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The Burden of Frequency of Hospitalization and Length of Hospital Stay by Children with Major Congenital Abnormalities That Require Surgical Treatment during the First Year of Life – a Case-control Study

Dorotea Sinjeri[1, 2], Tomislav Luetić[1, 2], Marko Bašković[2, 3, 4, a]

[1] Department of Pediatric Surgery, University Hospital Centre Zagreb, Croatia, [2] School of Medicine, University of Zagreb, Croatia, [3] Department of Pediatric Surgery, Children's Hospital Zagreb, Croatia, [4] Scientific Centre of Excellence for Reproductive and Regenerative Medicine, School of Medicine, University of Zagreb, Croatia

Correspondence: *baskovic.marko@gmail.com*; Tel.: +385 1 3636379

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Abstract

Objective – To determine how much children with "major" congenital abnormalities during the first year of life, compared to those without them, burden the health care system more in terms of length of stay and number of admissions and discharges. **Methods** – The electronic records of 57 patients with major congenital abnormalities (study group) and 57 patients who were surgically treated for another condition in the first year of life (control group) were reviewed retrospectively. **Results** – Children with congenital abnormalities were first hospitalized at the age of 1 (IQR=5) day, compared to 121 (IQR=278) days in children without congenital abnormalities (P<0.001). The total number of hospitalizations in the study group was 2.39±1.57, while in the control group, it was 1.14±0.35 (P<0.001). The length of stay in the hospital in children with congenital abnormalities was 48 (IQR=74) days, compared to the control group, which was 3 (IQR=15) days (P<0.001). The average length of stay in children with congenital abnormalities was 22.5 (IQR=29) days, while in the control group, it was 3 (IQR=11) days (P<0.001). The average share of the length of stay in the intensive care unit in relation to the total length of stay in the hospital for the group with congenital abnormalities was 46.6%, while for the control group, it was 23.3% (P<0.001). **Conclusion** – Children with congenital abnormalities had a 4.9× overall longer length of hospital stay and a 3.1× longer length of stay in the intensive care unit.

Key Words: Congenital Abnormality ▪ Eurocat ▪ Length of Hospital Stay ▪ Children ▪ Pediatric Surgery.

Introduction

Congenital abnormalities include a number of structural and functional abnormalities that can appear as an isolated defect or as a group of defects, better known as syndromes and associations (1). They vary considerably in severity. While some are "minor", others are associated with spontaneous abortion, stillbirth, or death in the early postnatal period. We usually describe abnormalities that affect an infant's life expectancy, health status, and physical or social functioning as "major" abnormalities (2, 3). Although diagnostics are progressing day by day, many abnormalities remain of undetermined etiology. Some structural and many functional defects are attributed to basic genetic defects or chromosomal abnormalities, but also to the interaction of numerous environmental factors with genes (4, 5).

EUROCAT is a European network of population-based registries for the epidemiological surveillance of congenital abnormalities. In 2023, the network had 43 member registries from 23 countries covering more than 25% of the European birth population (6). Croatia actively participates in the

[a] ORCID: 0000-0003-4218-6184

network almost from the very beginning (7). The EUROlinkCAT project, which was completed in the 2022 year, included 17 registers from 14 countries, and important facts were established. In the period from 2005 to 2014, 97% of children with a congenital abnormality survived to the age of 10 and were 30% less likely to die than children born before 2005. During the first year of life, 85% of children with a congenital abnormality were admitted to the hospital compared to 31% of children without a congenital abnormality. Children with a congenital abnormality spent 2-3 times more time in the hospital, and during the first year of life, 37.8% of them were operated on compared to only 0.8% without a congenital abnormality (8).

The aim of our study was to determine how much more, during the first year of life, children with "major" congenital abnormalities, compared to those without, burden the health system of the largest tertiary health institution in the Republic of Croatia.

Materials and Methods

Patients

For the purposes of the research, electronic records of patients in the hospital information system (IN2 BIS®, IN2 Group, Zagreb, Croatia) were reviewed retrospectively. The study population of patients were all patients with a major congenital abnormality (according to EUROCAT) (9) born in the period from January 1, 2018, to December 31, 2019 (pre-COVID-19 period), who were exclusively treated in the University Hospital Centre Zagreb, Croatia during the first year of life. Excluding criteria were conditions in the domain of cardiac surgery and neurosurgery, given that pediatric surgeons do not deal with the mentioned pathology. The control group, whose population of patients were randomly selected (simple random sampling), consisted of patients comparable by gender during the same time period, who were surgically treated during the first year of life for some other condition that is not covered by the EUROCAT definition of a major congenital abnormality.

