

Parental Acceptability of Artificial Womb Technology for Extreme Prematurity

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Abstract

Objective:

Extreme prematurity results in high mortality and morbidity. Artificial womb technology (AWT) has the potential to revolutionize care for these infants, and first-in-human (FIH) trials are imminent. Our objective was to assess parental acceptability and decision-making regarding AWT.

Study Design:

Interviews were completed with 30 parents regarding a hypothetical choice for a 23 week gestational age baby between participation in a FIH AWT trial, neonatal intensive care, or comfort care.

Result:

Most parents (63.3%) indicated that they would participate in a FIH AWT trial. Reasons for participation included: hope for better outcomes, naturalness, comfort, trust in medical progress, and furthering science. The most common reason for not participating was a general hesitancy of FIH trials.

Conclusion:

AWT may be acceptable to many families facing periviable birth, but that acceptability will depend on transparent counseling about uncertainty, clear communication of preclinical evidence and trial safeguards, and attention to parents' questions.

INTRODUCTION

Extreme prematurity, defined as birth before 28 weeks of gestation, is the leading cause of neonatal mortality and morbidity(1–3). Although extremely premature births account for fewer than 5% of births worldwide, they represent the most common cause of death in the first month of life and contribute to greater than 75% of deaths in the neonatal period in developed countries(4, 5). Infants born at these early gestations are at high risk for a trajectory of complications, including respiratory failure, intracranial haemorrhage, necrotizing enterocolitis during neonatal period, as well as longer term complications such as neurodevelopmental impairment(2, 6). These complications of prematurity persist despite ongoing advancements in neonatal and obstetric care(2, 7–12).

Given the limitations of conventional intensive care, researchers have explored a fundamentally different approach to supporting extremely preterm infants through the development of an artificial womb-like, fluid-filled environment to preserve fetal physiology. First conceptualized in the 1950s, artificial womb technology (AWT) has been developed by several research groups worldwide, leading to different

functioning models(12–16). In 2017, investigators reported support of fetal lambs for up to four weeks in a closed, sterile, fluid-filled AWT system using pumpless arteriovenous extracorporeal support via umbilical cannulation(17). In light of these preclinical advances, the FDA Pediatric Advisory Committee met in September 2022 to consider the safety and efficacy requirements for first-in-human (FIH) trials, underscoring that clinical translation of AWT is imminent(18).

Anticipating such FIH trials, it is crucial to understand parental acceptability. Decision-making at the threshold of viability is already complex, requiring obstetricians, neonatologists, and parents to navigate emotionally charged goals-of-care discussions(19, 20). The addition of research participation further complicates these conversations(21). Therefore, we sought to evaluate parental willingness to consider enrollment in a FIH trial of AWT alongside other modalities for peri-viable neonates and to identify key factors associated with willingness to consider AWT as well as hesitancies.

METHODS

Study Design

This was a single-center, combined survey study and interview conducted at Duke University between December 2025 and April 2026. The study was approved by the Duke University Institutional Review Board (Pro00119680), and all participants provided consent before participation.

Participants

Participants were recruited from three groups: pregnant patients (PP) presenting for routine anatomy ultrasound between 18- and 22-weeks' gestation, parents (AP) of children born extremely preterm who survived after neonatal intensive care (NICU) (both mothers and fathers), and bereaved parents (BP) of children born extremely preterm who did not survive (both mothers and fathers). To be eligible for this study, all participants were at least 18 years old at the time of participation and were fluent in English. Expectant parents were eligible in the absence of known maternal or fetal complications. For the latter two groups, participants with a child born between 22–26 weeks' gestation at least 12 months before the interview were considered. Eligible participants were identified through the electronic medical record. Expectant parents were recruited in-person at the time of their prenatal visit, whereas NICU parents were recruited by email and phone.

Survey and Interview

A survey and interview guide were formatted after reviewing the literature and consulting with multidisciplinary experts. Data was collected in person for the expectant mothers following their anatomy ultrasound and using Zoom Workplace (Version 7.0.5) for former NICU parents. A single team member conducted all interviews.

