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Brief Report

The complexity and challenges of the *International Classification of Diseases, Ninth Revision, Clinical Modification* to *International Classification of Diseases, 10th Revision, Clinical Modification* transition in EDs☆,☆☆,★

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ABSTRACT

Beginning October 2015, the Center for Medicare and Medicaid Services will require medical providers to use the vastly expanded *International Classification of Diseases, 10th Revision, Clinical Modification* (*ICD-10-CM*) system. Despite wide availability of information and mapping tools for the next generation of the *ICD* classification system, some of the challenges associated with transition from *ICD-9-CM* to *ICD-10-CM* are not well understood. To quantify the challenges faced by emergency physicians, we analyzed a subset of a 2010 Illinois Medicaid database of emergency department *ICD-9-CM* codes, seeking to determine the accuracy of existing mapping tools in order to better prepare emergency physicians for the change to the expanded *ICD-10-CM* system. We found that 27% of 1830 codes represented convoluted multidirectional mappings. We then analyzed the convoluted transitions and found that 8% of total visit encounters (23% of the convoluted transitions) were clinically incorrect. The ambiguity and inaccuracy of these mappings may impact the workflow associated with the translation process and affect the potential mapping between *ICD* codes and *Current Procedural Codes*, which determine physician reimbursement.

1. Introduction

In October 2015, the Center for Medicare and Medicaid Services (CMS) will require a transition from version 9 (*ICD-9-CM*) to version 10 (*ICD-10-CM*) of *International Classification of Diseases, Clinical Modification* administrative codes. The forthcoming national switch to the new *ICD-10-CM* administrative codes may require substantial changes to coding operations, information technology support, and workflow processes. *ICD-10-CM*'s overall term content is 7 times larger than *ICD-9-CM*: 3.2 times larger in those chapters describing disease or symptoms and 14.1 times larger under the injury and cause sections [1]. Under *ICD-10-CM* code definitions, more granular problem or diagnosis descriptions will provide greater detail in such areas as laterality, acuteness, and related comorbidites [2].

Hospitals and emergency departments (EDs) rely on correct classification of diagnoses for proper hospital reimbursement, clinical documentation, case-mix acuity indices, medical necessity for procedures, services and admissions, and reporting of disease to public health departments. However, although CMS provides forward and backward mappings between *ICD-9-CM* and *ICD-10-CM* classifications, many codes share complex reciprocal relationships that may lead to confusion and incorrect coding [3]. This issue has potential to be exacerbated by the fact that a significant percentage of the billed codes are highly complex, pointing to the problem of *ICD-10-CM* conversion complexity and the increased number of clinically incorrect codes used under the *ICD-10-CM* classification. Furthermore, given this increased complexity, physician groups attempting to perform coding internally (rather than relying on outsourcing agencies) may encounter challenges in adoption that will require dramatic changes to current procedures and operations. The objective of this study is to reveal actual emergency diagnostic code complexities using a set of Medicaid data from the state of Illinois and link these complexities to visit encounters.

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2. Background and literature review

Formatting differences between *ICD-9-CM* and *ICD-10-CM* nomenclatures exist. For example, there are field size expansions to support greater details, jumping from 3 to 5 digits under the *ICD-9-CM* system to 3 to 7 digits under *ICD-10-CM*. If a digit or alpha character is missing, it requires placement of a dummy "x" to signify missing character [4]. Although the first digit in the *ICD-9-CM* format can be alpha or numeric, it is always alpha under *ICD-10-CM*, the second character is numeric, and the remaining 5 can be either alpha or numeric [5]. Under both *ICD-9-CM* and *ICD-10-CM* nomenclatures, a decimal is placed after the first 3 characters. All *ICD-10-CM* codes require longer descriptions because of more extensive specificity. *ICD-9-CM* contains approximately 14 000 diagnostic codes, compared with 68 000 diagnostic codes under *ICD-10-CM*.

