

**BET 2: IN PATIENTS PRESENTING
WITH AN EXACERBATION OF COPD
CAN A NORMAL VENOUS BLOOD GAS
PCO₂ RULE OUT ARTERIAL
HYPERCARBIA?**

Authors: Mark Woods,¹ David Hodgson,²

Affiliations: ¹Whiston Hospital, Merseyside, UK,

²Mersey School of Emergency Medicine, UK

ABSTRACT

A shortcut review was carried out to establish whether a normal partial pressure of carbon dioxide (pCO₂) on a venous blood sample could be used to rule out hypercarbia. Eleven studies were directly relevant to the question. The author, date and country of publication, patient group studied, study type, relevant

Table 2 Relevant papers

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Elbom <i>et al</i> , ¹ 1991, Ireland	48 inpatients with COPD	Single-centre prospective study	Difference between arterial and venous pCO ₂ values	No significant difference between the arterial and venous pCO ₂ tensions (PaCO ₂ 41 ±9.5 mm Hg, PvCO ₂ 42±10.6 mm Hg), with the two being closely related (r=0.84, p<0.001)	Small sample. No power calculation. Single centre. No inclusion or exclusion criteria stated
Rang <i>et al</i> , ² 2002, Canada	218 patients presenting to a single centre requiring blood gas analysis for any reason	Single-centre prospective convenience study	Correlation between arterial and venous pCO ₂	r=0.921	Small cohort. Single centre. Cohort not limited to COPD
Kelly <i>et al</i> ³ 2002, Australia	201 patients presenting with 'acute respiratory illness or potential ventilatory compromise'	Single-centre prospective convenience study	Sensitivity and specificity of venous pCO ₂ to detect arterial normocarbica with a cut-off value of 6 kPa	Sensitivity 100%. Specificity 57.1%	Single centre. No power calculation. Population not limited to patients with COPD
Kelly <i>et al</i> ⁴ 2005, Australia	107 patients presenting to a single centre with COPD	Single-centre prospective validation study	Sensitivity of venous pCO ₂ to detect arterial normocarbica with a cut-off value of 6 kPa	Sensitivity 100%. 95% CI 91% to 100%	Single centre. Small sample size. No power calculation. Limited demographics available for interrogation
Ak <i>et al</i> ⁵ 2006, Turkey	132 patients presenting with AECOPD	Single-centre prospective observational study using convenience sampling	Correlation between arterial and venous pCO ₂ Equation to estimate arterial pCO ₂ from venous pCO ₂ using linear regression Utility of venous pCO ₂ to detect arterial hypercarbica (>46 mm Hg)	r=0.908 Arterial pCO ₂ =0.873× venous pCO ₂ 100% sensitivity and NPV. 47% specificity	Single centre. No power calculation. No CI provided for statistics. Cohort limited to COPD but not excluding other metabolic disorders. Possible confounders: high altitude and skewed populations towards men
Razi and Moosavi. ⁶ 2007, Iran	107 patients presenting with COPD and type 2 respiratory failure (pCO ₂ >45 mm Hg). Convenience sampling used	Single-centre prospective observational study	Correlation between arterial and venous pCO ₂	r=0.761	Single centre. No power calculation. Cohort limited to patients with hypercarbica COPD. Excessive exclusion criteria. Skewed population towards men
Lim and Kelly ⁷ 2010, Australia	Meta-analysis of the literature on the use of peripheral VBGs in ED patients with COPD	Meta-analysis of prospective observational studies	The weighted average difference for pCO ₂	5.92 mm Hg	Limits of heterogeneous individual studies included in analysis. Only six studies, three of which not limited to COPD population. One author of meta-analysis is also author of two of the included studies
Ibrahim <i>et al</i> ⁸ 2011, Singapore	122 patients requiring ABG analysis as decided by treating physician	Single-centre cross-sectional study	Sensitivity and negative predictive value of excluding arterial hypercarbica with a venous pCO ₂ of below 30 mm Hg	100% sensitivity and 100% NPV	Single centre. No power calculation. Cohort not limited to COPD. Possible interpreter bias—pCO ₂ threshold calculated retrospectively
McCanny <i>et al</i> ⁹ 2012, Australia	89 patients presenting with COPD. Paired arterial and venous blood gas analyses	Single-centre prospective observational study	Sensitivity of venous pCO ₂ to detect arterial normocarbica with a cut-off value of 6 kPa	100% sensitivity	Single centre. Underpowered sample size. Small cohort. Convenience sampling used
Kelly ¹⁰ 2013, Australia	529 patients presenting with COPD across four studies	Systematic review	Sensitivity of venous pCO ₂ to detect arterial normocarbica with a cut-off value of 45 mm Hg	100% sensitivity	Reliance on validity of included studies
Sur ¹¹ 2013, Scotland	Patients presenting with an acute exacerbation of COPD to a Scottish urban ED had arterial and venous blood gas analyses. 68 paired samples were compared over a 2-month period	Prospective observational study	Correlation between arterial and venous pCO ₂ Detection of arterial hypercarbica, pCO ₂ >45 mmHg.	Pearson's r=0.973, but 95% LOA -4.94 to 14.26 mm Hg 31 patients (46%), all cases detected by venous pCO ₂ >45 mm Hg. Sensitivity 100% (95% CI 89% to 100%), specificity 86% (95% CI 71% to 95%)	Results presented as a poster. Blood gas analysis performed at physician's discretion rather than according to preset criteria

AECOPD, acute exacerbation of chronic obstructive pulmonary disease; COPD, chronic obstructive pulmonary disease; ED, emergency department; LOA, limits of agreement; NPV, negative predictive value; pCO₂, partial pressure of carbon dioxide; VBG, venous blood gas.

outcomes, results and study weaknesses of these papers are tabulated. The clinical bottom line is that a normal venous pCO₂ effectively rules out arterial hypercarbia.

