Subjective Experience, Gestational Preferences and Justice: Valuing Both Uterus Transplantation and Ectogestation

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Abstract: There is a growing body of literature exploring whether uterus transplantation and emerging ectogestation technologies provide desirable alternatives for persons who cannot achieve genetic parenthood without access to gestational surrogacy. This chapter considers the practical and ethical dimensions of these alternative routes to parenthood, in addition to salient differences that might account for individual preferences regarding assisted gestative technologies. The central concern of promoting equitable access to emerging reproductive biotechnologies is approached from a justice perspective, paying particular attention to the needs of marginalised communities.

Keywords: uterus transplantation, UTx, ectogestation, artificial placenta, assisted gestation, assisted reproductive technologies

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I. INTRODUCTION

Uterus transplantation is sought after as a means of enhancing the reproductive choices of persons who do not have a uterus but want to undertake gestation.[1] A further highly

[1] Laura O'Donovan, 'Pushing the boundaries: Uterine transplantation and the limits of reproductive autonomy,' (2018) 32 Bioethics 489–498

anticipated development for persons unable to complete a (full) gestation is ectogestation, during which an artificial system facilitates gestation outside of the body (sometimes referred to as an 'artificial womb' or more accurately 'artificial amniotic and placenta technology').[2] There is a growing body of literature exploring whether these technologies provide desirable alternatives for persons who cannot achieve genetic parenthood without access to gestational surrogacy.[3] In this chapter, we reflect on how uterus transplantation (UTx) and ectogestation provide alternative routes to becoming a parent where an individual needs or prefers the use of assisted gestative technologies for biological or social reasons.[4] We contribute to the ongoing conversation by highlighting nuances in how different forms of technological assistance with gestation may shape individual lived experiences of reproduction, thereby influencing the decisions of those who seek technological assistance to reproduce. Ultimately, the availability of other reproductive technologies will determine who *wants* a uterus transplant and in *what circumstances*.

The potential implications of limited access to assisted gestative technologies, likely to be less accessible for marginalised populations, is a central ethical concern.[5] It is notable, however, that such concern usually focuses on artificial amniotic and placenta technologies (hereafter 'artificial placenta') and is primarily speculative; imagining a future in which artificial placentas are capable of completely gestating entities from embryo to mature fetus outside the human body. In this chapter, we demonstrate that concerns about limited access should also be considered in the context of UTx and ectogestation. We consider both partial ectogestation (use of an artificial placenta to complete a gestation after a period of

[2] For a discussion of the terms 'artificial amniotic and placenta technology' and 'ectogestation' as the most conceptually appropriate see: Elselijn Kingma and Suki Finn, 'Neonatal incubator or artificial womb? distinguishing ectogestation and ectogenesis using the metaphysics of pregnancy,' (2020) 34 Bioethics 354–63
[3] Michael Grynberg and others, 'Uterine transplantation: a promising surrogate to surrogacy?' (2011) 1221 Reproductive Science 47-53; John Robertson, 'Other women's wombs: uterus transplants and gestational surrogacy,' (2016) 3 Journal of Law and the Biosciences 68-86
[4] For an explanation of Assisted Gestative Technologies as a genus see: Elizabeth Chloe Romanis, 'Assisted gestative technologies,' (2022) 48 Journal of Medical Ethics 439-446
[5] Claire Horn and Elizabeth Chloe Romanis, 'Establishing Boundaries for Speculation About Artificial Wombs, Ectogenesis, Gender, and the Gestating Body,' in Chris Dietz and others (eds), A Jurisprudence of the Body, (Palgrave Macmillan 2020); Elizabeth Chloe Romanis and Claire Horn, 'Artificial wombs and the ectogenesis conversation: A misplaced focus? Technology, abortion, and reproductive freedom,' (2020) 13 International Journal of Feminist Approaches to Bioethics 174-194; Claire Horn, 'Ectogenesis, inequality, and coercion: a reproductive justice-informed analysis of the impact of artificial wombs,' (2022) Biosocieties <https://doi.org/10.1057/s41292-022-00279-3>; Giulia Cavaliere, 'Gestation, equality and freedom: ectogenesis as a political perspective,' (2020) 46 Journal of Medical Ethics 76-82

pregnancy)[6] and, although a much more futuristic prospect, complete ectogestation. Moreover, we argue that there is a need to be attentive to this not only in imagined futures, but also in the development and research phases of reproductive technologies - such as UTx and artificial placentas - in the present. In this chapter, we argue that justice must be *embedded* as a fundamental value, with specific concerns about health disparities and reproductive coercion acknowledged and considered, in the development and design of new technologies. Failure to do this not only results in *injustice* but has a formative influence on the potential for stratified access in the future.

Justice is a core principle of many biomedical ethics frameworks and is concerned with 'treating like cases alike', in other words, avoiding differential or prejudicial treatment based on characteristics that are not medically salient, e.g., racial discrimination.[7] Equal opportunity legislation is an example of a legal instrument meeting an ethical demand (justice) and is relevant when considering the distribution of healthcare goods and services, including reproductive biotechnologies. One complexity present regarding UTx and ectogestation is how 'like cases' can be defined. Each family is unique and each person's preferred pathway to parenthood is different, and as we explain in this chapter, subjective preferences in this context are personal and deeply meaningful. There is a need to avoid discrimination in how assisted reproductive services are allocated, especially where subjective preferences are formed in social and cultural contexts.

