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Growth Failure Prevalence in Neonates with Gastroschisis: A Statewide Cohort Study

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Abstract

OBJECTIVES: To perform a multicenter study to assess growth failure in hospitalized infants with gastroschisis.

STUDY DESIGN: This study included neonates with gastroschisis within sites in the University of California Fetal Consortium (UCFC). The study's primary outcome was growth failure at hospital discharge, defined as a weight or length z-score decrease > 0.8 from birth. Regression analysis was performed to assess changes in z-scores over time.

RESULTS: Among 125 infants with gastroschisis, the median gestational age was 37 weeks (IQR 35–37). Length of stay was 32 days (23–60); 55% developed weight or length growth failure at discharge (28% had weight growth failure, 42% had length growth failure, and 15% had both weight and length growth failure). Weight and length z-scores at 14 d, 30 d, and discharge were less than birth ($p<0.01$ for all). Weight and length z-scores declined from birth to 30 days (−0.10 and −0.11 z-score units/week, respectively, $P < .001$). Length growth failure at discharge was associated with weight and length z-score changes over time ($p <0.05$ for both). Lower gestational

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age was associated with weight growth failure (OR=0.70 for each gestational age week, 95% CI 0.55–0.89, p=0.004).

CONCLUSION: Growth failure, in particular linear growth failure, is common in infants with gastroschisis These data suggest the need to improve nutritional management in these infants.

In adults and children, malnutrition is under-diagnosed and associated with increased sepsis and mortality rates and prolonged hospital stays.[1–3] In neonates, growth failure is associated with poor neurodevelopment, and catch-up growth appears to be protective.[4–7] Infants with gastroschisis are at high risk for growth failure. Up to 80% of these infants are born prematurely, with an average gestational age of 36 weeks;[8] 15% of infants with gastroschisis have intrauterine growth restriction.[9] These infants are often exposed in utero to tobacco and illicit drugs.[10,11] All infants with gastroschisis are at risk for intestinal strictures, necrotizing enterocolitis, sepsis, and prolonged feeding intolerance. Approximately 20% of infants with short bowel syndrome have gastroschisis.[12] Infants with short bowel syndrome require prolonged parenteral nutrition, which is associated with growth stunting and intestinal failure associated liver disease.[12]

Most growth studies in infants with gastroschisis are retrospective, single site, have small sample sizes, and involve infants with other gastrointestinal anomalies.[13–21] Understanding the extent of growth failure is also complicated because studies characterize growth failure differently. Z-scores are considered the gold standard for defining growth failure and reflect the standard deviation of the population. Our objective was to determine the incidence and degree of growth failure and describe changes in weight, length, and head circumference (HC) z-scores over time in a large contemporary cohort of infants with gastroschisis.

We hypothesized that >40% of infants with gastroschisis would have growth failure, defined as a decline in the z-score for weight or length >0.8 at hospital discharge, that weight and length z-scores would be lower at hospital discharge than birth, but HC would be unchanged, *that* prematurity, small for gestational age (SGA), sepsis, and necrotizing enterocolitis would negatively correlate with growth failure, and that age at first feed and full feeds would positively correlate with growth failure.

METHODS

Infants with gastroschisis were eligible for this retrospective cohort study if they were cared for at one of the sites in the University of California Fetal Consortium (UCFC) and born between February 2015 to July 2019. Patients who died prior to discharge from the NICU were excluded. In 2015, The UCFC implemented a surgical, obstetrical and neonatal pathway to standardize care for infants with gastroschisis. This pathway prioritizes vaginal delivery, prompt closure of the intestinal defect, minimizing the use of paralytics, antibiotics, and opioids. The pathway recommends initiating 20 cc/kg/d of human milk after 48 hours of non-bilious Repogle output and advancing feeds by 20 cc/kg/d (Table I; available at www.jpeds.com). This pathway does not provide any recommendations for parenteral nutrition or fortification of enteral nutrition. The UCFC published a moderate to high adherence (60–96%) to individual components of this pathway.[22] Implementation of this pathway was associated with a decrease in median ventilator and antibiotic days, and earlier initiation of feeds.[22]

Our primary outcome was weight or length growth failure at hospital discharge. Growth failure was classified as mild, moderate, or severe.[23] Mild growth failure was defined as a z-score change from birth greater than or equal to 0.8, but less than 1.2. Moderate growth failure was defined as a z-score change from birth >1.2, but <2. Severe growth failure was defined as a z-score change from birth >2.