Outcome Measures

The main outcome of the research was to determine the difference in overall hospital length of stay and in the intensive care unit during the first year of life between children with major congenital abnormalities (according to EUROCAT) compared to children without congenital abnormalities. The secondary outcomes of the study were to determine the age (in days) at which children with a congenital abnormality present for the first hospitalization compared to children without a congenital abnormality and to determine the total number of hospitalizations of children with a congenital abnormality compared to children without a congenital abnormality during the first year of life. Also, the average length of stay (length of stay / total number of discharges), and the average share of the length of stay in the intensive care unit in relation to the total length of stay in the hospital were determined for both groups.

Statistical Analysis

Descriptive statistics were used to characterize the patient cohort. Collected measurements were analyzed for normal distribution using the Shapiro–Wilk test. Categorical variables were expressed as frequencies and percentages. Chi-squared test was used to assess differences in the distribution of categorical data. Continuous variables were expressed as mean with standard deviation (SD) and median (Mdn) with interquartile range (IQR) and were analyzed using the Student's t-test or Mann–Whitney U test as appropriate. The obtained data were analyzed using the Microsoft Excel® software program (XLSTAT®) for Windows, version 2020.5.1 (Microsoft Corporation, Redmond, WA, USA). A significance level of 0.05 was used.

Results

During the 2-year period, a total of 57 children were identified with a major congenital abnormality and were surgically treated at the Department of Pediatric Surgery, University Hospital Centre

Table 1. Diagnoses of Children Who Made up the Study and Control Groups

Children with a major abnormality* (study group)	N (%)	Children without major abnormality (control group)	N (%)
VACTERL association	2 (3.51)	Pneumothorax	4 (7.02)
Diaphragmatic hernia	8 (14.05)	Inguinal hernia	15 (26.33)
Hirschsprung's disease	3 (5.26)	Dermoid cyst	1 (1.75)
Atresia of small intestine	2 (3.51)	Neuroblastoma	1 (1.75)
Esophageal atresia with tracheoesophageal fistula	3 (5.26)	Hypertrophic pyloric stenosis	3 (5.26)
Multicystic renal dysplasia	1 (1.75)	Undescended testicle	9 (15.80)
Down syndrome	5 (8.77)	Ileus	4 (7.02)
Posterior urethral valve	2 (3.51)	Necrotizing enterocolitis	7 (12.29)
Omphalocele	2 (3.51)	Intussusception	1 (1.75)
Anorectal malformation	6 (10.53)	Phimosis	1 (1.75)
Congenital hydronephrosis	5 (8.77)	Hepatoblastoma	1 (1.75)
Anomalies of intestinal fixation	4 (7.02)	Adrenal hemangioma	1 (1.75)
Atresia of bile ducts	5 (8.77)	Abscessus perianalis	2 (3.51)
Conjoined twins	2 (3.51)	Naevus	1 (1.75)
Gastroschisis	2 (3.51)	Combustion	1 (1.75)
CHARGE syndrome	1 (1.75)	Fracture	2 (3.51)
Bladder exstrophy	3 (5.26)	Intestine perforation	2 (3.51)
Pallister-Killian syndrome	1 (1.75)	Sacrococcygeal teratoma	1 (1.75)

*According to the EUROCAT definition.

Zagreb [N (boys)=28 (49.12%), N (girls)=29 (50.88%)]. For the control group, 57 children [(N (boys)=35 (61.40%), N (girls)=22 (38.60%)] were randomly selected comparable by gender (P=0.187) (Table 1). Children with congenital abnormalities were first hospitalized at the age of 1 day (IQR=5), compared to 121 days (IQR=278) in children without congenital abnormalities (P<0.001) (Fig. 1. a). The total number of hospitalizations in the study group was 2.39±1.57 [Mdn=2 (IQR=2)], while in the control group, it was 1.14±0.35 [Mdn=1 (IQR=0)] (P<0.001) (Fig. 1. b). The largest number of hospitalizations, as many as 9, involved children with a posterior urethral valve. The total length of stay in the hospital (ward + intensive care unit) in children with congenital abnormalities was 48 days (IQR=74), while in the control group, it was 3 days (IQR=15) (P<0.001) (Fig. 1. c). The longest length of stay involved children with gastroschisis, Pallister-Killian syndrome, and VACTERL-associated abnormalities (vertebral defects, anal atresia, cardiac defects, tracheoesophageal fistula, renal anomalies, and limb abnormalities). The average length of stay in children with congenital abnormalities was 22.5 days (IQR=29), while in the control group, it was 3 days (IQR=11) (P<0.001). The study group's length of stay in the intensive care unit was 12 days (IQR=34), while in the control group, it was 0 days (IQR=8) (P<0.001) (Fig. 1. d). Conjoined twins spent the longest time in the intensive care unit, 233 days. Children with congenital abnormalities spent a total of 4720 days in the hospital, of which 2048 days were in the intensive care unit, while children without congenital abnormalities stayed in the hospital and intensive care unit for 964 and 546 days respectively (P<0.001). The average share of the length of stay in the intensive care unit in relation to the total length of stay in the hospital for the group with congenital abnormalities was 46.6%, while for the control group, it was 23.3% (P<0.001).