Decisions about gestation are highly significant to individuals; many of whom may feel that fundamental aspects of their identities as a 'parent', 'gestator', or 'woman' are at stake. We want to emphasise that our concerns about justice are not limited to ensuring 'access to choices' about whether to use/refuse technological intervention. Matters beyond individual choice are at the crux of equality of access since social structures can create environments that limit maximally autonomous choices. These include, but are not limited to, health

[6] Elizabeth Chloe Romanis, 'Artificial womb technology and the frontiers of human reproduction: conceptual differences and potential implications,' (2018) 44 Journal of Medical Ethics 751-755, 751

[7] Mohammadjavad Hosseinabadi-Farahani and others, 'Justice and unintentional discrimination in health care: A qualitative content analysis,' (2021) 10 Journal of Education and Health Promoton <https://doi.org/10.4103/jehp.jehp_885_20>; Sarah Hamed and others, 'Racism in healthcare: a scoping review,' (2022) 22 BMC Public Health 988

disparities surrounding reproductive functions (resulting from structural conditions created by systems such as racism and patriarchy) as well as coercive social forces.[8]

II. UTx AND ECTOGESTATION

Olausson and others claim UTx is unique among organ transplants as the only example explicitly intended to be 'life-propagating' rather than life sustaining or quality of life enhancing for the recipient.[9] They further note UTx is the 'first ephemeral transplantation type' which has both clinical and ethical relevance, as the temporary nature of the transplant eliminates the need for life-long immune suppression, setting it apart from other transplant surgeries.[10] UTx is challenging from a resource distribution perspective, as Arora and Blake note, unlike life-saving or sustaining transplants, 'sickest first, best prognosis or quality of life assessments' cannot dictate organ allocation decisions, particularly when UTx is presented as an intervention for absolute uterine factor infertility, as all potential recipients would be infertile to the same degree.[11] It would be impossible to judge which candidate (or couple) would experience the greatest quality of life enhancement from receiving a donated uterus, and it would likewise be nonsensical to try to determine who 'needs' to become a parent most acutely. It is, however, arguable that the teams currently performing UTx are making some attempt to do this through their use of selection criteria, particularly those groups that will not perform UTx for individuals who are already parents (by any means, including adoption and step-parenthood).[12]

The uterus is one of a limited number of organs that can be harvested from both living and cadaveric donors, but has various unique considerations compared to other donations. Unlike live donation of a lobe of the liver, for example, the uterus must be donated in its entirety and there is no regeneration of the lost tissue. Other organs that can be donated by the living include kidneys, parts of the lung or pancreas, and small sections of the intestines. However, while these also do not regenerate in the donor, the major difference is the remaining tissue is

[8] For more exploration see Horn (n5); Horn and Romanis (n5)
[9] Michael Olausson and others, 'Ethics of uterus transplantation with live donors,' (2014) 102 Fertility and Sterility 40-43, 40
[10] ibid 40
[11] Kavita Shah Arora and Valarie Blake, 'Uterus transplantation: Ethical and regulatory challenges,' (2014) 40 Journal of Medical Ethics 396-400, 399
[12] Natasha Hammond-Browning, 'UK criteria for uterus transplantation: a review,' (2019) 126 British Journal of Obstetrics and Gynaecology 1293-1405, 1323

fully functional, whereas the living donor of a uterus must sacrifice any future gestational capacity. There is not a second uterus that can take over reproductive function, as in the case for live kidney donation, where the remaining kidney can continue to filter wastes from the body alone.[13] With regards to cadaveric donation, UTx represents the only transplantation type where the family of the deceased may one day meet a person that has come into being - been *gestated* - using their loved one's organ. Other reproductive tissue donations typically result in a genetic link between the donor and future offspring, but UTx presents a new possible relationship, with whatever claims of kinship this might inspire for bereaved families. As UTx is still considered somewhat experimental, people who are currently registered as organ donors are unlikely to have considered the potential for this type of transplant, yielding concerns regarding informed consent for donation.[14] As such, in the future it might be particularly challenging for their next of kin to try to parse out what they may have wished, had the option of UTx been known at the time they registered. Further complicating matters, jurisdictions that have presumed consent organ donation often do not include the uterus in presumed consent.[15]

UTx is not only unique among transplants. It also differs substantially from other assisted reproductive technologies currently available in that it attempts to assist an individual currently unable to undertake gestational labour themselves (rather than outsourcing that labour as in surrogacy).[16] While also intending to aid those who want to become a genetic parent but are unable to complete a gestation, the object of research into an artificial placenta is the opposite of that of uterus transplantation. The purpose is not to facilitate pregnancy in one of the intended parents, but explicitly to enable gestation *without* a person sustaining it.

There are prototype artificial placenta models in development that have illustrated 'proof of principle' for partial ectogestation; *continued* gestation outside of the body. There are several

[13] U.S. Department of Health & Human Services, Health Resources & Services Administration, 'Donate Organs While Alive,': <https://www.organdonor.gov/learn/process/living-donation> accessed 4 July 2022
[14] Elizabeth Chloe Romanis and Jordan Parsons, 'Directed and conditional uterus donation,' (2022) 48 Journal of Medical Ethics 810-815; Nicola J Williams, Laura O'Donovan and Stephen Wilkinson, 'Presumed Dissent? Opt-out Organ Donation and the Exclusion of Organs and Tissues,' (2022) 30 Medical Law Review 268-298
[15] ibid.
[16] Robertson (n3); Alexandra Mullock, Elizabeth Chloe Romanis and Dunja Begović, 'Surrogacy and uterus transplantation using live donors: Examining the options from the perspective of 'womb-givers,'' (2021) 35 Bioethics 820-828

models in development, such as EXTEND therapy at the Children's Hospital of Philadelphia, United States[17] and the EVE platform developed by a partnership between the University of Western Australia and Tohoku University Hospital in Japan.[18] These models are designed as alternatives to conventional neonatal intensive care with the object of 'taking over'/continuing a gestation where a pregnancy is spontaneously or therapeutically ended prematurely.[19] Conventional neonatal intensive care demonstrates high rates of morbidity and mortality, and the current reliance on mechanical ventilation means that entities without sufficiently developed lungs (usually before 22 weeks' gestation) are beyond assistance.[20] In the belief that a completely new physiological approach is needed to improve such outcomes, teams of specialists are developing ways of 'continuing gestation outside of a pregnancy' to enable continued development and organ maturation, rather than trying to support undeveloped entities to perform life functions in the external environment.[21] Existing models have similar fundamental designs: essentially a sealed bag of artificial amniotic fluid, umbilical cord access and a pump-less oxygenator circuit.[22] This set up is designed for fetal, rather than neonatal, physiology, and thus gestation can continue, albeit outside of the human body enabling crucial organ development. These models have continued to yield positive results in animal testing, and there are suggestions that the technology may be ready for human trials in the not-too-distant future (since 2017, researchers have suggested within five to ten years).[23] There are various research teams working on similar models across the world, including Canada and the Netherlands.[24]

