Xenotransplantation

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Religious Perspectives Regarding the Ethical Issues Associated With Clinical Xenotransplantation

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ABSTRACT

Background: As xenotransplantation advances toward clinical trials, viewpoints from various segments of society are continually needed to engage the public and to inform the prospective clinical trials. As the majority of the world's population identifies with a religious tradition, religious perspectives regarding the ethical issues associated with clinical xenotransplantation are an important element to take into account.

Methods: At the 2024 Congress of The Transplantation Society in Istanbul, Türkiye, a group of religious scholars from Catholicism, The Church of Jesus Christ of Latter-day Saints, Hinduism, Shia Islam, Judaism, Protestant Christianity, and the African American religious traditions met together to discuss viewpoints toward xenotransplantation from their respective religious tradition. Additional contributions were received from representatives from the American Anglican Episcopal Church and Sunni Islam faith traditions.

Results: Each speaker presented viewpoints on the ethical issues associated with clinical xenotransplantation from their own religious perspective. Common issues that were raised include the treatment and stewardship of animals, xenozoonotic infection and other risks, while religious dictums of particular relevance for each faith tradition were noted.

Conclusion: Overall, none of the participants considered xenotransplantation to be impermissible within their religious tradition. Yet, it is important to note that persons of religious faith may come to different conclusions from their coreligionists about the permissibility of xenotransplantation as a personal choice or as spokespersons for others of their faith. Additional empirical viewpoint data from each religious tradition will be helpful to further inform normative views and measure the impact of public education. As xenotransplantation continues to advance to the clinic, continued exploration of religious perspectives is needed to best support individual decision-making and optimize patient-centered care.

1 | Introduction

Xenotransplantation (cross-species transplantation; specifically, genetically modified pig-to-human transplantation) is advancing as a potential alternative to allotransplantation (human-to-human transplantation). To date, seven patients have received genetically modified pig xenografts. In the United States (US), four patients have received kidney xenografts [1, 2] and two have received cardiac xenografts [3, 4]. One patient has received a liver xenograft in China [5]. In addition, several decedent studies in which a xenograft has been transplanted into a person declared dead by neurological criteria have been undertaken in the US and China [6–10]. Clinical trials are likely forthcoming in the US and elsewhere in the coming years.

Engaging diverse societal perspectives in a discussion about novel medical technology is an important complement to support the ethical conduct of clinical research. The importance of societal engagement is recognized in international research ethics guidelines, such as the United Nations Educational, Scientific, and Cultural Organization's "Universal Declaration on Bioethics and Human Rights" [11] and the "International Ethical Guidelines for Health-Related Research Involving Humans", a joint venture from the Council for International Organizations of Medical Sciences and the World Health Organization (WHO) [12]. The Changsha Communiqué, a summary document published following the First WHO Global Consultation on Regulatory Requirements for Xenotransplantation Clinical Trials, specifies that any xenotransplantation regulatory system "should be transparent, must include scientific and ethical assessment and should involve the public" [13]. This was reaffirmed by the WHO in 2011 and 2018 in collaboration with the International Xenotransplantation Association (IXA), an official section of The Transplantation Society [14, 15].

Overall, attitudes toward xenotransplantation have been assessed empirically in certain populations [16–18]. Given that around 85% of the world's population identifies with a religious tradition [19], and that religion and/or spirituality oftentimes play a role in a patient's medical decision-making [20], assessing religious viewpoints toward xenotransplantation is important. Religious viewpoints of persons toward xenotransplantation have only been assessed to a limited degree by empirical means [21]. Viewpoints of Protestant Christianity [22], Catholicism [23, 24], Hinduism [25], Judaism [26], Shia Islam [27], and Sunni Islam [28] have been described by academics and clergypersons. Theological symposiums have been held with various religious traditions to discuss viewpoints toward xenotransplantation [29, 30]. In 2017, at the 14th Congress of the International Xenotransplantation Association, a theological symposium was hosted that described Jewish, Christian, and Muslim theological perspectives toward xenotransplantation [31].

In the past several years, as enumerated above, the field of xenotransplantation has experienced several advances. Ethical issues continue to be at the forefront of the field, and religious viewpoints may shift or become more well-defined with the progression of xenotransplantation. Hence, assessing religious perspectives toward xenotransplantation will not be a one-time occurrence, but will likely require periodic review.

