Evaluation of immunization status in patients with cerebral palsy: a multicenter CP-VACC study

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Abstract

Children with chronic neurological diseases, including cerebral palsy (CP), are especially susceptible to vaccine-preventable infections and face an increased risk of severe respiratory infections and decompensation of their disease. This study aims to examine age-appropriate immunization status and related factors in the CP population of our country. This cross-sectional prospective multicentered survey study included 18 pediatric neurology clinics around Turkey, wherein outpatient children with CP were included in the study. Data on patient and CP characteristics, concomitant disorders, vaccination status included in the National Immunization Program (NIP), administration, and influenza vaccine recommendation were collected at a single visit. A total of 1194 patients were enrolled. Regarding immunization records, the most frequently administrated and schedule completed vaccines were BCG (90.8%), hepatitis B (88.9%), and oral poliovirus vaccine (88.5%). MMR was administered to 77.3%, and DTaP-IPV-HiB was administered to 60.5% of patients. For the pneumococcal vaccines, 54.1% of children received PCV in the scope of the NIP, and 15.2% of children were not fully vaccinated for their age. The influenza vaccine was administered only to 3.4% of the patients at any time and was never recommended to 1122 parents (93.9%). In the patients with severe (grades 4 and 5) motor dysfunction, the frequency of incomplete/none vaccination of hepatitis B, BCG, DTaP-IPV-HiB, OPV, and MMR was statistically more common than mild to moderate (grades 1–3) motor dysfunction (p = 0.003, p < 0.001, p < 0.001, p < 0.00, and p < 0.001, respectively). Physicians’ influenza vaccine recommendation was higher in the severe motor dysfunction group, and the difference was statistically significant (p = 0.029).

Conclusion: Children with CP had lower immunization rates and incomplete immunization programs. Clinicians must ensure children with CP receive the same preventative health measures as healthy children, including vaccines.

What is Known:

• Health authorities have defined chronic neurological diseases as high-risk conditions for influenza and pneumococcal infections, and they recommend vaccines against these infections.
• Children with CP have a high risk of incomplete and delayed immunization, a significant concern given to their increased healthcare needs and vulnerability to infectious diseases.

What is New:

• Influenza vaccination was recommended for patients hospitalized due to pneumonia at a higher rate, and patients were administered influenza vaccine more commonly.
• Children with CP who had higher levels of motor dysfunction (levels 4 and 5) were more likely to be overdue immunizations.

Keywords Cerebral palsy · Immunization status · Respiratory infections · Pneumococcus · Influenza

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Introduction

Cerebral palsy (CP) is the most common chronic neurological disorder and the most common cause of physical disability in childhood. Patients have decreased muscle tone, weakness, inability to handle the secretions, and pulmonary function impairment. Children with neurological disorders have a 5–7 times higher risk of hospitalization due to respiratory diseases among all children [1]. Recurrent respiratory infections are one of the most important causes of morbidity and mortality for these patients. Like in healthy children, routine immunization is one of the most important preventive measures for infectious disease among children with chronic neurological diseases, including CP. Health authorities have defined chronic neurological diseases as high-risk conditions for influenza and pneumococcal infections, and they recommend vaccines against these infections [2]. Although children with chronic diseases face greater risks, their vaccine coverage rates appear lower than in the general population [3]; nonetheless, exact figures are unavailable. Previous studies revealed that patients with chronic neurological diseases were vaccinated more delayed and less frequently than the healthy population [1, 4, 5].

Today, an up-to-date vaccination schedule is established in Turkey with the gradual development of new vaccines, strains, and application methods. Turkey’s National Immunization Program (NIP) is effective against 13 different antigens (tetanus, diphtheria, pertussis, polio, *Haemophilus influenzae* type B, hepatitis B, tuberculosis, mumps, measles, rubella, pneumococcus, hepatitis A, varicella). Only a few studies in Turkey determine the immunization status of children with chronic illnesses, especially chronic neurologic diseases [5]. Immunization in these children is particularly important as they often have underlying chronic illnesses that result in a significantly higher risk of complications from infectious diseases that are vaccine-preventable (e.g., influenza and invasive pneumococcal disease).

Many misconceptions about and prejudices against vaccines and parents of children with CP may fear adverse reactions because of their children’s condition [6]. The main objective of the present study is to examine vaccination rates in the CP population of our country. The secondary objective is to explore whether there is an association between demographic, medical, and receipt of the vaccines which are included in the NIP. We hypothesized that patients with CP receive the vaccinations less frequently than the healthy population.

Methods

Study protocol

In August 2018, a questionnaire form including demographic and clinical features, vaccination status of patients with CP, and the vaccination recommendation of clinicians was prepared at the Izmir Tepecik Training and Research Hospital Pediatric Infection Diseases and Izmir Katip Celebi University Pediatric Neurology Clinics. In September 2018, we contacted the hospitals via e-mails requesting that a pediatric neurologist from each center complete the questionnaire. Detailed information about the study was given to the clinics that accepted to participate in the study. Pediatric neurologists were asked to fill in the questionnaire forms by obtaining an informed consent form from the parents/legal guardians of the patients. Printed questionnaires were sent to centers that agreed to participate in the study, and data were collected from September 2018 to February 2019.

Data sources

Data on patient demographics (age, gender), CP characteristics (etiology and type of CP, affected body parts, GMFCS (Gross Motor Function Classification System) level), concomitant non-neuromotor impairments, hospitalization in the last year, number of hospitalizations and reasons, medicines used regularly, vaccination status for each antigen (included and non-included in the NIP), and recommended influenza vaccine from clinicians were collected at a single visit. The evaluation of the immunization rate in the population included immunization cards/records provided by parents. We defined “complete” or “incomplete” vaccinations, considering whether the vaccine was available in the NIP during the children’s immunization period.

In Turkey, conjugated pneumococcal vaccine-7 (PCV7) was introduced to the NIP in a 3+1 (2, 4, 6, and 12 months)
schedule in April 2008, and was switched to PCV13 in November 2011, and then a 2+1 schedule for PCV13 has been used since March 2019.

In terms of developments in the vaccination schedule, in 2006, Hib vaccine was added; in 2008, DaBT-IPA-Hib was added; DaBT-IPA vaccine was implemented instead of Td and OPV in the classroom in primary education in 2010; hepatitis A vaccine in 2012 was added; and varicella vaccine in 2013 was added to the NIP. The primary school first and 8th grade school age vaccinations were changed on June 3, 2020, in line with the recommendation of the Immunization Advisory Board, and it was decided to be implemented in Family Medicine Clinics. MMR and DaBT-IPA vaccines applied in primary 1st grade schools will be applied in Family Medicine Clinics to all children who have entered the 48th month, starting from those born on 1 July 2016. The Td vaccine applied in schools in the 8th grade of primary education will be applied in Family Medicine Clinics to all children born on July 1, 2007, and have turned 13 (156th month). The current Turkey’s NIP is shown in Table 1.

| Vaccines                          | At birth | 1 month | 2 months | 4 months | 6 months | 9 months | 12 months | 18 months | 24 months | 48 months | 13 years |
|----------------------------------|----------|---------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|----------|
| Hepatitis B                      | I        | II      | III      |          |          |          |           |           |           |           |          |
| BCG                              | I        |         |          |          |          |          |           |           |           |           |          |
| DTaP-Hib-IPV                     | I        | II      | III      | R        |          |          |           |           |           |           |          |
| PCV13                            | I        | II      | R        |          |          |          |           |           |           |           |          |
| MMR                              |          |         |          | R        |          |          |           |           |           |           |          |
| DTaP-IPV                         |          |         | R        |          |          |          |           |           |           |           |          |
| OPV                              |          |         |          | R        |          |          |           |           |           |           |          |
| Td                               |          |         |          |          | R        |          |           |           |           |           |          |
| Hepatitis A                      |          |         |          | I        | II       |          |           |           |           |           |          |
| Varicella                        |          |         |          | I        |         |          |           |           |           |           |          |

BCG, Bacillus Calmette-Guerin; DTaP-Hib-IPV, diphtheria, tetanus, pertussis-Haemophilus influenzae type B–inactivated poliovirus; PCV13, pneumococcal conjugate 13; MMR, measles, mumps, rubella; OPV, oral poliovirus; Td, tetanus, diphtheria

CP was clinically categorized into spastic, dyskinetic or extrapyramidal, cerebellar or ataxic, hypotonic, and mixed, based on the predominant motor impairment [7]. GMFCS was used to classify the severity of motor impairment into five subgroups, including level I (walks without limitations), level II (walks with limitations), level III (walks using a hand-held mobility device), level IV (self-mobility with limitations, may use powered mobility), and level V (transported in a manual wheelchair) according to published criteria [8].

**Study population**

Patients diagnosed with CP and ages under 18 years were included in the study. Of 1202 patients initially enrolled from 18 centers, 1194 patients were found eligible to participate in this study since eight patients were excluded due to detection of protocol violation (all vaccine data were missing) after enrollment. Written informed consent/assent was obtained from children and/or children’s parents or legal guardians following a detailed explanation of the objectives and protocol. The study was conducted following the ethical principles stated in the Declaration of Helsinki and approved by the institutional ethics committees (number: 21.02.2018/92).

**Statistical analysis**

The obtained questionnaires were transferred to IBM SPSS (Windows, version 23.0, IBM Corp, Armonk, NY) program on a computer. The suitability of the variables to normal distribution was examined by visual (histogram and probability plots (PP plot)) and analytical (Kolmogorov–Smirnov test for $n > 50$) methods. Descriptive data were given as mean and standard deviation for continuous variables and median (minimum–maximum values) for categorical variables. The parameters with normal distribution were compared by independent samples $t$-test in independent groups, and non-normal parameters were compared with the Mann–Whitney $U$ test. Comparisons for categorical variables were made using the Pearson chi-square test and Fisher’s exact test in $2 \times 2$ order. In the study, the significance of the $p$-value was considered as $< 0.05$.

**Results**

Questionnaires were obtained from 1202 patients, and eight patients were excluded due to significant missing data. Overall, 1194 children (57.7% boys and 42.3% girls) with CP and ages between 8 months and 18 years from 18 pediatric
neurology clinics were enrolled. The number of patients according to centers is shown in Fig. 1. The mean age of patients was 93.9 ± 57.6 months (IQR: 44–135 months). The main etiology of CP was asphyxia (39.7%) and prematurity (39.6%); most of the patients had level V gross motor dysfunction (42.1%). Spastic CP (83.4%) with quadriplegic (29.2%) or hemiplegic (17.3%) topography was the most common type. The etiology and characteristics of CP have been summarized in a supplementary file. The most common concomitant diseases were epilepsy (56.2%), orthopedic problems (15.2%), and growth retardation (29.1%). Most of the patients were using medications (63.9%); the most frequently used drugs were antiepileptics (44.2%) and muscle relaxants (6.8%). Among patients with CP, 342 (28.6%) were hospitalized in the last year, of whom 178 were hospitalized due to pneumonia (Table 2).

Regarding immunization records, the most frequently administrated and schedule completed vaccines were Bacillus Calmette-Guerin (BCG) \(n = 1084, 90.8\%\), hepatitis B \(n = 1062, 88.9\%\), and oral poliovirus vaccine \(n = 1057, 88.5\%\). Measles, mumps, rubella (MMR) were administered to 77.3\% \((n = 923)\) of patients, and diphtheria, tetanus, acellular pertussis-inactivated polio vaccine, Haemophilus influenzae type B (DTaP-IPV-HiB) were administered to 60.5\% \((n = 722)\) of patients (Table 3). In Turkey, PCV7 was introduced to the NIP in April 2008 and was switched to PCV13 in November 2011. Before 2008, PCV requires a specific recommendation for patients. In our study population, 30.8\% \((n = 367)\) of the study group had not been previously vaccinated with PCV. For the pneumococcal vaccines, 646 children (54.1\%) had received PCV in the scope of the NIP, and 181 children (15.2\%) were not fully vaccinated for their age. The varicella vaccine, which was included to NIP in 2012 and started to be administered in 2013, was not administered to 611 children (54.4\%). Similarly, the hepatitis A vaccine, which was included in the NIP in 2012, was not administered to 650 children (54.4\%). Age-appropriate vaccination according to the NIP is depicted in Table 3. The influenza vaccine, which is still not included in our NIP, was administered only to 3.4\% of the patients at any time.

**Table 2** Demographical and clinical characteristics of patients with CP

| Characteristics                  | Values |
|----------------------------------|--------|
| Age \(^a\)                        | 93.9 ± 57.6 |
| Gender (male) \(^b\)              | 689 (57.7) |
| Concomitant diseases \(^b\)       | 959 (80.3) |
| Epilepsy                         | 671 (56.2) |
| Orthopedic problems              | 500 (41.9) |
| Growth retardation               | 348 (29.1) |
| Visual disorders                 | 182 (15.2) |
| Recurrent pneumonia              | 116 (9.7)  |
| Auditory disorders               | 33 (2.8)   |
| Using medications \(^b\)         | 763 (63.9) |
| Antiepileptics                   | 528 (44.2) |
| Antiepileptics + muscle relaxants| 105 (8.8)  |
| Muscle relaxants                 | 81 (6.8)   |
| Antipsychotics                   | 13 (1.1)   |
| Antiepileptics + antipsychotics  | 11 (0.9)   |
| Muscle relaxants + antipsychotics| 4 (0.3)    |
| Antiepileptics + muscle relaxants + antipsychotics | 2 (0.2) |
| Others                           | 19 (1.6)   |
| Hospitalization in the last year \(^b\) | 342 (28.6) |
| Hospitalization in the last year due to pneumonia \(^b\) | 178 (14.9) |

\(^a\)Values were given as mean ± SD
\(^b\)Values were given as percentage

There were only 27 (2.3\%) patients who received the influenza vaccine during the study season. Influenza vaccine had never been recommended to 1122 parents (93.9\%). Considering the administration rates of vaccines not included in the NIP, the rotavirus vaccine was administered to 4.8\% \((n = 58)\) and the meningococcal vaccine to 3.2\% \((n = 39)\) of the patients. None of the children with CP received the human papillomavirus vaccine.

**Table 3** Age-appropriate vaccination according to the National Immunization Program

| Vaccines       | Completed | Incomplete | None |
|----------------|-----------|------------|------|
| Hepatitis B    | 1062 (88.9) | 41 (3.4)  | 91 (7.6) |
| BCG            | 1084 (90.8) | -          | 110 (89.2) |
| DTaP-Hib-IPV   | 722 (60.5)  | 379 (31.7) | 93 (7.8)  |
| OPV            | 1057 (88.5) | 26 (2.2)   | 111 (9.3) |
| PCV            | 646 (54.1)  | 181 (15.2) | 367 (30.8) |
| MMR            | 923 (77.3)  | 111 (9.3)  | 160 (13.4) |
| Varicella      | 583 (48.8)  | -          | 611 (51.1) |
| Hepatitis A    | 492 (41.2)  | 52 (4.4)   | 650 (54.4) |

BCG, Bacillus Calmette-Guerin; DTaP-Hib-IPV, diphtheria, tetanus, pertussis-Haemophilus influenzae type B–inactivated poliovirus; OPV, oral poliovirus; PCV, pneumococcal conjugate; MMR, measles, mumps, rubella
In Turkey, MMR and DTaP-IPV were administered to children in the first grade of primary school. Among the reported reasons, the most important one for incomplete vaccination was the lack of primary school vaccination in our study population. Less reported reasons were parents thought that their children’s immune system was not strong enough to handle the vaccines and the cause of CP was due to vaccines, ACTH, or IVIG therapy as it affects vaccination.

In the patients with severe (grades 4 and 5) motor dysfunction, the frequency of incomplete/none vaccination of hepatitis B, BCG, DTaP-IPV-HiB, OPV, and MMR was statistically more common than mild to moderate (grades 1–3) motor dysfunction (\( p = 0.003, p < 0.001, p < 0.001, p < 0.00, \) and \( p < 0.001, \) respectively). Physicians’ influenza vaccine recommendation was higher in the severe motor dysfunction group, and the difference was statistically significant (\( p = 0.029 \)). Administration of influenza vaccine at any time or during the study period was also higher in patients with severe dysfunction, but the differences were not statistically significant (\( p = 0.313 \) and \( p = 0.163 \)). There was no statistical significance between severe and mild to moderate motor dysfunction in terms of pneumococcal vaccine administration (\( p = 0.470 \)).

It was noted that BCG, OPV, MMR, and PCV vaccines were administered statistically more frequently in hospitalized patients with pneumonia in the last year (\( p < 0.001, p < 0.001, p < 0.001, \) and \( p = 0.004, \) respectively). Moreover, influenza vaccine recommendation, getting an influenza vaccine at any time, and during the study season were statistically more common in this group (\( p < 0.001, p = 0.034, \) and \( p = 0.022, \) respectively).

Discussion

Our study aimed to explore immunization status in CP patients and examine whether there is an association between demographic, medical, and receipt of the vaccines included in NIP. To the best of our knowledge, the present multicenter study is the first in the English literature to investigate the immunization status of the CP population from our country. Our results showed that the vaccination rate of children with CP for vaccines included in the Ministry of Health’s NIP was lower than healthy children. These findings are similar to a Canadian study [9] that examined vaccination status in children with physical disabilities and included 57 children with CP. Their results showed lower than expected rates of vaccination (63%). The study results from Australia were found more remarkable, and the “up-to-date” vaccination rate was demonstrated to be 19.2% in CP patients [10].

In contrast, a study from Turkey [5] showed no significant difference between immunization rates of children with chronic neurologic diseases versus the healthy population. According to the Ministry of Health’s NIP, this study put forth the vaccination rate in 95.6% of patients with chronic neurologic diseases who received age-appropriate vaccination. It is a fact that childhood diseases that can be prevented by vaccination are decreasing in our country and the most important reason for this is that vaccination programs have been implemented successfully for many years. According to the 2018 Health Statistics Yearbook published in 2019 [10], the vaccination rate for 3 doses of DaBT was 98%, for BCG vaccine was 96%, for 3 doses of hepatitis B vaccine was 98%, for MMR was 96%, and for 3 doses of conjugated pneumococcal vaccine was 98%. Our study noticed that the administration rates were higher in vaccines included in the NIP previously (e.g., hepatitis B, BCG, OPV, MMR, DTaP-IPV-HiB) and lower in those added lastly (e.g., PCV, varicella, hepatitis A). This was attributed to the fact that nearly half of the patients presented in our study were born before vaccines were included in the NIP. MMR and DaTP-IPV-HiB vaccines, which are the other components of childhood vaccinations, have been found less completed with a rate of 77.3% and 60.5% respectively in this group than the vaccines included in the NIP for a long time. Similarly, Greenwood et al. evaluated the vaccination status of patients with CP, and the MMR vaccine was reported to be the most missed vaccine followed by DaTP-Hib and OPV [11].

The patients with CP have a higher risk of morbidity and mortality than the healthy population for vaccine-preventable diseases. Respiratory diseases are the most frequently reported cause of morbidity and mortality in CP; hence, ameliorating respiratory status, quality of life, and life expectancy might be augmented. All studies of CP mortality investigating cause attribute more than half of the observed deaths to respiratory diseases [12]. It is important to implement pneumococcal and influenza vaccines that cause pneumonia, not aggravate respiratory problems, which are the cause of almost half of the deaths. As with typically developing children, children with CP should be vaccinated per the currently used vaccination schedule. The rate of complete vaccination with PCV, which is recommended for all Turkish children, was lower in our study than in the general population, among which it is reported to exceed 95% after 2008 [13]. Because of the recent implementation of the PCV, most of the older children born in Turkey before 2008 had not received it as a generally administered vaccine like our patients. The most common cause associated with required hospitalization was pneumonia, with a rate of 52%, in the last year in our study population. It was noted that the rate of none/incomplete vaccination was higher in those hospitalized patients for pneumonia. Also, it was found that the pneumococcal vaccine and BCG, OPV, and MMR vaccines were implemented at a lower rate in this group. Another remarkable result was that
influenza vaccination was recommended for patients hospitalized due to pneumonia at a higher rate, and patients were administered influenza vaccine more commonly. This may be because preventive implementation and vaccines are considered more frequently during follow-up in patients hospitalized due to pneumonia.

The Advisory Committee on Immunization Practices recommended influenza vaccine for people with chronic pulmonary, cardiovascular, renal, hepatic, neurological, hematological, metabolic diseases, or immunocompromised people in their recommendations for 2020–2021 Control of Seasonal Influenza with Vaccines [14]. In a cohort study by Keren et al., 322 of 745 patients with laboratory-confirmed influenza had one or more chronic diseases. Neurological and neuromuscular diseases are independent risk factors for respiratory failure [15]. In another study of 830 pediatric deaths associated with laboratory-confirmed influenza reported to the Center for Disease Control between October 2004 and September 2012, an underlying neurological disease was found at a rate of 33% [16]. In the meta-analysis by Gill et al. in 2014, in 27 studies involving 14,086 patients, neurological diseases were accepted as a high-risk factor for influenza-related hospitalizations [17]. In a study by Pandolfi et al., among 275 patients with chronic diseases, the lowest vaccination rate for influenza vaccine was found in patients with a neurological disease with 25% [18]. Considering that the frequency of influenza vaccination is generally low in our country, it is low in patients with CP who are in the risk group. In our study, only 3.4% of the patients with CP were vaccinated against influenza throughout their lives.

Similarly, only 2.6% of the patients were vaccinated during the season of the study. In a study from our country, Dinleyici et al. evaluated the vaccination of 366 patients with chronic neurological disease and found that 86.6% of patients had never been vaccinated against influenza in their life [5]. Although it is not as rare as in our country, there are examples of missing vaccination opportunities for these patients in other countries in the literature. In a study from the USA, Havers et al. evaluated the vaccination records of 184,460 patients with ≥1 neurological disease(s) between 2006 and 2014. They found that even in the 2013–2014 season when vaccination was the highest, less than half of the patients and 1/3 of these in the 10–17-year age group were vaccinated against influenza [19]. Worldwide, we need to develop interventions to increase the vaccination rates of the patients with CP who are in the risk group for influenza complications.

Patients may encounter many problems commonly seen in this disease, e.g., behavioral disorders, epilepsy, orthopedic deformities, and gastrointestinal and nutritional problems [20, 21]. The most common concomitant diseases were epilepsy, orthopedic problems, and growth retardation in our study population. More than half of patients present in our study have severe motor dysfunction, making it difficult to move. Children with CP who had higher levels of motor dysfunction (levels 4 and 5) were more likely to be overdue immunizations. A study from Canada [9] showed that children with moderate to severe disabilities are less likely than those with a mild disability to have received a basic series of immunizations. Similarities in this study and those observed associations between severe motor dysfunction and vaccination prompted us to investigate the potential role of the immunization status of this disease. In our study, the vaccination rate of hepatitis B, BCG, DTaP-IPV-HiB, OPV, and MMR was statistically significantly lower in patients with severe motor dysfunction. The clinical picture of the association between low vaccination rate and severe motor dysfunction is most likely due to a complex interplay between direct and indirect effects of CP. It may be that this group of children has an ongoing severe chronic illness resulting in frequent hospitalizations delaying age-appropriate immunizations or that the high level of care required may limit the time available for immunization appointments. Or, vaccines may have been neglected because the physicians who follow patients are concerned with other medical problems. Despite our results, Greenwood et al. demonstrated no association with motor dysfunction and vaccination rates [11]. They discussed that the results might have been influenced by survival bias as most children who died were with severe motor dysfunction, and the immunization records for these children had been removed from their national database.

Barriers to vaccination of patients with CP are familial factors and false contraindications of both parents and healthcare professionals. The most important reason for incomplete vaccination in our study was due to primary school vaccination in children. Therefore, we think that the administration of primary school vaccinations from primary care physicians and the development of a catch-up vaccination schedule for those patients without an age-appropriate vaccination will greatly benefit in protecting against diseases and increasing the quality of life in children with CP. One study concluded that some parents might be concerned that the possible adverse outcomes of immunizations may outweigh the potential benefits, such as increasing frequency of seizures, and a small proportion of parents may believe that immunizations contributed or caused their child’s disability [11]. The parents of our patients rarely mentioned these concerns.

Our study has some limitations based on survey data. Whether the patients were vaccinated or not was checked from the vaccination cards, but the patients’ vaccine-preventable diseases’ viral serology was not examined.
Conclusion

Although the management of CP is not curative, it is a disease in which the quality of life of patients and their relatives can be increased with an appropriate approach. One of the most important approaches to increasing the quality of life is preventing and controlling infections, including vaccination. This study demonstrates that children with CP have a high risk of incomplete and delayed immunization, a significant concern given to their increased healthcare needs and vulnerability to infectious diseases. Consequently, providing information to parents and clinicians following these patients on influenza and other vaccination practices is important, not only for the vaccination of these children but also for their parents. Moreover, the clinician must be aware of immunization status in outpatients and inpatients of children with CP. Investigations can include immunization cards and awareness to none/incomplete vaccination, both including and excluding NIP. Only in this way will it be possible to increase the rates of vaccination in the CP population.

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Authors’ Contributions Sema Bozkaya-Yilmaz wrote the paper. Eda Karadag-Oncel designed and performed the analysis. Nihat Olgac-Dundar organized, supervised the course of progress and taking the responsibility of the research/study. Pinar Gencpınar, Berrak Sarioğlu, Pınar Arican, Atilla Erson, Dilek Yilmaz-Ciftüloğan, Merve Feyza Yusuf, Omer Bektas, Serap Teber, Betül Kilic, Mustafa Calık, Meryem Karaca, Mehmet Campolat, Sefer Kumbanad, Huseyin Per, Hakan Gunus, Selcan Ozturk, Cetin Öksüz, Mustafa Komur, Rojan Ipek, Ebru Arhan, Hülya İnce, Gurkan Gurbuz, Gulen Gul Mert, Neslihan Oxcan, Akgun Olmez Türkler, Hande Gazeteci-Teke, Sevcan Kirik, Ceren Günbey, Kürşat Bora Carman, Coşkun Yarar, and Dilek Çavusoğlu collected the data.

Availability of data and material The lead author (the manuscript’s guarantor) affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Declarations

Ethics approval The study was conducted following the ethical principles stated in the Declaration of Helsinki and approved by the institutional ethics committees (number: 21.02.2018/92).

Consent to participate Approval was obtained from all patients to participate in the study.

Consent for publication Approval was obtained from all patients to publication of the study.

Conflict of interest The authors declare no competing interests.

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