Guideline 11.6.1 – Targeted Oxygen Therapy in Adult Advanced Life Support

Summary

This guideline provides advice on the administration of oxygen in the peri-arrest period.

To whom does this guideline apply?

This guideline applies to adults who require advanced life support.

Who is the audience for this guideline?

This guideline is for health professionals and those who provide healthcare in environments where equipment and drugs are available.

Summary of Recommendations

The 2016 Australian and New Zealand Committee on Resuscitation (ANZCOR) guideline has been reviewed and updated based on evidence reviews including the 2020 and 2024 International Liaison Committee on Resuscitation (ILCOR) ALS Taskforce evidence review.[1,2] The recommendations aim to provide consistency with recommendations from the Thoracic Society of Australia and New Zealand, National Stroke Foundation, National Heart Foundation of Australia, and Cardiac Society of Australia and New Zealand. ANZCOR makes the following recommendations:

1. Oxygen therapy should only be used by personnel trained in its use, and its effects should be monitored whenever possible using pulse oximetry.

2. ANZCOR recommends the use of 100% oxygen (or the highest concentration available) during adult cardiac arrest.

3. ANZCOR recommends avoiding hypoxemia in adults with return of spontaneous circulation (ROSC) after cardiac arrest in any setting.

4. ANZCOR suggests avoiding hyperoxemia in adults with ROSC after cardiac arrest in any setting.

5. ANZCOR suggests the use of 100% oxygen (or the highest concentration available) until the arterial oxygen saturation (SaO_2), or the partial pressure of arterial oxygen (PaO_2) can be measured reliably in adults with ROSC after cardiac arrest in any setting.

6. Once ROSC has been established and the oxygen saturation of arterial blood can be monitored reliably (by pulse oximetry (SpO_2) and/or arterial blood gas analysis (SaO_2)), it is reasonable to titrate the inspired oxygen to achieve an initial target saturation between 94 to 98%, or 88 to 92% if the patient has hypercapnic respiratory failure.

7. ANZCOR suggests targeting normocapnia (arterial partial pressure CO_2 35 to 45 mmHg) in adults with ROSC after cardiac arrest.

8. In patients with suspected or proven acute coronary syndromes, the routine use of supplemental oxygen is not recommended. Oxygen therapy is indicated for patients with suspected or proven acute coronary syndromes, with hypoxia and those with evidence of shock, to correct tissue hypoxia. It is recommended that oxygen administration be targeted to achieve SpO_2 of 90 to 96%, or 88 to 92% if the patient has hypercapnic respiratory failure.

9. ANZCOR suggests against the routine administration of oxygen in persons with stroke. If supplemental oxygen is required (SpO_2 <92% on room air) a target oxygen saturation of 92 to 96% is reasonable, or 88 to 92% if the patient has hypercapnic respiratory failure.

10. Oxygen should be administered to acutely unwell adults if the SpO_2 falls below 92% and oxygen therapy should be titrated to achieve a SpO_2 of 92 to 96%, or 88 to 92% if the patient has hypercapnic respiratory failure.

11. The routine use of high concentration oxygen via a reservoir mask is recommended for a patient with carbon monoxide poisoning.

12. Patients developing symptoms of decompression sickness after diving should be treated with high concentration oxygen as soon as possible.

13. In patients with Paraquat poisoning or bleomycin lung injury the routine use of supplemental oxygen is not recommended.

14. In patients with Paraquat poisoning or bleomycin lung injury it is recommended that oxygen administration be targeted to achieve SpO_2 of 88 to 92%.

15. In patients who are at risk of hypercapnic respiratory failure, the routine use of supplemental oxygen is not recommended.

16. In patients who are at risk of hypercapnic respiratory failure it is recommended that oxygen administration be targeted to achieve SpO_2 of 88 to 92%.

