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Detached From Humanity: Artificial Gestation and the Christian Dilemma

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The development of artificial womb technology (AWT) is continuing to proceed and raises important ethical and theological questions for Christians. While there has been extensive secular discourse on artificial wombs in recent years, there has been minimal Christian engagement with this topic. There are broadly two primary uses of artificial womb technology: first, ectogestation, which is a form of enhanced neonatal care, where only some of the gestation period takes place in an artificial womb, and second, ectogenesis, where the entire period of gestation occurs in an artificial womb. It is plausible that some form of ectogestation in the latter weeks or months of pregnancy could be possible within a decade or so, while ectogenesis for humans remains far more speculative. Ectogestation is likely to significantly reduce maternal and neonatal morbidity and mortality, and so there is a strong prima facie *case for supporting its development. Ectogenesis, however, may bring several challenges, including the further commodification of children, and the potential pathologizing of pregnancy and childbirth. Its long-term effects on those created through this process are also unknown. If it becomes ubiquitous, we may also find the central theological significance of pregnancy and birth diminished. The dilemma for Christians is that the development of seemingly unproblematic ectogestation is likely to normalize the use of artificial gestation, and, in time, pave the way for ectogenesis.*

Keywords: gestation, ectogenesis, childbirth, ectogestation, artificial womb, surrogacy, pregnancy, embryo, abortion

I. INTRODUCTION

The development of artificial womb technology (AWT) is forcing a re-evaluation of numerous issues in reproductive ethics. As is often the case with new technologies, particularly those involving human reproduction, AWT will likely involve benefits, risks, unknown risks, and unknown unknowns. Notably, it will also raise some difficult ethical and theological questions that have, thus far, received little theological attention. Consequently, it is crucial for Christians[1] to come to grips with its implications before it becomes a reality. This is necessary to form a considered view on whether the development of AWT should be supported or resisted and to contribute wisely to shaping policy, legislation, and the public discourse.

AWT is likely to be utilized in two different ways. First, *ectogestation* describes the process where *some* of the gestational period would occur in an ex utero artificial environment. For example, a woman diagnosed with an aggressive uterine cancer at 19 weeks of pregnancy could have her fetus transferred to an artificial womb so she could undergo urgent treatment. Ectogestation has already been utilized for up to four weeks in lamb fetuses without any untoward outcomes in what has been described as a

"biobag" (Partridge et al., 2017). More recently, towards the end of 2019, a team of researchers at the Eindhoven University of Technology was awarded a substantial grant to develop AWT (Davis, 2019). Ectogestation could feasibly be tested on human beings within the next decade or so. Second, *ectogenesis* describes the creation of an embryo via in vitro fertilization (IVF), followed by the entire gestation period occurring within an artificial womb. Ectogenesis is far more speculative than ectogestation, and it is likely to be many decades before it is technologically possible.

The benefits of using ectogestation in the latter stages of the gestational period seem clear—a reduction in maternal and neonatal morbidity and mortality. Ectogestation also raises questions about what it means for a fetus to be viable, and so might impact the ethics of abortion. If a fetus can be safely extracted and relocated to an artificial womb, abortion may become more difficult to justify irrespective of debates around their moral status (Stratman, 2021). The availability of ectogestation may also add additional stigma to the decision to choose an abortion, as it offers alternative means of 'terminating' a pregnancy without killing the fetus.

Ectogenesis could bring several apparent benefits that Christians may initially find attractive. For example, it might offer a means to more easily deal with the millions of so-called "spare" cryopreserved embryos generated by IVF and could help eliminate the incentives for surrogacy. However, ectogenesis may continue the trends of minimizing women's gestational roles and responsibilities, the further commodification of children that was initiated by the introduction of IVF, and the gradual pathologizing of pregnancy and childbirth. Moreover, the long-term effects on embryonic and early fetal development are unknown, and the research required to determine such effects remains ethically dubious. Also, conception, pregnancy, and birth are of special theological significance to Christians, and advocating technology that is capable of entirely replacing this process may eventually diminish our appreciation of their role.

