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A Review of EXIT: Interventions for Neonatal Airway Rescue

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Abstract

Purpose of Review This review aims to examine the evidence and trends of ex utero intrapartum therapy (EXIT) and its various treatment modalities, with a focus on foetal survival outcomes.

Recent Findings A review of the literature (2017–2022) revealed 126 reported cases. EXIT for the management of congenital diaphragmatic hernias is now infrequently performed due to alternative foetoscopic techniques. Airway management remains the main indication for EXIT. Overall mortality was 24% whilst the EXIT interventions themselves had low immediate 'procedure-specific' mortality (4%). This suggests that subsequent mortality is related to other perinatal factors. Recent developments also include use of 3D modelling for simulation and MDT training before embarking on the procedure.

Summary EXIT is a controlled intervention for complex foetal airway pathology which has good outcomes with minimal morbidity. In the future, EXIT may continue to broaden its indications; therefore, more evidence and structured guidance should be adopted for reporting of intervention outcomes.

Keywords Ex utero intrapartum treatment (EXIT) · Delivery on placental support · Operation on placental support (OOPS) · Congenital high airway obstruction syndrome (CHAOS) · Foetal head and neck tumours · Multidisciplinary team

Introduction

Ex utero intrapartum therapy (EXIT) is a term that describes interventions on the foetus whilst still connected to utero-placental circulation. First described in the late twentieth century, EXIT strategies have matured over the last three decades, and are currently adopted worldwide to manage complex foetal airway conditions, which would otherwise be incompatible with life [1•, 2, 3, 4•]. For a successful outcome, accurate prenatal diagnostic workup, multidisciplinary team (MDT) collaboration and good communication are paramount [5••].

In this review, we aim to (1) introduce EXIT and its role; and (2) highlight the latest findings from the literature in the last 5 years.

The 'EXIT' Procedure

Early EXIT was termed operation on placental support (OOPS). Norris et al., in 1989, were the first to report OOPS for management of foetal upper airway obstruction. The foetus with a large anterior neck mass was partially delivered and maintained, for several minutes, on utero-placental circulation by delaying umbilical cord clamping [6]. In 1997, Mychaliska et al. were the first to coin the term 'EXIT procedure'; they described a systematic approach for managing complex foetal airways. Their series of eight consisted of EXIT performed for two cases of head and neck lymphangioma and six cases of congenital diaphragmatic hernias (CDH) [7]. For the management of CDH, EXIT has been used for the reversal of foetoscopic endoluminal tracheal occlusion (FETO), where the foetal tracheal is plugged with a balloon or clip, to encourage lung maturation and improve pulmonary hypoplasia in severe cases of CDH [7, 8].

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Initially, no attempts were made in order to prolong utero-placental circulation, which resulted in short procedure times, ranging 5–20 min, from start of caesarean section to cord clamping, and therefore higher foetal morbidity [6]. Since then, a better understanding and advances in maternal anaesthesia and pharmacological agents have enabled prolongation of the third phase of labour, with improved and sustained uterine relaxation, to maximise the utero-placental circulation time [9–13]. Although utero-placental circulation times of up to 150 min have been reported in literature, most studies reported times from 45 to 60 min, which is more relevant for EXIT planning [14–16].

In 2002, Bouchard and his team at the Children's Hospital of Philadelphia published a landmark series of 31 EXIT cases. The most common indications in their paper for EXIT were foetal airway obstruction secondary to a head and neck mass, and reversal of FETO for CDH [17]. Other indications for EXIT also included congenital high airway obstruction syndrome (CHAOS), extracorporeal membrane oxygenation (ECMO), unilateral pulmonary agenesis and delivery of conjoined twins. In the ECMO cases, their mean duration of utero-placental bypass was 30.3 min, and all infants were haemodynamically stable. Amongst their 31 cases, there was one death during EXIT from failure to establish a secure airway.

Another milestone in the literature, in 2004, is the case series from Hirose et al. on 52 patients who underwent EXIT [15]. As with the previous reports, the most common indication for the procedure was CDH. Seven patients underwent EXIT due to airway obstruction secondary to neck masses and CHAOS. Amongst them, five patients underwent tracheostomy, one patient was intubated, and another patient underwent resection of the causative mass whilst under utero-placental circulation.

