Infertility: An Evaluation of Treatment Modalities and Ethical Considerations

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Abstract

This thesis reviews a variety of options for treatment of infertility, along with ethical considerations for each. The basis for ethical concerns will be primarily a biblical worldview, as the goal is to support Christian couples in decisions regarding infertility treatment. The biblical worldview is outlined to provide readers with an understanding of its core principles, and the Bible is used as the primary source for ethical discussion. The most common etiologies of infertility are outlined, followed by treatment modalities grouped by category. While some modalities present very few ethical concerns, others require careful consideration in many regards. Many of these treatments fall into ethical grey areas, and thus the decision regarding their allowability is left in the hands of the reader. While this thesis discusses a wide variety of treatment modalities, it is not intended to encompass every possible option. The most commonly utilized and those with significant ethical concerns are addressed.

Keywords: Infertility, Ethics, Biblical Worldview

Infertility: An Evaluation of Treatment Modalities and Ethical Considerations

Fertility is the ability of a couple to conceive through sexual intercourse (Choma, 2020). Under normal conditions, this is possible. Infertility is defined as a lack of ability to conceive after a minimum of 12 months of regular unprotected intercourse (Choma, 2020). The reasons for infertility are numerous, and can involve the female, the male, or both.

This topic is one that can be very difficult to discuss, as it has profound effects on the emotional and mental well-being of those struggling with it. According to the Centers for Disease Control and Prevention (2023), 19% of women between the ages of 15 to 49 years and unable to conceive within one year of unprotected intercourse. 26% of women are unable to carry a pregnancy to term. This issue has led to the development of a variety of treatment methods and artificial reproductive technologies in recent years.

While these treatments have allowed countless couples to conceive and bear children, they also pose several new ethical issues that should be addressed. The purpose of this thesis is to consider a variety of these methods, and to address concerns that may arise with them, in order to provide the reader with information to make informed decisions regarding the usage of infertility management. Ethical considerations will be addressed from a biblical standpoint, and the primary goal is to help Christian readers to understand the mechanisms at work and their implications.

Diagnosis

The main components of female reproduction are ovulation, the fallopian tubes, the uterus and the cervix, and irregularity in one or multiple of these can render a woman unable to conceive or to carry a child to term (Choma, 2020). The main components of male reproduction are the prostate, penis, urethra, ejaculatory duct, scrotum, testes, epididymis, vas deferens, and

semen. Due to the wide variety of possible etiologies, extensive testing may need to be done, and should be done in order of least invasive to most invasive. It may be beneficial to begin with male infertility testing before moving to female diagnosis, as male fertility testing is less invasive (Choma, 2020).

Infertility diagnostic testing typical begins with semen analysis, as this is the least invasive procedure (Davidson et al., 2020). Ovulation tests are then performed using methods such as basal body temperature monitoring, serum testing, over-the-counter urinary ovulation luteinizing hormone (LH) detection kits, endometrial biopsy (EMB), and transvaginal ultrasound. EMB shows histological evidence of ovulation and corpus luteus formation (Davidson et al., 2020). Transvaginal ultrasound is used to monitor follicles to track timing of ovulation.

Cervical factors are evaluated through cervical mucus examination and the ferning capacity (Davidson et al., 2020). During ovulation, mucus production is increase greatly and it very stretchy. This mucus is called spinnbarkeit. The ferning capacity, or crystallization, is evaluated by obtaining mucus, spreading it on a glass slide, allowing it to air dry, and examining it under a microscope. Crystallization occurs as a result of lower salt and water levels interacting with mucus glycoproteins. Sperm survival is dependent upon spinnbarkeit and ferning capacity, so these factors are indicators of fertility. Intrauterine insemination is a leading treatment for infertility that is due to cervical insufficiency (Davidson et al., 2020).

An evaluation of uterine structures and patency of the fallopian tubes may also be warranted of other diagnostic measure do not yield sufficient information (Davidson et al., 2020). Hysterography is done by injecting a radiopaque substance into the uterus to visualize it. This allows for discovery of abnormal areas as well as determines the patency of the tubes. If

there are concerns, hysteroscopy is used to further diagnose and treat. Laparoscopy is an invasive procedure that allows for direct viewing of organs to screen for endometriosis or adhesions (Davidson et al., 2020).

Female Infertility

Age is an important factor in fertility (Choma, 2020). After age 30, a woman's ability to conceive begins to diminish, and by age 40, there is only a 10% chance of conception. In the mid-thirties, follicular function loss speeds up, and the number and quality of released eggs declines (Mayo Clinic, n.d.a). Chronic diseases, infections of reproductive organs, and toxins from the environment all have roles in infertility (Choma, 2020). Lifestyle habits also have implications on fertility, as smoking damages the cervix, fallopian tubes, and ovaries, and obesity leads to infrequent or irregular ovulation (Mayo Clinic, n.d.a). Hormonal imbalance due to hypothalamic and/or pituitary dysfunction play roles as well.