Herein, we report on religious perspectives regarding the ethical issues associated with clinical xenotransplantation that were presented at a session of the 30th International Congress of The Transplantation Society in Istanbul, Türkiye (September 2024). Definitive "official" statements on the permissibility or impermissibility of xenotransplantation are lacking from most religious communities; the Catholic Church's Pontifical Academy for Life is the exception [23]. As many religions lack an official governing body empowered to issue decisive rulings regarding medical decision-making or are cautious about doing so, this is likely to continue to be the case for the foreseeable future. In addition, the authors– each of whom is a subject matter expert in their respective tradition– agree that religions are not monolithic and include individuals who may have diverse opinions regarding personal decision-making, directly informed by or apart from their faith orientations. Followers may understand or practice aspects of their faith tradition in diverse ways, potentially leading to different conclusions about whether a specific act or procedure, such as xenotransplantation, is permissible or not. Importantly, each author emphasized that they are communicating their personal view from their perspective as a member of their faith community and do not officially represent all members of their faith group. A summary of faith group perspectives can be seen in Table 1.

The viewpoints expressed here, and the religious groups represented, are not meant to imply that the religious groups represented in Istanbul are the only ones whose viewpoints are important. Rather, our hope is that viewpoints, value systems, and ethical priorities of other faith communities– in particular, religious groups that are a minority in the contexts where xenotransplantation clinical trials are likely to originate, as well as individuals who eschew religious organizations or identify as agnostic or atheistic– will continue to be elicited and studied empirically. Both prevailing perspectives within various faith communities and the particular views of individual members of each community must be taken into consideration to more effectively support community education– including the education of faith community leaders. Education and access to authoritative, accurate information are essential to inform individual and community decision-making, while taking into account of the variety of perspectives and consequential differences discussed and debated by academics and clergypersons.

2 | Individual Faith Traditions' Religious Perspectives

2.1 | Catholicism (Contributed by Don Renzo Pegoraro)

The Roman Catholic Church has had a long history of commenting on the status and ethics of xenotransplantation. Following the baboon cardiac xenotransplantation of Baby Fae in 1984, Rev. Gino Concetti– a leading Vatican moral theologian of the time– commented on the case, providing initial criteria by which experimental xenotransplantation may be evaluated [32]. As xenotransplantation continued to scientifically advance, in 2001, the Pontifical Academy for Life– a Pontifical Academy of the Roman

TABLE 1 | Summary of faith group perspectives.

Faith group	Summary of position toward xenotransplantation
Catholicism	Xenotransplantation is acceptable if the personal identity of the individual is not compromised. Wisdom should be exercised in how xenotransplantation is advanced.
Church of Jesus Christ of Latter-day Saints	No formal position on the topic. Latter-day Saints are generally supportive of emerging technologies, as long as careful attention is paid to risks and benefits. The Latter-day Saints' focus on human dignity plays a critical role.
Hinduism	The dynamic and contextual approach to moral reasoning may lead to diverse viewpoints regarding the permissibility of xenotransplantation but will always consider the suffering and needs of both humans and animals.
Judaism	The Jewish mandate to preserve human life permits xenotransplantation and encourages pursuing the necessary research to see it become successful.
Protestantism (theologically conservative)	No formal position on the topic. Xenotransplantation would likely be acceptable as a therapeutic alternative to allotransplantation, though there is concern that transplantation de-emphasizes humanity's biggest problem, which is spiritual.
Protestantism (Episcopalian)	No formal position on the topic. Episcopalians should look to Holy Scripture, our faith tradition, and human reason to make decisions as to whether to accept xenotransplantation as individual patients and to be active in the broader medical and political communities to develop guidelines on its use.
Shia Islam	Views are nuanced and multifaceted, considering the ethical, medical, and social implications. While permissible under specific circumstances, scholars emphasize the importance of animal welfare, health risks, and the preservation of human dignity.
Sunni Islam	Most contemporary jurists begrudgingly permit porcine xenotransplantation when medically necessary, though it is not universally accepted.
African American Religious Studies	While African American Religious Studies is a broad and nuanced field, on the face of it, there is nothing to suggest that xenotransplantation would be wholly unethical from the perspective of African Americans Religions.

Catholic Church that is dedicated to promoting the Church's consistent life ethics– published a report entitled *Prospects for Xenotransplantation: Scientific Aspects and Ethical Considerations* [23]. The report was positive, offering commentary on the anthropological and ethical aspects of xenotransplantation. Regarding the use of animals, the Church holds that humanity is the central being of creation, and that due to this position, humanity may use creation (including animals) in a wise and responsible manner to the benefit of humankind. While the report noted that certain organs would never be morally legitimate to transplant due to their indissoluble link with the personal identity of the individual (e.g., encephalon, gonads), overall, the position toward xenotransplantation is positive. The report concluded with practical guidelines to guide the development of xenotransplantation.

