Prospective outlook on negative pressure wound therapy (NPWT) for gastroschisis and ruptured omphalocele: A scoping review

Nabila Ananda Kloping[1], Barmadisatrio[2]

[1]Resident of Pediatric Surgery Division, Surgery Department, Dr. Soetomo General Academic Hospital, Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia, [2]Pediatric Surgery Division, Surgery Department, Dr. Soetomo General Academic Hospital, Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia

ABSTRACT

Introduction: In cases of gastroschisis and ruptured omphalocele where primary closure is not feasible, physicians must employ alternative strategies to gradually reduce the herniated contents and promote epithelialization, either through non-surgical methods or with surgical intervention. Negative pressure wound therapy (NPWT) is a device specifically designed to promote wound healing by controlling sub atmospheric pressure. Despite the benefits of NPWT, its use in paediatric patients, particularly congenital abdominal wall defect, remains unclear. This study aimed to assess the benefits of NPWT as part of the treatment strategy for gastroschisis and ruptured omphalocele.

Materials and Methods: A literature search was conducted through electronic databases including Pubmed, ScienceDirect and JSTOR from inception through January 2025. The outcomes identified included NPWT application details (pressure, timing, duration), outcomes related to length of stay, initial feeding, complications, wound progression, and follow-up results. Quality assessment was not conducted as the review aimed to provide a broad overview of the topic.

Results: Sixteen studies were included in the final analysis. Subjects consisted of 41 patients (32 gastroschisis, and 9 ruptured omphalocele), with a mean gestational age of 36.9 weeks and a mean birth weight of 2,216 g. The most common herniated contents were small bowel and liver, with an average defect size of 6 cm. The initial NPWT pressure ranged from -25 mmHg to -100 mmHg, with -40 mmHg being the most common starting pressure. At 10-12 months follow-up, most subjects demonstrated no fascial defects and intact epithelialized skin. NPWT was found to be an effective alternative, particularly as part of immediate primary closure, facilitating wound healing during staged closure, or managing infection. Although most evidence came from case reports or series, and there is a lack of standardized protocols for NPWT, its benefits over conventional care were evident.

Conclusion: NPWT shows its benefit in adjunct to delayed closure, primary suture less closure, and in the management of gastroschisis and ruptured omphalocele. Future research should further investigate the optimal use of NPWT in a larger larger prospective or randomized controlled trials to refine protocols and better understand its long-term benefits and risks.

KEYWORDS:
Negative pressure wound therapy, gastroschisis, omphalocele

INTRODUCTION

Gastroschisis is one of the most common types of abdominal wall defect, characterised by a defect typically to the right of the umbilical cord.[1] A study conducted at a single centre in Indonesia found that the mortality rate of gastroschisis was 69% among 42 subjects. Early closure within 1 day is associated with a lower mortality rate.[2] In southern Brazil, the incidence of gastroschisis has increased by 85%, with an annual incidence of 2.69 per 10,000 live births.[3] Globally, in 24 countries, gastroschisis occurs in 1 per 3,268 births, or 3.06 per 10,000 live births.[4] Omphalocele is another type of abdominal wall defect, occurring through the umbilicus, and it can present with or without a sac.[5] The prevalence of omphalocele between 2000 and 2012 was 2.6 per 10,000 births, with a mortality rate of 32.1%. Most omphalocele related mortalities occur within the first 24 hours of life, with a one-year mortality rate of 30.7%.[6]

Managing both gastroschisis and omphalocele remains a significant challenge for physician. In cases where primary closure cannot be performed, physicians must find an alternative solutions to slowly reduce the herniated contents and allow for epithelialization to form, with or without surgical management.[7,8] This is where negative pressure wound therapy (NPWT) has been introduced as a potential treatment option. NPWT has been widely used for all various types of wound injuries.[9,10] In a study focused on open abdominal wounds in paediatric patients, NPWT was applied until healthy granulation tissue formed, allowing the wound edges to be safely sutured without tension.[9,11–13] Evidence suggests that NPWT promotes faster wound healing by applying negative pressure to the wound bed through a specialized dressing, sponge, and vacuum system. However, wound healing in neonates presents additional challenge including fragile skin, immature immune system, and impaired thermoregulation, all of which can hinder proper restoration.[13–15] To date, there are no established guideline or

This article was accepted: 06 September 2025
Corresponding Author: Nabila Ananda Kloping
Email: nabilananda159@gmail.com

protocols for using NPWT in neonates or paediatric patients.[15] In this scoping review, we aim to explore the characteristics and the clinical benefits of NPWT, particularly in the context of congenital abdominal wall defects such as gastroschisis and ruptured omphalocele.

MATERIALS AND METHODS

This scoping review was conducted in accordance to Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for scoping reviews (PRISMA-ScR).[16]

Search Strategy and Selection of Studies

A comprehensive computerized search was conducted using databases such as Pubmed, ScienceDirect, and JSTOR. We retrieved relevant study from inception through January 2025. The search terms included the following combinations: ((“negative pressure wound therapy") OR ("NPWT") OR ("vacuum assisted closure") OR ("VAC")) AND (("gastroschisis") OR ("omphalocele") OR ("congenital abdominal wall defect")). Boolean operators’ combination was used to broaden and narrow search result. The search was limited to human subjects, with language restricted to only English.

Eligibility Criteria

All publications that met inclusion criteria were considered. Inclusion criteria were as follows: (i) type of studies included randomized or non-randomized trials, observational studies, pilot studies, case report, or case series; (ii) neonates or children diagnosed with gastroschisis or ruptured omphalocele; (iii) studies where negative pressure wound therapy (NPWT) was used as part of the management; (iv) studies reporting outcomes related to NPWT pressure, timing of NPWT application, duration of NPWT, length of stay, initial feeding, and complications. The exclusion criteria included animal studies, irretrievable full texts, non-English language publications, and studies on irrelevant topics.

Data Extraction and Quality Assessment

After removing duplicates, screening was performed on all studies based on their titles and abstracts. Full-text articles of studies that met the inclusion criteria were then retrieved and reviewed in detail. Disagreements regarding the eligibility of studies and data extraction were resolved by consensus among the authors. In cases of persistent disagreement, a third expert was consulted to reach a final decision. Each included study was carefully reviewed to extract the following details: author(s), year of publication, study design and setting, sample size, NPWT application specifics (including pressure, timing, and duration), and the outcomes related to length of stay, initial feeding, complications, wound progression, and follow-up results. Quality assessment of the studies was not conducted as part of this review, as the goal of the scoping review was to provide a comprehensive overview of the topic.

RESULTS

Results of Literature Search

A total of 308 publications were identified through database searches (Figure 1). After removing duplicates and excluding studies marked by the automation tool, we screened 271 titles and abstracts. Thirty-six studies were further assessed based on the inclusion criteria. Ultimately, 16 studies (5 case series 9 case reports, and 2 retrospective observational studies) were included and analysed.

Study Characteristics

The studies were conducted in Canada[17], the USA[10,18–21], Australia[22,23], South Africa[24,25], Japan[26,27], Romania[28], Vietnam[29], Germany[30], and China.[31] The oldest publication was from 2006 [17], and the most recent was from January 2025.[31] All included studies detailed the use of NPWT as part of the management process for either gastroschisis or ruptured omphalocele. Two studies described the use of NPWT in the treatment of an open abdomen but did not specifically focus on gastroschisis or ruptured omphalocele, so these articles were excluded.[11,12]

Patient and Abdominal Defect Characteristics

A total of 41 participants (9 ruptured omphalocele, 32 gastroschisis) were included (Table I). The reported gender distribution was 21 males and 16 females, with a mean gestational age of 36.9 weeks. The average defect size was 6 cm, and the mean birth weight was 2,216 grams. Herniated contents primarily consisted of small bowel loops and liver. In gastroschisis cases, the bowels were generally eviscerated, matted, and oedematous. Congenital dysmorphic features in ruptured omphalocele patients included low-set ears, frontal head bossing, short neck [25] patent omphalomesenteric duct and cleft palate.[30]

Indications for using negative pressure wound therapy (NPWT) included the need to accelerate wound closure, inadequate conditions for primary closure, and failure of staged abdominal closure. Some subjects were diagnosed prenatally via ultrasonography.[10,18,21,30] After reduction, there are cases where the abdominal wall was non-compliant, and closing the defect would create excessive tension. In the included studies, NPWT was generally used after silo reduction. Two studies achieved complete reduction using a silo, and then NPWT was used to aid in skin closure.[10,18] In the case of ruptured omphalocele, it was treated similarly to gastroschisis by placing a silo or attempting to suture the bloody sac.[25,27,29] One patient with a history of ruptured omphalocele was admitted for NPWT due to delays in developmental milestones such as rolling and crawling. This patient was also fed via nasogastric tube due to feeding intolerance.[23] Another patient with gastroschisis treated with NPWT was also put on a vacuum trial due to abdominal viscera disproportion.[23] One omphalocele case involved the use of NPWT to treat wound dehiscence and infection during staged closure.[27] Detailed characteristics of each case are provided in Table II and Table III.

Technique of implementing NPWT

Several options were used for dressing the herniated abdominal contents, including clear sheets, hydrocolloid, mesh, and biological patches.[21,26-28] These were followed by polyurethane ether[24], white foam[20,26], or granufoam/blackfoam.[20,26] A clear film or transparent tape was then applied over everything, with the apex cut to allow insertion of the suction tube. Hattori et al., (2017) used a

Table I: Characteristics and demographics of included studies (N=41)

