable safety profile to date
Hyperlipidaemia

- WOSCOPS - further data
- 24% reduction LDL - almost 50% reduction CHD events
- proportionally same risk reduction throughout LDL range studied
- at equivalent ‘treated’ LDL levels (range 3.6 - 4.6 mmol/l) - patients on pravastatin had a benefit over placebo
Obesity and Risk

- Wt directly related to BP
- adverse lipid profile
- insulin resistance
- greater CVS mortality
- greatest risk with central obesity (waist/hip ratio, waist circumference)
Cardiovascular Risk Calculators

- Doctors assessing risk by themselves – unreliable

- Several calculators available for absolute risk combining assessment of risk factors

- Study in BMJ 2009 suggests QRISK for UK populations

- Commonest in use currently are derived from .........
Framingham - Massachusetts, USA

- Epidemiological study started in September 1948
- 3rd generation entered in 2001
CVS risks and the aviator

- intervention thresholds may fall
- treatment guidelines may be more aggressive
- multiple therapy may be more common
- drug safety profiles will need to be scrutinised
- more aviators will require medical monitoring
- which means that life style modification becomes even more valuable in this occupational group
Way ahead

- Emphasis on cardiovascular risks and health promotion in younger pilots

- More attention to absolute risk assessment in older age groups with possible lowering of threshold for further cardiovascular assessment
Resting ECGs

- required routinely depending on age & certificate required
- insensitive tool for presymptomatic coronary artery disease
- better for detecting rhythm & conduction disturbances
- minor anomalies -> further & fuller review
# Routine Resting ECGs

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<tr>
<th>Age</th>
<th>&lt;30yr</th>
<th>30-40yr</th>
<th>40-50yr</th>
<th>50-60yr</th>
<th>&gt;60yr</th>
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<tr>
<td>Class 1</td>
<td>At initial</td>
<td>(At least every 2 yr)</td>
<td>At least every year</td>
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<tr>
<td>Class 2</td>
<td>(At initial)</td>
<td>At first issue after 40yr</td>
<td>At least every 2 yr</td>
<td></td>
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<tr>
<td>Class 3</td>
<td>At initial</td>
<td></td>
<td>At least every 2 yr</td>
<td></td>
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</tr>
</tbody>
</table>
Exercise ECGs

- ICAO SARP not required routinely
- Widely used for “further & fuller review”
- Bruce Protocol is most widely used
- Minimum 9 minutes (completed Stage 3)
Exercise ECGs

For 1000 middle age pilots where prevalence of significant coronary artery disease ~2%

<table>
<thead>
<tr>
<th></th>
<th>Abnormal Ex ECG</th>
<th>Normal Ex ECG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot has coronary artery disease</td>
<td>True Positives 12-14</td>
<td>False Negatives 6-8</td>
</tr>
<tr>
<td>Pilot does not have coronary artery disease</td>
<td>False Positives &gt;50</td>
<td>True Negatives &lt;930</td>
</tr>
</tbody>
</table>

60-70% sensitive and 95% specificity at best (but may be much lower)
Hypertension

- “The systolic and diastolic blood pressures shall be within normal limits.”
- “The use of drugs for the control of blood pressure shall be disqualifying except for those drugs, the use of which is compatible with the safe exercise of the applicant’s licence and rating privileges.”
Hypertension

- Manual of Civil Aviation Medicine – “consistently >160/95 mmHg is disqualifying from all classes of certification.”

