Updated Diagnosis Grouping System for Pediatric Emergency Department Visits

Colleen Fant, MD, MPH,* Jennifer R. Marin, MD, MSc,† Sriram Ramgopal, MD,*
Norma-Jean E. Simon, MPH, MPA,* Rachel Richards, MStat,‡ Cody S. Olsen, MS,‡
Evaline A. Alessandrini, MD,§ Elizabeth R. Alpern, MD,* and For the PECARN Registry Study Group

Objectives: This study aims to update the Diagnosis Grouping System (DGS) for *International Classification of Disease, Tenth Revision* (*ICD-10*) codes for ongoing use. The DGS was developed in 2010 using *ICD-9* codes with 21 major groups and 27 subgroups to facilitate research on pediatric patients presenting to emergency departments and required updated classification for more recent *ICD* codes.

Methods: All emergency department discharges available in the Pediatric Emergency Care Applied Research Network (PECARN) database for 2016 were included to identify *ICD-10* codes. These codes were then mapped onto the DGS codes originally derived from *ICD-9*. We used *ICD-10* codes from the PECARN database from 2017 to 2019 to confirm validity.

Results: The DGS was updated with *ICD-10* codes based on 2016 PECARN data, and this updated DGS was successfully applied to 6,853,479 (97.3%) of all codes from 2017 to 2019.

Discussion: Using *ICD-10* codes from the PECARN Registry, the DGS was updated to reflect *ICD-10* codes to facilitate ongoing research.

Key Words: Diagnosis Grouping System, *ICD-10*, PECARN, pediatric diagnoses

A meaningful classification of pediatric diagnoses seen in emergency departments (EDs) can provide a systematic method to describe, aggregate, and compare trends within and across institutions to facilitate clinical research and quality improvement. For this purpose, the Diagnosis Grouping System (DGS) was created, with 21 clinically relevant major diagnosis groups and 77 subgroups that are largely based on body system or body region involved.[1] The DGS was first developed using *International Classification of Disease, Ninth Revision, Clinical Modification* (*ICD-9*) codes available from more than 750,000 pediatric ED visits in the multicenter Pediatric Emergency Care Applied Research Network (PECARN) Core Data Project administrative database.[2] To date, the DGS has been used in more than 35 articles for data categorization to investigate a variety of clinical topics.[3–6]

The *ICD-10* coding replaced *ICD-9* in the United States in October 2015. This revised system includes combination diagnosis/symptom codes and provides greater specificity in code assignment.[7] As such, there is a need to update the DGS to facilitate its continued use for pediatric research. In this investigation, our objective was to assign *ICD-10* diagnosis codes into the appropriate DGS categories.

METHODS

We used the first generation of the DGS to provide a classification scheme for *ICD-10* codes for pediatric conditions encountered in the ED.[1] The data source used in this investigation to derive the updated DGS (DGS–*ICD-10*) was the PECARN Registry, a multicenter electronic health record data registry from 7 health systems, including 7 academic pediatric hospital EDs and 3 affiliated community pediatric EDs.[8] We extracted all ED visit discharge *ICD-10* codes from the PECARN Registry in 2016 to identify codes for the derivation data set for the DGS–*ICD-10*. Consistent with our prior methodology, *ICD-10* external causes of morbidity codes (*ICD-10* codes starting with V, W, and Y) were excluded.[1]

The *ICD-10* codes identified in the PECARN Registry were mapped to corresponding *ICD-9* codes using the general equivalence mapping published by the Centers for Disease Control and Prevention.[9] General equivalence mappings provide bidirectional translation references, with the goal of identifying all valid relationships between the *ICD-9* and the *ICD-10*. Once codes were mapped to *ICD-9*, the DGS–*ICD-9* was applied to assign diagnosis groupings for *ICD-10* codes. Codes of the *ICD-10* that did not map to a single DGS–*ICD-9* diagnosis group underwent manual review. For these, 2 authors (C.F. and J.R.M.), independently assigned *ICD-10* codes to a DGS major group and subgroup. Codes of the *ICD-10* were assigned to the DGS–*ICD-10* if there was exact agreement by both reviewers. Discrepancies were discussed among 3 authors (C.F., J.R.M., E.R.A.) and arbitrated by the senior author (E.R.A.).

