

Zoonotic Diseases Causing Abortion in Humans

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ABSTRACT

Zoonotic diseases are contagious diseases that are transmitted from animals to humans. Among these zoonotic diseases, some are associated with potential losses of pregnancy in pregnant women. A variety of pathogens cause emerging infections which are zoonotic in nature. Travelling facilities across the globe have given rise to the spread of these pathogens. Humans' intervention in distant places has caused the development of contact with zoonotic infections. Although, thorough research of rare outbreaks can be difficult, the knowledge of emerging pathogens and their effect on women is accumulating. That's why zoonotic infections should be considered a serious challenge as they are persistent risk for human populations. Brucellosis, Leptospira, and Rift Valley Fever are important agents of abortion in humans, they also induce abortion in animals. Brucellosis is considered to be the cause of abortion around the globe, and it remains mostly undiagnosed in both humans and animals thus leading to extreme losses. Studying the relation of this disease with pregnancy loss has the potential to help in the reduction of its reproductive stress. Despite the availability of effective vaccine drugs, pregnant women are at possible risk of infection from zoonotic infections. These zoonotic diseases can be prevented by adopting certain practices like maintaining biosecurity, education of public through awareness campaigns, and encouraging people to learn the hazards of zoonotic diseases. Government should initiate programs to develop vaccines against zoonotic infections.

Key words: zoonotic, abortion, infection, pathogens, humans

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1. INTRODUCTION

Animals, Humans, and the Environment are vital in the spread and emergence of many infectious diseases (Thompson and Kutz 2019). Infectious diseases affecting humans mostly have an animal basis. The "Asia Pacific Strategy for emerging diseases, 2010" states that approximately 60% of human potential infections are zoonotic, and above 70% come from wildlife animals (WHO 2010). The recently originated diseases in humans in the last years are predominantly animal-borne and have a clear association with animal-based foods (Slingenbergh 2013). Abortion is the delivery of an immature fetus, live or dead, earlier than normal gestation length due to the failure of processes that control gestation. If gestation terminates before organ development, it is early embryonic mortality. If a fetus is born dead after reaching full maturity, it is called a stillbirth (Gelaye et al. 2014). Infectious causes of abortion include viral, fungal, protozoal, and bacterial infections. Non-infectious causes include physical, chemical and nutritional factors. The most familiar cause of abortion in humans is infectious agents (Pretzer 2008).

Zoonosis poses a severe public health threat to humans, sometimes proving lethal. Around the world, 13 zoonoses were most dreadful on poor livestock individuals in third-world countries and resulted in about 2.4 billion cases of illness each year with their hazardous effects on people's health (Grace et al. 2012). Zoonotic pathogens can be transferred from animals to humans directly or indirectly (Mortimer 2019). Toxoplasmosis is believed to be one of the most infections which causes abortion in pregnant women around the globe. About 1/3 of people possess antibodies against *T. gondii*. The possible route of infection transmission is through the placenta, resulting in encephalitis, mental dysfunction, and vision loss in birth-affected children. The intermediate and dead-end hosts of sarcosporidiosis are humans, but no lethal effects are exhibited by it. However, one case of abortion due to *Trypanosoma evansi* has been documented (Shaapan 2016). A common cause is eating or tasting uncooked meat or meat products and handling cat litter (Shaapan 2016).

Brucellosis is a zoonotic disease present throughout the world. Reproductive stress in humans and animals can be reduced by understanding the association of this infection with abortion. Brucellosis has an abortion rate of 11.8% in humans. Thus, brucellosis is a direct cause of abortions in human communities. There is a manifestation that brucellosis is becoming an increasing cause of abortion in domestic ruminants (Ntirandekura et al. 2018). Abortive infections pose serious health threats to humans (Walder et al. 2005). Pelvic inflammatory infection by *C. abortus* in pregnant women proliferates in the epithelium of the trophoblast (Pospischil 2002).

Hospitalization with critical care is sometimes required if a pregnant woman is infected and indirect contact by living in the neighborhood of a farm affected with enzootic abortion has also been reported. For women from rural places, a complete history is required when brought in a hospital emergency with developing an influenza-like illness, and doctors should provide proper attention (Meijer et al. 2004). Adequate care is required in case of human infection with *C. abortus*, but timely detection, lab confirmation, and proper treatment can cut short abortion and other effects in pregnant women (Pichon et al. 2020).