This study was a retrospective analysis of a quality improvement project. Growth data was collected prospectively. Chart review of the maternal record included: illicit drug/alcohol/tobacco use, intrauterine growth restriction (IUGR), and maternal age. IUGR was defined as weight <10th percentile on ultrasound for a given gestational age.[24] Chart review of the neonatal record included: gestational age, mode of delivery, duration of parenteral nutrition, days to reach full enteral feeds, and complications such as sepsis and necrotizing enterocolitis. Full feeds was defined as 100 cc/kg/day of enteral nutrition or ad libitum feeding, whichever occurred first. Late onset sepsis was defined as a positive blood culture after 72 hours of age. Necrotizing enterocolitis was defined by Bell's stage two or greater.[25] Gastroschisis diagnosis was differentiated as simple versus complex. Complex gastroschisis was defined as gastroschisis with intestinal atresia, intestinal stricture, ischemic bowel prior to closure, or severe pulmonary hypoplasia.[22]

Weight, length, and HC and their respective z-scores were measured by clinical staff at birth, and approximately 14 and 30 days of age, and at discharge. Length was measured using rigid length boards for all sites except one. Means and standard deviations to calculate z-scores were obtained from Fenton et al for preterm infants (<37 weeks gestational age) and the World Health Organization for term infants.[26,27] Growth velocity was calculated using a two-point model with birth weight as a starting point and accounted for birth weight (g/kg/d).[28] Length and HC velocity was expressed as cm/week. SGA was defined as <10th percentile for birth weight using the appropriate growth chart.

Statistical analyses

To achieve at least 80% power with a one-sided binomial test at a 5% significance level, a sample size of 120 would detect an incidence of 41% in the primary outcome (weight or length growth failure), when the population incidence was assumed to be 30%. Quantitative variables were summarized using quartiles (median and IQRs), and differences were examined using the paired t-test, mean differences, and 95% confidence interval (CI). Qualitative variables are summarized using frequencies and percentages, and were compared using the Fisher exact test. Generalized linear mixed models for repeated measures were used to estimate the rate of change in weight, length, and HC z-scores over time. The growth velocity (weight, length, and HC) between infants with and without growth failure were compared using the Wilcoxon test.

The association between gestational age, birth weight z-score, IUGR, SGA, length of stay, complicated gastroschisis, days until first feed, site, surgical method, late onset sepsis, and days until abdominal closure, discharge weight growth failure, and discharge length growth failure were examined using a series of univariable logistic regression models. The results are summarized using odds ratios (ORs) and their 95% CI. All tests were two sided and p-values less than 0.05 were considered statistically significant. The analyses were performed using SAS 2016 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Infants with gastroschisis (n=132) were eligible for this study, and 125 infants were included. No infants died or were transferred to another hospital. Seven infants were excluded due to missing birth growth measures. Of those included, 120 infants had growth data at 14 days, 90 infants at 30 days, and 125 infants at NICU discharge. Patients were treated at one of the UCFC sites: University of California San Francisco (28), University of California Davis (27), University of California Los Angeles (32), University of California Irvine (20), University of California San Diego (14), and Rady Children's Hospital (6).

Demographic and hospital course data are summarized in Table 2: 14% (17 infants) had complex gastroschisis, 4% (5 infants) developed necrotizing enterocolitis, two of whom required surgery and 1 infant developed abdominal compartment syndrome requiring surgical intervention. When feeds were initiated, 90% (105 infants) received either maternal breastmilk or donor milk. At discharge, 42% (48 infants) received human milk, 31% (37 infants) received human milk and formula, 25% (29 infants) received formula only, and 2% (2 infants) received parenteral nutrition.

The mean day for growth data collected at 14 days of age was 13.7 days (CI 13.1, 14.4) for weight, 15.9 days (CI 8.6, 23.1) for length, and 15.6 days (CI 8.5, 22.1) for HC. The mean day for growth data collected at 30 days was 31.5 days (CI 24.2, 38.7) for weight, 30.9 days (CI 22, 39.8) for length, and 30.3 days (CI 22.7, 38) for HC. Mean day for growth data collected at NICU discharge was 50.3 days (CI 40.1, 60.5) for weight, 48.1 days (CI 38, 58.2) for length, and 47.9 days (CI 38.6, and 57.2) for HC.

Overall, 55% of infants in this study had the primary outcome. Table 3 provides data on the incidence of growth failure; 28% (35 infants) had weight growth failure at discharge, 42% (53 infants) had length growth failure, and 15% (19 infants) had both weight and length growth failure at discharge. The mean (CI) z-scores at birth, 14 and 30 days of age, and discharge are displayed in Table 4 (available at www.jpeds.com). The median time to regain birth weight was 8 days (IQR 5,13). At birth, 36% (48 infants) and 41% of infants (54 infants) had a birth weight or length z score < −1.28 at birth (10^{th} percentile, or small for gestational age), respectively. At discharge, 59% (78 infants) and 59% (78 infants) had a weight and length z-score < −1.28. Compared with birth, the odds of having a weight or length z-score < −1.28 at discharge were 3 (p<0.001) and 2.2 (p=0.003) times higher, respectively.

Weight, length, and HC z-scores were all significantly less than zero at birth, 14 and 30 days, and discharge (p=0.001 for all). Weight and length z-scores at 14 and 30 days and discharge were significantly less than birth weight and length, respectively (p=0.001 for all). However, when HC z-scores at later time points were compared with birth HC, there was no difference (p=0.28 at 14 days, p=0.54 at 30 days, and p=0.17 at discharge). Weight and length z-score from birth to 30 days demonstrated a significant decrease over time (−0.10 z-score units/week and −0.11 z-score units/week, respectively, p<0.001 for all). In contrast, there was not a significant change in HC from birth to 30 days (−0.02 z-score units/week, p=0.66).

There was not a significant increase in the incidence of weight (p=0.32) or length growth failure over time (p=0.06), but there was a significant increase in both weight and length growth failure over time (p=0.04). At 14 days, 6% of infants (8 infants) with gastroschisis had both weight and length growth failure. By NICU discharge, 15% (19 infants) had both weight and length growth failure. Change in weight z-score from birth to 30 days was significantly different between those who had the primary outcome compared with those who did not have the primary outcome (−0.13 versus −0.07 z-score units/week, p=0.004, Figure 1). Likewise, change in length z-score from birth to 30 days was significantly different between the two groups (−0.54 versus 0.16 z-score units/week, p=0.026, Figure 1). However, change in head circumference z-score from birth to 30 days was similar between those who had the primary outcome compared with those who did not (−0.005 versus 0.0067 z-score units/week, p=0.086, Figure 1). In contrast, median weight and HC growth velocity were similar when the group of infants with the primary outcome was compared with the group of infants without the primary outcome (p=0.32 for weight and p=0.16 for HC, respectively) (Table 5; available at www.jpeds.com). However, there was a significant difference in median linear growth velocity. Linear velocity in infants with growth failure was 0.58 cm/week, and linear velocity in infants without growth failure was 1 cm/week (p=0.01).

Gestational age was associated with growth failure; more mature infants had a decreased odds of growth failure (OR=0.70 for each gestational age week, 95% CI 0.55–0.89, p=0.004). An increase in one standard deviation for birth weight z-score was associated with an increased the risk for growth failure (OR 1.83, 95% CI 1.78–2.83, p=0.007). The odds of developing growth failure was 28% greater if the infant was not SGA versus SGA (OR 0.78, 95% CI p=0.02) (Table 6; available at www.jpeds.com). Weight z-score trajectories for SGA infants and infants without SGA are shown in Figure 2. Of note, infants born SGA had a significantly higher median gestational age than infants born appropriate for gestational age (37.1 (IQR 36.7–37.1) versus 36.3 (IQR 34.4–37.9), p=0.001). Weight growth failure was not associated with sepsis, necrotizing enterocolitis, or age at first feed and full feeds. There were no significant associations for length growth failure at discharge.

