



Review

What the World's religions teach, applied to vaccines and immune globulins

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ABSTRACT

For millennia, humans have sought and found purpose, solace, values, understanding, and fellowship in religious practices. Buddhist nuns performed variolation against smallpox over 1000 years ago. Since Jenner developed vaccination against smallpox in 1796, some people have objected to and declined vaccination, citing various religious reasons. This paper reviews the scriptural, canonical basis for such interpretations, as well as passages that support immunization. Populous faith traditions are considered, including Hinduism, Buddhism, Jainism, Judaism, Christianity, and Islam. Subjects of concern such as blood components, pharmaceutical excipients of porcine or bovine origin, rubella strain RA 27/3, and cell-culture media with remote fetal origins are evaluated against the religious concerns identified.

The review identified more than 60 reports or evaluations of vaccine-preventable infectious-disease outbreaks that occurred within religious communities or that spread from them to broader communities. In multiple cases, ostensibly religious reasons to decline immunization actually reflected concerns about vaccine safety or personal beliefs among a social network of people organized around a faith community, rather than theologically based objections per se. Themes favoring vaccine acceptance included transformation of vaccine excipients from their starting material, extensive dilution of components of concern, the medicinal purpose of immunization (in contrast to diet), and lack of alternatives. Other important features included imperatives to preserve health and duty to community (e.g., parent to child, among neighbors). Concern that 'the body is a temple not to be defiled' is contrasted with other teaching and quality-control requirements in manufacturing vaccines and immune globulins.

Health professionals who counsel hesitant patients or parents can ask about the basis for concern and how the individual applies religious understanding to decision-making about medical products, explain facts about content and processes, and suggest further dialog with informed religious leaders. Key considerations for observant believers for each populous religion are described.

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Contents

1. Background.....	2012
2. Methods.....	2012
3. Results.....	2013
3.1. Populous religious groups.....	2013
3.1.1. Hinduism.....	2013
3.1.2. Buddhism.....	2013
3.1.3. Jainism.....	2013
3.1.4. Judaism.....	2014
3.1.5. Christianity.....	2014
3.1.6. Islam.....	2016
3.2. Vaccine components and processes.....	2017
3.2.1. Bacteria, viruses, cell substrates.....	2017
3.2.2. WI-38 and MRC-5 cell lines.....	2017

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3.2.3.	Rubella virus strain RA 27/3	2017
3.2.4.	Porcine excipients	2018
3.2.5.	Bovine excipients	2018
3.2.6.	Misunderstandings of vaccine production or content	2018
3.2.7.	Pathogen route of exposure	2018
4.	Discussion	2019
5.	Personal note	2020
	Acknowledgements	2020
	Appendix A. Supplementary data	2020
	References	2020

1. Background

People conducting immunization programs may encounter individuals who hesitate, question, or decline some or all vaccines or immune globulins based on religious beliefs or related cultural reasons. Such matters are intensely personal and may be disconcerting for health professionals not comfortable discussing religious issues or who usually make immunization decisions based on matters more closely aligned to quantitative sciences.

The word religion derives from the Latin *religio* or *religionem*, describing respect for the sacred or reverence for God or gods [1,2]. Multiple definitions of religion have been proposed, but religions are fundamentally sets of beliefs about God or spirituality held by groups of people. Like all groups, religious groups develop their own systems of culture. And yet, as we will see, behaviors of like-minded individuals are not necessarily related to the theological basis of their religions. “Religious” differs from “theological,” in part, as social differs from scholarly.

Religious concerns about immunization have a long history, reaching back to those who rejected Edward Jenner’s 1796 mode of smallpox vaccination as contrary to God’s will [3]. In the United Kingdom, the Anti-Vaccination League formed in 1853 in London to oppose compulsory vaccination acts [3–6]. Similar events occurred in the Netherlands and elsewhere [6]. In the United States, several Boston clergymen and devout physicians formed the Anti-vaccination Society in 1879 [3,4,6–8]. In contemporary cases, such objections involve blood products, porcine or bovine pharmaceutical excipients, or the remote fetal origins of cell-culture media and rubella strain RA 27/3. In contrast, it is also worth remembering that some of the earliest descriptions of variolation to prevent smallpox involved the proponency of Buddhist religious women [9].

Individual rights are deeply embedded in many cultures. With contagious diseases, though, vaccine and immune globulin decisions may affect more than an individual’s health. This occurs if a parent chooses to withhold immunization from a child or where vaccine-exempting people increase the infectious risk of their neighbors.

Numerous examples of vaccine-preventable outbreaks among religious schools, congregations, and communities illustrate how clusters of vulnerable people can enable epidemics, even spreading beyond those foci to neighboring, well-immunized communities [12–15]. Published examples include diphtheria [16,17], *Haemophilus influenzae* type b [18,19], hepatitis A [20,21], measles [22–51], mumps [52–55], pertussis [19,33,50,51,56,57], poliomyelitis [19,33,45,58–70], and rubella [45,71–80,82]. Tetanus cases have also resulted [50,51,83]. These infections occurred in multiple countries (including transmission across borders and oceans) and among a range of cultural traditions and socioeconomic situations, leading directly to hospitalizations, disabilities, and deaths.

In several analyses, the risk of measles or pertussis was 6–35 times higher among people claiming exemption to immunization, compared with the general population [32,33,84]. This

elevated risk applies regardless of the faith tradition involved. The infectious risk has nothing to do with religious denomination or righteousness of the objection. To paraphrase the Book of Genesis (chapter 4, verse 9), vaccine recipients are their brother’s keepers, as contributors to herd protection.

This review is intended to provide a factual and contextual basis for discussions about religious concerns about vaccines and immune globulins, as well as the role of religion in promoting immunization. The perspective taken here is that of religious institutions and authorities, as they would teach their doctrines to believers. It is important to note that there may be differences between what individual believers profess and what their canonical texts teach. Indeed, different sects within a faith tradition can interpret the same scriptural passages differently. Vaccines did not exist when the Torah, Bible, Qur’an, or major Sanskrit texts were originally written. Subsequent interpretations are fundamental to how contemporary believers approach immunization.

This review is not intended to criticize or argue against any religious beliefs, but rather to objectively describe the basis from which the beliefs arise, as well as various religious positions that may enable or even expect immunization to be conducted. The goal is a clearer understanding of the nature of some motivations for or objections to immunization, how broadly or narrowly the objections tend to be applied, and to help dispel misunderstanding. Philosophical objections to immunization are beyond the scope of this article.

Respectful consideration of religious beliefs within a clinical setting is important because medicine and religion come together to frame and enlighten choices made by patients as well as health professionals [4,45,68,85,86]. Scientists and clinicians confront moral and ethical choices daily and often observe a religious faith that helps guide their own personal conduct. Indeed, the religious beliefs of countless historical and contemporary researchers and clinicians have been a source of motivation to help relieve human suffering by means of immunization.

2. Methods

To identify professional and lay documents related to the acceptability or unacceptability of vaccines and immune globulins based on religious beliefs, PubMed and Google databases were searched using the search terms [outbreak and religion], [vaccine and religion], and [vaccine and “name of specific religious group”], specifying each of the world’s religions estimated to have at least 5 million adherents: Bahá’í Faith, Buddhism, Christianity, Confucianism, Daoism, Hinduism, Islam, Jainism, Judaism, Shinto, and Sikhism. Also searched were populous denominations within the Christian tradition: Roman Catholicism, Eastern Orthodox and Oriental Orthodox Churches, Amish, Anglican, Baptist, Church of Christ (Scientist), Church of Jesus Christ of Latter-day Saints (including “Mormon”), Congregational, Dutch Reformed Congregations, Episcopalian, Jehovah’s Witnesses, Lutheran, Methodist, Pentecostal, Presbyterian, and Seventh-Day Adventist.

Table 1
Notable scriptural passages.

1A. Hindu Texts: Bhagavad Gītā 3.14. Shikshapatri Śloka 16 and 31
1B. Sayings of the Buddha: Sermon at Benares. Dhammapada X:130 and XV:204. Sāmaññaphala-sutta. Sigālovāda-sutta, Advice to Sigāla. Bodhicharyavatara of Santideva III
1C. Hebrew Bible: Genesis 4:9, Leviticus 11:7–8, 11:10–11, 19:16, and 19:19, Deuteronomy 4:9, 14:7–8, 22:1–4, and 22:8, and Proverbs 23:12–13
1D. Christian New Testament: Passages cited to support immunization: Mark 7:18–23, Luke 10:33–35, Luke 14:1–6, 1 Corinthians 10:24, 2 Timothy 1:14, James 2:8, and 3 John 1:2. Passages cited in declining immunization: Matthew 10:7–8 and 15:13, Mark 2:17 [Note similarities with Luke 5:30–31 and Matthew 9:10–12] and 5:34, and 1 Corinthians 3:16–17; 6:19–20. Consider also (C), with regard to Old Testament
1E. Jehovah's Witnesses: Genesis 9:3–4, Leviticus 17:10–14, and Acts of the Apostles 15:28–29 1F. Qur'ān: 2:173, 5:3, 5:4, 16:81, 16:116, 30:30.

Full text of these passages appears in the Supplemental material. These selected scriptural passages should be interpreted in context with text preceding and following them.

All documents identified via PubMed were assessed. For the Google searches, at least the top 50 entries for each individual search were evaluated, more when the search results delivered relevant documents. After each search, reference lists were scanned to identify other relevant documents. Religious reference books were consulted [1,2], as well as key scriptural texts (e.g., Hebrew Bible, Christian New Testament, Qur'ān, Table 1).

3. Results

3.1. Populous religious groups

Discussion of the major religious groups appears below, sequenced by the founding dates of these traditions. The Christian denominations are listed alphabetically. This review did not identify any canonical doctrine that has led to religious objection to vaccines or immune globulins for Bahá'í Faith, Confucianism, Daoism, Shinto, or Sikhism.

Most ostensible objections to immunization attributable to religious belief fell into three categories: (a) violation of prohibitions against taking life, (b) violation of dietary laws, or (c) interference with natural order by not letting events take their course. Each is addressed further below.

3.1.1. Hinduism

Various denominations of Hinduism share a fundamental set of common beliefs, but philosophies and practices vary across different Hindu denominations. With no single founder, Hinduism considers itself *Sanatan Dharma* (the Eternal Tradition) and traces its roots to the revelations in the Vedic sacred texts of ancient India (at least 1500 years before our common era (BCE) to 500 BCE) [1,2]. There are four major branches of Hinduism: Shaiva, Vaishnava, Shakta, and Smarta. The Vedic sacred texts were transmitted orally for many centuries before being committed to writing [1,2,87]. Important Hindu texts include the *Shrutis* and the *Smritis* (e.g., Vedas, Mahābhārata, Rāmāyana, Bhagavad Gītā). In Hinduism, the ethics and metaphorical meanings of the texts, as revealed by spiritually elevated gurus, may often be emphasized more than literal interpretations. Vaccination is widely accepted in predominantly Hindu countries.

Hindus advocate non-violence (*ahimsa*) and respect for life, because divinity is believed to permeate all beings, including plants and non-human animals [1,2,87,88]. The degree to which Hindu believers apply the principle of non-violence varies. Hindu scriptures support the use of violence in self-defense and do not equate *ahimsa* with pacifism [88]. Some reason that even vegetation must submit for human survival and that humans unknowingly destroy

life forms on a regular basis through daily activities, as Mohandas Gandhi acknowledged (Table 1A).

Some Hindus embrace vegetarianism to respect higher forms of life (Table 1A); some eat meat only on certain days. Food habits vary across communities and regions. Observant Hindus who do eat meat often abstain from beef. The cow in Hindu society is traditionally identified as a caretaking and maternal figure. Verses of the Rig-Veda refer to the cow as *devi* (goddess), but Hindus do not worship cows, but rather venerate (deeply respect) them. This review did not identify contemporary Hindu concerns with trace bovine components of some vaccines.

3.1.2. Buddhism

Buddhism involves traditions, beliefs, and practices based on teachings attributed to Siddhartha Gautama, commonly known as the Buddha (awakened or enlightened one). The Buddha taught in the eastern part of what is now India between the 6th and 4th centuries BCE, perhaps 563–483 BCE. He is recognized by Buddhists as an enlightened teacher who shared his insights (Table 1B) to help end ignorance, craving, and suffering, and attain Nirvana (*Nibbāna*, freedom from suffering) [1,2,89–91]. Major Buddhist sects include Theravada, Mahayana, Vajrayana, and Zen. Buddhism has no central text commonly referred to by each tradition, nor a central authority empowered to pronounce on doctrine or ethics. Vaccination is widely accepted in predominantly Buddhist countries.