No	Author, Year	Region	Study Design	N	Population	Gender (F/M)	GA	Birth Weight	Defect Size (cm)	Herniated Stomach Content	Associated Condition
1	Gabriel, 2006 [17]	Canada	CS	3	GC	M	36	N/A	8 x 10.5	N/A	Noncompliant abdominal wall after reduction using silo
					GC	N/A	35	N/A	5 x 6,5	N/A	Noncompliant abdominal wall after reduction using silo
					GC	N/A	38	N/A	5 x 5,5	N/A	Abdominal distention and noncompliant abdominal wall after reduction using silo
2	Hubbard, 2009 [18]	USA	CS	2	GC	M	37	N/A	4	Small bowel, large bowel, and bladder	N/A
					GC	M	37	N/A	4	Small bowel, large bowel, and bladder	Meconium aspiration and desaturation that required one day of mechanical ventilation
3	Hassan, 2011 [10]	USA	OBV	15	GC	F(7)/M(8)	33-39 (35)[a]	1.6-2.960 (2.371)[a]	4-5 (4.75)[a]	N/A	N/A
4	Choi, 2011 [22]	Australia	CS	4	GC	F	34	3070	5	Eviscerated oedematous and matted bowel	N/A
					GC	M	32	1730	1	Eviscerated bowel	N/A
					GC	M	35	1760	5	Stomach, small and large intestine thickened at birth.	N/A
					GC	F	36	2300	5	Features of both gastroschisis and omphalocele because the isolated loop of terminal ileum, caecum and appendix was contained in a pre-existing cavity within the umbilical cord.	Type IV intestinal atresia with a blind ending ileum isolated loop of terminal ileum, caecum and appendix; as well as a blind-starting colon that began 20 cm from the rectum.
5	Morris, 2013 [19]	USA	CR	1	GC	M	36	N/A	N/A	Small bowel, colon, stomach, 30% of liver	N/A
6	Mcbride, 2014 [23]	Australia	CS	3	RO	F	37	3000	N/A	N/A	N/A
					GC	M	35	2460	N/A	Bowel	N/A
					RO	M	37	2620	N/A	Gut and Liver	Congenital renal disease
7	Hattori, 2016 [24]	South Africa	CR	2	GC	N/A	35	1620[b]	N/A	N/A	N/A
					GC	N/A	35	1700[b]	N/A	N/A	N/A
8	Butler, 2018 [20]	USA	CR	1	GC	M	35	2120	4	Stomach, small intestines, colon	N/A
9	Horiike, 2020 [26]	Japan	CR	1	RO	F	38	3047	6	All abdominal organs except duodenum, rectum, kidneys, uterus, and ovaries	No other associated abnormalities in echocardiography or g-band analysis.
10	Morulana, 2020 [25]	South Africa	CR	1	RO	F	34	2090	12	Visible bowel and liver through the sac	Low set ears, frontal head bossing and short neck.
11	David, 2021 [28]	Romania	CR	1	RO	M	37	2600	8	Small bowel loops and liver	Small ventricular septal defect with patent ductus arteriosus
12	Tri, 2021 [29]	Vietnam	CS	3	RO	F	36	3000	12	N/A	N/A
					GC	F	36,5	2500	N/A	N/A	N/A
					GC	M	35	2600	N/A	N/A	N/A
13	Chen, 2021 [21]	USA	CR	1	GC	F	37	2300	N/A	Indurated bowel, bladder	Bladder fused to the inferior aspect of the defect wall.
14	Nakagawa, 2022 [27]	Japan	CR	1	RO	M	38	1896	10 x 10	Total Intestine and liver	N/A
15	Nissen, 2022 [30]	Germany	OBV	1	RO	F	37	3000	N/A	Bowel and liver	Patent omphalomesenteric duct Cleft Palate
16	Hou, 2025 [31]	China	CR	1	RO	M	N/A	2930	8	Bowel and liver	N/A

a = quantitative data are presented as median or mean; b = weight measured when NPWT was first used; CR = case report; CS = case series, OBV = retrospective observational; GC = gastroschisis; RO = ruptured omphalocele.
GA = gestational age; N/A = not available;

Table II: Characteristics negative pressure wound therapy application in gastroschisis cases (N=32)

No	Author, Year	N	Initial Treatment	Surgical Intervention	Technique of NPWT	NPWT pressure (mmHg)	NPWT initiation	NPWT duration (days)	Additional Treatment
1	Gabriel, 2006 [17]	3	Case 1: 7,5 cm, Case 2 and 3: 5 cm Silo spring loaded	Not applied.	Visceral is covered by surgisis ES and SIS was secured to the fascial edge and sutured to the peritoneal surface of the abdominal wall	-75	15 days; 9 days; 13 days	54 28 58	Dressing changes every 2-3 days with additional SIS coverage
2	Hubbard, 2009 [18]	2	Application of spring-loaded silo (bedside procedure)	Not applied.	Approximate edges with steri strips. Small perforation in the center to create an exit for fluid. Tegaderm to protect surrounding skin from sponge	-50 to -75	4 days after silo usage. 5 days after silo usage.	4 17	Application of dressing after NPWT machine removal. Dressing changes on day 12 and 19 during the use of NPWT.
3	Hassan, 2011 [10]	15	Application of Silo performed at bedside under sedation.	Not applied.	Approximate the defect edges. Several steri strips over the edges. Cut a small hole in the center and vacuum sponge is placed on top.	-100 to -125	4-5 days after silo usage.	14	N/A
4	Choi, 2011 [22]	4	Application of spring-loaded silo	After 9 days of silo, the isolated loop of terminal ileum, caecum, and appendix was removed. An ileocolic anastomosis was performed with formation of tube jejunostomy (Case 4)	Acticoat as interface between bowel and RENSYS as gauze dressing. NPWT applied on top of it.	-80	17 days;8 days;6 days;9 days after silo usage	26 21 14 21	Dressings were changed weekly for Case 1 and 2
5	Morris, 2013 [19]	1	Silo placement with a 5 cm per-formed appliance.	Partial fascial closure at 7 DOL	NPWT applied in the operating room.	-75	5 days after silo usage.	7	N/A
6	Mcbride, 2014 [23]	1	Partial reduction using silo, subsequent NPWT and split thickness skin graft.	Surgical reduction by removing excess skin and adhesions. Bowel was returned to abdominal cavity and full fascial and skin closure was done.	A ring of hydrocolloid is applied to the surrounding the abdominal hernia. Open weave gauze is wrapped around the mass in a fashion similar to a head dressing. An adhesive plastic dressing is applied to attain a seal. A port is then sited at the apex of the mass and NPWT device is sealed.	-80	Initial at birth and 9 months old	3 weeks after birth; 9 days during 1st admission	N/A
7	Hattori, 2016 [24]	2	Attempt to close abdomen	Attempt to close abdomen	Sterile polyvinyl chloride sheet cut from an intravenous fluid bag as an interface between bowel and a polyurethane ether foam. Foam trimmed to wound size. Transparent and adhesive film dressing to seal the wound. A small hole in the center of the film over the foam and the vacuum device is placed over the hole	-40	7 DOL 11 DOL	4 2	The wound was inspected for either closure or reapplication of the dressing in the operating room routinely at 2-day intervals

Table II: Characteristics negative pressure wound therapy application in gastroschisis cases (N=32)

