



USING ULTRASOUND TO DIAGNOSE AND MONITOR HIGH ALTITUDE PULMONARY OEDEMA: A SCOPING REVIEW



Dr Sophie Shergold

Email: sophie.shergold@nhs.net

INTRODUCTION

- Ultrasound use is increasing in pre-hospital and austere environments as technology becomes more portable.
- Currently High-altitude pulmonary oedema (HAPE) is a clinical diagnosis and can affect 0.2-15% of individuals at 2500-5000m¹, it can be life threatening.
- Ultrasound (USS) can be used to identify extravascular lung water (EVLW) as B-lines (Figure 1) ², which can help to identify HAPE and exclude other pathologies ³.

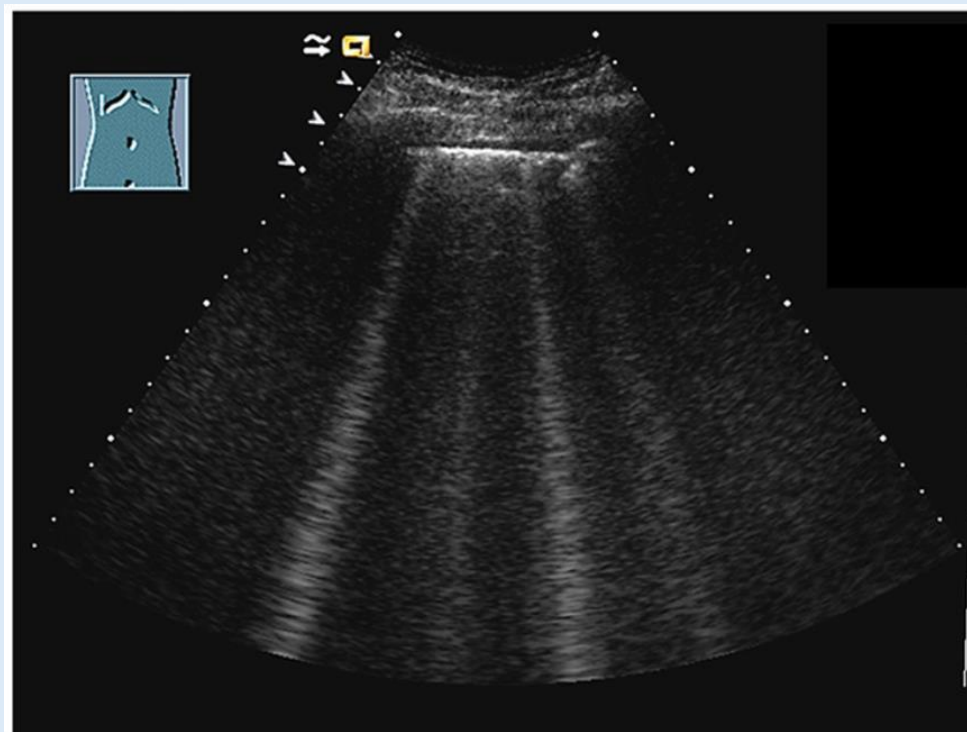


Figure 1: Four B-Lines on Ultrasound, re-used with permission (2)

AIMS: To identify studies using USS to aid diagnosis and/or monitoring of HAPE, assess their quality and utility of results.

METHODS

- Scoping review using PRISMA extension for scoping review ⁴.
- Inclusion and exclusion criteria:
 - Included – any published article where USS used to aid diagnosis of HAPE, no restriction in demographics.
 - Excluded – no clinical diagnosis HAPE, full text not available, not in English.
- Studies screened (Ti/Ab, then by full text) by one author.
- Quality of included studies assessed using JBI appraisal tools⁵ and QUADAS-2.
- Data extracted: Demographics, USS used, altitude, B-line numbers, operators, use in monitoring.