- From NAA suggested protocol
  - 24-hour ambulatory blood may be of value
  - If hypertension is confirmed the pilot should be made temporarily unfit or medical certificate issue should be delayed.
Hypertension

- Suggest Class 1 and 3 assessment be by a cardiologist, Class 2 by a cardiologist or family practitioner.
- Risk factors analysis may include measurement of lipid levels, checks for diabetes, family history, smoking and alcohol history, and weight.
- Investigations may include urea and electrolytes, resting ECG, urinalysis and echocardiogram (the latter may not always be necessary but will be if the ECG shows Left Ventricular Hypertrophy, repolarisation changes or LA overload, or when proteinuria is present).
Hypertension

- **Acceptable medication**
  - ACE inhibitor
  - angiotensin-II receptor antagonist
  - calcium-channel blocker
  - beta-blocker (cardioselective preferred, e.g. atenolol or bisoprolol. Not propranolol)
  - thiazide diuretic (usually bendroflumethiazide)
  - potassium-sparing diuretic (e.g. spironolactone or amiloride)

- **Unacceptable medication**
  - Centrally acting agents (e.g. methyldopa)
  - Adrenergic blocking drugs (e.g. guanethidin)
  - Alpha-blocking drugs (e.g. doxazosin)
  - Loop diuretics (e.g. furosemide)
Hypertension

- Confirm that the BP has stabilised on acceptable treatment (for a minimum of 2 weeks) and that the pilot has no treatment-related side-effects
- Attention to risk factors
- If satisfactory a fit assessment can be made and a medical certificate can be issued.
- Cardiology follow up may be required.
- A change of medication or increase in dose will require a further period of grounding (usually two weeks) and reassessment
- Pilots with complications of hypertension or multiple risk factors need more careful consideration and possibly a multicrew or safety pilot
Class 1/2 certification - Hypertension

Hypertension
(Note 1)

Unfit or Certificate issue delayed if
BP exceeds 160 systolic and/or 95 diastolic

Assessment (notes 1&2)
and Treatment (note 3)

NOTES:
1) DIAGNOSING HYPERTENSION
   If blood pressure (BP) >140/90, take second measurement during examination. If second measurement substantially different, take a third measurement. Record the lower of the last 2 measurements on MED 161. If BP >140/90, perform 24hr ambulatory BP. Use mean value of at least 14 measurements during waking hours. If 24hr ambulatory BP cannot be tolerated or for class 2 certificate holders, home blood pressure monitoring is acceptable (for each blood pressure recording, take 2 measurements 1 minute apart, take 2 recordings a day for at least 4 days, discard 1st day measurements and use average value of remaining measurements).

2) ASSESSMENT
   See NICE guidelines. (http://www.nice.org.uk/nicemedia/live/13561/58815/58815.pdf)
   Check for end organ damage: echocardiography should be performed if ECG shows LVH, repolarisation changes or LA overload; hypertensive retinopathy or chronic renal disease
   Check urinalysis and urea, creatinine and electrolytes.
   Certificate holders with hypertension should be referred to their GP (Class 2) or Cardiologist (Class 1) for Investigation and treatment

3) BLOOD PRESSURE MEDICATION:
   For pilots already established on a thiazide-like diuretic whose blood pressure is stable and well controlled, treatment can be continued, but if treatment plan is reviewed then alternative acceptable medications should be considered.

   Acceptable medication:
   - Non-Loop diuretics
   - ACE inhibitors (e.g. Ramipril)
   - Angiotensin II / AT1 blocking agents (sartans)
   - slow-release calcium channel blocking agents
   - beta-blocking agents (e.g. Atenolol)

   Unacceptable medication:
   - Centrally acting agents (e.g. methyl dopa)
   - Adrenergic blocking drugs (e.g. guanethidine)
   - Alpha-blocking drugs (Doxazosin may be acceptable in exceptional cases, providing not used as first line treatment- consult AMS)
   - Loop diuretics (e.g. furosemide)

4) A full report from cardiologist (Class 1) or GP (Class 2) to the AME should confirm that the BP has stabilised on acceptable treatment (for a minimum of 2 weeks) and that the pilot has no treatment-related side-effects. If satisfactory a fit assessment can be made and/or a medical certificate issued. For Class 1 holders, reports should be copied to the AMS.