Guideline

The use of high concentrations of inspired oxygen has been routine during Advanced Life Support (ALS). The use of supplemental oxygen is not without risk, and its routine use has been questioned. Oxygen therapy should only be used by personnel trained in its use, and its effects should be monitored whenever possible, usually by the use of pulse oximetry. The pulse oximeter usually reads within ± 2%, but is less accurate in some specific situations (e.g., poor perfusion, darker skin pigmentation and carbon monoxide toxicity).[3,4]

Adverse effects of the administration of oxygen include worsened ventilation/perfusion matching; absorption atelectasis; myocardial ischaemia; reduced cardiac output; reduced coronary, cerebral and renal blood flow; increased peripheral resistance and blood pressure; and increased reactive oxygen species.[2]

Of particular concern in the peri-arrest period is the concern about increased oxidative damage, increased neuronal death, and worse neurologic function.[5,6]

Recommendations

Oxygen therapy should only be used by personnel trained in its use, and its effects should be monitored whenever possible, usually by the use of pulse oximetry [Good Practice Statement].

1.0 | Oxygen Use During Cardiac Arrest

This topic was previously reviewed by ILCOR in 2015. An Evidence Update was included in the 2020 ILCOR review process and identified 2 relevant observational studies published since 2015. A systematic review (SR) was not considered necessary. There are no adult studies that address directly whether titrated oxygen compared with 100% oxygen during cardiopulmonary resuscitation (CPR) affects outcome. A 2013 publication observed an association between improved oxygenation during cardiac arrest and improved rates of hospital admission.[7] The treatment recommendation is unchanged.

Recommendations

ANZCOR recommends the use of 100% oxygen (or the highest concentration available) during adult cardiac arrest [CoSTR 2015, weak recommendation, very low-certainty evidence].[8]

2.0 | Oxygen Use after Return of Spontaneous Circulation (ROSC)

After ROSC, toxic oxygen byproducts (reactive oxygen species and free radicals) are produced that

may damage cell membranes, proteins, and DNA, resulting in a reperfusion injury.

A number of animal studies have suggested that significant harm may result from the use of high concentrations of oxygen in the early resuscitation period.[4]

One randomised prospective clinical trial in patients who had been resuscitated from a cardiac arrest compared ventilation with 30% oxygen or 100% oxygen for the first 60 minutes after ROSC. Mean partial pressure of oxygen in arterial blood (PaO2) at 60 min after ROSC was 110 ± 25 mmHg in the 30% oxygen group and 343 ± 174 mmHg in the 100% oxygen group. No statistical difference was detected in serum biomarkers of acute brain injury, survival to hospital discharge, or the percent of patients with good neurological outcome (cerebral performance category of 1 or 2) at hospital discharge. However, this study was not adequately powered to detect important differences in survival and cerebral performance category at hospital discharge (n = 14 per group). A significant subset of patients in this study (30%) who were ventilated with 30% oxygen after ROSC required increased fraction of inspired oxygen (FiO_2) to maintain a pulse oximetry reading of >95%. The study was underpowered to determine efficacy or harm.[9]

The results of large observational studies which assessed the association between hyperoxemia (utilising a number of ways of defining hyperoxemia) after ROSC and in-hospital mortality in humans have been inconsistent and conflicting.[10-16]

This topic was previously reviewed by ILCOR in 2015, and ILCOR commissioned a systematic review in 2019.[6] The final ILCOR recommendations on oxygen dose after ROSC in adults were published in a section of the 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations.[1]

Recommendations

ANZCOR recommends avoiding hypoxemia in adults with ROSC after cardiac arrest in any setting [CoSTR 2020, strong recommendation, very low-certainty evidence].

ANZCOR suggests avoiding hyperoxemia in adults with ROSC after cardiac arrest in any setting [CoSTR 2020, weak recommendation, low-certainty evidence].

ANZCOR recommends the use of 100% oxygen (or the highest concentration available) until the arterial oxygen saturation can be measured reliably in adults with ROSC in the pre-hospital setting (CoSTR 2024, strong recommendation, moderate certainty evidence) and in-hospital setting (CoSTR 2024, strong recommendation, low-certainty evidence).