2. ORIGIN OF ZONOTIC DISEASES INDUCING ABORTION

Arthropods are one of the most potential vectors of zoonoses due to their high adaptation, evolution to various pathogens, and hurdles in applying for proper eradication programs. Fleas, ticks, flies, and bugs are significant vectors for transmission, but the most critical human disease vectors are mosquitoes, while in domestic animals, ticks are important vectors (Bueno-Marí et al. 2015). Zoonotic infections in humans are acquired mainly by infections caused by viruses, bacteria, protozoa, and arthropods. These infections may lead to intense and lethal medical conditions in seriously infected humans. Interaction between

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livestock and wild animals and among cats, dogs, and humans serves as a pillar for zoonoses. Humans are accidentally infected in endemic areas, where environmental conditions enhance the vector spread and animal populations behave as reservoirs. Climate, vectors, temperature, and humidity are important parameters to understand zoonoses' development. Around 60% of human infections are of zoonotic basis, and 75% of newly emerging pathogens originate from animals (Morchón et al. 2021).

Many emerging infections in humans are the result of pathogens that comes from animals and animal products. A vast range of animals which may be wild or domestic, serve as a reservoir for these pathogens. Adequate eradication and control have become challenging due to the wide variety of reservoirs (Meslin et al. 2000). Progressive deforestation and agricultural land use for city development result in ecological changes that modify the disease epidemiology. Man-vector contact resulting from changes in the habitats of wild species poses a threat to public health. In the last twenty years, many ignored infections have re-evolved with wide distribution (Pavani 2014).

3. SERO-EPIDEMIOLOGY OF ABORTIFACIENT ZOOTIC PATHOGENS IN HUMANS

Cross-sectional studies suggest the prevalence of closely related diseases like Brucellosis and Q-fever in cattle, humans, and sheep. Particularly, ungulates are believed to adopt more than 300 pathogens on a zoonotic basis. Many new infections are zoonotic (Cleaveland et al. 2001). There is a need to study these diseases in populations where there are chances of their stability. Multidisciplinary teams should work together on these infectious diseases. Some zoonoses are significant bacterial infections that cause a wide range of clinical conditions. Additionally, they infect people who eat contaminated products derived from milk (Haydon et al. 2002). In healthy animals, infection by *T.gondii* has been seen with an occurrence of 0 to 47 percent across countries (Bisson et al. 2000). Various problems, including reproductive issues like miscarriage and maceration, have been inflicted by this pathogen (Szeredi and Bacsadi 2002).

There is evidence of individuals facing simultaneous infections with *T. gondii* and *C. abortus*, which may present a complicated examination (Sharma et al. 2003). It is known that research models have a seroepidemiological nature fact that there was no separation of pathogens conducted. There is a fact that *T.gondii* is involved in miscarriage. The cat population on the farm must be controlled to reduce financial losses and health threats, especially in pregnant women. There should be awareness about the possible modes of transmission of this pathogen. Animal shelters may help to limit cat populations away from farms (Borde et al. 2006). Diagnosis of zoonotic infections is dependent on serological procedures, which are inexpensive and easily available (McDermott et al. 2013). Bovine brucellosis has prevalence of 0 to 68% (Godfroid et al. 2019).

4. ETIOLOGY

Infectious and non-infectious causes are general causes of abortions (Fig. 1). The presence of abnormal chromosomes in one or both partners can induce abortion. Chromosomal aberrations are the main causative agents of abortion (Suzumori and Sugiura-Ogasawara 2010). In humans, insufficient progesterone secretion is an important cause of early and late abortions (Kaur and Gupta 2016).

4.1. LYME DISEASE

Spirochete belonging to the *borrelia burgdoferi* sensu lato complex is responsible for Lyme disease. This infection is mainly known as Lyme Disease in North America, while it is called Lyme Borreliosis or Borreliosis in Europe and some other countries. Bite from an Ixodid tick is the source of Lyme disease transmission. These species differ by geographical location (Trevisan et al. 2021).

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4.2. BRUCELLOSIS

Genus *Brucella* is responsible for this zoonotic infection (Kaltungo et al. 2014).

It is a serious health problem in many countries with high incidence in humans and animals. Drivers of disease transmission are unpasteurized milk items, contact with the affected population and aerosol spread. Its prevalence is different in different regions, with the most reported cases in places with increasing animal populations and lack of health awareness among people, which lead to human infections and financial losses (Asrie et al. 2023). Studies suggest that consumption of raw milk can be the source of transmission to humans. It occurs more frequently than toxoplasmosis and Q fever (Fig. 2) (Ahmad et al. 2020).