Anaesthetic Considerations

The main anaesthetic challenge in the EXIT procedure is to achieve optimal uterine relaxation [11]. This reduces the risk of placental abruption and allows the continuation of utero-placental circulation.

Several maternal factors pose challenges for anaesthesia during the EXIT procedure. At the depth of anaesthesia required to achieve uterine relaxation, maternal hypotension may occur in the supine position and consequently utero-placental hypoperfusion [11, 18–21]. Also, changes in maternal respiratory physiology can cause decreased maternal functional residual capacity, which can result in maternal hypoxia [20, 21].

Foetal physiology also poses an additional challenge in anaesthesia. Foetal cardiovascular circulation may be negatively affected by inhaled anaesthetics during EXIT, giving rise to cardiac depression, vasodilation and ultimately hypoxia and acidosis [22, 23]. Furthermore, foetal skin is thin and sensitive to fluid evaporation, and this increases the susceptibility for hypovolaemia during the duration of intervention [19].

Despite the above difficulties, an inhalation-based technique has traditionally been considered the anaesthetic of choice for EXIT, for example desflurane, halothane and isoflurane in isolation or in combination [4•, 24]. These inhalation agents have a superior effect on uterine relaxation, rapid placental transfer and quick elimination, improving titration of anaesthesia [19]. Intravenous anaesthesia such as propofol and remifentanil has also been reported as alternatives to inhalation anaesthesia and has a dose-dependent effect on uterine muscle contraction [14]. Uterine relaxation is further achieved by administration of tocolytics, such as indomethacin and nitroglycerin [18].

Perioperative monitoring of the mother and foetus is vital during the EXIT procedure. Maternal arterial blood pressure, oxygen saturation and end-tidal carbon dioxide levels are continuously monitored to detect potential maternal hypotension and hypoperfusion. Similarly, foetal saturation is continuously monitored to identify any foetal hypoperfusion [4•]. Foetal echocardiogram is also used during the EXIT procedure to detect any signs of foetal bradycardia [25–27].

Obstetric Considerations

Obstetric techniques in EXIT depend on the indication and modality of intervention, as well as the position of the placenta and the foetus. As utero-placental circulation needs to be maintained, placental integrity needs to be protected during the hysterotomy stage of C-section. Planning the incision depends largely on the position of the placenta. For example, in cases where the placenta is anteriorly placed, a transverse laparotomy skin incision may be required, rather than the traditional low horizontal pfannenstiel incision [18]. Intraoperative ultrasound can be utilised to accurately identify the position and borders of the placenta, as well as the foetal head position to avoid unnecessary trauma and compromising the placenta during the hysterotomy incision [4•, 28]. Only the foetal head, neck and shoulders are delivered during the procedure whilst the umbilical cord remains within the uterus in order to prevent cord compression. Maintenance of uterine volume during partial delivery of the foetus is crucial and can be considered a form of controlled amnioreduction; this can be achieved by infusing warm Ringer's solution through the hysterotomy site [4•, 29, 30].

Once EXIT is completed, after completion of delivery or the utero-placental circulation comes to an end, continued uterine relaxation increases the risk of maternal blood loss, following placental detachment. Therefore, it is vital to achieve prompt uterine contraction following delivery [18, 19]. Initiation of oxytocin is typically administered to

initiate uterine contraction and the timing of this relies on good communication within the EXIT MDT members, particularly the obstetric and the anaesthetic teams [4•, 29, 30].

Otolaryngology Considerations

The role of otolaryngology in EXIT is to obtain surgical access of the airway, where intubation is not feasible or has been unsuccessful. Depending on the underlying pathology and the clinical condition, the otolaryngologist may need to perform airway interventions (i.e. direct or endoscopic intubation), surgical access (i.e. tracheostomy, excision or debulking lesions in the head and neck), and even palliation.