Endometriosis is a leading cause of infertility in women (Davidson et al., 2020). In this disease process, there is endometrial tissue found outside of the uterus. While it can be found many places in the body, its most common location is the abdominal cavity. Due to its reproductive nature, the endometrial tissue is sensitive to hormones, and bleeds during menstruation. This bleeding of tissues within the abdominal cavity causes inflammation, scarring and adhesion formation. The hallmark symptom is pain during menstruation, and in some cases, pain during intercourse. Endometriosis is often discovered during diagnostic testing to evaluate infertility in women (Davidson et al., 2020).

Polycystic ovarian syndrome (PCOS) encompasses a wide variety of symptoms that stem from endocrine dysfunction (Davidson et al., 2020). The three primary symptoms are menstrual dysfunction, excessive androgen production resulting in hirsutism and acne, and infertility. This

infertility is related to the presence of anovulatory cycles, in which an egg is not released from the ovary during the menstrual cycle. This means there is no chance for conception to occur, because the sperm do not have access to an egg to fertilize in the fallopian tube. This is a primary reason that many women opt to employ the fertility treatment measures discussed in this thesis, including hormones, injections, artificial reproductive technology (ART), in vitro fertilization (IVF), intrauterine insemination (IUI) and intracytoplasmic sperm injection (ICSI) (Davidson et al., 2020).

There are some causes of infertility that render a woman unable to conceive or carry a child to term, despite treatment (Davidson et al., 2020). This is considered sterility. A hysterectomy is the removal of the uterus. Without a uterus, a woman cannot conceive or carry a child, as there is no suitable environment in her body. These women may consider adoption, or possible surrogacy, to bear children. Oophorectomy refers to the removal of one or both ovaries. Ovaries function to mature oocytes, or eggs, to be released each month. In the absence of ovaries, no eggs are released, and a woman cannot conceive. Women may opt to freeze eggs prior to oophorectomy, to be used for IVF in the future. If eggs are not saved, then the woman must rely on donated eggs or embryos if she wishes to carry a child in her uterus (Davidson et al., 2020).

Male Infertility

Male infertility comprises approximately 25% of fertility issues, and can be categorized into pretesticular, testicular, and post testicular causes (Lutz, 2020). Pretesticular dysfunction refers to disorder of the endocrine system, which is responsible for the production of hormones necessary for sperm production and erectile function. Nearly half of male infertility arises from testicular problems (Lutz, 2020). These include varicocele, infection, physical anomalies, drugs,

radiation, and environmental toxins. Varicoceles form when there is vasodilation of the veins that drain the testes. The cause is not known, but studies have shown a significant decrease in fertility as a result (Lutz, 2020).

Post testicular causes are primary due to obstruction, infection, and surgical procedures (Lutz, 2020). Obstruction is most often the result of benign prostatic hyperplasia (BPH), which not only obstructs urine outflow, but also ejaculatory function. Age is a significant factor in BPH development, because the body produces more of the hormone dihydroxytestosterone (DHT), which stimulates prostate tissue growth. Additionally, proportions of estrogen increase as a man ages, and estrogen promotes DHT activity. The treatments available for BPH are effective in relieving the constriction but can also damage reproductive function further or even completely. Erectile dysfunction also falls into this category, as it prevents the entry of sperm into the vaginal cavity (Lutz, 2020).

Biblical Worldview

Ethical consideration in the conversation of infertility management is crucial, as there are many treatments that have effects on not only parents, but also their progeny. Ethics are best discussed when grounded in a worldview that shapes the way morality is determined. This thesis will approach the issue of infertility treatment from a biblical worldview. This worldview falls into the category of the divine command theory (Foreman, 1999). This is an ethical theory that grounds ethical duties in the commands of God. These commands are found in the Bible, and the English Standard Version (ESV) will be utilized in this thesis.

The premise of the Christian faith is quite different from other religions, as Christians are not dependent on good works to earn entry into heaven. Rather, the bible portrays the process of sin, repentance, forgiveness, reconciliation, sanctification, and glorification. Romans 3:23

explains the state of mankind by saying, “for all have sinned and fall short of the glory of God” (*English Standard Version Bible,* 2011).

As a result, sinful mankind is unable to be in communion with God, who is holy, and all are destined for hell. Ephesians 2:4-8 says, “But God being rich in mercy, because of the great love with which he loved us, even when we were dead in our trespasses, made us alive together with Christ… by grace you have been saved through faith” (*English Standard Version Bible,* 2011). God sent Jesus Christ into the world to live a sinless life and die as a sacrifice for the sins of all who trust in his work on the cross for salvation. 1 John 1:9 says, “If we confess our sins, he is faithful and just to forgive us our sins and to cleanse us from all unrighteousness” (*English Standard Version Bible,* 2011). The one who trusts Jesus Christ alone for salvation is granted forgiveness from sins.

However, this is not a license to sin. Romans 6:15 is clear when it states, “What then? Are we to sin because we are not under law but under grace? By no means!” (*English Standard Version Bible,* 2011). Rather, as a result of the grace given to Christians by God, they are to honor his commands that are given in the Bible. For this reason, the Bible must be the primary authority when approaching ethical considerations from a Christian worldview.