DISCUSSION

In this multi-site study of 125 infants with gastroschisis, growth failure, specifically, linear growth failure, was common. The incidence of infants with both weight and length growth failure increased during the hospital stay. Our data suggest that growth failure may be detected prior to hospital discharge and bring up the possibility that improved nutritional practices and clinical strategies should be considered.

Our findings validate previous finding by other investigators.[4,15,19–21] Growth failure during initial hospital stay in gastroschisis infants was investigated in two single site, retrospective studies. These studies had a sample size of 60 and 90 infants, respectively. In both studies, 30% of infants with gastroschisis had a weight z-score less than one at discharge.[15,20] This is comparable with our study; 28% of infants had a weight z-score <0.8 at discharge. In contrast to these studies, we investigated growth in larger group of infants who were cared for at six different sites. Each site utilized a standardized obstetrical, surgical, and medical approach for the management of gastroschisis. We also investigated longitudinal measurements for weight, length, head circumference, and growth velocity.

Weight velocity is commonly used to assess growth in the NICU. Growth velocity is calculated in g/kg/day, which accounts for birth weight, or g/day[4,23]. When using g/kg/d, some investigators use birth weight, and others will use the physiologic nadir for this calculation.[29] We opted to report g/kg/d, accounting for birth weight, to be consistent with the growth failure definitions published by Goldberg et al.[23] Although the infants in this study had a median gestational age of 37 weeks, many infants were born prematurely and were SGA or growth restricted. We compared z-score changes with velocities for weight, length, and HC. There was no significant difference in weight velocity between gastroschisis infants who developed growth failure and gastroschisis infants who did not develop growth failure. In this study, the median weight growth velocity for infants with gastroschisis was 5.8 g/kg/d, which is far below the recommended growth velocity of at least 15 g/kg/day.[23] In contrast, gastroschisis infants who developed growth failure had a significantly different and worse linear velocity compared with infants without growth failure.

In preterm infants, poor linear growth and microcephaly are associated with neurodevelopmental delays.[30–33] Fetuses with gastroschisis have smaller occipitofrontal circumference and crown-heel length compared with healthy control fetuses matched for gestational age.[34] In preterm infants, smaller occipitofrontal circumference and shorter fetal lengths have been associated with a decreased amount of white matter on magnetic resonance imaging.[35] In this study, HC z-score did not change over time, and HC velocity was similar for infants with gastroschisis with growth failure and those without growth failure. Although it is unclear why HC was spared, we hypothesize that these infants were not severely malnourished or stunted. Studies in preterm infants with postnatal growth failure reported similar findings.[36–38]

Increased energy and protein provisions are associated with improved somatic growth and a decreased risk for cerebral palsy in very low birth weight infants.[39–44] It is possible that some infants with gastroschisis and growth failure develop an energy and protein deficit. Providing sufficient parenteral protein beginning at birth and not prematurely discontinuing parenteral nutrition may be an important nutritional practice to consider in infants with gastroschisis. Fortification of enteral nutrition may also improve growth. However, some infants with gastroschisis may not tolerate bovine fortification. Given our results, we have recently amended our clinical guidelines to include recommendations for parenteral nutrition and enteral nutrition fortification.

Gestational age, SGA, and birth weight z-score were associated with weight growth failure at discharge. As expected, infants with gastroschisis who were born less mature had a higher risk of growth failure. Studies that have demonstrated that late-preterm infants are at risk for growth failure and later disabilities.[45] SGA and IUGR infants are at high risk for growth failure.[46,47] In our study, there was a high incidence of SGA and IUGR; 43% and 32% of the infants had SGA or IUGR, respectively. Unexpectedly, SGA was associated with a decreased risk for growth failure. This is inconsistent with our hypothesis and prior research.[46,47] This may be explained by the fact that SGA infants had a significantly higher gestational age at birth compared with infants who were born appropriate for gestational age. In this study, there was a 30% reduction in growth failure for each additional week of gestation. It is also possible that clinicians caring for infants who are born SGA may pay more attention to growth and nutrition compared with infants born appropriate for gestational age.