[17] Emily Partridge and others, 'An extra-uterine system to physiologically support the extreme premature lamb,' (2017) 8 Nature Communications 1–15
[18] Haruo Usuda and others, 'Successful maintenance of key physiological parameters in preterm lambs treated with ex vivo uterine environment therapy for a period of 1 week,' (2017) 217 American Journal of Obstetrics and Gynecology 457.e1-457.e13.
[19] Romanis (n6), 751
[20] Emily Partridge and Alan Flake, 'The Artificial Womb,' in Mark Kilby, Anthony Johnson and Dick Oepkes (eds.), *Fetal Therapy: Scientific Basis and Critical Appraisal of Clinical Benefits*,' (CUP 2020), 83
[21] Romanis (n6), 753; Tom Lissauer and Graham Clayden, *Illustrated Textbook of Paediatrics,* (Moby Elsevier 2012), 159
[22] Partridge and Flake (n20), 84-85
[23] Children's Hospital of Philadelphia, 'Unique womb-like device could reduce mortality and disability for extremely premature babies,' <https://medicalxpress.com/news/2017-04-unique-womb-like-device-mortality-disability.html> accessed 8 August 2022; Lyn Chitty and others, 'In case you missed it: The Prenatal Diagnosis editors bring you the most significant advances of 2019,' (2019) 40 Prenatal Diagnosis 287-293, 293
[24] Alex Charest-Pekeski and others, 'Achieving sustained extrauterine life: Challenges of an artificial placenta in fetal pigs as a model of the preterm human fetus,' (2021) 9 Physiological Reports doi:10.14814/phy2.14742; Swan Gie Oei, 'Incubation system for liquid-based incubation of prematurely born infants' US Patent App 17/599 (2022)

Importantly, the current iteration of artificial placenta models are capable only of *partial* ectogestation.[25] Several elements of the design, for example the oxygenator circuit, rely on fetal physiology, such as a primitive heartbeat.[26] Design teams are currently suggesting that their target population are those born on the threshold of viability to meet their clinical objective of improving neonatal outcomes.[27] Sustaining a *complete* ectogestation would require the development of a more complex artificial placenta system for which there are several barriers. First, it is unlawful in many jurisdictions to experiment on embryos after 14 days' development, meaning we have limited knowledge about the process of embryogenesis (the development from embryo to fetus) or how to artificially support it.[28] Second, even if it were lawful to research this development, the clinical need does not appear as pressing as reducing neonatal morbidity and mortality and so is unlikely to garner as much immediate support or funding. There are teams working on the possibility of complete ectogestation – for example, in Israel,[29] but realistically an artificial placenta capable of complete ectogestation is much further away. Our discussions of complete ectogestation are therefore inevitably speculative.

III. DIFFERENT EXPERIENCES OF GESTATION

UTx and both partial and complete ectogestation both have the objective of assisting a person who may be unable to gestate as a matter of course, for whatever reason, with their goal of becoming a parent.[30] UTx and ectogestation differ in terms of *how* a person becomes a parent and specifically whose labour is required in the process of creation. For this reason, the technologies appeal to different groups of people with different reproductive needs and/or preferences. Despite the technologies not being 'direct alternatives' in facilitating the same *mode* of gestation, both UTx and ectogestation perform an important function for people with different needs/preferences regarding gestation. Both can help 'persons who are unable to

[25] Romanis and Horn (n5), 176
[26] ibid. See also Partridge and Flake (n20), 84-85
[27] Partridge and others (n17), 11
[28] Elizabeth Chloe Romanis, 'Regulating the 'Brave New World:' Ethico-Legal Implications of the Quest for Partial Ectogenesis' (PhD Thesis, University of Manchester 2020), 32; Insoo Hyun and others, '"Embryology Policy: Revisit the 14-day Rule,' (2016) 533 Nature 169-171
[29] Shadi Tarazi and others, 'Post-Gastrulation Synthetic Embryos Generated Ex Utero from Mouse Naïve ESCs,' (2022) Cell <https://doi.org/10.1016/j.cell.2022.07.028>; Antonio Regalado, 'A mouse embryo has been grown in an artificial womb – humans could be next,' <https://www.technologyreview.com/2021/03/17/1020969/mouse-embryo-grown-in-a-jar-humans-next/> accessed 8 August 2022.
[30] Romanis (n4), 440

undertake gestation (or the entirety of gestation themselves) for a variety of reasons: whether biological or social' to reproduce – possibly with their own gametes.[31] Thus, it is plausible that persons without a uterus who want to experience gestation may seek UTx; persons needing/wanting assistance with (at least some part of) gestation may seek ectogestation. In this section, we examine how some of the nuances in how these technologies may work may affect user preferences.