The intent of approaching these topics from a biblical worldview is to provide insight into the mechanisms of the technologies as well as applications of God’s word, so that individuals who seek to live according to a biblical standard may make informed decisions regarding infertility treatment. While some treatments blatantly oppose the Christian worldview, there are others that fall into more of a moral grey area. In these areas, scripture will be provided, but there may be room for a wider variety of interpretations regarding the allowability of the technology. Ultimately, Christians are given the Holy Spirit as an indwelling moral compass, and convictions

should not be ignored. The apostle Paul in the book of Acts says that he "take(s) pains to have a clear conscience toward both God and man" (Acts 24:16, *English Standard Version Bible,* 2011). This is important in the lives of Christians.

An Overview of Treatment Modalities

Infertility treatment modalities fall into several categories. Fertility medications include Clomid, gonadotropins, gonadotropin releasing hormone, letrozole, bromocriptine, metformin, and erectogenic drugs. Surgical options include uterine transplant and varicocele surgery. Donation involves sperm, egg, and embryo donation. In vivo fertilization includes conception from sexual intercourse, intrauterine insemination, and gamete intrafallopian transfer. In vitro fertilization involves artificial gamete development, surrogacy, assisted hatching, intracytoplasmic sperm injection, and cryopreservation.

Fertility Medications

Clomiphene Citrate

Clomiphene citrate, or Clomid, is and oral medication used in women as a treatment option for PCOS (Davidson et al., 2020). This is useful in women with normal ovaries, prolactin levels, and pituitary glands. It functions by binding with estrogen receptors in the pituitary gland and hypothalamus, thereby blocking negative feedback from estrogen in circulation. This stimulates release of GnRH, LH, and FSH, which are needed for induction of ovulation. There is a 70% success rate at restoring ovulation in women treated with Clomid, however less than 50% achieve pregnancy (Davidson et al., 2020).

Clomid is often used in conjunction with vitamin D supplementation (Rasheedy et al., 2020). This is because many women are deficient in this vitamin, which is known to have a link to obesity, metabolic syndrome, PCOS development, and therefore ovarian dysfunction. Vitamin

D controls blood calcium levels, which are believed to play a role in selection of follicles to be matured and released. By improving stability of blood calcium levels while also stimulating the production of LH and FSH, Clomid and Vitamin D have improved fertility in many cases (Rasheedy et al., 2020).

The purpose of clomid use it to restore healthy functioning in the individual. It promotes the production of natural endogenous hormones in order to initiate ovulation (Vallerand & Sanoski, 2019). It does not cause directly impact a fertilized egg, and therefore does not have the direct ability to cause harm to another life. For these reasons, there do not seem to be any contraindications to the use of Clomid by itself according to biblical principles.

Gonadotropins

Human menopausal gonadotropins (hMGs) are the first line treatment for anovulatory women who have low to normal levels of FSH and LH (Davidson et al., 2020). The supplementation of these hormones is useful in stimulating maturation of an oocyte within an ovary. Close monitoring of estradiol levels and follicle development is important to avoid the release of multiple eggs, resulting in multiple pregnancies.

HMG therapy begins with a daily injection of 50 to 100 IU and is titrated according to measured estradiol levels and ultrasound evaluation of follicle development (Davidson et al., 2020). Once ovarian follicles are sufficiently mature, the release of the oocyte is stimulated by the administration of human chorionic gonadotropin (hCG) (Davidson et al., 2020). Sexual intercourse is recommended within 24 to 36 hours of hCG administration, and for the next two days, for the best changes of pregnancy occurring (Davidson et al., 2020).

There are several risks involved with gonadotropin use (Davidson et al., 2020). First, the likelihood of a multiple gestational pregnancy is higher, which may be undesirable to many

couples. Close monitoring may be cumbersome, and the need for daily injections can be daunting. Additionally, there is a risk of developing ovarian hyperstimulation syndrome (OHSS), which can cause life-threatening effects such as renal failure, hypovolemic shock, thromboembolism and third-spacing (Davidson et al., 2020).

The primary ethical concern with gonadotropins is rooted in the risk of multiple gestation (Davidson et al., 2020). While many couples may welcome this possibility, it may not be accepted by others. For some, this leads to the consideration of abortion of one or more embryos to reduce the number of pregnancies. Gonadotropin use is not inherently wrong, however it may lead to ethical concerns.

Gonadotropin Releasing Hormone

Gonadotropin releasing hormone (GnRH) is used specifically in women who do not have sufficient amounts of endogenous GnRH (Davidson et al., 2020). This option can be administered by injection of by a portable infusion pump that administers the medication intravenously. It is used as an adjunct to gonadotropin therapy, and the goal of its use is to induce ovulation. The ethical considerations for GnRH mirror those of Clomid use. The purpose of this medication is to support normal reproductive function and does not involve a fertilized egg. Therefore, it does not have the direct ability to cause harm to another life, so there are no blatant ethical concerns involved.