No	Author, Year	N	Initial Treatment	Surgical Intervention	Technique of NPWT	NPWT pressure (mmHg)	NPWT initiation	NPWT duration (days)	Additional Treatment
8	Butler, 2018 [20]	1	Spring loaded 5 cm silo bag placed at birth, upsized to 7.5 cm	N/A	Whitefoam and GranuFoam dressings were cut to half their thickness, fashioned in the shape of a cup by sewing strips together, placed over the eviscerated bowel. Strips of adhesive drapes were used to secure the dressing, circumferentially wrapping the infant. After puncturing the drape, a SensaT.R.A.C. Pad was placed over the dressing, connected to a VAC unit	-25 to -75	22 DOL	28 19	Biweekly dressing change until the viscera were consolidated. After the viscera consolidated mepitel was placed over the viscera prior to whitefoam and granufoam dressings.
9	Tri, 2021 [29]	2	Suture of bloody sac Use bloody sac, silo sac, abdominal wall closure with gore tex band	Suture of bloody sac	The VAC system includes a suction machine, a sponge, transparent tape, and a suction tube.	-30	15 DOL 47 DOL	14	VAC was change 3 times over 19 days and daily wound care. Wound cleaning and daily bandages changes for 7 days
10	Chen, 2021 [21]	1	Blunt and cautery dissection the separate the bladder from the defect and ligation of persistent urachal remnant followed by insertion of 5 cm spring loaded silo	Failed primary abdominal closure followed by biologic patch to cover the defect and sutured to the fascia circumferentially	StratticeTM biologic patch was cut to the size of the defect and sutured to the fascia circumferentially in an interrupted manner using 3–0 PDS suture without any changes to ventilator pressures or tidal volume. The patch was then dressed with a negative pressure wound vacuum device,	N/A	Immediately after surgery, removed after 3 days to petroleum gauze dressing	3	Biological path under the NPWT device

DOL = day of life; N/A = not available; SIS = small intestinal submucosa

Table III: Characteristics of negative pressure wound therapy application in ruptured omphalocele cases (N=9).

No	Author, Year	N	Initial Treatment	Surgical Intervention	Technique of NPWT	NPWT pressure (mmHg)	NPWT initiation	NPWT duration (days)	Additional Treatment
1	Mcbride, 2014 [23]	2	Applying a silo, NPWT, split thickness skin graft. Primary Closure which is then released put in silo	Staged Surgical Closure: bowel was separated from previous skin graft then mesh was applied (no skin closure) 4:1 meshed split skin graft was placed, minimal debridement.	A ring of hydrocolloid is applied to the surrounding the abdominal hernia. Open weave gauze is wrapped around the mass in a fashion similar to a head dressing. An adhesive plastic dressing is applied to attain a seal. A port is then sited at the apex of the mass and NPWT device is sealed.	-40 to -80 N/A	8 months old first admission; followed by 9 months old second admission after staged surgical closure Use multiple times before and after Surgery. Also while waiting for renal transplant.	9 days for 1st admission; 14 days for 2nd admission Was used multiple times. Specifically 7 days until pressure garment was available.	NPWT dressing is changed once a week
2	Horiike, 2020 [26]	1	Applying a silo	Silo using small size wound retractor and biomaterial silo	Non-adherent wound dressings, white foam, granufoam were applied in this order, and then a clear film was applied to the entire omphalocele. The apex was cut into 1 cm squares and connected to the negative pressure system.	-25	65 DOL	6	A continuous infusion of dialysate was started, in the hope that it would remove fluid and electrolytes in its passage through the abdomen from the catheter tip up through the gauze and out via the NPWT suction tubing. Collagen based artificial dermis
3	Morulana, 2020 [25]	1	Ruptured membrane were sutured with absorbable monofilament suture.	Prolene mesh was sutured to the edge of the abdominal defect over the repaired membranes.	Dressings applied over mesh	N/A	After initial treatment	14	Sac painted with gentian violet dressings changed every 72 days.
4	David, 2021 [28]	1	Immediate Staged Closure	Staged closure (1st: partial resection and attachment of the membrane, 2nd: deatched, partial resection, and re attached of the membrane. 3rd: reduced hernia to abdominal cavity, but defect could not be closed.	Defect closed with gore tex mesh, NPWT, and anti-microbial silver dressing.	-40	50 DOL	28	Dressing changed every 4 days

Table III: Characteristics of negative pressure wound therapy application in ruptured omphalocele cases (N=9).

No	Author, Year	N	Initial Treatment	Surgical Intervention	Technique of NPWT	NPWT pressure (mmHg)	NPWT initiation	NPWT duration (days)	Additional Treatment
5	Tri, 2021 [29]	1	Suture of bloody sac		The VAC system includes a suction machine, a sponge, transparent tape, and a suction tube.	-30	24 DOL	14	N/A
6	Nakagawa, 2022 [27]	1	Silo placement using with artificial mesh	Not applied.	Artificial dermis then the NPWT device on top	-50	33 DOL	27	Artificial mesh, collagen based artificial dermis, dualmesh Dressing changed every 3-4 days
7	Nissen, 2022 [30]	1	The use of NPWT immediately	Continuous sutures of omphalocele membrane	White foam attached to OC surface; cutaneous sagittal and horizontal tight four point fixation; no sting barrier film; transparent film adhesive drape; soft port connector	-80	1 DOL	10	Dressing changed every 3 days
8	Hou, 2025 [31]	1	Silo placement	Silo sutured at the base	Vaseline gauze, CMC-Ag dressing patched on the wound then NPWT machine on top	-60 continuous → -70 for 5 min -40 for 2 min variable therapy mode	13 DOL	19	CMC-Ag dressing; wound dressing changed every 5-7 days; Rh-bFGF after NPWT device was removed

