

Fertility preservation options for transgender and nonbinary individuals

Jensen Reckhow, Hakan Kula and Samir Babayev 

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Abstract: Transgender and nonbinary individuals are historically underserved by healthcare systems. A crucial area for improvement is fertility preservation counseling and service delivery, as gender-affirming hormone therapy and gender-affirming surgery may negatively affect future fertility. The methods available for fertility preservation depend on the patient's pubertal status and utilization of gender-affirming therapies, and counseling and delivery of these services are complex and require a multidisciplinary approach. Further research is needed to identify pertinent stakeholders in managing the care of these patients, as well as to better understand the optimal frameworks for delivering integrated and comprehensive care to this patient population. Fertility preservation is an active and exciting area of scientific discovery and offers a wealth of opportunities to improve the care of transgender and nonbinary individuals.

Keywords: transgender, nonbinary, fertility preservation, family planning

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Introduction

Transgender and nonbinary individuals comprise a small but underserved population in reproductive medicine. It is estimated that 150,000 youths and 1.4 million adults in the United States identify as transgender, and an additional of 1.2 million identify as nonbinary.^{1,2} This population suffers a myriad of adverse mental and physical health outcomes, with nearly one-quarter of individuals avoiding engaging with the healthcare system due to concern for discrimination.^{3–5} Of particular concern in this population is the poor utilization of preventive health services and other future-oriented services, including fertility preservation.

Fertility preservation care has historically centered around oncofertility, and only in recent years has fertility preservation for transgender and nonbinary individuals come to the forefront.⁶ This is a critical aspect of quality medical care for these patients, as many gender-affirming treatments sought by this group may negatively impact future fertility.⁷ Additionally, these individuals desire biological parenting at rates similar to the general population, with estimates ranging from 18–54%.^{8–10} The aim of this narrative review is to summarize the existing literature regarding

fertility preservation technologies for adolescents and adults, as well as to review barriers to the administration of well coordinated and timely care for transgender and gender-diverse patients (Table 1).

Fertility preservation options

Fertility preservation options depend primarily on the patient's reproductive organs, whether they have experienced puberty, and whether they have utilized gonadotoxic gender-affirming therapy. Options are limited for some patient groups. Fortunately, this remains an active area of research, and currently, experimental fertility preservation methodologies may soon join the repertoire of options available for patients. Please see Table 2 for details regarding fertility preservation options for individuals based on these factors.

Individuals with ovaries

Patients with ovaries have several options for fertility preservation, each of which comes with a unique set of risks and benefits. Pubertal patients with ovaries (at or beyond Tanner Stage II breast

Correspondence to:

Jensen Reckhow
Obstetrics & Gynecology,
Mayo Clinic, 200 1st Street
SW, Rochester, MN 55907,
USA.
reckhow.jensen@mayo.edu

Hakan Kula
Obstetrics & Gynecology,
Dokuz Eylul University,
Izmir, Turkey

Samir Babayev
Obstetrics and Gynecology,
Mayo Clinic, Rochester,
MN, USA

Table 1. Terminology and definitions.

Term	Definition
Sex	Refers to biological attributes, including chromosomes, gene expression, and reproductive anatomy. Terms include male, female, and intersex, and there is variation in the biological attributes that contribute to defining these categories.
Gender	Social construct of personal identity that is derived from behaviors and expressions which are consistent with societal roles. Gender was historically understood by many as a binary (man/masculine and woman/feminine) but is now understood to include the considerably wider diversity. Examples of gender include masculine, feminine, agender, bigender, cisgender, transgender, genderfluid, and more.
Gender dysphoria	Defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as clinically significant distress and/or impairment related to a strong desire to be of a gender that is perceived as discordant from the sex assigned at birth. This may include a desire to change primary and/or secondary sex characteristics.
Primary and secondary sex characteristics	Primary sex characteristics are present at birth and include internal and external reproductive anatomy. Secondary sex characteristics are physical features that emerge during the peripubertal period.
Transgender	Having a gender identity that differs from the gender presumed from the sex assigned at birth.
Cisgender	Having a gender identity that aligns with the gender presumed from the sex assigned at birth.
Nonbinary	Gender identity that does not fall exclusively in the categories of masculine or feminine.
Gender fluid	Gender identity that changes over time.
Transman or Transmasculine	Gender identity is masculine. Sex assigned at birth is not male.
Transwoman or Transfeminine	Gender identity is feminine. Sex assigned at birth is not female.
Gender-Affirming Hormone Therapy (GAHT)	Medical treatment that affirms an individual's gender. This may include estrogen, testosterone, and other endocrine hormones related to expression or suppression of secondary sex characteristics.
Gender-Affirming Surgery (GAS)	Surgical treatment that affirms an individual's gender. This may include genital and chest reconstruction as well as other procedures such as hair implantation or removal.

