Will Artificial Blood Reduce the Need for Red Cell Transfusions

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Brief History of Red Cell Substitutes

• Early empirical attempts
  – ale, wine, milk, animals

• 20th century
  – purified haemolysate
  – HIV epidemic
  – HBOCs
  – PFCs

• 21st century
  – recombinant HBOC
Nomenclature & Attributes

• Blood substitute?
• Key terms
• Attributes
  – transport of respiratory gases
  – lack antigenicity and disease transmission
  – long half life
  – prolonged storage at RT
  – readily available
  – no adverse effects
Drivers for Development

- Military
- TTD
- HTR
- Cost
- Redundancy
Design & Composition – HBOC’s

- PolyHb/Cross-Linked Hb
  - via cross-linkage to reactive amino groups
- Conjugated Hb
  - cross-linked to polymers
- Recombinant Hb
  - produced via genetically engineered *E.coli*
- Encapsulated Hb
  - formation of encapsulated Hb and enzymes
Design & Composition – HBOC’s
Design & Composition – PFC’s

- Mainly chemical based
- Mainly composed of carbon and fluorine
- Synthetic fluids oxygen can dissolve
- Made into emulsions for use as oxygen carriers
- Hydrophobic
Applications

- Oxygenation of tissues in human body
- Alternative for blood transfusions
- Ready use for mass trauma incidents
- Restoration of blood volume
- Remote and emergency supply
- Alternative for religious communities
- Alleviation of decompression sickness (PFC's)
Benefits

- “Universal donor”
- Avoidance of ABO and antibody incompatibility
- Less blood typing required
- Reduction of work (less mistakes, less cost!)
- Increased shelf life (RT, 36 months)
- Reduced transmission of blood borne viruses
- Increased oxygen perfusion
Disadvantages: Side Effects

• Haemoglobin-Based Oxygen Carriers
  – vasoconstriction
  – abdominal pain, nausea/vomiting
  – colloidal osmotic effect
  – increased mean arterial pressure
  – risk of myocardial infarct
  – risk of prion pathogens (bovine-derived Hb)
Disadvantages: Side Effects

• Perfluorocarbons
  – decreased immune function
  – fever, malaise and back pain
  – bronchospasm
  – thrombocytopenia
  – chronic anaemia
  – chemical pneumonitis

Currently, risk of using AOCs outweighs the benefits...
Problems with Commercialisation

• Costs
  – lead to bankruptcy of several developers

• FDA approval

• Legal approval
  – no HBOCs approved for use in North America, Australia or Europe
  – Hemopure® has been approved for use in South Africa

• Won’t eliminate need for human blood products
Conclusions

• Current
  – risks outweigh benefits
  – valuable in certain selected applications

• Future (IF successful...)
  – may reduce the need for red blood cell transfusions
  – but will NOT replace red cell transfusions
  – still require other human blood products
  – another tool for treatment of at-risk patients
References


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