A key precept within Buddhism generally prohibits killing, either humans or animals [1,2,92,93]. Some canonical passages seem to accept meat consumption, whereas certain *Mahayana* sutras (texts) denounce eating meat [94]. In the modern Buddhist world, attitudes toward vegetarianism vary by location. This review did not identify contemporary Buddhist concerns with trace bovine components of some vaccines.

Buddhism does not oppose treatment of an existing illness by use of non-animal derived medicines, because treatment is an act of mercy [95–98]. Antibiotics kill microorganisms, yet antibiotics are accepted because they help people get closer to reaching Enlightenment. Serious diseases separate the body from the mind. Preventing disease means preventing disharmony within the body. The Nepalese Lama Zöpa Rinpoche describes a prayer of the Healing Buddha, to prevent diseases not yet experienced [99]. He also describes Logyönma (or Loma Gyönma), “a female healing buddha in leaf-wearing aspect,” known as an opponent to epidemic diseases [99,100].

The first written account of variolation describes a Buddhist nun (*bhikkhuni*) practicing around 1022–1063 CE [9]. She ground scabs taken from a person infected with smallpox (*variola*) into a powder, and then blew it into the nostrils of a non-immune person to induce immunity. Continuing this tradition, the 14th Dalai Lama participated in poliovirus immunization programs personally [101].

3.1.3. Jainism

Jainism arose in India between the 9th and 6th centuries BCE, based on the teachings of Nataputta Vardhamana (also called Mahavira), who prescribed a path of non-violence toward all living beings [2,88,102,103]. Their scriptures are known as the *Jaina Sutras*. In the practice of *ahimsa*, expectations are less strict for lay persons than for monastics.

Jains recognize a hierarchy of life forms, such that mobile beings are accorded more protection than immobile ones [2]. Jains are vegetarians or vegans [2,102]. They avoid eating root vegetables in general, as cutting the root from a plant kills it, unlike other parts of the plant (e.g., leaves, fruits, seeds). Although Jains acknowledge that plants must be destroyed for the sake of food, they accept such violence only inasmuch as it is indispensable for human survival [2,88,102].

Jains may drink boiled water, cook food, use paper or soap, and take necessary antibiotics, but perhaps with some regret. When considering vaccination, Jains may benefit from an explanation of the seriousness of the diseases to be prevented, to explain the rationale for killing microorganisms in the course of vaccine production [103,104]. Jains agree with Hindus that violence in self-defense can be justified [88,102].

Jains filter water, to remove any small insects that may be present. Observant Jains drink primarily water that has been filtered and boiled. Boiling kills the multitude of tiny beings in the water, but this is considered preferable to allowing the beings to reproduce in the water and later die, which would result in a greater number of deaths. As one Jain writer explained: "... we should not cause violence to creatures; but we cannot live without water; so minimizing sins, we should use water. ... Meaningless use is improper" [104].

3.1.4. Judaism

Judaism is based on the relationship between God and the children of Israel. Judaism considers itself the religion of Jacob (alternately Yisrael or Israel), grandson of Abraham and father of Judah [1,2]. Major Western branches or denominations include Orthodox, Conservative, Reform, and Reconstructionist. The first five books (Torah) of the Hebrew Bible date to around 1200 BCE, with an evolution of ancient Judaism that reached its present form around 450 BCE. The documentary basis of Judaic teaching is the Hebrew Bible (Tanakh or Miqra), expounded in later texts such as the Talmud and the Shulchan Aruch [1,2].

Judaism traditionally expects certain actions of its believers to maintain health. *Pikuakh nefesh*, acting to save one's own or another's life, is a primary value, a positive commandment (*mitzvah aseh*) [105–115]. Judaic principles emphasize the community benefits of disease prevention in a manner superior to individual preference, based on scriptures such as Leviticus 19:16 (Table 1C) that counsel not to stand idly by while a neighbor is in trouble. Jewish scholars applied this directive to encourage smallpox vaccination in previous eras. Rabbi and physician Mosheh ben Maimon (also called Maimonides or Rambam) expounded: "Anyone who is able to save a life, but fails to do so, violates 'You shall not stand idly by the blood of your neighbor'" [105,108,109]. Indeed, in settings where vaccination services were intermittently available, several scholars stated it is permissible to set aside Sabbath restrictions on activity to allow vaccination [105,106,109,110,112,113,115]. Similarly, there are exemptions from fasting if one is ill.

Parental responsibilities are detailed in a number of Jewish texts [105,107,111], based in Proverbs 23:12–13 (Table 1C). The Talmud has long encouraged parents to teach their children to swim, as a means of preventing drowning in some unknown, but foreseeable scenario. Scholars have taken this as a metaphor for vaccination against a future infection [105,107,108]. Maimonides wrote about prevention: "One must avoid those things which have a deleterious effect on the body, and accustom oneself to things which heal and fortify it" [105].

Another metaphor related to community responsibility is elevated to the status of a paradigm: the admonition to erect a railing around one's roof, when it was often used as a porch, to prevent harm to others who may later walk there from an anticipatable hazard (Deuteronomy 22:8, Table 1C) [105,106,108,109,111,115]. This paradigm has been applied as a proactive call for communal protection: vaccinating oneself and one's family to reduce the risk of transmission of infectious diseases to neighbors and bystanders.

Within *halacha* (Jewish law), the *kashrut* is the collection of Jewish dietary laws, followed more closely by branches such as Orthodox than by other branches. Food considered fit for consumption is termed "kosher" in English, with most dietary laws derived from the Books of Leviticus and Deuteronomy (Table 1C).

Among these dietary laws are prohibitions on consuming animals considered impure (e.g., pork, shellfish). Products of impure or improperly slaughtered animals are also non-kosher (*treif*). Animal gelatin, for example, may be avoided as food; nonetheless, kosher gelatin (from cows or fish prepared to be kosher) may be an alternative food.

In distinction to dietary laws, Jewish medical issues are judged based on concepts of medical law contained in halachic codes. The propriety of using vaccines or immune globulins within Judaism would be evaluated from a therapeutic or disease-prevention perspective. Multiple Jewish authorities agree that limitations on medications with porcine components are only an issue with oral administration (for those who observe kosher rules), not products given by injection [86,105]. Thus, the teachings to avoid pork products do not apply to injectable medications, in contrast to food-stuffs.

Permissibility of oral administration of medications with non-kosher ingredients, if necessary to preserve life, is provided in the Talmud [105]. In the case of oral medications, the transformation (*ponim chadashos*) of "primary" pork components into processed materials would make them more acceptable. Oral medication containing small amounts of material derived from non-kosher animals devoid of its taste could be kosher under some circumstances. According to a principle known as *bitul b'shishim*, a small amount of non-kosher food mixed with a much greater quantity of kosher food may be acceptable if the non-kosher item loses its taste or is diluted beyond a 1:60 ratio [116]. Additional conditions (e.g., intention, gentile source) need to be considered before this ruling can be made.

Rabbi Abraham Nanzig, writing in London in 1785 in the era of smallpox outbreaks, described the halachic basis for exposing a child to variola virus (variolation) to induce immunity against smallpox: "One who undergoes this treatment while still healthy, God will not consider it a sin. Rather, it is an act of eager religious devotion, and reflects the Commandment to 'be particularly careful of your well-being'" (Deuteronomy 4:15, Table 1C) [105,115]. In the 1850s, distinguished Rabbi Yisroel Lipschutz described Edward Jenner as a "righteous gentile," for his efforts in developing smallpox vaccination [105,109].

Jewish communities (often ultraorthodox, those who adhere meticulously to Jewish law and tend to be more isolated from others) in several countries have experienced measles and mumps outbreaks associated with declining vaccination [37,41,43,46,47,52,55,111]. The transnational social networks between such communities have allowed outbreaks to spread from one country to another [37]. Based on this review, contemporary Jewish vaccine decliners are more likely to cite concerns about vaccine safety than to invoke a specific religious doctrine that has not been considered by acknowledged Jewish scholars. Those scholars have rejected arguments that medical interventions interfere with divine providence [105,106,111].

The orthodox Hasidic Jews who constitute most of the residents of the village of Kiryas Joel in Orange County, New York, volunteered for several pivotal vaccine trials. These included trials for hepatitis A vaccine and mumps vaccine [117–119].

3.1.5. Christianity

Christians are followers of Jesus, whom they consider the Christ (i.e., Messiah, anointed one). Christians believe that Jesus, descended from Abraham through Isaac, is the Son of God prophesied in the Hebrew Bible [1,2]. Christianity began as a Jewish sect around 30 CE. Today, the largest groups within Christianity are the Roman Catholic Church, the Eastern Orthodox and Oriental Orthodox Churches, and the denominations of Protestantism [1,2].

The life and teachings of Jesus are presented in four canonical gospels ("good news") and other writings appended to the Hebrew

Bible (Old Testament) in the form of a New Testament. Various branches of Christianity define separate lists of books of the Bible that each considers canonical [1,2].

3.1.5.1. Multiple Christian denominations. Most Christian denominations have no scriptural or canonical objection to use of vaccines or immune globulins per se, based on this review (Table 1C and D). These include Roman Catholicism, Eastern Orthodox and Oriental Orthodox Churches, Amish, Anglican, Baptist, the Church of Jesus Christ of Latter-day Saints (LDS), Congregational, Episcopalian, Lutheran, Methodist (including African Methodist Episcopal), Pentecostal, Presbyterian, and Seventh-Day Adventist Church.

Exceptions appear in following sections. Roman Catholicism and some other Christian denominations have expressed concern about the aborted fetal origins of the principal formulation of rubella vaccine and some cell lines used to manufacture certain types of viral vaccines, discussed in later sections. The second half of Table 1D provides scriptural passages interpreted by a minority as contrary to vaccination.

Within a Christian creation-fall-redemption-restoration framework, immunization advocacy can form a basis for Christian service to humanity. This is consistent with themes of being one's brother's keeper (Genesis 4:9, Table 1C), loving your neighbor as yourself (James 2:8, Table 1D), and acting kindly to strangers, as did the good Samaritan (Luke 10:33–35, Table 1D).

3.1.5.2. Amish and related communities. The Amish, sometimes called old-order Amish or Amish Mennonites, are a group of Christian fellowships among Mennonite churches. Amish fellowships began with a schism within a group of Anabaptists in Switzerland in 1693 CE. Related groups in Canada and the northern US are known as Hutterites.

Immunization is not prohibited by Amish or Hutterite religious doctrine, but vaccine acceptance varies from district to district. Districts that typically decline immunization reflect a social tradition within these religious communities, related to modernity, more than a theological objection. Low immunization rates in Amish communities have been attributed variously to limited access to care, limited disease understanding, higher priority to other activities, and concerns about vaccine safety, with variability among various communities [18,120–123]. They tend to define illness in terms of failure to function in a work role, more than in terms of symptoms [19]. Within Amish and related communities, multiple *Haemophilus influenzae* type b, measles, pertussis, poliomyelitis, rubella, and tetanus cases and outbreaks have been reported [11,18,19,26,50,51,56–58,64,67,70–80,83]. District leaders have been more accepting of immunization at times of local outbreaks.

3.1.5.3. Church of Christ, Scientist. Spiritual healing of disease is a central tenet for members of the First Church of Christ, Scientist, founded in 1879 CE in Boston by Mary Baker Eddy. Christian Scientists frequently decline some or all medical help for disease. Individual believers often forego immunization, and church members have lobbied governments for religious exemptions from immunization.

Eddy called believers to unmask the devil's lies, one manifestation of which is disease. Disease, in this construct, is not fundamentally real, but rather something that can be dispelled, to reveal the perfection of God's creation. "Sickness is part of the error which Truth casts out" [124]. From this arose the Christian Science principle that disease is cured or prevented by prayer that affirms human perfection as God's child and denies the reality of disease. This principle is featured in Eddy's canon, *Science and Health with Key to the Scriptures* [124]. Christian Science "practitioners" (who do not practice medicine) aid believers in focused prayer.

