High-volume hospitals experience fewer postoperative complications after neonatal surgery: Analyses of the National Clinical Database pediatric surgical registry in Japan

Kentaro Hayashi [a], Hiraku Kumamaru [b], Hisateru Tachimori [b], Tadashi Iwanaka [b], Hiroaki Miyata [b], Jun Fujishiro [a]

a Department of Pediatric Surgery, The University of Tokyo, Graduate School of Medicine, Japan

b Department of Healthcare Quality Assessment, The University of Tokyo, Japan

PT47

OBJECTIVES

Reports on volume–outcome relationships have suggested that surgical and interventional procedures should be centralized. However, because pediatric surgery is rare and complex, there is limited evidence in this field. We investigated the situation and hospital-level volume–outcome relationship for neonatal surgery in Japan.

METHODS

We utilized data recorded in the National Clinical Database (NCD) pediatric surgical registry (**January 2015–December 2020**). We represented this data in a histogram (Figure 1). Guided by the histogram and the criteria set by The Japanese Society of Pediatric Surgeons, which mandates a minimum of 10 annual neonatal surgeries for certified hospitals,Hospitals were categorized as **low-volume (>0 to <10), middle-volume (≥10 to <36), and high-volume (≥36)** based on the mean annual number of neonatal surgeries.

We compared the incidences of periprocedural outcomes among six major procedures **esophageal atresia, congenital diaphragmatic hernia, omphalocele, gastroschisis, intestinal atresia, and duodenal atresia** by surgical volume. The outcomes included **death at hospital discharge, any postoperative complications within 30 days, postoperative surgical complications (wound dehiscence, anastomotic leakage, reoperation, readmission) within 30 days, and operation time**. The hospital volume–outcome associations were adjusted for **surgery type, gestational age, preoperative cardiac risk, chromosomal abnormality, and Apgar score at 5 minutes**.

RESULTS

Of 738 registered hospitals, 154, 76, and 12 were categorized as low-, middle-, and high-volume hospitals, respectively; 496 performed no neonatal surgery. (Table 1)

The case volume of each disease is only 1 to 5 even in the high volume category, and the difference among the 3 categories is very small.

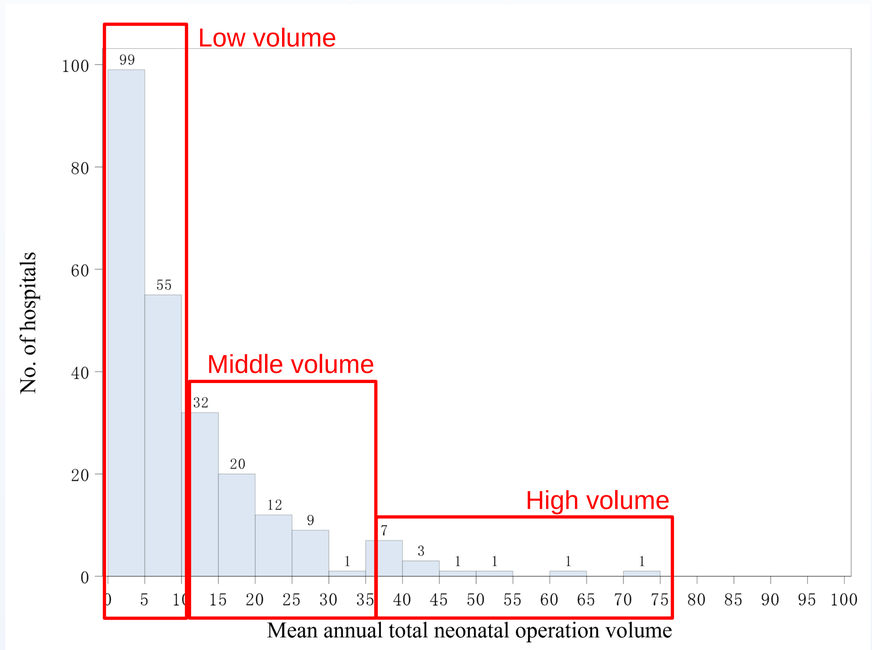

Figure 1 Histogram of the mean annual total neonatal operation volume in each hospital