The Center for Medicare and Medicaid Services and the Centers for Disease Control and Prevention created the General Equivalence Mappings (GEMs) in order to ensure data consistency at the national level during *ICD-9-CM* to *ICD-10-CM* transition [6]. The GEMs are not substitutes for either of the coding systems, but instead can be used to look up and organize the differences by linking a code to all valid alternatives in the other coding system. Although *ICD-10-CM*/Procedure Coding System transition is forecasted to be costly and represent logistical and business challenges in the health care field, its benefits are significant and include improved quality of care, cost savings from increased accuracy of payments and reduction of unpaid bills, and improved tracking of health care data as related to public health. These benefits are balanced by such challenges as planning and implementation, price of entry, shortage of qualified/trained coders, need and expense for further training of the workforce, and loss of productivity leading to escalated cost during transition [7].

Despite the total estimated *ICD-10-CM* conversion project's cost of $1.64 trillion, the Department of Health and Human Services estimates this cost to be quantitatively matched by societal benefits by 2018 [8]. The high cost will affect every provider, from physician practices that will need to spend between $25 000 and $50 000 per physician, to hospitals and integrated delivery networks that will be looking into millions of dollars in project spending to map *ICD-9* codes, some of which could result complex *ICD-10-CM* mappings [9].

3. Methods

General Equivalence Mapping files supplied by CMS provide distinct forward and backward directional mapping tables from *ICD-9-CM* to *ICD-10-CM* because these mappings are not necessarily reciprocal [5]. Because of the more detailed nature of the *ICD-10-CM* codes, any *ICD-9-CM* code could map to several *ICD-10-CM* ones. At the same time, each *ICD-10-CM* code could have backward mapping relationships to other *ICD-9-CM* codes, so forward and backward ICD version mappings are 2 unique structures. From these CMS mapping tables, we created a bipartite network consisting of 2 types of nodes, *ICD-9-CM* and *ICD-10-CM* diagnosis codes, and their directed relationships [3]. Both GEM files are required as a combination because each GEM set represents a unidirectional mapping with incomplete coverage, where the combination provides the largest coverage of *ICD-9-CM* and *ICD-10-CM* diagnosis codes. Analysis of the bidirectional mapping structure led to identification of 2 major classes of *ICD-9-CM* codes: convoluted (codes containing complex relationships between versions 9 and 10, with nonreciprocal mappings and entangled definitions) and simple (one-to-one, one-to-many, and many-to-one relationships) [3]. Complete methodology of the database operations, category creation, simplification, and data analysis technique for *ICD* codes can be found in Boyd et al [3]. This methodology outlines theoretical basis for outlining and classifying complexities associated with *ICD-10-CM* transition, with preliminary results in emergency medicine. This article expands upon those results in emergency medicine as well perform the first thorough analysis of the quality of the GEMs mapping relevant to emergency medicine.

The simple vs convoluted *ICD-9-CM* to *ICD-10-CM* translation is a complexity categorization methodology that was applied to the data set representing 1830 ED diagnosis codes (24 008 visits for a total of $31 million in reimbursement) collected from a subset of Illinois Medicaid in 2010. Classification of all visits or encounters by mapping complexity was performed [3].

A subset of 622 codes with high visit count from the initial review of all codes labeled as convoluted underwent additional analysis. Using the Delphi method, 2 emergency physicians analyzed this subset of the transition mapping for clinical correctness. Although most of the time there was agreement about the mappings, when disagreements did arise, a discussion ensued where both ED physicians explained their thought process and a consensus opinion arose. Visit frequency and delivery classifications were also noted for clinical correctness for each code. Example of a clinically incorrect code is shown in Fig. 1.

4. Results

The overall complexity and risks of the transition for EDs are illustrated in Fig. 2 by breakdown of codes from the 2010 Illinois Medicaid charges, indicating mapping classification, clinical correctness of the mappings,

