

## EVIDENCE WORKSHEET

### Guideline 10.4 The Use of Oxygen in Emergencies

ARC Subcommittee: BLS

Guideline author: Julie Considine

#### Clinical (PICO) question (ILCOR c2015):

P: Among adults and children who exhibit symptoms or signs of shortness of breath, difficulty breathing or hypoxia outside of a hospital

I: does administration of oxygen

C: compared with no administration of oxygen

O: change survival with favourable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, shortness of breath, time to resolution of symptoms , therapeutic endpoints (eg oxygenation and ventilation)

#### Search Strategies (ILCOR c2015):

**PubMed:** ( Search Completed: May 06, 2014 ) April 29 2014: **1188 results**

```
((((((("First aid"[TI] OR emergency[TI] OR emergencies[TI]) AND ("Oxygen Inhalation Therapy"[Mesh] OR oxygen[TI]))) OR (((("Dyspnea"[Mesh] OR Dyspnea[TIAB] OR dyspnoea[TIAB] OR Dyspneas[TIAB] OR "Shortness of Breath"[TIAB] OR "Breath Shortness"[TIAB] OR "short of breath"[TIAB] OR breathlessness[TIAB] OR "Difficulty Breathing"[TIAB] OR Wheezing[TIAB] OR "Respiratory Insufficiency/therapy"[Mesh] OR "Respiratory Distress Syndrome, Adult/therapy"[Mesh] OR "Anoxia/therapy"[Mesh] OR "Cyanosis/therapy"[Mesh] OR "Hypercapnia/therapy"[Mesh] OR "Hyperoxia/therapy"[Mesh] OR "Hypocapnia/therapy"[Mesh] OR "Hypoventilation/therapy"[Mesh] OR "Asthma/therapy"[Mesh] OR "Pulmonary Disease, Chronic Obstructive/therapy"[Mesh] OR "Emphysema/therapy"[Mesh] OR "Drowning/therapy"[Mesh] OR "Near Drowning/therapy"[Mesh] OR "Carbon Monoxide Poisoning/therapy"[Mesh] OR "Decompression Sickness/therapy"[Mesh] OR "Paraquat lung" [Supplementary Concept] OR "Diving/adverse effects"[Mesh] OR "Diving/complications"[Mesh] OR "Diving/injuries"[Mesh] OR "Diving/mortality"[Mesh] OR "Altitude Sickness/therapy"[Mesh] OR "inflight emergency"[TIAB] OR "inflight emergencies"[TIAB] OR "in-flight emergency"[TIAB] OR "in-flight emergencies"[TIAB] OR "Respiration/abnormalities"[Mesh]) AND ("Emergency Treatment"[Mesh] OR "Emergency Medical Services"[Mesh] OR "Emergency Responders"[Mesh] OR "Emergencies"[Mesh] OR "out-of- hospital"[TIAB] OR prehospital[TIAB] or prehospital[TIAB] OR urgent[TI] OR Emergency[TI] OR emergencies[TI] OR ems[TI]) AND ("Oxygen Inhalation Therapy"[Mesh] OR "Oxygen/administration and dosage"[Mesh] OR "Oxygen/therapeutic use"[Mesh] OR "Oxygen/therapy"[Mesh] OR "emergency oxygen"[TIAB] OR oxygen[TI] OR O2[TI] OR oxygenation[TI]))) NOT (animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp])) NOT "Extracorporeal Membrane Oxygenation"[Mesh])
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**Embase:** ( Search Completed: May 06, 2014 ) 601 results (estimated number of results after removal of duplicates = **242 results**)

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'first aid':ti OR emergency:ti OR emergencies:ti AND ('oxygen therapy'/exp OR oxygen:ti) OR 'dyspnea'/exp OR dyspnea:ab,ti OR dyspnoea:ab,ti OR dyspneas:ab,ti OR 'shortness of breath':ab,ti OR 'breath shortness':ab,ti OR 'short of breath':ab,ti OR breathlessness:ab,ti OR 'difficulty breathing':ab,ti OR wheezing:ab,ti OR 'breathing disorder'/exp/dm_th OR 'adult respiratory distress syndrome'/exp/dm_th OR 'asthma'/exp OR 'chronic obstructive lung disease'/exp/dm_th OR 'respiratory distress'/exp/dm_th OR 'respiratory failure'/exp/dm_th OR 'painful breathing'/exp/dm_th OR 'emphysema'/exp/dm_th OR 'drowning'/exp/dm_th OR 'carbon monoxide intoxication'/exp/dm_th OR 'decompression sickness'/exp/dm_th OR 'diving'/exp/dm_th OR 'paraquat poisoning'/exp/dm_th OR 'altitude disease'/exp/dm_th OR 'inflight emergency':ab,ti OR 'inflight emergencies':ab,ti OR 'in-flight
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emergency':ab,ti OR 'in-flight emergencies':ab,ti OR 'breathing'/exp AND ('emergency care'/de OR 'emergency treatment'/de OR 'emergency health service'/exp OR 'first aid'/exp OR 'emergency'/de OR 'ambulance'/exp OR 'rescue personnel'/exp OR 'emergency medicine'/exp OR 'out-of- hospital':ab,ti OR prehospital:ab,ti OR urgent:ti OR emergency:ti OR emergencies:ti OR ems:ti) AND ('oxygen therapy'/exp OR 'oxygen'/exp/dm\_th OR 'emergency oxygen':ab,ti OR oxygen:ti OR o2:ti OR oxygenation:ti) NOT 'extracorporeal oxygenation'/exp NOT ('animal'/exp NOT 'human'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim

**Cochrane:** ( Search Completed: May 06, 2014 ) **188 results**

("First aid":ti or emergency:ti or emergencies:ti) and ([mh "Oxygen Inhalation"/TH] or oxygen:ti) or (([mh Dyspnea] or Dyspnea:ti,ab or dyspnoea:ti,ab or Dyspneas:ti,ab or "Shortness of Breath":ti,ab or "Breath Shortness":ti,ab or "short of breath":ti,ab or breathlessness:ti,ab or "Difficulty Breathing":ti,ab or Wheezing:ti,ab or [mh "Respiratory Insufficiency"/TH] or [mh "Respiratory Distress Syndrome, Adult"/TH] or [mh Anoxia/TH] or [mh Cyanosis/TH] or [mh Hypercapnia/TH] or [mh Hyperoxia/TH] or [mh Hypocapnia/TH] or [mh Hypoventilation/TH] or [mh Asthma/TH] or [mh "Pulmonary Disease, Chronic Obstructive"/TH] or [mh Emphysema/TH] or [mh Drowning/TH] or [mh "Near Drowning"/TH] or [mh "Carbon Monoxide Poisoning"/TH] or [mh "Decompression Sickness"/TH] or Paraquat:ti,ab or [mh Diving/AE] or [mh Diving/CO] or [mh Diving/IN] or [mh "Altitude Sickness"/TH] or "inflight emergency":ti,ab or "inflight emergencies":ti,ab or "in-flight emergency":ti,ab or "in-flight emergencies":ti,ab or [mh Respiration]) and ([mh "Emergency Treatment"] or [mh "Emergency Medical Services"] or [mh "Emergency Responders"] or [mh Emergencies] or "out-of- hospital":ti,ab or prehospital:ti,ab or prehospital:ti,ab or urgent:ti or Emergency:ti or emergencies:ti or ems:ti) and ([mh "Oxygen Inhalation"/TH] or [mh Oxygen/AD] or [mh Oxygen/TU] or [mh Oxygen/TH] or "emergency oxygen":ti,ab or oxygen:ti or O2:ti or oxygenation:ti) not [mh "Extracorporeal Membrane Oxygenation"]

**Other: ( Search Completed: ) previous search strings:**

(Dyspnea[Mesh] OR Dyspnea[All Fields] OR Difficult Breathing[Mesh] OR Difficult Breathing[All Fields] OR Wheezing[Mesh] OR Wheezing[All Fields] OR Asthma[Mesh] OR Asthma[All Fields] OR Chronic Obstructive[Mesh] OR Chronic Obstructive[All Fields] OR Emphysema[Mesh] OR Emphysema[All Fields] OR Drowning[Mesh] OR Drowning[All Fields] OR Near-drowning[Mesh] OR Near-drowning[All Fields] OR Carbon monoxide[Mesh] OR Carbon monoxide[All Fields] OR Paraquat[Mesh] OR Paraquat[All Fields] OR Diving[Mesh] OR Diving[All Fields] OR Inflight emergency[Mesh] OR Inflight emergency[All fields]) AND (First Aid[Mesh] OR First Aid[All Fields] OR prehospital[Mesh] OR prehospital[All Fields] OR out-of-hospital[Mesh] OR out-of-hospital[All Fields] OR Emergency Medical Services[Mesh] OR ems[All Fields] OR early[All Fields] OR earlier[All Fields]) AND (Oxygen[Mesh] OR Oxygen[All Fields])

**Inclusion / exclusion criteria:** The first round of inclusion / exclusion was conducted by the ILCOR c2015 Evidence Reviewers. The second round of inclusion / exclusion was conducted by the ARC worksheet author as follows:

**Inclusion criteria:** Studies specifically looking at oxygen administration in pre-hospital context by first aiders or first aid provider, defined as follows as per Australian Resuscitation Council glossary:

- FIRST AIDER or FIRST AID PROVIDER: a person with formal training in first aid, emergency care, or medicine who provides first aid
- FIRST RESPONDER: a first responder is a person competent in advanced first aid (including oxygen administration and the use of an automated external defibrillator). A first responder may be a salaried/non-salaried member of a fire/police/ambulance service, a community based organisation (e.g. first aid and water safety/rescue services), or any other organisation having in place the necessary systems.

**Exclusion criteria**

Studies of oxygen administration in hospital environments, studies of oxygen administration by health care professionals, defined as follows as per Australian Resuscitation Council glossary:

- HEALTH CARE PROFESSIONAL: (in the context of first aid, pre-hospital care and resuscitation) a person who is a registered medical practitioner, registered nurse or qualified ambulance paramedic or Australian Defence Force medic.

**Search results:**

The combined searches outlined above yielded 1853 studies, which were assessed for inclusion as evidence by the ILCOR c2015 Evidence Reviewers, leaving 4 articles for further review. Review of those 4 articles showed:

- one RCT of pre-hospital use by paramedics in 405 patients with COPD of high flow oxygen treatment compared with titrated oxygen treatment
- one double-blind, randomized, controlled, crossover trial of 24 outpatients with newly diagnosed obesity associated hypoventilation of 100% oxygen vs room air in a respiratory laboratory
- one chart review of oxygen use by paramedics in 1022 patients
- one chart review of oxygen use by EMS in 27 paediatrics patients less than 18 years of age with asthma who required hospitalization

None of these studies address oxygen use in pre-hospital context by first aiders, two studies (one RCT and one retrospective audit) were of oxygen use by qualified paramedics (Hale et al. 2008; Austin et al 2010), and one study (retrospective audit) was of oxygen use by EMS first responders or qualified paramedics (Wijesinghe et al. 2011). The remaining study was a randomised, controlled, crossover trial but was conducted in a respiratory laboratory by respiratory physiologist and respiratory physician.

**Number of studies meeting inclusion / exclusion criteria for worksheet inclusion: Nil**

<b>Methodological quality, levels of evidence &amp; outcomes of studies examining pre-hospital oxygen use</b>							
<b>Good</b> The methodological quality of the study is high with the likelihood of any significant bias being minimal	<b>Fair</b> The methodological quality of the study is reasonable with the potential for significant bias being likely.			<b>Poor</b> The methodological quality of the study is weak possessing considerable and significant biases			
<b>1. Studies <i>supportive</i> of oxygen administration:</b>							
<b>Good</b>		Austin 2010					
<b>Fair</b>						Hale et al. 2008	
<b>Poor</b>							
	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
	NH&MRC levels of evidence						
<b>2. Studies <i>neutral</i> for oxygen administration:</b>							
<b>Good</b>							
<b>Fair</b>							
<b>Poor</b>						Fisher et al. 1995	
	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
	NH&MRC levels of evidence						
<b>3. Studies <i>opposing</i> oxygen administration:</b>							
<b>Good</b>		Wijesinghe 2011					
<b>Fair</b>							
<b>Poor</b>							
	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
	NH&MRC levels of evidence						
<b>Endpoints:</b>							
A = survival with favourable neurological/functional outcome at discharge							
B = survival with favourable neurological/functional outcome 30 days, 60 days, 180 days AND/OR 1 year							
C = survival only at discharge							
D = survival only at 30 days, 60 days, 180 days AND/OR 1 year							
E = shortness of breath							
F = time to resolution of symptoms							
G = therapeutic endpoints (eg oxygenation and ventilation)							
<b>Treatment recommendation: N/A</b>							
<b>Class: N/A</b>							
<b>Summary of science</b>							
In the ILCOR c2015 process, there were no published high level studies that examined oxygen use in the pre-hospital context by first aiders or first responders identified. Two of the four studies included in the c2015 review (one RCT and one audit) were related to oxygen use by paramedics, one study (audit) was related to oxygen use by EMS and paramedics, and the remaining study (RCT) was related to oxygen use by respiratory physiologist and respiratory physician in a respiratory physiology laboratory.							

**Reviewer's final comments:** as above

**Evidence gaps and research priorities:**

The pre-hospital use of supplemental oxygen by first aiders and first responders on patient outcomes warrants further evaluation.