Here, we argue that while ectogestation offers significant therapeutic benefits with little downside, the case for ectogenesis is more dubious, and its ethical and theological implications are cause for concern. Accordingly, while we believe that Christians have good *prima facie* reasons to support the initial development of AWT for ectogestation, we urge caution with ectogenesis. We believe that the sacrifices involved are unlikely to be worth the gains. Of course, the dilemma is that the development of ectogestation is likely to normalize the process of artificial gestation, and therefore culturally and technologically enable ectogenesis in the future.

II. ECTOGESTATION

The purpose of conventional neonatal intensive care is to improve outcomes and reduce neonatal and infant morbidity and mortality. These goals are self-evident goods that should be understood to be respecting the *imago Dei* in some of the most vulnerable members of the human community. Improving the quality of neonatal care is clearly a goal that Christians can and should endorse. However, ectogestation—despite some obvious similarities—is not "normal" neonatal care. Neonates are prematurely born humans who are physiologically distinct from the fetus due to key differences in oxygenation, circulation, hematology, metabolism, and thermoregulation (Morton and Brodsky, 2016), and who have different therapeutic needs to those being gestated. Fetuses extracted and placed into AWTs—termed *gestatelings* by Elizabeth Chloe Romanis (2018)—have quite different physiological needs. Kingma and Finn (2020) describe this distinction by explaining that the gestateling is "born-by-location-change" but not "born-by-physiology-change," while the neonate is born by both (and the fetus by neither).

The "biobag" developed to gestate a lamb fetus for 4 weeks was done to assess the technology for future use in humans as an alternative to conventional neonatal intensive care (Partridge et al., 2017). Formal human trials may commence within the next ten years. As the gestateling has been "born" in an important and straightforward sense (Colgrove, 2019; Rodger et al., 2020), it seems appropriate to regard the "biobag" as an extension of conventional neonatal care. Ectogestation using this technology will continue to require medical input from neonatologists and other clinicians during the process (Wozniak and Fernandes, 2020). Its limitations mean that the "biobag" is unlikely to significantly change current survival limits in the short-term—to artificially gestate a fetus of less than 20 weeks is likely to require a different technological and medical approach.

This raises the question of what really "viability" means. According to Di Stefano et al. (2020), "viability can loosely be described as the ability of a fetus or infant to survive independently of its pregnant mother." A gestateling is certainly independent of its mother, and as we consider that the gestateling has been "born," all gestatelings should be considered viable. In Di Stefano et al.'s (2020) survey, 88% of doctors agreed. Therefore, as ectogestative technologies improve, viability limits will decrease.

One example of the therapeutic use of ectogestation would be in complications of pregnancy such as preeclampsia, which can have dire consequences for both maternal and neonatal health, and which results in 50,000–100,000 deaths globally each year (Oyston et al., 2015). In many cases, the only sure treatment is immediate delivery, which in some cases is too early for conventional neonatal care to be effective. Ectogestation promises a far more effective solution in such cases where it is available and is not cost prohibitive.

Ectogestation and Abortion

If ectogestation one day becomes a real-world therapeutic option, we expect that its continued development will gradually reduce viability limits, although as we have noted, a significant reduction will require considerable resources and advances in medical technology. Provided that equivalent advances are made in the ability to safely extract fetuses during pregnancy, this raises the possibility that ectogestation could eventually become an alternative to abortion.

Christians have traditionally condemned abortion as a deeply sinful action (Cherry, 2011), a stance that is recorded in two early second-century—or possibly late first-century—documents: the Didache and the Epistle of Barnabas,[2] both of which likely draw on even earlier Jewish sources from the first century (Mistry, 2015). The author of the Epistle of Barnabas implies that the human fetus is to be treated as one's neighbor and abortion must be rejected on this basis (Gorman, 1998). Care of the human fetus therefore has a significant historical and theological precedent in the Christian tradition.

