

Coming age of Xenotransplantation: Would you accept an organ from a pig to save your life?

Would you accept an organ transplant from a pig, cow, baboon or a chimpanzee to save your child's life, or your own?

More than [123,000 people](#) in the United States currently need an [organ transplant](#), and about 21 people die each day waiting for one, according to the Department of Health and Human Service, but less than 30,000 actually receive a transplant. U.S. government information on transplantation reports that an average of 79 people receive organ transplants every day, but that 18 people die each day because of a shortage of organs. In other words, there is a severe organ shortage and many of the people on waiting lists are under age 50. [js7ih8cxrslufue91dm](#)

A shortage of organs means a shortage of organs from human donors, and in the years to come, non-human organs may be used to fill the gap. Known as xenotransplantation, the idea of grafting organs from non-human animals to human patients is not new, but historically, it's been essentially a surgical research tool.

As early as 1963, 13 patients were xenotransplanted with chimpanzee kidneys, but their survival was measured only in months. A year later, the first heart xenotransplant was attempted, also with a chimpanzee donor. Since then, fewer than ten such procedures have been carried out, and the survival has been horrible. The longest survivor of cardiac xenotransplantation was "baby Fae"; she lived 21 days after receiving a baboon heart at [Loma Linda Children's Hospital](#) in 1984. But the purpose of the procedures was not actually to save the patients lives.

"In those days, the advice to parents was to leave the baby here to die or take it home to die," noted surgeon Leonard Baily, 25 years after he performed the baby Fae transplant, referring to a handful of congenital heart conditions that were incurable prior to the age of pediatric heart transplantation.

Essentially, the procedures like that performed on baby Fae were carried out to give the surgeons practice, and to this end they were extremely successful. The rehearsals with non-human hearts soon allowed Baily and other pediatric heart surgeons to perform human-to human heart transplants. This has saved thousands of lives since the mid 1980s and similar histories have played out with transplants of hearts in adult patients.

It's also been the story of transplantation of other organs, such as liver. During the 1990s, [baboon-to-human liver transplants](#) were conducted at the University of Pittsburgh and this helped advance procedure that subsequently allowed liver transplants from human to human. The surgical technique is not the obstacle anymore, nor is the medical support and organ preservation that makes the transplantation possible. Instead, the limiting factor today is the organ supply, and that's where xenotransplantation may have a new role.

In contrast to full organs, transplantation of tissues from non-human animals to human patients has a long

track record of clinical success. Documentation of people being treated with non-human tissue goes back as early as 1682, when a piece of dog skull was apparently transplanted to the skull of a Russian nobleman. Over the last few decades, xenotransplantation of tissues and pieces of organs has become routine in the clinic. Many people, for example, have received replacement valves from the hearts of pigs and cows. It is completely routine now, and the decision between an animal versus a mechanical valve always comes down to tradeoff between the various clinical pluses and minuses of each.

Expanding from tissues to organs

As the technology has advanced, researchers have begun developing a technique that could get more kidneys to people who need transplants. But the method is controversial: It is now feasible to remove a kidney from an aborted human fetus and implant the organ into a rat, where the kidney can grow to a larger size. It's possible that further work could find a way to grow kidneys large enough that they could be transplanted into a person, the researchers said, although much more research is needed to determine whether this could be done.

“Our long-term goal is to grow human organs in animals, to end the human donor shortage,” [said](#) study co-author Eugene Gu, a medical student at Duke University and the founder and CEO of Ganogen, Inc., a biotech company in Redwood City, California.
[kidney-growth-620w](#)

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Previously, other scientists had attempted to grow immature human kidneys in the abdomens of mice, but the new research “is definitely the first time an actual whole human organ has been grown in an animal, and has sustained the life of that animal,” said Gu.

The principal obstacle to organ xenotransplantation has been rejection of the donor organ by the recipient's immune system. Based on complex interactions of various genes, cells of humans, pigs, cows, apes, and other animals all express certain molecules on the cell surface. Seeing those surface molecules as “foreign”, the immune system mounts a massive attack. This is a major issue even for human-to-human organ transplants, but using donor-recipient genetic matching and also immunosuppressive drugs, transplant medicine has been able to overcome the problem, although the risk is always present.

With transplantation between species, however, the genetic mismatch between the donated organ and the recipient's immune system is bigger. Thus, even when a xenograft organ is the correct size anatomically –as a pig heart is to replace a human heart, for instance– the rejection potential is a showstopper. Another concern has been the possibility of viruses transmitted from the donor animal to the human recipient, but this type of infection has not shown up in all the years of pig and cow heart valve transplantation to humans.

Due to advances in biotechnology, genetics, and immunology, xeno-organ transplantation now beckons as a viable, long-term solution to the organ shortage. One particular xenotransplant area that's advancing is for the treatment of type 1 diabetes. This is the type of diabetes in which an individual is unable to produce insulin from special cells in the pancreas known as islet beta cells, and it tends to manifest in young patients.

While only the tissue containing islet beta cells is needed, not the entire pancreas, to harvest enough islet beta cells to cure a type 1 diabetic, actually more than a full human pancreas is needed (generally, somewhere between 1 and 2 pancreases worth of islet beta cells). However, the state of technology for harvesting the cells from a pig pancreas has advanced such that recent analysis shows that it would be [cost effective](#), particularly for young diabetics. Of course, it would also be better for them, as they'd be cured and no longer would have to depend on constant insulin injections to stay alive.

Toward the goal of transplanting entire organs into humans from other species, a very recent study reports pig hearts [remaining viable](#) for more than a year after transplantation into baboons. Genetically, the difference between pigs and baboons is no greater than the difference between pigs and humans. Consequently, this is a major achievement that could pave the way to pig-to-human heart transplants –not as a research tactic, nor even for stalling in a patient awaiting a human heart, but to provide the patient a heart for the long-term.

Societal issues

As for how people feel about xenotransplantation, a poll conducted at the turn of the century found [71 percent](#) of the public saying that they would consider xenotransplantation for a family member, if no human organ match were available. But there is also the animal rights objection. While use of such parts certainly can be troubling to many people from the standpoint of animal rights, popular media sometimes play up more of a yuk factor, or seek out controversy – for instance suggesting that adherents to dietary rules of organized religion –prohibitions against eating beef or pork– would [refuse pig or cow tissue or organs](#).

In western societies, the current drift away from organized religion in younger generations could soon render these types of discussions moot. But for the time being, religious prohibitions still influence a great number of people, and consequently public policy. Nevertheless, a check of the blogosphere reveals that generally people who won't eat pork (kosher Jews and halal Muslims) are [no more hesitant](#) about putting pig tissue into their body for medical purposes than they are about wearing leather shoes. Hindus are talking about the issue too. Despite prohibitions against eating animals, there is no general Hindu

consensus saying that non-human tissues and organs shouldn't be transplanted to humans. As one Indian [writer](#) put it:

The issue of animal sacrifice for the sourcing of transplant organs is linked to the controversy regarding the use of animals in medicine and medical research in general.

So, in the end, the choice will come down to personal preference. Just as people choose not to eat meat, people will refuse hearts, livers, and kidneys from pigs or cows. As for whether society as a whole will move against xenotransplantation for ethical reasons, it seems unlikely. At least, as long as society continues to breed and raise animals as food in numbers that are sure to dwarf the number of animals bred for their organs.

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