Letrozole

Letrozole is an aromatase inhibitor that can be used for induction of ovulation (Davidson et al., 2020). The mechanism of action is to block the conversion of androgens to estrogens. In the presence of low estradiol levels, the amount of negative feedback to the hypothalamus and pituitary is less. Therefore, there are higher levels of GnRH and FSH which are needed to

develop the ovarian follicle. Letrozole is given daily for five doses, beginning around day 3 of a woman's cycle. While this is not first line, it is used in women if Clomid is not successful.

This treatment falls into the same category as both Clomid and GnRH as far as ethics are concerned. It should be left to the discretion of the woman to weigh the benefits and side effects of the medication in order to determine if it should be used. The ethical concerns stem from the use of letrozole in conjunction with in vitro fertilization.

Bromocriptine

Bromocriptine, or Parlodel, is useful specifically in cases where infertility is due to high prolactin levels (Davidson et al., 2020). When this is the case, there is diminished production of FSH and LH by glands, and the action of these hormones on the ovaries may even be blocked. It is an oral medication usually taken twice daily with food (Vallerand & Sanoski, 2019). Parlodel exerts its action on cells that secrete prolactin in the anterior pituitary. It inhibits prolactin production, which allows FSH and LH levels to return to normal. Ideally, this leads to restoration of ovulation. A study comparing bromocriptine with four other treatments for hyperprolactinemia showed that bromocriptine use resulted in the highest number of adverse events (Fachi et al., 2021). This is important for women to consider as they evaluate different infertility treatment options. The ethical considerations for bromocriptine are similar to those of clomiphene citrate, GnRH, and letrozole.

Metformin

Metformin is used in the treatment of PCOS to restore ovulatory function (Davidson et al., 2020). Individuals with PCOS are often overweight and at risk for diabetes (Li et al., 2022). These individuals have higher rates of infertility and gestational complications. Metformin works to sensitize the body to insulin by inhibiting gluconeogenesis in the liver and assisting in glucose

uptake into skeletal muscle. It has positive effects on body weight, which in turn has been shown to have positive effects on ovulation and therefore fertility. Normal dosing of metformin for this purpose is 500-100 mg orally twice daily. The ethical considerations for metformin are similar to those of Clomid, GnRH, and Letrozole, and Bromocriptine.

Erectogenic Drugs

Erectile dysfunction is treated with erectogenic drugs, including avanafil (Stendra), sildenafil (Viagra), tadalafil (Cialis), and vardenafil (Levitra, Staxyn) (Lutz, 2020). The mechanism of action of these medications is the inhibition of PDE5, which relaxes smooth muscles and promotes the flow of blood into the corpus cavernosum. This aids in penile erection. These medications are taken orally prior to sexual activity and are considered safe and effective in most cases of erectile dysfunction. An alternative route of administration is via injection into one cavernosa or into the urethra as a suppository (Brown, 2019). These medications seek to restore natural functioning, and therefore fall into the same ethical category as clomiphene citrate, GnRH, and letrozole, and bromocriptine, and metformin.

Surgical Treatments

Uterine Transplant

Uterine transplant is a very recent development in fertility technology, and the first clinical trial was successful in 2014 (Carson & Kallen, 2021). It is used in cases of absolute uterine factor infertility, especially in cases of congenital uterine absence (Ricci et al., 2021). The recipient receives immunosuppression medications prior to surgery in order to minimize the risk of rejection. After implantation of the new uterus, the recipient continues to receive maintenance immunosuppressants. Typically, embryos are created in vitro and then cryopreserved prior to

surgery (Ricci et al., 2021). This ensures availability of embryos for implantation after the transplant.

A uterus may be retrieved from either a live or deceased donor (Ricci et al., 2021). As with any organ donation, medical ethics requires informed consent from the donor prior to donation. Medically, there are concerns that maternal ingestion of immunosuppressants while pregnant may result in adverse fetal effects. Data has shown a correlation between immunosuppressant use and prematurity and low birth weight infants, but no major congenital malformations have occurred (Ricci et al., 2021).

The process of transplanting a uterus from a living donor raises concerns, as it is nonvital organ, and the risk of the surgery must be carefully considered (Ricci et al., 2021). These risks take the form of medical comorbidities, surgical complications, and psychosocial implications to both the donor and the recipient. The American Society for Reproductive Medicine encourages thorough counseling of the risk of the procedure prior to surgery (Theilen & Heuser, 2021). Due to the pioneering nature of this treatment, extra care must be taken to avoid unnecessary harm and prevent the causation of ethical concerns.

Varicocele Surgery

Surgery may be performed to reverse the damaging effects of varicoceles (Lutz, 2020). Varicoceles cause scrotal pain, infertility, and progressive testicular dysfunction (Zhao et al., 2021). The pathophysiology behind them involves varicosities in the pampiniform plexus, which is the vein network that supplies the testes (Brown, 2019). Surgery is most effective when it is performed early. A sclerosing agent is injected into the spermatic vein or surgical ligation is performed (Brown, 2019). This procedure seeks to restore natural reproductive function, and

therefore falls into the same ethical category as Clomid, GnRH, and Letrozole, and Bromocriptine, metformin and erectogenic drugs.

