Volume-targeted versus pressure-limited ventilation in neonates

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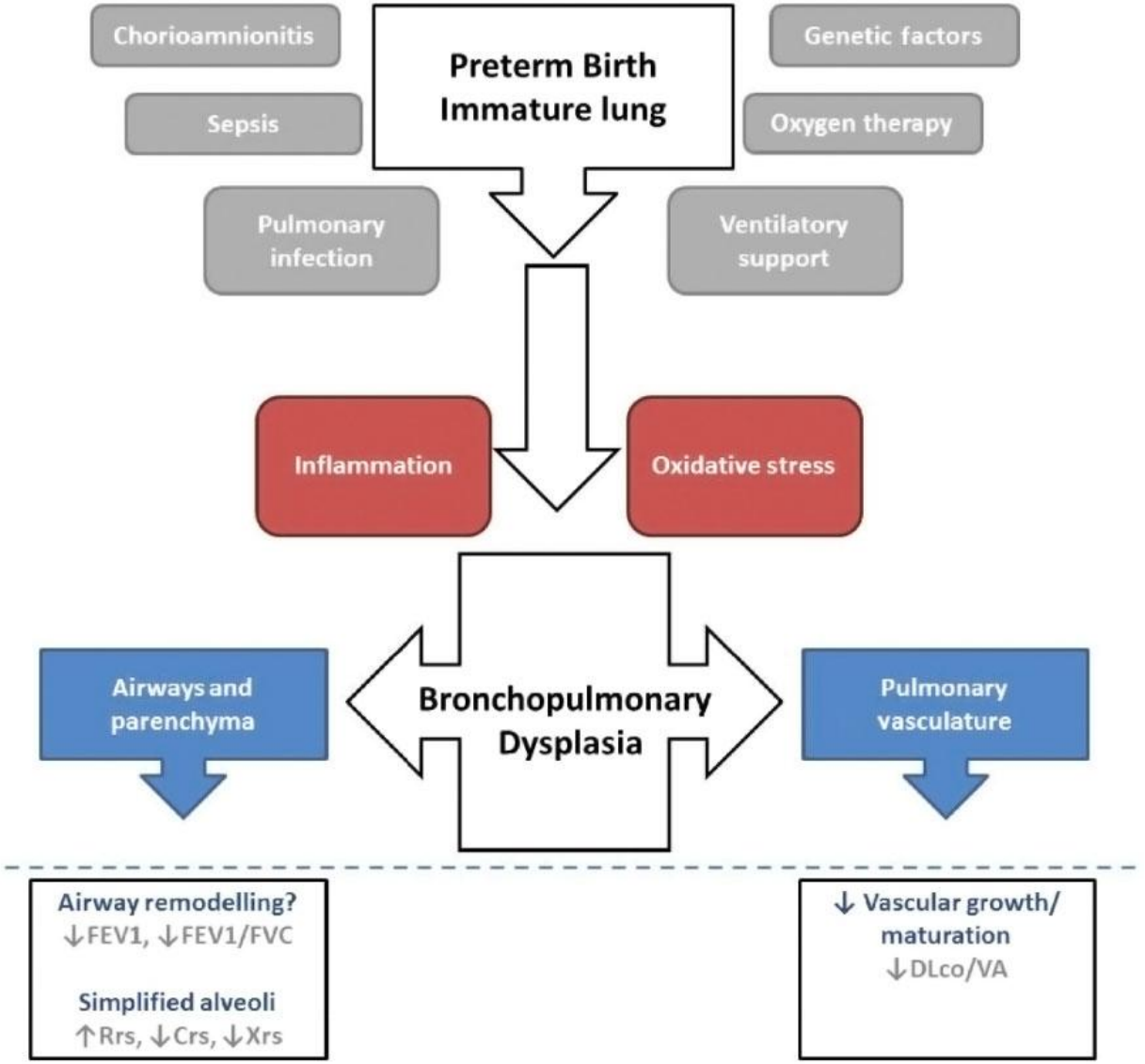
CONTENTS

Background

- Mechanical ventilation (MV) : an essential tool in the care of critically sick and very preterminfants.
- The Neonatal Research Network in the USA – 2012:
  - 82% of infants < 29 weeks' gestation age (GA) received MV during their stay in the NICU.
  - 40% of surviving infants ≤28 weeks' GA → bronchopulmonary dysplasia (BPD) → ↑duration of respiratory support, hospital stay, need for home oxygen, impaired neurodevelopmental outcome, more readmissions to hospital and ↑ mortality.
- MV have been identified as potentially modifiable cause of BPD. (atelectasis and volutrauma)