development) may consider oocyte or embryo cryopreservation. These options involve controlled ovarian hyperstimulation and a surgical procedure to retrieve oocytes.⁷ This requires frequent contact with the healthcare system over a relatively short period, which can contribute to anxiety among individuals who may already be distrustful of the medical system.

Patients often need multiple transvaginal ultrasounds to assess follicular growth, and oocytes are most commonly retrieved through a transvaginal approach, both of which may trigger dysphoria. Reproductive endocrinology and infertility (REI) specialists should also consider utilizing

transabdominal over transvaginal ultrasound approaches when gonad positioning and body habitus allow.^{4,11} Furthermore, the increased estrogen levels experienced during this process, as well as the potential for menses to resume at its conclusion, may cause significant dysphoria. Individuals may choose to preserve oocytes through this technique or elect to preserve embryos with sperm from a partner or known or unknown sperm donor.

Exogenous testosterone exposure may simultaneously increase the ovarian follicle pool (similar to what is seen with polycystic ovary syndrome patients) and blunt the response to gonadotropins,

Table 2. Fertility preservation options by pubertal status.

Prepubertal individuals	
Individuals with ovaries	Individuals with testes
<ul style="list-style-type: none"> - Ovarian Tissue Cryopreservation (OTC) (with in vitro oocyte maturation or ovarian tissue reimplantation) 	<ul style="list-style-type: none"> - Testicular Tissue Cryopreservation with in vitro spermatocyte maturation
<ul style="list-style-type: none"> - Requires surgical intervention, anesthesia - OTC itself is no longer experimental, however in vitro maturation of oocytes from cryopreserved ovarian tissue and reimplantation of cryopreserved ovarian tissues for future IVF remain experimental - Can be performed during GAS 	<ul style="list-style-type: none"> - Requires surgical intervention, anesthesia - Experimental: may only be performed within a research protocol - Can be performed during GAS
Pubertal individuals	
Individuals with ovaries	Individuals with testes
<ul style="list-style-type: none"> - Oocyte Cryopreservation - Embryo Cryopreservation - OTC 	<ul style="list-style-type: none"> - Sperm Cryopreservation - Surgical Sperm Extraction (TESE/PESA)
<ul style="list-style-type: none"> - May be performed regardless of prior gender-affirming hormone therapy, however cessation of GAHT may be required for the procedures - Ovarian stimulation process may trigger profound gender dysphoria 	<ul style="list-style-type: none"> - May be performed regardless of prior gender-affirming hormone therapy, however cessation of GAHT may be required for the procedures - TESE/PESA may be performed in an outpatient setting under local anesthesia - Sperm collection via ejaculation may trigger profound gender dysphoria
<p>GAHT, Gender-Affirming Hormone Therapy; GAS, gender-affirming surgery; IVF, in vitro fertilization; TESE, testicular sperm extraction; PESA, percutaneous sperm aspiration.</p>	

requiring prolonged and more expensive stimulation cycles.¹² Notably, AMH levels, which may predict response to controlled ovarian stimulation, tend to decrease after exogenous testosterone exposure, consistent with the above reported trends.¹³ However, the clinical significance of these changes remains under scrutiny as they are often minor.¹⁴ One retrospective cohort study found no difference in baseline follicle count or cycle length between transgender men with and without a history of Gender-Affirming Hormone Therapy (GAHT) use; however, those with a history of GAHT use had lower peak estradiol levels and lower oocytes retrieved.⁹ Still, this study reported three successful pregnancies conceived using oocytes from transgender men who had used GAHT.¹⁵ However another study found no difference in peak estradiol levels or the number of oocytes retrieved between transgender men with a history of GAHT use, transgender men without a history of GAHT use, and cisgender females. Five of the six transgender men with a history of GAHT

use achieved good-quality embryos suitable for in vitro fertilization (IVF).¹⁶ Recent research corroborates that there does not appear to be any negative impact of exogenous testosterone exposure on preimplantation embryo quality, development, or fertilization rates.¹⁷