In a 1901 interview with the *New York Herald*, Eddy said [125]: "At a time of contagious disease, Christian Scientists endeavor to rise in consciousness to the true sense of the omnipotence of Life, Truth, and Love, and this great fact in Christian Science realized will stop a contagion." Later, she said: "Rather than quarrel over vaccination, I recommend, if the law demand, that an individual submit to this process, that he obey the law, and then appeal to the gospel to save him from bad physical results" [125].

Outbreaks of diphtheria, measles, and poliomyelitis have been reported among followers of Christian Science [16,17,23–25,28,50,66], including repeat measles outbreaks at Principia College and affiliated K-12 schools between 1985 and 1994 [48]. Three measles deaths and hundreds of cases occurred during those outbreaks. The Church has a policy for members to report communicable diseases to health authorities, but members have limited ability to do so. First, their practitioners and nurses are not trained in disease recognition. Second, members are taught that disease is healed by convincing oneself of its unreality. As a result, several outbreaks have been recognized only after many people were infected [28,48]. In such cases, Christian Science parents were more willing to accept immunization after outbreaks were recognized by health authorities.

3.1.5.4. Dutch reformed congregations. Members of certain traditional reformed (*bevindelijk gereformeerden*) Christian denominations in the Netherlands, founded in the 1570s CE, have a tradition of declining immunization that dates back to concerns about adverse events after smallpox vaccination from 1823 onward [15,45,59,126]. These communities were the epicenters of paralytic poliomyelitis, measles, congenital rubella syndrome, and mumps outbreaks between 1971 and 2008 [11,15,34,45,54,58–65,77–80,82,126].

Members of these denominations have familial and cultural ties to associated Christian communities in other countries (e.g., Canada, United States), where immunization rates may also be low. These ties have resulted in international transmission of vaccine-preventable diseases (e.g., measles, poliomyelitis, rubella) with multiple outbreaks in locations otherwise free of circulating disease [11,58,61,64,78–80,82].

The contemporary basis for the objection of some members of these churches includes choosing to forego immunization rather than making a person less dependent on God [15,45,59,126]. For a subset, avoiding interference with divine providence before infection may be paramount; another subset described immunization as a gift from God to be used with gratitude [15,59]. Arguments against immunization have been refuted by other members of the traditional reformed community [15], for example by pointing out that using agricultural practices or raising dikes, to prevent flooding, could also be construed as contrary to divine intent, yet are common practices [45]. Recent increases in immunization rates in Dutch communities suggest that objections to immunization may be declining [45].

3.1.5.5. Jehovah's Witnesses. The Jehovah's Witnesses is a Christian denomination tracing its roots to the late 1870s CE. The Watch Tower Bible and Tract Society is its organizing body [127–130]. Since 1945, the Watch Tower Society has instructed its followers to refuse transfusions of whole blood and certain blood components (e.g., red blood cells, white blood cells, platelets, whole plasma), which they consider a violation of God's law. This interpretation derives from several scriptural passages (Table 1E) [127–138]. Their blood doctrine has undergone multiple changes since 1945, principally in 1978, 2000, and 2004 [139–142].

By abstaining from blood, Witnesses express their faith that only the shed blood of Jesus can redeem them and save their life. In this view, those who respect life as a gift from God do not try to sustain

life by taking in blood, even in an emergency [129,130]. While albumin, antimicrobial immune globulins, Rho(D) immune globulin, and coagulation factors VIII and IX have been declared acceptable to believers since 1978 [137,142], Witnesses today are taught that the use of various blood fractions are “not absolutely prohibited” and are a matter of personal choice [128,129,136–138,143–145]. More recently permissible products include those derived from white blood cells (e.g., interferons, interleukins), cryoprecipitate, cryosupernatant, erythropoietin, and preparations derived from hemoglobin [129,135,146]. It is unclear what proportion of Jehovah’s Witnesses offered such therapeutic products accept them.

The Watch Tower Society distributes worksheets and preformatted power-of-attorney advance directives, on which members can specify which allowable fractions and treatments they would personally accept, if any [129,131,132,135,136,144,147]. Important questions have been raised regarding how much freedom and what degree of information about risks, benefits, and alternatives are available to individual Jehovah’s Witnesses when considering these documents [128,129,131–135,148–150].

Some Jehovah’s Witnesses dissent from the blood-product doctrine, including the Associated Jehovah’s Witnesses for Reform on Blood [129,135]. They see no Biblical or ethical wrongness with accepting transfusion of donor blood or with donating blood for transfusion. This group functions with anonymity, because congregations have ostracized or expelled those who ignore or criticize their doctrine [128,129,134–136].

The Watch Tower Society denounced vaccination from the 1920s through the 1940s, citing scriptural passages such as those in Table 1E [127–129,138,151,152]. The group banned their members from vaccination around this time, under penalty of excommunication [138,151]. The Society revised this doctrine in the December 15, 1952, issue of *The Watchtower*, saying that those passages did not apply to vaccination [153]. In 1961, the Society took a neutral stand, neither endorsing nor prohibiting vaccination. In the 1990s, *Awake!* magazine began acknowledging the clinical value of vaccination. A contemporary Watchtower web page acknowledges the efficacy of vaccination in preventing hepatitis A and hepatitis B [154].

3.1.5.6. Churches that rely on faith healing. In addition to discussion above, several small Christian denominations or churches hold core beliefs that focus on healing through faith alone (Table 1D), with active avoidance of medical care (e.g., Faith Tabernacle, Church of the First Born, Faith Assembly, End Time Ministries) [155]. Several vaccine-preventable outbreaks (and associated deaths) involved faith healing to the exclusion or neglect of immunization or treatment after infection [27,39,40,50,51,155–157]. These outbreaks involved both adults who choose not to have themselves immunized and parents who withheld routine vaccines from their children.

3.1.6. Islam

Islam professes beliefs articulated by their Holy Book, the *Qur’ān* (the recitation), and through the teachings and example of Muhammad (570–632 CE). Muhammad, the last messenger of Allāh (the God, in Arabic), descends from Abraham (*Ibrahim*) through his son Ishmael [1,2]. The two major Islamic sects are Sunni and Shī’āh.

The *Qur’ān* and tradition forbid consumption of several animals outright (e.g., “the flesh of swine,” Table 1F), while other animals are permitted (halal) or forbidden (haram) based on conditions of how they died or were slaughtered. Gelatin made from porcine skin or bones is forbidden as food. Gelatin made from other halal animals, beef or fish for example, is acceptable as food.

Opinions or rulings on interpretation of the *Qur’ān* are issued as fatwas by Islamic scholars (mujtahids), with varying degrees of strictness. But fatwas are not always widely held to be authoritative,

in part because of varying degrees of expertise and also because the relationship for each Muslim is directly with God. According to the *Qur’ān*, a person is not guilty of sin in a situation where the lack of a halal alternative creates an undesired necessity to consume that which is otherwise haram (*Qur’ān* 2:173). This is the basis for the “law of necessity” in Islamic jurisprudence: “That which is necessary makes the forbidden permissible” in exceptional circumstances (Table 1F).

Opposition to immunization programs among selected Muslim communities has occurred during poliovirus immunization programs in Nigeria, Pakistan, and Afghanistan [158]. The opposition within northern Nigeria, notably in the state of Kano, was particularly long-lasting and an impediment to the global eradication effort [68,158–163]. Detailed consideration of the Nigerian situation revealed that what was described as ostensibly religious objections and assertions that vaccines spread the HIV virus or were vehicles for sterilization programs masked deeper struggles related to political power, inadequate health services, and a controversial clinical trial of an investigational antibiotic [68,159,162]. While the boycott was centered within Islamic social networks, most of the objections raised related to social issues, rather than theological issues. Eventually, the Nigerian government sent religious representatives to South Africa, Indonesia, and India to observe quality-control tests of poliovirus vaccines to be used in their areas and then sourced the vaccine from manufacturers they trusted [68,162].

In contrast, multiple imams and other Islamic leaders issued clear statements and fatwas describing how immunization is consistent with Islamic principles [68,69,162]. In the Nigerian case, engagement of the Organization of the Islamic Conference (including 17 African countries) and the 15th annual conference of the International Fiqh Council (a global forum of Islamic lawyers, scholars and philosophers to address the practice of Islam in contemporary life) provided assurances to Nigerian leaders [68].

Earlier, in 1995, the Islamic Organization for Medical Sciences, a well-regarded set of 112 jurists and medical experts conducted a seminar in Kuwait on “The judicially prohibited and impure substances in foodstuff and drugs” [164]. Participants included the muftis (experts in Islamic law) of Egypt, Tunisia, Oman, and Lebanon, the secretary general of the Islamic Fiqh Academy in Jeddah, and many other accomplished Islamic scholars. Citing the accepted principle of transformation (fundamental change, as from wine to vinegar) within Islam, they concluded that “The Gelatin formed as a result of the transformation of the bones, skin, and tendons of a judicially impure animal is pure, and it is judicially permissible to eat it” (see also Section 3.2.4) [164]. The full document also addressed issues related to medication capsules, alcohol, pig fat, and porcine insulin.

Omar Kasule, professor of Islamic medicine at the Institute of Medicine University of Brunei Darussalam noted that polio immunization is obligatory (*wajib*) when disease risk is high and the vaccine shown to have benefits far outweighing its risks [165,166]. Muslims will be interested in issues of vaccine safety, Professor Kasule explained, because immunization to prevent disease should not lead to side effects of the same magnitude as the disease. He based this judgment on the purpose of the law to protect life, the principle of preventing harm (*izalat al-dharrar*), and the principle of the public interest (*maslahat al-ummah*). He noted that the *Qur’ān* uses the concept of *wiqaya* in multiple situations to refer to taking preventive action (e.g., against hell-fire, punishment, greed, bad acts, harm, heat) and concludes that prevention is one of the laws of Allāh, with obvious application to medicine.

Muslims may apply additional scrutiny to vaccines required for pilgrims to the annual Hajj in Mecca, when purity takes on extra significance [167–170]. Another guiding principle comes from the prophetic statement of Muhammad: “God has not made

things that are unlawful for you to consume to be your medicine” [171].

3.1.6.1. Nation of Islam. The Nation of Islam is a US-based movement that aims to improve the condition of African-Americans in the US [172]. Its religious practices have some similarities and some differences, compared with traditional Islam. In 1997, the minister of health of the Nation of Islam advised believers to avoid all immunizations, based on concern about viral contamination with pathogens that cause “AIDS, Ebola, Hanta, Chronic Fatigue Syndrome, Gulf-War Syndrome, ‘mad cow’ disease, etc.” [173]. No objective evidence to substantiate these claims has been offered. That statement was framed as “until further notice,” although it no longer appears on the Nation of Islam website. The basis was rooted in safety and distrust-of-government concerns, rather than theological grounds.

3.2. Vaccine components and processes

3.2.1. Bacteria, viruses, cell substrates

The Hindu, Buddhist, and Jain religions have long prioritized respecting all forms of life, in the form of ahimsa [88]. The Jains in particular extend this respect even to the bacteria or viruses contained in a vaccine, as well as the culture-media cells used to grow viruses or produce recombinant proteins.

The Google searches identified a posting contending that Jains cannot take vaccines because microbes are killed in the process of manufacturing the vaccines. But this would seem to be a misreading of the Jain approach to regretting the loss of microbial (one-sensed) life, yet taking actions necessary to sustain life (e.g., ingesting life forms along with food, boiling water) [88,103,104].

Mohandas Gandhi observed: “The very fact of his [humanity’s] living—eating, drinking and moving about—necessarily involves some himsa, destruction of life, be it ever so minute” (Table 1A) [174].

3.2.2. WI-38 and MRC-5 cell lines

Unlike bacteria, viruses do not replicate on their own. To make viral vaccines, large numbers of viruses must be grown in cell cultures specific to each virus. Some licensed viral vaccines (i.e., some formulations of hepatitis A, poliovirus, rabies, rubella, and varicella-zoster viruses or combination vaccines containing such component viruses) are produced by growing viruses that infect humans in WI-38 or MRC-5 cell cultures [175,176]. WI-38 and MRC-5 represent two commonly used lineages of human diploid cell cultures, batches of immature cells with twice as many chromosomes as sperm or egg cells. Embryonic diploid cells are valuable in vaccine manufacture, because each aliquot of these cells can propagate several dozen times before senescence.