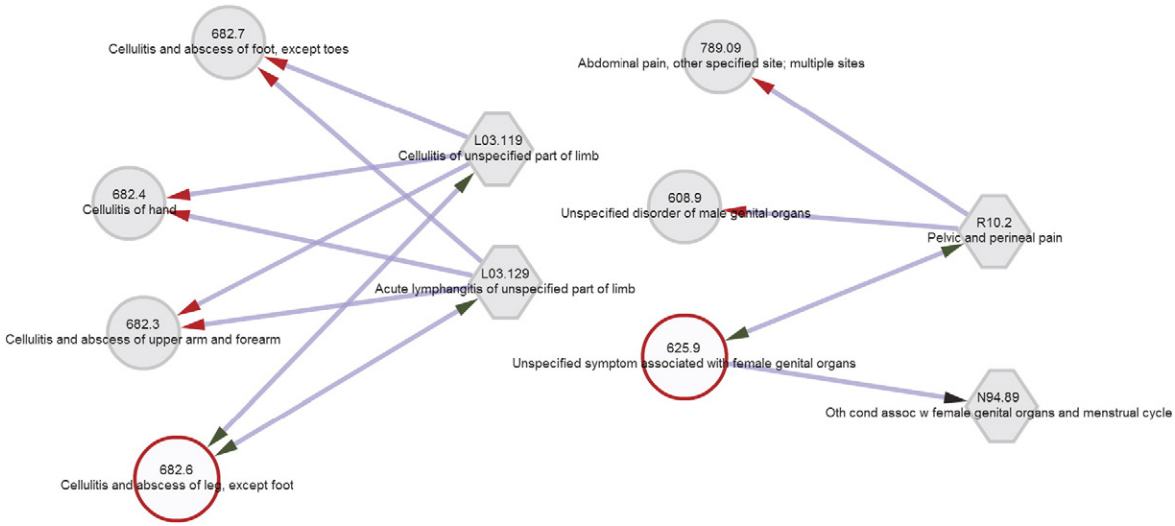

Fig. 1. Example of the clinically incorrect Illinois Medicaid *ICD-9-CM* diagnosis codes. Two clinically incorrect *ICD-9-CM* to *ICD-10-CM* code mappings, as determined by ED physicians, for the *ICD-9-CM* 682.6 (cellulitis and abscess of leg, except foot) and 625.9 (unspecified symptom associated with female genital organs) diagnosis codes.

