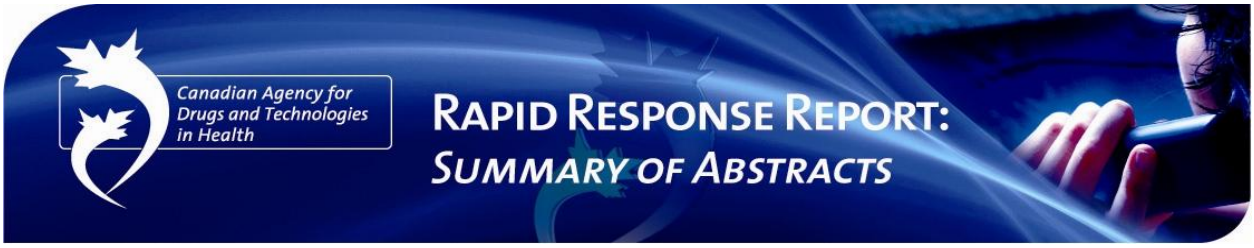

TITLE: Accuracy of Sidestream CO_2 Monitors for Spontaneously Breathing Non-Intubated Adult Patients

DATE: 14 December 2010

RESEARCH QUESTION:

What is the reliability and accuracy of sidestream CO_2 monitors for spontaneously breathing non-intubated adult patients?

KEY MESSAGE

Limited evidence from non-randomized studies suggests that end-tidal CO_2 measured by sidestream capnography should not be used to replace arterial CO_2 partial pressure as measured by blood gas analysis in spontaneously breathing adult patients.

METHODS

A limited literature search was conducted on key health technology assessment resources, including PubMed, the Cochrane Library (Issue 11, 2010), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI (Health Devices Gold), EuroScan, international health technology agencies, and a focused Internet search. The search was limited to English language articles published between January 1, 2005 and December 1, 2010. Retrieval was limited to the human population. Filters were applied to limit the retrieval by health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, and non-randomized studies. Internet links were provided, where available.

The summary of findings was prepared from the abstracts of the relevant information. Please note that data contained in abstracts may not always be an accurate reflection of the data contained within the full article.

RESULTS

Rapid response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials and non-randomized studies.

Six non-randomized studies were found pertaining to the reliability and accuracy of sidestream CO_2 monitors for spontaneously breathing patients. No relevant health technology assessment reports, systematic reviews, meta-analyses, or randomized controlled trials were identified. Additional information that may be of interest is included in the appendix.

OVERALL SUMMARY OF FINDINGS

Limited evidence is available regarding the accuracy of sidestream CO_2 analyzers in spontaneously breathing adult patients. Four non-randomized studies[1,2,4,6], one of which was performed on patients with COPD[1], concluded that end-tidal CO_2 measured by sidestream capnography was not sufficiently accurate to replace arterial CO_2 partial pressure as measured by blood gas analysis. One non-randomized study[3] concluded that the accuracy of sidestream capnometers could be improved with the use of an oral guide, while another[5] concluded that sidestream and mainstream capnography performed equally well in non-intubated, sedated volunteers. No information regarding sidestream capnometer reliability was identified. Further detail regarding the included studies is contained in Table 1.

Table 1: Details of the Included Studies

Author, Year, Study type	Study objectives, population	Results	Conclusions
Kartel et al., 2010, NRS[1]	To determine the value of SS-$ETCO_2$ measurement in COPD patients in the ED.	Agreement difference from PCO_2: 8.4 mmHg Precision: 11.1 mmHg	Authors concluded that $ETCO_2$ measurement should not be considered as a part of the decision-making process to predict PCO_2 level in COPD patients.
Jabre et al., 2009, NRS[2]	To assess agreement between $ETCO_2$ measured by a sidestream capnometer and values measured by a blood gas analyzer PCO_2 in non-intubated patients with respiratory distress in an out-of-hospital setting.	Agreement difference from PCO_2: 12 mmHg Precision: 8 mmHg	Authors concluded that $ETCO_2$ measurements poorly reflected PCO_2 values in non-intubated patients with respiratory distress of various origins.
Kasuya et al., 2009, NRS[3]	To evaluate the accuracy of a mainstream capnometer with an oral guide and a sidestream capnometer with or without an oral guide in spontaneously breathing non-obese and obese patients with	Differences from PCO_2 <u>Non-obese pts</u> Sidestream with oral guide: 4.9 +/- 2.3 mmHg Sidestream w/ standard cannula: 7.1 +/- 3.5 mmHg <u>Obese pts w/o OSA</u>	Authors concluded that an oral guide improved the performance of sidestream capnometry. Accuracy in non-obese and obese patients, with and without OSA, was similar.