We applied the DGS–*ICD-10* to all visits contained in the PECARN Registry for years 2017 through 2019. After initial application, we identified 18 codes that appeared with greater than 1% of frequency of visits and manually reviewed the codes for inclusion. At that time, we also reviewed 12 codes introduced in

TABLE 1. The DGS–*ICD-10* Distribution of Diagnosis Codes Within the PECARN Registry

Major and Subgroups	PECARN Core Data Project DGS–*ICD-9*	PECARN Registry DGS–*ICD-10*		
	2010, n (%)	2017, n (%)	2018, n (%)	2019, n (%)
Allergic, immunologic, and rheumatologic diseases	9635 (0.9)	47,296 (2.06)	50,555 (2.17)	50,577 (2.10)
Child abuse	4860 (0.4)	9623 (0.42)	9970 (0.43)	11,037 (0.46)
Circulatory and cardiovascular diseases	11,314 (1.0)	31,579 (1.38)	33,041 (1.42)	34,307 (1.42)
a. Congenital circulatory and cardiovascular diseases	2849 (0.3)	8799 (0.38)	8675 (0.37)	9864 (0.41)
b. Devices and complications of the circulatory system	2699 (0.2)	3681 (0.16)	4403 (0.19)	3913 (0.16)
c. Dysrhythmias	1727 (0.2)	5687 (0.25)	6409 (0.27)	6793 (0.28)
d. Other circulatory and cardiovascular diseases	4039 (0.4)	13,412 (0.58)	13,554 (0.58)	13,737 (0.57)
Diseases of the eye	17,941 (1.6)	37,292 (1.62)	37,281 (1.60)	38,648 (1.60)
a. Infectious diseases of the eye	12,402 (1.1)	22,894 (1.00)	22,655 (0.97)	24,107 (1.00)
b. Noninfectious diseases of the eye	5539 (0.5)	14,398 (0.63)	14,626 (0.63)	14,541 (0.60)
ENT, dental, and mouth diseases	184,970 (16.5)	312,227 (13.60)	307,421 (13.17)	321,101 (13.31)
a. Infectious dental disorders	4118 (0.4)	5230 (0.23)	5323 (0.23)	5352 (0.22)
b. Infectious ear disorders	54,828 (4.9)	73,062 (3.18)	70,709 (3.03)	75,044 (3.11)
c. Infectious mouth and throat disorders	35,090 (3.1)	52,763 (2.30)	49,553 (2.12)	51,012 (2.11)
d. Infectious nose and sinus disorders, including URI	65,388 (5.8)	117,103 (5.10)	114,914 (4.92)	118,881 (4.93)
e. Noninfectious ENT, dental, and mouth diseases	25,546 (2.3)	64,069 (2.79)	66,922 (2.87)	70,812 (2.93)
Endocrine, metabolic, and nutritional diseases	11,384 (1.0)	51,412 (2.24)	54,648 (2.34)	58,950 (2.44)
a. Diabetes mellitus	3407 (0.3)	7241 (0.32)	7473 (0.32)	7252 (0.30)
b. Other endocrine, metabolic, and nutritional diseases	7977 (0.7)	44,171 (1.92)	47,175 (2.02)	51,698 (2.14)
Fluid and electrolyte disorders	19,859 (1.8)	29,322 (1.28)	30,989 (1.33)	34,529 (1.43)
a. Dehydration	17,543 (1.6)	21,918 (0.95)	23,066 (0.99)	25,649 (1.06)
b. Other fluid and electrolyte disorders	2316 (0.2)	7404 (0.32)	7923 (0.34)	8880 (0.37)
Gastrointestinal diseases	131,392 (11.8)	284,931 (12.41)	284,027 (12.16)	300,447 (12.45)
a. Abdominal pain	27,968 (2.5)	49,288 (2.15)	52,428 (2.25)	54,738 (2.27)
b. Appendicitis	2330 (0.2)	5379 (0.23)	4908 (0.21)	3402 (0.14)
c. Devices and complications of the gastrointestinal system	3177 (0.3)	15,170 (0.66)	15,618 (0.67)	16,806 (0.70)
d. Gastroenteritis	40,376 (3.6)	70,550 (3.07)	63,974 (2.74)	70,687 (2.93)
e. Infectious gastrointestinal diseases	846 (0.1)	2179 (0.09)	2095 (0.09)	1856 (0.08)
f. Vomiting	24,011 (2.1)	52,836 (2.30)	54,908 (2.35)	61,160 (2.53)
g. Other gastrointestinal diseases	32,684 (2.9)	89,529 (3.90)	90,096 (3.86)	91,798 (3.80)
Genital and reproductive diseases	14,164 (1.3)	25,653 (1.12)	27,407 (1.17)	26,067 (1.08)
a. Infectious genital and reproductive diseases	5066 (0.5)	9625 (0.42)	9741 (0.42)	9885 (0.41)
b. Other genital and reproductive diseases	6527 (0.6)	11,154 (0.49)	11,305 (0.48)	11,758 (0.49)
c. Pregnancy	2571 (0.2)	4874 (0.21)	6361 (0.27)	4424 (0.18)
Hematologic	12,470 (1.1)	26,963 (1.17)	28,109 (1.20)	30,291 (1.26)
a. Sickle cell anemia	5411 (0.5)	8353 (0.36)	7959 (0.34)	8984 (0.37)
b. Other hematologic diseases	7059 (0.6)	18,610 (0.81)	20,150 (0.86)	21,307 (0.88)
Musculoskeletal and connective tissue diseases	31,178 (2.8)	66,009 (2.88)	68,239 (2.92)	69,704 (2.89)
a. Chest pain	7293 (0.7)	15,446 (0.67)	16,117 (0.69)	16,315 (0.68)
b. Devices and complications of the musculoskeletal system	256 (0.0)	427 (0.02)	456 (0.02)	458 (0.02)
c. Infectious musculoskeletal and connective tissue diseases	388 (0.0)	704 (0.03)	774 (0.03)	821 (0.03)
d. Musculoskeletal pain	15,571 (1.4)	33,505 (1.46)	34,314 (1.47)	35,801 (1.48)
e. Noninfectious musculoskeletal and connective tissue diseases	7670 (0.7)	15,927 (0.69)	16,578 (0.71)	16,309 (0.68)
Neoplastic diseases (cancer, not benign neoplasm)	2796 (0.3)	7712 (0.34)	7859 (0.34)	8371 (0.35)
Neurologic diseases	47,546 (4.3)	110,220 (4.80)	116,153 (4.97)	121,381 (5.03)
a. Developmental disorders	4858 (0.4)	16,762 (0.73)	18,082 (0.77)	20,866 (0.86)
b. Devices and complications of the nervous system	2855 (0.3)	4019 (0.18)	4165 (0.18)	4166 (0.17)
c. Headache	11,769 (1.1)	31,570 (1.38)	31,642 (1.36)	32,661 (1.35)
d. Infectious neurologic diseases	1173 (0.1)	1137 (0.05)	1158 (0.05)	1088 (0.05)

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TABLE 1. *(Continued)*

Major and Subgroups	PECARN Core Data Project DGS–*ICD-9*	PECARN Registry DGS–*ICD-10*		
	2010, n (%)	2017, n (%)	2018, n (%)	2019, n (%)
e. Seizures	14,708 (1.3)	24,849 (1.08)	25,814 (1.11)	26,244 (1.09)
f. Other neurologic disease	12,183 (1.1)	31,883 (1.39)	35,292 (1.51)	36,356 (1.51)
Psychiatric and behavioral diseases and substance abuse	29,863 (2.7)	100,618 (4.38)	106,687 (4.57)	107,418 (4.45)
Respiratory diseases	136,983 (12.3)	266,093 (11.59)	279,155 (11.96)	304,711 (12.63)
a. Asthma	54,454 (4.9)	74,561 (3.25)	70,825 (3.03)	65,642 (2.72)
b. Bronchospasm and wheezing	7019 (0.6)	9560 (0.42)	10,829 (0.46)	11,176 (0.46)
c. Devices and complications of the respiratory system	654 (0.1)	3806 (0.17)	4228 (0.18)	3993 (0.17)
d. Infectious respiratory diseases	36,964 (3.3)	83,959 (3.66)	88,750 (3.80)	107,299 (4.45)
e. Other respiratory diseases	37,892 (3.4)	94,207 (4.10)	104,523 (4.48)	116,601 (4.83)
Skin, dermatologic, and soft tissue diseases	55,854 (5.0)	120,656 (5.26)	118,231 (5.06)	114,921 (4.76)
a. Infectious skin, dermatologic, and soft tissue diseases	19,815 (1.8)	42,809 (1.86)	41,861 (1.79)	40,739 (1.69)
b. Noninfectious skin, dermatologic, and soft tissue diseases	36,039 (3.2)	77,847 (3.39)	76,370 (3.27)	74,182 (3.07)
Systemic states	135,482 (12.1)	262,827 (11.45)	272,412 (11.67)	270,450 (11.21)
a. Acute systemic states	21,411 (1.9)	30,874 (1.34)	37,553 (1.61)	37,770 (1.57)
b. Bacterial and fungal illnesses	4726 (0.4)	6169 (0.27)	5434 (0.23)	5578 (0.23)
c. Chronic systemic states	2289 (0.2)	9066 (0.39)	9373 (0.40)	10,101 (0.42)
d. Fever	55,175 (4.9)	74,714 (3.25)	77,606 (3.32)	79,894 (3.31)
e. Viral illnesses	51,881 (4.6)	142,004 (6.19)	142,446 (6.10)	137,107 (5.68)
Toxicologic emergencies	7501 (0.7)	24,163 (1.05)	24,275 (1.04)	22,069 (0.91)
Trauma	195,908 (17.5)	265,437 (11.56)	248,884 (10.66)	257,040 (10.65)
a. Abdominal trauma	755 (0.1)	826 (0.04)	771 (0.03)	856 (0.04)
b. Brain and skull trauma	17,602 (1.6)	29,081 (1.27)	28,345 (1.21)	30,287 (1.26)
c. Burns (external, of any body part)	6523 (0.6)	8244 (0.36)	7787 (0.33)	8469 (0.35)
d. Chest trauma	2391 (0.2)	3183 (0.14)	3104 (0.13)	3412 (0.14)
e. Complications of trauma	429 (0.0)	871 (0.04)	833 (0.04)	596 (0.02)
f. Contusions and abrasions (external, of any body part	40,375 (3.6)	51,709 (2.25)	48,492 (2.08)	46,771 (1.94)
g. Face, dental, mouth, and eye trauma	9998 (0.9)	8395 (0.37)	7940 (0.34)	8128 (0.34)
h. Fractures and dislocations (extremities)	26,808 (2.4)	53,855 (2.35)	50,229 (2.15)	54,589 (2.26)
i. Lacerations, amputations, and uninfected foreign bodies (external)	51,576 (4.6)	53,242 (2.32)	50,402 (2.16)	51,610 (2.14)
j. Other extremity trauma	8389 (0.8)	15,931 (0.69)	15,847 (0.68)	16,681 (0.69)
k. Other trauma	12,167 (1.1)	17,633 (0.77)	15,207 (0.65)	14,936 (0.62)
l. Pelvis and external genitalia trauma	1038 (0.1)	1176 (0.05)	1194 (0.05)	1233 (0.05)
m. Spinal trauma (including spinal cord and vertebrae trauma)	403 (0.0)	955 (0.04)	884 (0.04)	1185 (0.05)
n. Strains and sprains (extremities)	17,454 (1.6)	20,336 (0.89)	17,849 (0.76)	18,287 (0.76)
Urinary tract diseases	17,402 (1.6)	42,829 (1.87)	44,161 (1.89)	43,446 (1.80)
a. Devices and complications of the urinary system	294 (0.0)	914 (0.04)	908 (0.04)	897 (0.04)
b. Infectious urinary tract diseases	8989 (0.8)	16,712 (0.73)	17,519 (0.75)	16,359 (0.68)
c. Other noninfectious urinary tract diseases	8119 (0.7)	25,203 (1.10)	25,734 (1.10)	26,190 (1.09)
Other	26,614 (2.4)	111,733 (4.87)	121,646 (5.21)	122,230 (5.07)
a. Screening examinations, laboratories, and administrative issues	12,545 (1.1)	43,686 (1.90)	52,393 (2.24)	55,171 (2.29)
b. Other devices and complications	3230 (0.3)	9163 (0.40)	9392 (0.40)	9434 (0.39)
c. Other infectious diseases	4824 (0.4)	12,491 (0.54)	11,960 (0.51)	10,835 (0.45)
d. Other neonatal disorders	3287 (0.3)	13,092 (0.57)	13,036 (0.56)	13,456 (0.56)
e. Other noninfectious diseases	2728 (0.2)	33,301 (1.45)	34,865 (1.49)	33,334 (1.38)
Not categorized	13,189 (1.2)	60,898 (2.65)	63,759 (2.73)	65,275 (2.71)