**Citation List:**

**Austin MA, Wills KE, Blizzard L, Walters EH, Wood-Baker R. Effect of high flow oxygen on mortality in chronic obstructive pulmonary disease patients in prehospital setting: randomised controlled trial. *BMJ* 2010; 341.**

**Objectives:** To compare standard high flow oxygen treatment with titrated oxygen treatment for patients with an acute exacerbation of chronic obstructive pulmonary disease in the prehospital setting. **Design:** Cluster randomised controlled parallel group trial. **Setting:** Ambulance service in Hobart, Tasmania, Australia. **Participants:** 405 patients with a presumed acute exacerbation of chronic obstructive pulmonary disease who were treated by paramedics, transported, and admitted to the Royal Hobart Hospital during the trial period; 214 had a diagnosis of chronic obstructive pulmonary disease confirmed by lung function tests in the previous five years. **Interventions:** High flow oxygen treatment compared with titrated oxygen treatment in the prehospital (ambulance/paramedic) setting.

**Main outcome measure:** Prehospital or in-hospital mortality. **Results:** In an intention to treat analysis, the risk of death was significantly lower in the titrated oxygen arm compared with the high flow oxygen arm for all patients (high flow oxygen n=226; titrated oxygen n=179) and for the subgroup of patients with confirmed chronic obstructive pulmonary disease (high flow n=117; titrated n=97). Overall mortality was 9% (21 deaths) in the high flow oxygen arm compared with 4% (7 deaths) in the titrated oxygen arm; mortality in the subgroup with confirmed chronic obstructive pulmonary disease was 9% (11 deaths) in the high flow arm compared with 2% (2 deaths) in the titrated oxygen arm. Titrated oxygen treatment reduced mortality compared with high flow oxygen by 58% for all patients (relative risk 0.42, 95% confidence interval 0.20 to 0.89; P=0.02) and by 78% for the patients with confirmed chronic obstructive pulmonary disease (0.22, 0.05 to 0.91; P=0.04). Patients with chronic obstructive pulmonary disease who received titrated oxygen according to the protocol were significantly less likely to have respiratory acidosis (mean difference in pH 0.12 (SE 0.05); P=0.01; n=28) or hypercapnia (mean difference in arterial carbon dioxide pressure -33.6 (16.3) mm Hg; P=0.02; n=29) than were patients who received high flow oxygen. **Conclusions:** Titrated oxygen treatment significantly reduced mortality, hypercapnia, and respiratory acidosis compared with high flow oxygen in acute exacerbations of chronic obstructive pulmonary disease. These results provide strong evidence to recommend the routine use of titrated oxygen treatment in patients with breathlessness and a history or clinical likelihood of chronic obstructive pulmonary disease in the prehospital setting.

NHMRC: cluster RCT

QUALITY: Good

OUTCOME: Survival (Prehospital or in-hospital mortality)

INTERVENTION: Supportive of titrated oxygen over high flow oxygen

**Wijesinghe M, Williams M, Perrin K, Weatherall M, Beasley R. The Effect of Supplemental Oxygen on Hypercapnia in Subjects With Obesity-Associated Hypoventilation A Randomized, Crossover, Clinical Study. *CHEST Journal* 2011; 139(5): 1018-24.**

**Background:** It is unknown whether oxygen therapy causes worsening hypercapnia in patients with obesity-associated hypoventilation (OAH), similar to the response observed in COPD. The objectives of this study were to investigate whether breathing 100% oxygen results in an increase in hypercapnia in patients with OAH and the mechanisms of any effect. **Methods:** In this double-blind, randomized, controlled, crossover trial, 24 outpatients with newly diagnosed OAH inhaled 100% oxygen or room air for 20 min on 2 separate days. Transcutaneous CO<sub>2</sub> tension (Pt CO<sub>2</sub>), minute ventilation, and volume of dead space to tidal volume ratio were measured at baseline and at 20 min. A mixed linear model was used to determine differences between the two treatments. **Results:** The study was terminated in three subjects breathing 100% oxygen due to a Pt CO<sub>2</sub> increase  $\geq 10$  mm Hg, which occurred after 10:35, 13:20, and 15:51 min. Pt CO<sub>2</sub> increased by 5.0 mm Hg (95% CI, 3.1-6.8; P, .001) with oxygen compared with room air. Minute ventilation decreased by 1.4 L/min (95% CI, 0.11-2.6 L/min; P 5 .03), and volume of dead space to tidal volume ratio increased by 0.067 (95% CI, 0.035-0.10; P, .001) with oxygen compared with room air. **Conclusions:** Breathing 100% oxygen causes worsening hypercapnia in stable patients with OAH.

NHMRC: double-blind, randomized, controlled, crossover trial of 24 patients

QUALITY: Good