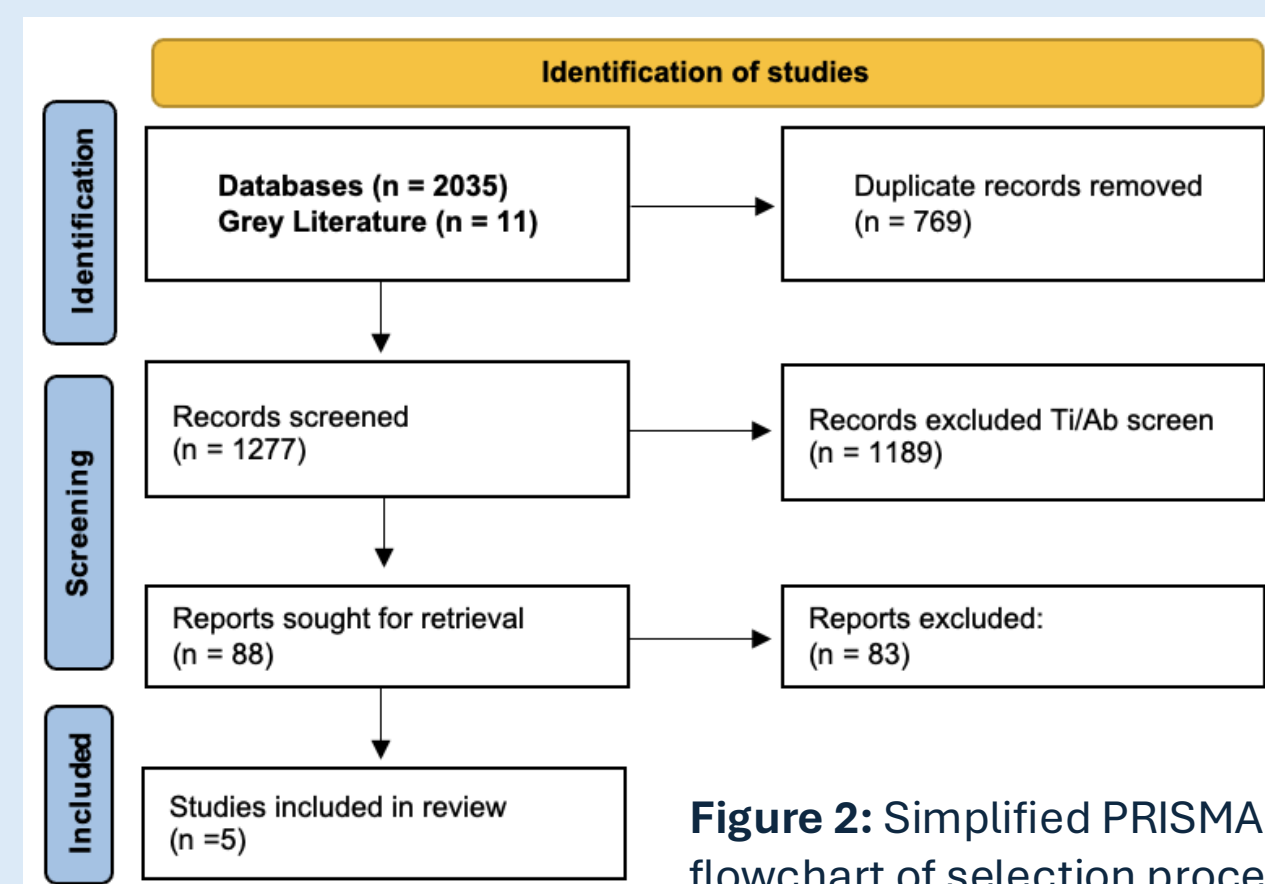


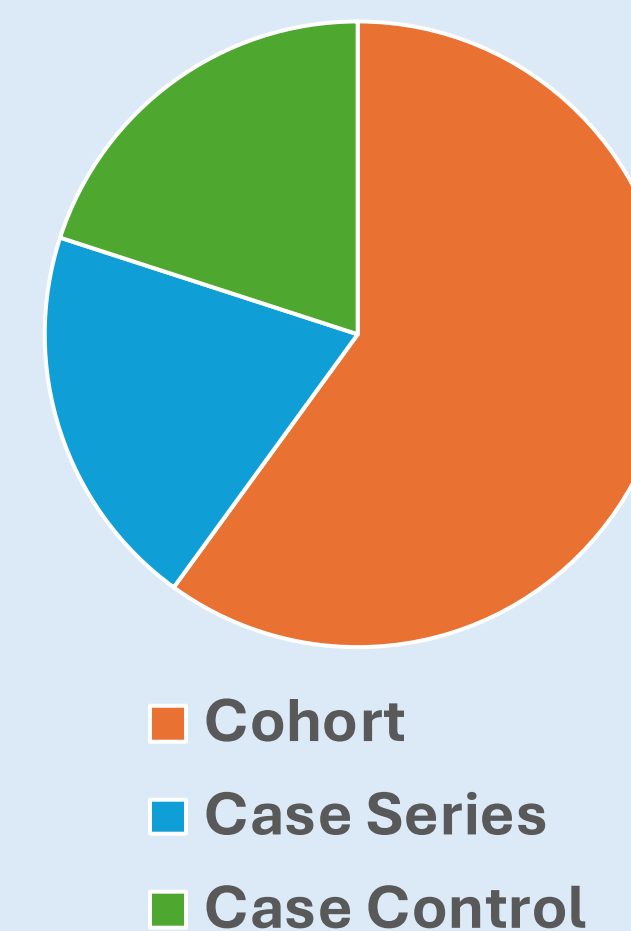
Figure 2: Simplified PRISMA