

Acute Mountain Sickness HACE and HAPE

急性高山症、高地腦水腫、高地肺水腫

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Acute Mountain Sickness

急性高山症

- Simple AMS
單純型急性高山症
- High Altitude Cerebral Edema (HACE)
高地腦水腫
- High Altitude Pulmonary Edema (HAPE)
高地肺水腫
- Mixed HAPE + HACE
複合型高地腦水腫與肺水腫

AMS (simple) symptoms

急性高山症（單純型）症狀

- Headache
頭痛
- Anorexia – vomiting
食慾不振－嘔吐
- Malaise – misery
不適－痛苦
- Poor sleep
睡眠不良

Nobody dies from AMS

沒人因急性高山症喪生

But many wish they could
但很多人想就此死去
(因為生不如死)

But many wish they could



AMS, von Humbolt, 1802

急性高山症



We all felt a malaise,
a weakness, a wish to
vomit which came
from the lack of
oxygen in these
regions.

我們都覺得不舒適、虛
弱且因缺氧而產生嘔吐
感

• Letter to Delambre after

Expedition to Chimborazo ^{5/30/2024} 6

AMS (Simple) Features 1

急性高山症（單純型）特色1

- Rapid altitude gain.快速提升高度所致
- A latent period of 6-24 hours before symptoms start.症狀發生之潛伏期達 6-24小時
- Great individual variation of susceptibility regardless of fitness level.
個體各別差異極大，且與體適能水準無關
- Only predictor is past altitude history. 過
往紀錄僅能為參考
- All ages, races, both sexes at risk.
所有年齡層、運動能力、性別均處於危險之中

AMS (Simple) Features 2

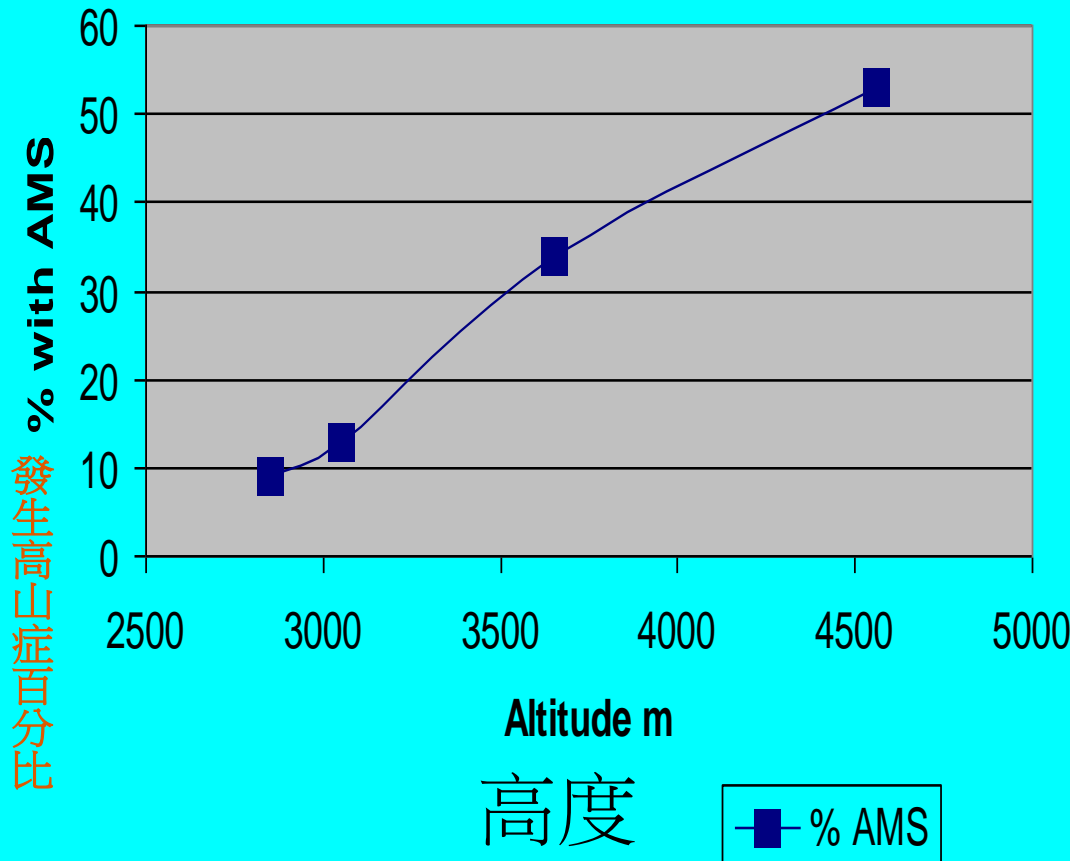
急性高山症（單純型）特色2

- AMS is self-limiting and clears after 3-5 days.
急性高山症是自限性病症，約在3-5天後可逐漸恢復
- Does not recur at that altitude
停在該登山高度，將不會再復發
- May recur if the subject goes higher
但若再升高登山高度，恐將再復發