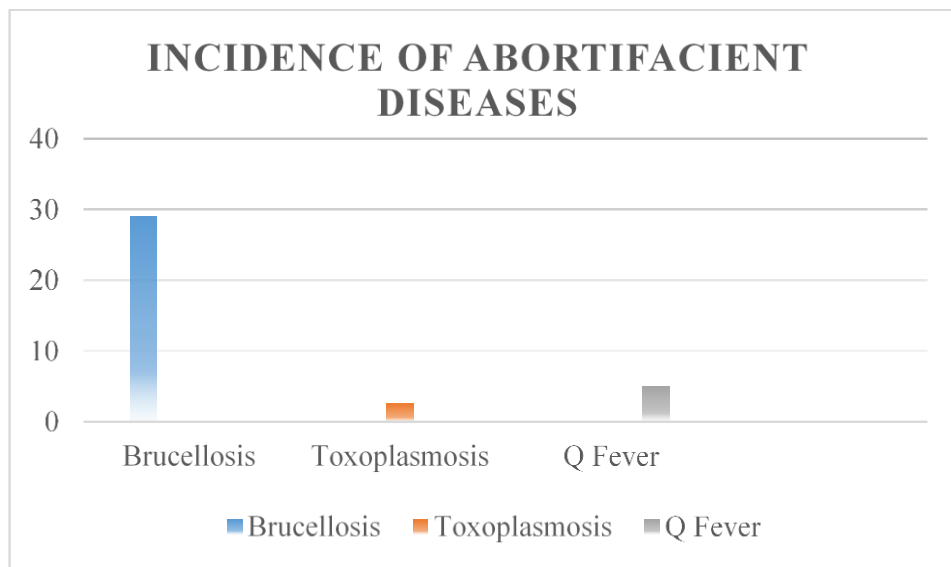


Fig. 1: Occurrence rate of abortifacient infections

4.3. TOXOPLASMOSIS

Toxoplasma gondii can lead to fetal death. Other problems caused by *T. gondii* include loss of eyesight, mental abnormality, and other health problems. These health problems may not be evident until twenty or thirty years of life (Jones et al. 2003).

4.4. SARCOSPORIDIOSIS

is caused by a wide range of *Sarcocystis* species (Barbosa et al. 2009). These are protozoan species, intracellular in nature, and their life cycle depends on prey-predator interaction. In the intermediate host, their asexual stages develop. Sarcocysts are ingested through meat consumption and their life cycle initiates in the host's intestine (Fayer 2004). Evaluation of cattle tissues proves that many are infected with sarcocyst (Van Knapen et al. 1987).

4.5. Q Fever

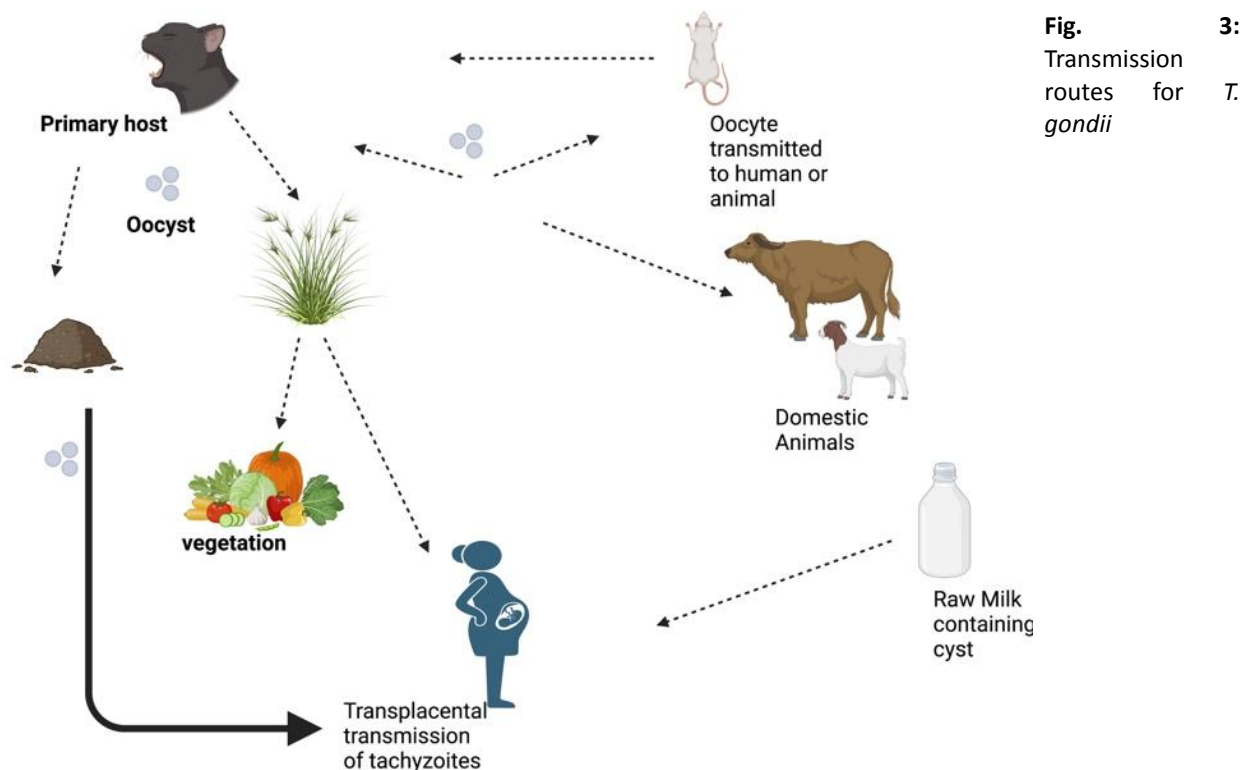
Q fever is responsible for long-term clinical conditions. Its causative factor is *Coxiella burnetii*. A broad clinical boundary is related to this infection. Q fever can cause a serious illness in humans, mostly in immunosuppressed patients and pregnant women (Angelakis and Raoult 2010). The role played by Q fever in abortion is not known. A relationship exists between its serology and areas in which it is endemic

