FA 1549 Use of Supplementary Oxygen in First Aid

**Data Table**

**Carbon Monoxide Poisoning**

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| **Author;**  **Year Published**  **(References)** | **Study Type** | **Setting** | **Population** | **Intervention** | **Comparison** | **Outcomes** | **Results/Key findings** |
| Smith 1970 65 | Retrospective case series | Prehospital and hospital emergency departments | accidental and deliberate carbon monoxide poisoning | oxygen, oxygen carbon dioxide mixture, hyperbaric oxygen | no supplementary oxygen | delirium, persistent psychiatric symptoms | Mostly epidemiological study. Found fewer persistent symptoms if oxygen administered, advised oxygen carbon dioxide mixture if hyperbaric oxygen not available |
| Winter 1976 1502 | Literature review | pre and in hospital | persons with carbon monoxide poisoning | 100% oxygen as first aid, hyperbaric oxygen in hospital | not specified | reverse hypoxia and accelerate elimination of CO | "One hundred percent 02 at atmospheric or hyperbaric pressures should be administered to reverse hypoxia and accelerate elimination of CO" |
| Olson 1984 233 | Literature review | pre and in hospital | persons with carbon monoxide poisoning | 100% oxygen as soon as possible, multiple others not FA | not specified | time to resolution of neurological and neuro-psychiatric symptoms | Recommends 100% oxygen as soon as carbon monoxide poisoning suspected, viz "The most widely used treatment for CO poisoning is oxygen, which competes directly with CO for hemoglobin binding sites. The half-life of the COHb complex in room air is approximately three to four hours. Administration of 100% oxygen shortens the half-life to 30 to 40 minutes, and this treatment should be started in the field as soon as the diagnosis is suspected. Use of a simple face mask or even a nonrebreather mask may not deliver 100% oxygen, so patients should receive oxygen using a tight-fitting rubber mask or via an endotracheal tube." Clearly the endotracheal tube is not in the gamut of most if not all first aid |
| Koster 2003 80 | Literature review | pre and in hospital | Persons with carbon monoxide poisoning | 100% oxygen, recompression chamber if available | None | not specified | Advises "Promptly administer 100% oxygen through a properly fitted oxygen mask or nonrebreather |
| Kao 2006 99 | Literature review | pre and in hospital | persons with carbon monoxide poisoning | Supplementary oxygen and hyperbaric oxygen | None | not specified | Advises "Treatment of the CO-poisoned patient begins with supplemental oxygen and aggressive supportive care, including airway management, blood pressure support, and stabilization of cardiovascular status." |
| Jüttner 2021Doc13 | Evidence based guideline | pre and in hospital | Persons with carbon monoxide poisoning | 100% oxygen | none | Not specified | Advises highest concentration of oxygen possible in pre-hospital setting. Viz "Oxygen administration is the most important measure of prehospital care for CO poisoning. Regardless of the oxygen saturation (SpO2), oxygen should be administered immediately at the highest possible concentration." |