Prenatal ultrasound and magnetic resonance imaging (MRI) are the primary imaging modalities used for diagnosis of foetal pathology, which may be performed serially depending on local resources [31–35]. Of interest to otolaryngology are the findings suggestive of a compromised or difficult airway access. These signs may present along a spectrum, such as degree of micrognathia, facial or skeletal anomalies, the location, nature and size of head and neck masses and severity of CHAOS [5••, 18, 36•, 37•]. The dynamic effect of pathology on the airway may only be appreciated ex-utero, therefore the otolaryngologist and the multidisciplinary team should prepared for and be familiar with different EXIT strategies in the event of intrapartum variations or complications [7, 18, 38].

Recent reports of EXIT, which will be discussed in more detail later in this paper, have introduced novel non-airway indications, where the neonatal airway remains safe and stable without tracheostomy [18, 39, 40, 41]. However, for majority of those delivered via EXIT, otolaryngology will have a continued role in care as part of the complex airway multidisciplinary team; for decisions on investigations, genetics, and subsequent airway procedures. The key disciplines in the complex airway multidisciplinary team are, but not limited to, otolaryngology, respiratory, neonatal and paediatric medicine. In practice, EXIT is the start of the surgeon-patient relationship for otolaryngologists, as foetal pathology that necessitates EXIT is likely to need further intervention and long-term surveillance if the patient survives beyond the neonatal period [5,42, 43, 44].

Recent Updates: the Last 5 Years of EXIT

Method

A literature review was undertaken from the PubMed/EMBASE and MEDLINE databases, to identify new publications on EXIT and CHAOS published in the last 5 years (2017–2022). Abstracts and full-text articles were screened to determine their relevance for inclusion. All publications that reported EXIT outcomes were included for analysis; non-English language articles without available English translations were excluded from this review. Publications where perinatal events ultimately did not lead to EXIT (e.g. foetal demise, elective termination of pregnancy), or where significant case-specific details were not available, were also excluded. Data was collated on the sample size, indication of EXIT, gestational age at delivery, modality of interventions, confirmed pathology and survival outcomes. For the purpose of this review, survival outcomes were analysed at the following time points: (1) immediate: at the end of the intervention or the end of delivery, (2) day 1: 24 h from delivery, (3) neonatal: 28 days and (4) infant: 1 year. The end of the EXIT intervention was defined as the point where separation of the foetus from utero-placental circulation occurred, and the intervention was deemed a success if the neonate was successfully transitioned from utero-placental circulation to an alternative support mechanism (i.e. intubation and ventilation, ECMO or tracheostomy).

Results

Forty-one publications met criteria for review, reporting 126 new cases of EXIT, of which only 114 had EXIT-specific data available and were included. The highest level of evidence for EXIT outcomes remained at level 4—case series.

The indications for EXIT were consistent with previous literature and in this cohort, the most common indications were EXIT for head and neck masses ($n=70$, 61%), followed by CHAOS ($n=21$, 30%). 23% were for other indications: mediastinal mass, CDH, congenital heart disease and giant omphalocele. Interestingly, there was only one case reporting EXIT for CDH (4%). Whilst most of these cases were for established indications of EXIT, Chen et al. were the first to report a series of seven patients who underwent EXIT for the management for giant omphalocele, which will be discussed in more detail later on in the paper [41•]. A further novel indication was reported by Zhuang et al., where EXIT enabled the immediate drainage of a severe pericardial effusion secondary to a cardiac haemangioma, which further broadens the utilisation of EXIT [45•].

Of the head and neck mass indications, the most common histopathological diagnoses was teratoma, followed by lymphatic malformation. Over half of the CHAOS cases were found to be due to laryngeal atresia, with the remaining cases being tracheal atresia, multilevel airway atresia and tracheal agenesis.

Intubation was the most common EXIT modality. Sixty-five cases (57%) were successfully intubated, 43 (38%) had tracheostomy, two were transitioned to ECMO, and one had reversal of FETO. Within the intubated cohort, 36 were intubated, with no further details of procedure specified, 10 achieved direct laryngoscopy and intubation, three reported the use of video

or flexible endoscopes, 15 required rigid bronchoscopy, and 1 required retrograde intubation. The mean gestational age at delivery was 35 weeks (95% CI 34.2–35.8). In 3 cases, EXIT intervention was unsuccessful leading to demise. Table 1 summarises the key findings from our review of EXIT including a descriptive summary of EXIT modality and outcomes.