An important question for Christians, then, is whether the possibility of ectogestation will impact abortion practice. If we assume that extraction of a fetus incurs risks that are not significantly greater than those incurred by abortion procedures, then ending a pregnancy clearly does not require the death of the fetus. The Roman Catholic philosopher Christopher Kaczor (2011) has argued that this possibility would likely resolve the intellectual debate surrounding abortion, as the majority of the most prominent defenders of abortion—such as Judith Jarvis Thomson (1971), Mary Anne Warren (1973), and David Boonin (2003)—only argue for a right to extract the fetus, not a right to its death. If there is no right to the death of the fetus, then a consistent defender of abortion should embrace ectogestation as an alternative.

There are several reasons why we believe this is unlikely to influence abortion practice, and indeed, Kaczor also expresses doubt that this will occur. First, as Daniel Rodger (2021) argues, most women who have abortions do not wish to give their future child up for adoption and would not *voluntarily* use ectogestation. Second, it is unlikely that women would be *forced* to do so, despite the fears expressed by some secular feminists (Langford, 2008). While there is ethical and legal precedent for the practice of "forced" or court-ordered cesarean delivery without the mother's consent, this occurs only in very rare circumstances (Dyer, 2013; Morris and Robinson, 2017). Moreover, some philosophers argue there *is* a right to the death of the fetus (Räsänen, 2017)[3], and so the intellectual debate may not be settled. Finally, many jurisdictions currently permit abortions beyond current viability limits when it is clear that the fetus could survive without the use of AWT.

Perhaps the most significant impact of ectogestation will be in the eventual reduction of viability limits. As Elizabeth Romanis (2020) notes, fetal viability features prominently in abortion legislation, and so if ectogestation entails fetuses of (say) 18 weeks are viable, there is potential for pressure to be applied to correspondingly reduce current legal limits for abortion. Unfortunately, in the countries most likely to adopt ectogestative technologies, most abortions would be unaffected by such reduced viability limits—in high-income countries, at least 90% of induced abortions are completed before the 13th week of pregnancy (Popinchalk and Sedgh, 2019). Ectogestative technology would need to be available much earlier during pregnancy to act as an alternative to abortion (Rodger, 2021). Therefore, the development of ectogestation is unlikely to have any significant impact on abortion

law for the foreseeable future, and so should not be an important factor in whether Christians should support its development.

Ectogestation Concerns

Although ectogestation differs from "normal" neonatal care, it has the same goals. Its potential to reduce neonatal morbidity and mortality is considerable and is a compelling reason for Christians to support its development. There are, however, two concerns. First, as with any new medical technology, care must be taken to ensure human trials are conducted ethically. Neonates born before 28 weeks have a high chance of suffering complications such as bronchopulmonary dysplasia, and so, if "biobags" show considerable promise in preventing such conditions in animals, this might justify trials for extremely premature neonates (Wozniak and Fernandes, 2020).

Second, supporting the development of ectogestative technologies such as the "biobag," while providing obvious benefits, will in the long term inevitably pave the way to the development and eventual introduction of ectogenesis. As we shall explain, we are dubious that ectogenesis will bring substantial additional benefits, and it may be accompanied by significant harm.

III. ECTOGENESIS

Ectogenesis, if it ever becomes a reality, will have far-reaching effects on conception, pregnancy, and birth. We have noted that its development is likely to be decades away, and so our analysis is, of course, speculative. Christians need to consider these significant effects before its implementation so that we may be well prepared to propose or influence legislation. Although its use will initially be extremely rare, some human beings will eventually have the distinction of being conceived and gestated entirely artificially. We must therefore consider the consequences of moving towards a future where humans can enter the world detached from humanity, originating almost entirely from technology rather than human relationships.

First, let us consider some factors that may encourage the development and adoption of ectogenesis. There is a strong financial incentive for its development—Carolin Schurr (2018) reports that the global market for assisted reproductive technologies (ART) exceeded 22 billion US dollars in 2015, and this is projected to steadily increase. Ectogenesis is a natural extension of ART services, and the considerable funds currently directed toward paying surrogates can potentially be subsumed into the revenues of ART providers.