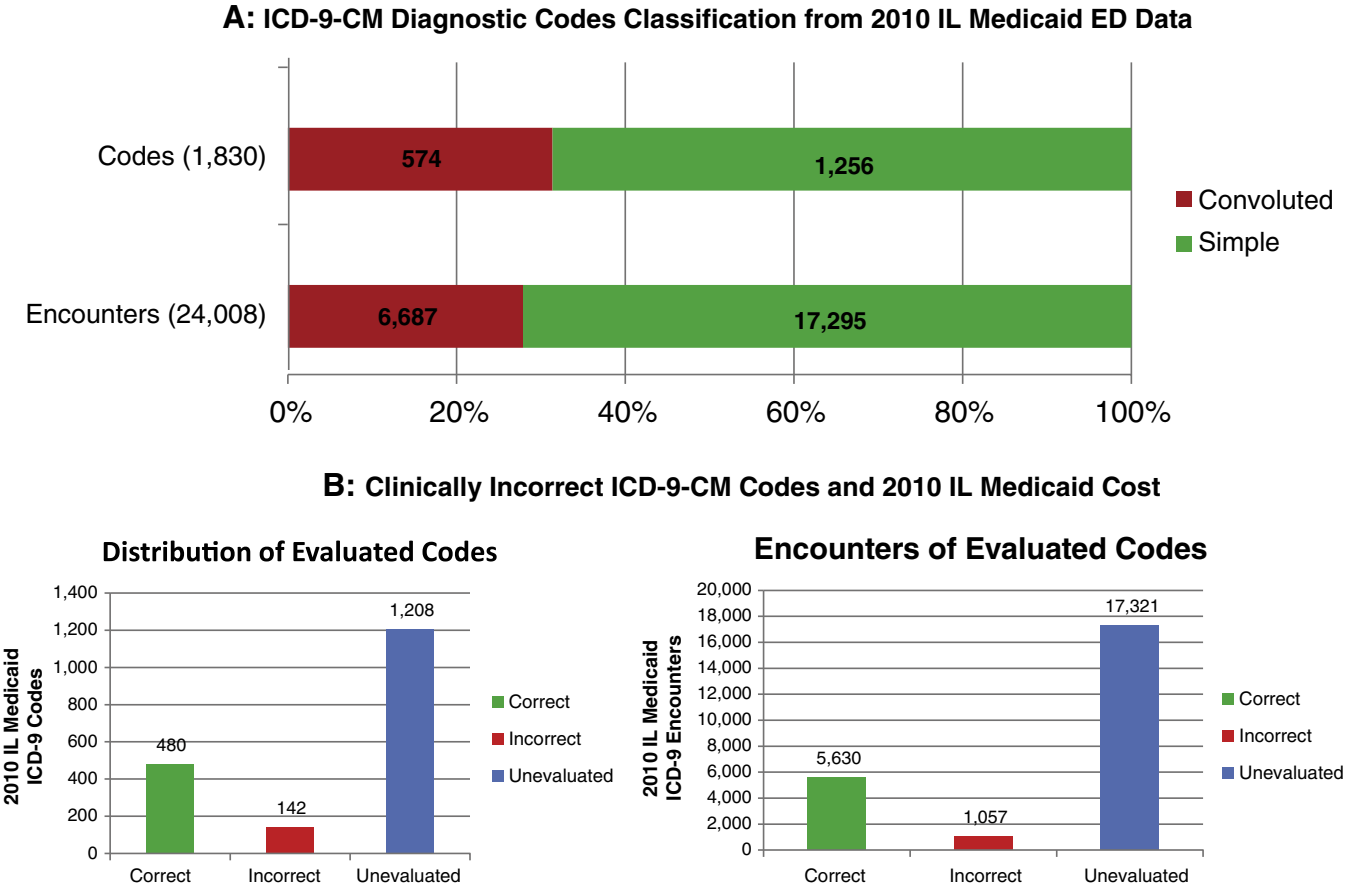

Fig. 2. 2010 Illinois Medicaid emergency codes classification by complexity, clinical correctness, and encounters. A, The proportion of convoluted vs simple *ICD-9-CM* to *ICD-10-CM* code mappings within the 2010 Illinois Medicaid data set, along with corresponding encounters. Convoluted mappings represent a significant percentage of the total, leading to operational complexities and higher costs of conversion. B, Distribution of code mappings by clinical correctness within the same Medicaid data set, along with corresponding encounters associated with these codes.

and representative number of encounters for each of the code mapping categories. A total of 574 (27%) of 1830 diagnosis codes, representing 6687 (28%) of the encounters, were classified as convoluted (Fig. 2A).

In the second analysis, 142 (23%) of the 622 diagnosis code mappings evaluated for clinical correctness were found to be clinically incorrect. These 142 clinically incorrect mappings represent 8% of the total 1830 Illinois Medicaid emergency diagnostic codes. One hundred forty-two clinically incorrect mappings (Fig. 2B) represented 1057 (4.4% vs total) ED visits. A subset of clinically incorrect codes with the highest associated number of visits is listed in Table. A full set of clinically incorrect codes with associated number of visits is listed in Appendix.

Twenty-four (4%) of the 622 codes, representing 59 (5.6%) ED visits, selected for analysis were related to deliveries (Appendix, Table A2). Eighteen (75%) of these delivery code mappings were clinically incorrect. These clinically incorrect delivery code mappings represented 51 ED visits (86% of all mappings with deliveries). Delivery codes were selected for additional analysis because of significant change in structure of OB/GYN codes documenting care during second and third trimesters, potentially requiring significant guidance for professional coders.

5. Discussion

More than one-quarter (27%) of a subset of ED *ICD-9-CM* codes billed to Illinois Medicaid were convoluted, whereas 8% of total (23% of the convoluted transitions) were found to be clinically incorrect. The findings are significant because they point to potentially higher complexity and impact of the conversion that could affect clinical workflow and financial health of the hospitals and carry negative clinical research implications. Moreover, most codes that represented deliveries were deliveries that have changed. Because of significant changes in the diagnostic codes for OB/GYN in ICD version 10, there is potential for clinically incorrect mappings to translate into significant cost challenges for EDs that have not grasped the extent of these changes and did not take appropriate steps to review and mitigate business risks.

Chute et al [10] recommended postponing the initial deadline of October 2013 for the *ICD-10-CM* implementation because of complexity of issues, a wide array of technical complexity, level and quantity of resources necessary to pull off a major migration/conversion project, and the overall organizational impact and cost. Health care organizations are currently in the race to complete conversion by the second delayed deadline of October 2015. Emergency departments are not alone in facing *ICD-10-CM* transition challenges. Prior studies indicated a significant percentage of convoluted code mappings and information loss due to clinically incorrect mappings in evaluation of hematology-oncology [11] and pediatrics [12] patient accounting data. Because *ICD* codes are used for adverse effects reporting by hospitals, Patient Safety Indicators compiled by the Agency for Healthcare Research and Quality might suffer from similar challenges [13]. The ED convolution of 27% is similar to the pediatrics convolution of 26% [12] but higher than the hematology-oncology [11] of 18% convoluted.