Today, most fertility centers require patients to discontinue testosterone therapy for 1–3 months prior to an ovarian stimulation cycle. Gender dysphoria triggered by discontinuation of GAHT may be life-threatening, so this is a prohibitive barrier to care for many patients. There is currently one published case report of a pregnancy resulting in live birth following oocyte retrieval from a transgender man who was maintained on testosterone therapy throughout a controlled ovarian stimulation cycle. That patient had a 10-year history of testosterone use. The ovarian stimulation cycle was longer than average and the embryo aneuploidy rate was more than twice the expected rate for the patient's age cohort.¹² Still,

this case shows promise for future fertility preservation that minimizes at least one aspect of gender dysphoria. Other considerations to minimize the dysphoria associated with ovarian stimulation may include the addition of aromatase inhibitors such as letrozole to reduce estradiol elevations during stimulation cycles and random-start protocols that do not require patients to have a menses prior to beginning a stimulation cycle.

Ovarian tissue cryopreservation (OTC) is an alternative option for prepubertal individuals as well as individuals with contraindications to ovarian stimulation, such as those who cannot delay or pause gonadotoxic treatment for an ovarian stimulation cycle. This technique requires an invasive procedure that comes with surgical and anesthetic risks. Until 2020, this procedure was considered experimental by the American Society of Reproductive Medicine (ASRM). While the removal of ovarian tissue is no longer experimental, the techniques to attempt future pregnancy after this do remain experimental. One technique, future autotransplantation of cryopreserved ovarian tissue, is being investigated with caution among select oncology patients. This may be a useful tool for some transgender and gender-diverse individuals, however it is critical to appreciate that reintroduction of this tissue may trigger gender dysphoria, which is often a reason for tissue removal in the first place. Alternative to this is *in vitro* maturation of oocytes harvested from cryopreserved ovarian tissue. To date, no successful pregnancies utilizing *in vitro* maturation of oocytes from cryopreserved ovarian tissue have been reported.¹⁸ However, live births have been reported using this technique for cancer patients. The effect of testosterone exposure on *in vitro* maturation of cryopreserved oocytes is poorly understood, however there is evidence that the developmental capacity of such oocytes may be diminished.¹⁹ Now that OTC is no longer experimental for transgender and gender-diverse patients, we may see this being offered to more patients, and with more data, we can improve its efficacy and outcomes.

Individuals may elect for removal of the ovaries (oophorectomy) as a gender-affirming surgery (GAS) regardless of desires for fertility preservation. Other GAS procedures for individuals with ovaries may include removal of the uterus (hysterectomy), fallopian tubes (salpingectomy), and/or

breast tissue (mastectomy). Evaluation of removed ovarian tissue has identified histologic changes associated with exogenous testosterone exposure, including increased ovarian cortical stiffness, stromal luteinization, and an increased prevalence of primordial and atretic follicles.^{20–22} The clinical significance of these changes is under investigation. No increased rates of dysplastic or malignant changes have been observed in these samples.²³

Individuals with testes

Fertility preservation options for individuals with testes are, in general, less invasive and less time- and resource-intensive. The most widely available options include sperm cryopreservation and testicular sperm extraction (TESE), which may be used to cryopreserve gametes or embryos. Cryopreserved gametes may later be used for intrauterine insemination or IVF, and cryopreserved embryos may later be used for IVF. Sperm cryopreservation requires the patient to provide a semen sample – a noninvasive process that may trigger significant dysphoria. TESE may be done in an outpatient setting under local anesthesia. These options are available to patients who have reached Tanner Stage II or more and who have a testicular volume of at least 5 mL.¹⁸