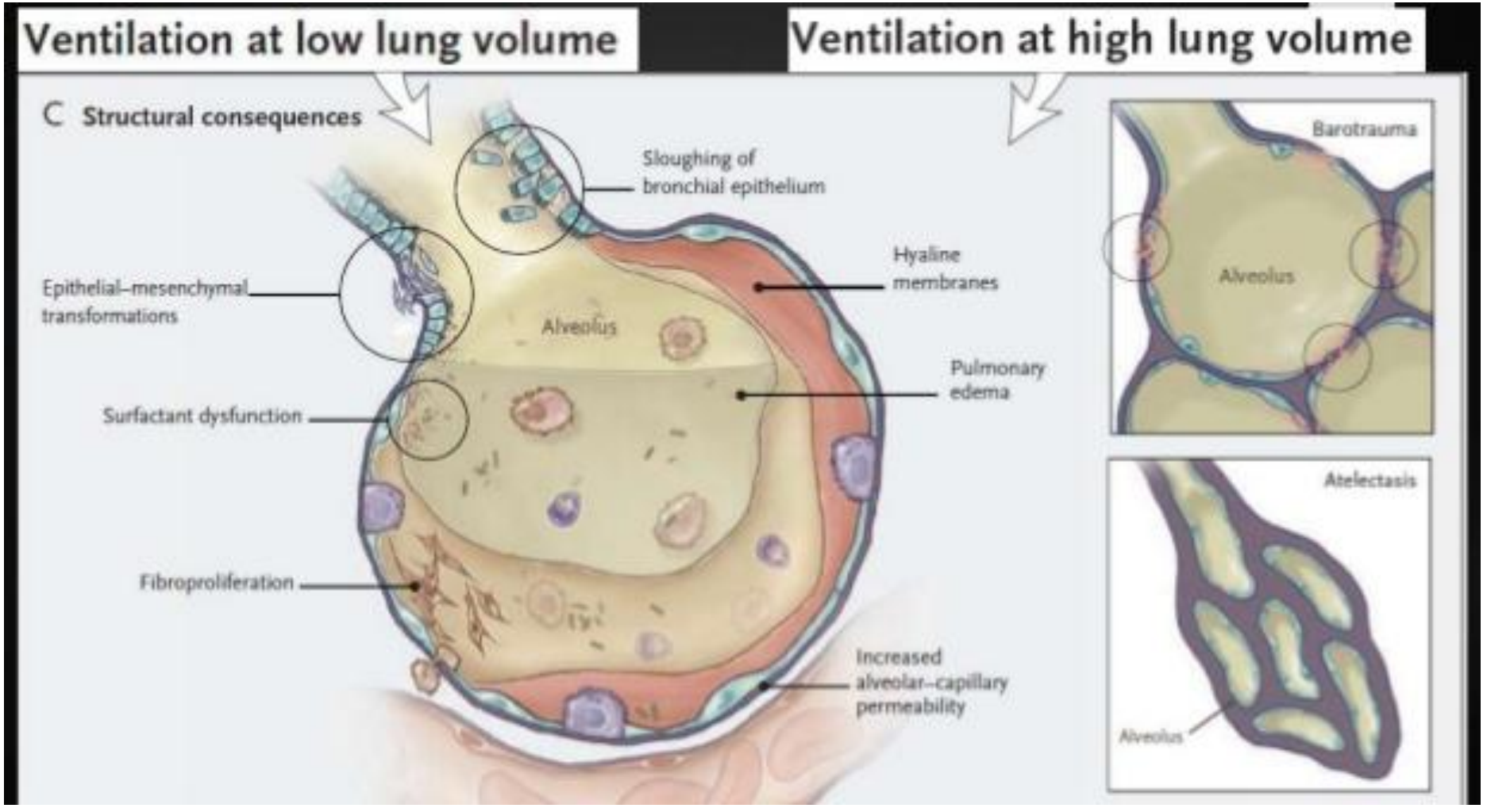
Background

- BPD: characterised by the histopathological findings of impaired alveolarisation, altered pulmonary microvasculature and pulmonary fibrosis

