

Exploring the Growth and Limitations of *Ex Utero* Intrapartum Treatment

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ABSTRACT: *Ex utero* Intrapartum Treatment (EXIT) offers a method to secure fetal airways during delivery by temporarily preserving placental support, yet its use remains rare. This paper analyzes the administrative, financial, and organizational factors that continue to limit the expanded adoption of EXIT across the United States. The procedure is exclusively feasible at a small number of centers due to equipment costs, personnel costs, and management. Regional inequalities bolster this effect, and underserved areas are even further restricted. Research efforts face similar obstacles. The low number of cases and inconsistent process protocols hinder data collection. Additionally, the NIH, under the current administration, is confronting considerable budget cuts. Historically low federal support for maternal health research further halted progress. However, strengthening training pipelines and targeting grant allocation alongside expanding institutional support through public and private partnerships will open pathways to greater utilization. The remediation of funding and access issues is necessary for EXIT to move beyond specialized centers and become a viable and just option for a larger range of patients facing prenatal complications.

KEYWORDS: Translational Medical Sciences, Disease Treatment and Therapies, Maternal-Fetal Medicine, Fetal Surgery, *Ex utero* Intrapartum Treatment.

■ Introduction

Ex utero Intrapartum Treatment (EXIT) is a complex surgical technique that allows for the controlled delivery of fetuses with airway compromise. It does this through the maintenance of uteroplacental circulation during the establishment of a secure airway. In spite of its potential, EXIT remains underutilized in clinical settings and has struggled to gain the widespread recognition it needs for significant change.

Originally developed in the 1990s, EXIT was first used to “treat temporary tracheal occlusion in patients who had undergone fetal surgery for severe congenital diaphragmatic hernia.”¹ Since its initial application, the procedure has evolved to manage a wide variety of conditions. Some of these conditions include congenital high airway obstruction syndrome (CHAOS), large cervical or thoracic masses, and tracheoesophageal fistula.

The EXIT approach includes 4 possible procedures, including EXIT-to-Airway, EXIT-to-ECMO, EXIT-to-Resection, and EXIT-to-Separation. EXIT-to-Airway is the most common and is surgically indicated by CHAOS, severe micrognathia, or an obstructing mass.² EXIT-to-ECMO is a controversial procedure with no recent statistically significant difference in morbidity for severe congenital diaphragmatic hernia (CDH) patients.³ This cohort is primarily used in cases with CDH or Cardiothoracic anomalies.² In cases of mass obstructions in the head, neck, or chest, EXIT-to-Resection is often performed. Finally, EXIT-to-Separation is reserved for conjoined-twin procedures.² In general, EXIT has a low maternal complication rate, with only 3 of 40 responding institutions (7.5%) reporting major adverse maternal outcomes.⁴ 11 of the same 40 responding institutions (27.5%) report adverse events such as

hypoxic-ischemic encephalopathy (HIE), “death, need for fetal resuscitation, and ‘adverse events such as sequela of disease.’”⁴

Although it has potential, the use cases of EXIT remain limited, in part due to high resource requirements and the complicated nature of the procedure itself. The procedure demands a qualifying patient and the availability of a multidisciplinary surgical team. It also requires an institution with access to advanced surgical infrastructure. This combination of selective eligibility and high institutional costs restricts the general adoption of EXIT. In doing so, the production of procedural research is also limited. Moreover, clinical implementation and research into EXIT are mutually dependent: lacking frequent use, meaningful research is hindered; without sufficient research, hospital systems may lack the evidence base required to justify its use.

Another barrier to the advancement of EXIT-related research is the threat of federal budget cuts, particularly in proposed reductions to National Institutes of Health (NIH) funding under the current administration. The Department of State requested a ~40% cut to the NIH budget, entailing a reduction from \$27.5 billion to \$18 billion for 2026.⁵ Given the already limited research on this topic, if enacted in the future, such cuts could implicate serious threat to progress. Furthermore, despite large advances in maternal health over the past decade, considerable improvements are still necessary. Though the United States invests nearly \$5 trillion annually in healthcare, this investment does not consistently translate into positive maternal health outcomes. In fact, the U.S. continues to hold the highest maternal mortality rate among economically comparable nations.⁶

Overall, the potential for a wider implementation of EXIT in the United States is hindered by worsening funding limitations. Additionally, extensive qualifying criteria make the employment of the procedure currently hard to justify, given the high costs, most prevalently in the areas of research, staffing, and equipment. This paper intends to explore these limitations and present possible solutions that could improve both the accessibility of the procedure and the knowledge of its clinical value.