At present, surrogacy is the technologically facilitated option for persons who need assistance with gestation.[32] However, this does not always meet the needs and/or preferences of some intended parents: specifically, those wanting to *experience* gestation because they see being physically pregnant as a valuable part of becoming a parent. Similarly, for people who can carry a pregnancy for a period but are worried about the impact on their health of a full gestation, for example, people with an underlying health condition or a history of pregnancy complications, partial ectogestation would enable a person to carry a pregnancy for a period (likely three months or more)[33] before relying on technology to 'take over'.[34] Nelson also advocates that some people may just see partial ectogestation as offering the possibility of more choice about gestation, pregnancy and birth.[35] The 'experiential value' of gestation[36] should be understood as multi-faceted. For some, the value may be the sensation of the fetus being a part of them: feeling it move, grow etc.[37] At present, UTx does not facilitate this aspect of the gestational experience, as the relevant nerves are not transplanted and thus recipients do not feel fetal movements.[38] Robertson claims this lack of nervous innervation and sensation 'may exacerbate feelings of estrangement to the transplanted organ' for some recipients, possibly increased by knowledge of any previous gestations that uterus completed

[31] ibid.
[32] Note, however, that surrogacy is not a technology – but gestational surrogacy is made possible by technological assistance with conception. Romanis is grateful to Dr Laura O'Donovan and Dr Nicola Williams for discussion on this point
[33] This is because the entity must have in utero developed fetal physiology before it can be transferred to the artificial placenta
[34] Elizabeth Chloe Romanis, 'Partial ectogenesis: freedom, equality and political perspective,' (2020) 46 Journal of Medical Ethics 89-90, 89; Elizabeth Chloe Romanis, 'Artificial Womb Technology and the Choice to Gestate Ex Utero: Is Partial Ectogenesis the Business of the Criminal Law,' (2020) 28 Medical Law Review 342-274, 349; Natasha Hammond-Browning, 'A New Dawn? Ectogenesis, Future Children and Reproductive Choice' (2018) 14 Contemporary Issues in Law 349-373, 359
[35] Anna Nelson, 'Should Delivery by Partial Ectogenesis be Available on Request of the Pregnant Person?' (2022) 15 International Journal of Feminist Approaches to Bioethics 1-26, 3-4
[36] O'Donovan (n1), 490
[37] Robertson (n3)
[38] Robertson (n3), 74

within another person.[39] There are, however, other aspects of pregnancy that a person may value: there are visual and psychosocial aspects to carrying a pregnancy that, to many, do matter.[40]

Pregnancy and gestation 'can under certain conditions, be empowering for women. It can confer on them, political power or prestige or moral status within a specific community'.[41] Being 'socially pregnant' has been shown to involve both the visible, physical changes associated with gestation, but also recognition of those changes as signifying a pregnancy, with surrogate mothers in one study describing their pregnancies as 'absent' and unacknowledged by their friends and family, while intending parents related the opposite experience, with friends and colleagues often referring to their 'pregnancy glow' etc.[42] Beyond the visibility of pregnancy, some people may value other aspects of gestation, physically, emotionally, and socially. Descriptions of 'bonding' occurring during gestation are common, and many people report a deep desire and enjoyment of pregnancy.[43]

In contrast, there are also many people who describe pregnancy as a burden; physically, psychologically, socially, and financially.[44] Importantly, these burdens are not equitably distributed, with cisgender women bearing the brunt of reproductive risks in society.[45] Gestation carries significant health risks and those who struggle with morning sickness, dizziness, body aches, fatigue, headaches and other common symptoms often report a lack of support from medical professionals as these are considered mere 'inconveniences'.[46] For those who suffer or fear more severe complications, pregnancy can represent a harrowing

[39] ibid.
[40] Anji E Wall and others, 'Decision making and informed consent in uterus transplant recipients: A mixed-methods study of the Dallas uterus transplant study (DUETS) participants,' (2021) 222 The American Journal of Surgery 819-824, 821
[41] Reyes Lázaro, 'Feminism and Motherhood: O'Brien vs Beauvoir,' (1986) 1 Hypatia 87-102, 95
[42] Elly Teman, 'Embodying Surrogate Motherhood: Pregnancy as a Dyadic Body-project,' (2009) 15 *Body & Society* 47-69, 57
[43] Larissa Rossen and others, 'Maternal Bonding through Pregnancy and Postnatal: Findings from an Australian Longitudinal Study,' (2017) 34 American Journal of Perinatology 808-817
[44] For some, this is the reason why there is an imperative to develop technology capable of rendering pregnancy a reproductive choice: Anna Smajdor, 'The Moral Imperative for Ectogenesis,' (2007) 16 Cambridge Quarterly of Healthcare Ethics 336-345; Evie Kendal, *Equal Opportunity and the Case for State Sponsored Ectogenesis,* (Palgrave, 2015)
[45] Kendal (n44), 3
[46] ibid.

experience, and in the most extreme cases a lethal one.[47] Such risks and burdens should be taken seriously. But both the risks and the perception of risk will differ for each person, and the cost/benefit analysis involved when choosing whether to gestate is highly sensitive to individual circumstances. Estimates for women who fear pregnancy range from 20-78% in the literature,[48] with the variance in self-reporting likely influenced by pronatalist pressure and social disapprobation targeting those who indicate a preference to remain childless.

Space must be made for all individual conceptions of the value (or lack thereof) of pregnancy to facilitate the availability of options that best meet people's needs. Neither account of pregnancy – as *always* valuable or *always* burdensome – encapsulates the variety of lived experiences of (potential) gestators. Reproductive choices are subjective and situated. That these positions seem contradictory if one is trying to advance a unified theory of pregnancy and gestation, should not detract from the fact that lived realities – no matter how messy, how fundamentally different, and how antithetical in meaning when we try to explain them – represent truth. Reproduction is recognised as a fundamental aspect of self: 'control over whether one reproduces or not is central to personal identity, to dignity, and to the meaning of one's life'[49] Beyond the choice of whether to become a parent, however, we argue that *how* that project is undertaken can similarly have a profound impact on a person's sense of self, their relationships, and the life they are designing for themselves. The choices a person may wish to make about gestation will be based on their personal preferences and shaped by strongly held personal values or intuitions. There are significant differences between UTx and ectogestation and the experiences they facilitate that could influence a person's choice of how to become a parent.