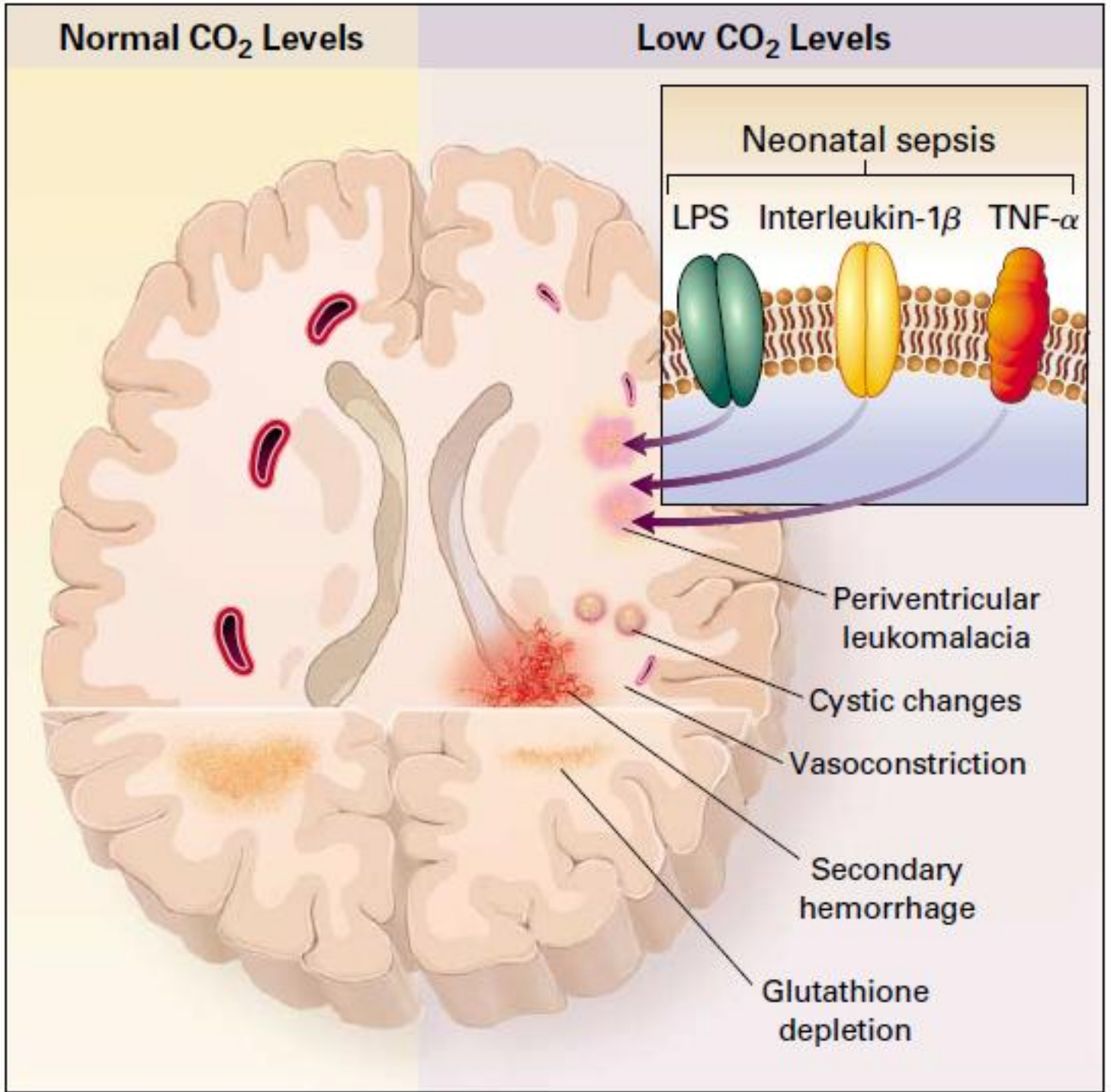


Background

Atelectasis and volutrauma:



Background


Normal CO_2 Levels
Low CO_2 Levels
Neonatal sepsis
LPS
Interleukin-1β
TNF-α
Periventricular leukomalacia
Cystic changes
Vasoconstriction
Secondary hemorrhage
Glutathione depletion