Once ROSC has been established and the oxygen saturation of arterial blood can be monitored reliably (by pulse oximetry [SpO_2] and/or arterial blood gas analysis [SaO_2]), it is reasonable to titrate the inspired oxygen to achieve initial target saturation between 94 to 98%, or 88 to 92% if the patient has hypercapnic respiratory failure [Good Practice Statement].

ANZCOR suggests targeting normocapnia (arterial partial pressure CO_2 35 to 45 mmHg) in adults with ROSC after cardiac arrest [CoSTR 2024, weak recommendation, moderate-certainty evidence].

3.0 | Oxygen use in other specific scenarios

3.1 | Acute Coronary Syndromes (also see Guideline 14.2)

The routine use of supplemental oxygen is not recommended. Supplemental oxygen should be initiated if the patient has breathlessness, hypoxaemia and signs of heart failure or shock.[17] There is relatively limited evidence from clinical studies to support the routine use of oxygen therapy in ACS.[18] The use of oxygen saturation monitoring by non-invasive techniques such as pulse oximetry, may be very useful in guiding oxygen therapy.[19] However it is important to understand that hyperoxemia may be potentially harmful in uncomplicated myocardial infarction.[17,20]

Recommendations

In patients with suspected or proven acute coronary syndromes, the routine use of supplemental oxygen is not recommended. Oxygen therapy is indicated for patients with suspected or proven acute coronary syndromes, with hypoxia and those with evidence of shock, to correct tissue hypoxia. It is recommended that oxygen administration be targeted to achieve SpO_2 of 90 to 96%, or 88 to 92% if the patient has hypercapnic respiratory failure[Good Practice Statement].

This recommendation is consistent with National Heart Foundation of Australia & Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2025 https://www.heartfoundation.org.au/for-professionals/fp-acs-guidelines.

3.2 | Stroke

The use of oxygen in acute stroke is controversial.[21] The routine use of supplemental oxygen is not recommended in acute stroke patients who are not hypoxic. Patients with oxygen saturation <92% should be given supplemental oxygen.[22]

Recommendations

ANZCOR suggests against the routine administration of oxygen in persons with stroke [2020 COSTR, weak recommendation, low-to-moderate certainty evidence]. If supplemental oxygen is required (SpO_2 <92% on room air) a target oxygen saturation of 92 to 96% is reasonable, or 88 to 92% if the patient with hypercapnic respiratory failure[Good Practice Statement].

This recommendation is consistent with the National Stroke Foundation: Australian and New Zealand Clinical Guidelines for Stroke Management https://app.magicapp.org/#/guideline/QnoKGn/section/Lw5e5E.

3.3 | Other critical illnesses

Recommendations

Oxygen should be administered to acutely unwell adults if the SpO_2 falls below 92% and oxygen therapy should be titrated to achieve a SpO2 of 92 to 96%, or 88 to 92% if the patient has hypercapnic respiratory failure [Good Practice Statement].

3.4 | 3.4 Carbon monoxide poisoning

The most important treatment for a patient with carbon monoxide poisoning is to give high-dose oxygen via a reservoir mask. Pulse oximetry cannot screen for carbon monoxide exposure as it does not differentiate carboxyhaemoglobin from oxyhaemoglobin. The blood carboxyhaemoglobin level must be measured to assess the degree of carbon monoxide poisoning.[3]

Recommendations

The routine use of high concentration oxygen initially via a reservoir mask is recommended for a patient with carbon monoxide poisoning [Good Practice Statement].

3.5 | Diving emergencies

Musculoskeletal or neurologic symptoms occurring soon after diving may be signs of decompression sickness and should be treated with high concentration oxygen as soon as possible.[23,24]

Recommendations

Patients developing symptoms of decompression sickness after diving should be treated with high concentration oxygen as soon as possible [Good Practice Statement].