Incidence of AMS: various altitudes

急性高山症之影響：不同的高度

% of subs with AMS
from Maggiorini et al. (1990)



A study in Swiss mountain huts
瑞士的山上小屋研究

Sleeping altitude
在高山睡眠

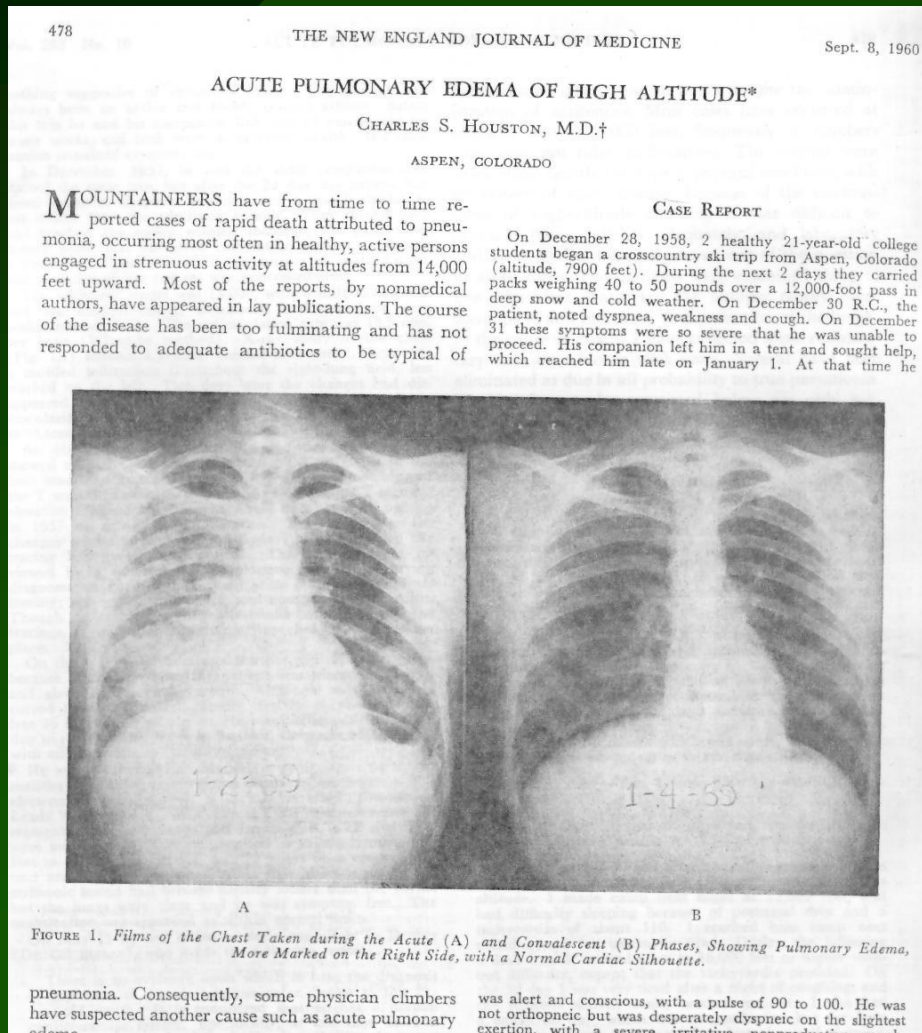
Alt. of huts V %AMS
n=466 subjects

HACE Symptoms, Signs

高地腦水腫症狀與徵兆

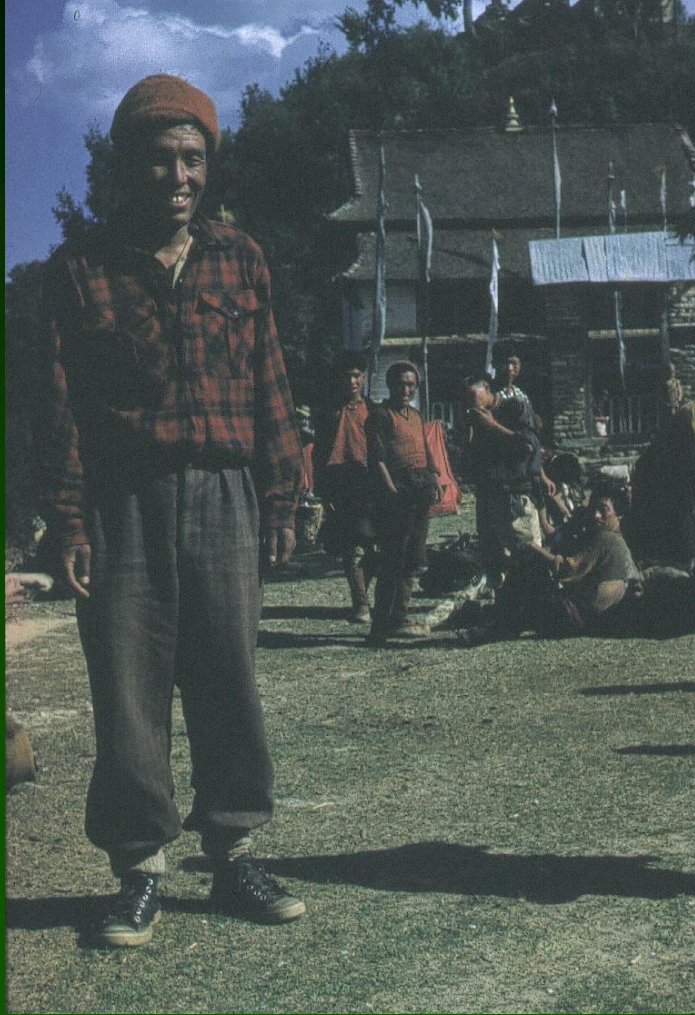
- Initially symptoms of simple AMS. Then
最初是單純型急性高山症，然後
- Ataxia on walking or standing.
走路或站立時，發生運動失調
- Ataxia on sitting up. 起坐時發生運動失調
- Hallucinations. 產生幻覺
- Neurological signs - plantars up, ocular palsies, papilledema.
神經性徵兆－腳底板上翻，眼神呆滯、視網膜乳突水腫
- Coma – death if untreated.
昏迷－若未治療可能喪生

HAPE first report (in English) 高地肺水腫第一份報告(英文)



Houston CS (1960)
N. Engl. J. Med. 263, 470

My first case of HAPE (1961) 我的第一位高地肺水腫病患



Advanced BC, Makalu 6300m

- Climber with HAPE

- 罹患高地肺水腫之登山者





ॐ नमो भगवते वासुदेवाय
HARISHWAR DAYAL
19.7.64

HAPE, symptoms & signs 1.