A typical *ICD-10-CM* conversion project would involve traditional project management elements of initiation, planning, execution, monitoring, and closing; the detail level and involvement would make this project stand out among the rest. Project team must be represented by

Table
A subset of clinically incorrect convoluted *ICD-9-CM* to *ICD-10-CM* mappings, by ED visit encounters

ICD-9-CM code	Description	No. of visits
616.10	Vaginitis not otherwise specified (NOS)	124
682.6	Cellulitis and abscess of leg, except foot	102
682.3	Cellulitis and abscess of upper arm and forearm	66
057.9	Viral exanthemata NOS	59
918.1	Superficial injury of cornea	57
625.9	Unspecified symptom associated with female genital organs	44
919.4	Insect bite, nonvenomous, of other, multiple, and unspecified sites, without mention of infection	33
493.22	Chronic obstructive asthma, with acute exacerbation	29
295.34	Paranoid type schizophrenia, chronic state with acute exacerbation	26
873.64	Open wound of tongue and floor of mouth, uncomplicated	21
590.10	Acute pyelonephritis without lesion of renal medullary necrosis	19
959.3	Other and unspecified injury to elbow, forearm, and wrist	18
959.4	Other and unspecified injury to hand, except finger	17
379.93	Redness or discharge of eye	17
998.11	Hemorrhage complicating a procedure	15
825.25	Fracture of metatarsal bone(s), closed	15
959.5	Other and unspecified injury to finger	14
873.40	Open wound of face, unspecified site, uncomplicated	13
511.0	Pleurisy without mention of effusion or current tuberculosis	13
682.7	Cellulitis and abscess of foot, except toes	13
681.11	Onychia and paronychia of toe	12
682.4	Cellulitis of hand	11
648.73	Bone and joint disorders of back, pelvis, and lower limbs of mother, antepartum	10
998.83	Nonhealing surgical wound	10
681.02	Onychia and paronychia of finger	10
–	117 more codes	289

executives from nearly every clinical and nonclinical unit of a hospital organization, requires local and global sponsorship at various levels, and should involve all associates, use various training methods including train-the-trainer, assume multiple oversight and evaluation methods, and have numerous control mechanisms in place [14]. All of these steps, processes, and methods are costly and impact productivity by diverting people away from their day-to-day responsibilities.

Independent physician groups staffing EDs and performing their own billing will face even greater challenges because of the fewer resources typically available in these smaller organizations. Many of such organizations still perform their own coding and may be overwhelmed by the sheer amount of analysis and challenges posed by *ICD-10-CM*, from software upgrades to dealing with vastly expanded number of codes. One of the largest code increases happens to be in the musculoskeletal area, particularly among fractures. Besides primary location of the injury, version 10 will also require laterality along with the fracture type in addition to physical location. For example, the *ICD-9-CM* convoluted code 813.42 titled "other closed fractures of distal end of radius (alone)" will map to 44 potential *ICD-10-CM* codes in a multidirectional manner, that is, identity mapping, *ICD-9-CM* to *ICD-10-CM* only, and *ICD-10-CM* back to *ICD-9-CM* only. The *ICD-10-CM* coding software may or may not cover the entire array of these complexities, but regardless of the coverage, challenges in identifying correct sets of codes to generate accurate documentation will require additional time, training, and, potentially, emergency physicians participation in the process.

In contrast to codes under musculoskeletal system that introduce high mapping complexity, such *ICD-9-CM* codes as the convoluted 789.09 "abdominal pain, other unspecified site; multiple sites," resulting into 7 *ICD-10-CM* mappings, will continue to present documentation challenges with lack of specificity for a frequently reported chief complaint. These codes do not reveal detail such as sex information that is contained under *ICD-9-CM* codes 625.9 "unspecified symptom associated with female genital organs" and 608.9 "unspecified disorder of male genital organs," and include pelvic pain among other patient complaints. However, both *ICD-9-CM* codes 625.9 and 608.9 are classified as convoluted mappings and link to several *ICD-10-CM* codes.

