



Australian Government
Civil Aviation Safety Authority



Cerebral Aneurysm

Aviation Risk Management



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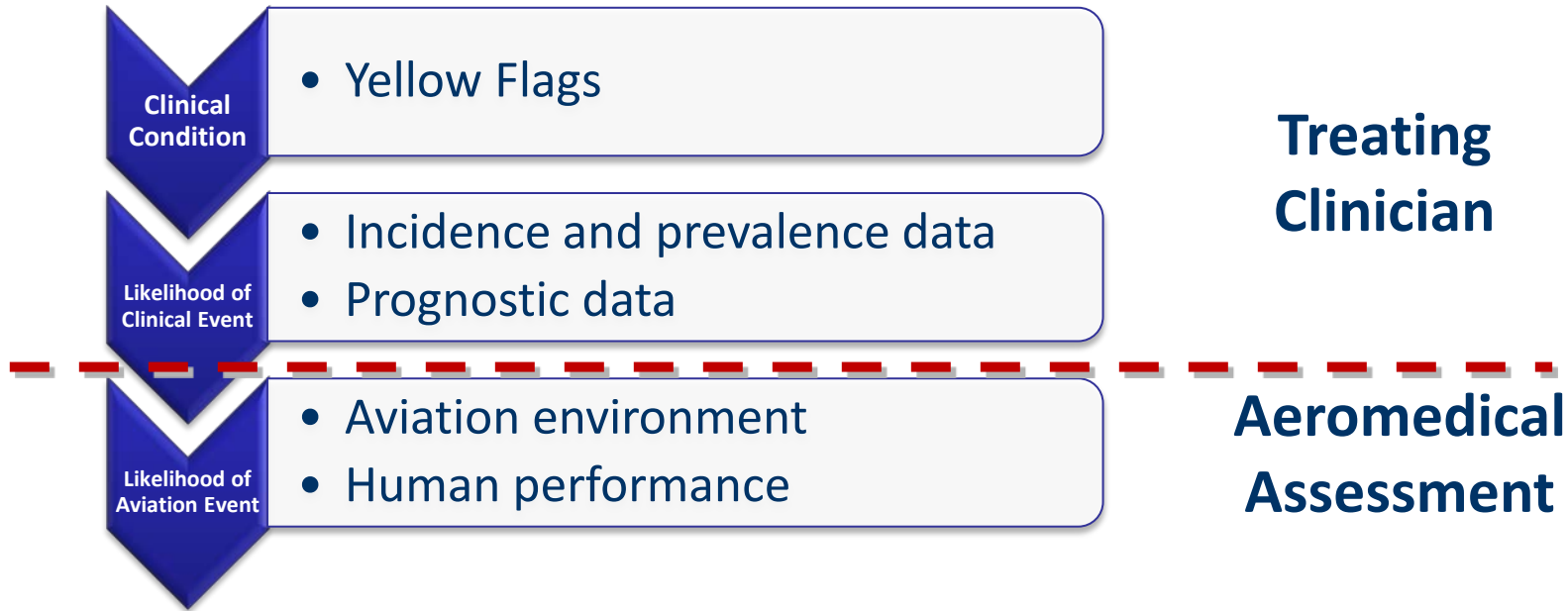


Aeromedical Significance

- “Aneurysm is an abnormal local dilatation in the wall of a blood vessel...”
- Most subarachnoid haemorrhages are caused by ruptured saccular aneurysms.
- Important because of acute onset and incapacitation
- Only about one-third have a “good outcome”



Aeromedical Risk Assessment





Incidental finding

- 3.2% population, (Vernooij 2007, Vlak 2011) 20-30% multiple (Stehbens 1963)
- Mean age 50
- Gender M=F, but F>M over 50yrs
- 85% anterior circulation, mainly Circle of Willis at arterial junctions

Post-rupture



Associated hereditary conditions

- Polycystic kidney (6.9X risk)
- Connective tissue disorder
 - Ehlers-Danlos
 - Pseudoxanthoma elasticum
- Familial aldosteronism Tp 1
- Alpha1 antitrypsin deficiency



Incidence / prevalence data

- Aneurysmal subarachnoid haemorrhage 6 – 16/100,000 [Sarti C 1991]

Risk of rupture

- Size
- Rate of enlargement
- Location & initial size
- Hypertension / Cigarette smoking / Oestrogen deficiency

Post-treatment complications



Size of Aneurysm

International Study of Unruptured Intracranial Aneurysms [ISUIA 2003]