Once ectogenesis is proven and available, several factors may encourage its adoption. If ectogenesis is shown to be safer or more convenient than pregnancy, it may become a convenient means of avoiding the burdens or sacrifices of gestation and childbirth altogether. An instructive example is the rapid acceptance of elective cesarean sections to replace vaginal delivery. The cesarean section rate is now as high as 55.6% in Brazil, 51.8% in Egypt, and 47.9% in Iran (Betrán et al., 2016). Several contributory factors have been shown to lead to the increased prevalence of elective cesarean section in Brazil, including level of education, maternal age, and having health insurance (Eufrásio et al., 2018). This is despite delivery by cesarean section being associated with an increased risk of morbidity and mortality for both mother and child (Souza et al., 2010; Mylonas and Friese, 2015)[4]. If ectogenesis offered an alternative means of gestation that did not involve any of the inherent risks associated with "natural" gestation and childbirth, then those with the resources to do so may increasingly utilize it.

Social pressures may also help to speed its adoption. Secular bioethicists such as Anna Smajdor (2007) believe that developing and utilizing ectogenesis is a justice issue—a way to relieve women of the inherent burdens and risks of pregnancy and childbirth. Smajdor argues that ectogenesis would help to ensure that women with access to this technology could reproduce as men do, without risking their physical and mental health, as well as avoiding the significant demands that pregnancy places on their bodily autonomy. Evie Kendal (2015) has made a similar point, arguing that ectogenesis is necessary to bring about sexual equality in reproduction by liberating women from the existing burdens of pregnancy and childbirth.

If ectogenesis does become a reality, we expect that, as it is more widely adopted, it will have an increasing impact in several key areas, and so the consequences require careful consideration by Christians. We begin by examining in vitro fertilization (IVF).

IVF

As ectogenesis requires the use of IVF to obtain a zygote, it will be an important part of the process. If ectogenesis becomes widespread, we expect this will increase its use. However, there are well-known ethical and theological concerns with IVF, which we outline below, and the benefits ectogenesis might bring do not alleviate these concerns.

First, the Roman Catholic Church argues that IVF detaches the conjugal act from the procreative act and should therefore not be permitted (Catechism of the Catholic Church, 1992; Congregation for the Doctrine of the Faith, 1987). So, Roman Catholics will be unable to support the development of ectogenesis. Second, IVF leads to the destruction of embryos, as typically more are created than actually used, and increasingly preimplantation genetic diagnosis (PGD) is used to select embryos for implantation. Combining both is now common practice and entails that couples can avoid giving birth to children with known genetic diseases. This practice risks turning children into a commodity that must meet certain standards, rather than a blessing or gift from God. Additionally, as Gilbert Meilaender (2019) has argued, producing human beings through IVF and PGD undermines the notion of human equality: when *you* create something, *you* get to decide its worth, rather than merely being thankful that it exists.

Third, IVF has resulted in the creation of vast numbers of so-called "spare" embryos, which in the United States alone are estimated to number between 600,000 and 1,000,000 (Zimon et al., 2019). In one study, 37% of respondents stated they had no intention of using their cryopreserved embryos whilst a further 39% remained undecided (Deniz et al., 2016). From a Christian perspective, these embryos are equally valuable human beings created in concert with God and made in the *imago Dei.* Embryo destruction and long-term cryopreservation are therefore horrendous acts.

It is possible that ectogenesis could be used to gestate some of the many cryopreserved embryos for the purposes of adoption. In fact, David Reiber (2010) argues that from a Roman Catholic perspective, the only ethically licit use of ectogenesis would be for rescuing abandoned cryopreserved embryos. Because a human being already exists, the question of violating the conjugal act is moot. There are only three options for preserving the life of the embryo—remaining cryopreserved; being gestated by the biological mother; or donated and gestated by someone else. Only the latter two options provide a means of being gestated, born, and the opportunity to live. Moreover, leaving embryos in their cryopreserved state leaves them at an increased risk of being destroyed for research purposes or discarded. If the biological parents have abandoned or are unable to gestate them, then the only remaining option is embryo adoption. Stephen Napier has argued that, although the Catholic Church states that a child has the right to be gestated by his or her own parents, it is the parents who have violated this right by utilizing IVF and then abandoning them (Napier and Haas, 2009). If the duty to be gestated by one's biological parents can no longer be fulfilled, then embryo adoption becomes an act of Christian love and sacrifice to a vulnerable member of the human community. Over the last decade, there has been a sharp increase in the number of Christians opting to adopt embryos with many utilizing theological themes as justification (Cromer, 2018).