3.6 | Paraquat poisoning and bleomycin lung injury

Oxygen is known to be hazardous to patients with paraquat poisoning. Oxygen worsens bleomycin lung injury. Because of these risks, supplemental oxygen should be given to patients with these conditions only if needed, aiming for a target range of SpO_2 of 88 to 92%.[3]

Recommendations

In patients with Paraquat poisoning or bleomycin lung injury the routine use of supplemental oxygen is not recommended [Good Practice Statement].

It is recommended that oxygen administration be targeted to achieve SpO_2 of 88 to 92% [Good Practice Statement].

3.7 | Patients at risk of hypercapnic respiratory failure

Uncontrolled supplemental oxygen therapy can be harmful to patients who are at risk of hypercapnic respiratory failure. If high concentrations of oxygen are given to these patients, the oxygen level in the blood will rise but the level of carbon dioxide will also rise and this can cause acidosis with subsequent organ dysfunction and, when severe, coma. The target SpO_2 is 88 to 92% if the patient is at risk of hypercapnic respiratory failure.

A small reduction in ventilation may be a contributing factor to the rise in carbon dioxide levels during oxygen therapy in chronic obstructive pulmonary disease (COPD). Much of the rise in carbon dioxide which occurs is due to deterioration in the matching of blood flow and gas flow in the lungs.[3] This can be avoided by giving controlled lower concentration oxygen therapy to vulnerable patients.

It is not possible to predict if individual patients with COPD will develop hypercapnia during an acute exacerbation, so all patients with moderate or severe COPD should be considered to be at risk of this complication until the results of blood gas measurements are available.

If the diagnosis is unknown, patients aged >50 years who are long-term smokers with a history of chronic breathlessness on minor exertion such as walking on level ground and no other known cause of breathlessness should be treated as if having COPD. Patients without diagnosed COPD, but at risk of hypercapnic respiratory failure include patients with:

- cystic fibrosis
- bronchiectasis
- severe kyphoscoliosis or severe ankylosing spondylitis
- severe lung scarring from old tuberculosis (especially with thoracoplasty)
- morbid obesity (body mass index >40 kg/m^2)
- musculoskeletal disorders with respiratory muscle weakness (especially if on home ventilation)
- overdose of opioids, benzodiazepines or other respiratory depressant drugs.

Recommendations

In patients who are at risk of hypercapnic respiratory failure, the routine use of supplemental oxygen is not recommended [Good Practice Statement].

In these patients, it is recommended that oxygen administration be targeted to achieve a SpO_2 of

88 to 92% [Good Practice Statement].

This recommendation is consistent with Thoracic Society of Australia and New Zealand Oxygen Guidelines.[25]

Abbreviations

Abbreviation	Meaning/Phrase
ALS	advanced life support
ANZCOR	Australian and New Zealand Committee on Resuscitation
COPD	chronic obstructive pulmonary disease
CoSTR	Consensus on Science with Treatment Recommendations
CPR	cardiopulmonary resuscitation
FiO_2	Fraction of inspired oxygen
ILCOR	International Liaison Committee on Resuscitation
PaO2	partial pressure of arterial oxygen
ROSC	return of spontaneous circulation
SaO2	saturation of arterial oxygen
SpO2	saturation of peripheral oxygen / pulse oximetry
SR	Systematic review

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About this Guideline

Search date/s	ILCOR literature search details and dates are available on the CoSTR page of the ILCOR website (https://costr.ilcor.org) and the relevant CoSTR documents: https://costr.ilcor.org/document/oxygen-and-carbon-dioxide-targets-in-adult-patients-with-return-of-spontaneous-circulation-after-cardiac-arrest-task-force-systematic-review-costr https://costr.ilcor.org/document/oxygen-and-carbon-dioxide-targets-in-patients-with-return-of-spontaneous-circulation-after-cardiac-arrest-als-sr
Questions/PICOs:	Are described in the CoSTR documents (https://costr.ilcor.org)
Method:	Mixed methods including ARC NHMRC methodology before 2017 and ILCOR GRADE methodology described in ILCOR publications since 2017.
Main changes:	No major changes to the clinical aspects of the guideline. Updating of review evidence, references, and terminology to increase consistency with GRADE terminology.
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