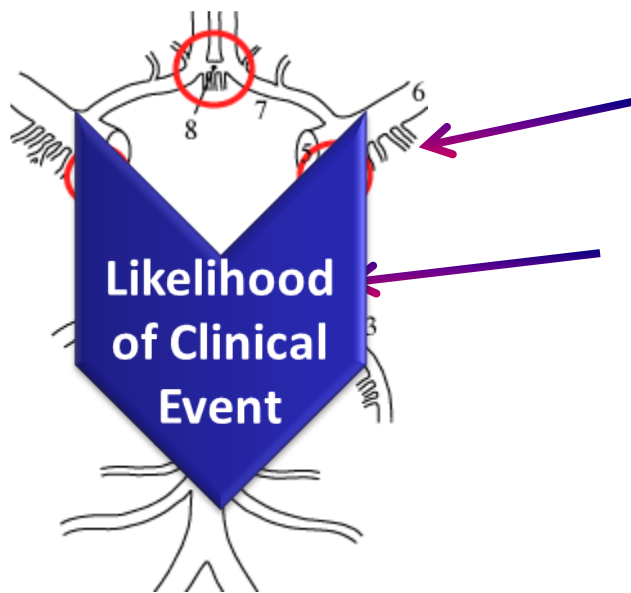
- 6544 pt –years,
- mean 4.1 yrs follow-up

Aneurysm Verification Study [Sonobe 2010]

- 1306.5 pt-years,
- mean 3.4yrs follow-up

Size	Rupture Risk p.a.
<7mm	0.1%
7 – 12mm	0.5%
13 – 24mm	3%
>25mm	8%

Size	Rupture Risk p.a.
<5mm	0.54%
Single	0.34%
Multiple	0.95%



Circle of Willis

Location

**Percent of Aneurysms Enlarging
(Mean 17.7 months)**

Middle Cerebral A	0%
Internal Carotid A	8.8%
Basilar A bifurcation	40%

Initial Size

2 - 4mm	2.4%
5 - 9mm	9.1%
10 - 20mm	50%

[Matsubara S 2004]



Treatment

- Monitor
 - Annual CTA or MRA to demonstrate stability, then @2-3 years
- Surgical clipping
 - Hospital mortality 1.6%¹
 - Morbidity & mortality at 1 year: 30.9%
- Endovascular repair (2D and 3D coils)
 - Hospital mortality 0.6%¹,
 - Recurrence 5 – 15% in 1st 6months
 - Morbidity & mortality at 1 year: 23.5%



Complications: Post-operative Seizures

Predictors of risk for a seizure	Hazard ratios
Neurosurgery	1.64
Younger age	1.54
Neurological deficit	2.1
Thromboembolic complications	5.1

Neurosurgical group had increased seizure risk up to 14 years after clipping, compared with the endovascular group.

[Hart 2011]



Post-operative seizures in patients with good recovery at 2 months.

Non-MCA Treatment	After 1 Year	After 2 Years
Surgical Clipping	1.5%	0.4%
Endovascular	1.8%	0.8%

MCA Treatment	After 1 Year	After 2 Years
Surgical Clipping	10.5%	3.5%
Endovascular	3.4%	2.6% [Hart 2011]



Aviation environment

- Hypoxia & fatigue – increase seizure risk
- ?"Stress"

Human performance

- Acute onset total incapacitation
- Cognitive and executive impairment

Likelihood
of Aviation
Event



CASA Paradigm: Incidental finding

- Low Risk - 5mm or less diameter
- High risk
 - Larger than 5mm
 - Enlarging
 - Multiple aneurysms with $>$ or $=$ 4 mm
 - Previous subarachnoid haemorrhage
 - $<$ 50 years old, hypertensive or family history



CASA Paradigm: Incidental finding

Risk	Class	Certification	Surveillance
Low Risk	1, 3	Multi-crew 1Y	Annual neurosx RV
	2	Unrestricted 1Y	Annual neurosx RV
High Risk	Case - by - case		

Initial certification requires demonstration of stability
eg Rpt CTA/MRA at 6 – 12 months



CASA Paradigm: Post-treatment

- Low risk = <2% seizure risk at one year:
 - Non Middle Cerebral A aneurysm
 - Either clipping OR endovascular coiling
 - No complications at 2 months post-op.
- High risk include:
 - Middle cerebral artery aneurysms
 - Op complications / thromboembolism / ischaemic damage
 - Larger subarachnoid haemorrhages (Fisher Grade >1)



CASA Paradigm: Post-treatment

Risk	Class	Stand-down	Certification	Surveillance
Low Risk	1, 3	2Y	1Y Multi-crew	Annual RV
	2	1Y	1Y With safety pilot	Annual RV
High Risk	Case - by - case			



Summary

- Cerebral aneurysms are common, and not all bleed
- Bleeding aneurysms have high mortality and morbidity
- Look for high risk features in clinical history
 - Familial conditions
 - Past history of SAH
 - Multiple
- Identification low risk group (incidental findings or post uncomplicated treatment) permits medical certification.
- High risk group (Middle Cerebral A or treatment with complications) carries significant risk of seizure which may persist for at least 14 years.



Questions?