Background

- $PaCO_2$< 30 mmHg/ first 48h of life → ↑risk of severe IVH or PVL (OR= 2.38; 95% CI 1.27–4.49;*P* = 0.007). $PaCO_2$<30 mmHg/ first 24 h of life → ↑ risk of BPD (OR= 2.21; 95% CI 1.05–4.57;*P* = 0.036) *(Ericsson SJ et al, J Pediatr Child Health 2002).*
- Hypercapnia / first 3 days of life is associated with severe IVH in VLBW infants *(JR Kaiser et al, Journal of Perinatology (2006) 26, 279–285).*
- Extremes and fluctuations of PaCO2 were associated with severe IVH (grades 3 and 4) in Preterm Infants *(Jorge Fabres et al, Pediatrics Volume 119, Number 2, February 2007).*
- Extreme fluctuations and higher max PaCO2 / first 4 days of life are associated with worse neurodevelopmental outcomes in ELBW Infants at 18 to 22 months (*Lara A., J Pediatr 2009;155:217-21)*

Background

Pressurelimited ventilation (PLV)

- The magnitude of each inflation is determined by the change in airway pressure (PIP and PEEP).
- VT may not be consistent.

Volume-targeted ventilation (VTV)

- Deliver a consistent VT.

➢Reduce lung injury (atelectasis and volutrauma).

➢Avoiding rapid changes $PaCO_2$ →stabilise cerebral blood perfusion, reduce brain damage.

Background

- The older ventilators were unable to accurately deliver the small VT required when ventilating small preterm infants.
- Modern microprocessor- controlled neonatal ventilators with flowsensors permit accurate measurement and delivery of a set VT. With appropriate software, the ventilators measure and control ventilator parameters to target the delivered VT, and reduce VT variability delivery compared with pressurelimited ventilation (PLV) modes

Cochrane Library

Cochrane Database of Systematic Reviews

Volume-targeted versus pressure-limited ventilation in neonates (Review)

