The Pig with a Human Heart: Xenotransplantation
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Purpose
Due to the ongoing organ shortage crisis, medicine may be turning to xenotransplantation as a consistent source for organ transplants.

What is Xenotransplantation?
- Transplantation and implantation of human organs that previously existed within a live nonhuman animal (FDA, 2021)
- Organ was existing outside of a human (i.e., a pig) and was later put into a human
- Other uses:
  - Using cells, tissues, or organs from a nonhuman animal source and transplanting them into a human
  - Using cells and tissues from a human source, but had contact with a nonhuman animal, and transplanting them into a human host

Source of Xenotransplanted Organs
- Gal-knockout (GTKO) pigs are made to have an absent galactose-α1,3-galactose antigen that makes their organs viable for use in humans
- Immunocompromised patients are at high-risk for contracting zoonotic viruses from donation
- Risks of infection are reduced through breeding, testing, and managing symptoms.

Xenotransplantation in the News
(Porrett, et al, 2022)
- A transplant with a GTKO kidney into a brain-dead patient was performed in January 2022
- The kidney was viable with no signs of rejection or zoonotic infection
- The kidney sustained the patient for the 72 hour duration of the study

Legal and Ethics of Xenotransplantation
(Shaw et al., 2018)
- Little promise without genetic modification
  - Genetic modification using human DNA has potential for animal to develop human traits
  - Possible cross species infection. Some organisms inactive in animal can be active in human
  - To prevent disease spreading requires close monitoring testing and screening
- Lack of knowledge on length of effectiveness of organ
- Breeding solely for organ transplantation is unethical.

Cultural Considerations of Xenotransplantation
(Paris et al., 2018)
- Christians- Accept if benefits are greater than risk. Forbid receiving tissues from brain or reproductive organs. Animal must not be abused or mistreated during process
- Judaism- Patients have the right to be healed, but no cruelty should be inflicted on animals. Kosher laws overridden for lifesaving treatments
- Muslims- Accept xenotransplantation for lifesaving benefits. Only considered if no other alternatives available. The animal must be treated with respect. There is no clear consensus on the use of pig organs, but most agree it is acceptable when all other options have been exhausted

Future of Xenotransplantation
- Potential answer to world wide shortage and demand
- May be hybridized with regenerative medicine
  - Produces a human organ from human stem cells within a nonhuman animal then transplanted into human (Yokoo et al., 2020)
- Use genetically modified pigs to grow and house human organs
  - CRISPR/CAS9 enzyme system will inactivate adverse pig genes and introduce other genes (Cozzi et al., 2021)
- Future advances in genome editing will allow pigs to safely produce human organs with reduced risk of post-transplant organ dysfunction

References: