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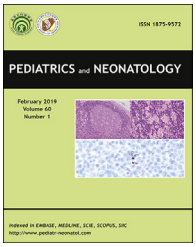

Original Article

Prolonged length of stay for acute hospital admissions as the increasing of age: A nationwide population study for Taiwan's patients with cerebral palsy

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Key Words
admission reason;
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Background: Studies investigating reasons for the admission and the associated lengths of stay (LOSs) among cerebral palsy (CP) patients are limited. This study determined common reasons for acute hospitalizations and the LOSs among children, adolescents, and young adults with CP.
Methods: We performed a secondary analysis of data. CP patients aged 4–32.9 years were identified by CP registry in the catastrophic illness patient registry of the 2010 Taiwan National Health Insurance Research Database. Data of admission claims from 2010 to 2011 were analyzed. Reasons for admissions were identified according to International Classification of Diseases codes. Common reasons, frequencies of admissions for each reason, and LOSs were reported.
Results: Pneumonia, other respiratory problems, and epilepsy were the top three reasons for admissions in all groups. Other common reasons in all groups were sepsis, other respiratory infections, and gastrointestinal problems. The reasons specific to children included orthopedic issues; ear, nose, and throat problems; and urinary tract infections (UTIs). In youths, scoliosis, and contractures, were unique reasons. In young adults, UTIs, blood problems, and mental illness, were special reasons. Most admission reasons appeared to prolong LOS, and the LOS exhibited an increasing trend as age increased.

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Conclusion: The results implied that patients with CP are more susceptible to most disease invasions. Our results also suggest that the current care system in Taiwan is unsuitable for patients with CP. These results can be used as guidance for planning effective multidisciplinary assessments in the future.

1. Introduction

Cerebral palsy (CP) is a heterogeneous group of permanent, nonprogressive neurological disorders of movement development and muscle tone of posture, causing activity limitations.[1] The prevalence of CP is 1.5–4 per 1000 live births or children of a defined age range.[2–4] In Taiwan, the estimated prevalence of CP varies from 1.3 to 4.1 per 1000 depending on different case definitions.[5] Using a minimum age of 4 years at diagnosis and a diagnosis made by specialists, the mean estimated prevalence of CP is 3.2 per 1000. During growth, children with CP exhibit gradually increasing levels of handicaps; therefore, meeting their physical and mental demands becomes a complex medical concern. Therefore, they need long-term care, and the quality and quantity of care must be guaranteed in advance. In fact, CP causes significant burdens to families and societies, and healthcare expenditures necessitated by CP impose a notable financial burden on a country.[6–8]

Over the last three decades, the life expectancy of most individuals with CP has been extended beyond youth into adulthood, even for children with severe disabilities and tube-fed adults.[9,10] Currently, over 90% of individuals with CP live past adolescence and 80% live to be over young adulthoods.[11,12] Some problems experienced by children with CP are specific to childhood. In adulthood, their ongoing health problems from childhood tend to become more troublesome, and they develop new health problems. The increasing medical complexity of CP necessitates extensive health care support, particularly in patients with severe disability.

Previous studies have reported that patients with CP had more hospital admissions, more recurrent readmissions, longer lengths of stay (LOSs), and more same-day admissions than patients without CP, and patients with CP are more likely to expire during an admission.[13–16] Respiratory and nervous systemic disorders have been reported to be the major problems of hospital admissions in this group, followed by musculoskeletal and gastrointestinal systemic disorders.[15,17] These results raise serious concerns about the health of patients with CP and necessitate examination of how these comorbidities respond to strategies employed for alleviating them. Information about CP can guide the development of services for patients with CP and can educate clinicians regarding what to expect when a person with CP presents to their practice; however, such information is still sparse. The majority of studies in the literature have focused on individual clinical diagnoses and have not provided sufficient information on the frequency and reasons for acute admissions associated with these key issues. Studies investigating reasons for the admission of CP populations are limited because such studies only include particular age groups[14,15,17]; studies on adults with CP remain insufficient.

Taiwan adopted a national health insurance (NHI) system in 1995. The strengths of the NHI system include good accessibility; short waiting times; relatively low costs; universal health care coverage of more than 98% of the residents of Taiwan; and a national health insurance databank for planning, monitoring, and evaluating health services.[18,19] Thus, the NHI program offers a unique environment conducive to studying the impact of the transition from child-oriented to adult-oriented health services.

In the current study, we investigated the common reasons for acute hospitalizations among patients with CP and examined the admission rates for each age subgroup. In addition, we hypothesized on why patients with CP in the older age group had longer hospitalizations compared with patients in the younger age group.

2. Methods and materials

We analyzed the primary and secondary reasons for admissions based on International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) codes in the National Health Insurance Research Database (NHIRD). The most common reasons for hospital admission, relative frequencies of admissions for each reason, mean LOS, and period admission rates of each age group were recorded. Our study was approved by the Institutional Review Board of Kuang-Tien General Hospital. A flowchart of the current study protocol is presented in Fig. 1.

2.1. Data source

We performed a secondary analysis of data from the Taiwan NHIRD to determine the most common reasons for admissions and the associated LOSs. Each year, the National Health Insurance Administration (NHIA) collects data from the NHI program and sorts them into data files, including registration and original claims data, for reimbursement. These data files are deidentified by scrambling the identification codes of both patients and medical facilities and sent to the National Health Research Institutes to form the original files of NHIRD.

In the current study, we used two specific patient data sets of NHIRD, namely the registry for beneficiaries (ID) and inpatient expenditures by admissions (DD). The "ID" data

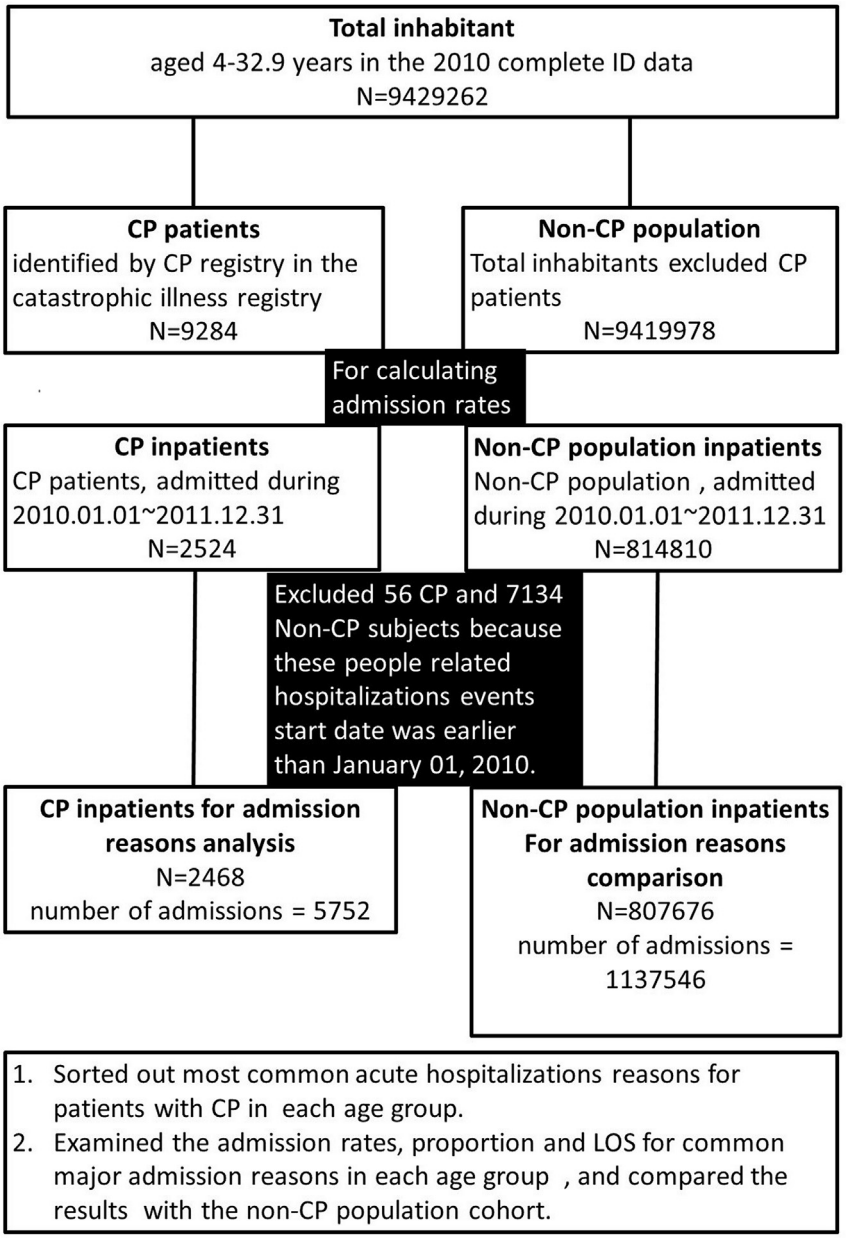

Figure 1 Flowchart of current study protocol. First, we sorted the most common acute hospitalizations reasons for patients with CP in each age group. Second, we examined the admission rates, proportion, and LOS for common major admission reasons in each age group and compared the results with the non-CP population cohort.

set included identification number (scrambled), insurance type, date of birth, sex, and coverage period. The "DD" data set contained the complete original claims data of inpatients by admissions. We also used the data of registry for catastrophic illness patients, which is a data subset of registration data sets.

2.2. Definitions of CP and non-CP general population cohorts

CP is one of the most common causes of childhood physical disability, and it imposes a heavy cost over the lifetime of the patient. In Taiwan, CP is a category encompassing several conditions labeled in the registry of catastrophic disorders; subsidies are paid to defray the medical expenses of severe cases. Thus, in the current study, we defined severe CP as all registered CP cases in the registry for catastrophic illness patients.

Patients with CP aged 4—32.9 years were identified by the CP registry in the catastrophic illness patient registry of 2010 NHIRD. The non-CP general population cohort was defined as NHI beneficiaries of the same age in the 2010 complete ID data set excluding those in the CP registry. A total of 9,429,262 inhabitants, including 9284 patients with CP, from the catastrophic registry data were included in our analysis, of which 41.8% ($n = 3885$) were women and 58.2% ($n = 5399$) were men. (See the upper part of the flowchart in Fig. 1).

2.3. Admission rate

The 2010–2011 complete original claims data were obtained in the current study. The CP and non-CP population cohort hospitalization rates were estimated using each age and gender group. Individuals aged 4–12.9 years were defined as children, those aged 13–17.9 years were defined as youths, and those aged 18–32.9 years were defined as young adults. CP admission patients were defined as any CP registry patient with an admission claims record from January 1, 2010 to October 31, 2011 in each age group. Admission patients of the non-CP population cohort were defined as beneficiaries who met all admission criteria, excluding CP admission patients. We calculated the admission rates of each gender–age group of the CP and non-CP population cohorts. The odds ratio (OR) was calculated, and an independent paired *t* test was performed.

2.4. Admission reasons

Patients with a start date of hospitalization episodes before January 1, 2010, as indicated by the claims data, and their associated admission episodes, were excluded from the admission analysis. We excluded 56 patients according to this criterion. The health records of children ($n = 1200$), youths ($n = 555$), and young adults with CP ($n = 713$) were analyzed in this study.

Reasons for admissions were identified according to ICD-9 codes from the admission claims. Common reasons, frequencies of admissions for each reason, and mean LOS were reported. Median LOS with an interquartile range (IQR) was also estimated. Therapeutic treatment codes of each admission claim were also considered as references for examining the diagnosis accuracy. The ICD-9 codes were grouped into categories that were considered clinically meaningful in the context of CP by two clinical experts. Thus, a list of 50 potential reasons for admissions was generated, which was used to summarize the proportion of admissions attributed to each reason, subdivided by age group (child, youth, and young adult). Any clinically important differences between age groups were noted. The LOS for each reason category was also computed. More detailed rates, such as those for specific diagnostic codes, could not be reported by age group without compromising the anonymity of the patients (raw frequencies < 5).

Kruskal–Wallis tests of analysis of variance and post hoc analysis with the Mann–Whitney test were performed for comparing the LOSs for each reason category among the three age groups. $P = 0.05$ was considered statistically significant. Finally, we used the most common 15 admission reasons of inpatients with CP to examine the proportional differences in the numbers of admissions between the CP and non-CP cohorts.

3. Results

Our hospital admission data were based on the analysis of 9284 patients with CP. Among them, 2524 (27.2%) patients were admitted. The mean age ±SD in the child group was 8.8 ± 2.6 years, and 42.2% were girls. The mean age ±SD in the youth group was 15.2 ± 1.3 years, and 40.0% were girls. The mean age ±SD in the adult group was 24.0 ± 4.4 years, and 39.5% were women. During the 2-year study period, 37.4% of children, 24.6% of youths, and 19.8% of young adults were admitted to an acute care hospital at least once. The admission rates were significantly higher in the CP population than in the non-CP population.

A total of 9,419,978 patients were included in the non-CP population control group. Among them, 814,810 (8.6%) were admitted. Table 1 presents a comparison of the admission rates between the CP and non-CP population cohorts. The OR for CP admission was 3.96 (3.78–4.14), and the ORs for the child, youth, and adult CP groups were 4.66 (4.35–5.00), 8.21 (7.47–9.03), and 2.39 (2.20–2.59), respectively.

For the analysis of admission reasons, we enrolled 2468 patients with CP, which included 1200 children, 555 youths, and 713 young adults. The total number of admissions was 5752, of which children accounted for 3081, youths accounted for 1145, and young adults accounted for 1526. The mean LOS was 9.8 days among children, 10.4 days among youths, and 12.8 days among young adults. The main reasons for admissions among the child, youth, and young adult groups with CP are presented in Table 2. We grouped similar reasons together within the table. A total of 24 major reason categories were identified in the current study. We identified pneumonia, epilepsy, and other respiratory conditions as the top three reasons for admissions in all age groups. These conditions accounted for 62.0% of child admissions, 58.3% of youth admissions, and 54.3% of young adult admissions.

The other common admission reasons for all groups were sepsis or bacteremia; upper gastrointestinal (GI), lower GI, and other GI problems; other respiratory infections excluding pneumonia; and urinary tract infections (UTIs). The reasons that were specific to children included ear nose throat (ENT) problems, contractures and spasms, congenital orthopedic issues (especially congenital hip dislocation, 1.1%), and blood disorders. In youth, musculoskeletal issues were relative common admission reasons, including contractures and spasms, other orthopedic conditions, congenital orthopedic conditions, and fracture. In young adults, mental disorders constituted the unique admission reason, and other reasons included blood disorders, other orthopedic conditions, and fracture. In addition, UTI was among the top five admission reasons in young adults with CP. Other respiratory conditions caused the longest mean LOS ± SD among all age groups with CP (25.8 ± 68.1 in children, 27.3 ± 54.2 in youths, and 29.5 ± 68.7 in young adults) (Table 2).

A comparison of the statistic results of LOS of the common major reasons between the three age groups revealed that the results in the following reason categories were significant: pneumonia, other respiratory conditions, epilepsy, UTI, mental problems, lower GI problems, other GI problems, nutritional problems, other orthopedic conditions, and hydrocephalus. Mostly, the LOSs of the aforementioned reasons exhibited a trend of the adult CP group being hospitalized longer than the youth CP group and the youth CP group being hospitalized longer than the child CP group.

Table 3 presents the most common reasons for hospital admissions observed in the current study. Other respiratory

Table 1 Characteristics and admission rates of the CP and non-CP general population cohorts.

Characteristics OR, P value (95% CI),	CP Groups							Non-CP general Population						
	Children (4–12.9) 5.28, **0.000 (4.92–5.67)		Youth (13–17.9) 8.21, **0.000 (7.47–9.03)		Adults (18–32.9) 2.39, ** 0.000 (2.20–2.59)		Total 3.96, ** 0.000 (3.78–4.14)	Children (4–12.9)		Youth (13–17.9)		Adults (18–32.9)		Total
	Girls	Boys	Girls	Boys	Women	Men		Girls	Boys	Girls	Boys	Women	Men	
Number	1351	1906	965	1353	1569	2140	9284	1,037,137	1,135,517	758,802	823,602	2,962,040	2,702,880	9,419,978
Admission rate (%)	38.1	36.9	23.5	25.3	18.5	20.8	27.2	9.6	10.7	3.2	4.4	11.5	7.0	8.6

P value (Pearson's chi-squared test, **p < 0.01).
CP = cerebral palsy; OR: odds ratio (compared with the corresponding Non-CP group).

conditions had the longest mean LOS ±SD among all subgroups with CP; a detailed analysis of the compositions revealed that the longest LOS in the diagnosis subgroup was for respiratory failure or respiratory insufficiency with ventilator use. The LOS + SD was 56.9 ± 109.2 in children, 44.4 ± 71.0 in youth, and 52.7 ± 102.7 in young adults for other respiratory conditions.

The numbers of hospitalizations due to common admission reasons between the CP and non-CP population cohorts were compared. The non-CP inpatient control group comprised 807,676 patients, and the total number of admissions was 1,137,546. A significant difference in the number of hospital admissions between the two groups was observed (Fig. 2). Patients with CP had an evidently higher number of hospitalizations due to pneumonia, epilepsy, gastrointestinal problems, UTI, and bacteremia.

4. Discussion

In this study, we analyzed the common admission reasons among patients with CP. Pneumonia, other respiratory problems, and epilepsy were the top three reasons for CP admissions. Other common reasons for admission in all age groups were other infections (UTI, sepsis, and other respiratory infections) and GI problems. ENT was a unique admission reason for children with CP, UTI accounted for a large proportion of young adult admissions, and mental illness was unique for young adults with CP. Musculoskeletal problems were also important factors among all age groups. In addition, the LOS exhibited a trend of increase as age increased in several admission reason categories.

Studies have reported that children with chronic medical complexity or neurological impairment account for a substantial proportion of inpatient resource utilization,[20,21] and the proportion of inpatient pediatric admissions, days, and costs has increased over the past few decades. In addition, they experienced longer hospitalizations, higher recurrent readmissions, and more diagnoses. A retrospective cohort study reported that children and youth with CP are likely to have a higher frequency of admissions and same-day admissions; in particular, those with a moderate-to-severe motor impairment.[14] The aforementioned cohort study inspired the present study to investigate the relationship between age and length of hospitalization in patients with CP. In the present study, all included patients were defined as having a disability (at least to a moderate level) and were identified by the CP registry in the catastrophic-illness patient registry. Our results are comparable with those reported previously.

Studies that investigated reasons for admission in children with CP are limited. Murphy et al.[15] reported that the main reasons for admission among children with CP were disorders of the respiratory system, nervous system, musculoskeletal/connective tissue systems, digestive system, and nutrition/endocrine/metabolic systems. Our study had some differences regarding the reasons for admissions of children with CP. Our child CP cohort was more commonly admitted for other infections other than pneumonia and relatively less frequently hospitalized for nutrition/endocrine/metabolic problems. Moreover, most

Table 2 Proportion and LOS for common major admission reasons in each age group based on NHIRD.

	Children (C) (Age 4–12.9)			Youth (Y) (Age 13–17.9)			Young adults (A) (Age 18–32.9)			P
	Percent of admission	LOS	Median (IQR)	Percent of admission	LOS	Median (IQR)	Percent of admission	LOS	Median (IQR)	
Pneumonia	34.8	10.7 ± 24.9	6 (4–10)	35.0	12.0 ± 20.7	7 (4–13)	27.4	13.2 ± 20.5	8 (5–15)	**0.000 C < Y < A
Other respiratory infection excluded pneumonia	7.1	4.7 ± 2.7	4 (3–6)	4.9	4.2 ± 2.9	4 (2.3–6)	2.4	4.3 ± 2.4	4 (3–5)	0.172
Other respiratory conditions (eg, asthma, lung disease, pleural effusion, respiratory failure)	11.0	25.8 ± 68.1	8 (4–17)	10.7	27.3 ± 54.2	13.5 (5.8–25)	15.2	29.5 ± 68.7	13 (6–26.8)	**0.000 C < Y,A
Epilepsy	16.1	7.6 ± 15.7	5 (3–8)	12.5	7.3 ± 19.6	3 (2–7)	11.4	7.3 ± 7.1	5 (3–9)	**0.000 Y < C,A
UTI	2.4	10.5 ± 13.9	7 (4–11)	2.8	6.8 ± 5.0	6 (4–7.5)	5.8	9.2 ± 6.9	7.5 (5–11.3)	*0.044 Y < A
Mental disorders	1.1	5.8 ± 8.5	2 (2–5.3)	1.1	6.5 ± 6.9	4 (3–5.5)	2.2	17.5 ± 24.6	8.5 (3–21.3)	**0.001 C < A
Upper GI (eg, acute gastritis, chronic stomach ulcers, esophagitis)	4.1	7.6 ± 11.1	4 (3–8)	4.5	5.8 ± 5.6	4 (2–6.3)	5.5	6.6 ± 4.6	5 (3–9)	0.062
Lower GI/constipation	4.6	6.2 ± 7.2	4 (3–6)	4.0	8.5 ± 14.5	4 (3–9)	8.7	9.1 ± 17.6	5 (3–9)	**0.001 C < A
Other GI (eg, abdominal pain, appendicitis, GI hemorrhage, malabsorption, nausea and vomiting, ascites)	1.8	13.4 ± 21.3	7 (4–15)	5.1	6.4 ± 8.5	4 (2–7)	4.7	9.4 ± 9.5	7 (4–11)	**0.000 Y < A,C
Nutritional, Metabolic and Endocrocrine Problems	1.2	4.7 ± 5.7	3 (2–5)	1.2	5.9 ± 3.6	6 (3–8)	0.4	7.7 ± 5.1	4 (3.5–12.5)	*0.027 C < Y,A
Contractures and spasms	2.1	3.9 ± 2.8	3 (2–4)	3.2	3.4 ± 1.5	3 (3–4)	0.4	3.4 ± 2.2	3 (2–3)	0.609
Congenital orthopedic conditions (eg, dislocation, deformities, arthropathy)	1.8	4.8 ± 2.2	5 (3–6)	1.9	8.7 ± 16.0	5 (4–6)	0.3	5.7 ± 4.8	4.5 (3.3–5)	0.411
Scoliosis or other spinal deformity	0.3	5.9 ± 4.8	3.5 (2–8.8)	0.8	10.2 ± 6.5	9 (6.5–12.5)	0.5	7.5 ± 4.2	6 (4.5–11.8)	0.266
Fractures	0.6	5.0 ± 5.0	4 (2–5)	1.4	4.7 ± 3.8	4 (2.8–6)	1.3	9.2 ± 6.8	6 (5–12)	**0.002 C,Y < A
Others orthopedic conditions	1.5	4.6 ± 5.7	3 (2–4)	2.7	7.9 ± 14.9	4 (3–5.8)	2.0	10.5 ± 12.0	6 (3.5–13)	**0.000 C < Y < A
Hydrocephalus and shunt related procedures	0.8	14.7 ± 16.5	6 (4–21.5)	0.8	13.9 ± 15.6	8 (4.5–13.5)	0.4	5.7 ± 5.7	2 (1.5–8.5)	0.237
ENT	2.2	5.5 ± 6.9	4 (3–6)	1.0	4.4 ± 2.5	4 (2–6)	1.1	7.9 ± 10.2	5 (3–7.8)	0.737
Heart diseases	0.6	3.2 ± 2.1	3 (2–4)	0.9	12.0 ± 17.2	3 (1–12)	0.7	11.7 ± 16.6	4 (1–11)	0.463
Malignant (eg, solid, hematologic)	0.4	8.9 ± 10.5	3 (1.5–11)	/	/		/	/		
Eyes problems	1.0	3.7 ± 6.9	2 (1–3)	0.6	2.4 ± 0.9	2 (2–3)	0.3	7.3 ± 7.8	5 (2.3–7)	0.210
Blood disorders (eg, anemia, thrombocytopenia, coagulopathy)	1.6	6.0 ± 5.6	4 (3–7)	1.1	4.5 ± 5.4	2.5 (2–5)	2.2	5.7 ± 4.5	5 (3–7)	0.112

(*continued on next page*)

Table 2 (*continued*)

	Children (C) (Age 4—12.9)			Youth (Y) (Age 13—17.9)			Young adults (A) (Age 18—32.9)			P
	Percent of admission	LOS	Median (IQR)	Percent of admission	LOS	Median (IQR)	Percent of admission	LOS	Median (IQR)	
CVA	0.4	12.7 ± 11.8	8 (7—13)	0.4	16.5 ± 21.0	7 (3.8 —15.5)	0.3	8.8 ± 4.4	11 (4—13)	0.882
Sepsis or bacteremia	2.5	19.9 ± 41.1	10 (5	3.3	11.4 ± 13.4	8 (4—12)	6.3	11.8 ± 10.6	9 (4—15)	0.476
Skin pressure ulcers	0.2	9.2 ± 1.6	—19) 8 (7 —12.3)	0.2	11.7 ± 2.3	14 (7-)	0.6	12.8 ± 3.1	10.5 (4.5 —13.8)	0.734

Kruskal—Wallis test (post hoc analysis: Mann—Whitney test), $^{**}p < 0.01$, $^{*}p < 0.05$.
CVA = cerebrovascular accidents; ENT = diseases of the ear, nose, and throat; GI = gastrointestinal problems; IQR = interquartile range; LOS = length of stay; UTI = urinary tract infection.

Table 3 Most common reasons for hospital admissions (guided by the current study).

All age group CP • Pneumonia • Epilepsy • Respiratory problems other than pneumonia and other infection		
Children (4—12.9)	Youth (13—17.9)	Adults (18—32.9)
• Other respiratory infections excluded pneumonia	• Other GI	• Lower GI/ constipation
• Lower GI/ Constipation	• Other respiratory infections excluded pneumonia	• Sepsis or bacteremia
• Upper GI	• Upper GI	• UTI
• Sepsis or bacteremia	• Lower GI/ constipation	• Upper GI
• UTI	• Sepsis or bacteremia	• Other GI
• **ENT**	• Contractures and spasms	• Other respiratory infection excluded pneumonia
• *Contractures and spasms*	• UTI	• *Blood disorders*
• Other GI	• *Others orthopedic conditions*	• **Mental disorders**
• *Congenital orthopedic conditions (eg, dislocation, deformities, arthropathy)*	• *Congenital orthopedic conditions (eg, dislocation, deformities, arthropathy)*	• *Others orthopedic conditions*
• *Blood disorders*	• *Fractures*	• *Fractures*

Bold text denotes conditions unique to one age group; italic text denotes conditions unique to two age groups.
CVA = cerebrovascular accidents; ENT = diseases of the ear, nose, and throat; GI = gastrointestinal problems; UTI = urinary tract infection.

admission reasons caused a longer LOS than those reported in previous studies.

The youth and young adult subgroups with CP were more commonly admitted for infections other than pneumonia. These reasons were respiratory infections other than pneumonia and sepsis or bacteremia in both groups. Primary care in CP may require a more aggressive management strategy to maximize airway clearance and treatment of pulmonary infections as recommended in neuromuscular conditions.[22,23]

A significant difference in the number of hospitalizations due to common admission reasons was observed between the CP and non-CP populations. Patients with CP exhibited an evidently higher number of hospitalizations due to pneumonia, epilepsy, gastrointestinal problems, UTI, and bacteremia. We think patients with CP are more susceptible to most disease invasions than patients without CP, especially infectious diseases. However, a definitive answer

Percentage of each admission reasons, comparison of CP and non-CP cohort

Top 15 reasons	CP(%)	non-CP (%)
Pneumonia	32.79	11.29
Epilepsy	14.04	0.73
Other respiratory conditions	12.10	1.72
Lower GI/ constipation	5.61	4.47
Other respiratory infection	5.33	7.67
Upper GI	4.55	1.40
Sepsis or bacteremia	3.72	0.36
UTI	3.43	1.77
Other GI	3.27	2.19
Others orthopedic conditions	1.88	1.24
Contracture and spasm	1.85	0.04
Blood disorders	1.66	0.55
ENT	1.64	2.01
Discolocation, arthropathy	1.42	0.93
Mental disorders	1.39	4.91
Others	5.31	58.71