■ Results and Discussion

One noteworthy aspect of the underutilization of EXITs is found in equipment restrictions. Due to the highly specialized nature of the procedure, equipment is often costly and hard to get. While the specific required equipment varies on a case-by-case basis, generally, EXIT uses what is listed in Table 1.

Table 1: This table gathers estimated price ranges for critical equipment and materials required in Ex Utero Intrapartum Treatment. Using the midpoints of each range totals ~\$181,000. Quality and brand determine where in the listed ranges a specific item's cost may fall. In equipment like an ultrasound machine, fetal resuscitation bay, or adjacent operating room, specific styles and features also affect the price range. The cost of blood for transfusions is a generalization and not entirely indicative of what a specific institution may pay. *List of items cited from Jong, R. and Fordham, T.⁷

Item	Estimated Cost
Anesthesia circuits for both mother and fetus with invasive maternal blood pressure monitoring*	\$10,000-\$150,000
Foley catheter*	\$10-\$50
Two large-bore peripheral intravenous lines*	\$10-\$50
Type-and-crossed blood for possible maternal transfusion in the room*	\$180-\$300
Epidural catheterization*	\$300-\$1,000
Ultrasound machine with sterile sleeve*	\$5,000-\$120,000
Cesarean delivery surgical set*	\$300-\$1500
Electrocautery*	\$2,000-\$15,000
Uterine stapling device*	<\$1000
Amnioinfusion*	\$485-\$1000
Fetal resuscitation bay*	\$7,500
Adjacent operating room set up to receive infant*	>\$20,000

The expensive equipment required for EXIT procedures, as seen in Table 1, limits their workability. Only a small number of institutions, often academic medical centers containing dedicated fetal programs, can perform the surgery. A 2014 survey identified 59 fetal care centers in the United States. Of 29 survey responses, 23 have the capability to perform EXIT procedure, and only 15 have the capability to perform the similar procedure of EXIT to ECMO.⁸ 2023 Data from the North American Fetal Therapy Network (NAFTNet) indicated that, of a responding 41 institutions from a pool of centers from the United States, Mexico, Canada, Argentina, Belgium, and Switzerland (91% response rate for a survey sent to all NAFTNet institutions), 40 are capable of performing EXIT.⁴ There are currently 54 NAFTNet centers internationally, 47 of which are in the United States.⁹ These centers are concentrated on the West Coast, the Northeast, and select parts of the Midwest and South. Though some regions are concentrated, others are scarce; ultimately leaving significant areas of the country,

particularly the Mountain West and rural Southeast, without direct access to EXIT-capable facilities.⁹ The scarcity of these centers potentially leaves patients outside of these regions to face geographic difficulties in accessing potentially necessary critical surgical intervention.

Another costly limitation of EXITs is staffing. Having a multidisciplinary team of specialists is necessary because of the risks intrinsically associated with EXIT. Teams will regularly include an obstetrician, an obstetric anesthesiologist, a neonatal anesthesiologist, a pediatric surgeon, a pediatric otolaryngologist, a neonatal intensivist, a possible ECMO team, a possible pediatric cardiology or cardiothoracic surgery team, a circulating nurse, and a surgical technician.⁷

Additionally, examining the training patterns in maternal-fetal medicine reveals how some problems regarding the availability of doctors may persist into the future. Training in Maternal-Fetal Medicine still follows a structured, usually multi-year fellowship model, although some shifts are being made in program size and scheduling that could potentially affect workforce availability in the future. For instance, UCLA's maternal-fetal medicine fellowship. It will begin to alter its match cycle starting in August 2025, in which they admit two fellows in one year, then one fellow the next, thus reducing the rate of new specialists.¹⁰ This draws attention to potential training constraints in the future. ACGME's 2025 standards mandate the completion of at least 18 months of clinical training in addition to 12 months of research time with cross-disciplinary exposure. Many programs still adhere to this. Given the opportunity cost and length of obligation to the lengthy training durations, these requirements may also turn away trainees even though they demonstrate competency. Some programs, like UCSD, report one fellowship position annually or three fellows every three years. As a whole, the volume of trainees is stable although restricted, therefore potentially preventing further growth. A significant increase in fellowship slots or program flexibility is needed to ensure increased fellowship output and respond to the growing clinical demand in high-risk maternal-fetal surgery.