Given the advances of the past 20+ years and that the field seems to be on the cusp of clinical trials, the Church has deemed it necessary to revisit this report and produce an updated version. This report is being drafted by a global group of experts in the field, as well as Church officials, and is due to be published in 2025. The revision will include scientific, anthropological, theological, and bioethical aspects of xenotransplantation that are important for the Church and Catholics globally, offering contributions to social and ethical approaches. While great detail has been provided in the 2001 report and will also be included in the updated report, it can be concluded that Catholicism does not have preclusions, on a religious or ritual basis, in using any animal as a source of organs or tissues for transplantation to humankind. The question of the acceptability of an animal organ, once it has been established that personal identity is not affected by xenotransplantation, and once all the general ethical requirements of transplantation have been met, particularly safety and informed consent, has a positive answer.

2.2 | Church of Jesus Christ of Latter-day Saints (Contributed by Samuel Brown)

The Latter-day Saint tradition lives inside Christianity in a hybrid way. It is both highly pragmatic and theologically innovative, with few professional theologians or ethicists. In addition to more traditional Christian beliefs, Latter-day Saints maintain that human beings are the literal children of God, with whom they share a basic identity. In other words, Latter-day Saints believe that humans are children rather than creatures. These human children of God gather together into communities, and that gathering is the purpose of life. While Latter-day Saints teach a stewardship ethic for the created world that would mandate careful and sensitive treatment of animal donors, there are no prohibitions against human receipt of animal tissues or the sacrifice of an animal donor to save the life of a human recipient. While Latter-day Saints believe that humans must honor God and are God's children rather than his peers or superiors, if proposed activities meet other ethical standards, Latter-day Saints do not reject medical advances as "playing God". In fact, Latter-day Saints are generally supportive of life science technologies, as

long as careful attention is paid to risks and benefits. With great power comes great responsibility, and there, the Latter-day Saints' focus on human dignity plays a critical role.

Specifically, there are substantial risks of coercion and inducement related to selecting recipients for early xenografts, given the scarcity of human organs. (While there are viable treatment alternatives for organ failure, they are rationed by the scarcity of human organs.) Once the technologies are robust and xenografts are demonstrated to be equivalent to human organs, these ethical considerations may be less pressing. However, in the early phases of xenotransplantation, survival will almost certainly be worse with animal organs than with human organs, so the determination of which patients are to receive animal organs must be just. If, for example, only patients who are refused access to destination cardiac mechanical support are referred for xenotransplantation, then systematic biases in receipt of such mechanical support would constitute a serious ethical breach from a Latter-day Saint perspective. As one simple metric, it would, in general, be unethical for xenotransplants to be preferentially performed in more vulnerable patient populations– affluent, well-connected individuals should have the same basic probability of referral to xenotransplant as individuals who are currently poor and marginalized. Based on the principles of Latter-day Saint theology, decisions about referral to xenotransplant should likely be made by a representative group of individuals that includes community representatives and patient advocates unaffiliated with the transplanting hospital.

A related concern is xenozoonosis, the transmission of animal donor pathogens to humans, with the risk of further spread in the community. In terms of xenozoonosis, Latter-day Saint theology would urge careful, thorough, systematic evaluation of donor virus ecology and risks of transmission and dissemination before clinical initiation. Despite efforts to reduce the risk of xenozoonosis, important risks cannot be ruled out, as some have argued, without substantial additional investigation [33]. Latter-day Saint theology– like most other philosophical systems– would not embrace a treatment that led to the death of millions in a viral epidemic.

2.3 | Hinduism (Contributed by Joris Gielen and Komal Kashyap)

Hinduism is characterized by a diversity of holy scriptures, religious practices, and beliefs. Yet, there are certain beliefs that play an important role in the religious lives of most Hindus. Karma and *ahiṃsā* (non-violence) are pivotal examples of such beliefs that may, also, inform Hindu attitudes to xenotransplants [25]. However, while applying these concepts to the issues of xenotransplants, Hindus may reach diverging conclusions regarding the moral permissibility of xenotransplants.