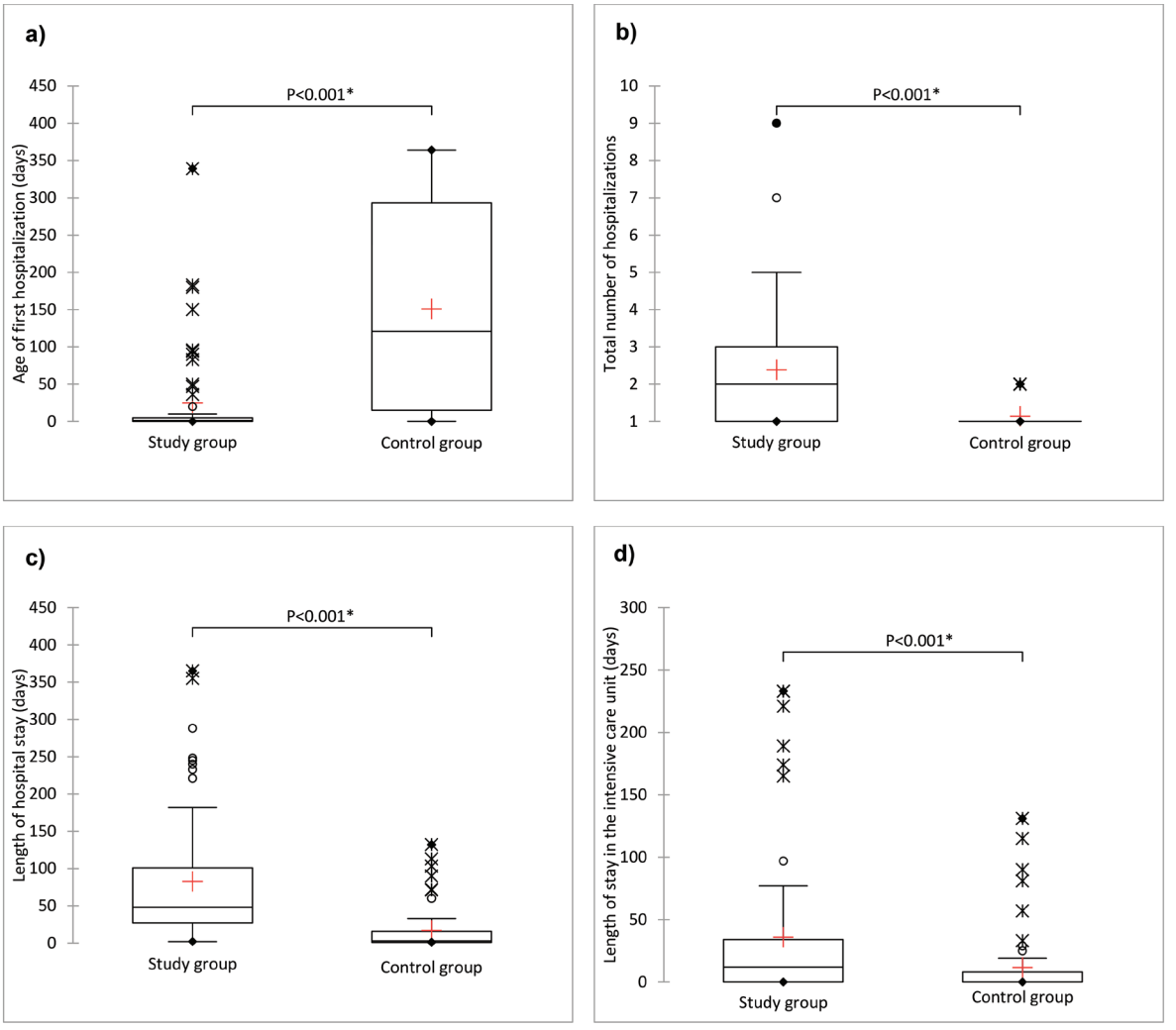

Fig. 1. *(a) age of first hospitalization (days); (b) total number of hospitalizations; (c) length of hospital stay (ward + intensive care unit) (days); (d) length of stay in the intensive care unit (days). *Mann–Whitney U test.*