2019 and 2020 for emerging pediatric disease including COVID-19, vaping, and zika, given their utility for pediatric research. We calculated the proportion of encounters grouped in the major groups and subgroups for each year and present these data with the DGS–*ICD-9* groupings conducted in 2010.[1] Analyses were performed using SAS (software version 9.4; SAS Institute, Cary, NC).

RESULTS

Using the 2016 PECARN Registry data, 19,229 *ICD-10* codes were identified and used to derive the DGS–*ICD-10*. Of these, 15,066 had a single *ICD-9* equivalent. Of the remainder (4163 codes), 2654 mapped to more than 1 DGS *ICD-9* diagnosis group, and 1509 codes were mapped to *ICD-9* codes not previously categorized or did not map to any *ICD-9* code. In constructing the DGS–*ICD-10*, approximately 20% required manual review and 4% required arbitration.

We applied the DGS–*ICD-10* to 2017–2019 data from PECARN Registry. Upon application, 23,554 *ICD-10* unique codes were identified for visits in the database, of which 1757 were excluded as external causes of morbidity codes and 5776 were excluded as not valid *ICD* codes. Of the remaining 16,021 codes, 10,909 (68.1%) unique *ICD-10* codes in the database were categorized. After excluding invalid codes and external causes of morbidity codes, there were a total of 7,043,411 *ICD-10* codes in the 2017–2019 PECARN Registry database assigned to 2,042,551 visits. Of those *ICD-10* codes, 6,853,479 (97.3%) were categorized with the DGS–*ICD-10*. Use of the DGS–*ICD-10* allowed for categorization of at least 1 diagnosis code for 98.2% of visits overall in the study period, improving for each calendar year (97.5% in 2017, 98.0% in 2018, and 99.2% in 2019). Table 1 demonstrates the distribution of diagnosis codes in DGS–*ICD-10* compared with the original DGS–*ICD-9*.[1] There were some observed differences in disease category frequency from the DGS–*ICD-9*. For example, allergic, immunologic, rheumatologic, and developmental disorders were approximately twice as frequent in the DGS–*ICD-10* as compared with the DGS–*ICD-9*. Visits with mental health–related codes were also seen with increasing frequency. In addition, the broader category of other noninfectious disease and diagnoses not categorized were more frequently applied in the updated DGS.

The updated DGS–*ICD-10* classification system is provided as a supplementary Microsoft Excel and a comma-separated file to facilitate independent use (Supplementary Files 1 and 2, http://links.lww.com/PEC/A964) and can be found at www.PECARN.org.

DISCUSSION

The DGS–*ICD-9* was published in 2010 as a clinically sensible, parsimonious, and comprehensive grouping system to allow for the meaningful use of pediatric ED *ICD-9* data. Our work provides an updated DGS for *ICD-10* to advance the continued investigation of clinically relevant disease groupings with the goal of facilitating research, quality improvement, and systems improvement.