UTx is an option for persons without a (working) uterus who want to be pregnant,[50] and could be supplemented by partial ectogestation if the pregnancy were to become dangerous. Partial ectogestation could provide for persons who want to experience pregnancy but cannot or do not want to carry a full pregnancy, for whatever reason.[51] Complete ectogestation may one day be able to facilitate reproduction for anyone, with or without a uterus, that does not

[47] World Health Organization, 'Maternal Mortality,' https://www.who.int/news-room/fact-sheets/detail/maternal-mortality> accessed 30 August 2022
[48] Manjeet Singh Bhatia and Anurag Jhanjee, 'Tokophobia: A dread of pregnancy,' (2012) 21 Indian Journal of Psychiatry 158-159
[49] John Robertson, *Children of Choice: Freedom and the New Reproductive Technologies,* (Princeton 1994), 24.
[50] Arora and Blake (n11), 396
[51] Romanis (n34); Nelson (n35)

want any bodily reproductive labour to occur.[52] One of the major differences between the technologies, therefore, is the type of gestation they enable, whether in or ex utero (see **figure 1**). This is likely to be one of the major decisive factors for people seeking assisted gestation.

Figure 1: Differences in experience between UTx and ectogestation for the potential service user

	UTx	**Partial Ectogestation**	**Complete Ectogestation**
Conception	Assisted	Assisted or 'Natural'	Assisted
Pregnancy	Complete duration of gestation	Partial duration of gestation	No pregnancy
Delivery 'Birth'	Surgical delivery at 'term'	Surgical/vaginal delivery pre-term	No physical delivery from a human gestator
Baby 'Born'	At point that the entity is delivered from the pregnant person	At the point that the entity is delivered from the artificial placenta[53] (though this is a contested conclusion)[54]	At the point the entity is delivered from the artificial placenta

A further significant difference between these technologies, is the way in which a user will experience 'birth'. UTx inevitably requires surgical delivery,[55] while partial ectogestation is often talked of as also requiring surgical intervention as part of the delicate process of

[52] Kendal (n44)
[53] For arguments defending the position that an entity is or should be determined legally birthed at the end of the process of gestation whether in or ex utero see: Elizabeth Chloe Romanis, 'Challenging the 'Born Alive' Threshold: Fetal Surgery, Artificial Wombs, and the English Approach to Legal Personhood,' (2020) 28 Medical Law Review 93-123; Elizabeth Chloe Romanis, 'Is 'viability' viable? Abortion, conceptual confusion and the law in England and Wales and the United States,' (2020) 7 Journal of Law and the Biosciences <https://doi.org10.1093/jlb/lsaa059>. For ethical arguments see Romanis (n6); Elizabeth Chloe Romanis, Artificial womb technology and the significance of birth: why gestatelings are not newborns or fetuses,' (2019) 45 Journal of Medical Ethics 728-731; Kingma and Finn (n2)
[54] See Nick Colgrove, 'Subjects of ectogenesis: are 'gestatelings' fetuses, newborns or neither? (2019) 45 Journal of Medical Ethics 723-726
[55] Vaginal delivery is specifically contraindicated: Elliot Richards and others, 'Uterus transplantation: state of the art in 2021' (2021) 38 Journal of Assisted Reproduction and Genetics 2251-2259, 2256

translocation from human pregnancy to artificial placenta.[56] A caesarean delivery allows more control, aimed at preventing the physiological changes that attend delivery to ensure the entity can continue *fetal* development.[57] More recently there has been discussion of techniques to facilitate transfer through the birth canal in ways that do not trigger physiological transition.[58] Thus, birthing experiences for pregnant people following UTx bear some similarity to those involved in partial ectogestation, however, it is notable that surgical intervention is inevitable in one case (UTx), and *potentially* not in the other (partial ectogestation).

Beyond the matter of how the delivery is undertaken, partial ectogestation results in a unique separation of birthing (experienced by the birthing person as the end of their pregnancy and the separation of a new human entity from their body) and birth (the end of gestation resulting in a new human entity existing in the external environment).[59] We take the view that the entity is born at the end of gestation - rather than the end of a pregnancy in the case of partial ectogestation - because this is the point at which the entity adapts to survive in the external environment.[60] In partial ectogestation, therefore, there is a period in which a person has 'birthed', but the product of reproduction is not yet *born*, because it is continuing to undergo the generative process of gestation. In UTx, birthing and birth are synchronised, but partial ectogestation illustrates that the occurrences are not necessarily coetaneous.[61] The 'being born' of the subject of the artificial placenta, it has been argued, occurs when the entity is delivered from the artificial placenta and makes the necessary physiological adaptations to survive in the external environment.[62] The impact on a formerly pregnant person of the separation of delivery and the entity being 'born' may affect their experience of

[56] Amel Alghrani, 'Regulating the Reproductive Revolution: Ectogenesis: A Regulatory Minefield? in Michael Freeman (ed.), *Law and Bioethics: Volume 11* (Oxford University Press 2008) 303-328, 316*;* Julien Murphy, 'Is Pregnancy Necessary: Feminist Concerns about Ectogenesis,' in Scott Gelfand and John Shook (eds.), *Ectogenesis; Artificial Womb Technology and the Future of Human Reproduction* (Rodopi Press 2006), 34
[57] M Beatrijs van der Hout and others, 'Interprofessional Consensus Regarding Design Requirements for Liquid-Based Perinatal Life Support (PLS) Technology' (2022) Frontiers in Pediatrics <https://doi.org/10.3389/fped.2021.793531>
[58] ibid.
[59] Romanis, 'Artificial womb technology and the significance of birth' (n53), 727
[60] See (n53)
[61] Romanis, 'Artificial womb technology and the significance of birth' (n53), 727
[62] *ibid;* Romanis (n28), 203-210; Elselijn Kingma, 'In defence of gestatelings: response to Colgrove,' (2021) 47 Journal of Medical Ethics 355-356. NB this is a contested conclusion: see Nick Colgrove, 'Subjects of ectogenesis: are 'gestatelings' fetuses, newborns or neither?' (2019) 45 Journal of Medical Ethics 723-726: though we take the view that these objections are unpersuasive

reproduction. As some commentators have observed,[63] following birthing, the body makes adaptations to encourage 'caring behaviours' (e.g. by production of the oxytocin hormone), thus there may be ways in which a formerly pregnant person finds the temporal disconnection between their birthing and the 'being born' of their future child very physically and emotionally difficult. By contrast, complete ectogestation involves no pregnancy and as such no putative parent (or other person) undergoes birthing, with birth occurring at the point the entity exits the artificial placenta.[64] For some putative parents who can only partially gestate (due to underlying health problems, for example) complete ectogestation may be preferable to avoid the physical toll of birthing and the risks of transfer to an artificial placenta, while also avoiding the temporal separation of birthing and birth and any associated physical or psychological consequences. However, for some individuals even limited experience of bodily gestation is so valuable that such physical and psychological difficulties will be considered worth it.