While current data on the effect of testosterone on oocyte maturation is conflicting, most evidence to date shows an association between gender-affirming estrogen use and sperm quality. In one study of semen specimens collected via ejaculation, specimens collected from patients on GAHT were associated with abnormal semen parameters. This effect did not appear to be permanent, as semen parameters were comparable among patients who had never used GAHT and those who had discontinued GAHT, with an average discontinuation interval of 4.4 months.²⁴ Several studies support these findings of the detrimental effect of GAHT on spermatogenesis and sperm quality.²⁵ However, other studies show continued semen parameter abnormalities even after discontinuation of GAHT,²⁶ and yet others show semen parameter abnormalities among transgender individuals even prior to initiating GAHT.^{27,28} Data regarding histologic changes after GAHT have been noted as well.²⁹ Because of the inconclusive data, many providers recommend fertility preservation prior to initiating

GAHT with estrogen in patients with testes.^{24,30} Additionally, strong consideration for the use of intracytoplasmic sperm injection to increase fertilization rates in this population, regardless of prior hormonal exposure, is recommended.²⁸ The youngest reported age of successful specimen collection for sperm cryopreservation is 11 years.

Currently, there are no fully approved options for fertility preservation for prepubertal patients with testes. Testicular tissue cryopreservation remains experimental, and can only be offered within a research protocol, so the use of this technology remains limited.³¹

Considerations for adolescents

Many individuals have a strong sense of self in childhood and adolescence, and the ability to initiate gender-affirming care at an early age is important. Patients must be informed about the potential impacts of gender-affirming care on future fertility to allow them the opportunity to make decisions about fertility preservation and other aspects of their care. Fertility preservation can be a high-risk undertaking without a guarantee of desired results, and there are often multiple medically reasonable options for individuals to consider.³² It is challenging to make future-oriented medical decisions, particularly when patients have not yet considered whether they want children in the future, whether having biological children is important to them, and when they do not know what their future financial solvency will be. Children and adolescents face additional challenges with this, as their prefrontal cortex is not yet fully developed to take on this type of complex, forward-thinking decision-making. Furthermore, providers and guardians may feel uncomfortable broaching this subject with patients. Still, this is a key population to consider, as children and adolescents are less likely to have already initiated gonadotoxic treatments and, therefore, may be more likely to succeed with fertility preservation if this is pursued.³¹ Lessons can be learned from Israel, where one study showed that 100% of child and adolescent patients were offered a fertility preservation consultation during their first visit to a gender-affirming clinic.³³ It is important to remember that gender-affirming therapy aims to achieve gender euphoria rather than only to minimize gender dysphoria. Not all patients, especially children and adolescents who have not yet reached

puberty will experience functional limitations because of their gender identity discordance. Yet, these individuals may still stand to improve with gender-affirming therapy. Pediatric and adolescent gynecology specialists are uniquely positioned as experts in sexual and reproductive health and development to help guide these conversations. Counseling may focus on internal and external motivations for treatment, as more externally motivated patients may be less likely to see the positive changes in their sense of identity and interpersonal reactions following the treatment.³⁴ Some individuals may elect to initiate gonadotropin-releasing hormone therapy prior to Tanner Stage II–III, as this can provide additional time for patients to make care decisions without simultaneously dealing with the potentially dysphoric effects of experiencing puberty in a gender-discordant body.³³

Barriers to care

Though parenting desires remain high among transgender and gender-diverse individuals, utilization of fertility preservation services remains low.^{8,35,36} Transgender and gender-diverse individuals face many barriers to fertility preservation care, but the two main ones are lack of awareness of this service and lack of access to it. These barriers are multifactorial. ASRM, the World Professional Association for Transgender Health Standards of Care, and the Endocrine Society Clinical Practice Guidelines recommend that all mental health professionals, hormone-prescribing physicians, and surgeons being involved in gender-affirming surgeries discuss fertility preservation options prior to initiating any medical intervention for gender-affirming therapy.⁷ Yet this standard of care is far from being met,^{4,37} with fewer than half of transgender and gender-diverse individuals receiving fertility preservation counseling.³⁸ When asked, 95% of transgender respondents stated that fertility preservation should be offered to all transgender and nonbinary people.³⁹ In one study in Israel, 86% of transgender women and 36% of transgender men pursued fertility preservation after such counseling.⁴⁰ Recent data from Australia, Germany, and the United States suggest that 10% or fewer transgender individuals pursue fertility preservation.^{39,41,42} Fertility preservation options for transgender individuals are not equally available in all countries and regions. Please see Table 3 for additional details regarding fertility preservation

Table 3. Fertility preservation options around the globe.