The last 5 years of EXIT modalities remained consistent with established interventions. The success of intubation may be attributed to the utilisation of adjuncts, such as video and flexible endoscopes, which provide better visualisation and navigation capabilities of the complex foetal airway [41•, 45•]. Although only three cases reported the use of intubation adjuncts, this may be an underestimate as 32% of cases did not have available details on the intubation procedure. Tracheostomy was required in 38% of cases.

Meta-analysis on Survival and Mortality

From past literature, survival and mortality rates for EXIT have not been clear, with perinatal mortality rates of 10–50% being reported and some papers preferring to discuss the theoretical risk instead [5••, 65, 72]. Therefore, it is not clear whether these reported outcomes represent 'procedure specific mortality rate', i.e. death due to the failure of the EXIT itself; 'disease specific mortality rate' due to the progression of primary pathology that necessitated EXIT to begin with; or 'overall mortality rate' that encompasses all aetiologies, including non-specific causes such as infection, preterm or cardiopulmonary complications. Unfortunately, there remains no consensus on minimum reporting standards or follow-up period for EXIT, resulting in a large variation in available information that makes a formal meta-analysis difficult.

Of the cases included in the review, only 75 had sufficient case-specific details on foetal outcomes for meta-analysis. In this group, overall mortality was at 24%. Where case-specific details on survival outcomes, timing and modality of EXIT were available, data was constructed into a Kaplan Meier curve, for review of survival following EXIT (Fig. 1).

Our analysis showed that the vast majority of patients survive (95%, 71 out of 75 cases) immediately after EXIT. In three cases (4%), mortality was immediately after birth: two due to failure of airway management, and another due to massive tumour haemorrhage. All of the remaining patients survived for the first 24 h. Eight cases (11%) passed away in the neonatal period due to the following causes: neonatal sepsis; cerebral venous thrombosis; non-immune hydrops; coagulopathy; tumour lysis syndrome; palliation due to poor prognosis with aggressive tumour. Two more deaths were observed during infancy, at 5 and 18 months of age, as a result of tracheostomy accidents.

These results demonstrates that, at 4%, the procedure-specific mortality rate of EXIT is much lower than the often associated. Overall mortality for patients undergoing EXIT is largely related underlying pathology as a consequence of disease progression or complications of surgical procedures and interventions. Whilst this raises difficult clinical and ethical questions regarding when EXIT should be offered, more research is necessary for better prognostication of the foetal pathologies that necessitate EXIT.

Discussion

EXIT Update on Indications

With increased knowledge and technical abilities, the indications for EXIT have expanded. Broadly, they are EXIT for (1) reversal of tracheal occlusion; (2) the treatment of upper airway obstruction; (3) the treatment of chest and mediastinal masses; (4) ECMO; and (5) separation of conjoined twins. As previously mentioned, EXIT was originally designed for the reversal of tracheal occlusion at delivery for foetuses with severe CDH. This indication has been replaced largely by foetoscopic transabdominal puncture, to deflate the occluding tracheal balloon, reserving EXIT as a last resort [66]. This is supported by our review of recent literature which shows that upper airway obstruction, from head and neck masses and CHAOS, is the most common indication for EXIT.

Omphaloceles are herniation of peritoneal contents through a weakness in the abdominal wall and are often diagnosed on routine prenatal imaging. Surgical correction of omphalocele is dependent on the size of the herniation and is ideally done within the first few days of life [28]. The case series by Chen et al. was the first to report EXIT for the management of omphaloceles ($n=7$) [41•]. Prenatally, there was no concern about a difficult airway or foetal distress. They proposed that prompt securing of the airway facilitates surgery soon after birth, by minimising air ingestion, reducing intra-abdominal pressures and minimising the need for multiple or staged procedures to obtain closure of the abdominal wall. However, further evidence is required to determine if EXIT provides additional benefit over traditional methods of post-partum omphalocele surgery.