The crucial question for Christians is whether ectogenesis is the most suitable option for doing so. There are several reasons why it is unlikely to be. First, for the foreseeable future, it will be far more affordable to implant "spare" donated embryos into women willing to gestate and adopt them. Second, it seems likely that the widespread adoption of ectogenesis required for it to be available for this purpose will generate at least as many unused embryos as it might rescue, as it will encourage the use of IVF as well as PGD. So, ectogenesis is likely to *contribute* to the "spare" embryo problem rather than helping to alleviate it. Of course, ectogenesis will also permit women who are unable to gestate or for whom it may be dangerous to do so to have their own children without using a surrogate. This will avoid various ethical and theological concerns with surrogacy which we discuss below, but as we have noted, it is unlikely to be affordable by most and will not have a significant impact.

There is one final concern regarding ectogenesis and IVF—in many countries, it is not legally permitted to keep or use an in vitro embryo more than 14 days after fertilization. For ectogenesis to become a reality, such laws need to be altered as the embryo will never be implanted. The consequence, however, may be that researchers are freed to experiment on embryos beyond this limit, compounding a situation that is already unacceptable to most Christians.

Surrogacy

There are several ethical issues regarding the use of surrogacy to have children, in addition to those noted for IVF. General concerns include the potential commodification of women, disruption of the maternal-gestational bond, and exploitation of women as paid incubators. Surrogacy is expensive, costing at least $50,000 in the United States (Scherman et al, 2016), and given a commercial surrogate is potentially sacrificing her health for financial gain, perhaps exploitation is inevitable—particularly if surrogates from less wealthy countries are used. According to Clara Watson (2016), in some cases, surrogacy has even been linked with human trafficking, and as a result, India has banned commercial surrogacy. All these issues are of concern to Christians.

Some theological traditions have additional issues with surrogacy: for example, the Roman Catholic Church states that "surrogate motherhood represents an objective failure to meet the obligations of maternal love, of conjugal fidelity and of responsible motherhood" (Congregation for the Doctrine of the Faith, 1987). Most Protestant traditions, while also disapproving of surrogacy, tend to restrict their ethical concerns to the welfare of the surrogate and the effect on the child—they do not usually share Catholic concerns regarding the separation of sex and reproduction, as evidenced by their widespread acceptance of IVF[5].

If ectogenesis becomes a reality it will likely significantly reduce the demand for surrogates, alleviating concerns regarding the exploitation of women to satisfy people's desire for children. Although ectogenesis will likely be very expensive, it may well be similar to the costs of surrogacy and, eventually, could eliminate surrogacy altogether. Roman Catholics will remain opposed to ectogenesis because of its reliance on IVF; for most Protestants, the likely reduction in demand for surrogates provides a significant reason to support its development.

Once ectogenesis provides an alternative to surrogacy, the removal of ethical and legal barriers to conceiving a child without a parent gestating it may result in an increase in the use of donated gametes. This increases concerns regarding the commodification of children. The combination of IVF, PGD, and CRISPR gene editing technology is a particular worry, as it could permit the creation of enhanced human beings, i.e. those with superior physical and mental capacities. Of course, these technologies are or will soon be available for any IVF conception, including surrogacies, so ectogenesis is not unique in this regard.

Pregnancy and Birth

Gestation is an experience universally shared by all human beings, and in the distant future, ectogenesis may eventually make it obsolete, making women unnecessary. Given that ectogenesis is many decades away, and its costs are likely to confine its use to the wealthy, ubiquitous adoption of ectogenesis seems unlikely. However, it is worth speculating on the consequences of this occurring, even if the probability of this is small.