CLINICAL SCENARIO

A 74-year-old male patient with known chronic obstructive pulmonary disease (COPD) presents acutely breathless with widespread wheeze. He refuses an ABG and complains that last time he was here it took a long time to get the sample and it was very painful. You have already obtained a venous blood gas, which has a pCO₂ of 5.5 kPa. You wonder whether this is sufficient to rule out arterial hypercarbia, and therefore, is an ABG in this patient an unnecessary test?

THREE-PART QUESTION

In [patients with an Acute Exacerbation of COPD] can a [normal venous blood gas CO₂] [rule out arterial hypercarbia]?

SEARCH STRATEGY

Ovid MEDLINE(R) 1948 to week 4 November 2014. EMBASE and CINAHL databases via the Athens gateway. Cochrane database of systematic reviews. Date of search is 31 July 2013.

MEDLINE:[chronic obstructive pulmonary disease.ti,ab OR chronic obstructive airway* disease.ti,ab OR COPD.ti OR COAD.ti OR BRONCHITIS OR BRONCHITIS, CHRONIC OR EMPHYSEMA OR PULMONARY EMPHYSEMA] AND [venous blood gas*.ti,ab OR vbg*.ti,ab OR venous co2.ti,ab OR [exp BLOOD GAS ANALYSIS AND VENOUS] OR [hypercarbia.ti,ab AND VEOUS] OR [exp HYPERCAPNIA AND VENOUS] OR [exp CARBON DIOXIDE/bl [bl=Blood] AND VENOUS] LIMIT to English Language

EMBASE: [chronic obstructive pulmonary disease.ti,ab OR chronic obstructive airway* disease.ti,ab OR COPD.ti OR COAD.ti OR BRONCHITIS OR BRONCHITIS, CHRONIC OR EMPHYSEMA OR PULMONARY

EMPHYSEMA] AND [venous blood gas*.ti,ab OR vbg*.ti,ab OR venous co2.ti,ab OR [exp BLOOD GAS ANALYSIS AND VENOUS] OR [hypercarbia.ti,ab AND VEOUS] OR [exp HYPERCAPNIA AND VENOUS] OR [exp CARBON DIOXIDE/bl [bl=Blood] AND VENOUS] LIMIT to English Language

SEARCH OUTCOME

Seventeen papers were identified in total. Eleven were of sufficient quality and relevance for inclusion (table 2).

COMMENTS

ABG analysis is conventionally a routine test in the assessment of patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD). One has to question this practice. ABG analysis has many complications, including severe pain, failure of procedure, haematoma formation, aneurysm formation, arterial laceration, sepsis and rarely loss of limb. This must be weighed up with the benefit of the procedure, and the principle of 'first do no harm' borne into mind. These studies demonstrate that if the venous pCO₂ is within range, then this excludes arterial hypercarbia. One may argue an arterial sample is still required to assess the pO₂; however, the British Thoracic Society guidelines support using transcutaneous oxygen saturations to titrate O₂ therapy.

Clinical bottom line

In patients presenting with AECOPD, a normal pCO₂ on venous blood gas analysis means that they do not need an arterial blood gas sample to exclude hypercarbia.

REFERENCES

- 1 Elborn JS, Finch MB, Stanford CF. Non-arterial assessment of blood gas status

in patients with chronic pulmonary disease. *Ulster Med J* 1991;60:164–7.

- 2 Rang LCF, Murray HE, Wells GA, *et al*. Can peripheral venous blood gases replace arterial blood gases in emergency department patients? *CJEM* 2002;4:7–15.
- 3 Kelly AM, Kyle E, McAlpine R. Venous pCO₂ and pH can be used to screen for significant hypercarbia in emergency patients with acute respiratory disease. *J Emerg Med* 2002;22:15–19.
- 4 Kelly AM, Kerr D, Middleton P. Validation of venous pCO₂ to screen for arterial hypercarbia in patients with chronic obstructive airways disease. *J Emerg Med* 2005;28:377–9.
- 5 Ak A, Ogun CO, Bayor A, *et al* Prediction of arterial blood gas values from venous blood gas values in patients with acute exacerbation of chronic obstructive pulmonary disease Tohoku *J Exp Med* 2006;210: 285–90.
- 6 Razi E, Moosavi GA. Comparison of arterial and venous blood gases analysis in patients with exacerbation of chronic obstructive pulmonary disease. *Saudi Med J* 2007;28: 862–5.
- 7 Lim BL, Kelly AM. A meta-analysis on the utility of peripheral venous blood gas analysis in exacerbations of chronic obstructive pulmonary disease in the emergency department. *Eur J Emerg Med* 2010;17: 246–8.
- 8 Ibrahim I, Ooi SBS, Huak CY, *et al*. Point-of-care bedside gas analyzer: limited use of venous pCO₂ in emergency patients *J Emerg Med* 2011;41:117–23.
- 9 McCanny P, Bennett K, Staunton P, *et al*. Venous vs. arterial blood gases in the assessment of patients presenting with an exacerbation of chronic obstructive pulmonary disease. *Am J Emerg Med* 2012; 30:896–900.
- 10 Kelly AM. Agreement between arterial and venous blood gases in emergency medical care: a systematic review Hong Kong. *J Emerg Med* 2013;20:166–171.
- 11 Sur, E COPD: is it all in the vein? *Thorax* 2013;68(Suppl 3):P182.

Provenance and peer review Commissioned; internally peer reviewed.

Emerg Med J 2015;32:251–253.
doi:10.1136/emered-2014-204599.2