Uniqueness of the *ICD-10* migration project relative to most of the other health care initiatives is its global nature with many dependencies on hand: it involves collaboration of nearly every area of a hospital and affects almost all clinical, business, and technology teams. A more typical hospital project involves select few teams and impacts one of a few clinical or administrative areas. Emergency departments face additional challenges associated with the nature of ED physicians' work that involves multiple and varying shifts, increasing scheduling complexity, potential use of a different Electronic Health Records application relative to rest of the hospital, and a separate patient registration system structured differently and interfacing with other registration and billing systems used in the organization. These differences put EDs in a position of facing unique *ICD-10-CM* conversion project complexities associated with operational and technological factors typical of ED environments. Prior work demonstrated that the incorrect mappings were located in the convoluted *ICD-9-CM* to *ICD-10-CM* mapping areas [3]. Therefore, any significant percentage of convoluted mappings demonstrated by this analysis of the past Medicaid charges has potential for posing administrative issues of serious concern for EDs. Complexity of EDs' work, technologies supporting the departments, and varieties seen in physician workflows will be exacerbated by the increased coding complexities requiring more of physician participation in the documentation process. One way to help address this complexity concern is additional investment into staff and physician training programs based on recognizing the unique challenges faced by emergency physician groups. Such investment represents the added cost of the *ICD-10-CM* transition.

Limitations of the study include (1) applying *ICD-10-CM* mapping classification and clinical correctness methodologies to a data subset that was limited to the 2010 Illinois Medicaid charges; (2) the unique nature of ED physician work that led to selection of only a subset vs the entire data set of the Medicaid charges, driven by limited resources available for this research project; and (3) lack of analysis of reimbursement due to the complex nature of *Current Procedural Codes* and *ICD-9* volume 3 codes that would affect the overall collected amount for each encounter.

6. Conclusion

ICD-9-CM to *ICD-10-CM* transition is not straightforward and contains hidden mapping and planning challenges that may have not been accounted for even at this late stage of the sprint toward *ICD-10-CM* implementation. These challenges, if not addressed, may carry significant cost and workflow issues that will be shared by providers and payers alike. The research team at University of Illinois at Chicago [15] developed a free tool that empowers users to receive a graphical or tabular report on the *ICD-9-CM* to *ICD-10-CM* code mappings, along with their respective classifications, as described in this study. The tool is available at http://www.lussierlab.org/transition-to-ICD10CM.

Contributions

JK compiled materials, analyzed data, and prepared the manuscript. MP analyzed data and completed initial data analysis phases. LG and MM provided emergency medicine expertise in analyzing code mappings for clinical correctness. EK provided medical expertise in the manuscript review process. JL created the code mapping database and helped analyze data. YL and ADB are senior authors who guided this research.

Appendix

Table A1
Full listing of clinically incorrect convoluted *ICD-9-CM* to *ICD-10-CM* mappings, by ED visit encounters