OUTCOME: CO<sub>2</sub> tension (P<sub>t</sub>CO<sub>2</sub>), minute ventilation, and volume of dead space to tidal volume ratio

INTERVENTION: 100% oxygen caused worse hypercapnia than breathing room air

**Hale KE, Gavin C, O'Driscoll BR. Audit of oxygen use in emergency ambulances and in a hospital emergency department. *Emergency Medicine Journal* 2008; 25(11): 773-6**

**Background:** Oxygen is widely used but poorly studied in emergency medicine, with a limited evidence base for its use in specific conditions. There are safety concerns about the underuse of oxygen in patients with critical illness and its overuse in conditions such as chronic obstructive pulmonary disease (COPD). A baseline audit was required to assess current practice prior to the introduction of new national emergency oxygen guidelines in late 2008.

**Methods:** The use of pulse oximetry and oxygen therapy was audited in patients brought by ambulance to the "majors" section of the emergency department (ED) in a university hospital. Oxygen therapy in the ambulance and the ED was subsequently documented. Oxygen use in ambulances was compared with Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidance and with subsequent patient management. **Results:** The ambulance and ED records of 1022 patients were audited manually. Oxygen saturation (SpO<sub>2</sub>) was recorded for 90% of patients, 17% of whom had SpO<sub>2</sub> <94% at some time and 7% had SpO<sub>2</sub> <90%, including 33% of patients with COPD and 5.5% of patients without COPD. 34% of patients received oxygen in the ambulance and almost half of these had oxygen discontinued in the ED. Only 62% of ambulance oxygen use was in accordance with JRCALC guidance, but most "undertreated" patients were stable normoxaemic patients for whom guidance recommends high-flow oxygen. Only 58% of patients with COPD were correctly identified in the ambulance and 73% of these patients were treated with flow rates <.4 l/min (equivalent to <.35% oxygen). **Conclusions:** Oxygen use in ambulances is very common, equivalent to 2.2 million episodes annually in the UK. The quality of oxygen use is suboptimal, especially for patients with COPD. Emergency oxygen therapy will become simpler when new evidence-based UK emergency oxygen guidelines are published, and it is hoped that future audits will show better protocol adherence.

NHMRC: retrospective case series of 1022 ambulance patients

QUALITY: Fair

OUTCOME: Exploratory study to assess current oxygen administration practice by paramedics

INTERVENTION: oxygen use is common however quality of oxygen use is suboptimal

**Fisher JD, Vinci RJ. Prehospital management of pediatric asthma requiring hospitalization. *Pediatric emergency care* 1995; 11(4): 217-9**

Our objective was to evaluate the quality of prehospital assessment and management in pediatric asthma requiring hospitalization via a retrospective chart review. Charts were obtained from a pediatric emergency department (ED) with 24,000 annual visits. Included in the study were 27 patients less than 18 years of age with asthma requiring hospitalization, transported to the Boston City Hospital Pediatric ED by Boston Emergency Medicine Services (EMS). We found that 12 patients admitted to the pediatric intensive care unit over an 18-month period, and 15 patients admitted to the ward over a six-month period, received prehospital care from Boston EMS. Only 63% of cases (17/27) had a physical examination marker of asthma severity noted on the EMS record. Twenty-six percent of cases (7/27) did not receive O<sub>2</sub> in the field. Thirty percent of cases (8/27) were hypoxic at ED presentation. None of the hypoxic patients had received albuterol in the field, and one did not receive O<sub>2</sub>. We conclude that further study of the prehospital assessment and management of pediatric asthma is warranted.

NHMRC: retrospective audit of prehospital care of 27 children with asthma

QUALITY: Poor

OUTCOME: Exploratory study, quantifying pre-hospital oxygen use in children with asthma

INTERVENTION: 26% of children received oxygen during pre-hospital care, one hypoxic patient did not receive oxygen.