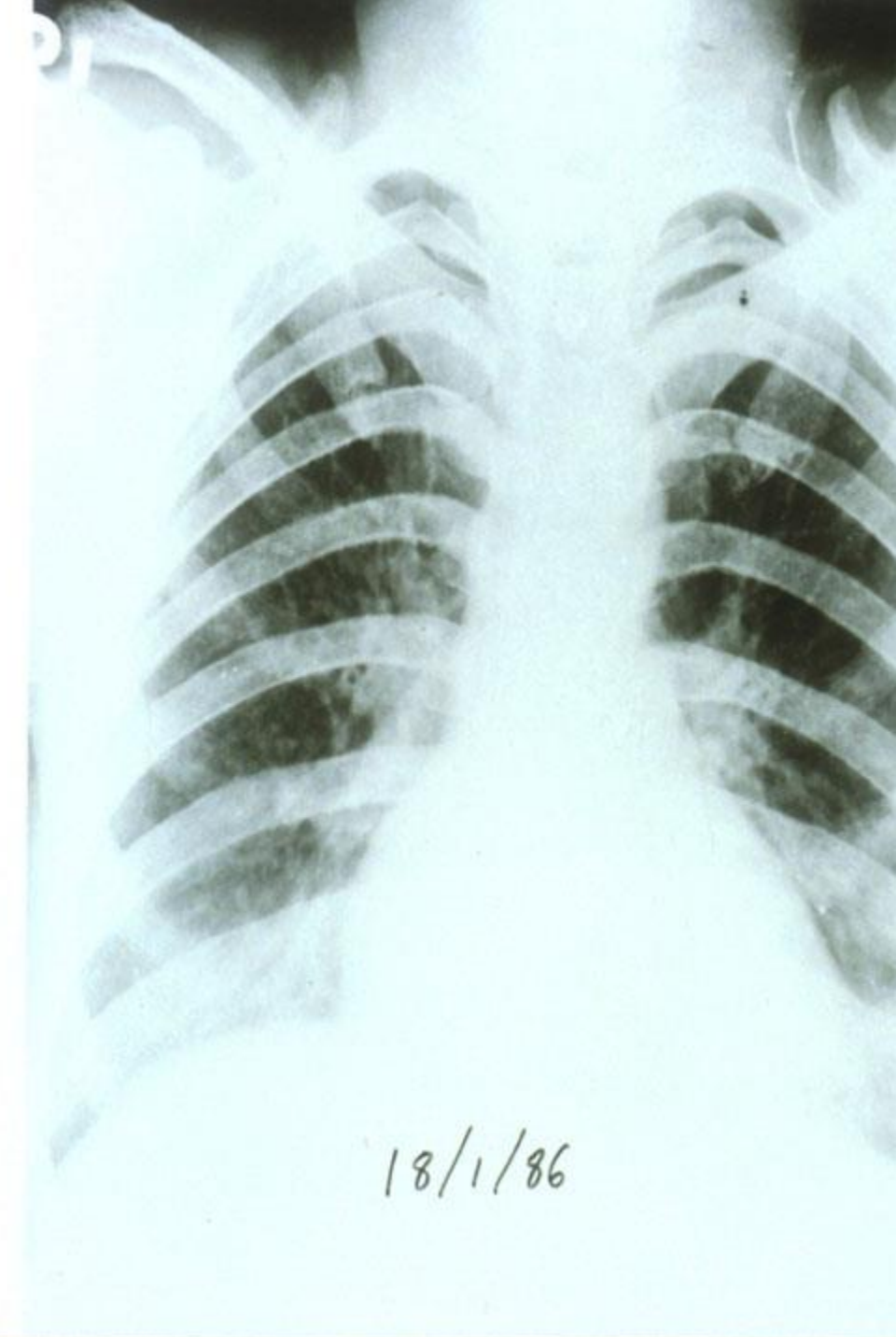
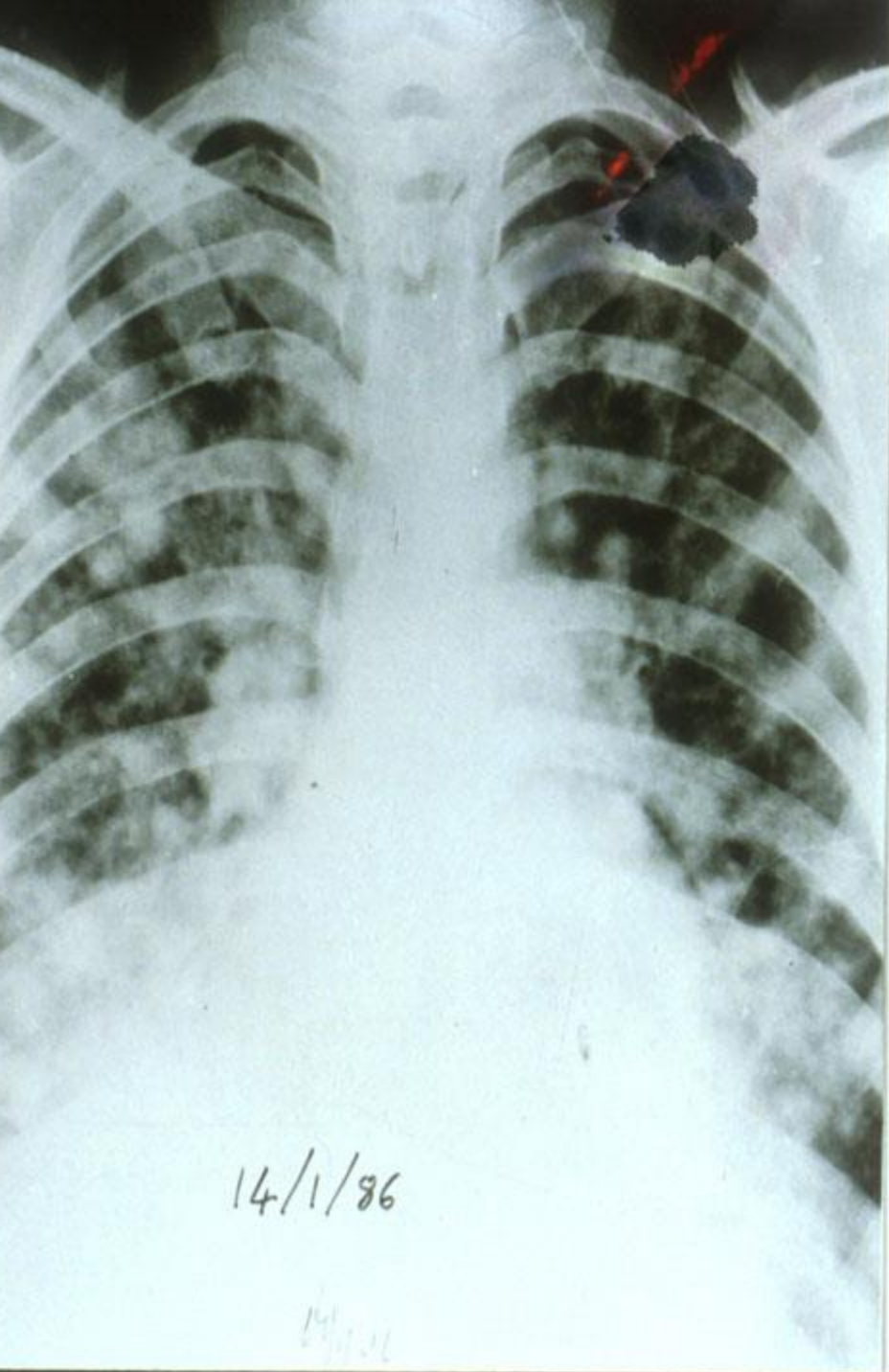
高地肺水腫症狀與徵兆1