FIH Trial of AWT

Participants were asked to imagine that they or their partner were in preterm labor at 23 weeks' gestation and premature delivery was imminent. They were informed that birth at this gestational age is associated with substantial uncertainty and risk, including death, intracranial hemorrhage, visual impairment, serious infection, necrotizing enterocolitis, respiratory failure requiring mechanical ventilation, prolonged oxygen dependence and possible tracheostomy. Participants were shown an icon array depicting outcomes for infants born at 23 weeks' gestation (**Supplement 1**), including death (45%), survival without severe complications (14%), and survival with severe complications (41%), using selected outcomes from the Vermont Oxford Network from 2020–2022(2). An icon array was used to improve risk communication and comprehension(22–24).

Three options were described: neonatal intensive care, comfort care, or enrollment in a research study of a novel device. Explanations of intensive care and comfort care are included in **Supplement 2**. The device was described as maintaining the infant in a uterus-like environment with the goal of improving survival and reducing the mentioned complications. Participants were told that use of AWT would require cesarean delivery; the infant would be placed in the device before breathing and would be surrounded by fluid resembling amniotic fluid; oxygen would be delivered through tubing connected to the umbilical cord; the infant would remain in the device for several weeks; and parents would be able to see, but not touch or hold, their infant during that time. Participants were shown previously published images of a fetal lamb in an AWT system at birth and after four weeks (**Supplement 3**)(17), as well as an AI-generated image of human patient in the device (**Supplement 4**).

Participants were asked whether they would choose intensive care, comfort care, or enrollment in a FIH trial of AWT and how they made their decision. They were also asked what questions they anticipated parents would have about this device.

Demographics

We measured key demographic characteristics including age, gender, race, ethnicity, education, household income, and religiosity. Parents were also asked about prior pregnancies, previous children born extremely preterm, and if they had any experience with NICU care.

Data Analysis

Categorical variables were summarized using frequencies and percentages. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate. Inferential statistics were not performed due to the sample size.

Audio recordings of each interview were transcribed through Otter.ai, de-identified, and verified for accuracy. Transcripts were uploaded to NVivo for extraction and analysis. Participants responses were

analyzed using inductive thematic analysis done independently by two coders(25–27). Coding was compared and any discrepancies were discussed until consensus was achieved.

Results

Sample Description

Thirty participants completed the survey and interview. Most participants were mothers (n=26 [87%]). Ages ranged from 24 to 45 years, with a mean of 33 years (SD, 6.4 years). Other characteristics are reported in **Table 1**.

Hypothetical FIH AWT Trial

After participants were given the hypothetical, 19 participants (63%) chose trial participation, whereas 10 (33%) chose intensive care, and 1 (3%) bereaved parent chose comfort care (**Figure 1**).

Arguments for FIH AWT trial participation

When asked why they chose the FIH trial, there were five major themes (**Table 2**). Some participants discussed multiple themes.

Theme 1: Hope for Better Outcomes

The most common factor supporting AWT trial participation (n=13 [43%]) was hope for better outcomes. Participants had high hopes that AWT would increase survival and allow babies to avoid the complications associated with NICU care.

“I would say, then, functionally, that kind of avoids some of the parts of intensive care that can have long-term effects.” –AP10

“I would try it, just being that I had the two losses. I wish it was around then just to see, you know, so they can have a chance.” –BP10

Theme 2: Natural

The second most cited reason (n=12 [40%]) had to do with the perceived naturalness of AWT. Participants felt this technology more closely emulated being inside the womb.

“It looks like they were able to develop more you know like they usually would if they were in, in utero.” –BP10

“I would see as a gift, that, you know, it extends the period that baby looks like baby already in the womb, so I would definitely try to choose that.” –BP5

Theme 3: Comfort

The third most common factor (n=5 [17%]) had to do with the appearance of the device. Participants felt the device appeared more comfortable than the environment and interventions they associated with the NICU.