Country	Legislation and policies related to fertility preservation
United States	<ul style="list-style-type: none"> - No federal legislation exists regarding fertility preservation for transgender and gender-diverse individuals. - Insurance coverage for fertility preservation is limited and varies by insurance provider and state. Few states mandate insurance coverage for fertility preservation (Washington, Minnesota, Illinois, Hawaii, Massachusetts, Montana, New Mexico, Texas, Oregon). Storage costs for preserved gametes and embryos are rarely covered by insurance.
Germany	<ul style="list-style-type: none"> - Transsexuellengesetz: Law initially passed in 1980 requiring individuals to undergo GAS to change gender identity on legal documents. This has since been ruled unconstitutional and the law has been modified accordingly. - Insurance coverage for fertility preservation is limited to married individuals between the ages of 25 and 40 years for females and 25 and 50 years for males. Insurance coverage varies by state. Few states offer programs for funding fertility treatments (Saxony, Mecklenburg-Western Pomerania, Thuringia, Hesse, Brandenburg, Berlin). Storage costs for preserved gametes and embryos are not covered by insurance.
United Kingdom and Ireland	<ul style="list-style-type: none"> - The National Institute for Health and Care Excellence, which provides guidelines for healthcare coverage under NHS, does not provide guidance regarding coverage for fertility preservation in the setting of gender dysphoria. - Utilization of NHS funding for fertility preservation coverage is inconsistent across the UK and Ireland.
Spain	<ul style="list-style-type: none"> - No federal legislation exists regarding fertility preservation for transgender and gender-diverse individuals. Use of a gestational carrier is illegal for all individuals in Spain. Same-sex couples must apply for special recognition from the government to participate in IVF. - Insurance coverage for fertility preservation varies by region. Fertility preservation may be partially covered for childless individuals and couples.
Canada	<ul style="list-style-type: none"> - Assisted Human Reproduction Act: Passed in 2007, this law permits fertility preservation for all individuals regardless of age. - Fertility preservation costs vary by province. Such services are partially covered by the Ontario Health Insurance System.
Sweden, Denmark, and The Netherlands	<ul style="list-style-type: none"> - GAHT, GAS, and fertility preservation for medical indications and elective reasons are all legal in these countries. - Government insurance plans cover female fertility preservation only.
Australia	<ul style="list-style-type: none"> - No federal legislation exists regarding fertility preservation for transgender and gender-diverse individuals. - Insurance coverage for fertility preservation varies by region, but these services are not typically covered by insurance, regardless of indication.
Thailand	<ul style="list-style-type: none"> - Legal fertility preservation methods include semen cryopreservation for individuals assigned male sex at birth and oocyte cryopreservation for individuals assigned female sex at birth. Marriage is only legally permissible between individuals assigned male sex at birth and individuals assigned female sex at birth. - Fertility preservation services are not covered by insurance, but out-of-pocket costs are affordable for the majority of the population.
Brazil	<ul style="list-style-type: none"> - No federal legislation exists regarding fertility preservation for transgender and gender-diverse individuals. - The government encourages, but does not mandate coverage for fertility preservation. Few public hospitals offer these services free of charge and private insurance coverage is not available.
China	<ul style="list-style-type: none"> - Chinese Expert Consensus on Fertility Preservation: National guidelines for fertility preservation published in 2021. - Fertility preservation is not permitted for transgender or gender-diverse individuals, who fall under the 'special populations' for whom such treatment coverage is excluded.
Israel	<ul style="list-style-type: none"> - Fertility preservation policies are determined by the Health Ministry. Private fertility treatments are heavily regulated and rarely utilized. - Fertility preservation for medical indications is covered by the national insurance program for up to two live births for all individuals.