ICD-9-CM code	Description	Visits
616.10	Vaginitis not otherwise specified (NOS)	124
682.6	Cellulitis and abscess of leg, except foot	102
682.3	Cellulitis and abscess of upper arm and forearm	66
57.9	Viral exanthemata NOS	59
918.1	Superficial injury of cornea	57
625.9	Unspecified symptom associated with female genital organs	44
919.4	Insect bite, nonvenomous, of other, multiple, and unspecified sites, without mention of infection	33
493.22	Chronic obstructive asthma, with acute exacerbation	29
295.34	Paranoid type schizophrenia, chronic state with acute exacerbation	26
873.64	Open wound of tongue and floor of mouth, uncomplicated	21
590.10	Acute pyelonephritis without lesion of renal medullary necrosis	19
959.3	Other and unspecified injury to elbow, forearm, and wrist	18
959.4	Other and unspecified injury to hand, except finger	17
379.93	Redness or discharge of eye	17
998.11	Hemorrhage complicating a procedure	15
825.25	Fracture of metatarsal bone(s), closed	15
959.5	Other and unspecified injury to finger	14
511	Pleurisy without mention of effusion or current tuberculosis	13
682.7	Cellulitis and abscess of foot, except toes	13
873.4	Open wound of face, unspecified site, uncomplicated	13
681.11	Onychia and paronychia of toe	12
682.4	Cellulitis of hand	11
681.02	Onychia and paronychia of finger	10
998.83	Nonhealing surgical wound	10
648.73	Bone and joint disorders of back, pelvis, and lower limbs of mother, antepartum	10
379.92	Swelling or mass of eye	9
250.12	Type II diabetes mellitus [non–insulin-dependent type] [NIDDM type] [adult-onset type] or unspecified type, uncontrolled, with ketoacidosis	8
250.10	Type II diabetes mellitus [non–insulin-dependent type] [NIDDM type] [adult-onset type] or unspecified type, not stated as uncontrolled, with ketoacidosis	7
977.9	Poisoning by unspecified drug or medicinal substance	7
996.73	Other complications due to renal dialysis device, implant, and graft	7
250.62	Diabetes mellitus type II [non–insulin-dependent type] [NIDDM type] [adult-onset type] or unspecified type, uncontrolled, with neurological manifestations	7
873.8	Other and unspecified open wound of head without mention of complication	7
848.9	Unspecified site of sprain and strain	7
648.21	Anemia of mother, with delivery	7
V70.2	General psychiatric examination, other and unspecified	6
295.74	Schizoaffective type schizophrenia, chronic state with acute exacerbation	6
536.2	Persistent vomiting	6
658.11	Premature rupture of membranes, delivered	6
642.41	Mild or unspecified preeclampsia, with delivery	6
919.5	Insect bite, nonvenomous, of other, multiple, and unspecified sites, infected	6
919.0	Abrasion or friction burn of other, multiple, and unspecified sites, without mention of infection	5
716.96	Arthropathy unspecified, involving lower leg	5
846.9	Unspecified site of sacroiliac region sprain	5
958.3	Posttraumatic wound infection not elsewhere classified	5
659.61	Other advanced maternal age, delivered, with or without mention of antepartum condition	5
295.94	Unspecified schizophrenia, chronic state with acute exacerbation	4
836.3	Dislocation of patella, closed	4
719.49	Pain in joint involving multiple sites	4
295.64	Residual schizophrenia, chronic state with acute exacerbation	4
914.4	Insect bite, nonvenomous, of hand(s) except finger(s) alone, without mention of infection	4
658.21	Delayed delivery after spontaneous or unspecified rupture of membranes, delivered	4
649.31	Coagulation defects complicating pregnancy, childbirth, or the puerperium, delivered, with or without mention of antepartum condition	4
572.2	Hepatic encephalopathy	3
977.8	Poisoning by other specified drugs and medicinal substances	3
250.63	Diabetes mellitus type I [juvenile type], uncontrolled, with neurological manifestations	3
873.61	Open wound buccal mucosa	3
608.9	Unspecified disorder of male genital organs	3
V29.8	Observation for other specified suspected condition	3
V58.43	Aftercare following surgery for injury and trauma	3
647.61	Other viral diseases of mother, with delivery	3
648.41	Mental disorders of mother, with delivery	3
656.51	Poor fetal growth, affecting management of mother, delivered	3
658.01	Oligohydramnios, delivered	3
637.91	Unspecified abortion, incomplete, without mention of complication	2
729.89	Other musculoskeletal symptoms referable to limbs	2
998.13	Seroma complicating a procedure	2
813.82	Fracture of unspecified part of ulna (alone), closed	2
730.27	Unspecified osteomyelitis involving ankle and foot	2
914.0	Abrasion or friction burn of hand(s) except finger(s) alone, without mention of infection	2
681.01	Felon	2
813.81	Fracture of unspecified part of radius (alone), closed	2
680.3	Carbuncle and furuncle of upper arm and forearm	2
998.12	Hematoma complicating a procedure	2
916.1	Abrasion or friction burn of hip, thigh, leg, and ankle, infected	2
919.2	Blister of other, multiple, and unspecified sites, without mention of infection	2
825.29	Other fracture of tarsal and metatarsal bones, closed	2
649.43	Epilepsy complicating pregnancy, childbirth, or the puerperium, antepartum condition or complication	2
872.02	Open wound of auditory canal, uncomplicated	2
873.62	Open wound of gum (alveolar process), uncomplicated	2
914.6	Superficial foreign body (splinter) of hand(s) except finger(s) alone, without major open wound and without mention of infection	2
607.83	Edema of penis	2
659.41	Grand multiparity, with current pregnancy, delivered	2
648.81	Abnormal glucose tolerance of mother, with delivery	2
656.81	Other specified fetal and placental problems, affecting management of mother, delivered	2
658.41	Infection of amniotic cavity, delivered	2
801.02	Closed fracture of base of skull without mention of intracranial injury, with brief [less than 1 hour] loss of consciousness	1
637.92	Unspecified abortion, complete, without mention of complication	1
569.81	Fistula of intestine, excluding rectum and anus	1
801.01	Closed fracture of base of skull without mention of intracranial injury, with no loss of consciousness	1
730.25	Unspecified osteomyelitis involving pelvic region and thigh	1
831.00	Closed dislocation of shoulder, unspecified site	1
295.44	Acute schizophrenic episode, chronic state with acute exacerbation	1
V71.09	Observation for other suspected mental condition	1
730.26	Unspecified osteomyelitis involving lower leg	1
633.01	Abdominal pregnancy with intrauterine pregnancy	1
295.14	Disorganized type schizophrenia, chronic state with acute exacerbation	1
839.21	Closed dislocation, thoracic vertebra	1
914.8	Other and unspecified superficial injury of hand(s) except finger(s) alone, without mention of infection	1
306.1	Respiratory malfunction arising from mental factors	1
716.97	Arthropathy unspecified, involving ankle and foot	1
996.75	Other complications due to nervous system device, implant, and graft	1
923.01	Contusion of scapular region	1
718.91	Unspecified derangement of joint of shoulder region	1
865.03	Laceration of spleen extending into parenchyma without mention of open wound into cavity	1
967.9	Poisoning by unspecified sedative or hypnotic	1
295.84	Other specified types of schizophrenia, chronic state with acute exacerbation	1
813.83	Fracture of unspecified part of radius with ulna, closed	1
719.91	Unspecified disorder of joint of shoulder region	1
847.3	Sprain of sacrum	1
646.61	Infections of genitourinary tract in pregnancy, with delivery	1
V72.5	Radiological examination, not elsewhere classified	1