**Diving Emergencies**

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| **Author;**  **Year Published**  **(References)** | **Study Type** | **Setting** | **Population** | **Intervention** | **Comparison** | **Outcomes** | **Results/Key findings** |
| Dick 1985 667 | Retrospective case series | pre and in hospital | "sport divers" (compressed gases) | 100% oxygen and hyperbaric oxygen in some | no oxygen treatment | "Neurological decompression illness" and "cerebral air aneurysm" | "Although no controlled studies have been done to examine the benefit of early breathing of 100% oxygen in these injuries, we observed prompt improvement in the few cases when injured divers breathed oxygen immediately after onset of neurologic symptoms from either decompression sickness or air embolism " |
| Shinnick 1994 105 | Literature review | pre and in hospital | Divers with compressed gas (probably recreational) | 100% oxygen as first aid, hyperbaric oxygen in hospital | no oxygen treatment | prevention of "permanent disability or even death" | Substantially about delay to initiation of treatment for diving accidents and call for emergency physicians to contact Divers Alert Network (DAN). Specifically for first aid: " DAN for recommendation to administer 100% oxygen as first aid, asserts demand valve gives highest concentration, no reference for this assertion." Cites a publication by DAN 1992 as authority for 100% oxygen as first aid for diving accident |
| Spira 1999 180 | Literature Review | EMS and in hospital | Divers with compressed gas (probably recreational) | 100% oxygen during transfer to unit with hyperbaric oxygen | not specified | prevention of sequelae of diving injuries | Advises 100% oxygen during transport to hyperbaric oxygen |
| Lippmann 2003 192 | Proceedings of conference | prehospital | divers using compressed gas | 100% oxygen | not specified | "Earlier relief of symptoms and lower chance of post treatment residua" | "There are plethora of oxygen equipment available and careful consideration need to be given when selecting appropriate equipment to manage a diving accident. Such equipment needs to provide high oxygen concentrations to responsive or unresponsive ,breathing or non-breathing victims." |
| Longphre 2007 43 | Retrospective cohort, 2,231 individuals | prehospital | divers using compressed gas | "first aid oxygen" prehospital, multiple others in hospital | no supplementary oxygen | resolution of symptoms and number of retreatment recompression | "First aid oxygen increased recompression efficiency and decreased the number of recompression treatments required if given within four hours of surfacing" |
| Liow 2009 e173 | Retrospective case series | hospital and prehospital | Divers with compressed gas | Hyperbaric oxygen and normobaric 100% oxygen | none | neurological recovery | Recommends 100% normobaric oxygen until HBO available, cites earlier paper by R Ball which doesn’t have any details of prehospital treatment |
| Moon 2009 81 | Literature review | pre and in hospital | recreational divers | "first aid oxygen" prehospital, multiple others in hospital | no supplementary oxygen | resolution of symptoms and need for more than one recompression treatment | Recommends "first aid oxygen" within 4 hours of injury |
| Vann 2011 153 | Literature review published in seminar proceedings | Pre and in hospital | divers using compressed gas | 100% oxygen in prehospital setting | not specified | recovery from diving injury, "symptom resolution" | Advises "The best and primary first aid for decompression illness is 100% oxygen delivered for several hours even if manifestations resolve." |
| Blake 2015 79 | Laboratory | Laboratory | healthy volunteers | Non rebreather (NRB) mask at 10 and 15 L.min, demand valve oxygen mask | 100% oxygen head hood | Transcutaneous measurement of tissue oxygen tension in upper and lower limbs | Nonrebreather mask at 15L/min clinically and statistically significantly better than demand valve mask, statistically better than nonrebreather mask at 10 L/min |
| Pollock. 2017 301 | Literature Review | Pre and in hospital | recreational divers (with compressed gas) | High partial pressure oxygen | not specified | Poorly specified for first aid, but "resolution of symptoms" given for advanced care | Review of all aspects, physiology, pathology, diagnosis and treatment both first aid and in hospital. Wrt first aid: "High partial pressure oxygen is the primary first aid measure for DCI. High oxygen concentration in the lungs will accelerate inert gas elimination. High oxygen partial pressure in the bloodstream can also alleviate ischemic insults produced by bubble blockages. Sustained oxygen delivery can reduce or even eliminate symptoms. Continuous-flow oxygen systems, using nonrebreather or pocket masks, are frequently available in diving environments; however, such equipment delivers modest oxygen fractions. Much higher fractions can be achieved for spontaneously breathing patients with demand masks." |
| Whayne 2018 344 | Literature Review | Pre and in hospital | Commercial and recreational divers using compressed gases | 100% oxygen in prehospital setting | not specified | `"decrease complications and save lives" | Recommends "In the meantime, knowledge of the importance of administering 100% oxygen and rehydration with intravenous normal saline may contribute to clinical success before the definitive recompression," ie until hyperbaric oxygen therapy available |