IV. DESIGNING & EXPERIMENTING WITH ASSISTED GESTATION

Having established how UTx and ectogestation facilitate different experiences of gestation, in this section, we outline the importance of considering diversity of experience from an intersectional perspective and subjective reproductive preferences in the development of novel forms of assisted gestation. Artificial placentas are speculative treatment – and clearly will be experimental when prototypes are trialled in humans.[65] UTx is on the boundary; it is an 'emerging therapy that is transitioning from an experimental phase to an established clinical practice'.[66] While the procedure might be thought of as *becoming* routine for individuals in the initial target population – that is, cisgender women of reproductive age –

[63] E Joanne Verweij, 'Ethical Development of Artificial Amniotic Sac and Placenta Technology: A Roadmap,' (2022) 9 Frontiers in Pediatrics <https://doi.org/10.3389/fped.2021.793308>; Victoria Hooton and Elizabeth Chloe Romanis, 'Artificial womb technology, pregnancy, and EU employment rights,' (2022) 9 Journal of Law and the Biosciences <https://doi.org10.1093/jlb/lsac009>

[64] Maureen Sander Staudt, 'Ectogenesis: Artificial Womb Technology and the Future of Human Reproduction' in Scott Gelfand and John Shook (eds.), *Ectogenesis; Artificial Womb Technology and the Future of Human Reproduction* (Rodopi Press 2006), 124

[65] Elizabeth Chloe Romanis, 'Artificial womb technology and clinical translation: Innovative treatment or medical research?' (2020) 34 Bioethics 392-402; Felix De Bie and others, 'Artificial placenta and womb technology: Past, current, and future challenges towards clinical translation,' (2021) 41 Prenatal Diagnosis 145-158, 154

[66] Richards and others (n55), 2251

there is little data about other marginalised groups who may want access to UTx, for example, transgender women, and in these cases it would be experimental.[67]

Justice matters in the development of new reproductive technologies. It matters first in thinking about what gets studied: what is recognised as a problem for which a technical solution is necessary, and why? We must think about the benefits *and* disadvantages to different groups in design and research phases, to avoid the likelihood of technology failing to meet the needs of more structurally disadvantaged groups. While 'the relation between design and use is very complex and principally unpredictable',[68] ultimately, if we do not *try* to consider the diversity of experiences and subjective reproductive preferences in how we develop technologies assisting with gestation then we cannot ensure that the technology is *designed for* and *accessible to* everyone. This plays out as a part of the materiality of design, both in how a procedure/device functions[69] and in how it looks and feels. Furthermore, it can mean that by the time a technology/procedure is more routinely available, there is a much more limited evidence base (if any) about its safety in marginalised populations, limiting who can use it or posing unknown risks if it were used in those groups. There has been little discussion in the literature about the design of artificial placenta technologies (with some notable exceptions).[70] Van der Hout and others have suggested that an approach that is 'value sensitive' is preferred.[71] Value Sensitive Design, a framework developed by Friedman and others, places emphasis on accounting for human values in the conceptual, empirical, and technical processes of designing new technologies.[72]

If partial ectogestation is designed wholly as an alternative to neonatal intensive care, rather than also a reproductive technology, some of the design elements that could make it easier for people who want to use ectogestation as an alternative to a full-term pregnancy may fail to

[67] Benjamin Jones and others, 'Perceptions and Motivations for Uterus Transplant in Transgender Women,' (2021) 4 JAMA Network Open e2034561.
[68] Anders Albrechtslund, 'Ethics and technology design,' (2007) 9 Ethics and Information Technology 63-72, 63
[69] ibid 65.
[70] van der Hout and others (62); Seppe Seggers and Elizabeth Chloe Romanis, 'Ethical, translational and legal issues surrounding the novel adoption of artificial womb technologies,' (2022) 15 Risk Management and Healthcare Policy 2207-2220, 2212-2213
[71] ibid.
[72] Batya Friedman and others, 'Value Sensitive design: Theory and Methods,' (2002) 2 Washington Technical Report 12

meet their needs. Potentially even more importantly, the ways in which ectogestation is presented as useful in the literature may come to be autonomy-limiting for pregnant people through enabling reproductive coercion. Hammond-Browning suggests that because of the risks of fetal transfer, partial ectogestation might be best adopted in circumstances that avoid other risks for the fetus with – of course – full consent of the pregnant person. She gives the examples of 'foetuses carried by women addicted to alcohol and/or illegal drugs', 'foetuses of pregnant women who require chemotherapy [that are] at risk of termination' and 'foetuses that are diagnosed with complex health needs of their own that require in utero surgery'.[73] While Hammond-Browning is explicitly against pregnant people in these circumstances being coerced into using this technology, it should still be noted that there may be coercive potential in such framing.[74] Thinking about the appropriate circumstances for us of the technology where it is beneficial for the fetus has the potential to place more value in the fetus than the pregnant person and centres the fetus in decision making.[75] If such thinking is valorised in design processes, this could reinforce and enable reproductive coercion rather than being autonomy-enhancing, as will be discussed in the next section.