flowchart of selection process (4)

RESULTS

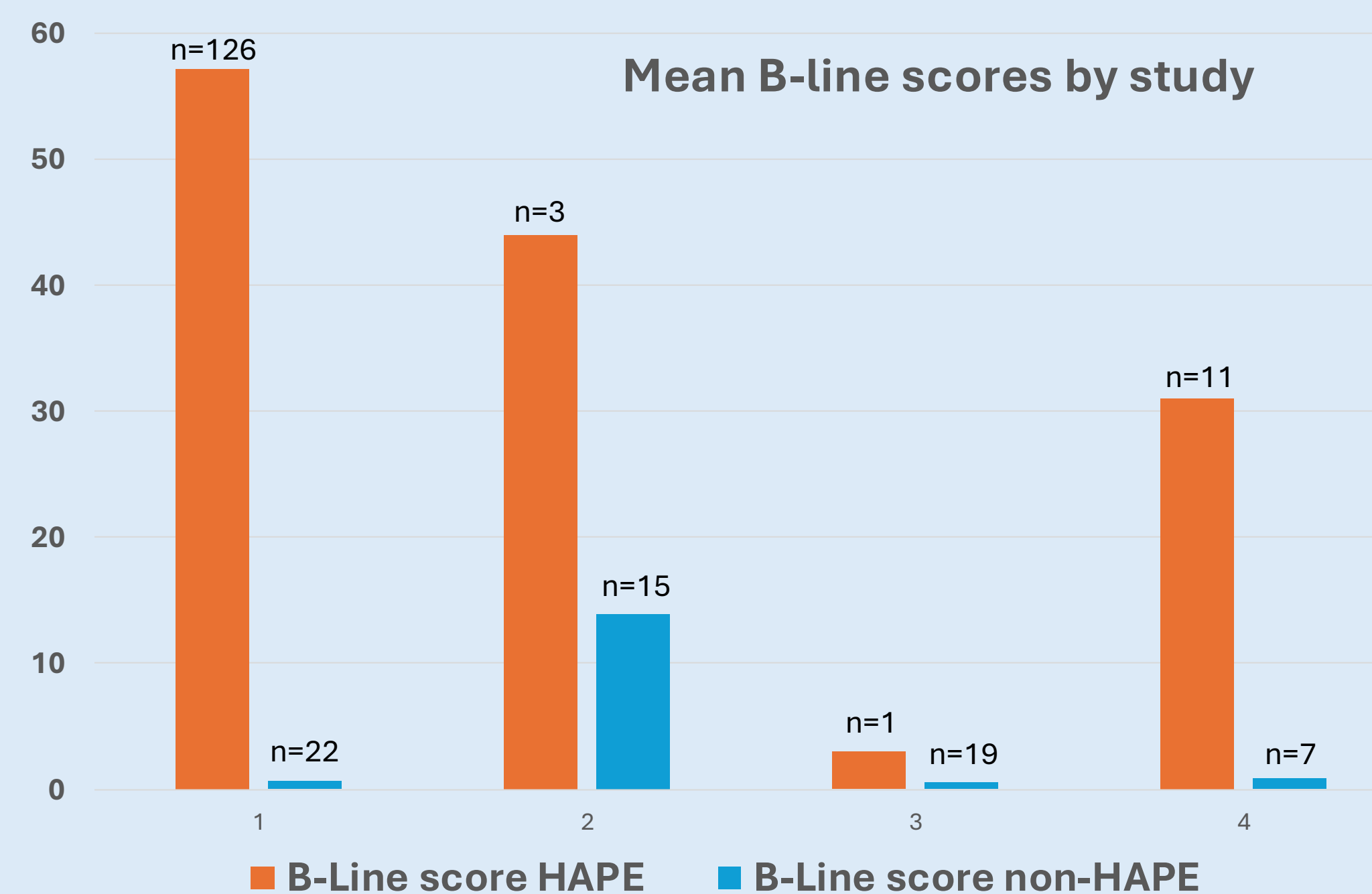
Study Characteristics:

- 5 included studies (n=3,18,18,20,148)
- Altitude 1350m – 5160m
- 4/5 studies used 28 USS scanning points on thorax
- 3/5 used small portable USS, 2/5 used a larger system
- Operator training – 2 physicians, 1 sonographer, 2 did not mention
- All studies used clinical/symptomatic criteria to diagnose HAPE

Study Type



Ultrasound findings:



Ultrasound used to monitor HAPE:

- All included studies showed a reduction in B-lines on USS post treatment for HAPE and/or descent.
- One study discussed allowing participants to continue a trek post treatment as clinical findings (including B-lines) had improved.

Comparative Imaging and diagnostic accuracy:

Assessed in one study (compared to CXR), which was able to show USS is sensitive and specific for identifying HAPE.

Sensitivity - 0.98

Specificity - 0.91

LIMITATIONS

- Small number of included studies and participants.
- Screening and data extraction was carried out by one individual.
- Studies assessed for B-lines at differing altitudes, using differing equipment/protocols and outcome measures, making comparison challenging.

CONCLUSIONS

- There seems to be increased numbers of B-lines in those diagnosed with HAPE compared to those not, and these seem to improve with treatment/descent.
- USS has been shown to be sensitive and specific for diagnosing HAPE.
- Whilst HAPE is ultimately a diagnosis based on clinical symptoms, USS can be used to aid this and improve certainty of decision making. This lends itself particularly to pre-hospital and expedition environments.
- Ultimately further research is required with a particular focus on patient outcomes and effect on clinical decision making.

FUTURE RESEARCH

- Larger data sets of ultrasound use in individuals clinically diagnosed with HAPE.
- Further focus on monitoring HAPE with USS.
- Further comparative imaging and diagnostic accuracy studies.
- Research using truly hand-held and portable USS devices, which are more suitable to austere and expedition environments.
- Research into the concept of 'sub-clinical' HAPE and the use of USS to aid early diagnosis of HAPE.

References

1. Cremona G, Asnaghi R, Baderna P, et al. Pulmonary extravascular fluid accumulation in recreational climbers: a prospective study. *Lancet*. Jan 26.2002;359(9303):303-9.
2. Mayr U, et al. (2020) 'B-lines scores derived from lung ultrasound provide accurate prediction of Extravascular Lung Water Index: An observational study in critically ill patients. doi:10.1177/0885066620967655.
3. Wimalasena Y, et al. (2013) 'Using Ultrasound Lung Comets in the Diagnosis of High-Altitude Pulmonary Edema: Fact or Fiction?'.
doi:10.7326/M18-0850.
4. Tricco AC, et al. (2018) 'PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation'.
doi:10.7326/M18-0850.
5. Hilton M. JBI Critical appraisal checklist for systematic reviews and research syntheses. *J Can Health Libr Assoc*. Dec 1, 2024;45(3):180-3.
Further references available on request.