Table1 Number of operations in each hospital category

	No volume hospital	Low volume hospital	Middle volume hosital	High volume hospital
Number of hospitals	496	154	76	12
Total number of all pediatric operations(<16 years)	22365	99922	121276	45714
Total number of neonatal operations		3453	7964	3269
Major 6 neonatal surgery cases		770	2219	1075
Common disease				
Inguinal hernia	8963	39440	39047	12474
Appendcitis	7691	9856	8736	1724
Mean annual operations in each hospital				
All pediatric operations (<16 years)	7.5	108.1	266.0	634.9
Inguinal hernia	4.4	43.8	85.7	173.3
Appendicitis	3.3	11.1	19.2	23.9
Neonatal operations		3.7	17.5	45.4
Esophageal atresia		0.4	0.8	2.3
Congenital diaphragm hernia		0.5	1.2	4.7
Omphalocele		0.3	0.6	1.5
Gastroschisis		0.3	0.5	1.0
Intestinal atresia		0.4	0.8	2.3
Duodenal atresia		0.5	1.2	3.5

Mean annual neonatal operations in each hospital

No volume=0; Low volume <10; 10≦Middle volume<36; 36≦High Volume

CONTACT

Kentaro Hayashi: 884kentaro@gmail.com

*The authors have no conflicts of interest relevant to this study.

東京大学 THE UNIVERSITY OF TOKYO

Patient characteristics of major 6 neonatal surgeries in each hospital category are shown in Table 2. In high volume hospitals, 136 (12.65%) were performed endoscopically, while the numbers were 25 (3.25%) and 118 (5.32%) in low and middle volume hospitals, respectively.

Table2 Patient characteristis of major 6 neonatal operations in each hospital category

	Low volume hospital (N=770)	Middle volume hosital (N=2219)	High volume hospital (N=1075)
Disease			
Esophageal atresia	122 (15.8%)	339 (15.3%)	158 (14.7%)
Congenital diaphragm hernia	132 (17.1%)	515 (23.2%)	333 (31.0%)
Omphalocele	80 (10.4%)	246 (11.1%)	99 (9.2%)
Gastroschisis	70 (9.1%)	199 (9.0%)	72 (6.7%)
Intestinal atresia	170 (22.1%)	337 (15.2%)	157 (14.6%)
Duodenal atresia	186 (24.2%)	552 (24.9%)	236 (22.0%)
Multiple operations	10 (1.3%)	31 (1.4%)	20 (1.9%)
Male	405 (52.6%)	1185 (53.4%)	596 (55.44%)
Gestational age			
<28weeks	6 (0.8%)	16 (0.7%)	8 (0.7%)
28weeks-31weeks	28 (3.6%)	47 (2.1%)	20 (1.9%)
32weeks-36weeks	234 (30.4%)	671 (30.2%)	325 (30.2%)
37weeks≦	502 (65.2%)	1483 (66.8%)	721 (67.1%)
Missing	0 (0.0%)	2 (0.1%)	1 (0.1%)
Preoperative cardiac risk			
None	608 (79.0%)	1672 (75.4%)	861 (80.1%)
Low	101 (13.1%)	331 (14.9%)	135 (12.6%)
Middle	37 (4.8%)	107 (4.8%)	43 (4.0%)
High	24 (3.1%)	109 (4.9%)	36 (3.4%)
Chromosomal abnormality	82 (10.7%)	286 (12.9%)	96 (8.9%)
Apgar score in 5 min			
<7	115 (14.9%)	400 (18.0%)	234 (22.8%)
7≦	625 (81.2%)	1725 (77.7%)	792 (73.7%)
Missing	30 (3.9%)	94 (4.2%)	49 (4.6%)
Endoscopic surgery	25 (3.25%)	118 (5.32%)	136 (12.65%)
Missing	0 (0.0%)	1 (0.05%)	0 (0.0%)

Total incidences of the outcomes and the median length of stay for the 6 major neonatal surgeries are shown in Table 3.

