Could Genetically Engineered Pigs Save Human Lives?

Earlier this year, surgeons at the University of Maryland School of Medicine made history when they successfully transplanted the heart of a genetically engineered pig into David Bennett, a 57-year-old man. As of March 2022, Mr. Bennett continues to recover with no signs of rejection.

This trailblazing surgery brought humanity closer than ever to a vision that transplant surgeons have been striving to achieve for countless decades: a future where one's best hope for transplant does not have to rely on someone else's tragedy.

Transplantation medicine is a well-established field that replaces the recipients' damaged organs with those of the donors, offering second chances at life for those with failing organs. The problem is supply and demand — there are over 100,000 names on the transplant waiting list in the US alone. This growing list sees a new name every 9 minutes, and each day 17 people die while waiting for a transplant. The increasing life expectancies of our aging population will only aggravate this shortage. A solution to this crisis could be xenotransplantation.

Xenotransplantation is the transplant of organs from animals to humans. As gene-editing technologies and biomedical discoveries continue to accelerate at an exponential speed, animal-to-human organ transplants are no longer within the realms of science fiction. Early attempts of xenotransplantation date back to the 1800s, but most of these desperate ventures were unsuccessful as the recipients' bodies quickly rejected the unfit organs.

Scientists started to focus on porcine organs for their human-like sizes and physiological capabilities. Moreover, the well-established pig breeding industry makes it a cost-effective endeavor, offering a variety of breeds to better match recipients to their ideal organ sizes.

However, two major genetic differences between pigs and humans have questioned the idea's feasibility. The first problem was raised by a discovery in 1984 that pig cells are coated with 'alpha-gal,' sugar molecule antigens that trigger human immune reactions. In the early 2000s, however, researchers at PPL Therapeutics announced the creation of pigs lacking alpha-gal, making them more compatible with our immune system.

Researchers at the Chester Beatty Laboratories recognized the second problem: an embedded viral genetic code in pigs – known as porcine endogenous retroviruses (PERVs) – may infect humans. However, according to researchers at Harvard Medical School, recent breakthroughs in gene-editing technology, such as 'Clustered Regularly Interspaced Short Palindromic Repeats', have already eradicated the risks of PERVs by precisely deleting all retrovirus genes integrated into the pig genome.

There is no doubt that xenotransplantation will revolutionize the organ shortage crisis one day. Nevertheless, it will also raise several ethical dilemmas for society to deliberate. An example is animal welfare.

"If we can grow pigs and everybody can have a pig waiting for when our organs fail, some people think that's a great future," says Brendan Parent, an Assistant Professor of Medical Ethics at NYU Langone. "Others say we're just bringing other beings into existence so that we can kill them and take their organs, and that's not the kind of future we want."