- Breathlessness more than others at same altitude
在同一高度與其他人相比較，發生呼吸急促、喘不過氣現象
- Poor physical performance, fatigue 體能偏差、疲勞
- Chest pain (sometimes) 胸痛(有時候)
- Cough, dry, then frothy white sputum, later blood-tinged.
咳嗽、乾咳、吐出白色泡沫，而後唾液泡沫會帶有血絲
- Crackles at lung bases, bubbly breathing
肺基部有細碎爆裂聲，含雜類似泡泡聲的呼吸聲

HAPE, symptoms & signs 2.

高地肺水腫症狀與徵兆2

- Cyanosis 發紺
- Mild fever, 38-9°C 輕微發燒，38~39°C
- Tachycardia, tachypnoea
心率過快，呼吸急促
- Progresses to more severe dyspnoea, coma and death if not treated .
逐漸嚴重致呼吸困難，昏迷，若未治療恐會死亡



Incidence of HACE, HAPE

高地腦水腫、高地肺水腫之影響

- HAPE, 1 – 3 % depending on altitude gained
高地肺水腫約1 – 3 % 因高地高度所致

- HACE, 1 - 2 %

“ “ “ “

高地腦

水腫約1 – 2 % 因高地高度所致

- Often mixed HACE plus HAPE
通常高地腦水腫與高地肺水腫多以複合型式展現

Mechanisms of AMS, HACE

急性高山症、高地腦水腫之機制

Symptoms suggestive of raised intracranial pressure due to cerebral edema.

因腦部水腫造成顱內壓上升

Evidence for this good in HACE 高地腦水腫之證據

Post mortem evidence of edema 過去水腫致死之證據

MRI evidence (Hackett *et al.* 1998) 核磁共振造影之證據
but lacking in simple AMS (so far),

缺乏單純型急性高山症之核磁共振造影

MRI studies show small increase in brain volume but
poor correlation with AMS scores. (Roach *et al.* 2003):

核磁共振造影研究指出急性高山症紀錄中腦體積有稍微增加；但與評估急性高山症分數呈低相關。

Mechanisms of AMS, HACE cont.

急性高山症、高地腦水腫之機制(續)

How does hypoxia produce cerebral edema?

低氧如何造成腦水腫？

Cerebral blood flow – increased by hypoxia
decreased by reduced PCO₂

Net result 1st days at alt. CBF increased

But no good correlation with AMS

腦血流－

第一天上高地因二氧化碳分壓下降刺激形成低氧現象，其淨效應是導致腦血流量增加；

但此效應與急性高山症並無良好相關性

Mechanisms of AMS, HACE cont.

急性高山症、高地腦水腫之機制(續) How does hypoxia produce cerebral edema?
低氧如何造成腦水腫?

- Fluid Balance?

体液平衡？

Some evidence that exercise in getting to altitude causes fluid & sodium retention. Some evidence of correlation with AMS

證據顯示上高地之運動將促使體液與鈉離子滯留，部分證據顯示與急性高山症有關

- But weak and no evidence in non-exercising subjects.

但對於身體虛弱或非專業運動者則較無明確證據

Mechanisms of AMS, HACE cont.

急性高山症、高地腦水腫之機制(續)

How does hypoxia produce cerebral edema?

低氧如何造成腦水腫?

- ? Hypoxia causes blood-brain barrier to become leaky
低氧造成血腦屏障產生漏洞 ?
- Hypoxia results in increase in oxygen free radicals which damage BBB
低氧造成氧自由基增加而損害血腦屏障
- Some evidence of protective effect of antioxidants in AMS (Bailey *et al.* 2001)
But an unpublished study found no effect
研究指出施用抗氧化物於急性高山症可形成保護之效益

Mechanisms of AMS, HACE cont.

急性高山症、高地腦水腫之機制(續)

Hypoxic Ventilatory Response and AMS

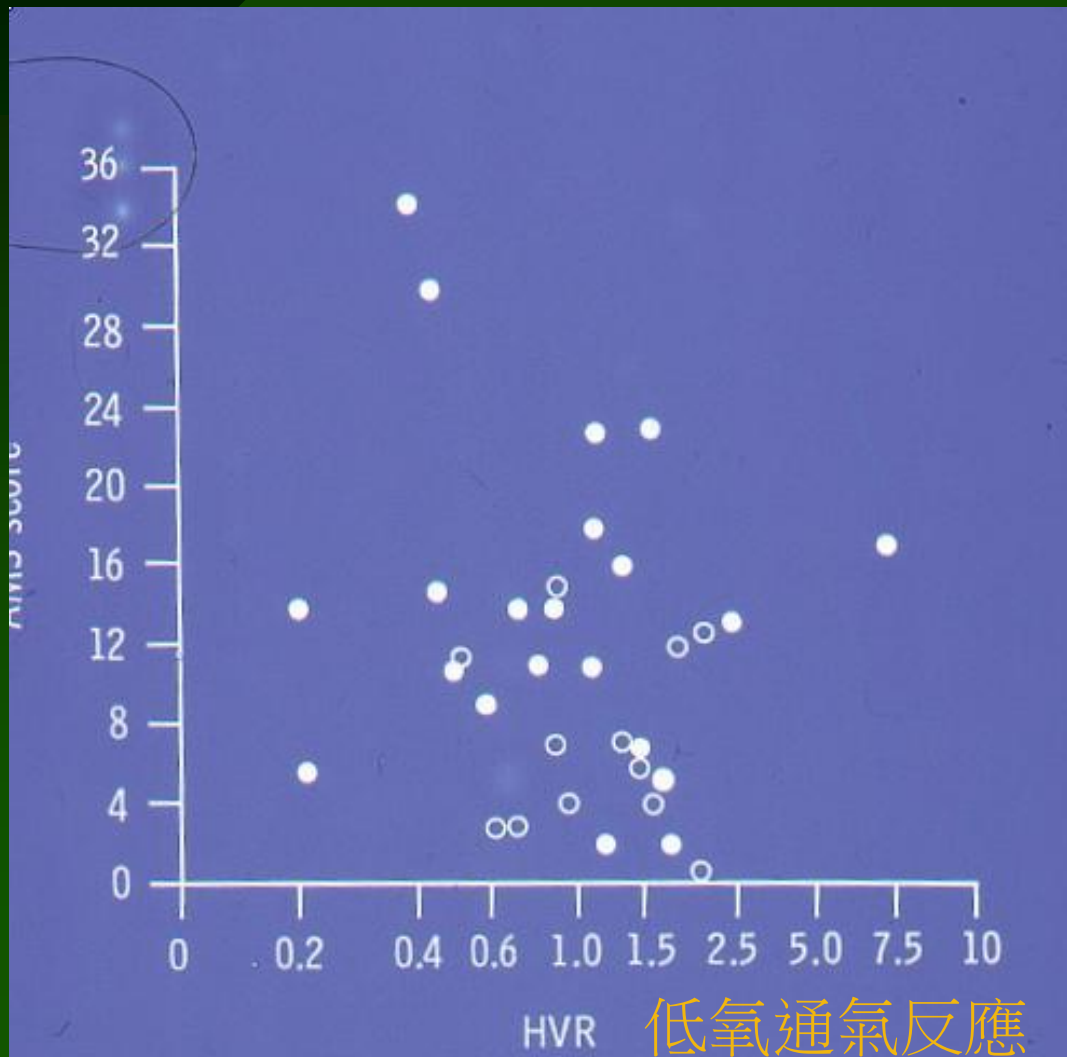
低氧通氣反應與急性高山症

1. Subjects susceptible to HAPE have low HVR on average (overlap)
高地肺水腫之發生與較低之低氧通氣反應（部份重疊）
2. Subjects with AMS have low SaO₂ but not high PCO₂
急性高山症病患有較低動脈飽和氧分壓，但不會提昇二氧化碳分壓
3. No correlation between SL HVR and subsequent AMS scores
海平面之低氧通氣反應與隨後於高地之急性高山症評估分數並無相關