Although the median surgical closure was two days of age, feeds were initiated at a mean of 12 days of age in this study. This delay in feeding is most likely secondary to underlying intestinal dysmotility. Chronic inflammation and intestinal dysbiosis may contribute to dysmotility and poor growth in neonates with gastroschisis. In the pediatric population, inflammation has been linked to abnormalities in the growth hormone/IGF-1 axis.[48] In gastroschisis fetuses, the intestinal exposure to amniotic fluid causes an inflammatory bowel "peel" that may cause feeding intolerance and prolonged parenteral nutrition courses, which may in turn, may cause growth failure.[49]

This inherent inflammation in neonates with gastroschisis may be exacerbated by the enteral diet. Although the majority of the infants received human milk when enteral feeds were started, 56% of infants were receiving some formula at discharge. In term infants fed an exclusively human milk diet compared with those who received formula, infants who received a human milk diet had lower concentrations of fecal calprotectin and alpha-1 antitrypsin levels, markers of inflammation, at three months of life.[50] Some mothers may not be able to provide a sufficient amount of human milk, or there may be contraindications to human milk. In very low birth weight infants, the prolonged use of unfortified donor milk has been associated with poor growth.[45] However, when donor milk is used as a "bridge," and a standardized approach to donor milk fortification is used, a human milk diet improves overall growth and neurodevelopment, and decreases the risk of sepsis, necrotizing enterocolitis, and hospital readmissions.[51–53]

We recognize the limitations of our study. Data was collected retrospectively and, as a result, there is some missing data. We did not assess growth or neurodevelopment beyond the NICU. Assessments of linear growth were not uniform. However, all but one site used length boards, which is the preferred method for measuring length in infants. We did not collect data on albumin concentrations, blood urea nitrogen, and urine sodium concentrations, which are markers of nutritional status. Last, we are unable to comment on specific components of parenteral and enteral nutrition. The UCFC gastroschisis clinical pathway provides limited guidance on nutritional management. As result, it is unclear if the growth patterns observed in our study are secondary to variability in nutritional practices.

Because this study enrolled a large group of infants from several large children's hospitals in the state of California and participating centers utilized a standardized approach to the management of gastroschisis, we believe our results are generalizable. These findings suggest that clinicians may need to develop a multi-disciplinary nutritional approach to prevent and treat growth failure in infants with gastroschisis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix

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Table 2.

Characteristics of gastroschisis infants.

	Percent (N) or Median (IQR)	N
Sex, female	46 (54)	117
Gestational age	37 (35,37)	125
Birth weight (g)	2458 (2165,2802)	124

	Percent (N) or Median (IQR)	N
Birth length (cm)	46 (43,48)	123
Birth head circumference (cm)	32 (30.5,33)	124
Birth weight z-score	−0.9 (−1.5, −0.1)	122
Birth length z-score	−0.9 (−1.7, 0.1)	121
Birth head circumference z-score	−1.1 (−1.7, −0.2)	122
Small for gestational age	43 (54)	122
Intrauterine growth restriction	32 (40)	124
Maternal tobacco use	11 (14)	124
Maternal alcohol use	3 (4)	125
Maternal illicit drug use	18 (21)	120
Complicated gastroschisis	14 (17)	122
Length of stay (days)	33 (23,60)	120
Necrotizing enterocolitis	4 (5)	119
Late onset sepsis	9 (11)	120
Age of first feed (days)	12 (9,18)	115
Age at full feeds (days)	24 (18,43)	123
Days to closure	2 (0,4)	123
Abdominal compartment syndrome	1 (1)	125
Silo utilized	72 (90)	125

Small for gestational age is a birth weight less than the 10th percentile. Intrauterine growth restriction is a fetal weight estimated to be less than the 10th percentile on ultrasound. Complicated gastroschisis is defined as pulmonary hypoplasia, intestinal atresia or stricture, or ischemic bowel prior to closure. Necrotizing enterocolitis is defined as Bell's staging two or greater. Late onset sepsis is a positive blood culture after 72 hours of age. N: number of observations.