Donation

Sperm Donation

Sperm donation is an option for couples in which the male has inadequate sperm quality or quantity or a hereditary genetic disorder (Carson & Kallen, 2021). It is also used by female homosexual couples in which neither partner produces sperm, and by single females desiring to conceive. The means by which sperm donation occurs is a primary issue with regard to biblical ethics. In many cases, masturbation and pornography are involved, which are contrary to the sexual purity commanded in scripture. Ephesians 5:3 says, “But sexual immorality and all impurity or covetousness must not even be names among you, as is proper among saints.” (*English Standard Version Bible,* 2011). 1 Corinthians 7 lays out the proper circumstance for sexual activity: marriage. Such things as masturbation and pornography seek instant gratification and represent sexual impurity. The use of donated sperm indicates condonement of the means by which it is attained. Christians must carefully consider this.

Egg Donation

Egg donation, or oocyte donation is an option when the female has inadequate oocyte quality or quantity or an X-linked genetic disorder (Carson & Kallen, 2021) (Bal et al., 2019). It is also used by male homosexual couples in which neither partner has eggs, and by single males desiring to have biological children. In the latter cases, a gestational carrier is necessary for growth and development of the zygote. It is important to recognize that children conceived via donated eggs are not genetically related to both parents. In cases where the male’s sperm and a donor egg are used, the genetic makeup of the child is that of the male and another woman.

While sexual intercourse with the other woman was not the means of conception, it is difficult to separate procreation and sex, as sex was ordained by God as the means to procreate.

Embryo Donation

Embryo donation refers to the use of surplus embryos by other couples for implantation (Hallich, 2019). Ethical discussions have proposed a new terminology for this concept, called embryo adoption. According to the bible, this process is indeed adoption, as embryo is indeed a child. This is seen in Psalm 139 when the Psalmist says in verse eight, “Your eyes saw my unformed substance; in your book were written, every one of them, the days that were formed for me, when as yet there was none of them.” (*English Standard Version Bible,* 2011). It appears that the implantation of a donated embryo constitutes adoption of the child. This action does not cause harm, but rather provides the potential for development and life of the embryo.

In Vivo Methods

In vivo methods of infertility management include those in which fertilization of the egg by the sperm occurs within the woman’s body (Healthline, 2016). These include conception from sexual intercourse, intrauterine insemination, and gamete intrafallopian transfer. Intrauterine insemination can be achieved using sperm from the woman’s partner or a donor. These methods have fewer ethical concerns due to the location of fertilization being within the body.

Intrauterine Insemination

Intrauterine insemination (IUI), formerly called artificial insemination, refers to the process of depositing semen into the cervix or into the uterus (Davidson et al., 2020). The sperm may be from the woman’s partner or from a donor, which will discussed later. There are multiple indications for IUI with male or female etiologies. Male factors include deficiency in the amount, motility, or morphology of sperm, the presence of structural abnormalities such as hypospadias,

retrograde ejaculation, or even erectile dysfunction. Female factors include a deficiency of cervical mucus, inhospitable mucus, recurrent cervicitis, and cervical stenosis.

IUI is most effectively used in conjunction with ovulation stimulation (Carson & Kallen, 2021). However, it may still be effective in the absence of ovarian stimulation if there is evidence of an endogenous LH surge. The sperm is inserted 24 to 36 hours after the identified LH surge or exogenous ovulation stimulation (Carson & Kallen, 2021). There have been multiple random control trials that have shown no difference between the use of IUI and timed intercourse (Carson & Kallen, 2021). Therefore, it may be advisable to first attempt timed intercourse prior to the use of IUI.

Donor Insemination

Donor insemination is a form of IUI that deposits sperm from a donor into the cervix or uterus of a woman (Davidson et al., 2020). There are several reasons couples opt to use donor sperm rather than the partner's sperm. Most of these reasons revolve paternal genetic diseases such as autosomal dominant diseases, male sex-linked disorders, and balanced translocations (Davidson et al., 2020). Additionally, if both parents are carriers of an autosomal recessive disorder, they may opt to use donated sperm to significantly lower or eradicate the risk of having a child with the condition. Couples in which the male does not produce enough sperm, or any sperm at all, may require donated sperm if the woman wishes to conceive. The indications for IUI now include single women and lesbian couples (Davidson et al., 2020). The ethical concerns of donor insemination mirror those of sperm donation.

Gamete Intrafallopian Transfer

Gamete intrafallopian transfer (GIFT) is a technology that stemmed from in vitro fertilization (Bensinger & Waller, 2019). It uses the same procedure to stimulate the ovaries and

retrieve oocytes. The father's sperm is collected two hours prior to retrieval of the eggs. After retrieval of both male and female gametes, GIFT uses laparoscopy to insert the gametes directly into the fallopian tube for fertilization. Between two and five oocytes and 100,000 to 500,000 motile sperm are instilled.