Applying the newly derived DGS–*ICD-10* to a multicenter electronic health record pediatric ED database, we observed similar distribution with some key differences of the visits within the major and minor groupings of the DGS–*ICD-10* compared with a DGS–*ICD-9* applied to a different multicenter administrative database of pediatric ED visits. Interestingly, we identified an increase in the psychiatric and behavioral diseases and substance abuse group, which is consistent with current trends in pediatric EDs.[10]

Our study has limitations. Because our work was based on the DGS–*ICD-9*, miscoding from the original grouping system may be potentially perpetuated. We relied on the general equivalence mappings crosswalk for linking *ICD-10* to ICD9 codes, and there may be limitations to this practice that could have impacted the assignments.[11] Although we assigned COVID *ICD-10* codes introduced in 2020 for severe acute respiratory syndrome coronavirus diagnoses, *ICD-10* codes continue to be introduced and would not be included in this iteration of the DGS. Of note, the current format does allow for updating with identification of new codes. We applied the DGS–*ICD-10* to a multicenter database that included both academic and community pediatric EDs and were able to categorize more than 97% of valid codes and 98% of visits, with steady improvement in identification over the study years. However, further work including validation of this new DGS–*ICD-10* is required, using other databases inclusive and other sites of care. We did not perform statistical comparison of the diagnosis groups over the included years, as expected changes over time are likely multifactorial and outside the scope of this manuscript. Use of the DGS–*ICD-10* may facilitate further investigations to better understand changes in disease frequency over time.

We present an updated DGS–*ICD-10* to reflect changes in documentation required by the transition *ICD-10*. This system is intended to provide a comprehensive and clinically relevant grouping system to conduct ongoing research and quality and systems improvement in pediatric ED care.

REFERENCES

1. Alessandrini EA, Alpern ER, Chamberlain JM, et al. A new diagnosis grouping system for child emergency department visits. *Acad Emerg Med*. 2010;17:204–213.

2. Alpern ER, Stanley RM, Gorelick MH, et al. Epidemiology of a pediatric emergency medicine research network: the PECARN Core Data Project. *Pediatr Emerg Care*. 2006;22:689–699.

3. Goyal NK, Fiks AG, Lorch SA. Association of late-preterm birth with asthma in young children: practice-based study. *Pediatrics*. 2011;128: e830–e838.

4. Ray KN, Shi Z, Ganguli I, et al. Trends in pediatric primary care visits among commercially insured US children, 2008–2016. *JAMA Pediatr*. 2020;174:350–357.

5. Lee HC, Bardach NS, Maselli JH, et al. Emergency department visits in the neonatal period in the United States. *Pediatr Emerg Care*. 2014;30: 315–318.

6. Lee JH, Kwon H. Development and validation of the Korean Pediatric Emergency Care Applied Research Network Diagnosis Grouping

System. *Ann Emerg Med*. 2013;62. Supplement. doi:10.1902/jop.1984.55.5.306.

7. International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). National Center for Health Statistics. Available at: https://www.cdc.gov/nchs/icd/icd-10-cm.htm. Published 2020. Accessed June 10, 2020.

8. Deakyne Davies SJ, Grundmeier RW, Campos DA, et al. The Pediatric Emergency Care Applied Research Network Registry: a multicenter electronic health record registry of pediatric emergency care. *Appl Clin Inform*. 2018;9:366–376.

9. 2015 ICD-10-CM and GEMs. Centers for Medicare and Medicaid Services. Available at: https://www.cms.gov/Medicare/Coding/ICD10/2015-ICD-10-CM-and-GEMs. Published 2014. Accessed June 10, 2020.

10. Cutler GJ, Rodean J, Zima BT, et al. Trends in pediatric emergency department visits for mental health conditions and disposition by presence of a psychiatric unit. *Acad Pediatr*. 2019;19:948–955.

11. Tian Y, Ingram ME, Raval MV. A pitfall of using general equivalence mappings to estimate national trends of surgical utilization for pediatric patients. *J Pediatr Surg*. 2020;55:2602–2607.