Karma is the belief that all actions have consequences, either in this life or in a future life. Good deeds will lead to good consequences; bad or evil deeds will have bad consequences. Some Hindus may argue that saving a human life through xenotransplantation could generate good karma for the animal that 'donated' the organ or tissue [34]. This reasoning in favor of xenotransplants could be further supported by Hindu stories in which the gods used animal parts to make a divine body whole, such as when the God Shiva put an elephant's head on his son's body. Nevertheless, others may hold the view that xenotransplants, by involving harm to animals, might contribute to negative karmic outcomes for those who forcefully took the organ or tissue from the animal, that is, both the doctor and the patient.

The belief in the centrality of *ahiṃsā* is related to the concept of karma in the sense that violence would most often be considered a bad act leading to bad consequences. In Hindu belief, *ahiṃsā* extends beyond human beings to include all living creatures, because every living being has a soul and a place in the cosmic order. Since xenotransplantation unavoidably involves violence to animals, it is morally problematic from a Hindu perspective, especially when it involves animals considered sacred in Hinduism, such as cows. On the other hand, even Mahatma Gandhi, who professed non-violence throughout his life, understood that *ahiṃsā* is not absolute [35].

This diversity in views on xenotransplantation reflects the broader Hindu approach to bioethical issues– emphasizing the ethical process rather than a singular outcome. Hinduism offers concepts and ideas that could be used in ethical reflection without imposing an outcome of ethical reasoning [36]. Bearing this in mind, the 20th century Hindu philosopher Sarvepalli Radhakrishnan described Hinduism as a "view of life" [37]. Mahatma Gandhi saw that view of life as a search for truth [38]. Within the context of Hindu views on xenotransplants, this dynamic and contextual approach to moral reasoning may lead to diverse outcomes but will always take into account the suffering and needs of both humans and animals. Given this diversity of views, it is essential for healthcare providers, especially in multicultural contexts, to approach the topic of xenotransplantation with cultural competence and humility.

2.4 | Judaism (Contributed by John Loike and Jonah Rubin)

The Jewish mandate to preserve human life permits xenotransplantation and encourages pursuing the necessary research to see it become successful. This principle is deeply rooted in biblical teachings that affirm all human beings are created in the image of God, and that preservation of life overrides nearly all other commandments. This premise should clarify several misconceptions that relate to xenotransplantation:

First, Jewish law prohibits the consumption of pork-containing products. However, the use of porcine products in medicine, such as pork insulin and porcine heart valves are perfectly permissible. Second, while Judaism values all of God's creations, this does not preclude the use of animal-based products or experimentation to advance human health. However, Jewish law does necessitate careful consideration of protective measures for animals involved in medical treatments to minimize any suffering as much as possible.

On a broader level, Judaism also weighs whether a new technology will improve the world in aggregate. Thus, negative environmental impacts on human health and survival must also be considered. Jewish law follows the bioethical mandate that

"just because we can, does not mean we should engage in any scientific experiment that we desire". Another vital aspect of respecting human dignity is the necessity for new biotherapeutics to be accessible to all. Financial systems must be established to ensure that those with fewer resources can obtain these costly treatments.

On an individual patient level, other Judeo-legal considerations will emerge regarding whether one could, must, or must not undergo a xenotransplant. For each patient, and over time, the risk-benefit calculus will evolve. For cases where the risk or benefit clearly and enormously outweighs the other, Jewish law may dictate what medical decision one must make. In cases where an intervention can certainly prolong someone's life for more than a year without undue suffering, one may, in fact, be obligated to pursue such an intervention. However, for very many health-related decisions, Jewish law grants patients the autonomy to make informed medical decisions, provided that they comprehend the associated risks and benefits of various therapeutic and experimental options. The psychological state and potential stigma faced by individuals undergoing xenotransplantation require consideration as well. Certainly, it is on the community itself to destigmatize any potential negative associations with a perfectly permissible practice.

In summary, Jewish law leverages its resources and legal precedents to harmoniously integrate Jewish values with medical practice. It aims to harness the potential benefits of xenotransplantation to save lives while ensuring that ethical considerations are rigorously addressed.

2.5 | Protestant Christianity

2.5.1 | Theologically Conservative Protestantism (Contributed by Daniel J. Hurst and Andrew T. Walker)

Protestant Christianity has engaged minimally with the permissibility of xenotransplantation, and no formal position exists. One way of arriving to a tentative conclusion on xenotransplantation is to look at the literature on how Protestants have approached allotransplantation. Within Protestantism, there is broad acceptance of allotransplantation, though caution is offered on specific points. For instance, the Southern Baptist Convention– the largest Protestant denomination in the United States– affirmed in 1988: "[W]e encourage voluntarism regarding organ donations in the spirit of stewardship, compassion for the needs of others, and alleviating suffering" [39]. Scriptural commands such as "You shall love your neighbor as yourself" (Matthew 22:39, ESV) and "Greater love has no one than this, that he lay down his life for his friends" (John 15:13, ESV) support this view.