Table 1: Details of the Included Studies			
Author, Year, Study type	**Study objectives, population**	**Results**	**Conclusions**
	and without OSA during recovery from general anesthesia.	Sidestream with oral guide: 6.4 +/- 3.1 mmHg Sidestream w/ standard cannula: 8.1 +/- 5.0 mmHg <u>Obese pt w/ OSA</u> Sidestream with oral guide: 6.3 +/- 3.2 mmHg Sidestream w/ standard cannula: 8.3 +/- 4.6 mmHg	
Law et al., 2009, NRS[4]	To explore the correlation and concordance between $ETCO_2$ and arterial PCO_2 in patients deemed to require arterial blood gas determination.	Agreement difference from PCO_2: 7.2 torr (95% CI:5.5-8.9)	Authors concluded that $ETCO_2$ was not significantly correlated with PCO_2, especially when supplemental oxygen was used. $ETCO_2$ currently cannot replace arterial blood gas measurement as a tool for monitoring arterial PCO_2.
Sakata et al., 2009 NRS[5]	To determine if $ETCO_2$ measured with flow-through capnometry will more closely resemble arterial PCO_2 than sidestream capnometry in a bench study and in healthy, non-intubated volunteers.	Bland and Altman plots comparing $ETCO_2$ to PCO_2 showed essentially equal performance between the two capnometers in the healthy volunteers.	Authors concluded that flow-through and sidestream capnometry performed equally well in non-intubated, sedated patients.
Stein et al., 2006 NRS[6]	To compare readings from a transcutaneous capnometer and an end-tidal capnometer to PCO_2 measurements made via arterial-blood-gas analysis.	Sidestream $ETCO_2$ agreement difference from arterial PCO_2: -14.1 +/- 7.4 mmHg	Authors conclude that clinical use of these monitors cannot be proposed under actual conditions but will be advantageous after correction of the limiting errors.

ED = emergency department; $ETCO_2$ = end-tidal carbon dioxide; mmHg = millimeters mercury; NRS = non-randomized study; OSA = obstructive sleep apnea; PCO_2 = carbon dioxide partial pressure; pts = patients; SS-$ETCO_2$ = sidestream end-tidal carbon dioxide; 95% CI = 95% confidence interval;

REFERENCES SUMMARIZED

Health technology assessments
No literature identified.

Systematic reviews and meta-analyses
No literature identified.

Randomized controlled trials
No literature identified.

Non-randomized studies

1. Kartal M, Goksu E, Eray O, Isik S, Sayrac AV, Yigit OE, et al. The value of ETCO2 measurement for COPD patients in the emergency department. Eur J Emerg Med. 2010 Mar 10. PubMed: PM20224417

2. Jabre P, Jacob L, Auger H, Jaulin C, Monribot M, Aurore A, et al. Capnography monitoring in nonintubated patients with respiratory distress. Am J Emerg Med. 2009 Nov;27(9):1056-9. PubMed: PM19931750

3. Kasuya Y, Akca O, Sessler DI, Ozaki M, Komatsu R. Accuracy of postoperative end-tidal Pco2 measurements with mainstream and sidestream capnography in non-obese patients and in obese patients with and without obstructive sleep apnea. Anesthesiology. 2009 Sep;111(3):609-15. PubMed: PM19672177

4. Law GT, Wong CY, Kwan CW, Wong KY, Wong FP, Tse HN. Concordance between side-stream end-tidal carbon dioxide and arterial carbon dioxide partial pressure in respiratory service setting. Hong Kong Med J. 2009 Dec;15(6):440-6. PubMed: PM19966348

5. Sakata DJ, Matsubara I, Gopalakrishnan NA, Westenskow DR, White JL, Yamamori S, et al. Flow-through versus sidestream capnometry for detection of end tidal carbon dioxide in the sedated patient. J Clin Monit Comput. 2009 Apr;23(2):115-22. PubMed: PM19301133

6. Stein N, Matz H, Schneeweiss A, Eckmann C, Roth-Isigkeit A, Huppe M, et al. An evaluation of a transcutaneous and an end-tidal capnometer for noninvasive monitoring of spontaneously breathing patients. Respir Care. 2006 Oct;51(10):1162-6. PubMed: PM17005062

PREPARED BY:
Canadian Agency for Drugs and Technologies in Health
Tel: 1-866-898-8439
www.cadth.ca

APPENDIX – FURTHER INFORMATION:

Review articles

7. Krauss B. Advances in the use of capnography for nonintubated patients. Isr J Emerg Med [Internet]. 2008 Nov [cited 2010 Dec 4];8(3):3-15. Available from: http://isrjem.org/isrjem_nov08%20kraus_capnography_postprod.pdf.
Note: see Limitation of Capnography, page 13.

Non-randomized studies – unclear if capnography was sidestream or mainstream

8. Lujan M, Canturri E, Moreno A, Arranz M, Vigil L, Domingo C. Capnometry in spontaneously breathing patients: the influence of chronic obstructive pulmonary disease and expiration maneuvers. Med Sci Monit. 2008 Sep;14(9):CR485-CR492. PubMed: PM18758420

9. Corbo J, Bijur P, Lahn M, Gallagher EJ. Concordance between capnography and arterial blood gas measurements of carbon dioxide in acute asthma. Ann Emerg Med. 2005 Oct;46(4):323-7. PubMed: PM16187465