5) Pilots with complications of hypertension or multiple risk factors may need to be referred to (Class 1) or discussed with (class 2) the AMS. Class 1 pilots with multiple risk factors (10 year cardiovascular risk >10%) should undergo periodic exercise testing. An OML may be required.

6) Pilots should provide evidence of BP stability to their AME at their periodic medical examinations.

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Coronary Artery Disease

6.3.2.5.1 An applicant who has undergone coronary artery bypass grafting or angioplasty (with or without stenting) or other cardiac intervention or who has a history of myocardial infarction or who suffers from any other potentially incapacitating cardiac condition shall be assessed as unfit unless the applicant’s cardiac condition has been investigated and evaluated in accordance with best medical practice and is assessed not likely to interfere with the safe exercise of the applicant’s licence or rating privileges.
Coronary Artery Disease

- Asymptomatic no anti-anginal medication
- Angiogram findings (from around time of event)
- Exercise ECG
- Echocardiogram
- Myocardial perfusion scan
- Holter
- Address risk factors
**Class 1/2 certification - Coronary artery disease**

**Coronary artery disease including:**
- Myocardial infarct
- Coronary artery surgery
- Angioplasty / stenting

**Unfit for 6 months**

**Cardiology review (note 1):**
- Symptoms / treatment / risk factors (note 2)
- An angiogram shall be available (note 3)
- Shall require:
  - Exercise ECG (note 4)
  - Echocardiogram (note 5)
  - Perfusion scan (angioplasty/stent/CABG only) (note 6)

**May require:**
- 24 hour ECG (note 7)

**Results acceptable (note 8)**

**Operational assessment (note 9):**
- Class 1 OML (Operational Multi-Pilot)
- Class 2 unrestricted
- Class 2 OSL (Safety pilot)

**Follow-up (note 10)**

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**NOTES:**

1) By a cardiology specialist.

2) No angina or anti-anginal medication. Risk factors shall be assessed and reduced to an appropriate level. All applicants should be on acceptable secondary prevention treatment.

3) Angiogram - obtained around the time of, or during, the ischaemic myocardial event. There shall be no stenosis more than 50% in any major untreated vessel, in any vein/artery graft or at the site of an angioplasty/stent, except in a vessel supplying an infarct. More than two stenoses between 30% and 50% within the vascular tree should not be acceptable. The whole coronary vascular tree shall be assessed (particular attention should be paid to multiple stenoses and/or multiple revascularisations). An untreated stenosis greater than 30% in the left main or the proximal left anterior descending coronary artery should not be acceptable.

4) Exercise ECG - should be symptom limited to a minimum of Bruce stage 4 or equivalent, with no evidence of myocardial ischaemia or significant rhythm disturbance.

5) Echocardiogram - myocardial function shall be assessed and show no important abnormality of wall motion and a LV ejection fraction of 50% or more (Echo not required if ejection fraction measured by stress echocardiography or myocardial perfusion scan).

6) Myocardial perfusion scan - showing no evidence of reversible ischaemia shall be required at least 6 months after angioplasty/stenting/CABG, but not after myocardial infarction unless there is doubt about myocardial perfusion. Stress echocardiogram or MRI perfusion may be accepted in lieu of myocardial perfusion scan.

7) 24 hour ECG - may be necessary to assess the risk of any significant rhythm disturbance.

8) The cardiology report will be reviewed by the Authority Medical Section AMS (Class 1) or AME for Class 2. It may be necessary to see the investigations, in which case the actual tracings/films/videos will be requested. Further investigations may be required. In difficult cases a secondary review panel will be convened. Initial Class 1 applicants will require individual assessment by the Licensing Authority (ILA).

9) Class 1 recertification will require a multi-pilot limitation (OML). Unrestricted Class 2 certification is possible having completed all the above investigations. Class 2 applicants not fully meeting the requirements may be recertificated with a safety pilot limitation (OSL) having completed a satisfactory exercise ECG test (as in note 4).