Discussion

This research established that in all observed parameters, children with congenital abnormalities are statistically significantly different compared to children without congenital abnormalities. Children with congenital abnormalities are hospitalized earlier, have a higher total number of hospitalizations, the length of stay in the hospital and intensive care unit is significantly longer, as well as the average length of stay compared to children without congenital abnormalities. The investigation showed that children with congenital abnormalities had a 4.9× longer length of hospital stay and a 3.1× longer length of stay within the intensive care unit during the first year of life.

Although this is the first study with this objective, several studies have dealt with this topic, primarily as part of international projects. Urhoj et al. (10) quantified the burden of disease in childhood for children with congenital abnormalities by assessing the risk of hospitalization, the number of days spent in the hospital, and the proportion of children with extended stays (≥10 days). Among EUROCAT children, 85% were hospitalized in the first year, compared to 31% of the control children,

while the median length of stay was 2–3 times longer for EUROCAT children. The percentages of children with extended stays in the first year were 24% for EUROCAT children and 1% for control children. The median length of stay varied greatly between congenital abnormality subgroups, with children with gastrointestinal abnormalities and congenital heart defects having the longest stays. Given that the focus of our study was on the first year of life, it is important to note the fact that the study by Urhoj et al. determined that the first year of life represents the greatest burden in terms of the number of hospitalizations and the number of surgical procedures compared to the period between 1-4 years and between 5-9 years of life. A population-based study from Australia showed that among almost 22,000 children with major congenital abnormalities, the mean number of hospital admissions up to the age of five years was higher than in children without congenital abnormalities (3.8 vs 2.2 admissions per child) (11). Similar to the study by Urhoj et al., the aim of the study by Garne et al. (12) was to report overall morbidity for children with rare structural congenital abnormalities measured as the risk of hospitalization, the median number of days spent in hospital, the proportion of children with extended stays of 10 days or more, the proportion of children having surgery, the median number of surgical procedures and age at first surgery. The results showed that in the first year of life, the median length of stay ranged from 3.5 days (anotia) to 53.8 days (atresia of bile ducts), while the median number of surgical procedures for those under 5 years was two or more for 14 of the 18 abnormalities and the highest for children with Prune-Belly at 7.4. The variable length of hospital stay is becoming a standard indicator in the assessment/evaluation of the number and severity of surgical procedures. The study by Apfeld et al. (13) evaluated the postoperative length of stay after minimally invasive surgery on children with non-cardiac congenital abnormalities, with the aim that surgeons around the world use these results as reference values when evaluating their own treatment outcomes. Silberbach et al. (14) were interested in the impact of primary diagnosis and preoperative parameters on hospital fees and postoperative length of stay for 10 types of low-risk congenital heart malformations, in order to predict the necessary resources and create a sound economic policy for the satisfaction of each patient. Analogous to the above, the study by Brennan et al. additionally incorporated the surgical procedure itself and postoperative factors (15). Certain lengths of stay are also used as treatment outcome parameters, so the study by Murthy et al. (16) predicted which risk factors in children with congenital diaphragmatic hernia could result in a length of stay >109 days, all with the aim of helping in risk adjustment for comparative benchmarking and for counseling affected families. Overall, the study by Berry et al. found that the presence of a congenital abnormality (OR=2.47) is a predictor of increased length of stay in neonatal intensive care units (17).

Limitation of Study

The study has limitations primarily in the size of the patient sample. The reason for the small sample comes from the fact that the research covered one (albeit the largest) tertiary center, out of a possible six in the Republic of Croatia. It is also important to emphasize that abnormalities from the domain of neurosurgery and cardiac surgery, as well as conditions that did not require surgical treatment, were omitted.

Conclusion

The burden of disease in early childhood is great both for children with major congenital abnormalities and their parents, as well as for the health system that cares for them. Based on the results of this study, parents of children with major congenital abnormalities should be adequately informed about the burden of diseases caused by major congenital abnormalities, especially in the first year of the child's life, while the health system should plan adequate resources in order to provide the most optimal health care. Families of children with major

congenital abnormalities should receive adequate support, not only from health professionals, but also from competent authorities and health and social policy.