Each of these cell lines started with cells harvested from a deliberately aborted fetus [177,178]. The cell lines are used to grow the viruses, then discarded and not included in vaccine formulations. These cell lines cannot form a human being.

The WI-38 line was developed at the Wistar Institute in Philadelphia in 1961, with lung cells from a female fetus of 3 months gestation aborted in Sweden, whose parents felt they had too many children [175,176,179–183]. Similarly, British scientists funded by the Medical Research Council developed the MRC-5 line in September 1966 with fetal lung fibroblasts “taken from a 14-week-old male fetus removed for psychiatric reasons from a 27-year-old woman. . .” [179,184,185]. These cell lines, still in use today, gradually replaced primary cultures of monkey, duck, rabbit, chicken, dog, or mouse tissue, an approach vulnerable to contamination with viruses and bacteria [175,176,183].

Vaccine manufacturers have few options for viral culture media, for reasons of microbiology and safety [175,176,179,186–190]. It is

not possible to simply replace one cell line with another, because various viruses grow abundantly only in some kinds of cell lines. WI-38 and MRC-5 lines are well described and understood, with experience accumulated via hundreds of millions of vaccinations, important for safety-assessment reasons.

The fetal origins of WI-38 and MRC-5 cell lines pose an ethical or moral problem for people who disapprove of abortion. Critically, the two abortions were not conducted for the purpose of harvesting the cells that were transformed into these cell lines [177,178,191–194]. This lack of intention is a key element in breaking the complicity link that could otherwise make use of the vaccines unacceptable. No additional abortions are needed to sustain vaccine manufacture. The cell lines are not the final product, and no human cells are present in the final vaccine formulations.

In the late 1990s—early 2000s, teams of ethicists at the National Catholic Bioethics Center and then at the Vatican’s Pontifical Academy for Life and elsewhere considered the virology, epidemiology, and theology of the matter in detail [177,178,193–195]. Their considerations included both cooperation with evil and the principle of double effect. In this case, the cooperation related to those involved with the specific abortions in the 1960s. The principle of double effect applied insofar as using implicated vaccines today could appear to endorse or acquiesce to the acceptability of additional abortions in our current time. These teams concluded that the association between implicated vaccines and abortion was noncomplicit, and that using these vaccines is not contrary to a principled opposition to abortion. These centers reasoned that, because the abortions that enabled the production of these vaccines are in the past and (critically) the abortions were not undertaken with the intent of producing the cell lines, being immunized does not involve any sharing in immoral intention or action of others. In short, they are morally separate actions. In 2008, this position was elevated to the status of official Roman Catholic teaching [196].

The bioethicist teams agreed that use of a vaccine in the present does not involve sharing in the action of those who carried out the abortion in the past [178,193–196]. Further, they found that parents have a moral obligation to provide for the life and health of their children by means of immunization [178,193–196]. The situation with vaccines differs morally from ongoing harvest of fetal tissue for pharmaceutical manufacturing or research, which could be used to justify future abortions [177].

Still, these ethicists concluded that alternate vaccines should be used if available. They also recommended that parents and clinicians should speak out against abortion by asking governments and vaccine manufacturers to stop using cell lines that have links to aborted fetuses [193,194].

3.2.3. Rubella virus strain RA 27/3

In 1964, the Wistar Institute developed the RA 27/3 strain of rubella virus. The rubella virus isolate “was recovered from the explanted [kidney] tissue of a fetus obtained at therapeutic abortion from a mother who had been infected with rubella virus” [179,197–199]. The scientific literature of that era indicates that the abortion was not conducted with the motive of isolating the virus, but rather because the mother was infected with rubella virus and risked major birth defects [179,197,198]. After the RA 27/3 strain was isolated, it has been propagated serially in human diploid cells. The RA 27/3 strain produced superior antibody responses and was better tolerated, compared with other rubella vaccine strains available in the 1960s [199,200]. No further abortions are necessary to sustain the manufacture of additional batches of rubella RA 27/3-strain vaccine.

Use of the RA 27/3 rubella virus strain was also considered by the National Catholic Bioethics Center and the Pontifical Academy for Life. Using the same logic, they reasoned that because the one abortion that yielded the viral isolate was not undertaken with the

intent to retrieve the virus and because no additional abortions are needed to obtain more virus, being immunized is morally acceptable and also associated with parental duty [178,193–195]. The same provisions for preferring alternatives and petitioning governments and manufacturers also apply.

Some find it meaningful that rubella vaccination prevents many cases of fetal death and congenital rubella syndrome that would otherwise occur if women were infected with rubella virus during pregnancy. Immunized women exposed to the virus during pregnancy are no longer confronted with the question (what some religions might consider temptation) of whether to terminate their pregnancies on that basis.

3.2.4. Porcine excipients

All vaccines require the use of excipients (inactive ingredients) in manufacturing. Some of these products, such as hydrolyzed gelatin or trypsin, may have a porcine (pork) origin.

Hydrolyzed gelatin is a mixture of peptides and proteins produced by partial hydrolysis of collagen (connecting fibers and tissues) typically extracted from skin, bones, or other components, most often from pigs or cattle. Hydrolyzed refers here to the process of breaking down collagen molecules into chains of amino acids (polypeptides) by acidic or alkaline treatment, followed by purification [187,201,202]. Gelatin hydrolysates are added to some vaccine formulations to help stabilize and preserve active ingredients during freeze-drying and storage; hydrolyzed gelatin may also act as a solvent [187,203,204].

The enzyme trypsin may be used in producing some viral vaccines, to resuspend cells adhering to the cell-culture dish wall during the process of harvesting cells [187,203,205]. Trypsin typically is removed from the product physically before further processing. Like hydrolyzed gelatin, trypsin is often derived from porcine or bovine sources.

Some Jews, Muslims, and others have expressed concern about porcine-origin components, derived from faith-based concerns about consumption of pork in their diet, despite the injectable nature of most vaccines. Injectable medications are not subject to kosher rules [86,105]. Permissibility of oral administration of medications with such ingredients, if necessary to preserve life, is described in earlier sections. Scholars of Judaism and Islam have issued various rulings or waivers that allow use of such vaccines, for several reasons [86,105–114,164,205,206]:

- (1) the components of concern (e.g., hydrolyzed gelatin) have been sufficiently transformed from original pork origins,
- (2) the minute quantities per dose administered (e.g., hydrolyzed gelatin, trypsin) invoke exceptions based on dilution, or
- (3) the vaccine is intended for important medicinal purposes and not a matter of ingestion, to which dietary rules apply.

Other important considerations include the necessity of the product to save life and the lack of alternatives. Different scholars may evaluate and weigh these criteria differently.

For Muslims, *Shari'ah* law includes the principle of transformation (*istihalah*) in which unclean products can be made clean by extensive processing, transforming the original product into something new (e.g., from wine to vinegar). Under certain circumstances, this can make it permissible for observant Muslims to receive vaccines, even if the vaccines contain porcine excipients. This principle of transformation was invoked by the 1995 conference convened by the Islamic Organization for Medical Sciences [164,206]. The scholars explicitly concluded that transformation of pork products into gelatin alters them sufficiently to make it permissible for observant Muslims to receive vaccines containing porcine gelatin and certain other medicines, including those formulated in gelatin

capsules [164]. Even so, alternative products without components of concern may be preferred, if available.

In 2003, the European Council of Fatwa and Research issued a fatwa finding the permissibility of using oral poliovirus vaccine produced with porcine-origin trypsin [205]. Their decision centered on lack of similarity between pork and purified trypsin, physical removal during processing, dilution of any residual, necessity, and lack of alternative.

3.2.5. Bovine excipients

Bovine serum or albumin may be added to some cell cultures as a source of nutrition (in the form of albumin, amino acids or peptides, and growth factors); albumin can act as a protein stabilizer [187,207]. Hydrolyzed gelatin or trypsin (see porcine excipients, above) may alternately derive from a bovine source. This review identified no explicit religious objection to bovine components.

3.2.6. Misunderstandings of vaccine production or content

Google searches revealed multiple postings (data not shown), both by members of the public and by those who describe themselves as health professionals, that misstate the actual contents of vaccines and immune globulins. These searches revealed erroneous assertions that all vaccines are grown in chicken eggs, that vaccines are blood products, or that vaccines are contaminated with alcohol, toxins, or heavy metals. Some sites incorrectly asserted that most vaccines are genetically modified, claiming that such products are forbidden in both Judaism and Christianity based on Leviticus 19:19 and Matthew 15:13 (Table 1C and D).

Objections of certain Catholic officials in the Philippines in the mid-1990s that tetanus toxoid immunization for adult women actually contained contraceptives or abortifacients were based on misunderstanding [208–211]. Similar confusion disrupted immunization programs in Kenya, México, Nicaragua, and Tanzania [208,210].

Several websites objected to immunization on the basis that God created humans in His own image and that the body is a temple not to be defiled (Table 1D). Interpretations of the first letter of Paul to the Corinthians contrast with Mark's gospel in this regard. Even so, vaccines are no less pure than various other commonly used medications and are subject to extensive quality-control and audit procedures by the manufacturers and by multiple government regulators [212,213].

3.2.7. Pathogen route of exposure

Many religions traditionally have been proponents of sexual propriety [1,2]. This review identified several objections to hepatitis B immunization or to human papillomavirus (HPV) immunization, centered on the sexual route of exposure that can be associated with the corresponding pathogens. These objections to immunization were not theologically based per se, but rather arose indirectly as religious beliefs (usually of parents) affected views of acceptable sexual practices or timing. In the case of hepatitis B virus (HBV), sexual activity is only one of many risk factors for infection, including mother-to-child transmission. For HPV, several studies have shown that immunization does not increase or accelerate a woman's likelihood of sexual behavior [214–217]. The proportion of never-married teenaged females in the US who had been sexually active at least once fell from 51% in 1988 to 43% in 2006–10 [218]. With both HBV and HPV, a person could forego the vaccines, lead a life fully compliant with religious belief, and still be infected. Many religions have rites that allow for atonement or forgiveness of sins, but the many diseases caused by HBV and HPV (including multiple cancers) remain among the most difficult infectious diseases to attempt to cure.

Table 2
Summary of key points from perspectives of selected religions.

Jainism, Buddhism, Hinduism (linked via <i>ahimsa</i>)	
○	Respect for all life, favoring nonviolence [1,2,88]
○	Recognize the need to sustain human life, with regretful acceptance of cooking food, boiling water, using antibiotics and vaccines [1,2,88,96,103,104,174]
Judaism	
○	Consider the imperative for <i>Pikuakh nefesh</i> , acting to save one's own or another's life [105,106,109,110]
○	Consider the duty to protect one's children and one's neighbors; do not stand idly by [105–109]
○	Dietary kosher limitations on medications with porcine components apply to oral administration, but not to injection [86,105]. Even so, consider the importance of medicine in preserving life
Christianity	
○	Vaccines with remote fetal implications are morally acceptable (with a duty to protect children), unless alternative products are available [177,178,193–196]
○	Jehovah's Witnesses may accept certain blood derivatives, including immune globulins, interferons, coagulation factors, erythropoietin, and others [129,135,137,142,146]
○	Concern that 'the body is a temple not to be defiled' contrasts with other Scripture passages (Table 1D) and modern quality-control requirements for vaccines and immune globulins [212,213]
Islam	
○	Consider the law to protect life, the principle of preventing harm (<i>izalat al-dharar</i>), and the principle of the public interest (<i>maslahat al-ummah</i>) [165,166]
○	Transforming haram components may generate halal products (e.g., wine to vinegar) [164,206]
○	Extensive dilution of components of concern may result in minute quantities per dose [164,205,206]
○	Vaccines are intended for important medicinal purpose, not diet [68,164,205,206]
○	Vaccines help protect others [68,164–166,205]
○	Consider the law of necessity, whether alternative vaccines are available [86]

4. Discussion

This review is intended to explain pivotal aspects of religious teaching that have been applied for and against the acceptability of vaccines and immune globulins. As various examples described above show, the scriptural, canonical passages cited here are not interpreted uniformly by each believer within a faith tradition. The multiple sects, denominations, and branches within each of the major religions demonstrates the multiple ways various passages have been applied [4,83,86].

This review identified multiple religious doctrines or imperatives that call for preservation of life, caring for others, and duty to community (e.g., parent to child, neighbors to each other). Even in cases where vaccine components could be objectionable, this review found several themes favoring vaccine acceptance, including transformation of components of concern from their starting material, extensive dilution of such components, the medical purpose of immunization (in contrast to diet), and lack of alternatives (see Table 2).

