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Medical Oxygen in the Area of Operations[1]

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The need for oxygen at casualty treatment centres is undisputed. The purpose of this paper is to outline the advantages and disadvantages of current oxygen supply and delivery systems compared with on-site manufacture at remote, within Australia, and overseas operations. Technological advances now allow the on-site manufacture and delivery of oxygen at any desired pressure and volume.

Present Situation

Compressed oxygen in individual cylinders, or bulked in steel containers or pallets, is transported to the Area of Operations' (AO) medical facilities. Filled cylinders replace empty cylinders (This required Cl30 air transport from Kigali to Nairobi and back during OP TAMAR). At the medical facility, oxygen is piped to treatment areas (e.g. operating rooms) from these stores. Individual casualties may be supplied from an oxygen cylinder or from an oxygen concentrator. These concentrators deliver 93 +/- 3% oxygen at 4 to 5 litres per minute at low pressure. There is insufficient pressure from currently in use oxygen concentrators for their use as driving gas source for gas-powered anaesthetic or intensive care ventilators. We resort to using large quantities (e.g. 12 or more litres/ minute) of cylinder stored gas pressure to drive these ventilators.

Alternate oxygen /Pressure Proposals

For casualties who are spontaneously breathing, oxygen from concentrators or Oxy- viva equipment is available. In locations where there is no mobile electricity supply to power an oxygen concentrator, the Oxy viva is an excellent source of oxygen. It is man-portable and can supply oxygen for up to 30 minutes. The Oxy-viva 3 or equivalent should continue to be available for first aid and short rearward aeromedical evacuation (RW-AME).

For dedicated medical facilities, on ground sea or air platforms, I recommend a multiple-input consideration of a range of onsite oxygen generating/ concentrating products.

Oxygen for Individual Use

For high altitude aircrew and passengers; casualties breathing spontaneously in Primary Health care centres, road or RW-AME ambulances; in forward aeromedical evacuation (FW-AME) or sea platforms; and pre-operatively, during anaesthesia and postoperatively, oxygen concentrators should be considered as a reliable safe and sustainable oxygen supply. They have been used in Rwanda and continue to be used in the Bougainville and East Timor health facilities. All that is needed is a source of electricity to drive the concentrator. Newer models (e.g., AIR-SEP Corporation's AIRLIFE) are compact small units that meet Air New Zealand's aviation regulations.

Gas Driven Ventilators

Where a compressed gas source is required to power and /or supply oxygen to each intensive care ventilator (e.g. T Bird, which requires a minimum 20 litres/ minute at 45 psi). The duplex ASM-80 model from AIR-SEP is expected to meet the need without the necessity for oxygen cylinder resupply. This and/or similar units should be trialed.

Electrically Driven Ventilators

Anaesthetic ventilator requirements can be met with a ventilator compressing a bag or "bellows in a bottle'. The ventilator can be driven by pressurised gas from cylinders, compressors or oxygen concentrators with built-in

pressure up to 45 psi capability. My personal preference is for the lightweight electrically powered and driven ventilator such as the BREAS PV501 which I trialed in Bougainville. An electrically driven ventilator is currently in use in Bougainville.

Advantages and Disadvantages: Oxygen Concentrators Versus Cylinders

Transport To AO

Once-off delivery of concentrator to site; man- portable units or MHE are required for larger installations. Oxygen cylinder banks will nearly always require MHE repeatedly as resupply becomes mandatory for sustained operations. There is also danger if cylinders are dropped or the transport vehicle, ship or aircraft crashes or is fired upon.

Dangerous Cargo

Oxygen cylinders are always dangerous cargos on land, sea or in the air; the danger increases with increasing number and size of cylinders transported and stored. Indeed, in the presence of heat and fuel, oxygen combines to form an intensely explosive mixture. This is not the case with oxygen concentrators during transport or in location. Concentrators pose a minimal risk only when in use.

Storage

Concentrators are always safe in storage whether in ships, vehicles or aircraft. Oxygen cylinders require storage in cool well-ventilated spaces, free of sparks and flames, and not next to combustible materials and fuels. The explosive risk increases with increased bulk of oxygen stored. leakage of cylinders in confined spaces, high-velocity projectiles and blast damage.

Handling

Oxygen concentrators are safe to handle. Except for the Oxy-viva resuscitator, other oxygen cylinders are awkward and heavy to handle and secure safely in position.

Versatility and Utilisation

The relationship of the bulk and weight of concentrator equipment to the sustainable reliable supply of oxygen (limited only by the supply of electricity) far exceeds the sustainability to bulk/weight ratio of cylinder oxygen. Where the logistic bill for the sustainable supply of oxygen in remote and mobile operations is high, oxygen concentrators allow a cost-effective alternative solution with minimal risk to personnel. On- site pressured oxygen generation can also be utilized to fill oxygen cylinders should a reserve or reservoir capacity be considered necessary.

Summary

Technological advances have allowed greater reliability in lighter and smaller on-site oxygen generation. It is time, in this era of fiscal frugality and risk management. To examine what I believe to be the safest and most cost- an effective option. In supply terms, oxygen cylinder bulk/weight characteristics need to be compared with those of oxygen concentrators. In particular, the dangerous cargo and logistic burden of bulk oxygen need to be contrasted with a safe, readily sustainable and versatile oxygen concentrator supply system.