Despite this, maternal-fetal medicine is a growing field that could remedy the need for multidisciplinary personnel for EXIT. In 2025, the Society for Maternal-Fetal Medicine (SMFM) had over 6,500 members.¹¹ This is a marked increase from the approximately 1,355 board-certified MFM subspecialists reported in 2010.¹² The increased institutional focus on fetal medicine is reflected in this growth. Nevertheless, access to care varies by region. Academic reviews from 2019 say that over 90% of counties don't have a practicing MFM physician. The regional distribution is emphasized even more, as it shows that counties without a practicing physician experience higher preterm birth rates.¹³ This disproportion appears to persist into 2025, with continued concentration of MFM practitioners in larger cities and major fetal health centers. Although numbers are increasing, there is still a disconnect between population need and subspecialist presence. Fellowship training spots need to be expanded in zones where they are lacking. The growing number of specialists might not result in an equita-

ble distribution of services like EXIT. Thus, the expansion of training may prove effective in broadening treatment equity.

The final major limitation of EXIT is in research. The limited sample size due to EXIT's narrow scope of patients is one aspect of this. EXIT is a procedure reserved mainly for highly complex conditions (CHAOS, large neck masses, tracheo-esophageal fistula), and by the nature of this, studies are often small-scale or case reports, rather than large-scale clinical trials. A review noted the limited data on maternal morbidity, long-term fetal outcomes, and cost-utility.¹ Examples such as this, displaying a lack of complete data, may make it difficult for non-specialized hospitals to consider adopting EXIT.

Another aspect of research limitations is the effects of the current administration on the NIH. The NIH is the primary research institution for health in the United States. Following \$1.81 billion in grant terminations from February 28, 2025, to April 8, 2025¹⁴ and the DEI-related funding cut of \$783 million in August 2025,¹⁵ the current NIH has fallen around \$1 billion behind the spending pace of previous years.¹⁶ As of late March 2026, the National Cancer Institute has funded only \$72 million in New and Competitive Grants, in comparison to the \$250 million pace intended to be spent by an agreed-upon point in the fiscal year 2026.¹⁶ The effect of these cuts is amplified because maternal health already receives poor fund allocation from the government. Of the top 15 institutes funded according to the NIH's RePORT page, only ~5.5% of projects funded are performed under the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), where most studies on the subject of maternal health lie.¹⁷

A lack of standardization contributes to EXIT's variability, which further impairs its general utilization. Limited research and consensus consultation recommendations restrict the accumulation of long-term data based on outcomes, making it difficult for hospitals to weigh risks versus benefits or for hospital administrations to justify expanding funding. A survey given to NAFNet centers identified that 64.9% of centers (91% completed the survey) reported "at least one experience of airway intervention and management having the potential to be successful without EXIT," and from an under allocation perspective, adverse outcomes were reported by 10.8% of those centers when "the fetal surgery team was unaware of the patient in any regard and a potential mitigation of these events would have been possible with EXIT."¹⁴ Perpetuating this idea, maternal and neonatal research in the United States remains underfunded and inequitable,¹⁸ which are problems that disproportionately disadvantage niche procedures, such as EXIT, that do not have the clinical trial data of more established procedures.

Strategic investment in fetal surgical research, equipment, and personnel will mend the knowledge gaps surrounding EXIT; the same gaps that stall its progress and limit access for patients who would benefit the most.

Solutions:

One method to expand the uses of EXIT is through increasing access to federal and private research grants targeted

towards maternal-fetal care. As of 2025, NIH funding has been cut, with even more damage proposed; however, financial assistance and innovation in procedures like EXIT still exist. The NIH's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs fund early-stage research for high-risk, high-reward projects. Inventions such as advanced fetal imaging, maternal monitoring systems, or surgical simulations for training, all related to EXIT innovation, fall within the eligibility of these research programs as well. Additionally, the NICHD offers grants under groups like the Human Placenta Project and Maternal Health Research Networks. These could be utilized for EXIT-focused studies with a wider perspective on maternal-fetal medicine. Pursuing these grants could allow specialized centers to track large-scale outcome data and conduct studies that would demonstrate the safety of EXIT. These demonstrations may provide the necessary data to allow hospitals to make well-informed decisions regarding EXIT.