10) Periodic follow-up (at least annually for the first 5 years) shall include a specialist cardiology review, cardiovascular risk assessment and an acceptable exercise ECG (as in note 4 above). In all cases coronary angiography and/or myocardial perfusion scanning (or equivalent) shall be considered at any time if symptoms, signs or non-invasive tests indicate cardiac ischaemia. In all cases of coronary artery bypass grafting (except Class 2 OSL) a myocardial perfusion (or equivalent) scan shall be performed 5 years after the procedure (if not done before).

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UK Civil Aviation Authority Guidance Material
Version 2.0 01/05/2013
www.caac.co.uk/medical
Class 1/2 certification – Investigation of Suspected Coronary Artery Disease

Suspected coronary artery disease (note 1)

Unfit

Cardiology review (note 2)
Shall require:
Exercise ECG or Coronary Calcium Score (CCS) (note 3)
May require:
24 hour ECG (note 4)
Echocardiogram (note 5)

Abnormal exercise ECG or CCS >100

Abnormal result

Shall require:
Myocardial perfusion scan, MRI perfusion scan, or Stress echocardiogram (note 6)

Normal result

Shall require: Angiogram (note 7)

Results acceptable to the AMS (note 8)

No significant disease Class 1/2 unrestricted
Minor disease Class 1 OML / Class 2 unrestricted or OSL

Follow-up (note 9)

NOTES:

1) Includes symptoms of chest pain/angina, breathlessness, abnormal resting ECG, and/or accumulation of cardiovascular risk factors. Class 1 pilots without symptoms may continue to fly at discretion of AMS.

2) By a cardiology specialist.

3) Exercise ECG - should be symptom limited to a minimum of Bruce stage 4 or equivalent, with no evidence of myocardial ischaemia or significant rhythm disturbance.

4) 24 hour ECG - may be necessary to evaluate any significant rhythm disturbance on resting or exercise ECG.

5) Echocardiogram - may be necessary to assess myocardial structure/function and show no important abnormality of wall motion and a LV ejection fraction of 50% or more.

6) Myocardial perfusion scan, MRI perfusion scan, or stress echocardiogram (dobsultamine or exercise) - showing no evidence of reversible ischaemia. Cases with suspicion of reversible ischaemia or silent infarction require angiographic evidence to decide if anatomical and functional evidence are congruent.

7) Angiogram - An invasive angiogram will normally be required. If a CT angiogram is performed it will only be acceptable when the coronary calcium score is less than 400 (this is to ensure good imaging of the vessels) and the anatomical requirements stated in note 8 are met.

8) The cardiology report will be reviewed by the Authority Medical Section (AMS) for class 1 or AME for Class 2. It may be necessary to see the investigations, in which case the actual tracings/films/videos will be requested. Further investigations may be required. In difficult cases a secondary review panel will be convened.

There shall be no stenosis more than 50% in any major vessel. More than two stenoses between 30% and 50% within the vascular tree should not be acceptable. The whole coronary vascular tree shall be assessed (particular attention should be paid to multiple stenoses). A stenosis greater than 30% in the left main or the proximal left anterior descending coronary artery should not be acceptable.

A normal angiogram (no stenoses >10%) is compatible with unrestricted certification. Class 1 certification of asymptomatic acceptable minor disease may require a multi-pilot limitation (OML). Unrestricted Class 2 certification is possible with acceptable minor disease; a safety pilot (OSL) restriction may be appropriate in borderline cases.