There are two important aspects to consider—the special theological significance of conception, pregnancy, and birth, and the broader ethical implications. First, let us consider the Incarnation, the central event in the Christian faith. Here, God somehow became a human being, with the intimate cooperation of Mary and the Holy Spirit. Mary carried the Christ Child for nine months, nurturing and protecting Him, and finally going through the pain of labor to bring Him into this world. Therefore, Jesus Himself went through the same process of prenatal development and birth that all human beings do. John states, "the Word became flesh and dwelt among us" (Jn. 1:14), while Paul states that "in Him all the fullness of Deity dwells in bodily form" (Col. 2:9). The Incarnation is a unique and profound mystery.

More generally, Janet E. Smith (2002) explains that parents "cooperate with God the Creator in conceiving and giving birth to a new human being." God Himself is drawn into the procreative love act, again in an utterly mysterious way. The ensuing child is a gift from God, and we have no control over the child's characteristics. Pregnancy and childbirth are marked by their unpredictability, from the sex of the child to the timing of its arrival. We do know, however, that every child bears the *imago Dei*, being made by Him in His image. Pregnancy and birth are also marked by suffering—a sign that we are sinners in need of a Savior (Gen. 3:15). It is also important to note that fetuses are themselves described in similar terms to those that have been born. In the New Testament the Greek term *Brephos*

[βρέφος] is used to describe those in utero (Luke 1:41, 44) as well as those that have completed gestation (Luke 2:12, 16; Acts 7:19).

Birth is also an important Biblical metaphor. Marking a radical transformation from one state to another, it is used to represent the Christian conversion experience: in John 3:3-5 Jesus famously tells the Pharisee, Nicodemus, that "you must be *born again*," and rather than being born again of the flesh, he must be "born of the Spirit." John later builds on this theme in his first epistle, making numerous references to being "born of God" (1 John 3:9, 4:7, 5:1, 5:4, 5:18). Peter tells his readers that "he has given us *new birth* into a living hope" (1 Peter 1:3) and that "you have been *born again*, not of perishable seed, but of imperishable, through the living and enduring word of God" (1 Peter 1:23). James writes that "he chose to give us *birth* through the word of truth, that we might be a kind of first fruits of all he created" (James 1:18). The pain of childbirth is also widely used as a metaphor in Biblical eschatology. Jeremiah 30 talks of the birth pains preceding the restoration of Israel. Matthew 24 and Mark 13 describe wars, earthquakes, and famines as the birth pains preceding our final redemption. Romans 8 describes the whole of creation as suffering birth pains while awaiting its liberation from decay. The implication is that the predicted events, like childbirth itself, must run their course until completion. Suffering will eventually cease, and the joy that accompanies childbirth will follow.

If ectogenesis replaces conception, pregnancy, and birth, our familiarity with these processes may diminish over time; eventually, our appreciation and understanding of their theological significance may also fade. Natural birth could well become a curiosity or quaint tradition, robbing the metaphor of its power to emphasize a radical transformation from one form of life to another. The timing of childbirth is usually a dramatic event beyond our ability to control, and we are uncertain of the outcome for both mother and child until it is complete. For many parents, it is a reminder of their powerlessness over one of life's most significant events—Christian parents must place their trust in God regarding the outcome. By contrast, ectogenesis will involve considerably more human control—over conception, the time of birth, and the expected outcome. The child will be fully known prior to birth, and so almost all the uncertainty and mystery of gestation and birth will be eliminated. It may be that, over time, this influences our understanding of Christian conversion, highlighting our role and diminishing the notion of God's intimate involvement in creating human beings. It will teach us that we have the power to create ourselves, rather than being children of God. This may well erode the concept of us as being made in the image of God—the *imago Dei*—and perhaps even dull our appreciation of the fatherhood of God.