References

1. Oliveira CI, Fett-Conte AC. Birth defects: Risk factors and consequences. J Pediatr Genet. 2013;2(2):85-90. doi: 10.3233/PGE-13052.
2. Rasmussen SA, Olney RS, Holmes LB, Lin AE, Keppler-Noreuil KM, Moore CA. Guidelines for case classification for the National Birth Defects Prevention Study. Birth Defects Res A Clin Mol Teratol. 2003;67(3):193-201. doi: 10.1002/bdra.10012
3. DeSilva M, Munoz FM, Mcmillan M, Kawai AT, Marshall H, Macartney KK et al. Congenital anomalies: Case definition and guidelines for data collection, analysis, and presentation of immunization safety data. Vaccine. 2016;34(49):6015-26. doi: 10.1016/j.vaccine.2016.03.047
4. Feldkamp ML, Carey JC, Byrne JLB, Krikov S, Botto LD. Etiology and clinical presentation of birth defects: population-based study. BMJ. 2017;357:j2249. doi: 10.1136/bmj.j2249
5. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;385(9963):117-71. doi: 10.1016/S0140-6736(14)61682-2
6. Kinsner-Ovaskainen A, Lanzoni M, Garne E, Loane M, Morris J, Neville A, et al. A sustainable solution for the activities of the European network for surveillance of congenital anomalies: EUROCAT as part of the EU Platform on Rare Diseases Registration. Eur J Med Genet. 2018;61(9):513-17. doi: 10.1016/j.ejmg.2018.03.008
7. Ligutic I, Barisic I, Kapitanovic H, Beer Z, Modrusan-Mozetic Z, Capar M, et al. Eleven years of registration of congenital anomalies in Croatia associated with the EUROCAT international project. Lijec Vjesn. 1997;119(2):47-53.
8. EUROlinkCAT: Establishing a linked European Cohort of Children with Congenital Anomalies [homepage on the Internet]. Available from: https://www.eurolinkcat.eu/
9. European Platform on Rare Disease Registration [homepage on the Internet]. Available from: https://eu-rd-platform.jrc.ec.europa.eu/eurocat/eurocat-data/prevalence_en
10. Urhoj SK, Tan J, Morris JK, Given J, Astolfi G, Baldacci S, et al. Hospital length of stay among children with and without congenital anomalies across 11 European regions-A population-based data linkage study. PLoS One. 2022;17(7):e0269874. doi: 10.1371/journal.pone.0269874
11. Colvin L, Bower C. A retrospective population-based study of childhood hospital admissions with record linkage to a birth defects registry. BMC Pediatr. 2009;9:32. doi: 10.1186/1471-2431-9-32
12. Garne E, Tan J, Damkjaer M, Ballardini E, Cavero-Carbonell C, Coi A, et al. Hospital Length of Stay and Surgery among European Children with Rare Structural Congenital Anomalies-A Population-Based Data Linkage Study. Int J Environ Res Public Health. 2023;20(5):4387. doi: 10.3390/ijerph20054387
13. Apfeld JC, Sebastião YV, Deans KJ, Minneci PC. Benchmarking utilization, length of stay, and complications following minimally invasive repair of major congenital anomalies. Surg Endosc. 2022;36(2):1633-49. doi: 10.1007/s00464-021-08413-1
14. Silberbach M, Shumaker D, Menashe V, Cobanoglu A, Morris C. Predicting hospital charge and length of stay for congenital heart disease surgery. Am J Cardiol. 1993;72(12):958-963. doi: 10.1016/0002-9149(93)91114-w
15. Brennan A, Gauvreau K, Connor J, Almodovar M, DiNardo J, Banka P, et al. A Method to Account for Variation in Congenital Heart Surgery Length of Stay. Pediatr Crit Care Med. 2017;18(6):550-60. doi: 10.1097/PCC.0000000000001168
16. Murthy K, Pallotto EK, Gien J, Brozanski BS, Porta NF, Zaniletti I, et al. Predicting death or extended length of stay in infants with congenital diaphragmatic hernia. J Perinatol. 2016;36(8):654-9. doi: 10.1038/jp.2016.26
17. Berry MA, Shah PS, Brouillette RT, Hellmann J. Predictors of mortality and length of stay for neonates admitted to children's hospital neonatal intensive care units. J Perinatol. 2008;28(4):297-302. doi: 10.1038/sj.jp.7211904