9) Periodic follow-up (normally annual) for established disease shall include a specialist cardiology review, cardiovascular risk assessment and an acceptable exercise ECG (as in note 3 above).
Valve Disease/Replacement

- **Aortic Valve disease**
  - Bicuspid valve
  - Stenosis (echo & Ex ECG – valve area, mean aortic gradient)
  - Regurgitation
  - Aortic Root Disease

- **Aortic Valve Replacement**
  - Tissue valve
  - Review after 6 months (Ex ECG & Echo)
  - For Class 1 restrict to flying multi-crew operations
Valve Disease/Replacement

- Mitral Valve Disease
  - Prolapse
  - Regurgitation

- If asymptomatic cardiology assessment to include at least an echocardiogram
  - Certification appropriate to findings

- Valve Repair (not replacement)
  - 6 months after surgery with similar assessment to aortic valve replacement
Cardiomyopathy

- Hypertrophic Cardiomyopathy (HCM)
  - Genetic link
  - Ventricular wall/Septal hypertrophy
  - Sudden death/Cerebrovascular Accident
- Make temporarily unfit when diagnosed
- Cardiology review
  - include Ex ECG, echo, Holter & may require MRI, angio/Myocardial Perfusion Scanning, Electrophysiological Studies
  - For Class 1 restrict to flying multi-crew operations
Cardiac Arrhythmias (and conduction disturbances)

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An applicant with an abnormal cardiac rhythm shall be assessed as unfit unless the cardiac arrhythmia has been investigated and evaluated in accordance with best medical practice and is assessed not likely to interfere with the safe exercise of the applicant’s licence or rating privileges.
Atrial Fibrillation

- No P waves or flutter waves seen
- Atrial activity absent or chaotic (amplitude & rate)
- Ventricular rate usually grossly irregular
Atrial Fibrillation

- Most common rhythm disturbance causing intermittent or persisting symptoms
- Often associated with structural abnormality
- Depolarisations mainly arising in left atrium
- Population prevalence increases with age
Atrial Fibrillation

- Common causes
  - Lone AF
  - Hypertension
  - Infection
  - Coronary artery disease
  - Alcohol abuse
  - Valvular heart disease
  - Thyrotoxicosis
  - Myocardial disease
  - Electrolyte disturbance
  - Congenital heart disease
  - Pulmonary disease
  - Cardiac surgery
  - Pericarditis
Atrial Fibrillation

- Management involves identifying cause
- Pharmacological or DC shock reversion to sinus rhythm
<table>
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<th>Condition</th>
<th>Score</th>
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<td>Congestive heart failure</td>
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<tr>
<td>Hypertension</td>
<td>1</td>
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<tr>
<td>Age &gt;+75 yrs</td>
<td>1</td>
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<tr>
<td>Diabetes</td>
<td>1</td>
</tr>
<tr>
<td>Stroke or TIA</td>
<td>2</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>1</td>
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<tr>
<td>Age 65-74yrs</td>
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<td>Sc (sex category) female</td>
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<table>
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<tr>
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<tr>
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<td>6.7</td>
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<td>6</td>
<td>9.8</td>
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</table>
Atrial Fibrillation

Class 1/2 Certification - Atrial Fibrillation

Unfit

NOTES:
1) By a cardiological specialist
No significant symptoms and adequate control if paroxysmal, persistent or permanent

Blood tests - Thyroid function normal. Alcohol as a cause of AF should be excluded with a minimum of LFTs (to include GGT and MCV).

Exercise ECG - Bruce protocol and maximal effort or symptom limited on current treatment. At least 9 minutes with no significant abnormality of rhythm or conduction, nor evidence of myocardial ischaemia. (See UK CAA exercise ECG protocol)

24 hr ECG - More than one may be required. The following criteria should be met:
- If in sinus rhythm - No episodes of AF and no pauses >2.5s whilst awake. Ventricular arrhythmia should not exceed an aberrant beat count >2% of total, with no complex forms.
- Established AF - RR interval >300ms and <3.5s (i.e. no very rapid rates or long pauses).
- Paroxysmal, persistent & permanent AF - As above plus the longest pause on recapture of sinus rhythm should not exceed 2.5s whilst awake.

Echocardiogram - Should show no significant selective chamber enlargement, or significant structural or functional abnormality, and an LVEF of 50% or more.

Further tests - may include repeat 24 hour ECG recordings, electrophysiological studies, cardiac MRI, myocardial perfusion scanning and/or coronary angiography.