HVR V AMS

低氧通氣反應 vs. 急性高山症

急性高山症評估分數

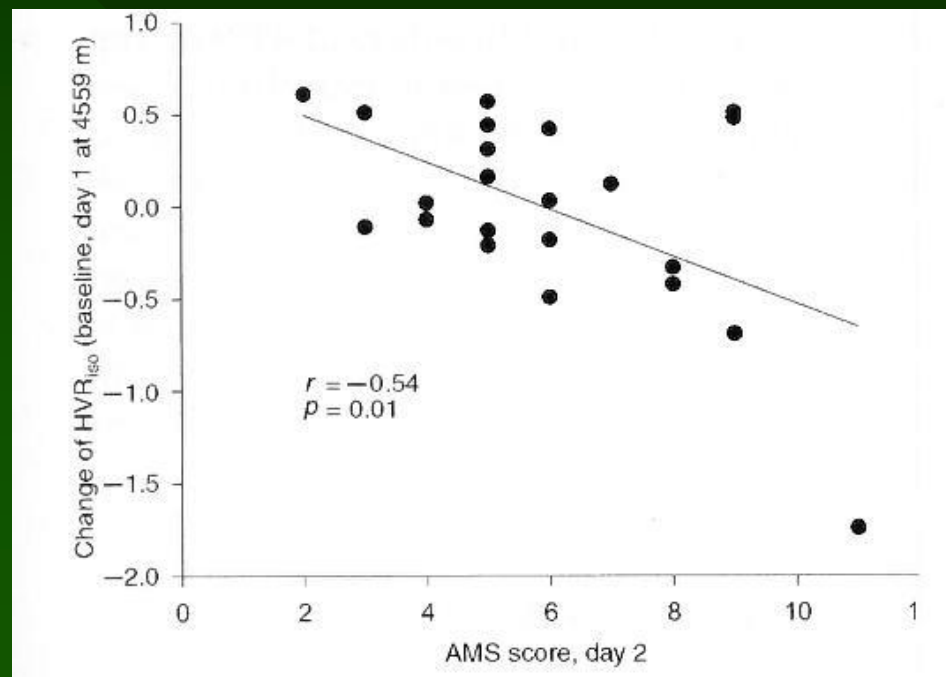


Milledge *et al.* 1988

Hypoxic Ventilatory Response and AMS

低氧通氣反應與急性高山症

- HVR increases during acclimatisation
在適應過程中低氧通氣反應會增加
- One study suggests AMS subjects fail to increase HVR. (Bartsch *et al.* 2002)
但另有研究指出急性高山症患者並未有效增加低氧通氣反應