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(Quijada et al. 2012). Very few reported cases exist due to contact as it is an occupational disease (Fig. 2) (Dupont et al. 1992).

5. FACTORS FACILITATING ZOO NOTIC INFECTION

Pathogens that pose a severe threat to human health may have very little in common with identified zoonotic agents as they go through an intermediate stage before invading humans. The biological characteristics of pathogens determine man-to-man transmission. Various factors, like changes in the exposure pattern of humans, may support this transmission (Fig. 3). The evolution of disease can be expected as a response to environmental alterations, including urbanization and advanced agricultural methods (Slingenbergh et al. 2004). Zoonotic diseases are specifically crucial given evolving infections of humans as most of them have a zoonotic basis (Cleaveland et al. 2001).



Human-animal interaction is complex, and it is affected by changes in climate and other natural factors. Geo-climatic variations primarily influence zoonotic disease transmission. Tourism, travel, and trade are major human factors responsible for triggering the spread. Pathogen adaptation to conditions is one of the causes of the re-emergence of zoonotic diseases. All these things contribute to causing infections like Lyme disease and West Nile Fever which are direct threats to public health (Naicker 2011).

The cause of severe epidemics is an animal-human relationship (Cutler et al. 2010). Zoonotic infections are considered as the ones transmitted from animals to humans and are not well transmitted among humans (Kotton 2010). Changes in reservoir and carrier dynamics alter the climatic change of zoonotic diseases. The temporal and spatial distribution of infections is affected by environmental variation (Lafferty 2009). Pathogen populations may be increased by increased food and crops resulting from increased rainfall. Flood risk is also responsible for disease transmission (Mac Kenzie et al. 1994).

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To employ methods to reduce the spread of zoonotic pathogens, it is important to study the causes that accompany the spread of pathogens from animals to humans (Ellwanger and Chies 2021). The relationship between humans and animals is enhanced by certain activities like consuming meat and meat-derived products (Kurpiers et al. 2016).

Wild animals and products derived from them serve as a food source and are sold in markets. These markets are a source of increased contact between humans and animals. Zoonotic species can be transmitted easily via contact in places where various animals are kept in closed boundaries. Possible sources of spread are blood, meat, air, etc. (Brown 2004; Aguirre et al. 2020).

Numerous zoonotic and vector-borne agents affect humans due to the ability of an infectious agent to cross the species barrier (Vorou et al. 2007). There are multiple causes of disease emergence in humans, but the main factors are the increase in population and international trade. The movement of different animal species and terrorism contribute to the emergence of human infections (Brown 2004).