Alongside grant access, alleviating infrastructure costs through public or private partnerships could help with the significant costs required to maintain the ability to perform EXIT. Existing groups like the Health Resources and Services Administration's (HRSA) Maternal and Child Health Services Block Grant Program offer funding to states to support services and systems for mothers and their children. States with low maternal health outcomes could potentially target these funds towards strengthening high-risk fetal centers capable of hosting EXIT procedures. In recent years, private organizations like the Bill & Melinda Gates Foundation and March of Dimes have provided funding for fetal technology and health programs. These joint efforts would be especially necessary in covering large-scale investments like fetal resuscitation bays and updated ultrasound technologies. These are often pieces of equipment that remain out of reach for many hospitals operating on smaller margins due to their substantial costs.

Finally, more access to specialized training and creating strong support structures within hospitals could contribute to the increase in the availability of EXIT procedures. Forming financial incentives for hospitals that develop the capabilities of EXIT could encourage growth, notably in areas that lack resources. It would also be beneficial to make it easier for EXIT-trained teams to function efficiently within the hospital environment. Changes like this prove necessary for EXIT's expansion, especially due to its high-risk nature. In addition, streamlining scheduling and procuring necessary equipment further helps to reduce barriers in implementation. For training, internet platforms such as OPENPediatrics and the Global Fetal Surgery Network provide growing infrastructure for online education, meaning specialized EXIT procedure knowledge could be more widely accessed than ever before.¹⁹

Researchers need to be aware of the specific grants available and the requirements to procure funding opportunities related to EXIT procedures. Considering the current administration, working through the current grant landscape endures as an essential step forward. Figure S1 provides examples of key grants, including federal, institutional, and private, that could be used

to expand EXIT-related research, training, and infrastructure expansion. These grants provide financial support and signal institutional interest in advancing maternal-fetal innovation for EXIT. By aligning EXIT-related proposals with the priorities of these funders, researchers and clinical teams could better position their work for further growth. With consistent support, EXIT can expand beyond its limited uses.

Limitations & Future Opportunities:

This study acknowledges possible limitations. The most notable of these is the scarce access to primary-source data. Figures like the number of fetal centers currently offering EXIT or analysis of EXIT outcomes per institution were referenced through secondary literature or older surveys rather than through direct and up-to-date institutional reports. Furthermore, detailed cost analyses relied on external equipment marketers and public health cost estimations rather than on internal hospital financial reports, meaning that the pricing estimates presented, while remaining conservative, are still generalizations and not specific.

Additionally, this research collects data from many non-standardized sources, including varying sample populations, clinical protocols, and reporting standards. As a procedure, EXIT is highly individualized, with outcomes heavily dependent on specific maternal status, fetal status, and institutional setup, and such diversity makes generalizations challenging. Because much of the existing research on EXIT is composed of case studies often following one specific instance of it, this paper is similarly limited in its power to draw definitive conclusions regarding 'best practices' or long-term cost-benefit analysis.

Further studies could help resolve these restrictions in several ways. First, interviews with hospital administrators and maternal-fetal medicine teams could provide helpful first-hand perspectives regarding EXIT. Furthermore, an analysis of cost-effectiveness, such as through hospital-accurate data collection, would be valuable. This would not only help measure the direct expense of EXIT, but also healthcare savings as a whole in relation to improving neonatal results and reducing hospital stays. Lastly, regularly updated versions of surveys administered to the North American Fetal Therapy Network could help determine EXIT readiness and how clinical attitudes have changed in response to changes in policy and funding cuts.

Conclusion

EXIT is a life-saving intervention for fetuses with a critical airway compromise; however, its adoption is limited by the factors that also hinder research into the procedure. High resource requirements and multidisciplinary dependencies both contribute to EXIT's underutilization and to the narrow evidence base available. Funding pressures on NIH from the current administration, coupled with limited maternal-fetal health resource assignment, may further restrict opportunities for substantial development.

However, progress is still achievable. Expanding the funding for EXIT research and adjacent studies through federal

and private grants, along with forming public and private partnerships to offset equipment and staff costs, could allow for greater access and procedural standardization. Furthermore, establishing data registries and accentuating transparent and reproducible study design (to the best of one's ability concerning patient variability) will build the research required to demonstrate safety, cost-effectiveness, and long-term benefit to hospital administrators.

EXIT has the potential to transition from a niche technology into a highly useful tool in improving outcomes for families facing complex prenatal diagnoses.

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