2) For class 1 certificate holders the cardiology report(s) will be reviewed by the Authority Medical Section (AMS). Class 2 applicants will be re-certificated by the AME in consultation with the AMS. It may be necessary to see the investigations, in which case the actual tracings/films/videos/CDs will be requested. In difficult cases a secondary review panel of cardiologists may be consulted.

CHADS2-VASC score

C Congestive heart failure (or Left ventricular systolic dysfunction) = 1
H Hypertension = 1
A Age >75 years = 2
D Diabetes Mellitus = 1
S Prior Stroke or TIA or thromboembolism = 2
V Vascular disease (e.g. peripheral artery disease, myocardial infarction, aortic plaque) = 1
A Age 65-74 years = 1
C Sex category (i.e. female) = 1
G Gender = 1

Assessment of CHADS2-VASC score for certification

0 Class 1 OML / Class 2 Unrestricted
1 Individual assessment
2 Class 2 OSL
>2 Unfit all classes

Acceptable treatment includes sotalol, bisoprolol or other beta-blocking drugs, digoxin, dronedarone (periodic blood testing required to check for hepatotoxicity), diltiazem and verapamil. Exceptionally flecainide or propafenone may be used in consultation with the AMS (with 6 month's demonstrated stability). Amiodarone is normally unacceptable for Class 1, but may be acceptable for Class 2 (maximum dose 200mg daily, night flying will require an AMS ophthalmological review).

3) Initial cardiological follow-up should be 6 monthly to include a minimum of 24 hour ECG monitoring. Subsequent follow-up at the discretion of the AMS, normally annual cardiological review with 24hr ECG and echocardiogram. Other tests if clinically indicated.

4) After 2 years follow up for Class 1, only applicants with a single original episode of AF with no recurrence may be able to achieve unrestricted Class 1 certification. Subsequent follow up normally annual with 24hr ECG.

UK Civil Aviation Authority Guidance Material
Version 1.0 17/09/2012
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Atrial Fibrillation

- Suggested protocol from member state
- Temporarily unfit
- Review with cardiologist
  - Blood tests GGT, MCV, TFTs
  - Exercise ECG (rhythm & ischaemia)
  - Holter (RR>300msec & <3.5sec, Ventric arrhythmia <2%)
  - Echocardiogram (structural & function abnormality)
Atrial Fibrillation

- Other tests – repeat Holters, EPS, MRI, MPS, angiography
- Acceptable treatments include sotalol & other cardio-specific beta-blockers, verapamil, digitalis. Exceptionally flecainide or propafenone may be used (Cl 1 with multipilot limitation)
- Anticoagulation not acceptable
Atrial Fibrillation

- Follow up 6 monthly with at least a Holter
- Follow up Cl 1 & 3 for 2 years and Cl 2 for 1 year
- After 2yr follow-up only applicants with single episode of AF likely to get unrestricted Cl 1 certificate
Atrial Flutter

- P waves missing & flutter waves seen at regular rate
- Rapid rates up to 300bpm may occur
- Troublesome symptoms due to abrupt rate changes
- Incompatible with flying status
Left Bundle Branch Block

- Absence of initial septal q wave in V5, V6, I & AVL
- QRS duration >0.12sec
- Absence of rSr’ in V1
Class 1/2 certification - Left Bundle Branch Block (LBBB)

LBBB on resting ECG

Unfit

Cardiology review
Shall require: (note 1)
- Exercise ECG
- 24 hour ECG
- Echocardiogram
Over age 40: (note 2)
- Investigation of coronary arteries
May require:
- Electrophysiological studies (note 3)

Results acceptable
(note 4)

Certification and first 3 years follow up:
- Class 1 OML (note 5)
- Class 2 Unrestricted or OSL (note 6)

After 3 years

Unrestricted Class 1/2
Follow up (note 7)

Notes:
1) By a cardiological specialist. Shall include:
- Exercise ECG - Bruce protocol and symptom limited. Requirements are at least 9 minutes and no significant ECG (apart from LBBB) or blood pressure changes. (See UK CAA exercise ECG protocol).
- 24 hr ECG - No significant rhythm or conduction disturbance apart from LBBB.
- Echocardiogram - Structurally normal heart and normal LV and RV function (ejection fraction ≥ 50%).