A related concern is that ectogenesis will contribute to a view of pregnancy and childbirth as pathological conditions that should be eliminated. We have already noted Kendall and Smajdor's view that females need to be liberated from pregnancy. This view is most clearly represented in the feminist Shulamith Firestone's (2015) claim in her 1970 book *The Dialectic of Sex* that "pregnancy is barbaric" and the predominant source of women's oppression. This is in stark contrast to the Christian view of pregnancy and birth, where pregnancy is understood as a blessing and the bearing of children as a source of joy. Numerous women throughout the Bible, such as Rachel, Hannah, and Elizabeth are described for a time as being unable to bear children and that this was experienced as a source of grief and lament (Gen 30:1; 1 Sam 1:15; Luke 1:23-25). Despite pregnancy being described as a blessing from God, the pain, anguish, and suffering that can accompany childbirth are neither ignored nor understated. Rather than seeing pregnancy as something to avoid, many Christian women experience pregnancy and childbirth as an opportunity to participate with God in the process of creation (Ditmore, 2008), in what is a uniquely female experience.

Many women do face oppressive social, physical, and economic disadvantages due to pregnancy and childbirth. In our view, however, if the goal is to promote justice, then any intervention to alleviate these disadvantages ought to be centered on those women that overwhelmingly experience these burdens. Given the likelihood that ectogenesis will only benefit the wealthy, it is implausible to consider that it would meet this criterion. As Horner (2020) notes, ectogenesis might help us imagine a world where women are not disadvantaged by pregnancy and childbirth, and we should work to make that world a reality without pinning our hopes on ectogenesis.

A related claim is that ectogenesis could serve as a therapeutic process that reduces the risks and complications of pregnancy and childbirth, saving women's lives. Christians have a long history of providing medical care to those in need. Jesus' parable of the Good Samaritan (Luke 10:25–37)

instructed Christians to care for those in physical need; Matthew 25:36 commends those who look after the sick. The mandate is not explicitly framed as an issue of justice, but rather as a compassionate act where we represent the hands and feet of Jesus himself in providing for people's physical needs. Gerald Arbuckle (2012) describes the parable of the Good Samaritan as the founding myth of the Western healthcare tradition that has inspired people through the ages to care for the disadvantaged and forgotten. Throughout the Bible, however, God is described as being deeply concerned with bringing justice to the world (Isaiah 30:18; Psalm 11:7; Psalm 103:6), and providing health care for those in need can be seen as part of that mission. However, as we have noted, ectogenesis is likely to be an extremely expensive endeavor only available to the wealthy. Women from low-income countries, who are already at an increased risk of maternal morbidity and mortality (Filippi et al., 2016; Girum and Wasie, 2017) would be the least likely to access or afford ectogenesis. Access to ectogenesis is likely to become another means of compounding the existing disparities in the distribution of maternal morbidity and mortality (Horn, 2020). Low- and middle-income countries already account for 99% of global maternal deaths (Filippi et al., 2016), and so we are skeptical of arguments for ectogenesis as therapeutic health care.

Finally, there are some additional ethical concerns raised by ectogenesis. The long-term effects of artificial gestation on human fetuses—absent of any gestation in an in utero environment—are obviously unknown at present, given the nascent status of AWT. There are potential physical and psychological harms that could result from a failure to effectively replicate the maternal environment. Perhaps the fetal-maternal bond will be negatively affected. There is also evidence to show that longer gestation at birth is associated with benefits for neurodevelopment and that shortened gestation can disrupt neurodevelopment that can have a lifelong impact (Davis et al., 2011; Espel et al., 2014), such as negatively affecting motor skills and academic achievement (Noble et al., 2012; Espel et al., 2014). These harms—especially the neurodevelopmental—may not be fully realized until numerous human beings have undergone the process, by which time thousands of children could be subject to a deprived human existence (Singer and Wells, 2006). Similar concerns were raised against the use of IVF; however, these concerns have now been shown to be largely unwarranted. The difference in this case is the marked time differences involved, the former requiring just days of human development outside of the maternal environment, whilst the latter requires several months. Nevertheless, lamb fetuses gestated for several weeks in the "biobag" did not show any apparent neurological deficit; however, the researchers acknowledged there were limitations in their assessment of neurologic function (Partridge et al., 2017).