This review revealed few canonical bases for declining immunization, with Christian Scientists a notable exception. Along these lines, it would seem that the instances of personal objections that are properly theological in nature (defined here as systematic and rational exploration of the nature of God) are relatively few, and that the preponderance might more accurately be defined as philosophical (i.e., a more general consideration of existence and reason) or simply personal choice [219]. For several religious groups, declination of immunization is more traditional or social than an essential religious precept [25,143]. The bulk of the objections identified in the searches for this review reflected concerns about vaccine safety, not matters of theology, as did an analysis of exemptions for school-aged children [219]. For Christian Scientists

who believe “Man is incapable of sin, sickness, and death” [124], vaccines would be superfluous.

One question-and-answer webpage started with this question: “I need to get a religious exemption or medical exemption for my children. We are moving to HI [Hawaii] and these are the only two exemptions they offer. Anyone know how to get around vaccinating my children?” [220]. How can we understand the intent of this writer? Understanding people's actual motives is important when discussing immunization.

Clinicians counseling people reluctant to be immunized may wish to probe for understanding of vaccine contents and provide factual information. From a Netherlands perspective, Ruijs et al. suggest discussing vaccine decision-making processes (e.g., criteria used, consequences), rather than medical information or an authoritarian stance [221]. Collaboration between public-health leaders and (religious) community leaders historically has helped resolve objections and enabled immunization programs to continue. Religious communities are a powerful social force, as shown in this review and in other studies [222,223].

The accumulation of susceptibles within a community creates vulnerability to infection [4,13,32,33,47,211,224]. A community can afford to have a small number of conscientious objectors to immunization. But each unimmunized person adds to the vulnerability of the group. If geographic clusters within a city neighborhood, among preschoolers, or within a suburb, a rural town, an island, a parish, or some other focal area are immunized at only 60% or 80% levels, herd protection does not occur and outbreaks can develop. An increasing collection of vulnerable people is like an increasing collection of kindling wood. Introduce a spark and fire can spring forth. One contagious person among a cluster of vulnerable people can ignite an outbreak involving many, including those unable to respond to vaccination.

One of the limitations of this review is that information about beliefs of less populous religions or denominations were not explicitly sought. On the other hand, the many searches and traces through reference lists frequently led to documents describing other religious traditions or denominations. None of those documents featured a canonical objection to immunization not already described above. But review of the medical literature identified multiple outbreaks of vaccine-preventable diseases among them [27,29,37,39,40,50,51,83]. Outbreaks rooted in personal or philosophical beliefs are not referenced here, but are numerous.

The outbreak reports cited in this review are likely not an exhaustive list of all religious-centered outbreaks, for several reasons: Some publications may not have been identified (especially those not written in English or relevantly coded in PubMed), some publications about outbreaks related to personal-belief exemptions may not have specified a religious basis for those beliefs, and some relevant outbreaks (or individual cases) may not have been published.

One element of acceptability for some believers is whether vaccines of concern have any alternatives [86,170,177,178,191–195]. Alternatives can be determined by comparing ingredients and culture media described in product prescribing information. Contrary to several web pages, measles vaccine is not a prophylactic alternative to measles-mumps-rubella (MMR) vaccine, insofar as selecting measles vaccine alone would be a decision to reject protection against mumps and rubella. Manufacturers attentive to global acceptability will endeavor to replace or avoid components of concern whenever possible.

If we are to serve our patients' needs in all their humanity, we should help them gain access to reasoned ethical and theological considerations of clinical issues [4,45,83,86,177,195,211]. When dealing with vaccines, the implications of a personal infectious-disease decision reach beyond the self, to affect neighbors [10,27,31–33,42,56,68,86,106,109,188]. My decision to immunize

or not immunize my family members changes the likelihood that you or your family will contract a contagious disease, and vice versa.

5. Personal note

The coming together of public health and religion is not a collision; rather it involves repeated intersections. We can advance both healthcare and our own condition by discussing them openly more often. I remain open to finding and reading doctrinal teachings not identified in my searches to date.

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Any remaining inaccuracies are the responsibility of the author alone.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.vaccine.2013.02.026>.

References

- Smith H. *The World's Religions (Plus)*. 50th anniv. ed. New York: HarperOne; 2009.
- Noss DS, Grangaard BR. *History of the World's Religions*. 12th ed. Upper Saddle Brook, NJ: Pearson Education; 2008.
- Williams G. *Angel of death: the story of smallpox*. Houndmills, UK: Palgrave Macmillan; 2010.
- Feudtner C, Marcuse EK. Ethics and immunization policy: promoting dialogue to sustain consensus. *Pediatrics* 2001;107(May):1158–64.
- Swales JD. The Leicester anti-vaccination movement. *Lancet* 1992;340:1019–21.
- Blume S. Anti-vaccination movements and their interpretations. *Soc Sci Med* 2006;62:628–42.
- Kaufman M. The American anti-vaccinationists and their arguments. *Bull Hist Med* 1967;41(September–October):463–78.
- Parment WE, Goodman RA, Farber A. Individual rights versus the public's health—100 years after *Jacobson v. Massachusetts*. *N Engl J Med* 2005;352(February 17):652–4.
- Fenner F, Henderson DA, Arita I, Jezek Z, Ladnyi ID. *Smallpox and its eradication*. Geneva World Health Organization; 1988.
- Grabenstein JD. Being immunized for the sake of others. *Hosp Pharm* 1999;34:54, 57–60, 107.
- Kulig JC, Meyer CJ, Hill SA, Handley CE, Lichtenberger SM, Myck SL. Refusals and delay of immunization within southwest Alberta. Understanding alternative beliefs and religious perspectives. *Can J Public Health* 2002;93(March–April):109–12.
- Silverman RD. No more kidding around: restructuring non-medical childhood immunization exemptions to ensure public health protection. *Ann Health Law* 2003;12(Summer):277–94.
- May T, Silverman RD. Clustering of exemptions' as a collective action threat to herd immunity. *Vaccine* 2003;21(March 7):1048–51.
- Thompson JW, Tyson S, Card-Higginson P, Jacobs RF, Wheeler JG, Simpson P, et al. Impact of addition of philosophical exemptions on childhood immunization rates. *Am J Prev Med* 2007;32(March):194–201.
- Ruijs WLM, Hautvast JLA, van Ijzendoorn G, van Ansem WJC, van der Velden K, Hulscher MEJL. How orthodox protestant parents decide on the vaccination of their children: a qualitative study. *BMC Public Health* 2012;12:408.
- Centers for Disease Control & Prevention. Fatal diphtheria—Wisconsin. *MMWR* 1982;31(October 22):553–5.
- Centers for Disease Control & Prevention. Childhood vaccine-preventable diseases—United States. *MMWR* 1994;43(October 7):718–20.
- Fry AM, Lurie P, Gidley M, Schmink S, Lingappa J, Fischer M, et al. Haemophilus influenzae type b disease among Amish children in Pennsylvania: reasons for persistent disease. *Pediatrics* 2001;108(October):E60.
- Swan R. Vaccine-preventable disease among the Amish. *Sioux City, IA: Children's Healthcare is a Legal Duty newsletter* 2006;(2):14–6. Available from: <http://childrenshealthcare.org/wp-content/uploads/2010/10/2006-02finalayout.pdf> [cited 17.09.12].
- Pavia AT, Nielsen L, Armington L, Thurman DJ, Tierney E, Nichols CR. A community-wide outbreak of hepatitis A in a religious community: impact of mass administration of immune globulin. *Am J Epidemiol* 1990;131:1085–93.
- Hockin J, Isaacs S, Kittle D, Brimmer G, Bailey N, Tamblyn S. Hepatitis A outbreak in a socially-contained religious community in rural southern Ontario. *Can Commun Dis Rep* 1997;23(November 1):161–6.
- Centers for Disease Control. Measles among children with religious exemptions to vaccination—Massachusetts, Ohio. *MMWR* 1981;30(November 13):550, 555–6.
- Centers for Disease Control & Prevention. Multiple measles outbreaks on college campuses—Ohio, Massachusetts, Illinois. *MMWR* 1985;34(March 15):129–30.
- Centers for Disease Control & Prevention. Measles in a population with religious exemptions to vaccination—Colorado. *MMWR* 1985;34(November 29):718–20.
- Novotny T, Jennings CE, Doran M, March CR, Hopkins RS, Wassilak SG, et al. Measles outbreaks in religious groups exempt from immunization laws. *Public Health Rep* 1988;103:49–54.
- Sutter RW, Markowitz LE, Bennetch JM, Morris W, Zell WR, Preblud SR. Measles among the Amish: comparative study of measles severity in primary and secondary cases in households. *J Infect Dis* 1991;163:12–6.
- Rodgers DV, Gindler JS, Atkinson WL, Markowitz LE. High attack rates and case fatality during a measles outbreak in groups with religious exemption to vaccination. *Pediatr Infect Dis J* 1993;12:288–92.
- Centers for Disease Control & Prevention. Outbreak of measles among Christian Science students—Missouri and Illinois. *MMWR* 1994;43:463–5.
- Valiquette L, Bédard L. Outbreak of measles in a religious group—Montreal, Quebec. *Can Commun Dis Rep* 1995;21(January 15):1–4.
- Expanded programme on immunization. Outbreak of measles in a religious group, Montreal, Quebec. *Wkly Epidemiol Rec* 1995;70(March 31):91–3.
- Centers for Disease Control & Prevention. Measles outbreak—southwestern Utah, 1996. *MMWR* 1997;46:766–9.
- Salmon DA, Haber M, Gangarosa EJ, Phillips L, Smith NJ, Chen RT. Health consequences of religious and philosophical exemptions from immunization laws: individual and societal risk of measles. *JAMA* 1999;282(July 7):47–53 [erratum 2000;283(May 3):2241].
- Feikin DR, Lezotte DC, Hamman RF, Salmon DA, Chen RT, Hoffman RE. Individual and community risks of measles and pertussis associated with personal exemptions to immunization. *JAMA* 2000;284(December 27):3145–50.
- Centers for Disease Control & Prevention. Measles outbreak—the Netherlands, 1999 April–2000 January. *MMWR* 2000;49:299–303.
- Outbreaks of measles in communication with low vaccine coverage. *Commun Dis Rep Wkly* 2000;10(January 28):29, 32.
- Cohen BJ, McCann R, van den Bosch C, White J. Outbreak of measles in an Orthodox Jewish community. *Euro Surveill* 2000;4(3), pii:1675.
- Centers for Disease Control & Prevention. Postexposure prophylaxis, isolation, and quarantine to control an import-associated measles outbreak—Iowa, 2004. *MMWR* 2004;53(October 22):969–71.
- Ehresmann KR, Crouch N, Henry PM, Hunt JM, Habedank TL, Bowman R, et al. An outbreak of measles among unvaccinated young adults and measles seroprevalence study: implications for measles outbreak control in adult populations. *J Infect Dis* 2004;189(1):S104–7.
- Centers for Disease Control & Prevention. Import-associated measles outbreak—Indiana, May–June 2005. *MMWR* 2005;54(October 28):1073–5.
- Parker AA, Staggs W, Dayan GH, Ortega-Sánchez IR, Rota PA, Lowe L, et al. Implications of a 2005 measles outbreak in Indiana for sustained elimination of measles in the United States. *N Engl J Med* 2006;355:447–55.
- Stewart-Freedman B, Kovalsky N. An ongoing outbreak of measles linked to the United Kingdom in an ultra-orthodox Jewish community in Israel. *Euro Surveill* 2007;12:E070920.1.
- Kennedy AM, Gust DA. Measles outbreak associated with a church congregation: a study of immunization attitudes of congregation members. *Public Health Rep* 2008;123(March–April):126–34.
- Stein-Zamir C, Zentner G, Abramson N, Shoo H, Aboudy Y, Shulman L, et al. Measles outbreaks affecting children in Jewish ultra-orthodox communities in Jerusalem. *Epidemiol Infect* 2008;136:207–14.
- Noury U, Stoll J, Haeghebaert S, Antona D, Parent du Château I, Investigation team. Outbreak of measles in two private religious schools in Bourgogne and Nord-Pas-de-Calais regions of France, May–July 2008 (preliminary results). *Euro Surveill* 2008;13(August 28), pii: 18961.
- Woonink W. Objections against vaccination: the perspective of those who refuse. *Bilthoven, Netherlands: National Institute for Public Health and the Environment*; 2009. Available from: <http://www.rivm.nl/en/Images/000652%20Bez%20tegen%20vacc%20EN.tcm13-67802.pdf> [cited 17.09.12].
- Anis E, Grotto I, Moerman L, Warshavsky B, Slater PE, Lev B, et al. Measles in a highly vaccinated society: the 2007–08 outbreak in Israel. *J Infect* 2009;59:252–8.