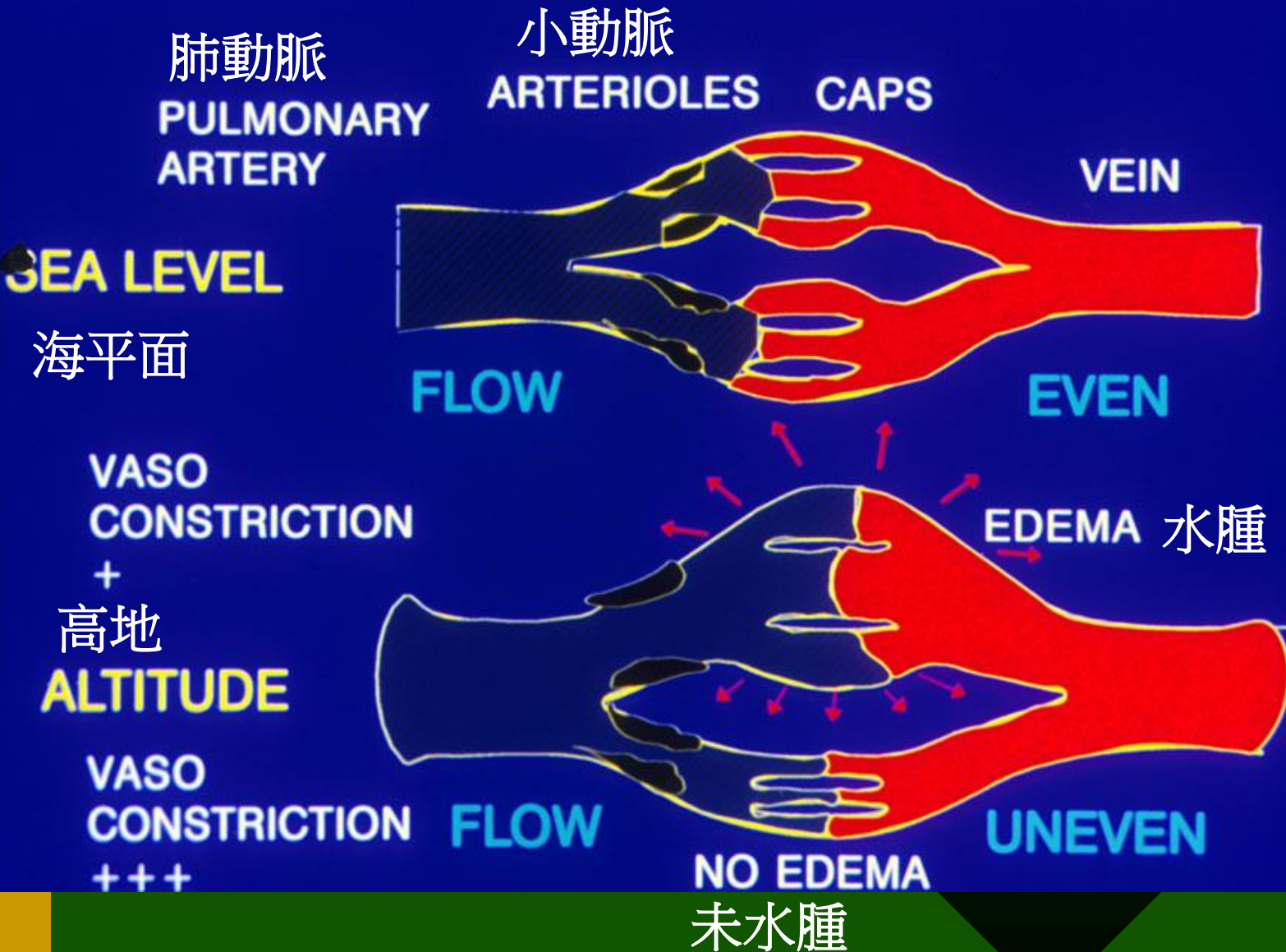
Mechanisms in HAPE

高地肺水腫之機制

- Susceptibility a strong feature in HAPE
高地肺水腫之發生有明顯特徵
- Hypoxia causes rise in Pulmonary artery pressure
低氧導致肺動脈壓上升
- In susceptible subjects this response is exaggerated even in absence of HAPE
在易發高地肺水腫族群中，反應較為誇大劇烈
- Patients with HAPE have very high pulmonary arterial pressure (normal wedge pressure)
高地肺水腫病患有非常高的肺動脈壓

Mechanism of HAPE- UNEVEN VASO CONSTRICTION

高地肺水腫之機制—不規則的血管收縮



Mechanisms in HAPE

高地肺水腫之機制

- It is suggested that in susceptible subjects the constriction is non-uniform
高地肺水腫易發族群中，其肺部區域生理緊壓特性並未一致
- so some lung areas are protected, others have increased flow and thus raised capillary pressure.
有些肺部區域有被正常保護，其他部位則會相對增加血流與微血管壓力
- These areas become oedematous.
這些區域將導致水腫現象

Mechanisms in HAPE cont.

高地肺水腫之機制（續）

- High capillary pressure results in stress failure of the cap. walls and leakage of fluid, proteins, and eventually red cells.
高微血管壓導致血管壁可滲透出體液、蛋白質，最後乃至壓出紅血球
- Later inflammatory mediators are released which add to the progress of the condition.
而後釋放發炎介質（如cytokin），促進後續發炎反應

Management, simple AMS

單純型急性高山症處理

- Go no higher until symptoms remit
直至症狀緩解前不再登上更高高度
- If symptoms persist, go down
若症狀持續則下山
- Analgesics if required, NSAIDs
若有需要，可使用非固醇類止痛劑
- Acetazolamide (better as prophylactic but helpful even after symptoms start) 500mg stat then 250mg bd.
開始時立刻服用Acetazolamide (Diamox) 500毫克(可為預防用藥，但若發病，將有助於舒緩症狀)而後每天二次每次250毫克

Management of HAPE and HACE

高地腦水腫、高地肺水腫之處裡

GET PATIENT DOWN as soon as diagnosis is made 儘快讓病人下山尋求醫療