GAHT, Gender-affirming hormone therapy; GAS, gender-affirming surgery; IVF, in vitro fertilization; NHS, National Health Service.

legislation and policies in selected countries around the world.

While comprehensive counseling is certainly a critical step in allowing patients to make appropriate and fulfilling healthcare decisions for themselves, other barriers limit the uptake of this service. All insurance companies are required to offer coverage for necessary medical care. Though gender-affirming care is essential and cost-effective, insurers may consider gender-affirming therapies to be experimental in some cases and, therefore, outside of coverage obligations. Providers may use the ‘equivalent care’ clause, which states that services covered for one medically necessary reason (such as fertility preservation prior to chemotherapy) should be covered for other medically necessary reasons (such as fertility preservation prior to gender-affirming therapy). This can be challenging, however, as the gonadotoxic effects of hormone therapies are in general less well understood than those of chemotherapy agents. Proving medical necessity to insurers can be an emotionally and psychologically draining process, even more so when the care in question is intimately related to an individual’s identity.⁴³ Adolescents and young adults covered by their caregivers’ insurance may be forced to disclose their gender identity to their loved ones when managing such insurance hurdles, taking away their agency in an important process. Finally, fertility preservation is rarely covered by insurance and is cost prohibitive for many.³⁷

Beyond the cost and uncertainty of outcomes, fertility preservation comes with a significant psychological toll in many cases.^{3,37,42} As discussed previously, patients may experience significant dysphoria with transvaginal ultrasound and transvaginal oocyte retrieval. They may also experience bothersome changes in secondary sex characteristics associated with the elevated estrogen levels experienced with controlled ovarian hyperstimulation. While sperm preservation is generally less invasive and a shorter process than oocyte preservation, patients may still experience significant dysphoria with ejaculation, and many may not be able to do this at all. Patients may fear delaying or discontinuing GAHT, which is often required for, and likely improves the efficacy of fertility preservation. For some, the fear of these possibilities is enough to prohibit the pursuit of fertility preservation, even when biological parenthood is desired.

Finally, as discussed above, many individuals begin the process of gender affirmation early in life, well before they are considering parenthood, well before they are partnered, and well before they have the financial means for either parenthood or fertility preservation. Likely, many of these individuals never receive fertility preservation counseling at all.

Future directions

Just as in many other populations, many transgender and gender-diverse individuals desire to build families and have biological children.^{4,31,38,41,44} Parenthood is associated with decreased rates of suicide, better mental health outcomes, and greater perceived self-efficacy.⁷ Transgender and gender-diverse individuals are at high risk for all of these and more adverse health outcomes. Improving awareness of and access to safe, feasible, and desirable fertility preservation opportunities may contribute to better mental health in this population.

Further research is needed to determine the optimal format for optimizing fertility preservation counseling. Integration of services, including counseling, initiation, maintenance of GAHT, and GAS, may increase access to care by establishing clearly designated safe spaces for patients and providing a single location for all the needed services.³¹ Whether this is best done by stand-alone transgender and gender-diverse care clinics or through coordination between relevant units within hospital systems remains in question. Providers involved in treating transgender and gender-diverse patients may also benefit from viewing and connecting patients to comprehensive fertility preservation counseling as being within their scope of practice and critical to providing optimal care for their patients. Table 4 details the role of various medical specialists in providing comprehensive fertility preservation and gender-affirming care for transgender and gender-diverse patients. Notably, the role of regret in fertility preservation care for these patients has not yet been well studied and is worthy of close examination.

Regarding treatment options, more research is needed to determine how to safely perform controlled ovarian stimulation and oocyte cryopreservation without requiring patients to discontinue testosterone. Conversely, research is needed to

Table 4. Stakeholders in fertility preservation.