However, scholars like Paul Ramsey and Gilbert Meilaender voice concerns about motives and ethical boundaries in transplantation. Ramsey ultimately judges the question of organ transplantation to be a "deliberately inconclusive inquiry" and cautions the Christian against "submitting the body unlimitedly to medical and other technologies" as it has the potential to strip us of "any Biblical comprehension of joy in creaturely life and the acceptable death of all who are flesh" [40]. Meilaender questions the pursuit of organ transplantation, stating the questions involved in organ donation are "questions that pit our deep-seated hunger to live longer and our fear of death against equally deep-seated notions of the sacredness of human life *in the body*" [41]. Meilaender further cautions, "The immense public pressure behind the effort to secure more organs for transplantation threatens to dehumanize the dying process in ways that belie glowing talk about the 'gift of life'" [41]. To sum it up, in a Christian ethic, motives matter. Hence, for organ donation and transplantation, as well as for xenotransplantation, we must consider the intention behind actions for, as Jesus himself has stated, "Blessed are the pure in heart, for they shall see God" (Matthew 5:8, ESV).

Xenotransplantation raises further issues for Protestants, including (i) the use of animals for human flourishing, (ii) the risk to neighbors from xenozoonotic infection, and (iii) the acceptability of human finitude. First, animals are used for a variety of purposes to benefit humanity in Christian Scripture, including sacrifice in the Old Testament, food, clothing, and agricultural purposes. Protestants would affirm that the privilege of dominion over the created world is always balanced in Scripture by the responsibility to be a good steward over that which has been entrusted to humanity. Generally, theologically conservative Protestants view the responsible use of animals for human advancement and flourishing as permissible.

Second, a central ethical issue in xenotransplantation is the risk of xenozoonotic infection to xenograft recipients, close contacts, and public health. The risk may conflict with the Christian duty to steward the body well (1 Corinthians 6:19-20) and love one's neighbor (Matthew 22:39). That is, what does it mean to "love my neighbor as myself" if a procedure for my benefit could also cause harm (possible xenozoonosis) to my neighbor? It could be reasonably argued that loving a neighbor would certainly include supporting xenotransplantation research as it provides the opportunity to express compassion for the needs of others and the alleviation of suffering (similar to allotransplantation). Yet, on the other hand, Christians should not be concerned with the welfare of the individual to the detriment of the community (Jeremiah 29:7). While xenotransplantation may lead to greater human flourishing, it could also (albeit, unlikely) prove disastrous for humanity and produce the opposite effect of flourishing. Without significant safety assurances, pursuing xenotransplantation might not align with loving one's neighbor. Yet, as the public health risk of xenozoonosis is currently considered low, the potential benefits for the thousands awaiting organ transplants may outweigh the risks.

Third, similar to allotransplantation, a theologically conservative Protestant approach may cautiously endorse xenotransplantation but emphasize that motives still matter. Xenotransplantation cannot be an act to overcome humanity's deepest problem, which a theologically conservative Protestantism would identify as sin, death, and the coming judgment by God. When it adopts a death-defying attitude, it risks alienating humanity from the acceptance of mortality and could be seen as unwise.

2.5.2 | Episcopalian (Contributed by Martha Stebbins)

Xenotransplantation from a veterinary and a faith perspective is full of "what ifs" and "what next" contemplations. In the

Anglican Communion, of which the Episcopal Church is part, there has been no consensus as to whether to allow or disallow the use of xenotransplantation to save a human life [42–44]. The veterinary profession has been integral in the development of transplantation and xenotransplantation technology, not only through its focus on the care of research animals but also an active role in the research of the technologies used in both allo- and xenotransplantation. For many decades, many hearts of Episcopalians and veterinarians have beat with pig or cow valves in place. Editorials on xenotransplantation from Anglican theologians generally do not mention this established technology. The more serious review seems to have happened when research started to focus on solid organ transplant, using genetic manipulation to reduce transplant rejection. So, while there has been no formal declaration concerning the use of animal organs for human use, there are a few scenarios that are likely to play a role for the individual for whom it is offered (and their families).