Similarly, the framing of UTx as solely a treatment for women's infertility[76] could come to limit other uses that are important to some individuals for identity-enhancing benefits. The desired outcome of UTx may not always be healthy offspring, with some candidates potentially desiring a transplant for non-reproductive purposes. For cisgender women born without a uterus, or who have lost their uterus due to disease or injury, this may include a desire to achieve a sense of bodily integrity or 'wholeness'. For transgender women, UTx might be desirable as part of gender-affirming care, including for those without reproductive intentions.[77] Where the procedure is developed only for reproductive purposes, this risks the exclusion of other benefits in the design (for example, what is and is not being transplanted into the recipient). The value underpinning this technology must be that it can be broadly autonomy enhancing, rather than only enhancing of *reproductive* autonomy. We

[73] Hammond-Browning (n34), 359
[74] As has been noted by several commentators: Elizabeth Chloe Romanis and others, 'Reviewing the Womb,' (2020) 41 Journal of Medical Ethics 820-829; Horn (n5); Cavaliere (n5)
[75] There is also the danger that, in practice, the way the option is presented to pregnant people may be or feel coercive to them
[76] As it most often is- see Giuseppe Del Priore and others, 'Uterine transplantation – a real possibility? The Indianapolis consensus,' (2012) 28 Human Reproduction 288-291, 289
[77] Jones and others (n67)

acknowledge here that UTx may be limited to reproductive purposes for reasons related to resource limitations, including the availability of uteruses,[78] however, we suggest that there are compelling reasons for uterus transplantation for non-reproductive purposes that ought not to be entirely dismissed. They are compelling enough to justify more research[79] so as not to prevent the possibility in the future.

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Regarding testing assistive gestative technologies, there are various justice concerns about who is involved in early trials of new technologies. Evidence from the US and UK (two economically developed countries) consistently demonstrates that people from marginalised racial groups and lower socio-economic backgrounds are more likely to experience preterm birth.[80] Consequently, Romanis and Horn have expressed concern that it is likely marginalised groups that will 'shoulder the risks and burdens in the development of [partial ectogestation] ... This might include, as just one example, invasive and experimental surgeries to perfect methods of fetal extraction'.[81] Historically, new procedures and techniques in obstetrics and gynaecology were tested on enslaved Black women and women of colour by white male doctors in pursuit of medical knowledge and benefits for white women.[82] The development of ectogestation risks being another site of the commodification of Black women's bodies for the benefit of others. Horn and Romanis posit that there are, therefore, 'pressing considerations here about how to ensure that pregnant people who are already harmed by contemporary inequity and discrimination are not placed at further risk during these trials'.[83]

Alternatively, there might also be the concern that it is only more privileged groups of people who are able (or want) to access 'cutting edge' trials. Diversification of research participants in biomedical research has long been an issue in developed economies and can result in

[78] There are reasons to believe that demand for uteri could outstrip supply as the surgery becomes more clinically available – see Romanis and Parsons (n14)
[79] Jones and others (n67)
[80] Jeanne Alhusen and others, 'Racial Discrimination and Adverse Birth Outcomes: An Integrative Review,' (2016) 61 Journal of Midwifery & Women's Health 70-720; Paul Aveyard and others, 'The risk of preterm delivery in women from different ethnic groups,' (2002) 109 BJOG: An International Journal of Obstetrics and Gynaecology 894-899
[81] Romanis and Horn (n5), 187
[82] See Deirdre Cooper Owens, *Medical Bondage,* (University of Georgia Press 2017)
[83] Horn and Romanis (n5), 247

marginalised populations being excluded from the benefits of novel treatments.[84] The same applies in the context of new reproductive technologies. Justice, therefore, demands inclusion of different groups. Despite this, research teams often adopt inclusion criteria that may exclude certain groups directly or indirectly.[85]

In some countries, private healthcare systems make innovative treatment prohibitively expensive. At least in some clinical trials, e.g., the first ten women in the Cleveland Clinic Trial,[86] the procedure has been offered for free (as the recipient is a research subject) but they have had to pay for their own IVF – which in the US averages between $12,000-$14,000 per cycle.[87] Such costs are likely to cause stratified access to experimental UTx along class lines. More broadly, there are often 'social criteria' recommended to be included in selection criteria that could act as indirect barriers and possibly promote discrimination. The Montreal Criteria, informally adopted as the most comprehensive inclusion criteria for experimental UTx surgeries published in 2012, specified that the recipient should not 'exhibit frank unsuitability for motherhood'.[88] This exact phrasing remained in the revised version one year later.[89] Such a criterion, allows for direct and indirect discrimination based on social circumstances and conscious and unconscious biases against certain individuals and types of families. In sum, more attention ought to be paid to how research into experimental forms of assisted gestation can be maximally inclusive.

V. THE FUTURE

In a future where UTx has become standard clinical care, the arguments outlined above serve to highlight that this does not mean other assisted gestative technologies should be abandoned or de-prioritised, either in research or practice. UTx and ectogestation promote different

[84] Leanne Woods-Burnham and others, 'The Role of Diverse Populations in US Clinical Trials,' (2021) 2 Med 21-24, 21
[85] See Hammond-Browning (n12)
[86] Brie Zeltner, 'Cleveland Clinic introduces nation's first uterus transplant recipient,': <https://www.cleveland.com/healthfit/2016/03/cleveland_clinic_introduces_it.html> accessed 6 June 2023.
[87] Putman and others, 'Clinical pregnancy rates and experience with in vitro fertilization after uterus transplantation: Dallas Uterus Transplant Study,' (2021) 225 American Journal of Obstetrics and Gynecology 155.e1-155.e11.
[88] Ariel Lefkowitz and others, 'The Montreal Criteria for the Ethical Feasibility of Uterine Transplantation,' (2012) 25 Transplant International 439-447, 444
[89] Ariel Lefkowitz and others, 'Ethical considerations in the era of the uterine transplant: an update of the Montreal Criteria for the Ethical Feasibility of Uterine Transplantation,' (2013) 100 Fertility and Sterility 924-826, 924

reproductive experiences and will be valued by different people as potential methods of family-making. What remains, however, is a discussion of how all these options can be ethically distributed, assuming the likely scenario of health resource limitations or scarcity. As noted, UTx depends on donation and demand is expected to far outweigh the supply of transplant organs.[90] Surrogacy services are limited by surrogate availability and in many jurisdictions certain legalities further restrict or prohibit access. There are also concerns regarding potential exploitation in both these cases, e.g. people with functioning uteruses (usually women) may be coerced by circumstances into uterus donation, particularly if there are financial incentives involved or significant societal or family pressure.[91] Meanwhile, especially in its early stages, ectogestation is expected to be extremely expensive. All these factors feed into our concerns regarding the potential for inequitable, stratified access to these technologies.