2) Coronary artery investigation - shall be required in all applicants over the age of 40. A myocardial perfusion scan, stress echo, CT angiogram or cardiac MRI will normally be sufficient. Pharmacological stress should be used to avoid difficulties in the interpretation of septal perfusion.

3) EPS studies - should be performed if the PR interval is >200 msec, and possibly if the ECG shows an abnormal axis. The HV interval should be less than 100 msec.

4) For Class 1 applicants the cardiology report will be reviewed by the Authority Medical Section (AMS). If necessary, it may be necessary to see the investigations in which case the actual tracings/films/videos will be requested. In difficult cases a secondary review panel of cardiologicalists will be convened.

5) Class 1 certification - Satisfactory investigations will allow Class 1 OML. Annual cardiology review with a minimum of 24 hour ECG. Review at 3 years should also include a 24 hour ECG and echocardiogram. If satisfactory - unrestricted Class 1 can be issued. Initial Class 1 applicants will need to show a 3 year period of stability, as above, before a class 1 certificate can be issued.

6) Class 2 certification - Satisfactory investigations will allow unrestricted Class 2. If coronary artery investigation was not done at initial assessment, Class 2 applicants over the age of 40 may need to be restricted to OSL (safety pilot). For these pilots unrestricted Class 2 certification can be considered after 3 years satisfactory follow up as in note 4 above.

7) Follow up after the 3 year period: pilots with long standing LBBB should expect to be asked to have occasional cardiology reviews to check that all remains well, particularly if any changes are noted on the resting ECG.

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Left Bundle Branch Block

- New finding of LBBB needs cardiology review & pilot/ATCO is unfit in the meantime
- Cardiology review with Ex ECG, Holter & Echocardiogram
- Consider coronary artery investigation in the over 40’s e.g. perfusion scan/stress echo
- If acceptable could be fit Cl 2 & 3 but for Class 1 consider Multicrew limitation
- Review all regularly for around 3 years & reconsider multicrew limitation if reviews satisfactory
Right Bundle Branch Block

- Secondary positive wave in V1
- Total QRS duration 0.12 sec or more
Class 1/2 certification - Complete Right Bundle Branch Block (RBBB)

Complete RBBB on resting ECG

Some flying may continue (note 1)

Cardiology review (note 2)
Shall require:
Exercise ECG
24 hour ECG
Echocardiogram
May require:
Investigation of coronary arteries

Results acceptable to the AMS (note 3)

Class 1 (note 4):
Age ≤40 Initial/Revalidation/Renewal - unrestricted
Age >40 Initial - no certificate - review 1 year
Age >40 Revalidation/Renewal - OML - review 1 year (note 5)

Class 2 (note 5):
All - unrestricted
Follow-up (note 6)

Notes:
1) Initial applicants should not receive a medical certificate until the cardiology assessment is complete. Established pilots may continue to fly (Class 1 OML/Class 2 unrestricted) but the assessment should be completed within 2 months.

2) By a cardiological specialist. Investigations shall include:
Exercise ECG - Bruce protocol and symptom limited. Requirements are at least 9 minutes and no significant ECG (apart from RBBB) or blood pressure changes. (See UK CAA exercise ECG protocol).

24 hr ECG - No significant rhythm or conduction disturbance apart from RBBB.

Echocardiogram - Structurally normal heart and normal LV and RV function (ejection fraction ≥ 50%).

Further evaluation may be required (for example investigation of the coronary arteries) if any of the above investigations are abnormal.

