Supplementary materials

Table 1. Clinical usefulness, advantages, and limitations of pulse oximetry in emergency and acute care.

Clinical condition/context	**How pulse oximetry is useful**	**Key advantages**	**Important limitations/cautions**
Initial triage of acutely ill or dyspnoeic patients	Provides rapid screening for hypoxemia and helps identify patients needing oxygen or urgent evaluation	Non-invasive, rapid, continuous, simple to use, useful for prioritising care	Normal SpO_2 does not exclude respiratory distress, pulmonary embolism, early ARDS, sepsis, anemia, shock, or hypercapnia
Monitoring during oxygen therapy	Helps assess response to supplemental oxygen and guides oxygen escalation or de-escalation	Allows continuous monitoring and trend-based assessment	Supplemental oxygen may mask deterioration; SpO_2 cannot distinguish adequate oxygenation from hyperoxia at high values
Acute respiratory infections, pneumonia, COVID-19, and ARDS	Helps identify hypoxemia and monitor progression or response to treatment	Useful for serial monitoring and early recognition of falling saturation	Silent hypoxemia and threshold-driven decisions may delay escalation if work of breathing and respiratory rate are ignored
Asthma or COPD exacerbation	Helps detect hypoxemia and guide controlled oxygen administration	Useful for bedside monitoring during bronchodilator	In COPD or hypercapnic respiratory failure risk, excessive oxygen may worsen CO_2 retention; ABG/VBG may be required

		therapy and transport	
Procedural sedation, opioid exposure, or neuromuscular weakness	Can detect oxygen desaturation during monitoring	Useful as part of procedural safety monitoring	Does not detect early hypoventilation or hypercapnia, especially when supplemental oxygen is used; capnography is preferred when available
Shock, sepsis, trauma, or hemorrhage	Can document arterial saturation and monitor trends during resuscitation	Easy continuous monitoring during resuscitation and transfer	May remain normal despite impaired oxygen delivery, poor perfusion, elevated lactate, anemia, or microcirculatory failure
Severe anemia or bleeding	Confirms haemoglobin saturation of available red cells	May remain technically normal despite severe anemia	Does not measure oxygen content or oxygen-carrying capacity; hemoglobin and perfusion status must be assessed
Carbon monoxide poisoning, methemoglobinemia, sulfhemoglobinemia, or suspected dyshemoglobinemia	May raise suspicion when SpO_2 is discordant with clinical appearance or ABG PaO_2	Useful as an initial clue when readings are unexpected	Conventional two-wavelength oximeters cannot reliably distinguish dyshemoglobins; co-oximetry is required
Post-cardiac arrest, acute coronary syndrome, and acute stroke	Helps avoid hypoxemia and monitor oxygen therapy	Continuous monitoring is useful during stabilization and transfer	High SpO_2 values may conceal hyperoxia; oxygen should be titrated to target range and ABG used when precise PaO_2 is needed
Prehospital care and patient transport	Allows rapid monitoring outside	Portable, low-cost, useful during ambulance	Motion, vibration, ambient light, cold extremities, poor perfusion, nail polish, and

	controlled hospital settings	transfer and field triage	probe displacement may produce unreliable readings
Pediatric, elderly, or non-communicative patients	Provides objective continuous oxygenation data when symptoms may be difficult to elicit	Helpful in patients unable to report dyspnoea reliably	Must still be interpreted with respiratory rate, work of breathing, mental status, perfusion, and clinical trajectory
Patients with darker skin pigmentation or borderline readings	Provides useful trend data when interpreted cautiously	Still valuable for serial monitoring when waveform and trends are assessed	May overestimate oxygen saturation and conceal occult hypoxemia; lower threshold for ABG/co-oximetry when discordant

Table 2. Context-based framework for interpreting SpO_2 in emergency and acute care.

Clinical context	**Why SpO_2 may mislead**	**Additional bedside/laboratory assessment**	**Practical action**
Stable patient with mild symptoms and reliable waveform	SpO_2 may appear reassuring despite early disease or supplemental oxygen use	Respiratory rate, work of breathing, mental status, perfusion, serial SpO_2 trend	Use SpO_2 as one vital sign; repeat assessment and document trend rather than relying on a single value

Dyspnoea with normal or near-normal SpO_2	Early respiratory distress, pulmonary embolism, early ARDS, silent hypoxemia, or compensated disease may be concealed	Respiratory rate, accessory muscle use, ability to speak, auscultation, chest imaging when indicated	Do not delay evaluation only because SpO_2 is normal; escalate assessment if clinical distress is present
Increased work of breathing or tachypnoea despite acceptable SpO_2	SpO_2 reflects oxygenation but not ventilatory effort or impending fatigue	Respiratory rate, work of breathing, mental status, serial examination, ABG/VBG when needed	Treat as possible respiratory distress; consider early senior review and escalation before desaturation occurs
Opioid/sedative exposure, procedural sedation, neuromuscular weakness, or obesity hypoventilation	Hypoventilation and hypercapnia may occur while SpO_2 remains normal, especially with supplemental oxygen	Capnography, respiratory rate, depth of breathing, mental status, ABG/VBG for $PaCO_2$ and pH	Use capnography where available; do not use SpO_2 alone to exclude respiratory depression
COPD or other risk of hypercapnic respiratory failure	Excess oxygen may worsen CO_2 retention despite acceptable or high SpO_2	ABG/VBG, $PaCO_2$, pH, respiratory rate, mental status	Titrate oxygen to 88–92% unless otherwise indicated; obtain blood gas if drowsiness, acidosis, or deterioration occurs
Shock, sepsis, trauma, or regional hypoperfusion	SpO_2 may remain normal despite poor oxygen delivery, microcirculatory	Lactate, capillary refill, skin temperature, urine output, blood pressure, hemoglobin, venous	Assess oxygen delivery and perfusion, not saturation alone; manage shock and

	failure, or impaired oxygen extraction	saturation where available	repeat lactate/ABG as clinically indicated
Severe anemia or hemorrhage	SpO_2 may be normal despite critically reduced oxygen content	Hemoglobin, hemodynamics, perfusion markers, lactate, clinical bleeding assessment	Recognize that normal SpO_2 does not exclude inadequate oxygen delivery; correct the underlying oxygen-carrying deficit
Suspected carbon monoxide poisoning, methemoglobinemia, sulfhemoglobinemia, or sickle cell-related crisis	Conventional pulse oximeters may misread dyshemoglobins or fail to reflect true arterial oxygenation	Co-oximetry, ABG with co-oximetry, clinical history, cyanosis, exposure history	Do not rely on standard SpO_2; confirm with co-oximetry when dyshemoglobinemia is suspected
Borderline SpO_2 in patients with darker skin pigmentation or discordant clinical findings	Device bias may overestimate oxygen saturation and conceal occult hypoxemia	SpO_2 trend, respiratory assessment, ABG/co-oximetry when values are borderline or discordant	Maintain a lower threshold for confirmatory testing and escalation when clinical findings do not match SpO_2
Post-cardiac arrest, acute coronary syndrome, acute stroke, or prolonged high-concentration oxygen therapy	SpO_2 of 98–100% cannot distinguish normoxia from hyperoxia	ABG for PaO_2, oxygen delivery device settings, serial reassessment	Treat oxygen as a drug; titrate to a documented target range and avoid unnecessary hyperoxia