- [47] Lernout T, Kissling E, Hutse V, De Schrijver K, Top G. An outbreak of measles in Orthodox Jewish communities in Antwerp, Belgium, 2007–2008: different reasons for accumulation of susceptibles. *Euro Surveill* 2009;14:15–8.
- [48] Swan R. Measles at Principia: the view from public health. *Sioux City, IA: Children's Healthcare Is a Legal Duty* newsletter 2009;(3–4):7–11. Available from: <http://childrenshealthcare.org/wp-content/uploads/2010/11/2009-03-04finallayout.pdf> [cited 12.09.12].
- [49] Parker Fiebelkorn A, Redd SB, Gallagher K, Rota PA, Rota J, Bellini W, et al. Measles in the United States during the post-elimination era. *J Infect Dis* 2010;202(10):1520–8.
- [50] Swan R. Some outbreaks of vaccine-preventable diseases in groups with religious or philosophical exemptions. *Sioux City, IA: Children's Healthcare is a Legal Duty*. Available from: http://childrenshealthcare.org/?page_id=171 [cited 12.09.12].
- [51] Swan R. Vaccine-preventable diseases, by denomination. *Sioux City, IA: Children's Healthcare is a Legal Duty*. Available from: http://childrenshealthcare.org/?page_id=200 [cited 12.09.12].
- [52] Centers for Disease Control & Prevention. Mumps outbreak – New York, New Jersey, Quebec, 2009. *MMWR* 2009;58(November 20):1270–4.
- [53] Centers for Disease Control & Prevention. Update: Mumps outbreak – New York and New Jersey, June 2009–January 2010. *MMWR* 2010;59:125–9.
- [54] Wielders CC, van Binnendijk RS, Snijders BE, Tipples GA, Cremer J, Fanoy E, et al. Mumps epidemic in orthodox religious low-vaccination communities in the Netherlands and Canada, 2007 to 2009. *Euro Surveill* 2011;16(October 13), pii: 19989.
- [55] Muhsen K, Shohat T, Aboudy Y, Mendelson E, Algor N, Anis E, et al. Seroprevalence of mumps antibodies in subpopulations subsequently affected by a large scale mumps epidemic in Israel. *Vaccine* 2011;29:3878–82.
- [56] Etkind P, Lett SM, Macdonald PD, Silva E, Peppe J. Pertussis outbreaks in groups claiming religious exemptions to vaccinations. *Am J Dis Child* 1992;146(February):173–6.
- [57] Centers for Disease Control & Prevention. Pertussis outbreak in an Amish community—Kent County, Delaware, September 2004–February 2005. *MMWR* 2006;55(August 4):817–21.
- [58] Centers for Disease Control & Prevention. Follow-up on poliomyelitis—United States, Canada, Netherlands reprint of report from July 27, 1979; 28:345–6. *MMWR* 1997;46(December 19):1195–9.
- [59] Veenman J, Jansma LG. The 1978 Dutch polio epidemic: a sociological study of the motives for accepting or refusing vaccination. *Neth J Sociol* 1980;16:21–48.
- [60] Centers for Disease Control & Prevention. Update: poliomyelitis outbreak – Netherlands, 1992. *MMWR* 1992;41:917–9.
- [61] Centers for Disease Control & Prevention. Isolation of wild poliovirus type 3 among members of a religious community objecting to vaccination – Alberta, Canada, 1993. *MMWR* 1993;42(May 7):337–9.
- [62] Expanded programme on immunization. Poliomyelitis outbreak, 1992. *Wkly Epidemiol Rec* 1993;68(October 8):297–300.
- [63] Oostvogel PM, van Wijngaarden JG, van der Avoort HG, Mulders MN, Conyn-van Spaendonck MA, Rümke HC, et al. Poliomyelitis outbreak in an unvaccinated community in The Netherlands, 1992–93. *Lancet* 1994;344(September 3):665–70.
- [64] Centers for Disease Control & Prevention. Poliomyelitis—United States, Canada. *MMWR* 1997;46:1194–5.
- [65] White FM, Lacey BA, Constance PD. An outbreak of poliovirus infection in Alberta: 1978. *Can J Public Health* 1998;72:119–24.
- [66] Advisory Committee on Immunization Practices. Poliomyelitis prevention in the United States. *MMWR* 2000;49(RR-5):1–22.
- [67] Centers for Disease Control & Prevention. Poliovirus infections in four unvaccinated children—Minnesota, August–October 2005. *MMWR* 2005;54(October 21):1053–5.
- [68] Yahya M. Polio vaccines—difficult to swallow. The story of a controversy in northern Nigeria. Brighton, UK: Institute of Development Studies; 2006. Available from: <http://www.ids.ac.uk/files/Wp261.pdf> [cited 12.09.12].
- [69] Kaufmann JR, Feldbaum H. Diplomacy and the polio immunization boycott in Northern Nigeria. *Health Aff (Millwood)* 2009;28(July–August):1091–101.
- [70] Alexander JP, Ehresmann K, Seward J, Wax G, Harriman K, Fuller S, et al. Transmission of imported vaccine-derived poliovirus in an under-vaccinated community in Minnesota. *J Infect Dis* 2009;199(February 1):391–7.
- [71] Centers for Disease Control & Prevention. Current trends in rubella and congenital rubella syndrome. *MMWR* 1991;40(February 15):93–9.
- [72] Outbreaks of rubella in Amish communities, 1991. *Wkly Epidemiol Rec* 1991;66(September 27):285–6.
- [73] Briss PA, Fehrs LJ, Hutcheson RH, Schaffner W. Rubella among the Amish: resurgent disease in a highly susceptible community. *Pediatr Infect Dis J* 1992;11(November):955–9.
- [74] Centers for Disease Control. Congenital rubella syndrome among the Amish – Pennsylvania, 1991–1992. *MMWR* 1992;41(July 3):468–9, 475–6.
- [75] Jackson BM, Payton T, Horst G, Halpin TJ, Mortensen BK. An epidemiologic investigation of a rubella outbreak among the Amish of northeastern Ohio. *Public Health Rep* 1993;108(July–August):436–9.
- [76] Mellinger AK, Cragan JD, Atkinson WL, Williams WW, Kleger B, Kimber RG, et al. High incidence of congenital rubella syndrome after a rubella outbreak. *Pediatr Infect Dis J* 1995;14:573–8.
- [77] van der Veen Y, Hahné S, Ruijs H, van Binnendijk R, Timen A, van Loon AM, et al. Rubella outbreak in an unvaccinated religious community in the Netherlands leads to cases of congenital rubella syndrome. *Euro Surveill* 2005;10(November 24):E051124.3.
- [78] Shapiro H. Rubella outbreaks in the news, May 3, 2005. Health Professionals Update, Region of Peel, Ontario, Canada. Available from: <http://www.peelregion.ca/health/professionals/pdfs/2005-05-03-rubella.pdf> [cited 17.09.12].
- [79] Hampson S, Bragg MR. Rubella outbreak—Oxford County Ontario, Canada. Public briefing; 2005. Available from: <http://www.mah.gov.on.ca/asset201.aspx> [cited 17.09.12].
- [80] Hahné S, Macey J, Tipples G, Varughese P, King A, van Binnendijk R, et al. Rubella outbreak in an unvaccinated religious community in the Netherlands spreads to Canada. *Euro Surveill* 2005;10(May 19):E050519.1.
- [82] Hahné S, Macey J, van Binnendijk R, Kohl R, Dolman S, van der Veen Y, et al. Rubella outbreak in the Netherlands, 2004–2005: high burden of congenital infection and spread to Canada. *Pediatr Infect Dis J* 2009;28(September):795–800.
- [83] Fair E, Murphy TV, Golaz A, Wharton M. Philosophic objection to vaccination as a risk for tetanus among children younger than 15 years. *Pediatrics* 2002;109(January):E2.
- [84] Glanz JM, McClure DL, Magid DJ, Daley MF, France EK, Salmon DA, et al. Parental refusal of pertussis vaccination is associated with an increased risk of pertussis infection in children. *Pediatrics* 2009;123(6):1446–51.
- [85] Grabenstein JD. Where medicine and religion intersect (editorial). *Ann Pharmacother* 2003;37(September):1338–9.
- [86] Mynors G, Ghalamkari H, Beaumont S, Powell S, McGee P. Drugs of porcine origin & clinical alternatives. London: Medicines Partnership Programme; 2004. Available from: [cited 17.09.12].
- [87] No author cited. Hinduism. Available from: <http://www.wikipedia.com> [cited 17.09.12].
- [88] No author cited. Ahimsa. Available from: <http://www.wikipedia.com> [cited 17.09.12].
- [89] No author cited. Buddhism. Available from: <http://www.wikipedia.com> [cited 17.09.12].
- [90] Gethin R, editor. Sayings of the Buddha: a selection of Suttas from the Pali Nikāyas. New York: Oxford University Press; 2008.
- [91] Buddha. Taking the thought on enlightenment. Quoted in Barnett LD. The Path of light: a translation of the Bodhicharyavatara of Santideva. Available from: <http://www.sacred-texts.com/bud/tpol/tpol06.htm> [cited 17.09.12].
- [92] Carter JR, Palihawadana M, editors. The Dhammapada: the sayings of the Buddha. New York: Oxford University Press; 2008.
- [93] Brahmavamsa A. What the Buddha said about eating meat. Buddhist Society of Western Australia Newsletter; 1990. Available from: <http://www.urbandharma.org/udharma3/meat.html> [cited 17.09.12].
- [94] Lankavatara Sutra & The Faults of Eating Meat. Amsterdam: Shabkar. Available from: http://www.shabkar.org/scripture/sutras/lankavatara_sutra1.htm [cited 17.09.12].
- [95] Buddha. The sermon at Benares. Quoted in Carus P. The Gospel of Buddha: Compiled from Ancient Records, 1909. Available from: <http://www.sacred-texts.com/bud/btg/btg17.htm> [cited 17.09.12].
- [96] Ratanakul P. Buddhism, health and disease. *Eubios J Asian Int'l Bioeth* 2004;15:162–4. Available from: <http://www.eubios.info/EJ145/ej145b.htm> [cited 17.09.12].
- [97] Yun H. Sutra of the medicine Buddha: with an introduction, comments and prayers. 2nd ed Hacienda Heights, CA: Buddha's Light Publishing; 2005.
- [98] Yun H. Buddhism, medicine, and health. Hacienda Heights, CA: Buddha's Light International Association. C Available from <http://blpusa.com/buddhism-medicine-and-health> [cited 17.09.12].
- [99] Zopa Rinpoche LT. Healing Buddha: a practice for the prevention and healing of disease. Taos, NM: Foundation for the Preservation of the Mahayana Tradition; 2001. Available from: <http://www.fpmt.org/images/stories/september11/HealingBuddhaLtrbklt.pdf> [cited 17.09.12].
- [100] Zopa Rinpoche LT. The meditation of Loma Gyönma, the yellow leaf-wearing female solitary ascetic. Taos, NM: Foundation for the Preservation of the Mahayana Tradition; 2003. Available from: <http://www.fpmt.org/images/stories/teachers/zopa/advice/pdf/contagdismar03bkltr.pdf> [cited 17.09.12].
- [101] Monthly Situation Reports, Dec 2009 and Jan 2010: endemic Countries, India. Geneva: Global Polio Eradication Initiative; 2010. Available from: <http://www.polioeradication.org/MediaRoom/Monthlysituationreports/2010/January.aspx> [cited 17.09.12].
- [102] Jainism. Available from: <http://www.wikipedia.com> [cited 17.09.12].
- [103] Shah BS. An introduction to Jainism. 2nd ed. New York: Setubandh Publications; 2002.
- [104] Bhadrabahu V. Guidelines of Jainism. Why should water be boiled? Alpharetta, GA: Jainworld. Available from: <http://www.jainworld.com/book/guidelinesofjainism/ch29.asp> [cited 17.09.12].
- [105] Prouser JH. Compulsory immunization in Jewish day schools. *Choshen Mishpat* 427:8. Available from: <http://mysite.verizon.net/bizeg2z8/Teshuvah%20Vaccine%20Policy.pdf> [cited 17.09.12].
- [106] DiPoce J, Buchbinder SS. Preventative medicine. *J Halacha Contemp Soc* 2001;62(Fall):70–101.