Table 3.

Growth failure at each time point in infants with gastroschisis.

	Mild Growth Failure	Moderate Growth Failure	Severe Growth Failure
Weight Z-score			
14 day N=120	21%	4%	0%
30 day N=90	16%	11%	0%
Discharge N= 125	13%	12%	3%
Length Z-score			
14 day N=120	15%	14%	2%
30 day N=90	17%	17%	8%
Discharge N=125	16%	15%	11%

Number of observations provided at each time point. Growth failure was categorized by changes in weight or length z-score at each time point from birth: mild 0.8–1.19, moderate 1.2–1.99, and severe ≥2.

Abbreviations:

NICU	Neonatal intensive care unit
UCFC	University of California Fetal Consortium

SGA	Small for gestational age
IUGR	Intrauterine growth restriction
HC	Head circumference
CI	Confidence interval

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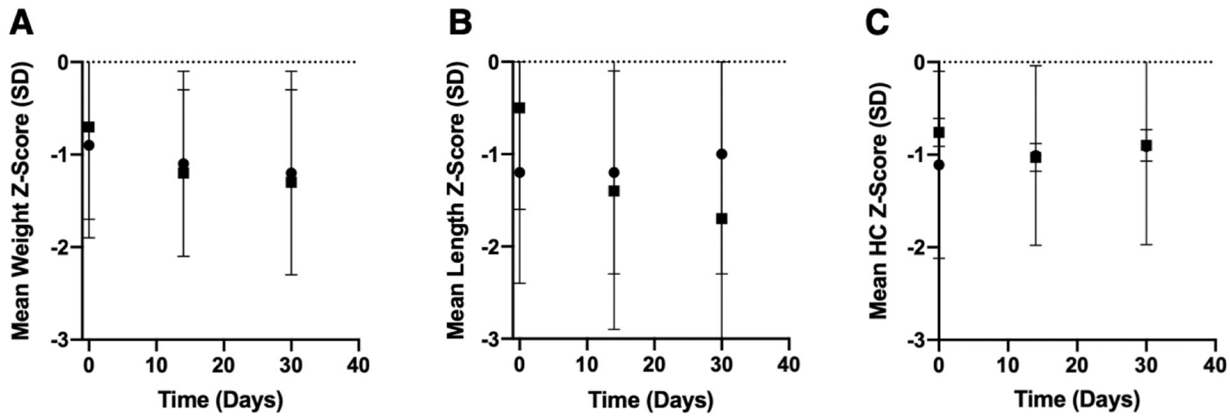

Figure 1.

Mean weight (A), length (B), and head circumference (HC) (C) z-scores from birth to 30 days. Circles represent those who had no growth failure (weight or length) at discharge. Squares represent those who had growth failure (weight or length) at discharge. Error bars represent standard deviation. The change in weight z-score from birth to 30 days was significantly different between those who developed growth failure at discharge compared those who did not (−0.13 versus −0.07 z-score units/week, p=0.004). The change in length z-score from birth to 30 days was significantly different between these two groups (−0.54 versus 0.16 z-score units/week, p=0.023). There was no significant difference in head circumference z-score changes from birth to 30 days between groups (−0.0050 versus 0.0067 z-score units/week, p=0.086).

