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

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**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

<table>
<thead>
<tr>
<th>Author, date and country</th>
<th>Patient group</th>
<th>Study type (level of evidence)</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Study weaknesses</th>
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<tbody>
<tr>
<td>Elborn et al, 1991, Ireland</td>
<td>48 inpatients with COPD</td>
<td>Single-centre prospective study</td>
<td>Difference between arterial and venous pCO₂ values</td>
<td>No significant difference between the arterial and venous pCO₂ tensions (PaCO₂ 41±9.5 mm Hg, PvCO₂ 42±10.6 mm Hg), with the two being closely related (r=0.84, p&lt;0.001)</td>
<td>Small sample. No power calculation. Single centre. No inclusion or exclusion criteria stated</td>
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<td>Rang et al, 2002, Canada</td>
<td>218 patients presenting to a single centre requiring blood gas analysis for any reason</td>
<td>Single-centre prospective convenience study</td>
<td>Correlation between arterial and venous pCO₂</td>
<td>r=0.921</td>
<td>Small cohort. Single centre. Cohort not limited to COPD</td>
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<td>Kelly et al, 2002, Australia</td>
<td>201 patients presenting with ‘acute respiratory illness or potential ventilatory compromise’</td>
<td>Single-centre prospective convenience study</td>
<td>Sensitivity and specificity of venous pCO₂ to detect arterial normocarbia with a cut-off value of 6 kPa</td>
<td>Sensitivity 100%. Specificity 57.1%</td>
<td>Single centre. No power calculation. Population not limited to patients with COPD</td>
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<td>Kelly et al, 2005, Australia</td>
<td>107 patients presenting to a single centre with COPD</td>
<td>Single-centre prospective validation study</td>
<td>Sensitivity of venous pCO₂ to detect arterial normocarbia with a cut-off value of 6 kPa</td>
<td>Sensitivity 100%. 95% CI 91% to 100%</td>
<td>Single centre. Small sample size. No power calculation. Limited demographics available for interrogation</td>
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<td>Ak et al, 2006, Turkey</td>
<td>132 patients presenting with AECOPD</td>
<td>Single-centre prospective observational study using convenience sampling</td>
<td>Correlation between arterial and venous pCO₂</td>
<td>r=0.908</td>
<td>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</td>
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<tr>
<td>Razi and Moosavi, 2007, Iran</td>
<td>107 patients presenting with COPD and type 2 respiratory failure (pCO₂ &gt;45 mm Hg). Convenience sampling used</td>
<td>Single-centre prospective observational study</td>
<td>Correlation between arterial and venous pCO₂</td>
<td>r=0.761</td>
<td>Single centre. No power calculation. Cohort limited to patients with hypercarbic COPD. Excessive exclusion criteria. Skewed population towards men</td>
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<td>Lim and Kelly, 2010, Australia</td>
<td>Meta-analysis of the literature on the use of peripheral VBGs in ED patients with COPD</td>
<td>Meta-analysis of prospective observational studies</td>
<td>The weighted average difference for pCO₂</td>
<td>5.92 mm Hg</td>
<td>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</td>
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<td>Ibrahim et al, 2011, Singapore</td>
<td>122 patients requiring ABG analysis as decided by treating physician</td>
<td>Single-centre cross-sectional study</td>
<td>Sensitivity and negative predictive value of excluding arterial hypercarbia with a venous pCO₂ of below 30 mm Hg</td>
<td>100% sensitivity and 100% NPV</td>
<td>Single centre. No power calculation. Cohort not limited to COPD. Possible interpreter bias—pCO₂ threshold calculated retrospectively</td>
</tr>
<tr>
<td>McCann et al, 2012, Australia</td>
<td>89 patients presenting with COPD. Paired arterial and venous blood gas analyses</td>
<td>Single-centre prospective observational study</td>
<td>Sensitivity of venous pCO₂ to detect arterial normocarbia with a cut-off value of 6 kPa</td>
<td>100% sensitivity</td>
<td>Single centre. Underpowered sample size. Small cohort. Convenience sampling used</td>
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<td>Kelly, 2013, Australia</td>
<td>529 patients presenting with COPD across four studies</td>
<td>Systematic review</td>
<td>Sensitivity of venous pCO₂ to detect arterial normocarbia with a cut-off value of 45 mm Hg</td>
<td>100% specificity</td>
<td>Reliance on validity of included studies</td>
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<td>Sur, 2013, Scotland</td>
<td>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</td>
<td>Prospective observational study</td>
<td>Correlation between arterial and venous pCO₂</td>
<td>Pearson’s r=0.973, but 95% LOA —4.94 to 14.26 mm Hg</td>
<td>Results presented as a poster. Blood gas analysis performed at physician’s discretion rather than according to preset criteria</td>
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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 pCO\textsubscript{2} 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 pCO\textsubscript{2} 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 CO\textsubscript{2}] [rule out arterial hypercarbia]?

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

**REFERENCES**

**Clinical bottom line**
In patients presenting with AECOPD, a normal pCO\textsubscript{2} on venous blood gas analysis means that they do not need an arterial blood gas sample to exclude hypercarbia.

**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 pCO\textsubscript{2} is within range, then this excludes arterial hypercarbia. One may argue an arterial sample is still required to assess pO\textsubscript{2}; however, the British Thoracic Society guidelines support using transcutaneous oxygen saturations to titrate O\textsubscript{2} therapy.

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