6. PATHOGENESIS OF ZOONOTIC DISEASES

Zoonotic diseases can pose serious public health concerns and cause disruptions of various systems in humans. One of the most lethal diseases is brucellosis, which causes fever, arthritis, endocarditis, etc. (Paixão et al. 2009). Brucella infection is capable of replication in phagocytic cells and trophoblasts as well. This capability comprises a short combination of a vacuole with a lysosome. After this, an association develops between the vacuole and the endoplasmic reticulum (Starr et al. 2008). Another health threat for pregnant women is Coxiellosis which induces miscarriage in humans and other reproductive problems. This can also lead to economic losses. Wide documentation of cases is rare in countries in which it is dominant. Moreover, the pathogen remains mostly ignored. It is not seen as a problem of attention by funding agencies (Sahu et al. 2021).

Chlamydia Abortus shows different development cycles, and the details about its invasion and release are not thoroughly elaborated (Van Lent et al. 2012). It is proven that chlamydia uses a needle-like apparatus to inject the proteins across the host's cell membranes (Stephens et al. 1998). The ability of zoonotic diseases to co-occur with other infections is a therapeutic barrier. This results in difficulty in probing the diseases, and the administration of many medicines can harm a particular individual (Rodríguez et al. 2014).

7. PUBLIC HEALTH IMPACT OF ABORTIONS

For the last 50 years, abortion has been considered as a critical public health problem by the World Health Assembly. Induced abortions can be performed safely if the staff is well-trained and properly equipped. WHO-recommended procedures should be considered while performing induced abortions. It is a national and global health imperative to address the complications of unsafe abortion that negatively impact individuals and society. Public health cost-effective interventions such as using effective contraception, providing legal and safe abortion, and sexual education can be crucial in preventing every abortion disability and death. Due to some factors, including prevailing stigma, lack of political commitment, poor socio-economic status, and restrictive legal regulations, safe abortions pursue to be a serious complication of public health. Education of policymakers, legislators, and the public at large about the harmful consequences of confining abortion policies, laws, and regulations are the responsibilities of health professionals in a society (Fathalla 2020).

8. SOCIAL IMPACTS OF ABORTIONS

Science and technology development plays a vital role in medicine and health care because it incorporates new concepts, products, techniques, and ideas to tackle health problems. Intensive diffusion of prenatal ultrasound can create new problems for pregnant women and their families and society in managing malformations of the fetus. This is because of very strict legislation on induced abortion (Novaes 2000). The stigma of abortion is poorly theorized, although it is widely acknowledged. The social production of abortion stigma is highly local. However, the media promotes the abortion stigma. It is neither essential nor natural but depends upon inequalities and disparities for its development (Kumar et al. 2009).

9. PREVENTION AND CONTROL STRATEGIES

Since the beginning of recorded history, abortion, typically with an increased risk of fatal impacts, has been considered a reality in women's life. Advancements in the medical field, including strategies for safe abortion and reliable methods of family planning, increasing gender and reproduction-related evolution in human rights, eradicated the need for unsafe abortion until the last century. The context of women's lives is crucial but, unfortunately, ignored. When national human rights laws, including life and health, are violated, regional and international human rights instruments are cited. Most maternal deaths due to abortion could be managed by addressing and ensuring human rights globally (Shaw 2010).

9.1. Eradication of Abortive Infections

Respiratory and genital tract infections, including infectious rhinotracheitis (IBR), balanoposthitis (IBP), infectious pustular vulvovaginitis (IPV), and abortion are caused by bovine herpesvirus type 1 (BoHV-1) which is a zoonotic virus. The virus never eradicates from an infected host despite of immune response but develops lifetime latency and can be activated at intervals of time. It has been a long era since Europe's fighting against BoHV-1 infections, but only a few countries have successfully achieved eradication against IBR. Woefully, the vaccinations are only caretaking and of limited value. The significant risks, the high costs, and the undesirable quality of tools require several considerations to keep forward against such plans of managing and eradicating the virus. Eradication or controlling viruses like IBR in animals requires better vaccines, tools, and companion tests. It would be a more beneficial task to gather viral stains from many countries collaboratively and include them in newly established clustering libraries (Ackermann et al. 2006).