- [107] Milgram G. Vaccinations and Judaism: Permitted? Optional? Forbidden? Philadelphia Jewish Voice, December 2009 (issue #50). Available from: <http://www.pjvoice.com/v50/50705judaism.aspx> [cited 17.09.12].
- [108] Milgram G, Kaplowitz E, Raucher N, Washofsky M. Regarding immunizations for children who will be attending day (Jewish or parochial) schools, what is the Jewish view of whether this is obligatory or optional? What Jewish values or ethics are involved in this question? Jewish Values Online. Available from: <http://www.jewishvaluesonline.org/question.php?id=566> [cited 17.09.12].
- [109] Eisenberg D. A Jewish perspective on the controversial issues surrounding immunization. Jerusalem: Aish.com. Available from: <http://www.aish.com/ci/sam/48943486.html> [cited 17.09.12].
- [110] Reichman E. Halachic aspects of vaccination. New York: Jewish Action Online, Magazine of the Orthodox Union. Available from: <http://www.jewishaction.com/article.asp?id=170912> [cited 17.09.12].
- [111] Bush A. Vaccination in Halakha and in practice in the orthodox Jewish community. Hakirah, Flatbush Journal of Jewish Law and Thought 2012;13(Spring):185–212. Available from: www.hakirah.org/Vol13Bush.pdf [cited 17.09.12].
- [112] Central Conference of American Rabbis. New American Reform Responsa: 147. Refusal of Immunization, December 1990. Available from: <http://data.ccrnet.org/cgi-bin/respdisp.pl?file=147&year=narr> [cited 17.09.12].
- [113] Cohen RA. Vaccination in Jewish law. *J Halacha Contemp Soc* 2010; 59(Spring):79–116.
- [114] Shafran Y. Halakhic attitudes towards immunization. *Tradition* 1991;26(Fall):4–13. Available from: www.traditiononline.org/news/article.cfm?id=104523 [cited 17.09.12].
- [115] Bleich JD. Hazardous medical procedures. *Tradition* 2003;37(Fall):76–100.
- [116] Heber D. When it's null and void: understanding batel b'shishim (one-sixtieth). Baltimore: Star-K Kosher Certification. Available from: www.star-k.org/kashrus/kk-ABISSELBITUL.htm [cited 17.09.12].
- [117] Armstrong ME, Gies PA, Davide JP, Redner F, Waterbury JA, Rhoad AE. Development of the formalin-inactivated hepatitis A vaccine, Vaqta(TM), from the live attenuated virus strain CR326F. *J Hepatol* 1993;18(Suppl. 2):S20–6.
- [118] Werzberger A, Kuter B, Shouval D, Mensch B, Brown L, Wiens B, et al. Anatomy of a trial: a historical view of the Monroe inactivated hepatitis A protective efficacy trial. *J Hepatol* 1993;18(Suppl. 2):S46–50.
- [119] Kutty P, Ogbuanu I, Glen A, Hudson J, Lawler J, Blog D, et al. Outbreak of mumps in a highly vaccinated population in Orange County, New York, 2009–2010: epidemiology and third dose. In: 48th Infectious Diseases Society of America Annual Meeting, 2010.
- [120] Dickinson N, Slesinger DP, Raftery PR. A comparison of the perceived health needs of Amish and non-Amish families in Cashton, Wisc. *Wis Med J* 1996;95(March):151–6.
- [121] Yoder JS, Dworkin MS. Vaccination usage among an old-order Amish community in Illinois. *Pediatr Infect Dis J* 2006;25(December):1182–3.
- [122] Wenger OK, McManus MD, Bower JR, Langkamp DL. Underimmunization in Ohio's Amish: parental fears are a greater obstacle than access to care. *Pediatrics* 2011;128(July):79–85.
- [123] Boyce TG. Vaccination usage among the Amish (letter). *Pediatr Infect Dis J* 2007;26(April):370.
- [124] Eddy MB. Science and health with key to the scriptures. Boston: Church of Christ, Scientist; 1895. Available from: www.christianscience.com/read-online [cited 17.09.12].
- [125] Eddy MB. The first church of christ, scientist, and miscellany. Boston: Church of Christ, Scientist; 1913. Available from: www.mbeinstitute.org/PWIntro.htm [cited 17.09.12].
- [126] Ruijs WL, Hautvast JL, van der Velden K, de Vos S, Knippenberg H, Hulscher ME. Religious subgroups influencing vaccination coverage in the Dutch Bible belt: an ecological study. *BMC Public Health* 2011;11(February):102.
- [127] Singelenberg R. The blood transfusion taboo of Jehovah's Witnesses: origin, development and function of a controversial doctrine. *Soc Sci Med* 1990;31:515–23.
- [128] Muramoto O. Bioethics of the refusal of blood by Jehovah's Witnesses: Part 1. Should bioethical deliberation consider dissidents' views? *J Med Ethics* 1998;24(August):223–30.
- [129] Muramoto O. Recent developments in medical care of Jehovah's Witnesses. *West J Med* 1999;170(May):297–301.
- [130] Watch Tower Bible & Tract Society. How can blood save your life? Blood—vital for life. Brooklyn, NY. Available from: www.watchtower.org/e/hb/article.01.htm [cited 17.09.12].
- [131] Migden DR, Braen GR. The Jehovah's Witness blood refusal card: ethical and medicolegal considerations for emergency physicians. *Acad Emerg Med* 1998;5(August):815–24.
- [132] Ridley DT. Honoring Jehovah's Witnesses' advance directives in emergencies: a response to Drs. Migden and Braen. *Acad Emerg Med* 1998;5(August):824–35.
- [133] Malyon D. Transfusion-free treatment of Jehovah's Witnesses: respecting the autonomous patient's rights. *J Med Ethics* 1998;24(October):302–7.
- [134] Ridley DT. Jehovah's Witnesses' refusal of blood: obedience to scripture and religious conscience. *J Med Ethics* 1999;25:469–72.
- [135] Elder L. Why some Jehovah's Witnesses accept blood and conscientiously reject official Watchtower Society blood policy. *J Med Ethics* 2000;26:375–80.
- [136] Muramoto O. Bioethical aspects of the recent changes in the policy of refusal of blood by Jehovah's Witnesses. *BMJ* 2001;322(January 6):37–9.
- [137] Sniecinski R, Levy JH. What is blood and what is not? Caring for the Jehovah's Witness patient undergoing cardiac surgery. *Anesth Analg* 2007;104(April):753–4.
- [138] Grundy P. Facts about Jehovah's witnesses: dangerous medical advice and changes. Brooklyn, NY. Available from: <http://jwfacts.com/watchtower/experiences/paul-grundy.php> [cited 17.09.12].
- [139] Watch Tower Bible & Tract Society. Are serum injections compatible with Christian belief? The Watchtower 1978;(June 15):30–1. Available from: http://4jehovah.org/images/stories/downloads/jehovahs_witness/medical/blood15.pdf [cited 17.09.12].
- [140] Watch Tower Bible & Tract Society. Do Jehovah's Witnesses accept any medical products derived from blood? The Watchtower 2000;(June 15):29–31. Available from: www.jwfiles.com/wt_blood/blood.htm [cited 17.09.12].
- [141] Watch Tower Bible & Tract Society. Rightly value your gift of life. Be guided by the living God. Do Jehovah's Witnesses accept any minor fractions of blood? The Watchtower 2004;(June 15):14–24, 29–31. Available from: http://4jehovah.org/images/stories/downloads/jehovahs_witness/medical/blood4.pdf [cited 17.09.12].
- [142] Jehovah's Witnesses and blood. JW files: research on Jehovah's Witnesses. Available from: www.jwfiles.com/wt_blood/blood.htm [cited 17.09.12].
- [143] Roy-Bornstein C, Sagar LD, Roberts KB. Treatment of a Jehovah's Witness with immune globulin: case of a child with Kawasaki syndrome. *Pediatrics* 1994;94:112–3.
- [144] Watch Tower Bible & Tract Society. How do I view blood fractions and medical procedures involving my own blood? Our Kingdom Ministry, 2006 (November):3–6. Available from: www.aggelia.be/km_nov2006.pdf [cited 17.09.12].
- [145] Sniesinski RM, Chen EP, Levy JH, Szlam F, Tanaka KA. Coagulopathy after cardiopulmonary bypass in Jehovah's Witness patients: management of two cases using fractionated components and factor VIIa. *Anesth Analg* 2007;104(April):763–5.
- [146] Isaacs D, Kilham HA, Alexander S, Wood N, Buckmaster A, Royle J. Ethical issues in preventing mother-to-child transmission of hepatitis B by immunisation. *Vaccine* 2011;29(August 26):6159–62.
- [147] Baron CH. Blood transfusions, Jehovah's Witnesses, and the American patients' rights movement. Boston College Law School Faculty Papers, paper 329, 2011. Available from: <http://lawdigitalcommons.bc.edu/mwg-internal/de5fs23hu73ds/progress?id=rjXgHFUsh&dl> [cited 17.09.12].
- [148] Malyon D. Transfusion-free treatment of Jehovah's Witnesses: respecting the autonomous patient's motives. *J Med Ethics* 1998;24(December):376–81.
- [149] Muramoto O. Bioethics of the refusal of blood by Jehovah's Witnesses: part 2. A novel approach based on rational non-interventional paternalism. *J Med Ethics* 1998;25(October):298–301.
- [150] Muramoto O. Bioethics of the refusal of blood by Jehovah's Witnesses: part 3. A proposal for a don't-ask-don't-tell policy. *J Med Ethics* 1999;25(December):463–8.
- [151] Robinson BA. Jehovah's Witnesses: past opposition to vaccinations. Kingston, Ontario, ReligiousTolerance.org: Ontario consultants on religious tolerance; September 2003. Available from: www.religioustolerance.org/witness6.htm [cited 17.09.12].
- [152] Associated Jehovah's Witnesses for Reform on Blood. Vaccination—'A crime against humanity.' Boise, ID. Available from: www.ajwr.org/science/vaccinat.html [cited 17.09.12].
- [153] Watch Tower Bible & Tract Society. Is vaccination a violation of God's law forbidding the taking of blood into the system? The Watchtower 1952;(December 15):764.
- [154] Watch Tower Bible & Tract Society. Hepatitis B: a silent killer. Brooklyn, NY. Available from: www.watchtower.org/e/201008hb/article.01.htm [cited 17.09.12].
- [155] Asser SM, Swan R. Child fatalities from religion-motivated medical neglect. *Pediatrics* 1998;101(April (Pt. 1)):625–9.
- [156] Hughes RA. The death of children by faith-based medical neglect. *J Law Relig* 2004;20(1):247–65.
- [157] Swan R. First-Century Gospel case heads for trial; second child dies in Philadelphia faith-healing sect, Sioux City, IA. Children's Healthcare is a Legal Duty [newsletter] 2010;3:1–2. Available from: <http://childrenshealthcare.org/wp-content/uploads/2010/10/2010-03finalayout.pdf> [cited 17.09.12].
- [158] Warracha HJ. Religious opposition to polio vaccination [letter]. *Emerg Infect Dis* 2009;15:978 www.ncbi.nlm.nih.gov/pmc/articles/PMC2700087/ [cited 17.09.12].
- [159] Kapp C. Surge in polio spreads alarm in northern Nigeria. Rumours about vaccine safety in Muslim-run states threaten WHO's eradication programme. *Lancet* 2003;362(November 15):1631–2.
- [160] Kapp C. Nigerian states again boycott polio-vaccination drive. Muslim officials have rejected assurances that the polio vaccine is safe – leaving Africa on the brink of reinfection. *Lancet* 2004;363(February 28):709.
- [161] Kapp C. Nigerian state promises to end polio vaccine boycott. *Lancet* 2004;363(June 5):1876.
- [162] Jegede AS. What led to the Nigerian boycott of the polio vaccination campaign? *PLoS Med* 2007;4(March):e73.
- [163] World Health Organization. Progress towards eradicating poliomyelitis – Nigeria, January 2010–June 2011. *Wkly Epidemiol Rec* 2011;86(August 12):356–63.
- [164] World Health Organization, Regional Office for the Eastern Mediterranean. Statement arising from a seminar held by the Islamic Organization for Medical Sciences on 'The judicially prohibited and impure substances in foodstuff and drugs'; July 17, 2001. Available from: www.immunize.org/concerns/porcine.pdf [cited 17.09.12].
- [165] Kasule OH Sr. Islamic Medical Education Resources-04, 0704-Islamic Legal Guidelines on Polio Vaccination in India Institute of