Anglicans are very committed to creating care, which includes animal welfare, including animals used for meat production or medical research. Given that the donor animal has been genetically modified and needs to be as close to gnotobiotic as feasible for the life of the animal, the care and welfare of the animal needs to be high. Since it is the pig, that is, the animal being used for this research, the physical care and mental health care of the animal are not inconsequential in terms of space, time, and other resources. The second part is when the animal's life is ended, the disposal of the remains, which potentially contain the human genome, becomes not only a biohazard assessment but also creates a question of how one mentally and spiritually addresses the disposal of the human genetic material. Historically, many Christian people would have a prayer service for an amputated limb which was then buried. This is not an understanding that the material, whether incorporated into a pig's genome or a human limb, is a human being. It is acknowledging that humans are made in God's image and that even our parts should be respected in light of that understanding.

While some people's theology draws strict lines of species separation, the science does not necessarily support that. The line that separates Escherichia coli and Salmonella enterica typhimurium is rather thin and the two do exchange genetic material. The use of xenotransplantation challenges the theological concept of strict species separation. The "what if" is how to help people come to terms with having living pig tissue functioning in a human body and having human genetic material in a living pig's body and encourage the discussion of what it means to be a human versus what it means to be a pig.

The next "what if" is how does one ensure that the animal does not transmit a virus or nascent virus to its human host. Episcopalians and the general public have become more aware of this risk since the COVID-19 pandemic and the ongoing zoonotic epidemics of the Marburg virus and other hemorrhagic zoonotic viruses. And the veterinary field should also be concerned about the reverse possibility, that ancient viruses incorporated into the human genome could be reactivated when spliced into the pig genome. This would mean that the human recipient would, by this concern, be a biohazard and potentially treated the same as the gnotobiotic pig. How to protect public health while honoring the human rights of the recipient needs to be worked out. For a person to be treated as a potential public health threat and become quarantined because of the life-saving procedure seems cruel and unusual punishment. How to handle the human remains when the person eventually dies needs to take into account both public health needs and the spiritual needs of the person's family and faith community. These may be in opposition to one another. A demonstration of this was the difficulty in containing an Ebola outbreak in the face of the funeral practices of family members washing their deceased relative's body as a sign of love and faith practice.

For Episcopalians and other Anglicans, the "what's next" is to use our theology tools of Holy Scripture, our faith tradition, and human reason/revelation to make decisions as to whether to accept xenotransplantation as individual patients and to be active in the broader medical and political communities to develop guidelines on its use. The "what's next" for the medical community is to address the concerns around creation care, the respect that all humans are made in the image of God, and how to best protect public health without violating the first two.

2.6 | Islam

Islam is a religion of compassion and mercy, comprising two major sects: Sunni and Shia. While both share core beliefs and principles, one primary difference is that Shias believe in *Wilayat* (leadership) centered on Imam Ali (a.s) and his descendants, while Sunnis emphasize *Khilafat* (caliphate), which is based on the early Muslim community's consensus on leadership. Both Sunni and Shia are guided by the Quran and Sunnah, with Sunni jurisprudence further relying on *Ijma* (consensus) and *Qiyas* (analogy), while Shia jurisprudence emphasizes *Aql* (reasoning) as well. *Ijtihad*– the interpretation of a particular problem, that is, not covered in the Quran by a legal scholar– is common to both traditions but is more frequently practiced by Shias. In the Shia tradition, *Marjae Taqleed* serves as the ultimate authorities on religious rulings.

2.6.1 | Shia Islam (Contributed by Syed Shabih Haider Zaidi)

Shia Islamic jurisprudence ("Fiqh") is a comprehensive legal framework derived from the Quran and the Sunnah (traditions of the Prophet Muhammad and his progeny). It is characterized by its distinct methodology and principles, particularly in the interpretation of religious texts and the application of laws. At the core of Shia jurisprudence is the belief in the Imamat, which posits that the leadership of the Muslim community should be vested in the Imams, who are divinely appointed and infallible. This belief influences the Shia approach to jurisprudence, as the teachings and interpretations of the Imams play a pivotal role in legal rulings. Unlike Sunni jurisprudence, which recognizes the authority of a broader range of scholars, Shia jurisprudence typically relies on the interpretations of the Twelve Imams. The Secondary sources involve reasoning (aql) and public interest (maslaha), and the practice of the community (urf). Shia jurisprudence also places significant importance on the concept of "ijtihad", or independent reason-

ing, allowing qualified scholars to interpret texts and establish rulings based on contemporary issues through ijtihad. Marjae Taqleed Ayatollah Syed Sistani in Najaf, Iraq, and Ayatollah Syed Ali Khameini in Tehran, Iran, are the two major Marjae at present.