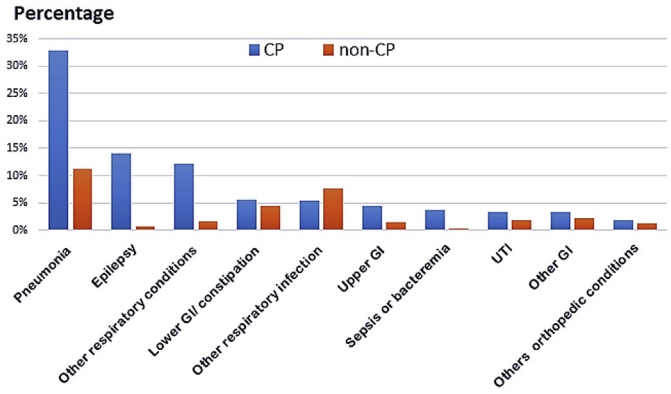

Figure 2 Numbers of the most common admission reasons of CP patients compared with those of the non-CP population cohort. ENT = diseases of the ear, nose, and throat; GI = gastrointestinal problems; UTI = urinary tract infection.

cannot be obtained from this study; further advanced molecular or genetic studies focusing on immune problems and other chronic comorbidities in patients with CP are required to provide detailed data from which to draw conclusions. The health policymakers and providers should pay attention to the fact and should increase the relevant health insurance budget for developing associated high-standard disease prevention measures for patients with CP.

Efficiently coordinated multidisciplinary team with comprehensive medical resources for CP patients should be implemented. These programs and teams must adhere to a high standard of Professionalism, thus these measures could extend the patients' lives and improve their quality of life. In addition, they could reduce the frequency of CP hospitalization and associated costs. Additionally, practitioners and service providers in adult systems need further education about CP.[25]

In the future, a learning diagnosis and health care assistance system with artificial intelligent should be pursued, possibly could drive simultaneous clinical quality improvement and reduced health care costs. To reduce the quality gap in health care, this research should also encourage further investigation on care providers' understanding of treating patients with CP. A smart health system can simultaneously drive clinical quality improvement and reduce health care costs.[26] By using artificial intelligence, personalized advice could be provided for the medical care of each individual patient with CP.

This study has several limitations. First, because the diagnoses were analyzed from administrative claims, they lacked exact clinical information regarding the CP severity and complexity levels and type. Nevertheless, our selection of CP patient records was based on the catastrophic illness registry, which might explain why the admission rates of CP and the CP admission problems in this study were relatively close to the real-life situation. Second, the reliability and validity of the secondary data in the NHIRD could not be verified. However, the NHIA has a medical review system to avoid fake diagnoses or coding mistakes. Third, the diagnosis and procedure coding data contained potential inconsistencies. For example, in admissions with a single discharge diagnosis of CP, the exact reason for admission was unknown. Finally, the admission diagnosis might be replaced by other new events (e.g., nosocomial infection) during the discharge coding because severe comorbidities have a higher weight in insurance claims.

5. Conclusion

We identify the common reasons and hospitalization quality of patients with CP. The results provided comprehensive insights into acute and chronic medical issues of patients with CP encountered from childhood to adulthood. Our results will provide important clinical information for physicians and guidance for planning health services in the future to prevent and manage CP in the patient lifespans. Our results also revealed much longer hospital stays than those reported by previous studies, and the LOS exhibited a trend of increase with increasing age in several admission reason categories; this implies that the current care system in Taiwan is not suitable for patients with CP. The Taiwanese government should develop high standard disease prevention programs for patients with CP, and establish a comprehensive care system for patients with cerebral palsy transitioning from hospital to home and build up associated chronic care facilities. These measures could reduce the number of hospitalizations and the LOS, thereby reducing the medical resource consumption and extending the patients' lives.

Conflicts of interest statement

The authors declare that they have no conflicts of interest.