DOL = day of life; CMC-Ag = Carboxymethylcellulose; Rh-bFGF = recombinant human basic fibroblast growth factor; N/A = not available

Table IV: Outcomes of negative pressure wound therapy

No	Author, Year	N	Population	LOS (days)	Time to first/full feed (days)	Wound Healing	Follow Up
1	Gabriel, 2006 [17]	3	GC GC GC	270 66 90	N/A N/A N/A	Wound epithelialized after 54 days Epithelialized wound Epithelialized wound	N/A 6 months follow up → small umbilical hernia that has subsequently closed Small reducible umbilical hernia that was managed conservatively
2	Hubbard, 2009 [18]	2	GC GC	25 N/A	Bolus tube feeding on day 11. Full feed on day 18. TPN discontinued on day 20. Bolus tube feeding on day 15. TPN discontinued on day 21	8 mm wide defect after NPWT removal followed by healed umbilical scar after hospital discharge Defect changes to 1-2 mm on 19 DOL	2 weeks of follow up showed appropriate growth curve 2 weeks of follow up showed scarless healed wound
3	Hassan, 2011 [10]	15	GC	18-131 (24)[a]	Time to initiate feed 6-61 (13) days[a] time to full feed 12-91 (20)	N/A	N/A
4	Choi, 2011 [22]	4	GC GC GC GC	45 56 22 74	N/A N/A N/A Difficulties in establish feeding.	Wound contracted significantly with epithelisation around wound edges → residual defect had epithelialized sufficiently Wound epithelized leaving behind small area of granulation tissue Wound contracted significantly with near complete epithelisation Wound contracted significantly with near complete epithelisation	6 months of age → large non problematic umbilical hernia 6 months of age small umbilical hernia Patient discharged with outpatient dressing changes. Follow up regularly as an outpatient.
5	Morris, 2013 [19]	1	GC	80	Initiated at 18 DOL, but goal feed was not achieved thus gastrotomy tube was placed	Fascia defect completely closed.	Follow up of 6 months of age without readmission.
6	Mcbride, 2014 [23]	3	RO GC RO	9 days for 1st admission ; 37 days for 2nd admission 9 days for 1st admission; 2 days for 2nd admission N/A	Oral intake improved and only required top-up nasogastric feeds. N/A N/A	Full and skin closure Suture line was healed with no further dressing required after 6 days Developed layer of granulation tissue over liver and bowel, facilitating graft take.	10 months post closure, patient was able to walk unaided. Patient has been followed up annually and there have been no further surgical requirements 3 years post-closure At 19 months old patient received adult cadaveric renal transplant, kidney functioning well at 10 months posttransplant.
7	Hattori, 2016 [24]	2	GC GC	N/A N/A	N/A N/A	N/A N/A	N/A N/A
8	Butler, 2018 [20]	1	GC	115	Feed started on DOL 57 and increased to goal by DOL 86.	Skin completely epithelialized	By age of 13 months weight was at 50th percentile for his age.
9	Horiike, 2020 [26]	1	RO	328	N/A N/A	N/A	1 year follow up without postoperative complications
10	Morulana, 2020 [25]	1	RO	N/A	N/A	Wound was epithelizing from edges and covered with dried scab under mush	By 3rd month follow up, mesh had fallen off
11	David, 2021 [28]	1	RO	60		After first two dressings, granulation was formed at edge of tegument and wall defect became progressively smaller from 7 cm to 3cm.	

Table IV: Outcomes of negative pressure wound therapy

No	Author, Year	N	Population	LOS (days)	Time to first/full feed (days)	Wound Healing	Follow Up
12	Tri, 2021 [29]	3	RO GC GC	78 69 67	N/A N/A N/A	Skin of abdominal completely recovered. Abdominal wall and fascia appeared intact. Granulation of skin epithelized	14 months old → intact abdominal wall and skin that was able to protect the viscera. Procedure for abdominal fascia will be planned 24 months old → abdominal wall and fascia appeared intact 24 months old → no fascia defects, and intact abdominal wall skin
13	Chen, 2021 21	1	GC	N/A	4 months post op → open gastrotomy	Healthy granulation tissue underneath	5,6,10 months old → epithelialized tissue leaving 2x1 cm ventral hernia (resolved at age 2.5 y.o); At 3 y.o → very small asymptomatic fascia defect and tolerate regular diet
14	Nakagawa, 2022 [27]	1	RO	N/A	N/A	Complete epithelization at 5 months of age after managed with prostandin ointment and debridement	Compression bandage wrapped around abdomen since 5 m.o → reduced to the abdominal cavity at 8 m.o
15	Nissen, 2022 [30]	1	RO	19	Full oral feed achieved after 18 DOL	Tension free closure of abdominal fascia and skin is possible	Abdominoplasty is planned 9 months of follow up found delayed umbilical cord rest drop off and omphalitis
16	Hou, 2025 [31]	1	RO	60	N/A	Epithelization of the wound and size was reduced to 1x1 cm	N/A

[a] = quantitative data are presented as median or mean ; DOL = day of life; GC = gastroschisis; RO = ruptured omphalocele; N/A = not available