Gestation and childbirth are significant causes of morbidity and mortality worldwide. As such, reproductive technologies that seek to change who gestates and in what ways carry various ethical concerns. A common articulation of one such justice concern focuses on the argument that if wealthy people can avoid gestation and outsource this task to others (surrogates) or technology (artificial placentas), opportunities and health outcomes for those who still rely on their own pregnancy to reproduce may worsen.[92] Some who stand to benefit the most from emerging reproductive technologies will be the least likely to be able to pay large out-of-pocket expenses for them; similarly, many potential UTx recipients will lack access to a transplant organ, including those with a lower likelihood of securing a directed donation from a living donor or from a centralised organ allocation system, due to perceived or actual lack of social and financial capital. In both cases, this demonstrates a compounding of disadvantage that is fundamentally unjust.

[90] Romanis and Parsons (n14)
[91] On exploitation by financial means see Bernard Dickens, 'Legal and ethical issues of uterus transplantation,' (2016) 133 International Journal of Gynecology and Obstetrics125-128, 127. On potential coercion because of close relationships see Lisa Guntram, 'May I have your uterus? The contribution of considering complexities preceding live uterus transplantation,' (2021) 47 Journal of Medical Humanities 425-437, 432
[92] Julien S. Murphy, 'Is Pregnancy Necessary? Feminist Concerns about Ectogenesis' (1989) 4 Hypatia 66-84, 69

While it is likely access to assisted gestation will never be truly universal, there are practical steps that can be taken to ensure providing more choice for some does not diminish choices for others. The first involves respecting the multiplicity of values at stake in human reproduction – for some, a visible pregnancy is a highly prized goal, while for others, avoiding surgical interventions might be a higher priority. Only supporting the former, for example through UTx, would disadvantage the latter, who might seek continued research into complete ectogestation. While issues with adopting existing organ allocation methods for UTx have been noted, those attending emergency healthcare rationing bear some relevance, particularly in the case of partial ectogestation. Here 'triage' is a meaningful term in ways it simply is not for many other reproductive services – a partially developed fetus can have an urgent medical need for artificial gestation that takes precedence over other uses of the technology at that time. Nevertheless, in most cases novel reproductive technologies will require novel distribution methods that can take into account personal preferences, risks and benefits, and accessibility, and which will promote the principle of justice in service provision.

Many jurisdictions already provide state subsidies for assisted reproductive services, but there are existing concerns regarding discriminatory selection criteria for access. Roberts observed that novel reproductive 'technologies rarely achieve their subversive potential' and that 'the politics of technologies that *assist* births is shaped by race'.[93] For example, she notes there is a lack of access for Black people in the US to novel reproductive technologies that 'stem[s] from a complex inter-play of financial barriers, cultural preferences and more deliberate manipulation.'[94] Regarding ectogestation in particular, Horn has highlighted the problem of stratified access along the lines of gender, class and racial divisions by centring reproductive justice approaches.[95] She states that we must ask not only what the benefits might be, but 'who might be excluded from the 'choices' the technology is purported to increase.'[96] As such, even if there are subsidies provided to offset expenses, this alone will not guarantee equitable distribution as other structural factors may work to limit real choices.

[93] Dorothy Roberts, Killing the Black Body: Race, Reproduction, and the Meaning of Liberty,' (Vintage Books 2017) 248; 250
[94] ibid 250
[95] Horn (n5). Reproductive justice approaches are based on Black feminist thought in the US – specifically the campaigns of the SisterSong Women of Color Reproductive Justice Collective in the United States. See Loretta Ross and Rickie Solinger, *Reproductive Justice: An Introduction,* (University of California Press 2017)
[96] Horn (n5)

Justice means also ensuring people can *refuse* technological interventions in reproduction if they wish. We have already noted our concerns about ectogestation and reproductive coercion in the context of framing the utility of ectogestation in the design of the technology. Many scholars have reflected on the need to ensure that particularly vulnerable persons, especially those socially disadvantaged by structures enforcing racism, classism, and patriarchy, are not coerced into using ectogestation in place of continuing their pregnancy.[97] Horn notes that we must 'consider whether the artificial womb could undermine the right to have a child or to control reproductive options, and… assess whether it could result in harm to those who have been historically and continually marginalized in reproductive care'.[98] Likewise, in the context of UTx, there might be concern about pronatalist narratives socially pressuring people into UTx rather than other forms of family creation, including adoption.[99] If the major argument in favour of pursuing assisted gestative technologies is enhancing reproductive choice, such coercion must be avoided as it is antithetical to achieving this objective.

In conclusion, justice matters in both the development of novel reproductive technology and in their use once/if they come to fruition. This means taking account of the differing and potentially conflicting subjective experiences of individuals seeking reproductive assistance, or to benefit from reproductive technologies in other ways.

[97] Cavaliere (n5); Horn (n5); Romanis and others (n74)
[98] Horn (n7), 5
[99] See Romanis and others (n74); Mianna Lotz, 'Commentary on Nicola Williams and Stephen Wilkinson: 'Should Uterus Transplants Be Publicly Funded?' (2016) 42 Journal of Medical Ethics 570-571,571