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References

1. Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M, Damiano D, et al. A report: the definition and classification of cerebral palsy April 2006. *Dev Med Child Neurol Suppl* 2007; **109**:8—14.
2. Winter S, Autry A, Boyle C, Yeargin-Allsopp M. Trends in the prevalence of cerebral palsy in a population-based study. *Pediatrics* 2002;**110**:1220—5.
3. Paneth N, Hong T, Korzeniewski S. The descriptive epidemiology of cerebral palsy. *Clin Perinatol* 2006;**33**:251—67.
4. Arneson CL, Durkin MS, Benedict RE, Kirby RS, Yeargin-Allsopp M, Van Naarden Braun K, et al. Prevalence of cerebral palsy: autism and developmental disabilities monitoring network, three sites, United States, 2004. *Disabil Health J* 2009;**2**:45—8.
5. Chang MJ, Ma HI, Lu TH. Estimating the prevalence of cerebral palsy in Taiwan: a comparison of different case definitions. *Res Dev Disabil* 2014;**36C**:207—12.
6. Zan H, Scharff RL. The heterogeneity in financial and time burden of caregiving to children with chronic conditions. *Matern Child Health J* 2015;**19**:615—25.
7. Wang B, Chen Y, Zhang J, Li J, Guo Y, Hailey D. A preliminary study into the economic burden of cerebral palsy in China. *Health Policy* 2008;**87**:223—34.
8. Park MS, Kim SJ, Chung CY, Kwon DG, Choi IH, Lee KM. Prevalence and lifetime healthcare cost of cerebral palsy in South Korea. *Health Policy* 2011;**100**:234—8.
9. Brooks JC, Strauss DJ, Shavelle RM, Tran LM, Rosenbloom L, Wu YW. Recent trends in cerebral palsy survival. Part II: individual survival prognosis. *Dev Med Child Neurol* 2014;**56**:1065—71.
10. Doyle LW, Victorian Infant Collaborative Study Group. Evaluation of neonatal intensive care for extremely low birth weight infants in Victoria over two decades: I. Effectiveness. *Pediatrics* 2004;**113**:505—9.
11. Hemming K, Hutton JL, Pharoah PO. Long-term survival for a cohort of adults with cerebral palsy. *Dev Med Child Neurol* 2006;**48**:90—5.
12. Oskoui M. Growing up with cerebral palsy: contemporary challenges of healthcare transition. *Can J Neurol Sci* 2012;**39**:23—5.
13. Berry JG, Hall DE, Kuo DZ, Cohen E, Agrawal R, Feudtner C, et al. Hospital utilization and characteristics of patients experiencing recurrent readmissions within children's hospitals. *JAMA* 2011;**305**:682—90.
14. Meehan E, Freed GL, Reid SM, Williams K, Sewell JR, Rawicki B, et al. Tertiary paediatric hospital admissions in children and young people with cerebral palsy. *Child Care Health Dev* 2015;**41**:928—37.
15. Murphy NA, Hoff C, Jorgensen T, Norlin C, Young PC. Costs and complications of hospitalizations for children with cerebral palsy. *Pediatr Rehabil* 2006;**9**:47—52.
16. Young NL, Gilbert TK, McCormick A, Ayling-Campos A, Boydell K, Law M, et al. Youth and young adults with cerebral palsy: their use of physician and hospital services. *Arch Phys Med Rehabil* 2007;**88**:696—702.
17. Young NL, McCormick AM, Gilbert T, Ayling-Campos A, Burke T, Fehlings D, et al. Reasons for hospital admissions among youth and young adults with cerebral palsy. *Arch Phys Med Rehabil* 2011;**92**:46—50.
18. Chien IC, Chou YJ, Lin CH, Bih SH, Chou P. Prevalence of psychiatric disorders among national health insurance enrollees in Taiwan. *Psychiatr Serv* 2004;**55**:691—7.
19. Chien IC, Lin CH, Chou YJ, Chou P. Prevalence, incidence, and stimulant use of attention-deficit hyperactivity disorder in Taiwan, 1996—2005: a national population-based study. *Soc Psychiatry Psychiatr Epidemiol* 2012;**47**:1885—990.
20. Berry JG, Poduri A, Bonkowsky JL, Zhou J, Graham DA, Welch C, et al. Trends in resource utilization by children with neurological impairment in the United States inpatient health care system: a repeat cross-sectional study. *PLoS Med* 2012;**9**:e1001158.
21. Simon TD, Berry J, Feudtner C, Stone BL, Sheng X, Bratton SL, et al. Children with complex chronic conditions in inpatient hospital settings in the United States. *Pediatrics* 2010;**126**:647—55.
22. Bach JR, Niranjan V, Weaver B. Spinal muscular atrophy type 1: a noninvasive respiratory management approach. *Chest* 2000;**117**:1100—5.
23. Finder JD, Birnkrant D, Carl J, Farber HJ, Gozal D, Iannaccone ST, et al. Respiratory care of the patient with Duchenne muscular dystrophy: ATS consensus statement. *Am J Respir Crit Care Med* 2004;**170**:456—65.
25. Bagatell N, Chan D, Rauch KK, Thorpe D. "Thrust into adulthood": transition experiences of young adults with cerebral palsy. *Disabil Health J* 2017;**10**:80—6.
26. Lowes LP, Noritz GH, Newmeyer A, Embi PJ, Yin H, Smoyer WE. "Learn from Every Patient": implementation and early results of a learning health system. *Dev Med Child Neurol* 2017;**59**:183—91.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.pedneo.2018.04.004.