"A lot of women would choose this, you know, just to have something comfortable, and be able to see their baby grow." –BP3

"It's more comfortable than an intensive unit with all the cables and cords and, you know, pokes and stuff." –PP1

Theme 4: Trust in Medical Progress

The fourth most common driver (n=4 [13%]) was an overarching trust in medical progress. Participants were encouraged by the preclinical evidence and felt that doctors and scientists were working towards better treatment options for babies.

"I feel like the doctors would know what they're doing in order to save my baby, so I definitely would try it." –AP9

"You see on a lamb it worked amazingly, and it would hopefully work the same way for a child." –PP6

Theme 5: Furthering Science

The final reason for trial participation (n=3 [10%]) was an altruistic drive to help future families. Participants hoped that by participating in a trial they might help other families in the future.

"If my baby is the first or second one to try this device, maybe it's helpful for other people." –PP7

Arguments against FIH AWT trial participation

When parents were asked why they would not choose to participate in FIH AWT trial there were four major themes (**Table 3**).

Theme 1: Hesitancy about FIH trials

The most common factor driving participants to choose NICU/ comfort care over AWT (n=9 [30%]) was hesitancy about FIH trials. Participants worried about having their baby be the first to test a new technology.

"It would be very difficult for me to be like, oh yeah, let's jump on being the first person to try this out." –PP1

"It's scary emotionally and mentally being the first." –PP10

Theme 2: Historical Evidence

The second most cited factor (n= 3 [10%]) was that NICU care is backed by more historical evidence. Participants valued the decades of research, medical practice, and outcomes from NICU care.

"We have years of success with [the NICU] model from humans." –AP6

"I've met so many... premature adults that survived and thrived and lived normal, healthy, happy lives with the current models of care." –AP7

Theme 3: Human Touch

The third most common factor (n=3 [10%]) was the sense that AWT didn't allow for the same sense of connection. Participants associated human touch with intensive care.

"I would definitely choose intensive care. It's more heartfelt and more heartwarming." –AP5

"I'm going to always trust human touch rather than machine." –BP3

Theme 4: Potential Complications

The fourth most cited factor (n=2 [7%]) was fear of complications.

"Anything could go wrong with the cord, anything could disconnect, you know, any wire could just stop working, you never know." –BP3

"I worry ... if there was any other, like, dangers for the baby, not just being premature." –PP1

Questions About AWT

Parents were asked, "What questions do you think other parents will have about this device?" Their answers included five thematic groups of questions.

Theme 1: Outcomes

The most common questions (n=18 [60%]) pertained to future outcomes of AWT. Participants really wanted to know if AWT would offer better short- and long-term outcomes.

"Is this going to improve my baby's chance of survival? Is this going to improve their chance of having less long-term complications." –AP10

"What is the survival rate? What are the developmental impacts of this?" –BP2

Theme 2: Practical Application of AWT

The second most common questions (n=16 [53%]) pertained to practical application of AWT. Parents wanted to know about length of use, switching to intensive care, cost and insurance coverage.

"I guess I wonder if we got into this, this study, and things weren't going well, could we eventually venture back to intensive care?" –AP7

"What is the cutoff gestational age for using it?" –AP10

"What is the cost? Is this covered by insurance?" –AP4

Theme 3: Preclinical Evidence

The third most common questions (n=14 [47%]) related to preclinical studies. Participants wanted specific information regarding length, number, and exact outcome of preclinical trials.

"How many trials have been done on lambs?" –PP5

"What did you say the success rate was on, like, the tests with animals? What was the sample size?" –AP4

Theme 4: Components of AWT

The fourth most common questions (n=12 [40%]) pertained to components of AWT. Participants wondered about nourishment, oxygenation, encasing, and function of the device.

"What are they nourished with? –PP1

"What does the amniotic fluid consist of?" –AP8

Theme 5: Care in and after AWT

The fifth most common questions (n=12 [40.0%]) pertained to how babies would be managed while in and after AWT.

