Length of stay and cost analysis of neonates undergoing surgery at a tertiary neonatal unit in England

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ABSTRACT

INTRODUCTION There is a lack of knowledge on the average length of stay (LOS) in neonatal units after surgical repair of common congenital anomalies. There are few if any publications reporting the activity performed by units undertaking neonatal surgery. Such activity is important for contracting arrangements, commissioning specialist services and counselling parents. The aim of this study was to describe postnatal LOS for infants admitted to a single tertiary referral neonatal unit with congenital malformations requiring surgery.

METHODS Data on nine conditions were collected prospectively for babies on the neonatal unit over a five-year period (2006–2011). For those transferred back to their local unit following surgery, the local unit was contacted to determine the total LOS. Only those babies who had surgery during their first admission to our unit and who survived to discharge were included in the study. Cost estimates were based on the tariffs agreed for neonatal care between our trust and the London specialised commissioning group in 2011–2012.

RESULTS The median LOS for the conditions studied was: gastroschisis 35 days (range: 19–154 days), oesophageal atresia 33 days (range: 9–133 days), congenital diaphragmatic hernia 28 days (range: 7–99 days), intestinal atresia 24 days (range: 6–168 days), Hirschsprung's disease 21 days (range: 15–36 days), sacrococcygeal teratoma 17 days (range: 12–55 days), myelomeningocele 15.5 days (range: 8–24 days), anorectal malformation 15 days (range: 6–90 days) and exomphalos 12 days (range: 3–228 days). The total neonatal bed day costs for the median LOS ranged from £8,701 (myelomeningocele) to £23,874 (gastroschisis). The cost of surgery was not included.

CONCLUSIONS There is wide variation in LOS for the same conditions in a single neonatal unit. This can be explained by different types and severity within the same congenital anomalies, different surgeons and other clinical confounders (eg sepsis, surgical complications, associated anomalies). These data will enable us to give more detailed information to families following prenatal or postnatal diagnosis. They also allow more detailed planning of resource allocation for neonatal admissions.

KEYWORDS

Paediatric – Neonatal – Length of stay – Surgical conditions

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The number of babies requiring specialist neonatal care has increased in recent years. Provision of a neonatal surgical service is a key aspect of both regional neonatal and regional paediatric surgical services.

In the UK, the average length of stay (LOS) in neonatal units after surgical repair of common congenital anomalies is not reported in the literature. LOS data are important for counselling parents of affected babies (both prenatally and after birth) as well as for commissioners to plan and fund services adequately. The aim of our study was to establish the median LOS for initial postnatal admission to the neonatal unit in a tertiary neonatal and surgical unit in London. In the current economic climate, commissioners and providers need to work together to identify the financial impact of

quality improvement measures such as the neonatal services toolkit, and to identify initiatives that may improve productivity and reduce costs so as to make improved, affordable, high quality neonatal services a reality.

Methods

Our centre is a regional neonatal surgical referral unit with an average of 20,000 births annually in the region. The median LOS was calculated for the main neonatal surgical conditions requiring surgery between 2006 and 2011 at a tertiary neonatal unit in London. The median gestational age was recorded for neonates with intestinal atresia (duodenal, jejunal, ileal and colonic), oesophageal atresia with or without fistula,

Table 1 Median total LOS, median LOS at our unit and median gestational age for different surgical conditions

Surgical conditions	<i>n</i>	Total LOS (range) in days	LOS on SGH NNU (range) in days	Gestational age (range) in weeks
Sacrococcygeal teratoma	7	17 (12–55)	16 (6–29)	38 (34–39)
Oesophageal atresia	35	33 (9–133)	25 (8–123)	38 (34–39)
Myelomeningocele	14	15.5 (8–24)	14 (2–23)	39 (36–40)
Intestinal atresia (duodenal / jejunal / ileal / colonic)	42	24 (6–168)	19 (8–120)	37 (31–42)
Hirschsprung's disease	7	21 (15–36)	16 (8–32)	39.5 (35–41)
Gastroschisis	27	35 (19–154)	29 (17–153)	37 (35–39)
Exomphalos	12	12 (3–228)	7 (2–227)	38.5 (33–42)
Congenital diaphragmatic hernia	23	28 (7–99)	22 (5–61)	39 (34–42)
Anorectal malformation	25	15 (6–90)	10 (3–89)	38 (31–42)

LOS = length of stay; SGH NNU = St George's Hospital neonatal unit

Figure 1 Length of stay for different surgical conditions

gastroschisis, anorectal malformation, congenital diaphragmatic hernia, myelomeningocele, exomphalos (major/minor), Hirschsprung's disease and sacrococcygeal teratoma.