**Chronic Obstructive Pulmonary Disease**

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| **Author;**  **Year Published**  **(References)** | **Study Type** | **Setting** | **Population** | **Intervention** | **Comparison** | **Outcomes** | **Results/Key findings** |
| Zotti 1994 13 | Not available |  |  |  |  |  |  |
| Austin 2006 Cd005534 | Systematic review of randomized controlled trials (RCTs) | Pre- hospital | Acute exacerbation of Chronic obstructive pulmonary disease (AECOPD) | High flow oxygen. Not defined except subgroup of flow for nebulized bronchodilators – “typically 6-8L/min” | “Controlled” oxygen | Mortality from respiratory causes *Secondary outcomes* 1. All causes mortality 2. Dyspnea score 3. Arterial blood gas (ABG)  4. Length of stay (LOS) 5. ICU admission 6. Mental status score 7. Consciousness score (i.e., GCS)  8. Invasive ventilation 9. Noninvasive ventilation 10.Lung function 11.Illness score | Only 2 RCTs were identified and were ongoing with no results published at the time of the review |
| Austin 2010 c5462 | Cluster randomized trial | Pre-hospital | COPD, including AECOPD | Oxygen titrated to saturations of 88-92% | High concentration oxygen: High flow oxygen treatment (8–10 L/min) administered via a non-rebreather face mask and bronchodilators delivered by nebulisation with oxygen flows of 6–8 l/min. | Mortality | Titrated oxygen treatment significantly reduced mortality, hypercapnia, and respiratory acidosis compared with high flow oxygen in acute exacerbations of chronic obstructive pulmonary disease. |
| Ntoumenopoulos 2011 70008 | Cluster RCT | Pre-hospital | AECOPD | Titrated oxygen by NC to sat 88%-92% | High flow oxygen (8-10 L/min) via NRFM | Pre- and in-hospital mortality; length of stay, ABGs. | Mortality in the intervention and control groups was 4% (n = 7) and 9% (n = 21), respectively. The relative risk was 0.42 (95% CI 0.20 to 0.89). Similar results were demonstrated when only those patients who had a physician-confirmed diagnosis of COPD were included in the analyses (mortality of 2%, n = 2, vs 9%, n = 11, and relative risk of 0.22, 95% CI 0.05 to 0.9]). (Likely repeat reporting of Austin 2010 study) |
| Wijesinghe 2011 618 | Retrospective observational | Pre-hospital | AECOPD | Oxygen administration per 1 liter per minute increase in flow | Oxygen administration with oxygen flow 1 liter per minute lower | Death, required assisted ventilation or in respiratory failure | Of 250 patients 10 (4%) died, and 77 (31%) died, required assisted ventilation or were in respiratory failure. Increased oxygen flow was associated with increasing risk of death, assisted ventilation or respiratory failure with an odds ratio (OR) of 1.2 (95% CI 1.0–1.4) per 1 L/min oxygen flow. Increasing PaO2 was associated with a greater risk of a poor outcome with an OR of 1.1 (95% CI 1.0–1.3) per 10 mmHg higher PaO2. |
| Cameron 2012 684 | Retrospective observational | Pre-hospital | AECOPD | Oxygen saturation on ABG within 4 hours of arrival in ED <88% or >96% | Oxygen saturation on ABG within 4 hours of arrival in ED 88-96% | Composite measure hypercapnic respiratory failure, assisted ventilation or inpatient death | PaO2 on ABG within 4 hours of arrival of <88%, 88-96% and >96% in patients brought to hospital by EMS and found a hazard ratio (HR) of 9 for saturation >96% and 2 for saturations <88% |
| Pilcher 2015 287 | Literature Review | Pre and in hospital; | AECOPD | Titrated oxygen | High “concentration” or “high dose" oxygen | Mortality | Inter alia, "In acute exacerbations of COPD, there is a 2.4-fold increase in the risk of death if patients receive high concentration oxygen therapy, compared with titrated oxygen therapy." |
| Ringbaek 2015 2 | Observational study | Pre and in-hospital | COPD | Oxygen, varying flow rates | Oxygen, varying flow rates | Respiratory acidosis at hospital admission, length of stay, ventilatory support, in-hospital mortality | Review aim was to assess the frequency of “inappropriate oxygen therapy” given in ambulance for AECOPD patients. Inappropriate oxygen therapy determined by a saturation of 92% or greater. A total of 352 (88.7%) of 397 patients were deemed to have received inappropriate oxygen therapy based on an O2 saturation of 92% or greater. Of this group of patients, 33.5% had respiratory acidosis at hospital admission |
| Lumholdt 2017 A8 | Retrospective observational | Pre-hospital | Patients brought to Emergency Department (ED) with “respiratory conditions” | CO2 retention | No CO2 retention | Not applicable (N/A) | 111 patients with respiratory conditions brought to ED by EMS and found to have acidosis and CO2 retention. They found the 11 patients with CO2 retention had a mean oxygen saturation of 84% on presentation to EMS and 95% on arrival in ED. They inferred this was due to excessive oxygen administration before arrival in hospital |