There are two primary areas of concern with this procedure. The first is the method of retrieval of the sperm. As previously discussed, the involvement of masturbation or pornography constitutes sexual immorality (Ephesians 5, *English Standard Version Bible,* 2011). However, if the sperm is attained privately by the husband and wife, sexual immorality does not appear to occur. The second concern is the risk of multiple gestation. If all instilled oocytes are fertilized, the woman may become pregnant with two to five children. Many facilities offer elective abortion of one or multiple embryos in this situation, however the bible is clear that the Lord despises this (Exodus 20:13, Psalm 139:13-16, *English Standard Version Bible,* 2011).

In Vitro Methods

In vitro methods of infertility management include those in which fertilization of the egg by the sperm occurs outside of the woman's body, in a laboratory (Medline Plus, n.d.). These include in vitro fertilization, artificial gamete development, and surrogacy. In vitro fertilization includes additional technologies such as assisted hatching, intracytoplasmic sperm injection, and cryopreservation (Davidson et al., 2020) (Carson & Kallen, 2021) (Bal et al., 2019). Due to fertilization occurring in a laboratory, these techniques carry the most ethical considerations.

In Vitro Fertilization

In vitro fertilization (IVF) is only used in cases where other methods of fertility treatment has not been successful or is not possible (Davidson et al., 2020). The indications include infertility from tubal factors, cervical factors, mucus abnormalities, male infertility, unexplained

fertility, and immunologic infertility. The process of IVF begins with the stimulation of a woman's ovaries with medications. During this time, follicular growth is closely monitored, beginning around day 5 of the menstrual cycle. Once the follicles have matured, hCG is given to initiate ovulation. Around 34 to 36 hours later, the eggs are retrieved. Upon retrieval, the woman is given supplements of progesterone, a hormone that supports implantation and the maintenance of early pregnancy (Davidson et al., 2020).

Typically, transvaginal ultrasound is used to retrieve multiple eggs from the stimulated ovaries just prior to ovulation (Davidson et al., 2020). The eggs are then fertilized with sperm in a culture medium in the laboratory. If there are two identifiable pronuclei are present within the zygote in 17 hours, then fertilization has occurred. The cells divide every 12 to 14 hours from that point on, so there are approximately eight cells, 72 hours post-retrieval.

In some cases, these embryos are transplanted into the woman's uterus at this point (Davidson et al., 2020). In other cases, they are allowed to continue multiplying in the lab until day 5, which may increase the likelihood of successful implantation. These steps occur over a two-week window of time called an IVF cycle. Placement of the embryo is done by first inserting a catheter into the uterus through the cervix, and then injecting the embryos carefully (Bensinger & Waller, 2019). If the inserted embryo successfully implants in the uterine wall and continues to develop, IVF is considered successful. The overall success rate of IVF is 36.8% according to Duke & Christianson (Davidson et al., 2020).

It is important now to consider the implications IVF has ethically. The creation account in the book of Genesis shows that each human is created in the image of God (Genesis 1:27). From the moment of conception, a new genetically unique individual is created and there is great reason to believe that conception is the moment of creation of a soul. Psalm 139 says that God

knit each person together in the womb. Personhood does not simply begin with birth. IVF does not inherently violate the personhood of embryos, but in many cases a surplus of embryos is created during a cycle. Only some of the embryos are transplanted into the uterus, and the others are either frozen, donated, or destroyed (Mayo Clinic, n.d.b).

The concept of destroying embryos directly opposes God's command in Exodus 20:13, "You shall not murder." (*English Standard Version Bible*, 2011). Once an egg is fertilized, it cannot be undone. A person has been created. If multiple zygotes have been created, multiple people now exist. This is where one must be very careful in the use of IVF. Multiple embryos are implanted simultaneously following IVF, as there is a high risk of failure to implant (Davidson et al., 2020). If multiple embryos do implant, then abortion is recommended to allow maximal opportunity for one or a few of the embryos to develop. However, biblical ethics deem this practice unallowable. If the full number of created embryos were implanted and not destroyed aborted, then these ethical issues would not apply. However, the reality of IVF is that the destruction of life is rampant.

Assisted Hatching

Assisted hatching (AH) is a concept that is used in conjunction with IVF to aid in sperm penetration of the egg (Davidson et al., 2020). It is a process that artificially thins or even breaches the zona pellucida of the ovum in cases where abnormalities prevent this from occurring naturally (American Society for Reproductive Medicine, 2022). The mechanism of doing so is most commonly full-thickness laser photoablation of the zona pellucida on the same day the embryo is transferred. While there is theoretical benefit to this technology, research has shown with moderate confidence that rates of live births after IVF are not significantly higher in embryos that have received AH.