Foetoscopic Interventions and EXIT

Foetoscopic laryngotomy has been described to relieve symptoms of foetal hydrops in cases of CHAOS and promote foetal cardiopulmonary development, rather than achieve adequate airway recannalisation, and it is known to be associated with increased risk of preterm labour [73, 74]. Nicolas et al. reported the first ultrasound-guided percutaneous aspiration of the foetal trachea instead of LASER laryngotomy [61•] and in our review, laser ablation remained

Table 1 Summary of EXIT from the last 5 years

Case Series	Number of cases	Indication for EXIT	Confirmed Post-natal Pathology	Mean gestational age at delivery (weeks)	Overall Mortality Rate (%)	EXIT Modality
Morales et al. 2022 [42•]	14	H&N mass	†	†	†	12 Intubation, 2 tracheostomy
Yan et al. 2022 [46]	2	H&N mass	LM	31	0	2 Intubation
Barrette et al. 2021 [47•]	15	H&N mass/ Mediastinal mass	†	†	27	3 Intubation, 8 rigid bronchoscopy 4 tracheostomy
Bouwman et al. 2021 [36•]	4	H&N mass	LM	†	0	†
Jeong et al. 2021 [48•]	5	CHAOS	2 Tracheal atresia, 2 laryngeal atresia, 1 subglottic stenosis, 1 laryngotracheal agenesis	36+4	40	Tracheostomy
Sangaletti et al. 2021 [49]	1	H&N mass	LM	37+6	0	Intubation
Shamshirsaz et al. 2021 [50•]	11	H&N mass	Teratoma	35+1	18	1 Intubation, 6 rigid bronchoscopy, 3 tracheostomy
Sirianni et al. 2021 [51]	1	H&N mass	LM	37	100	Intubation (video-laryngoscopy and flexible endoscopy)
Werner et al. 2021 [41•]	1	CHAOS	Tracheal agenesis/stenosis	31+5	100	Failed airway access
Zaretsky et al. 2021 [52]	1	CHAOS	Tracheal atresia	34+5	0	Tracheostomy
García-Díaz et al. 2020 [37•]	5	H&N mass	3 LM, 1 teratoma, 1 epilus	36+6,	0	5 Intubation (2 flexible endoscopy)
King et al. 2020 [53]	2	H&N mass	2 Teratoma	28	0	1 Intubation, 1 tracheostomy
Lee et al. 2020 [54]	1	H&N mass	Choroid plexus papilloma	38	0	Intubation
Lo et al. 2020 [55]	1	H&N mass	LM	37	0	Intubation
Peiro et al. 2020 [56]	1	CHAOS	Tracheal stenosis	31+1	0	Tracheostomy
Reeve et al. 2020 [57]	1	H&N mass	Teratoma	38	0	ECMO for resection and tracheostomy
Arteaga et al. 2019 [58]	1	H&N mass	LM	36	0	Intubation (video-laryngoscopy)
Beckman et al. 2019 [25]	1	CHAOS	Laryngeal atresia	34	0	Tracheostomy
Kornacki et al. 2019 [26•]	4	3 H&N mass, 1 CHAOS	1 Goitre, 1 LM, 1 teratoma, 1 tracheal agenesis	Range 35 – 37 (mean not reported)	25	3 Intubation, 1 failed airway access
Kumar et al. 2019 [27•]	1	CHAOS	Laryngeal atresia	38	0	Tracheostomy
Nolan et al. 2019 [59•]	3	CHAOS	Laryngeal/tracheal atresia	32+4	33	3 Tracheostomy
Hochwald et al. 2019 [60]	1	H&N mass	Teratoma	34	0	Rigid bronchoscopy
Nicolas et al. 2019 [61•]	1	CHAOS	Tracheal atresia	30	0	Tracheostomy

Table 1 (continued)

