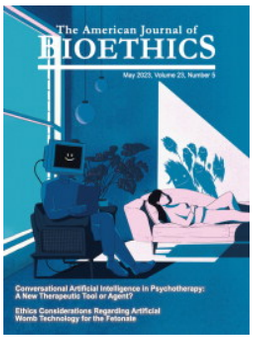

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The Dilemmas of Artificial Wombs: Conventional Ethics and Science Fiction

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OPEN PEER COMMENTARIES

The Dilemmas of Artificial Wombs: Conventional Ethics and Science Fiction

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Five years ago, remarkable animal experiments on artificial womb technology (AWT) at Children's Hospital of Philadelphia (CHOP) got us thinking about the ethical for premature babies. We recognized that AWT could push the borderline of viability below the current 22-week threshold. AWT appeared to be the latest in a long line of innovative neonatal interventions that have improved outcomes for premature babies (Lantos 2022). Then, we thought about the implications of AWT for debates about the ethics of abortion at different gestational ages, knowing that, even after the overturning of *Roe v. Wade,* questions about fetal viability remain important to many clinicians and parents who consider termination of pregnancy (Di Stefano et al. 2022) AWT seemed like one of many incremental innovations in neonatal intensive care (Ennis 2022).

But AWT raises issues that go well beyond the neonatal intensive care unit (NICU). For example, the CHOP approach requires a cesarean section delivery under general anesthesia. That intervention would increase the risk to the pregnant woman with, at first, no proven benefit for the baby. As with other innovative obstetrical/perinatal interventions, like in-utero maternal-fetal surgery, AWT raises questions about whether the known risks to the woman are balanced by the potential benefits to the baby. The only way to know would be to do a clinical trial, with informed consent, and see whether the promising animal results could be reproduced in humans. Such studies must carefully assess both short and long term outcomes for both mothers and babies. These are standard approaches to the ethical evaluation of such therapies.

In this issue of *AJOB,* Di Bie and others (2023) also discuss the possibility that AWT, if successful, could be used for babies at later stages of gestation and could potentially replace some currently used neonatal care technology. Choices of appropriate

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interventions will be scientifically complex but ethically easy. They will turn on data regarding the relative risks and benefits of traditional versus innovative approaches. The one that is safest and most effective will eventually prevail unless it is too exorbitantly expensive to justify the improved clinical outcomes.

Di Bie et al. broaden the scope of concerns from those that apply only to babies born (or at risk of being born) at the borderline of viability to those that arise from assisted reproductive technology at every stage of gestation. They begin with the controversies surrounding *in vitro* fertilization (IVF). Those controversies largely revolve around question about the moral status of the early embryo and the somewhat arbitrary limits on the stage of development to which such embryos are allowed to grow. Currently, policy in most countries limits that to 14 days. A recent proposal suggests that the 14 limit be abolished and protocols to study embryological development be evaluated on a case-by-case basis (Lovell-Badge et al. 2021) This has led some bioethicists to worry about whether there should be any limit. Greely encapsulated the concerns, "If you don't have any endpoint, could you take embryos to 20 weeks? To 24 weeks? Is viability the only endpoint?" (NPR 2021)

Di Bie and colleagues propose a framework based on different gestational ages, and considerations about the interests of different parties at each stage of gestation, as a way of conceptualizing the ethical issues and determining possible responses. They clearly distinguish between concerns that are likely to be relevant in the next decade and those that, for now, belong in the realm of science fiction. The reality-based concerns correctly identify this technology as an incremental change to current medical technology that raised ethical concerns that are only incrementally different than current concerns.

Di Bie and colleagues briefly acknowledge, but don't delve into, many more complex ethical concerns about AWT. There are pragmatic reasons to limit their inquiry. Many of those broader concerns seem, today, more like science fiction than like dilemmas that will arise in clinical or research ethics. But science fiction can quickly become fact and the issues that would arise if AWT becomes successful have implications that go beyond clinical or research ethics.

Complete ectogenesis would have profound implications. It could surmount many forms of infertility. It could enable biological parentage without pregnancy while avoiding the need for gestational carriers. If successful, it could provide an alternative to abortion in situations where pregnancy threatens the health of the pregnant woman (Horn 2020). It could increase gender equality by freeing women from the complications and burdens of pregnancy. It could fundamentally alter the medical management of extremely premature infants. It could also devalue or pathologize pregnancy and women's psychological experience of gestation-related self-fulfillment. It could facilitate eugenics.

The idea of using AWT to grow embryos from fertilization to term has fired imaginations for at least a century. In 1923, biochemist JBS Haldane, gave a somewhat whimsical speech about a group at Oxford University called The Heretical Society in which he speculated about the possible uses of AWT (Haldane 2023). He thought that such technology would be useful primarily to allow improvements in eugenics. He wrote that "ectogenesis" (as he called it) could save civilization from an impending and predictable collapse "owing to the greater fertility of the less desirable members of the population in almost all countries." He imagined that we would harvest eggs and sperm from the small proportion of men and women who were superior in musical taste and intelligence in order to amplify the proportion of their genes in the population. While eugenics has been disgraced, many eugenic ideas have resurfaced as justifications for prenatal diagnosis, in vitro fertilization, and pre-implantation genetic diagnosis.