In addition to the foundational texts and methodologies, Shia Islamic jurisprudence is marked by its approach to social justice and ethical considerations. The Prophet Muhammad was the Moalam e Akhlaq (the teacher of moral values). Shia scholars specifically emphasize the importance of justice ('adl) and promoting the welfare of the community (ummah). This focus aligns with the broader Islamic principles of equity and moral responsibility, suggesting that the role of a jurist (faqih) extends beyond mere legal rulings to encompass social advocacy and reform.

Many Shia scholars consider xenotransplantation permissible under certain conditions. Swine is forbidden in Islam (Quran 2:173). However, they argue that if xenotransplantation can save a human life or alleviate severe suffering, and no other alternative is available, it may be justified. The principle of necessity (darura) is often invoked, suggesting that actions typically deemed impermissible can become acceptable if they are essential to preserve life. Sanctity of life is a top priority (Quran: 5:32) and so is human dignity. Besides, the transplanted organs gain taharat (purity) over time which allows the recipient to perform all religious obligations without any concerns.

Shia jurisprudence places significant emphasis on the treatment of animals. Scholars often discuss the ethical implications of using animals for organ transplantation, considering their rights and welfare. The ethical treatment of donor animals is a critical factor in the permissibility of xenotransplantation. Concerns about the transmission of zoonotic diseases (diseases that can be transmitted from animals to humans) are also a point of consideration.

In conclusion, Shia views on xenotransplantation are nuanced and multifaceted, considering the ethical, medical, and social implications. While they are permissible under specific circumstances, scholars emphasize the importance of animal welfare, health risks, and the preservation of human dignity in their discussions.

2.6.2 | Sunni Islam (Contributed by Mansur Ali)

In Sunni Islam, legal interpretation is derived from the Qur'an, Prophetic practice, and jurists' interpretations. Modern ethical-legal reasoning often involves 'collective deliberations' where Islamic scholars and experts convene to address novel issues [28].

Regarding medication in Islamic law, while permitted and encouraged, it is not morally obligatory unless lifesaving. The use of prohibited substances (like pork) for medical purposes is debated, with most scholars allowing it in cases of dire necessity when no permissible alternatives exist [45, 46].

Xenotransplantation, particularly using porcine organs, presents unique challenges in Islamic thought. In the Qur'an (6:145), pigs are considered inherently impure with prohibitions extending beyond consumption to trading and raising them. However, most contemporary jurists begrudgingly permit porcine xenotransplantation when medically necessary, though some scholars reject it entirely. The former is the view of the Indian Islamic Law Council in 1989, as well as the view of the majority of Sunni scholars [47].

Despite reluctantly permitting porcine xenotransplantation, Muslim scholars often hesitate to fully endorse it due to concerns such as spiritual pollution based on a notion of psychological essentialism [48] where it is believed that the heart is the seat of the soul and the site of God's Grace. Similarly, the potential for the patient to no longer be perceived as fully human, but as a chimeric creature, raises questions about their self-identity within Islamic theological anthropology. Additionally, the Qur'an (5:60) mentions certain communities who were transmogrified into apes and pigs due to disobeying God, which also has an effect on the way Muslims view xenotransplantation. Finally, the risk of xenozoonosis still persists, which adds a layer of anxiety to Muslim scholars' grudging acceptance of xenotransplantation.

While Islamic teachings emphasize compassion for animals, the theology of *taskhīr*– that everything in creation is servile to humans– prioritizes human well-being in lifesaving situations. This justifies the sacrifice of animals, provided pain and harm are minimized. Concerns about animal welfare in xenotransplantation, such as quarantining pigs in sterile environments, are deemed theologically acceptable as long as there are defined benefits for humans. The lack of voluntary giving from the source animal may raise concerns about exploitation and potential guilt for some individuals. The theology of *taskhīr*, however, overrides any theological culpability, leaving individuals to manage their own psychological responses to the practice.

Despite the theology of *taskhīr* functioning as a buffer against theological culpability, three specific issues related to xenotransplantation may cause theological tensions. Firstly, testing xenografts on brain-dead individuals conflicts with Islamic teachings on honoring the deceased and providing a swift burial. Secondly, the use of human DNA in pigs during the fetal stage for transgenesis necessitates further theological reflection on human experimentation. Lastly, the restrictions imposed on xenograft recipients regarding blood and milk donation, breastfeeding, sexual intercourse, and mandatory medication raise questions about autonomy and require an Islamic response.