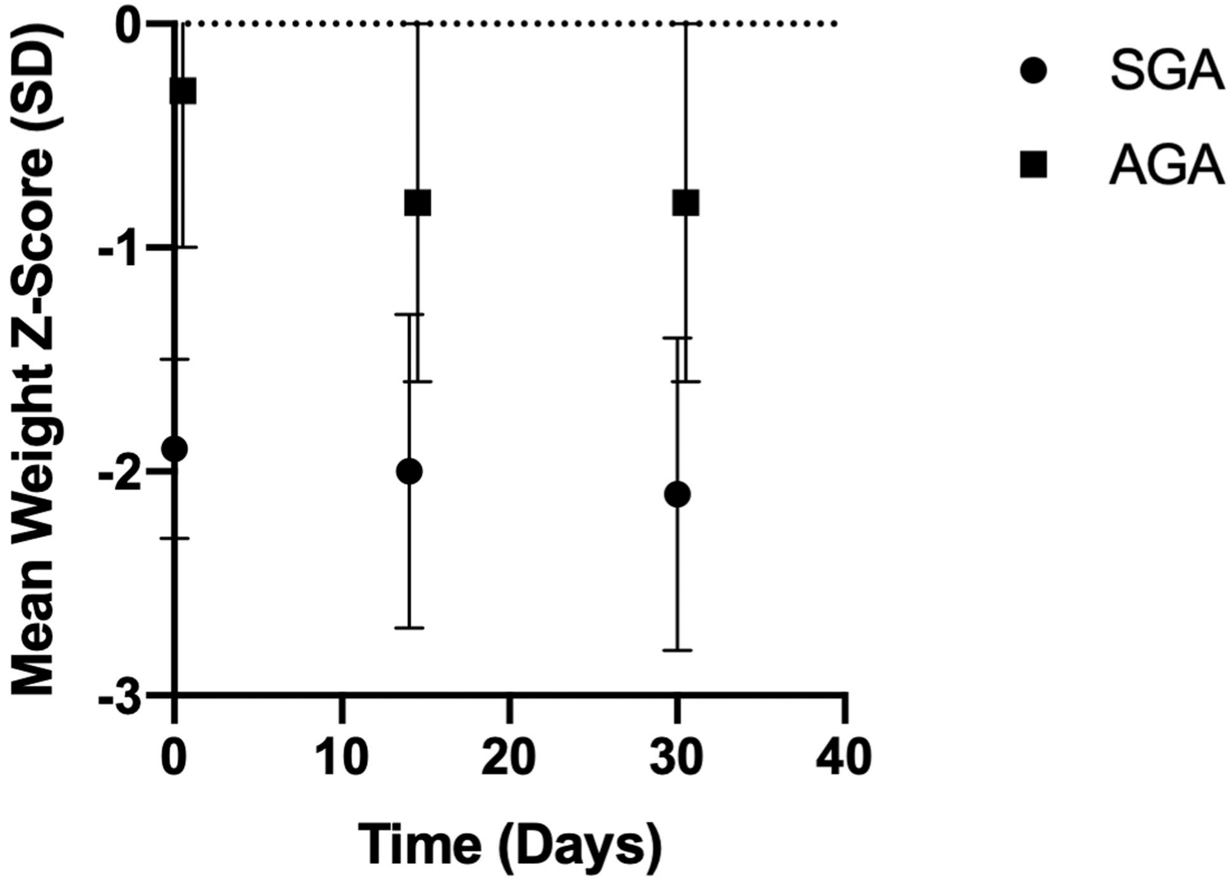

Figure 2.

Mean weight z-score from birth to 30 days in infants who are small for gestational age versus infants who are appropriate for gestational age.

Table 1.

2015 University of California Fetal Consortium Clinical Pathway for Gastroschisis.

Obstetrical Guidelines

- Recommend delivery at 38 weeks if routine pregnancy with fetal gastroschisis without other maternal or fetal indications for delivery
- In pregnancies with fetal gastroschisis that are complicated by fetal growth restriction or suboptimal interval fetal growth, the goal gestational age for delivery is 37 weeks
- Vaginal delivery is recommended with Cesarean section reserved for obstetrical indications

Surgical Guidelines

- [*]Attempt bedside silo placement and closure without intubation or anesthesia is encouraged when feasible (note: a narrow fascial defect requiring lateral extension does not prohibit this approach). Routine intubation and paralysis are NOT recommended
- If silo is utilized, closure within 3 days is recommended when feasible
- Recommend gastric and rectal decompression as strategies to facilitate reduction