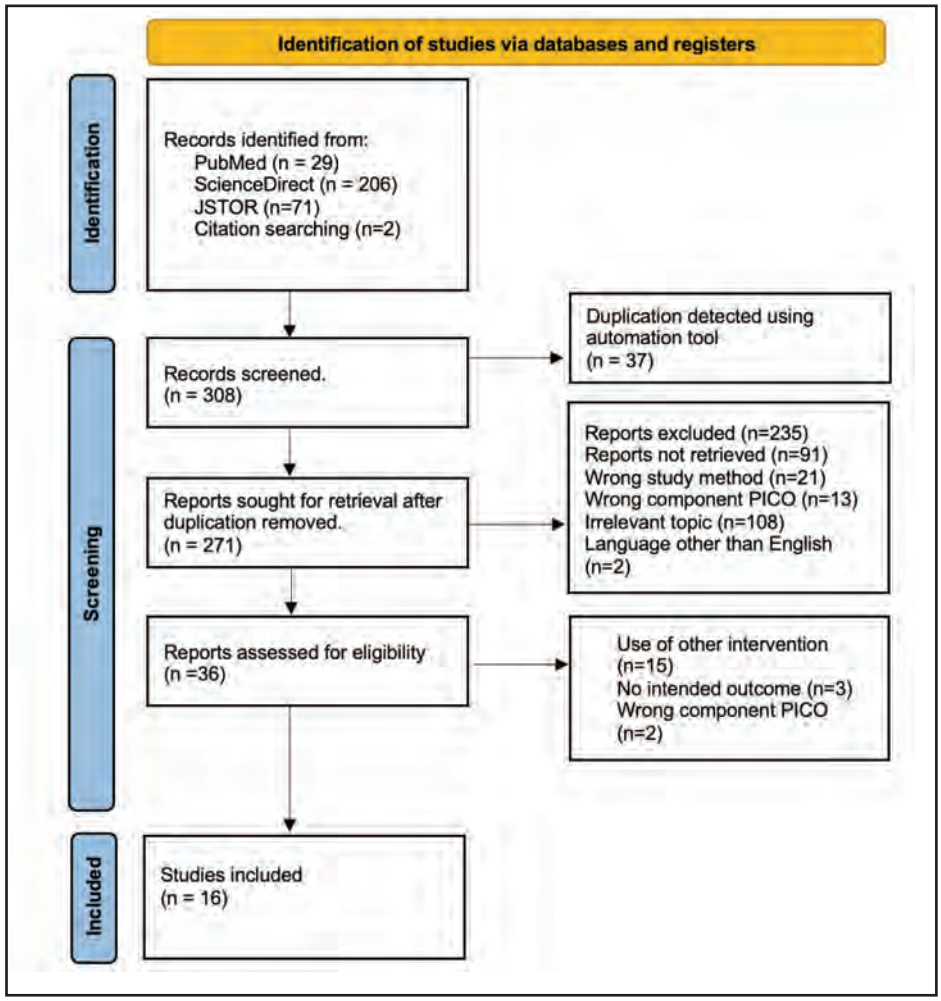

Fig. 1: PRISMA diagram with search strategy

sterile polyvinyl chloride sheet, cut from an intravenous fluid bag, as an interface between the bowel and foam.[24] The lowest starting pressure is -25 mmHg for both gastroschisis 20 and ruptured omphalocele [26], with -40 mmHg being the most common starting pressure across studies.[23-24,28] The highest starting pressure in gastroschisis is -100mmHg 10 and -80 mmHg for ruptured omphalocele.[30] One study employed variable pressure therapy, such as -70 mmHg for 5 minutes and -40 mmHg for 2 minutes.[31]

Outcome of NPWT

The length of stay in NICU varied among subjects, with the shortest being 19 days [30], and the longest being 328 days.[26] Full oral feeding was achieved on 18 day of life (DOL) [18,30], and total parenteral nutrition (TPN) was generally discontinued around day 20-21.[10,18] Two studies reported the need for gastrostomy due to unsuccessful feeding goal.[19,21] In the case described by Horiike et al., (2020), a conventional silo placement was attempted, but adhesion between the portal vein and fascia occurred.[26] Then the new biomaterial patch became infected, and NPWT was used, but a jejunal perforation developed. The perforation was repaired, and the giant omphalocele was subsequently treated using a collagen-based artificial dermis for epithelialization. Another complication associated with NPWT is the formation of enterocutaneous fistula.[24] One case of mortality reported by Hassan et al.[10] due to necrotizing enterocolitis. By 10 to 12 months of follow-up the subjects present no fascial defects with intact epithelialized skin. In the study by Tri et al., (2021) an additional suture of the abdominal wall was performed after the NPWT was removed.[29] Detailed outcomes are presented in Table IV.

DISCUSSION

This scoping review of sixteen studies displayed that NPWT is an effective tool for managing gastroschisis and ruptured omphalocele management in various clinical settings. Three strategies for managing congenital abdominal wall defects were identified: (1) immediate closure of the abdominal wall, (2) delayed closure, and (3) non-surgical treatment through spontaneous skin epithelialization.[32] A primary suture-less closure using NPWT can only be performed once the abdominal contents are reduced, and the wall defects are closed, which is a critical prerequisite for successful NPWT application.[10,18] Gastroschisis with exposed organs is particularly vulnerable to fluid loss and infection, making it essential to wait for the consolidation of the herniated abdominal contents before closure.[20,29] Suture-less closure is a gentle technique and minimizes concerns about skin tension.