9.2. Developing New Antimicrobials and Control Options

In placental mammals, the adaptive immune system has evolved to tolerate the fetus in the womb. It is a very rare event that the adaptive immune responses reject the fetus. Usually, the inflammation in the placenta leads to abortion. Feto-maternal status depends on the innate immune system and microbial infections in the womb (Kanellopoulos-Langevin et al. 2003). During evaluation in placental mammals, there are two opposing selective pressures. The first one is that specie's ability to eradicate pathogens demonstrates its survival. The second one is the ability to protect the fetuses from rejection by immune systems (Jiang and Vacchio 1999). It is not an evidence-based statement that the maternal adaptive immune system rejects the semi-allogeneic fetus just as the allogenic graft might be rejected. Unlike this, it is indicated by experimental evidence that the maternal adaptive immune system recognizes the fetal alloantigens. However, the tolerance for specific maternal B and T cells is induced by this recognition, just like the antigen-receptor transgenic models (Ait-Azzouzene et al. 1998).

9.3. Education and Awareness Programs

From the moment of conception, a fetus is considered a person. Abortion and miscarriage are two different things. Miscarriage is much deadlier than abortion, resulting in 89% of pregnancies. It means that miscarriage, a particularly very early miscarriage that leads to a dilemma is the biggest public health crisis of our time (Berg 2017).

9.4. Using Proper Treatment Methods

In developing countries, incomplete abortions contribute to maternal morbidity and mortality. Three ways to manage incomplete abortions can be surgically, expectantly, and with misoprostol. For many years, surgical methods' standard of care, safety, and effectiveness has been well established and provides good medical care. Expectant management is effective but not more than surgical methods because it is often neither an immediate treatment nor much desirable to women and some attendants. Misoprostol is gaining attention worldwide as a management tool for incomplete abortion because it is a more feasible, cost-friendly uterine evacuation method and a revolutionary and easy-to-use treatment (Blum et al. 2007).

10. FUTURE PERSPECTIVES AND RESEARCH GOALS

Up to 20% of the recognized pregnancies are affected by spontaneous abortion. It is the loss of a pregnancy before 20 weeks without any outside intervention. Spontaneous abortion can be categorized as missed abortion, complete abortion, incomplete abortion, septic abortion, and recurrent spontaneous abortion. Despite other testing needed during ectopic pregnancies, ultrasonography is a helpful diagnostic tool. Besides other factors, approximately 50% of abortions are due to chromosomal abnormalities. Surgical evacuation of the uterus is a traditional treatment and is considered best for unstable patients. Intravaginal misoprostol is a medical therapy with a great success rate of up to 80%. Medical staff should also consider the psychological issues of the women and their attendants. Usually, women are on a brick of anxiety and depression for up to 1 year. Counseling should be given to the affected women targeting the grief process, guilt feeling, and coping with family and friends (Griebel et al. 2005). Traditional treatments for abortion include curettage and dilatation, while another surgical procedure is manual vacuum aspiration (Scroggins et al. 2000).

10.1. Preventive Approaches

Pills are one of the well-known contraceptive methods for managing abortion and its complications. The effectiveness depends upon the use of the pills, whether they are used perfectly or typically. The first one is considered more effective (Trussell and Wynn 2008). Providing safe services for pregnancy termination also plays a vital role in safe abortion with minimal complications (Selassie 1995). When needed, the most advanced technologies and equipment should be used to complete the uterine evacuation. It is considered the provision of subtle quality of postabortion care (Tunçalp et al. 2010).

10.2. Innovative Methodologies to Combat Abortion Complications

Abortion is supposed to be a very important social justice and public health problem worldwide. Unsafe abortions lead the way to causing maternal mortalities. Young and poor women are greatly at risk for their lives and health when undergoing abortion. In comparison with other ailments and health

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complications, abortion has more economic costs. Access to legal and safe abortion fits antequely into the prevailing agenda. Structural social and economic equity-friendly policies should be developed (Lamas 2007).

10.3. Public Awareness

Family education and medicine training is the basic tool and strategy for ensuring the safety of abortion. Trained staff and physicians as positive interventions can play a very vital role in managing and minimizing the complications of abortion (Summit et al. 2020), as abortion is a common and simple medical procedure (Berer 2005).

11. CONCLUSION

Abortions are one of the most traumatic experiences faced by pregnant women. Various unsanitary practices enhance the spread of diseases from animals to humans. People having food animals kept near their homes are vulnerable to zoonotic diseases. Consumption of contaminated and raw food of animal origin is the leading cause of zoonoses. Among these zoonotic infections, some are very harmful to human beings. Lack of awareness is also an essential factor leading to increased disease spread. Pregnant women, if not conscious of the possible dangers of certain infections during pregnancy, can fall prey to multiple complications in the form of miscarriage, mummification, or other reproductive system diseases. These abortions can be prevented if proper hygienic practices are observed, and complete medical support is provided in case of infection.

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