| Bentsen 2020 76 | Retrospective observational | Pre-hospital | COPD transported to hospital by Emergency Medical Services (EMS) | Oxygen saturations 88-92% in care of EMS | Oxygen saturations >92% in care of EMS | 30-day mortality | 30-day mortality of 707 patients with COPD brought to hospital with either high flow or oxygen titrated to saturations of 88-92%. They found a relative risk (RR) of 4 for 30-day mortality for high flow oxygen in 178 with acute exacerbation of COPD, but no significant difference in the whole group with COPD They noted differences from Austin et al due to different patient groups. Average oxygen flow rates of 12 L/ min were noted for both the titrated oxygen group and the “high flow” oxygen group in Table 1. |
| Kopsaftis 2020 Cd005534 | Cochrane review | Pre-hospital EMS | Adults with acute exacerbation of COPD treated by EMS in te prehospital setting | "controlled oxygen" | "standard oxygen" cited in the single paper as: High concentration oxygen: High flow oxygen treatment (8–10 l/min) administered via a non-rebreather face mask and bronchodilators delivered by nebulisation with oxygen flows of 6–8 l/min. | "mortality" | The one included study found a reduction in pre/in-hospital mortality for the titrated oxygen arm compared to the high-flow control arm. However, the paucity of evidence somewhat limits the reliability of these findings and generalisability to other settings. There is a need for robust, well-designed RCTs to further investigate the effect of oxygen therapies in the pre-hospital setting for people with AECOPD. |
| Hodroge 2020 849 | Evidence Based Guideline | Pre-hospital | Adult patients with respiratory distress | Titrated Oxygen | High Flow oxygen (not defined) | Mortality | Inter alia: “Literature review revealed that oxygen titration to no more than 94-96% for most acutely ill medical patients and to 88-92% in patients with acute chronic obstructive pulmonary disease (COPD) exacerbation is associated with decreased mortality.”  ” |
| Barnett 2022 262 | Evidence based guideline | Pre and in hospital | COPD | N/A | N/A | N/A | Key recommendations relevant to the current PICOST are: assess oxygenation, oxygen requires prescription and to set oxygen saturation targets of 88-92% for potential hypercapnia, 92-96% for others |
| Gottlieb 2022 214 | Evidence based guideline | Pre-hospital | All patients considered for supplementary oxygen, implicit EMT or other advanced care | titrated oxygen | high flow oxygen | mortality and "functional outcome" | Predominant evidence found relates to prehospital CPR. Recommends use of oximetry and high flow oxygen if such not available or unreliable only for "critical situations" viz "With the exception of critical situations (e.g., during CPR), pulse oximetry is a meaningful tool for assessing a patient before initiating oxygen therapy, even in a pre- hospital setting." Notes "The insights regarding the benefit of lower SpO2 target ranges in the prehospital setting were gained especially for patients at risk of hypercapnia (COPD patients with exacerbation)" |
| Jensen 2023 | Randomised control trial registered in Europe | Pre-hospital, gas used to drive inhaled bronchodilators | AECOPD | “ titrated oxygen - a mix of supplemental oxygen and compressed atmospheric air as driver for inhaled bronchodilators to target SpO2 (oxygen saturation) 88-92%” | “Standard treatment, used compressed oxygen (100%)” | 30 day mortality | N/A not completed |
| Gude NCT05703919 | Randomised control trial registered in USA  Probably the same trial as immediately above | Pre-hospital, gas used to drive inhaled bronchodilators | AECOPD | “ titrated oxygen - a mix of supplemental oxygen and compressed atmospheric air as driver for inhaled bronchodilators to target SpO2 (oxygen saturation) 88-92%” | “Standard treatment, used compressed oxygen (100%)” | 30 day mortality | N/A not completed |

**Other Conditions**

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| Green 1987 229 | Literature review | Prehospital | spinal cord injuries treated by EMS | "supplementary oxygen" | none | not specified | Advises use of supplementary oxygen for all spinal cord injuries. Viz: "Patients with spinal cord injuries should receive oxygen supplementation at all times during the accident scene management and transportation phases. This should be administered via nasal cannula or 02 mask. Often, a patient with a spinal cord injury may appear to be breathing adequately, but on admission to a hospital, baseline arterial blood gases may be far below acceptable levels. An arterial blood gas P02 in the 60 to 70 range or a PC02 of 60 may be acceptable in a patient with a chronic spinal cord injury, but in the acutely injured individual, one should maintain a minimum P02 value of at least 100 and a PC02 of less than 45." |

Abbreviations:

AECOPD acute exacerbation of COPD

CO2 carbon dioxide

COPD chronic obstructive pulmonary disease

ED emergency department

EMS emergency medical services

HR hazard ratio

ICU intensive care unit

LOS length of stay

N/A not applicable

NC nasal cannula

NRFM nonrebreather face mask

RCT randomized controlled trial

RR relative risk