"Who is going to be involved? Like, you know, what kind of doctors will be involved?" –BP4

"How would doctors be able to...I guess, evaluate the baby, in a sense of, like, they can't put hands on them like they can in the intensive care." –BP7

DISCUSSION

AWT is a more physiologic approach to the care of extremely preterm infants, with the goal of supporting continued development while avoiding the limitations of conventional neonatal intensive care. As AWT moves toward FIH evaluation, understanding parents' reactions to this technology is essential. In this study, we found that most parents were open to AWT in the setting of a hypothetical 23-week delivery: 63% of participants selected enrollment in a FIH AWT trial, compared with 33% who selected conventional intensive care and 3% who selected comfort care.

Preferences across participant groups suggest that parental acceptability of AWT is shaped not only by hopes for improved outcomes, but also by lived experience with extreme prematurity. We specifically selected the three different groups aiming to evaluate acceptability in (1) the exact population who would be candidates for the FIH AWT trial, (2) parents of NICU survivors with insights into the short and long-term consequences of extreme prematurity and NICU care, and (3) bereaved parents with lived experience with extreme prematurity and neonatal loss. Pregnant participants and parents of survivors selected AWT at similar rates, whereas bereaved parents were most likely to select AWT and least likely to select intensive care. Among bereaved parents, 7 of 10 selected AWT, 2 selected intensive care, and 1 selected comfort care. These subgroup findings align with prior research and suggest that for families who experience neonatal loss, conventional intensive care may be closely associated with prolonged uncertainty, suffering, and limitations of NICU care(28–30). In that context, AWT may be viewed not simply as another intensive care modality, but as a meaningfully different approach. At the same time, one parent choosing comfort care underscores that prior loss does not lead to a single preference; rather, it highlights the need for individualized counseling. This aligns with research in neonatal decision-making more broadly which highlights the need to meet parents emotional and information needs through tailored counseling(31–33).

Reasons for selecting AWT were broadly shared. The most common driver of trial participation was hope that AWT might improve outcomes. Hope in the setting of FIH research requires careful attention. Counseling must be grounded in transparent discussion of what is known versus unknown, and what early trials are designed to evaluate. Consent for clinical trials involving neonates has proved challenging in the past, and research has highlighted the importance of conveying clear information and ensuring parents' understanding(34, 35). This will be especially important for AWT.

The most common reason participants declined AWT was hesitancy about enrolling an extremely preterm infant in a trial of an unproven intervention. Importantly, this concern did not necessarily reflect opposition to AWT itself, but rather discomfort with being among the first to expose their newborn to this technology. This distinction has direct implications for trial design and informed consent. Families will need clear explanations of what preclinical evidence supports translation, what safeguards are in place, what complications can be expected, and what options exist if the device does not function as intended.

Furthermore, the questions participants raised identify areas where counseling can meaningfully support informed decision-making and provide a practical framework for developing parent-centered materials for FIH AWT trials. Participants most often wanted information about survival, complications, and long-term developmental outcomes, but they also asked about duration of support, eligibility, transition to intensive care, preclinical evidence, device function, monitoring, and care during and after AWT. These findings suggest that counseling should be concrete and operational, a finding supported by prior literature into best practice for counseling parents(32, 36). Families will need to understand what daily care in the device would involve, how clinicians would assess the infant, what forms of parental presence or interaction would be possible, how decisions would be made if clinical deterioration occurred, and what long term care would look like.

Limitations

Several limitations should be considered. First, this was a single-center study conducted at an academic medical center. Findings may therefore not reflect the perspectives of families outside tertiary referral centers. Although the three participant groups were intentionally selected to capture distinct perspectives on pregnancy, extreme prematurity, NICU survival, and neonatal loss, further studies with a larger sample size will allow for subgroup analysis.

Second, participants responded to a hypothetical 23-week delivery scenario. Stated preferences may differ from decisions made regarding different clinical circumstances or those made during actual periviable counseling. In addition, participants' responses may have been influenced by how AWT was described and visually presented. Notwithstanding these limitations this study provides practical, early insights into parental hopes, concerns, and informational needs as AWT moves toward FIH evaluation.