Data were collected prospectively via the Standardised Electronic Neonatal Database. For babies transferred out to their local unit following surgery, the local unit was contacted to determine the total LOS. Only those infants who had surgery during their first admission to our unit and who survived to discharge were included in the study. Readmissions were not analysed.

Cost estimates were based on the tariffs agreed for neonatal care between our trust and the London specialised commissioning group in 2011–2012. Costs were £1,224 per

cot day for intensive care, £840 for high dependency care and £433 for special care. The median number of days at each level of care were calculated and the median total cost per patient was obtained for each surgical condition. The cost of surgery was not included.

Results

In 2011 there were 623 admissions (127 ex utero). More than 150 of these were surgical admissions. Fourteen ex utero surgical transfers were declined.

Table 1 shows the median total LOS, the median LOS at our unit and the median gestational age for neonates with

Table 2 Median number of days at different levels of care and associated costs with range in brackets

	Intensive care	High care	Special care	Total	Cost
Cost per day	£1,224	£840	£433		
Sacrococcygeal teratoma	2 (2–6)	13 (13–13)	10 (4–28)	15 (7–30)	£17,698 (£5,404–£17,698)
Oesophageal atresia	7 (2–37)	7 (1–42)	10 (3–109)	26 (8–124)	£18,778 (£6,270–£64,789)
Myelomeningocele	2 (2–4)	1 (1–1)	13 (1–19)	15 (3–24)	£8,701 (£2,881–£13,963)
Intestinal atresia (duodenal / jejunal / ileal / colonic)	4 (2–61)	9 (1–84)	9 (2–109)	20 (6–124)	£16,353 (£4,180–£1,19,773)
Hirschsprung's disease	3 (2–10)	4 (3–6)	12 (2–25)	17 (9–33)	£11,400 (£6,778–£21,766)
Gastroschisis	4 (1–20)	20 (7–134)	6 (2–34)	31 (18–154)	£23,874 (£13,807–£1,35,458)
Exomphalos total	2 (2–78)	7 (1–150)	4 (1–12)	9 (3–228)	£10,060 (£2,881–£221,472)
Exomphalos major	4 (2–78)	18 (1–150)	5 (4–11)	21 (7–228)	£16,124 (£4,613–£221,472)
Exomphalos minor	2 (2–3)	7 (6–7)	4 (1–12)	8 (3–16)	£5,225 (£2,881–£10,952)
Congenital diaphragmatic hernia	13 (2–36)	4 (1–29)	6 (2–19)	25 (6–62)	£21,042 (£4,613–£60,535)
Anorectal malformation	2 (2–14)	8 (1–14)	6 (2–75)	11 (4–90)	£11,766 (£4,154–£61,371)

Figure 2 Median costs for different surgical conditions

the nine surgical conditions studied while Figure 1 illustrates the median LOS, with outliers marked as circles. Our data showed wide variation in LOS.

For babies with exomphalos, data were also stratified by major ($n=4$) and minor ($n=8$). All cases of gastroschisis (simple and complex) were grouped under the same category, as were all cases of intestinal atresia (duodenal, jejunal, ileal and colonic).

Mortality rates were low. There were only two deaths: one in a baby with Hirschsprung's disease ($n=7$) and one in the intestinal atresia group ($n=42$).

The bed day cost analysis was based on the median number of days at each level of care (Table 2, Fig 2). The total cost per patient ranged from £8,701 (for myelomeningocele) to £23,874 (for gastroschisis). This did not include the cost of surgery.

Discussion

Gastroschisis, oesophageal atresia and congenital diaphragmatic hernia had a median neonatal LOS of 28 days or greater. Overall, there was marked variability in LOS

based on the different phenotypes within each group of congenital anomaly (eg major vs minor exomphalos).