3) For Class 1 applicants the cardiology report will be reviewed by the Authority Medical Section (AMS). It may be necessary to see the investigations in which case the actual tracings/films/videos/cds will be requested. In difficult cases a secondary review panel of cardiologists will be convened.

4) Class 1 applicants age 40 or under (initial and revalidation/renewal) may have unrestricted certification.

Initial Class 1 applicants over age 40 cannot be certificated until completing a satisfactory follow up review at one year to include an exercise ECG.

Class 1 applicants over age 40 for revalidation/renewal will need an OML and a review again in a year to include an exercise ECG. At that time an unrestricted certificate can be issued if there is no change. If there has been a documented gradual progression from incomplete RBBB to complete RBBB over several years, there will be no requirement for an OML.

5) Class 2 applicants can have unrestricted certification if all the requirements are met. Certification with OSL may be possible if only some requirements are achieved.

6) Pilots with long standing RBBB should expect to be asked to have occasional cardiology reviews to check that all remains well, particularly if there is a change to the resting ECG.

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UK Civil Aviation Authority
Guidance Material
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www.caa.co.uk/medical
Right Bundle Branch Block

- Incomplete RBBB is common & usually acceptable
- Complete RBBB usually ok in asymptomatic individuals
- Warrants cardiological review at first presentation
- Ex ECG, Echo, Holter
- May restrict Class 1 certificate during review and for 1yr in over 40yr pilots
1st Degree Heart Block

- PR > 210ms
- 1% asymptomatic aircrew
- Interval should shorten on exercise
- In absence of broadening QRS (>100ms) is usually benign
2nd Degree Heart Block

- Mobitz Type I 2nd degree heartblock
- Sometimes seen during sleep in normal young, athletic individuals
- Uncommon during the day & therefore warrants further investigation
2nd Degree Heart Block

- Mobitz Type II 2nd degree heart block
- Represents delay in the His-Purkinje network with risk of progression to complete block
- Incompatible with certification
3\textsuperscript{rd} Degree Heart Block

- Complete heart block
- Incompatible with certification
- If no other disqualifying pathology may consider certification after pacemaker inserted as long as not pacemaker dependent
Pacing

- To consider certification:
  - Grounded for 3 months
  - Needs to be bipolar lead system
  - Not be pacemaker dependent
  - Normal echocardiogram, acceptable Holter & Ex ECG
  - Class 1 restricted to multi-crew operations
  - Regular pacemaker/cardiology review

- Implantible defibrillators are disqualifying
Class 1/2 certification - Implantation of a cardiac pacemaker

Pacemaker implanted → Unfit for 3 months → Cardiology review (note 1)
- No other disqualifying condition
- Pacemaker acceptable
- Exercise ECG
- 24 hour ECG
- Echocardiogram

Results acceptable to the AMS (note 2)

Class 1 OML
Class 2 unrestricted

Follow-up (note 3)

NOTES:
1) By a cardiological specialist. Requirements:
   - Pacemaker - bipolar lead system.
   - Battery life - Minimum 1 year
   - Exercise ECG to the Bruce protocol or equivalent. The test should be to maximum effort or symptom limited. Bruce stage 4 should be achieved and no significant abnormality of rhythm or conduction, nor evidence of myocardial ischaemia shall be demonstrated. Withdrawal of cardioactive medication prior to the test should be considered.
   - 24-hour ambulatory ECG shall demonstrate no significant rhythm or conduction disturbance.
   - Echocardiogram shall show no significant selective chamber enlargement, or significant structural or functional abnormality, and a left ventricular ejection fraction of at least 50%.

2) For class 1 applicants, the cardiology report will be reviewed by the Authority Medical Section (AMS). It may be necessary to see the investigations, in which case the actual tracings/videos will be requested. In difficult cases a secondary review panel of cardiologists will be convened.

3) Follow-up will normally be a minimum of a six monthly pacemaker check and an annual cardiology review.

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Any questions?