In cases requiring long-term stability for gradual reduction of the herniated content, NPWT offers less frequent dressing changes (every 2–3 days) compared with traditional gauze dressings, which need to be removed daily. [10,18,33] However, the frequency of dressing changes should be based on the patient's condition, especially if there is more fluid production than usual.[29] Furthermore, the sponge is covered by a polyurethane drape that is impermeable to proteins and microorganisms, helping to prevent bacterial colonization. The semi-occlusive membrane also has limited permeability to gases and water vapor, which helps maintain moisture and warmth in the wound by reducing heat transfer due to water evaporation.[33,34]

Previous studies on gastroschisis have shown that earlier enteral feeding correlates with significant beneficial outcomes, such as quicker regaining of birth weight, reduced duration of parenteral nutrition, and shorter NICU stays.[35] If feasible, portable NPWT is an option for reducing length of hospital stay.[23] NPWT is generally considered a safe approach and rarely leads to complications. However, some complications of varying severity have been reported, most of which are attributable to poor technique or inadequate patient selection. In other words, most adverse events are preventable. Complications reported after NPWT placement in our review include intestinal perforation 26 and fistula formation.[24] Fistula formation was the least common adverse event, while infection-related conditions were the most common, including surgical site infection (2.5%), cellulitis or abscess (2%), and bleeding (0.6%).[14] To prevent fistula formation, steri-strips can be applied after complete approximation of the wound edges before placing the wound vacuum[10] or absorbable biologic or synthetic mesh can be attached to the organ as an interface organ as interface.[24] The most effective way to prevent infection is to ensure that the wound is clean before applying the device and to change the dressings at regular intervals. The incidence of enteric infections is significantly higher when the dressing is applied directly over exposed organs.[33,34] Depending on the wound's size and location, a significant amount of fluid may be suctioned during the initial days of NPWT therapy, which can sometimes result in hemodynamic instability. It's crucial to monitor patients closely and provide fluid and electrolyte support when necessary. If the foam dressing is left in place for an extended period, or if granulation tissue develops rapidly, it can adhere to the foam. When the sponge is removed, the capillary buds in the tissue may be disrupted, leading to potential bleeding. Most bleeding episodes can be controlled with manual pressure, but in cases of substantial bleeding, electrocoagulation or surgical intervention may be required. Infection risks can be minimized by properly debriding nonviable tissue before applying NPWT and ensuring sterile technique during sponge changes.[33,34]

Standardized protocols for NPWT must be developed, tailored to the clinical needs of gastroschisis and ruptured omphalocele patients. Given the diverse patient population, ranging from preterm neonates to full-term infants, protocols should remain adaptable, accounting for factors such as defect size, status of wound infection, and patient stability. Key components of the protocol include: (i) patient selection criteria: criteria for NPWT inclusion should be viable tissue, and the absence of severe infection or necrosis. Other considerations should include overall clinical state, and the presence of comorbidities; (ii) wound management: the technique should be standardized, ensuring sterile application, and thorough necrotic tissue debridement prior to application; (iii) monitoring and adjustments: a protocol for daily wound assessment, and fluid balance should be implemented. Clinical staff should oversee dressing changes and evaluate patient stability to identify and address complications such as bleeding, or infection; (iv) complication prevention and management. If infection is suspected, thorough debridement and the use of antibiotics are warranted.

The current literature on NPWT in gastroschisis and ruptured omphalocele is limited by small study sizes, lack of control groups, and variability in protocols. Furthermore, there was variability in the reported outcomes and the duration of follow-up. Complications were reported, but these were limited to only two studies.[24,26] Research should also aim to identify the ideal frequency of dressing changes, duration of therapy, and the best approach for managing complications. A more standardized approach to NPWT application will help ensure that this promising technique can be utilized safely and effectively across different clinical settings.

CONCLUSIONS

Based on the findings of this scoping review, negative pressure wound therapy (NPWT) offers a major improvement of wound healing in addition to primary closure or delayed closure. Given the severity of abdominal compartment syndrome, early intervention and management is crucial to optimize therapeutic approach. Future research should further investigate the optimal use of NPWT in these challenging cases to refine protocols and better understand its long-term benefits and risks.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ACKNOWLEDGEMENT

Not applicable.

FUNDING

The author(s) received no financial support for the research, authorship, and/or publication of this article.

REFERENCES

1. Bhat V, Moront M, Bhandari V. Gastroschisis: A State-of-the-Art Review. Children (Basel) 2020; 7(12): 302.
2. Rahayatri TH, Gunardi HD, Amin RBM, Tamba RP. Gastroschisis survival improvement and early intervention: experience in a developing country. Paediatr Indones 2024; 64(3): 264-9.
3. Egger PA, de Souza MP, Riedo C de O, Dutra A de C, da Silva MT, Pelloso SM, et al. Gastroschisis annual incidence, mortality, and trends in extreme Southern Brazil. J Pediatr (Rio J) 2022; 98(1): 69-75.