Many thinkers quickly recognized the dystopian implications of Haldane's ideas. In 1929, Vera Brittain suggested that ectogenesis would be misused by ruling classes to create lab-grown children. In particular, she imagined a genetically stratified future in which "laboratory-grown children … are selected from the best stock." (Brittain 2019) few years later, Aldous Huxley elaborated on Brittain's dystopian fears in his novel, *Brave New World.* (Huxley 1936) He imagines a totalitarian world in which children are grown in specially designed hatcheries and genetically manipulated to be either rulers or docile slaves.

In addition to issues of genetic engineering, AWT has implications for the roles of women in society. Fifty years after Haldane, Shulamith Firestone (Firestone 1970) speculated that "the biologic shackles of pregnancy and childbirth" (221) were "the heart of women's oppression" (79) and that AWT could free "free women from the tyranny of their reproductive biology (p206)."

Today, scholars analyze the complicated ethics of pregnancy and childbearing in ways that are more

scientifically grounded. Kingma and Finn (2020) worry that the language of "artificial wombs" minimizes the complexity of natural gestation and oversimplifies the biological and psychological role of the pregnant woman. They criticize much writing about these issues for promulgating a view of the pregnant woman as "a fetal container" and of the fetus as an already separate, individuated "baby" that for whom the pregnant woman is merely an incubator. This view was recently presented, and parodied, in an award-winning off-Broadway play in which the actors all played the parts of fetuses, awaiting decisions that would determine their fate (Lightning Rod Special 2023; *New York Times* 2023).

Kingma also distinguishes an artificial womb from an artificial placenta and discusses the implications of varied approaches to life support for a baby born at the borderline of viability. Romanis raised questions about what, exactly, it means to be "born." Does birth take place when the fetus is transferred from a womb to a container of amniotic fluid and an oxygenation circuit? Or should that be considered a "fetal transplant" with birth occurring when the fetus is delivered from the container? (Romanis 2018). Helen Sedgwick's 2017 novel *The Growing Season* depicts a world in which gestation takes place entirely in artificial wombs (Sedgewick 2017). She speculates about whether this is liberating for women, whether it is a masculine plot to commodify reproduction and make actual women irrelevant.

Pregnancy is absolutely unique in ways that make analogies to other clinical or research situations inadequate. It is the only human situation in which two separate individuals are physically intertwined with one another. These biological facts demand a rich bioethical imagination. AJOB readers who want to explore this further could start with recent articles by Kingma (2020), Kingma and Finn (2020), Colgrove (2022) and Romanis (2018). They should read *The Growing Season*.

Science and technology are pushing boundaries in ways that were imagined one hundred years ago but that have only become possible recently. These technologies will change the way we think about bioethics, law, and reproductive biology. As Horn (2020) writes, "… we must disentangle the discourse from the limitations of the world as it is now, and redirect it toward the work to be done in seeking the other worlds that could be."

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OPEN PEER COMMENTARIES

Artificial Placenta – Imminent Ethical Considerations for Research Trials and Clinical Translation

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De Bie et al. (2023) propose an organizing framework for different stages of human gestational development from conception to the viable premature. They also identify ethical considerations and concerns regarding artificial womb technology (AWT) and care of the fetonate by a scoping review.

De Bie et al. (2023) note that most of the recent ethical literature has focused on complete ectogenesis, at the expense of tackling important more immediate ethical considerations. We agree and therefore contribute a commentary directing research effort toward the following overlooked important immediate considerations: (1) the role and status of the mother; (2) research ethics, including the therapeutic misconception; and (3) hard and soft impact on the parents. Since we believe that the widespread and misleading framing of ectogestation as "the artificial womb" is substantially to blame for the literature's misdirection, we will use the more accurate (and less sensational) terminology "artificial amnion-and-placenta technology (AAPT)."

THE ROLE AND STATUS OF THE MOTHER

Much attention in the literature has focused on the legal and ethical status of the fetonate (Colgrove 2019; Romanis 2018). However, it seems to be forgotten that the first patient in AAPT is the mother.[1] In the first-in-human trials, she is the person whose consent should be sought. She will also be a direct patient—subject of the cesarean section currently deemed necessary to enable a transfer of the fetus onto the AAPT. As de Bie et al. (2023) note, cesarean sections have risks, which are aggravated in earlier stages of pregnancy. Extreme preterm cesarean sections are technically more challenging to perform as the lower segment of the uterus is not well formed—and also leave a comparatively larger scar. This incurs risk for the mother, for the neonate, and also for any future fetuses gestated by the mother. Examples of maternal risks are hemorrhage, serious infections and rupture of the uterine scar in a subsequent pregnancy.

It seems De Bie et al. (2023) seek to justify these risks by noting that "C-section is currently often used […]for extreme premature infants in distress." We do not think the concern can be so easily dismissed. Most guidelines counsel reluctance about early cesarean sections—a notable exception being pregnancies posing risks to the mother's life. The indication for an (extremely premature) cesarean section should be proportional: the increased chances for the neonate should outweigh the risks for the mother.

It is also important to consider that a timely transfer to the AAPT might require a cesarean section is performed earlier than would otherwise be clinically indicated. But nothing is so uncertain as obstetrics;

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[1]We note that not all pregnant persons are, or will continue to be, their (future) child's mother. "Mother" in this paper stands in for "pregnant person being considered for AAPT."