Table3 Outcomes of major 6 neonatal operations in each hospital category

	Low volume hospital (N=770)	Middle volume hosital (N=2219)	High volume hospital (N=1075)
Death at the hospital discharge	29 (3.8%)	100 (4.5%)	43 (4.0%)
Any postoperative complications*	230 (29.9%)	622 (28%)	252 (23.5%)
Postoperative surgical complications	60 (7.8%)	166 (7.5%)	70 (6.5%)
Wound dehiscence	19 (2.5%)	64 (2.9%)	14 (1.3%)
Anastomotic leakage	19 (2.5%)	51 (2.3%)	25 (2.3%)
Reoperation**	32 (4.2%)	88 (4.0%)	50 (4.7%)
Readmission**	1 (0.1%)	4 (0.2%)	2 (0.2%)
Operation time (Minutes), Mean (SD)	145.4 (79.3)	134.8 (76.9)	132.7 (80.9)
Length of stay (Days), Median (IQR)	39 (25-69)	38 (24-72)	42 (28-80)

*Any postoperative complications occurred within 30 days included surgical site infection, wound dehiscence, anastomotic leakage,pneumonia, unplanned intubation, pulmonary artery embolism, renal dysfunction, urinary tract infection, coma for more than 24hours, cerebrovascular disease, intraventricular hemorrhage, ECMO, liver dysfunction, peripheral neuropathy, cardiopulmonary resuscitation, red blood cells transfusion, systemic inflammatory response syndrome or sepsis, catheter related infection, mechanical ventilation for more than 30 days, or unplanned reoperation or readmission due to the primary operation.

**unplanned reoperation or readmission due to the primary operation occurred within 30 days.

The frequency of any postoperative complications was lower at high-volume (252/1075 [23.5%]) than at low-volume (230/770 [29.9%]; adjusted odds ratio [aOR] 1.46, 95% confidence interval [CI] 1.16–1.83) and middle-volume (622/2219 [28.0%]; aOR 1.31, 95% CI 1.09–1.58) hospitals. Average operation time was 15.2 (95% CI 9.08–21.4) and 6.68 (95% CI 1.85–11.5) minutes longer at low- and middle-volume hospitals than at high-volume hospitals, respectively. We found no significant differences in mortality or individual postoperative surgical complications. (Table 4)

Table4 Multivariable analysis of outcomes of major 6 neonatal operations in each hospital category

	Low volume hospital	Middle volume hosital	High volume hospital
Death at the hospital discharge [Odds ratio]*	1.17 (95%CI: 0.67-2.05)	1.12 (95%CI: 0.74-1.74)	Reference
Any postoperative complications [Odds ratio]* †	1.46 (95%CI: 1.16-1.83)	1.31 (95%CI: 1.09-1.58)	Reference
Postoperative surgical complications [Odds ratio]*	1.08 (95%CI: 0.73-1.59)	1.13 (95%CI: 0.83-1.54)	Reference
Operation time [Coefficient]**	15.2 (95%CI: 9.08-21.4)	6.68 (95%CI: 1.85-11.5)	Reference

Patients treated with ECMO were excluded

*Multivariable Logistic regression, **Multivariable regression; Explanatory variables：Hospital volume category, Gestational age, Preoperative cardiac risk, Chromosomal abnormality、Apgar score in 5 min, Disease included Esophageal atresia, Congenital diaphragm hernia (Primary repair), Congenital diaphragm hernia (Prosthetic patch or muscle flap), Omphalocele (Primary repair), Omphalocele (Others), Gastroschisis (Primary repair), Gastroschisis (Others), Intestinal atresia (single lesion), Intestinal atresia (multiple lesion), Duodenal atresia, Multiple operations of these.

CONCLUSIONS

The incidence of any postoperative complications after neonatal surgery was lower at high-volume hospitals where operation times were also shorter. Centralizing neonatal surgical facilities may improve the quality of pediatric surgery in Japan.