Case Series	Number of cases	Indication for EXIT	Confirmed Post-natal Pathology	Mean gestational age at delivery (weeks)	Overall Mortality Rate (%)	EXIT Modality
Masahata et al. 2019 [62•]	9	4 CHAOS, 5 H&N mass	4 Laryngeal atresia, 2 epignathus, 2 teratoma, 1 LM	33+6	44	6 tracheostomy, 2 intubation, 1 failed airway access
Asai et al. 2018 [63]	1	Congenital heart disease	Truncus arteriosus and truncal valve stenosis	34	100	ECMO
Beck et al. 2018 [64]	1	H&N mass	Rhabdoid tumour	36+5	100	Intubation
Chen et al. 2018 [41•]	7	Giant omphalocele	Giant omphalocele	†	0	7 Intubation
Gonzales et al. 2018 [65]	1	CHAOS	Tracheal atresia	33	0	Tracheostomy
Lee et al. 2018 [66]	2	1 H&N mass, 1 CHAOS	1 LM, 1 tracheal atresia	38+3	100	1 Intubation, 1 tracheostomy
Olivares et al. 2018 [67]	1	H&N mass	Teratoma	30	100	Tracheostomy
Tergestina et al. 2018 [68]	1	H&N mass	Rhabdoid tumour	36	100	Intubation
Subramanian et al. 2018 [21]	1	H&N mass	LM	35	0	Intubation
Dharmarajan et al. 2018 [69•]	11	H&N mass	Teratoma	†	0	2 Intubation, 9 tracheostomy
Yu et al. 2018 [70]	1	H&N mass	Teratoma (foetus in fetu)	36+3	0	Tracheostomy
Belfort et al. 2017 [40]	1	CDH	Reversal of FETO	34+3	100	Failed airway access
Brodsky et al. 2017 [1•]	4	H&N mass	Teratoma	†	0	3 Intubation, 1 tracheostomy
Wannemuehler et al. 2017 [71]	1	H&N mass	LM in teratoma	38+5	0	Intubation
Zhuang et al. 2017 [45•]	1	Mediastinal mass	Cardiac haemangioma with pericardial effusion	32	0	Intubation

Caption: Summary of data from EXIT cases published in the last five years (2017 – 2022). Legend: (†) case specific data not available, *H&N* Head and Neck, *LM* lymphangioma, *CHAOS* Congenital high airway obstruction syndrome, *ECMO* extracorporeal membrane oxygenation, *CDH* congenital diaphragmatic hernia, *FETO* foetoscopic endoluminal tracheal occlusion

the main foetoscopic airway procedure undertaken in the EXIT cohort. All patients who had foetoscopic airway interventions had preterm deliveries and tracheostomy as their EXIT modality, with 33% failure of EXIT to secure the airway ($n=2$).

International Paediatric Otolaryngology Group (IPOG) Guidance

In 2020, the International Paediatric Otolaryngology Group (IPOG) published their recommendations on the management of airway obstruction in the pre- and perinatal period; it is the first published guidance to support EXIT procedure planning and decision-making. This consensus document, aimed at the surgeons and MDT members professionals, was derived from the expert opinion of IPOG members, predominantly otolaryngologists working in tertiary and quaternary referral centres across eight different countries [5••].

3D Modelling and Simulation for EXIT

Recent IPOG guidance has recommended that annual simulation should be undertaken by members of the EXIT MDT team [5••]. We highlight here the recent trends in simulation for EXIT.

Werner et al. had previously described how 3D printing can be applied from imaging data to create models of foetal anatomy [75•, 76, 77]. In particular, for EXIT planning and simulation, their work has demonstrated how complex airways can be assessed prenatally through virtual bronchoscopy [75•].