Another concern is that children "born" via ectogenesis are dehumanised—treated as somehow less than human because of their origins. Elford and Jones (2010) point out that this has not been proven to be the case for IVF children—they note that despite over 3 million IVF babies having been born, no adverse social effects of IVF have been demonstrated. Given the similarities, it seems likely that if ectogenesis becomes as commonplace as IVF, it is also doubtful that ectogenic children will suffer any negative social effects, especially so if it one day becomes ubiquitous. There is some evidence from a large prospective cohort study that IVF is associated with a small but statistically significant risk of intellectual disability, although the absolute risk of this remains low (Sandin et al., 2013). A related worry is that children will be denied an experience that every human being has undergone and are somehow deprived as a result. Unless measurable physical or psychological harm is demonstrable, it is unclear what being deprived of the gestation experience means for a child—after all, for most of this period they lack consciousness, and reflective self-awareness is not achieved until at least 15–18 months (Brownell et al., 2007).

Dystopian concerns such as the "Brave New World" scenario described by Aldous Huxley—where human beings are created and raised in "hatcheries" and "conditioning centers"—seem far-fetched but need to be considered. Given the control societies such as China have at times exerted over reproduction—where a one-child policy was in effect between 1979 and 2015—it is certainly possible such fears could prove well-founded at some point in the future.

IV. CONCLUSION

Ectogestative technology is rapidly advancing, and it may be only a few years until it radically transforms neonatal care, pushing back human viability, and reducing the existing morbidity and

mortality rates for premature neonates. These are compelling benefits, given the current poor prognosis for premature neonates, and there is a *prima facie* case for Christians to support its development. Unfortunately, Christians are presented with a dilemma—development of ectogestation will almost inevitably open the path to the development of ectogenesis, even if its availability is likely to be decades in the future and dependent on overcoming various scientific challenges. This is problematic, as the case for ectogenesis is ethically dubious from a Christian perspective. Benefits such as the eventual elimination of surrogacy are countered by a likely increase in the use of IVF, resulting in more cryopreserved embryos, as well as another avenue for the potential commodification of children. Its cost means ectogenesis is unlikely to serve any purpose in a social justice context, and we have argued that ectogestation is unlikely to significantly impact the abortion debate. Ectogenesis also raises worries of a dystopian future where all human beings are artificially gestated, and women and men are no longer required for reproduction.

Apart from these issues, there are theological concerns for Christians. Christianity places a high value on God's intimate involvement in our creation as human beings, and ectogenesis threatens to undermine this value. It also may eventually diminish our hermeneutics of conception, pregnancy, and birth as key Biblical metaphors. Of course, concerns regarding a society where ectogenesis is ubiquitous are speculative, and it will only be possible with many years of hindsight to determine their legitimacy. It seems unlikely that traditional pregnancy and birth will be eliminated; however, it remains a possibility, and Christians should keep this in mind when considering their support for this technology. It behoves us to keep well informed regarding the development of AWT, and endeavor to be involved in its regulation before its use becomes widespread, as once technology is unleashed, it becomes difficult to control and regulate. IVF is a case in point—its original intention was to allow young childless couples to have children when other options were exhausted (Biggers, 2012). Now, IVF is being used for single women to use anonymous sperm donors to have children, and others to delay childbearing, both of which are morally dubious. Ectogenesis is likely to follow suit.

NOTES

1 Our intention is to address both Roman Catholic and Protestant Christians, although we recognize that Roman Catholics have clearer guidance regarding assisted reproductive technologies that will likely restrict any endorsement to life-saving applications of ectogestation only.
2 Both sources unequivocally state: *ou phoneuseis teknon en phthora* [you shall not kill a child by abortion].
3 For further discussion surrounding the right to the death of the fetus, see Mathison and Davis (2017), Kaczor (2018), Hendricks (2018), Blackshaw and Rodger (2019), Stratman (2021).
4 Though also acknowledge that there exists significant inequality with respect to access to life-saving obstetric interventions like cesarean section for women in many middle- and low-income countries. This significant inequality is part of the reason why women in middle- and low-income countries account for 99% of maternal mortality (Filippi et al, 2016).
5 Best et al. (2019) found that over 70% of Protestant Christians in their survey approved of IVF.

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