Klingenberg C, Wheeler KI, McCallion N, Morley CJ, Davis PG

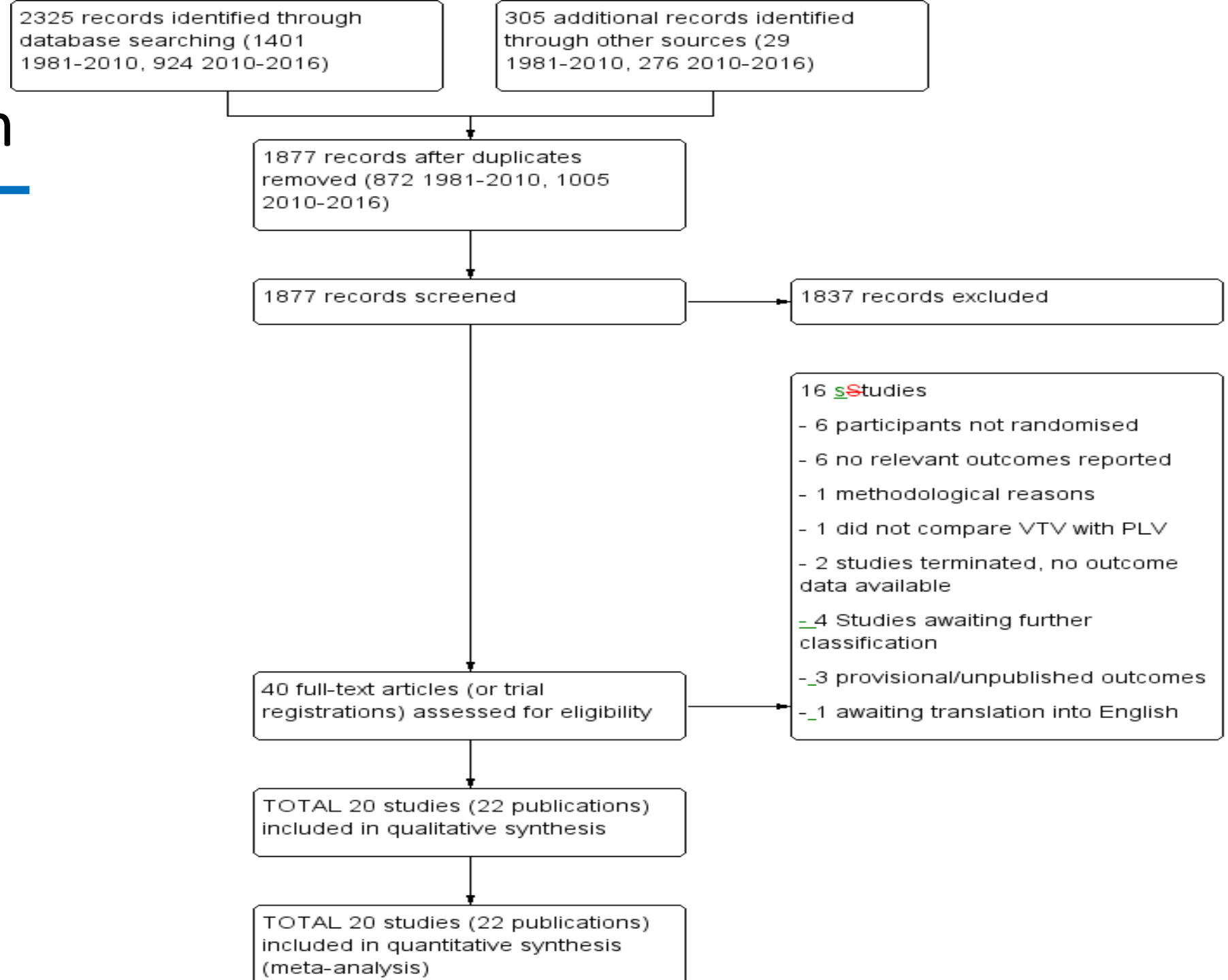
Objective

- To determine whether VTV compared with PLV leads to reduced rates of death and death or BPD in newborn infants
- To determine whether use of VTV affected outcomes including air leak, cranial ultrasound findings and neurodevelopment.

Methods

- RCTs and quasi-RCTs comparing VTV versus PLV in infants of less than 44 weeks' postmenstrual age and reporting clinically relevant outcomes.
- Assessed risk of bias for each trial, evaluated quality of evidence for each outcome, tabulated mortality, rates of BPD, outcomes.
- Results were expressed as risk ratios (RR) for categorical outcomes, risk differences (RD) and number needed to treat for an additional beneficial outcome (NNTB), mean differences (MD) for continuous variables. With 95% confidence intervals (CI) and assumed a fixed-effect model for meta-analysis.

Study flow diagram



Results

- Twenty randomised trials: 16 parallel trials (977 infants) and four cross-over trials (88 infants).
- No studies were blinded and the quality of evidence for outcomes assessed varied from moderate to low.

Results

- Death before hospital discharge: 11 trials(t.) (771 participants(p.)) No difference between VTV & PLV modes (RR 0.75, 95% CI 0.53 to 1.07, low quality evidence).

Results

Neurodevelopmental outcome:

- No studies reported neurodevelopmental outcome as defined by the review criteria.
- 1 study (109 p.) reported the combined outcome of death or severe disability (Singh 2006).There was no statistically significant difference between groups (RR 0.54, 95% CI 0.27 to 1.06;RD -0.15, 95% CI -0.31 to 0.01).
- 1 study (128 p.) reported grossmotor delay (D'Angio 2005). The results from this single trial demonstrated no statistically significant difference between groups (RR 1.00, 95% CI 0.47 to 2.14;RD 0.00, 95% CI -0.13 to 0.13).

Results

- VTV modes : ↓
  - ➢Death or BPD at 36 weeks' gestation: 8t. (584 p.)
    (RR 0.73, 95% CI 0.59 to 0.89)
  - ➢Pneumothorax: 13t. (575p.)
    (RR 0.52, 95% CI 0.31 to 0.87).
  - ➢Mean days of MV: 12t. (736p.)
    (MD -1.35 days, 95% CI -1.83 to -0.86).
  - ➢Hypocarbia : 3t. (98p.)
    (RR 0.49, 95% CI 0.33 to 0.72).
  - ➢Grade 3 or 4 IVH: 10t. (712p.)
    (RR 0.53, 95% CI 0.37 to 0.77).
  - ➢Periventricular leukomalacia ± grade 3 or 4 IVH: 6t. (441p.)
    (RR 0.47, 95% CI 0.27 to 0.80).

Conclusions

- VTV modes had reduced rates of death or BPD, pneumothoraces, hypocarbia, severe cranial ultrasound pathologies and duration of ventilation compared with PLV modes.

Thanks for your attention