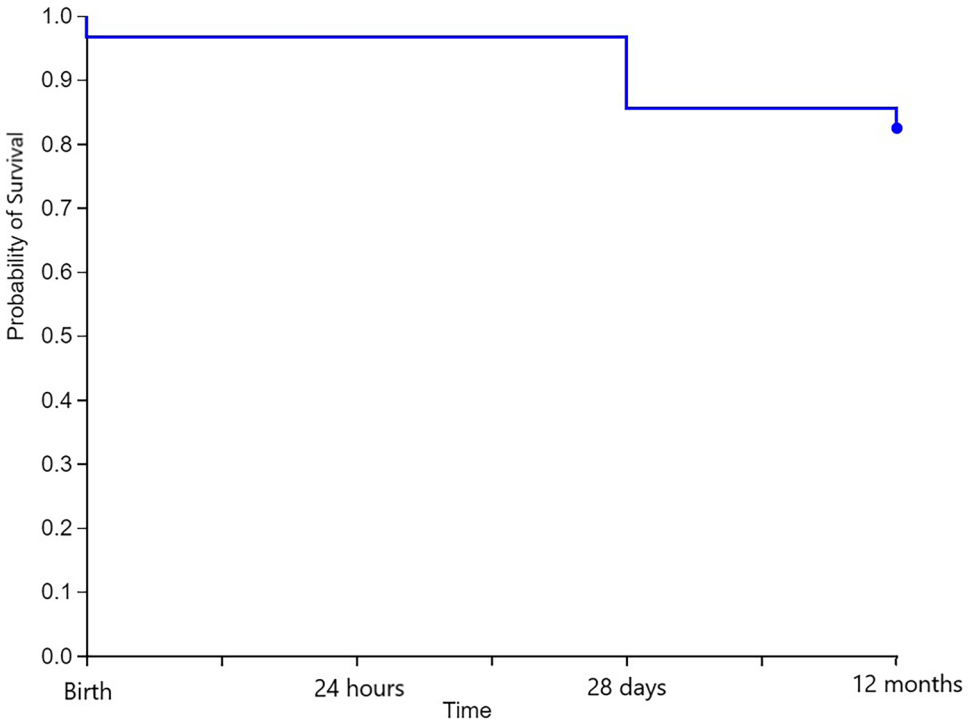

Fig. 1 Kaplan–Meier survival analysis for EXIT. Caption: A Kaplan–Meier survival curve showing the probability of death as a function of time; meta-analysis of EXIT cases from 2017 to 2022

In recent literature, low-fidelity moulage-style scenarios have been brought back into focus, through case reports on how pre-procedure simulation facilitates the delivery of EXIT [49, 53, 78, 79•]. For example, King et al. describe how their table-top simulation of different intraoperative scenarios helped coordinate performance on the day, involving as many as 29 individuals in a single operating theatre [53].

There has also been more work published on patient-specific 3D modelling as a simulation adjunct and mode EXIT planning [80, 81]. VanKoevering et al. reported a case where 3D modelling from foetal MRI helped differentiate a protuberant bilateral cleft lip and palate, with a prominent premaxilla and philtrum segment, from a potentially obstructive facial lesion (e.g. lymphangioma, epignathus) [82•]. This case demonstrates and shows how 3D modelling contributed to airway management planning and led to the de-escalation of a potential EXIT procedure. For an otherwise in-utero patient, imaging-based 3D models present an opportunity for the surgeon and airway MDT members to perform an assessment of the airway akin to their regular practice.

Albeit novel, the literature on 3D modelling for use in EXIT MDT is limited and yet to be validated. In addition, existing imaging protocols may not be adequate for 3D modelling and new software or repeat imaging may be required, which will expend further time and resources. Therefore, uptake of simulation and its adjuncts will depend on local infrastructure and resources, and may be of limited application in late-presenting or emergency EXIT cases. Nevertheless, MDT simulation or a pre-procedure run-through for EXIT is generally recommended.

Conclusion

EXIT is utilised worldwide for complex foetal pathology and airway rescue. Recent developments include the IPOG consensus guidance on EXIT. Whilst largely indicated for EXIT is the management of foetal head and neck masses and CHAOS, there is potential for wider utilisation of EXIT. The benefit of prolonged utero-placental circulation has been reported to be beneficial for neonatal procedures immediately after birth, such as drainage of pericardial effusions and management of giant omphaloceles. Pre-EXIT simulation and MDT coordination remain vital for the delivery of EXIT and it is generally encouraged, to maintain good outcomes for such a high-stakes intervention. Further research and consensus on minimum reporting standards should be considered in future studies and publications to build on the current evidence-base. Nevertheless, our review has shown that EXIT can be delivered with minimal morbidity to mother and foetus.

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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•• Of major importance

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