CONCLUSION

In this study, the majority of participants indicated that they would consider enrollment in a FIH AWT trial for extreme prematurity. Willingness to participate was motivated by hope for improved outcomes and perceptions of AWT as more natural and comfortable. At the same time, hesitancy about FIH research, known outcomes of NICU care, concern about unforeseen complications, and questions about parental connection and infant care were important barriers to trial participation. These findings suggest that AWT may be acceptable to many families facing periviable birth, but that acceptability will depend on transparent counseling about uncertainty, clear communication of preclinical evidence and trial safeguards, and attention to the practical and emotional questions parents bring to the decision. As AWT moves toward clinical translation, FIH trials should be designed not only around safety and feasibility, but also around the informational needs, values, and concerns of families asked to consider participation.

Declarations

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Contributors Statement:

H. Johnston conceptualized and designed the study, completed the interviews, carried out the initial analyses, drafted the initial manuscript, and critically reviewed and revised the manuscript.

F. De Bie conceptualized and designed the study, carried out the initial analyses, and critically reviewed and revised the manuscript.

S. Rent and S. Ellestad facilitated data collection and critically reviewed and revised the interview script and manuscript.

S. Docherty, D. Brandon, and P. Ubel critically reviewed and revised the interview script and manuscript.

R Antiel conceptualized and designed the study, drafted the initial manuscript, and critically reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Tables

Table 1. Demographic information

Variable	Expectant (N=10)	Alive (N=10)	Bereaved (N=10)
Age (Mean, SD)	31.2 (6.3)	33.4 (4.9)	35.7 (7.5)
Gender, Female	10 (100%)	8 (80%)	8 (80%)
Race			
White	4 (40%)	7 (70%)	5 (50%)
Black	3 (30%)	2 (20%)	4 (40%)
Asian	2 (20%)	0 (0%)	1 (10%)
Other	1 (10%)	1 (10%)	0 (0%)
Latino Ethnicity, yes	2 (20%)	4 (40%)	1 (10%)
Highest Education			
Highschool or less	2 (20%)	0 (0%)	1 (10%)
Some college/associate	3 (30%)	5 (50%)	3 (30%)
Bachelor's degree	3 (30%)	4 (40%)	3 (30%)
Post-graduate degree	2 (20%)	1 (10%)	3 (30%)
Income, \$			
< 35,000	0 (0%)	1 (10%)	1 (10%)
35,000 – 48,000	1 (10%)	3 (30%)	0 (0%)
48,000 – 143,000	5 (50%)	5 (50%)	8 (80%)
143,000 – 215,000	1 (10%)	1 (10%)	0 (0%)
> 215,000	3 (30%)	0 (0%)	1 (10%)
High religiosity, yes	5 (50%)	1 (10%)	3 (30%)
Number of Prior Pregnancies (Mean, SD)	0.7 (1.1)	2.8 (1.3)	2.6 (1.3)
Previous Extremely Premature, yes	0 (0%)	10 (100%)	10 (100%)

Table 2: Reasons for trial participation

	Overall (n=30)	Expectant (n=10)	Alive (n=10)	Bereaved (n=10)
Hope for better outcomes	13 (43%)	5 (50%)	4 (40%)	4 (40%)
Natural	12 (40%)	5 (50%)	4 (40%)	3 (30%)
Comfort	5 (17%)	1 (10%)	2 (20%)	2 (20%)
Trust in medical progress	4 (13%)	2 (20%)	2 (20%)	0 (0%)
Furthering science	3 (10%)	2 (20%)	0 (0%)	1 (10%)

Table 3: Reasons for not participating in FIH AWT trial

	Overall (n=30)	Expectant (n=10)	Alive (n=10)	Bereaved (n=10)
Hesitancy about FIH trials	9 (30%)	4 (40%)	3 (30%)	2 (20%)
Historical evidence	3 (10%)	0 (0%)	3 (30%)	0 (0%)
Human touch	3 (10%)	0 (0%)	2 (20.0%)	1 (10%)
Potential Complications	2 (7%)	1 (10%)	0 (0%)	1 (10%)