- Medicine University of Brunei Darussalam; April 2007. Available from: <http://omarkasule-04.tripod.com/id1406.html> [cited 17.09.12].
- [166] Kasule Sr OH. A critique of the biomedical model from an Islamic perspective. To 4th international scientific meeting of Islamic medical association of Malaysia in conjunction with the 19th council meeting of the federation of Islamic medical associations in Shah Alam, Malaysia, 4–7 July, 2002. Available from: <http://www.eimjm.com/Vol2-No2/Vol2-No2-H1.htm> [cited 17.09.12].
- [167] Memish ZA, Ahmed QA. Mecca bound: the challenges ahead. *J Travel Med* 2002;9:202–10.
- [168] Ahmed QA, Arabi YM, Memish ZA. Health risks at the Hajj. *Lancet* 2006;367:1008–15.
- [169] Shafi S, Booy R, Haworth E, Rashid H, Memish ZA. Hajj: health lessons for mass gatherings. *J Infect Public Health* 2008;1:27–32.
- [170] Barav D. How Cuba is tapping into the growing halal market, and improving public health in the process. Washington, DC: World Security Institute. Available from: www.muslimpopulation.com/America/cuba/How%20Cuba%20is%20tapping%20into%20the.php [cited 17.09.12].
- [171] Padela AI. Public health measures & individualized decision-making: the confluence of the H1N1 vaccine and Islamic bioethics. *Hum Vaccin* 2010;6(September):754–6.
- [172] Nation of Islam. www.wikipedia.com [accessed 17.08.12].
- [173] Muhammad AA. Health warning; 1997. Available from: www.mosque7.org/minofhealth/declarationofexem.doc [cited 17.09.12].
- [174] Gandhi MK. An autobiography: the story of my experiments with truth (1920). Mineola, NY: Dover Publications; 1983.
- [175] Plotkin SA. Vaccine production in human diploid cell strains. *Am J Epidemiol* 1971;94(October):303–6.
- [176] Hayflick L. A brief history of cell substrates used for the preparation of human biologicals. *Dev Biol (Basel)* 2001;106(5–23):23–4 [discussion].
- [177] Maher DP. Vaccines, abortion, and moral coherence. *Natl Cathol Bioeth Q* 2002;2(Spring):51–67.
- [178] Furton EJ. Vaccines and the right of conscience. *Natl Cathol Bioeth Q* 2004;4(Spring):53–62.
- [179] Hayflick L, Plotkin S, Stevenson RE. History of the acceptance of human diploid cell strains as substrates for human virus vaccine manufacture. *Dev Biol Stand* 1987;68:9–17.
- [180] Hayflick L, Moorhead PS. The serial cultivation of human diploid cell strains. *Exp Cell Res* 1961;25:585–621.
- [181] Hayflick L. The limited in vitro lifetime of human diploid cell strains. *Exp Cell Res* 1965;37:614–36.
- [182] Sven G, Plotkin S, McCarthy K. Gamma globulin prophylaxis; inactivated rubella virus; production and biological control of live attenuated rubella virus vaccines. *Am J Dis Child* 1969;118(August):372–81.
- [183] Fletcher MA, Hessel L, Plotkin SA. Human diploid cell strains (HDCC) viral vaccines. *Dev Biol Stand* 1998;93:97–107.
- [184] Jacobs JP, Jones CM, Baille JP. Characteristics of a human diploid cell designated MRC-5. *Nature* 1970;227:168–70.
- [185] Jacobs JP. The status of human diploid cell strain MRC-5 as an approved substrate for the production of viral vaccines. *J Biol Stand* 1976;4(April):97–9.
- [186] Grachev V, Magrath D, Griffiths E. WHO requirements for the use of animal cells as in vitro substrates for the production of biologicals (requirements for biological substances no 50). *Biologicals* 1998;26(September):175–93.
- [187] Burke CJ, Hsu TA, Volkin DB. Formulation, stability, and delivery of live attenuated vaccines for human use. *Crit Rev Ther Drug Carrier Syst* 1999;16(1):1–83.
- [188] Grabenstein JD. The value of immunization for God's people. *Natl Cathol Bioeth Q* 2006;6(Autumn):433–42.
- [189] Knezevic I, Stacey G, Petricciani J, Sheets R. WHO Study Group on Cell Substrates. Evaluation of cell substrates for the production of biologicals: revision of WHO recommendations. Report of the WHO Study Group on Cell Substrates for the Production of Biologicals, 22–23 April 2009, Bethesda, USA. *Biologicals* 2010;38(January):162–9.
- [190] Hess RD, Weber F, Watson K, Schmitt S. Regulatory, biosafety and safety challenges for novel cells as substrates for human vaccines. *Vaccine* 2012;30(April 5):2715–27.
- [191] Grabenstein JD. Moral considerations with certain viral vaccines. *Christianity Pharm* 1999;2(2):3–6.
- [192] Pruss AR. Cooperation with past evil and use of cell-lines derived from aborted fetuses. *Linacre Q* 2004;71(November):335–50.
- [193] Furton EJ. Catholic refusals of immunization: such actions are often unjustified. *Ethics Med* 2005;30(December):1–4.
- [194] Pontifical Academy for Life. Moral reflections on vaccines prepared from cells derived from aborted human fetuses, June 9, 2005. *Natl Cathol Bioeth Q* 2006;6(Autumn):541–50. Available from: www.ncbenter.org/vaticanresponse.pdf [cited 17.09.12].
- [195] Furton EJ. Vaccines originating in abortion. *Ethics Med* 1999;24(March):3–4.
- [196] The use of human "biological material" of illicit origin (sections 34 and 35). In *Congregation for the Doctrine of the Faith. Instruction Dignitas Personae, on Certain Biotechnical Questions*. Vatican City, Sep 8, 2008. Available from: www.vatican.va/roman_curia/congregations/cfaith/documents/rc_con_cfaith_doc_20081208.dignitas-personae.en.html [cited 17.09.12].
- [197] Plotkin SA, Cornfeld D, Ingalls TH. Studies of immunization with living rubella virus. Trials in children with a strain cultured from an aborted fetus. *Am J Dis Child* 1965;110(October):381–9.
- [198] Plotkin SA, Farquhar JD, Katz M, Buser F. Attenuation of RA27/3 rubella virus in WI-38 human diploid cells. *Am J Dis Child* 1968;118:178–85.
- [199] Perkins FT. Rubella: licensed vaccines. *Rev Infect Dis* 1985;7(1):S73–6.
- [200] Plotkin SA, Farquhar JD, Ogra PL. Immunologic properties of RA27/3 rubella virus vaccine: a comparison with strains presently licensed in the United States. *JAMA* 1973;225:585–90.
- [201] Saddler JM, Horsey PJ. The new generation gelatins. A review of their history, manufacture and properties. *Anaesthesia* 1987;42(September):998–1004.
- [202] Nhari RM, Ismail A, Che Man YB. Analytical methods for gelatin differentiation from bovine and porcine origins and food products. *J Food Sci* 2012;77(January):R42–6.
- [203] Offit PA, Jew RK. Addressing parents' concerns: do vaccines contain harmful preservatives, adjuvants, additives, or residuals? *Pediatrics* 2003;112(December (6 Pt. 1)):1394–7.
- [204] Grabenstein JD. *ImmunoFacts: vaccines & immunologic drugs*. 2013. Saint Louis: Wolters Kluwer; 2012.
- [205] Fatwa 11/11. European Council of Fatwa and Research, Eleventh Regular Session, July 1–7, 2003. Available from: www.who.int/immunization_standards/vaccine_quality/vmc/en/index.html [cited 17.09.12].
- [206] Al-Munajjid MS. Fatwa No. 97541. Ruling on using materials to which "animal glycerine" has been added. Riyadh: Islam QA. Available from: <http://islamqa.info/en/ref/97541> [cited 17.09.12].
- [207] Bovine serum. *United States Pharmacopeia 34th revision*. Rockville, MD: United States Pharmacopoeial Convention; 2011. p. 432–41.
- [208] Milstien J, Griffin PD, Lee J-W. Damage to immunisation programmes from misinformation on contraceptive vaccines. *Reprod Health Matters* 1995;3(November):24–8. Available from: www.sciencedirect.com/science/article/pii/S0968808095901558 [cited 17.09.12].
- [209] Tiff over anti-tetanus vaccine now erupted into battle. *Vaccine Wkly* 1995;(July):11–3.
- [210] UNICEF. Combating anti-vaccination rumors: lessons learned from case studies in Africa. Nairobi, Kenya: UNICEF; 1997. p. 1–68. www.path.org/vaccineresources/files/Combating_Antivac_Rumors_UNICEF.pdf (accessed 29.10.12).
- [211] Streefland P, Chowdhury AM, Ramos-Jimenez P. Patterns of vaccination acceptance. *Soc Sci Med* 1999;49(December):1705–16.
- [212] Chapter 1235: vaccines for human use—general considerations. In: *United States Pharmacopeia 34th revision*. Rockville, MD: United States Pharmacopoeial Convention; 2011. pp. 807–20.
- [213] Chapter 8: vaccines. *European Pharmacopeia Edition 7.5*. Strasbourg, France: European Directorate for the Quality of Medicines & Healthcare; 2012.
- [214] Liddon NC, Leichter JS, Markowitz LE. Human papillomavirus vaccine and sexual behavior among adolescent and young women. *Am J Prev Med* 2012;42(January):44–52.
- [215] Mather T, McCaffery K, Juraskova I. Does HPV vaccination affect women's attitudes to cervical cancer screening and safe sexual behaviour? *Vaccine* 2012;30(May 2):3196–201.
- [216] Forster AS, Marlow LAV, Stephenson J, Wardle J, Waller J. Human papillomavirus vaccination and sexual behaviour: cross-sectional and longitudinal surveys conducted in England. *Vaccine* 2012;30(July 13):4939–44.
- [217] Bednarczyk RA, Davis R, Ault K, Orenstein W, Omer SB. Sexual activity-related outcomes after human papillomavirus vaccination of 11- to 12-year-olds. *Pediatrics* 2012;130:798–805.
- [218] Martinez G, Copen CE, Abma JC. Teenagers in the United States: sexual activity, contraceptive use, and childbearing, 2006–2010 National Survey of Family Growth. *National Center for Health Statistics. Vital Health Stat* 2011;23:31. Available from: www.cdc.gov/nchs/data/series/sr_23/sr23_031.pdf [cited 17.09.12].
- [219] Salmon DA, Moulton LH, Omer SB, DeHart MP, Stokley S, Halsey NA. Factors associated with refusal of childhood vaccines among parents of school-aged children. *Arch Pediatr Adolesc Med* 2005;159:470–6.
- [220] Mothering.com, Forums, January 26, 2006. Santa Fe, NM. Available from: www.mothering.com/community/t/402196/what-religions-dont-vaccinate [cited 17.09.12].
- [221] Ruijs WLM, Hautvast JLA, van Ijzendoorn G, van Ansem WJC, Elwyn G, van der Velde K, et al. How healthcare professionals respond to parents with religious objections to vaccination: a qualitative study. *BMC Health Serv Res* 2012;12:231.
- [222] Chatters LM, Levin JS, Ellison CG. Public health and health education in faith communities. *Health Educ Behav* 1998;25(December):689–99.
- [223] Chatters LM. Religion and health: public health research and practice. *Annu Rev Public Health* 2000;21:335–67.
- [224] Omer SB, Enger KS, Moulton LH, Halsey NA, Stokley S, Salmon DA. Geographic clustering of nonmedical exemptions to school immunization requirements and associations with geographic clustering of pertussis. *Am J Epidemiol* 2008;168:1389–96.