Department	Role in patient care coordination	Role in fertility preservation treatment
Reproductive endocrinology and infertility subspecialists	<ul style="list-style-type: none"> - Support fertility needs by counseling patients about options for family planning and fertility preservation. REI subspecialists become involved in care by referral from a primary care provider and/or ob-gyn when patients are identified as being at risk for medical and/or surgical treatments that may affect future fertility 	<ul style="list-style-type: none"> - Provide fertility preservation services including controlled ovarian stimulation, sperm, oocyte, and embryo cryopreservation, and/or OTC depending on the scope of practice
Plastic surgery specialists	<ul style="list-style-type: none"> - Support fertility needs by counseling patients about options for gender-affirming reconstructive surgery. Plastic Surgery specialists become involved in care by referral from a primary care provider and/or ob-gyn when patients are considering interventions to change their primary and secondary sex characteristics through surgical reconstruction 	<ul style="list-style-type: none"> - Provide gender-affirming reconstructive surgery, often in conjunction with Urology and ob-gyn surgical specialists - Tailor reconstruction recommendations to meet the needs and goals of the individual patient (e.g. consider desire for future breastfeeding potential when performing chest reconstruction and sexual function desires when performing genital reconstruction)
Endocrinology specialists	<ul style="list-style-type: none"> - Support fertility needs by counseling patients about the options for gender-affirming hormone therapy. Endocrinology specialists become involved in care when patients express interest in GAHT. 	<ul style="list-style-type: none"> -Coordinate with REI and surgical specialists as well as the patient to determine optimal treatment course regarding initiation, interruption, and cessation of hormone therapy to optimize fertility preservation outcomes.
Ob-gyn specialists	<ul style="list-style-type: none"> - Support fertility needs by introducing patients to the scope of gender-affirming therapies and specialists available. - May serve as the primary care provider for the patient, including as the primary provider to offer gender- and sex-appropriate preventive health services 	<ul style="list-style-type: none"> - May perform gender-affirming surgeries including hysterectomy and salpingo-oophorectomy - May refer patients to other specialists as indicated.
Urology specialists	<ul style="list-style-type: none"> - Support fertility needs by counseling patients about options for fertility preservation and gender-affirming reconstructive surgery for individuals with testes 	<ul style="list-style-type: none"> - Perform gender-affirming surgeries including orchiectomy - Provide fertility preservation services including TESE
Psychiatry specialists	<ul style="list-style-type: none"> - Support the mental health needs of the patient and offer coordination of services for support persons, including management of gender dysphoria and associated mental health sequelae 	<ul style="list-style-type: none"> - Counsel patients to identify treatment goals, family planning, and parenting goals, and serve as a patient advocate when coordinating with other members of the care team
<p>GAHT, Gender-affirming hormone therapy; OTC, Ovarian tissue cryopreservation; TESE, testicular sperm extraction.</p>		

determine whether the gonadotoxic effects of estrogen exposure may be reversed in vitro after sperm extraction or if there are options to combat the effects of estrogen locally within the testes to allow for the extraction of high-quality sperm for preservation. Ovarian and testicular tissue cryopreservation remain active and promising areas of future research, as these techniques may be available to children and adolescents who currently have very limited options for fertility preservation.³² In vitro maturation of gametes from cryopreserved gonadal tissue may soon become available, with recent studies showing successful techniques for both oocytes^{45,46} and spermatogonia.⁴⁷ Admittedly, the strongest data in this realm come from animal studies, and human data remain limited.^{48–50} The development of these techniques is particularly critical for fertility preservation in transgender and nonbinary patients, for whom reimplantation of cryopreserved gonadal tissue may not be acceptable.

While the number of transgender and gender-diverse patients is unlikely to be increasing, the healthcare needs of this population are receiving increased and much-needed attention, as these individuals suffer a wide array of health disparities.⁶ Fertility preservation should be considered a critical aspect of high-quality, comprehensive gender-affirming care and should be made accessible to all patients.

Declarations

Ethics approval and consent to participate

Not Applicable.

Consent for publication

Not Applicable.

Author contributions

Jensen Reckhow: Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Validation; Visualization; Writing – original draft; Writing – review & editing.

Hakan Kula: Formal analysis; Investigation; Software; Visualization; Writing – review & editing.

Samir Babayev: Conceptualization; Formal analysis; Project administration; Supervision; Validation; Writing – review & editing.

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The authors declare that there is no conflict of interest.

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ORCID iD

Samir Babayev  <https://orcid.org/0000-0002-0178-5685>

Supplemental material

Supplemental material for this article is available online.

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