The LOS of any surgical neonate is a function of a large number of factors including co-morbidity, severity of condition, weight, gestation, social circumstances and age of the parents, distance from home or local unit and the inevitable demand for cots. In many cases, babies are discharged to the local unit to await readmission for a secondary procedure in order to free a cot in the tertiary unit. Conversely, many infants cannot be discharged from the tertiary unit, even when ready, as there is no cot in the local unit.

Gastroschisis

In a population-based cohort study of 301 live born infants with gastroschisis in 28 surgical centres from the UK and Ireland, Bradnock *et al* compared those with simple gastroschisis (intact, uncompromised, continuous bowel) and those with complex gastroschisis (bowel perforation, necrosis or atresia).¹ For all gastroschisis cases together, they observed a median LOS of 36 days (range: 8–365 days). The median LOS for simple gastroschisis was 36 days (range: 8–365 days) while for complex gastroschisis, it was 84 days (range: 20–365 days). Our gastroschisis patients ($n=27$) had a median LOS of 35 days (range: 19–154 days). Similar results were also found by Skarsgard *et al*.² The data for 106 live births in 16 paediatric centres were reviewed and the mean survivor LOS was 46 days.

Oesophageal atresia

In 39 cases studied by Putnam, infants with oesophageal atresia and associated anomalies had a longer mean hospitalisation: 17 versus 12 days.⁵ In our study, the neonates with oesophageal atresia ($n=35$) had a median LOS of 33 days (range: 9–133 days).

Congenital diaphragmatic hernia

The Congenital Diaphragmatic Hernia Study Group evaluated the impact of newer therapies on congenital diaphragmatic hernia patients.⁴ Twenty centres from five countries collected data prospectively on live born infants over a ten-year period. Of the total 1,569 patients, 218 (14%) had diaphragmatic agenesis. It was concluded that survivors with diaphragmatic agenesis had prolonged hospital stays compared with those without agenesis (median: 68 vs 30 days). The babies at our unit with a congenital diaphragmatic hernia ($n=25$) had a median LOS of 28 days (range: 7–99 days).

Intestinal atresia

In a large single institutional study over 15 years, Piper *et al* evaluated 63 infants with duodenal atresia, 60 with jejunal/ileal atresia and 9 with colonic atresia.⁵ The median LOS for duodenal atresia was 19 days (interquartile range [IQR]: 12–46 days) while for jejunal/ileal atresia, it was 25 days (IQR: 14–60 days) and for colonic atresia, it was 12 days (IQR: 8–90 days). Data in our study where intestinal atresias ($n=42$) were analysed together showed similar findings, with a median LOS of 24 days (range: 6–168 days).

Hirschsprung's disease

In a 10-year retrospective review of 51 patients treated with neonatal pull-through surgery for Hirschsprung's disease, Wilcox *et al* reported the total mean LOS to be 20.4 days (standard deviation [SD]: 11.2 days; mean gestational age: 39.6 weeks [SD: 1.7 weeks]).⁶ Our study found that babies with Hirschsprung's disease ($n=7$) had a median LOS of 21 days (range: 15–36 days), with a median gestational age of 39.5 weeks (range: 35–41 weeks).

Sacroccygeal teratoma

In our study, patients with a sacroccygeal teratoma ($n=7$) had a median LOS of 17 days (range: 12–55 days), with a median gestational age of 38 weeks (range: 34–39 weeks). Unfortunately, no comparative data are available.

Myelomeningocele

Bulbul *et al* reviewed surgical operations of 28 neonates with myelomeningocele.⁷ This prospective study over two years observed a mean LOS of 10.2 ± 9.7 days. Our median LOS for those with myelomeningocele ($n=14$) was 15.5 days (range: 8–24 days).

Anorectal malformation

In a retrospective study to evaluate the clinical advantages of single stage correction of anorectal malformation (group 1, $n=22$) over a staged pull-through procedure (ie with a colostomy) (group 2, $n=16$), Zheng *et al* noted that there was no statistically significant difference in the total LOS between the two cohorts.⁸ The LOS for group 1 was 12.06 ± 0.85 days and for group 2 was 33.85 ± 0.94 days. Our data on anorectal malformation ($n=25$), which mainly consisted of staged correction, showed a median LOS of 15 days (range: 6–90 days).