Ethically, the risks to the embryo must be identify and carefully considered. AH poses a risk of damaging the embryo or the individual blastomeres, thereby diminishing viability (American Society for Reproductive Medicine, 2022). There is no conclusive data to show benefits of AH, so it can be said that the risks outweigh the benefits of this treatment. The same ethical considerations apply to assisted hatching as to standard IVF.

Intracytoplasmic Sperm Injection

Intracytoplasmic sperm injection (ICSI) refers to the insertion of sperm into an aspirated oocyte in cases of severe male factor infertility (Carson & Kallen, 2021). This eliminates the need for the sperm to degenerate the zona pellucida, and the sperm can instead come directly into contact with the genetic material required for fertilization. The process of oocyte retrieval in ICSI mirrors that of IVF, and the process of culturing and implantation is also identical to that of IVF. Due to the extreme similarities between IVF and ICSI, the ethical implications are the same.

Cryopreservation

Cryopreservation refers to the freezing of zygotes for future use (Ricci et al., 2021). This commonly occurs in conjunction with IVF (Bal et al., 2019). In most cases, there is an excess in the number of embryos created in vitro, and couples do not wish to implant them all into the uterus. In this case, they have the option of freezing the extra embryos for five years. If one member of the couple wishes to terminate the storage or dies, or when the five-year period has ended, the storage facility disposes of the embryos. This disposal of human embryos raises a major concern in the biblical worldview, as seen in the discussion on IVF ethics.

Artificial Gametes

Artificial gametes, or germ cells, are sex cells that are derived from other body cells in a laboratory (Smajdor et al., 2018). This research began with the development of stem cells into gametes. Stem cells are undifferentiated cells that have the ability to mature into any specific cell type in the human body. Now, researchers are currently working to create gametes from other cells of an individual's body. This is done by reprogramming differentiated body cells into what are called induced pluripotent stem cells (iPSCs). This avoids the need for embryonic stem cells to create germ cells. An example of this would be taking a skin cell from a woman, reprogramming it, and then differentiating it into an egg (Smajdor et al., 2018).

The purpose behind this is to allow those who are unable to produce gametes to have biological children (Smajdor et al., 2018). These populations include menopausal women and homosexual couples, among others. Germ cells are produced and then used for conception either in vitro or in vivo. A female uterus is still required for development of the fetus, so in cases of homosexual males, a surrogate carrier is required.

While not fully developed currently, the concept of artificial gametes has struck a discussion on the ethics surrounding the creation of reproductive cells (Smajdor et al., 2018). The naturalness spectrum has been a major component in this discussion. Kant makes a distinction between natural organisms and artefacts, which is significant because artificial games share characteristics with both categories. Artefacts are the product of deliberate human design and action, which is evident in the development of artificial gametes. However, at the same time, the success of fertilization using artificial gametes would indicate their status as organisms.

This crossroads is where an approach from the biblical worldview is necessary in determining whether or not this technology should continue. The book of Genesis gives an account of the creation of the world and everything in it. Verse 27 of chapter one says, "So God

created man in his own image, in the image of God he created him; male and female he created them" (*English Standard Version Bible,* 2011). It is evident that God is the author or life itself, and he set into motion the process by which reproduction occurs. Throughout the Old Testament, there are incidences of infertility, in which a woman is barren into her old age. In many cases, these infertile couples attempt to take fertility into their own hands, and this displeases the Lord. Examples of this include Abram and Sarai (Genesis 16-17), and Jacob with Rachel and Leah (Genesis 30). On the contrary, Isaac prayed for his wife, Rebekah, while she was barren, and they were blessed with two children (Genesis 25).

Through these biblical figures, it is clear that one must be very cautious in taking extreme measures to achieve parenthood through ways outside of the marriage union. While this does not correlate directly to the creation of gametes from stem cells, a similar principle may be at work. At the end of each day of creation, God approved of his handiwork by calling it "good" (Genesis 1, *English Standard Version Bible,* 2011). However, on the day he created man, he referred to him as "very good". Ephesians 5:10 says, "For we are his workmanship, created in Christ Jesus for good works…" God is the creator and man is the creation. Jeremiah 18 depicts God as the potter and mankind as the clay. It is clear that creation of humans is the unique role of God. The development of artificial gametes threatens this order, and therefore requires careful consideration by Christians regarding its use.

Surrogacy

Surrogacy refers to a legal arrangement in which a woman agrees to become pregnant with the child of another couple, carry the pregnancy to term, and then relinquish the child to the parents who assume total parental rights and responsibility (Philips et al., 2019). Historically, this occurs in two main forms, traditional and gestational. Traditional surrogacy involves

insemination of the surrogate with the father's sperm, which means the child is genetically the surrogate's child. Gestational surrogacy involves the implantation of an embryo created through IVF, so the child is genetically related to the hiring couple rather than the surrogate. Altruistic arrangements do not involve monetary compensation, which commercial arrangements do (Philips et al., 2019).