In light of these theological and ethical dilemmas, some scholars argue for alternative solutions, such as synthetic models, 3D printed organs, and cloned organs from stem cells, to reduce reliance on allografts and porcine xenografts [22].

2.7 | African American Religious Studies (Contributed by Terri Laws)

African American Religious Studies (AARS) is the scholarly examination of the many faith traditions practiced among US African-descended persons, so this section does not outline

theological doctrines that identify a position on xenotransplantation. Rather, it provides an overview of the relevance of AARS to xenotransplantation and other forms of novel medicine. In the face of scarce empirical evidence related to xenotransplantation, making space for analytical arguments on the topic through the perspective of AARS, as a separate category, is itself a compelling, progressive, and pragmatic religio-ethical decision.

As a group, Black Americans[1] are more religious than the overall US adult population according to various attitudinal and practice measures such as "belief in God or a higher power (97% of Black Americans compared to 90% of overall US adults);" that 59% of Black Americans identify with the statement that "religion is *very important* to them" compared to 40% of the overall adult population, and 75% of Black Americans see "opposing racism as essential to faith" or "being a moral person" compared to 29% of the overall US adult population [49]. The largest religious affiliation among Black Americans is some form of Protestantism, and the majority of Black Americans attend a Black church where the other attendees predominantly are Black, as is the senior leader (although that interest is declining among younger generations). In these faith community settings, attendees were most likely to have "heard a sermon, lecture, or group discussion related to race relations or racial inequality within the past year" (44% compared to 29%) [49]. Regardless of affiliation– even none in particular– aspects of religion and its institutions remain significantly influential among Black Americans and suggest their salience with regard to progress in clinical research including xenotransplantation.

Short of the production of a critical mass of conclusive empirical studies or the same from nuanced focus-group generated research, religious perspectives among Black Americans related to xenotransplantation can be expected to follow the pattern of other novel or emerging medical issues– hampered by distrust [50]. In recent years, African American religious communities have played a role in COVID-19 vaccine uptake [51], the skepticism of legalized death with dignity [52], and the participation of sickle cell disease gene therapy clinical trials [53, 54]. Factors that have contributed to these evolving matters have been understood for generations: the inclusion of culturally relevant messages, the reduction of distrust, especially through the use of trusted messengers, and researcher social concordance [55, 56]. Pastors of Black congregations have successfully filled the first two of these strategies [57, 58]. Most importantly, African American religion should be understood not just as a cultural form, but as a centuries-old experience and expression that is self-affirming and resistant to negative narratives of African Americans and protective against institutions that contribute to misinterpretation of African American culture as misguided or irrational. When it comes to novelty in medicine, African American religion is a two-sided sword that can be helpful in the reduction of health disparity, motivating to demands for equitable care, and inhibitive in the worst moments of mistrust. Yet, on the face of it, there is nothing to suggest that xenotransplantation would be wholly unethical from the perspective of African Americans Religions. The significantly larger problem is the matter of learned mistrust in medicine in general. Hope remains in the fair distribution of the risks and benefits without fear of exploitation.

3 | Comment

None of the participants ultimately viewed xenotransplantation as impermissible within their religious tradition. Ethical issues that loomed large in several of the presentations included aspects of animal stewardship, anthropology, and various risks such as xenozoonosis. Several participants emphasized that within their religious tradition, individuals of faith may arrive at diverse conclusions regarding the permissibility of such practices. This may be especially the case for religious traditions that lack an official teaching body.

Additional empirical data from across the spectrum of religious traditions will be useful to inform normative perspectives, and in aiding health care providers and persons of religious faith– both laypersons and clergypersons– in forming personal or institutional positions on the permissibility of xenotransplantation. This empirical data will also be useful to xeno-affiliated medical professionals and faith community leaders to develop educational tools that take into account patient and family religious orientation and belief structures. This may be of particular importance among certain minority religious groups from whom scant data currently exists. As xenotransplantation advances toward clinical application, ongoing exploration of religious viewpoints will be crucial for supporting individual decision-making and optimizing patient-centered care.

Author Contributions

D.J.H. drafted the initial manuscript with feedback and assistance from R.N.P. and E.C. The remaining authors contributed to specific portions of the manuscript. All authors read and agreed with the finalized version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] Note that the phrase 'Black Americans' is often used to broaden the racial and cultural group from African Americans. All African Americans, generally US-born, US ancestors, are Black Americans, but not all Black Americans are African Americans.

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