Table 4: Questions regarding AWT

	Overall (n=30)	Expectant (n=10)	Alive (n=10)	Bereaved (n=10)
Outcomes	18 (60%)	7 (70%)	6 (60%)	5 (50%)
Practical application (length of use, transition to NICU, use case, cost)	16 (53%)	5 (50%)	5 (50%)	6 (60%)
Preclinical Evidence	14 (46%)	7 (70%)	4 (40%)	3 (30%)
Components of AWT (nourishment, oxygen, encasing)	12 (40%)	2 (20%)	5 (50%)	5 (50%)
Care in and after AWT	12 (40%)	2 (20%)	5 (50%)	5 (50%)

Figures

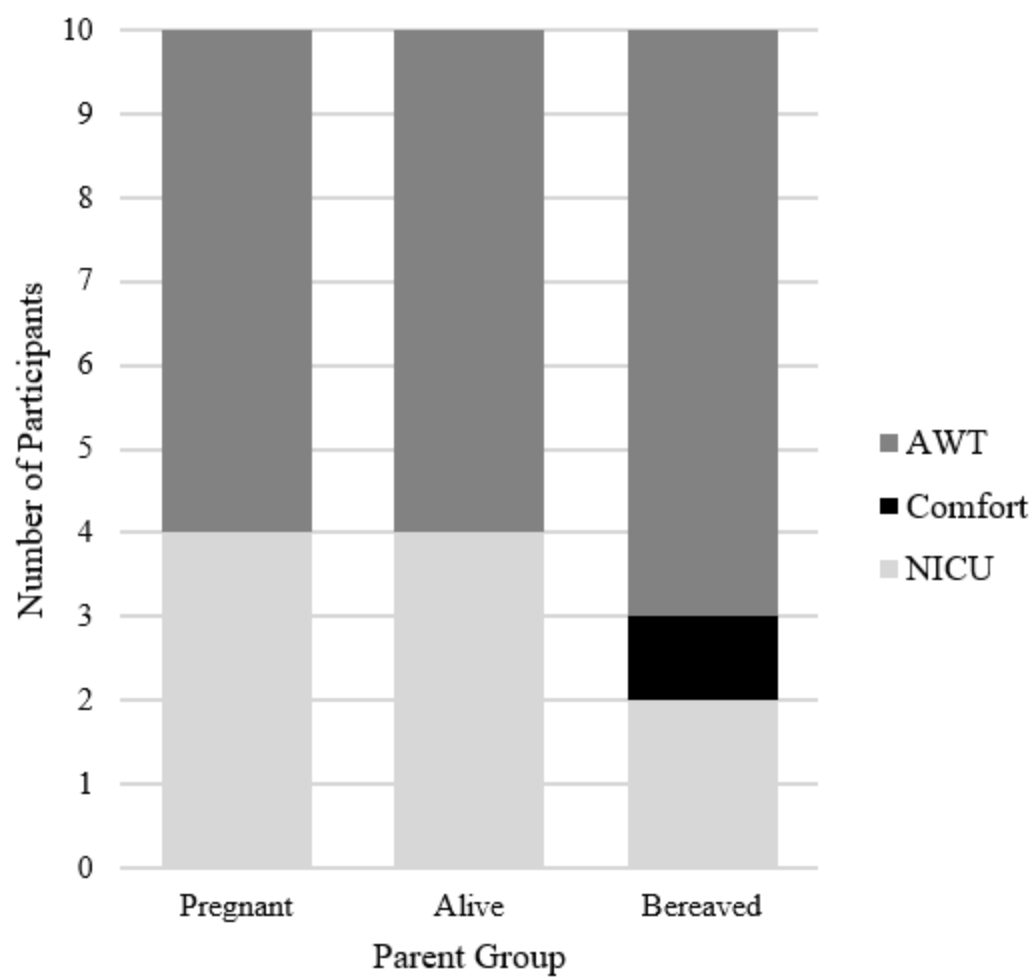


Figure 1

Decision-making in Hypothetical 23 Week Gestational Age Delivery

See alternative file for figure

Figure 1. Number of participants in each subgroup choosing AWT, intensive care, and comfort care in a hypothetical 23-week preterm delivery.

Supplementary Files

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