- HACE (高地腦水腫) – Dexamethasone (類固醇)
(立刻服用8mg，然後每4-6小時，服用 4mg直至見效)
- HAPE(高地肺水腫)– Nifedipine (鈣離子阻斷劑)
(每4-6小時，服用20mg直至見效)
- Portable compression chamber (Gamow bag)
Useful for temporary improvement of patient only
便攜式壓力艙(僅使用於短暫改善病患狀況)

Snow Bag 便攜式壓力艙





Prevention of AMS 1

急性高山症之預防1

- Plan time for acclimatisation 計畫適應時間
- Above 3000m height gain < 300m per day, with a “rest” day every 3 days (ideal)
高於3000公尺高度則每天上升高度需小於300公尺，每3天前進後需休息一天(理想)
- Climb high, sleep low
白天登高，夜晚睡於低海拔處
- If symptoms – go no higher
若出現症狀 - 不再向更高處推進（不再攀高）
- If symptoms get worse – GO DOWN
若症狀惡化 - 下山

Prevention of AMS 2

急性高山症之預防2

- Consider acetazolamide (Diamox) (125-250mg bd. Start 24 h before ascent)
考慮使用藥物acetazolamide (Diamox) 丹木斯
(上山前24小時首次服用，而後每天二次125-250mg)
- 1. For subjects who know they are slow acclimatisers
上山適應能力較為慢之登山者
- 2. When a major altitude gain is unavoidable (flying into, 3700m or no camp site at reasonable alt. gain)
無法避免而必須快速上升高度者（直接搭機飛至海拔3700公尺 La Paz高地或至合理高度卻苦無適合搭營之地點，而須上攻較高營地）





Further reading

- Travel at High Altitude, Medex. Avail on www.medex.org.uk
- Relevant Chapters in: The High Altitude Medicine Handbook, Pollard and Murdock, 3rd edition. Radcliffe Medical Press, Oxford
- Ditto, in: High Altitude Medicine and Physiology, West, Schoene and Milledge 4th edition, Hodder Arnold, London
- Barry PW and Pollard (2003) AJ Altitude Illness *BMJ* 326 915-919
- Hackett PH and Roach RC (2004) **High Altitude Cerebral Edema** [High Altitude Medicine & Biology](#), 5, 136-146