There are very few circumstances in which surrogacy does not seem to contradict the bible. The structure of the family as ordained by God is seen in Ephesians 5:31, which says, "Therefore a man shall leave his father and mother and hold fast to his wife, and the two shall become one flesh." (*English Standard Version,* 2011). It is clear that the sexual union is to be between a husband and wife. In Genesis, God tells Adam and Eve to be fruitful and multiply and to fill the earth (Genesis 1:28). This couple, within the confines of marriage, is to have children. The issue with surrogacy is that a third party is involved. This alters the divinely instituted family structure. Not only this, but commercial surrogacy devalues procreation, as it is seen as a commercial product. One instance in which surrogacy may be permissible is when it is used to provide nurture to an adopted embryo. In this case, it may be considered adoption more so than surrogacy.

Preimplantation Genetic Diagnosis

Preimplantation genetic diagnosis is a type of testing used to separate embryos with genetic disorders from those with the correct number of chromosomes (Carson & Kallen, 2021). Biopsies are taken from the selected embryos during the cleavage or blastocysts stage (Dondorp & Wert, 2019). In IVF cycles, only the euploid embryos are implanted into the uterus, while the others are discarded. This is where ethical concerns arise.

There is a great deal of controversy surrounding this topic, as there have been many cases in which genetic diagnosis has not been correct (Carson & Kallen, 2021). This is thought to be due to the development of mosaic embryos, in which there are two separate cell lines developing, one with the correct number of chromosomes, and one with an incorrect number. The current possible explanations for this include initial misdiagnosis due to incorrect technique or analysis, and embryotic self-correction of the anomaly while growing.

Adoption

Adoption is a concept that allows for the redemption of a child who otherwise would be left as an orphan (Mitchell, 2003). This concept is heavily woven throughout the pages of scripture. Romans 8 provides a clear picture of the adoption that has been given to Christians. "…You have received the Spirit of adoption as sons, by whom we cry, 'Abba! Father!' The Spirit himself bears witness with our spirit that we are children of God, and if children, then heirs…" (Romans 8:15-17, *English Standard Version Bible,* 2011). Throughout the bible, there is evidence that all mankind is sinful, and therefore utterly separated from God (Romans 3:23, Ecclesiastes 7:20, Romans 3:10). However, despite the depravity and hopeless future of man, God sent Jesus Christ as the sacrifice needed to reconcile sinners to himself. He adopted his people into his family and made them heirs of a kingdom that they did not deserve.

There are many parallels between the adoption seen from God toward man, and the adoption that exists among humans (Piper, 2007). It is costly. The cost to God was the life of Christ, and the cost to parents is emotional, physical, financial and psychological. It involves the pouring out of love on one who is an alien, and the rescue of someone from a very bad situation. God saved sinners who were part of the dominion of darkness and transferred them to the kingdom of light (Colossians 1:13, *English Standard Version Bible,* 2011). Parents choose to

adopt a child that is genetically not related, and to lavish on that child the love and blessings of sonship. The option of adoption does not pose ethical concerns, but rather is encouraged by the biblical worldview.

Implications for Clinical Practice

This topic is widely controversial, as there is such a variety of worldviews in the present culture. While the primary focus of this thesis is to give insight to Christian couples seeking infertility treatment, there are implications for Christian health care workers as well. It is important that health care workers provide thorough education to patients, in order for patients to make well-informed decisions. In general, the population looks to health care professionals for guidance and information on the whole range of treatment options available. Providing not only a list of options, but explanations on the mechanism of action for each one, is so important in helping clients make the best decision for themselves.

In addition, the American Nurses Association Code of Ethics stipulates that spiritual care is an important element of care to be provided for patient by the nurse (American Nurses Association, 2015). Clinical practice should not simply include physical treatment and medical teaching but should strive to provide holistic care that incorporates multiple domains of wellness. The ethical considerations from a Biblical worldview in this thesis lay the foundation for health care workers to address spiritual well-being and concerns with patients considering infertility treatment. This information may even be useful for individuals in a chaplain or spiritual leader position in a hospital, as they can help to provide counseling for couples making difficult decisions.

Conclusion

After a review of the methods of infertility treatment along with various ethical concerns from a biblical worldview, it is in the hands of the reader to disseminate the information gleaned. In vivo treatment modalities have fewer biblical concerns, while in vitro measures produce more. Ethical concerns regarding in vivo methods generally relate more to risks to the mother and her health, while those regarding in vitro relate heavily to the unborn. Christians affirm that all people are made in the image of God, and to destroy such life is a sin against the Holy God. For that reason, any modalities that deal with the creation of embryos outside the womb must be carefully examined for the practice of abortion.

Many of these methods fall into moral grey areas, in which there may not be a decisive conclusion regarding the correct biblical position. Additionally, some modalities may be ethically questionable in some instances, but allowable in others. Finally, there are some options that do not carry concern, but are actually celebrated in the Bible. Adoption is shown as a beautiful picture of the love of God the Father towards his children. Overall, the Holy Spirit is at work in the hearts of Christians to guide their lives and convict their hearts. This thesis is not intended as an all-encompassing ethical guide, but rather a presentation of the foundations of the topic, in order to encourage deeper study.

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