Exomphalos

Abdominal wall defects, particularly exomphalos, in newborn babies are associated with significant morbidity and mortality. In a 10-year retrospective study of outcome of exomphalos in 52 infants (24 minor, 27 major), Vachharajani *et al* found a mortality rate of 33% in the major group and 8% in the minor group.⁹ Exomphalos has chromosomal and syndromic associations, which may impact on the total LOS. The median LOS in the study by Vachharajani *et al* was 10 days for minor and 47 days for major exomphalos. Our median LOS was 10.5 days (range: 3–24 days) for minor exomphalos ($n=8$), with a median gestational age of 38.5 weeks (range: 36–39 weeks), and 26.5 days for major exomphalos ($n=4$), with a median gestational age of 38 weeks (range: 33–42 weeks).

Cost analysis

Burge and Drewett published a study looking into workload and cost associated with providing a neonatal surgery service, concluding that a level 3 perinatal centre will require one surgical cot per 5,000 live births.¹⁰ Calculations suggest that the annual cost per cot will be about £250,000. Our study calculated the total cost incurred based on the median number of days at each level of care. This

did not include the cost of surgery. There is a paucity of detailed national audit data and published literature against which to compare our figure.

Owing to the diversity of service organisation and provision in the UK, it is challenging to collect accurate data to assess the service requirements. This can also make pre-natal counselling difficult with regard to LOS for various surgical conditions. Although one must be cautious when generalising our findings for counselling parents across all units, it will be helpful to have a ballpark figure.

Study limitations

One of the main limitations of our study is that LOS was not adjusted for type of anomaly. Some cases are more complicated than others (eg long gap oesophageal atresia). Furthermore, our data could also have been affected by gestational age, multiple associated anomalies and surgeon's preference as well as surgical and medical complications during the admission.

Conclusions

This study shows wide variations in LOS for the same conditions. There are a number of possible causes for this, including different phenotype/severity and other additional co-morbidities. It is difficult to plan resources with this highly variable LOS but the median can guide further planning and commissioning.

Our study provides LOS data for a tertiary centre in the UK. These data can be used for counselling parents. However, there is a need to evaluate these data nationally to allow services to compare local outcomes with national data and to provide more accurate information for parents.

References

1. Bradnock TJ, Marven S, Owen A *et al*. Gastroschisis: one year outcomes from national cohort study. *BMJ* 2011; **343**: d6749.
2. Skarsgard ED, Claydon J, Bouchard S *et al*. Canadian Pediatric Surgical Network: a population-based pediatric surgery network and database for analyzing surgical birth defects. The first 100 cases of gastroschisis. *J Pediatr Surg* 2008; **43**: 30–34.
3. Putnam TC. Esophageal atresia. Critical analysis of 39 cases. *Arch Surg* 1979; **114**: 288–292.
4. Lally KP, Lally PA, Van Meurs KP *et al*. Treatment evolution in high-risk congenital diaphragmatic hernia. *Ann Surg* 2006; **244**: 505–513.
5. Piper HG, Alesbury J, Waterford SD *et al*. Intestinal atresias: factors affecting clinical outcomes. *J Pediatr Surg* 2008; **43**: 1,244–1,248.
6. Wilcox DT, Bruce J, Bowen J, Bianchi A. One-stage neonatal pull-through to treat Hirschsprung's disease. *J Pediatr Surg* 1997; **32**: 243–245.
7. Bulbul A, Can E, Bulbul LG *et al*. Clinical characteristics of neonatal meningocele cases and effect of operation time on mortality and morbidity. *Pediatr Neurosurg* 2010; **46**: 199–204.
8. Zheng S, Xiao X, Huang Y. Single-stage correction of imperforate anus with a rectourethral or a rectovestibula fistula by semi-posterior sagittal anorectoplasty. *Pediatr Surg Int* 2008; **24**: 671–676.
9. Vachharajani AJ, Rao R, Keswani S, Mathur AM. Outcomes of exomphalos: an institutional experience. *Pediatr Surg Int* 2009; **25**: 139–144.
10. Burge DM, Drewett M. Workload and costs associated with providing a neonatal surgery service. *Arch Dis Child Fetal Neonatal Ed* 2012; **97**: F179–F181.