Ventilator Guidelines

- Routine intubation and paralysis are not recommended for silo placement and bedside reduction

Antibiotic Guidelines

- Ampicillin and gentamicin are recommended as primary choice for prophylaxis
- Discontinue antibiotics within 48 hours after abdominal closure in the absence of culture-positive sepsis and clinical instability

Pain Management Guidelines

- [*]Recommend oral sucrose water for silo placement, reduction, and closure
- If narcotics are used, limit to a single dose when feasible to prevent against apnea or intubation
- Recommend nonnarcotic medications to control pain
- Discontinue opioids within 48 hours after abdominal closure

Central Venous Access Guidelines

- Peripherally inserted (PICC) venous access is preferred over central-insertion of tunneled catheters
- Discontinue central venous catheters as soon as 100 kcal/kg/day of enteral feeds (or ad lib oral feeds) are achieved

Feeding Guidelines

- Initiate feeds within 48 hours of gastric output becoming nonbilious
- Use mother's own breastmilk if available
- Advance feeding by at least 20 cc/kg/day as tolerated

[*]represents changes made in 2016.

Table 4.

Mean (95% confidence intervals) for weight, length and head circumference z-scores at birth, 14 and 30 days, and discharge in infants with gastroschisis.

	Birth	14 day	30 day	Discharge
Weight	−0.82 (−1,−0.7) *	−1.2 (−1.4,−1) *+	−1.2 (−1.4,−1.0) *+	−1.3 (−1.5,−1.2) *+
Length	−0.83 (−1,−0.6) *	−1.3 (−1.5,−1) *+	−1.4 (−1.8,−1.1) *+	−1.3 (−1.5, −1) *+
Head Circumference	−0.83 (−1.1,−0.7) *	−1.0 (−1.2,−0.8) *	−0.93 (−1.2,−0.8) *	−0.77 (−1,−0.6) *

* p<0.05 when compared to zero (average).

+ p<0.05 when compared to birth.

Table 5.

Median growth velocity (IQR) from birth to discharge in infants with gastroschisis. Velocities were compared between infants who developed weight or length growth failure and infants who did not develop weight or length growth failure at discharge.

	All Infants	Growth Failure	No Growth Failure	P-value
Weight gain velocity (g/kg/d)	5.8 (4.3–7.0)	5.2 (4.1, 6.9)	6.1 (5.2, 7.2)	0.32
Length velocity (cm/week)	0.6 (0.5–0.8)	0.58 (0.17, 0.74)	1.0 (0.83, 1.4)	0.01
Head circumference velocity (cm/week)	0.8 (0.4–1.1)	0.58 (0.41, 0.74)	0.67 (0.41, 0.74)	0.16

Table 6.

Predictors of weight growth failure at discharge.

	Odds Ratio (95% CI)	P-value
Gestational age (week)	0.70 (0.55–0.89)	0.004
Birth weight z-score	1.83 (1.78–2.83)	0.007
Small for gestational age (yes)	0.28 (0.10–0.80)	0.017
Intrauterine growth restriction (yes)	1.4 (0.62–3.3)	0.40
Length of stay (day)	1.0 (0.99–1.0)	0.59
Complicated gastroschisis (yes)	0.61 (0.16–2.3)	0.47
Days until first feed	1.0 (0.99–1.0)	0.44
Days until full feeds	1.0 (0.99–1.0)	0.75
Late onset sepsis	0.54 (0.11–2.7)	0.45
Silo (yes)	1.5 (0.60–4.0)	0.38
Days until closure	1.0 (0.85–1.2)	0.99
Site	--	0.45

Small for gestational age is a birth weight less than the 10^{th} percentile. Intrauterine growth restriction (IUGR) is a fetal weight estimated to be less than the 10^{th} percentile on ultrasound. Complicated gastroschisis is defined as pulmonary hypoplasia, intestinal atresia or stricture, or ischemic bowel prior to closure. Late onset sepsis is a positive blood culture after 72 hours of age. N/A: not applicable.