4. Feldkamp ML, Canfield MA, Krikov S, Prieto-Merino D, Šípek A, LeLong N, et al. Gastroschisis prevalence patterns in 27 surveillance programs from 24 countries, International Clearinghouse for Birth Defects Surveillance and Research, 1980–2017. Birth Defects Res 2024; 116(2): 1-14.
5. Malhotra R, Malhotra B, Ramteke H. Enhancing Omphalocele Care: Navigating Complications and Innovative Treatment Approaches. Cureus 2023; 15(10): e47638.
6. Nembhard WN, Bergman JEH, Politis MD, Arteaga-Vázquez J, Bermejo-Sánchez E, Canfield MA, et al. A multi-country study of prevalence and early childhood mortality among children with omphalocele. Birth Defects Res 2020; 112(20): 1787-801.
7. Aldridge B, Ladd AP, Kepple J, Wingle T, Ring C, Kokoska ER. Negative pressure wound therapy for initial management of giant omphalocele. Am J Surg 2016; 211(3): 605-9.
8. Fotouhi AR, Sacks JM, Keller MS, Patel KB. A staged reconstruction technique utilizing bioprosthetic mesh reinforcement in the repair of giant omphalocele. J Pediatr Surg Case Reports 2022; 82: 102307.
9. Bruhin A, Ferreira F, Chariker M, Smith J, Runkel N. Systematic review and evidence based recommendations for the use of Negative Pressure Wound Therapy in the open abdomen. Int J Surg 2014; 12(10): 1105-14.
10. Hassan SF, Pimpalwar A. Primary suture-less closure of gastroschisis using negative pressure dressing (Wound Vacuum). Eur J Pediatr Surg 2011; 21(5): 287-91.
11. Stoffan AP, Ricca R, Lien C, Quigley S, Linden BC. Use of negative pressure wound therapy for abdominal wounds in neonates and infants. J Pediatr Surg 2012; 47(8): 1555-9.
12. Rentea RM, Somers KK, Cassidy L, Enters J, Arca MJ. Negative pressure wound therapy in infants and children: A single-institution experience. J Surg Res 2013; 184(1): 658-64.
13. Elghandour MM, Naggar O El, Radwan AB, Abdel-Latif M. Vacuum assisted closure therapy in children with complicated abdominal wounds, with or without viscero-cutaneous fistulae. J Pediatr Surg Open 2024; 8: 100153.
14. Santosa KB, Keller M, Olsen MA, Keane AM, Sears ED, Snyder-Warwick AK. Negative-Pressure Wound Therapy in Infants and Children: A Population-Based Study. J Surg Res 2019; 235: 560-8.
15. Pouzet L, Lancien U, Hamel A, Perrot P, Duteille F. Negative Pressure Wound Therapy in children: A 25 cases series. Ann Chir Plast Esthet 2021; 66(3): 242-9.
16. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021; 29: 71.
17. Gabriel A, Gollin G. Management of complicated gastroschisis with porcine small intestinal submucosa and negative pressure wound therapy. J Pediatr Surg 2006; 41(11): 1836-40.
18. Hubbard BA, Pimpalwar A. Sutureless delayed primary gastroschisis repair with negative pressure dressing. Eur J Pediatr Surg 2009; 19(2): 132–3.
19. Morris MW, Westmoreland T, Sawaya DE, Blewett CJ. Staged closure with negative pressure wound therapy for gastroschisis with liver herniation: A case report. J Pediatr Surg 2013; 48(5): e13–5.
20. Butler M, Fuchs J, Bruzoni M. Serial Reduction of an Extremely Large Gastroschisis using Vacuum-Assisted Closure. Eur J Pediatr Surg Reports 2018; 06(01): e97-9.
21. Chen SY, Zamora AK, Kim ES. Biologic patch coverage for definitive management of giant gastroschisis defects. J Pediatr Surg Case Reports 2021; 64: 101752.
22. Choi WW, McBride CA, Kimble RM. Negative pressure wound therapy in the management of neonates with complex gastroschisis. Pediatr Surg Int 2011; 27(8): 907-11.
23. McBride CA, Stockton K, Storey K, Kimble RM. Negative pressure wound therapy facilitates closure of large congenital abdominal wall defects. Pediatr Surg Int 2014; 30(11): 1163-8.
24. Hattori K, Numanoglu A, Cox S. Temporary Vacuum-Assisted Closure of the Open Abdomen in Neonates. Eur J Pediatr Surg 2017; 27(5): 437-42.
25. Morulana TG, Tshifularo N. Novel management of ruptured giant omphalocoele. J Pediatr Surg Case Reports 2020;61:101602.
26. Horiike M, Kitada T, Santo K, Hashimoto T, Satoshi O. Successful abdominal wall closure following collagen-based artificial dermis induced epithelialization for giant omphalocele: A case report. Int J Surg Case Rep 2020; 75: 464-8.
27. Nakagawa Y, Uchida H, Hinoki A, Shirota C, Sumida W, Makita S, et al. Combined negative pressure wound therapy with irrigation and dwell time and artificial dermis prevents infection and promotes granulation formation in a ruptured giant omphalocele: a case report. BMC Pediatr 2022; 22(1): 1-8.
28. David VL, Neagu MC, Sosoi A, Stanciulescu MC, Horhat FG, Stroescu RF, et al. Combined Staged Surgery and Negative-Pressure Wound Therapy for Closure of a Giant Omphalocele. Case Rep Pediatr 2021; 1-4.
29. Tri TT, Duc NM, Duy HP, Thien NT, Thuan LNA, Bang MTL. A case series describing vacuum-assisted closure for complex congenital abdominal wall defects. Clin Ter 2021; 172(4): 273-7.
30. Nissen M, Romanova A, Weigl E, Petrikowski L, Alrefai M, Hubertus J. Vacuum-assisted staged omphalocele reduction: A preliminary report. Front Pediatr 2022; 10.
31. Hou S, Shi Z, Li X, Yang R, Song Y, Zeng Z. Combined negative pressure wound therapy with new wound dressings to repair a ruptured giant omphalocele in a neonate : a case report and literature review 2025; 4-9.
32. Kanamori Y, Tahara K, Kutsukake M, Yamada Y, Mori T, Kudo Y, et al. Giant omphalocele treated by staged operation and successive conservative therapy using artificial dermis (Terudermis®) for effective epithelization. J Pediatr Surg Case Reports 2021; 72: 101959
33. Horch RE, Ludolph I, Müller-Seubert W, Zetzmann K, Hauck T, Arkudas A, et al. Topical negative-pressure wound therapy: emerging devices and techniques. Expert Rev Med Devices 2020; 17(2): 139-48.
34. Normandin S, Safran T, Winocour S, Chu CK, Vorstenbosch J, Murphy AM, et al. Negative Pressure Wound Therapy: Mechanism of Action and Clinical Applications. Semin Plast Surg 2021; 35(3): 164-70.
35. Thompson P, Walker K, Halliday R, Holland A., Trivedi A. Early enteral feeding following repair of gastroschisis is associated with shorter length of admission and better nutritional outcomes. J Clin Neonatol 2017; 6(4): 231.