(continued on next page)

Table A1 (*continued*)

ICD-9-CM code	Description	Visits
842.11	Sprain of carpometacarpal (joint) of hand	1
716.92	Arthropathy unspecified, involving upper arm	1
716.95	Arthropathy unspecified, involving pelvic region and thigh	1
649.11	Obesity complicating pregnancy, childbirth, or the puerperium, delivered, with or without mention of antepartum condition	1
872.01	Open wound of auricle, uncomplicated	1
655.71	Decreased fetal movements, affecting management of mother, delivered	1
995.27	Other drug allergy	1
863.45	Injury to rectum without open wound into cavity	1
V07.9	Need for unspecified prophylactic or treatment measure	1
V67.00	Follow-up examination following surgery, unspecified	1
995.52	Child neglect (nutritional)	1
V67.09	Follow-up examination following other surgery	1
989.83	Toxic effect of silicone	1
680.6	Carbuncle and furuncle of leg, except foot	1
686.8	Other specified local infections of skin and subcutaneous tissue	1
963.3	Poisoning by alkalizing agents	1
873.65	Open wound of palate, uncomplicated	1
996.63	Infection and inflammatory reaction due to nervous system device, implant, and graft	1
716.99	Arthropathy unspecified, involving multiple sites	1
919.8	Other and unspecified superficial injury of other, multiple, and unspecified sites, without mention of infection	1
642.54	Severe preeclampsia, postpartum	1
641.21	Premature separation of placenta, with delivery	1
642.31	Transient hypertension of pregnancy, with delivery	1
654.92	Other and unspecified abnormality of organs and soft tissues of pelvis, delivered, with mention of postpartum complication	1
729.82	Cramp of limb	1
642.32	Transient hypertension of pregnancy, with delivery, with mention of postpartum complication	1
647.81	Other specified infectious and parasitic diseases of mother, with delivery	1
652.81	Other specified malposition or malpresentation, delivered	1
873.74	Open wound of tongue and floor of mouth, complicated	1
964.1	Poisoning by liver preparations and other antianemic agents	1
V29.9	Observation and evaluation of newborn, unspecified suspected condition not found	1

Table A2
Full listing of all ED *ICD-9-CM* codes, with deliveries, selected for the study

ICD-9-CM code	Description	Clinically correct?	Visits
648.21	Anemia of mother, delivered, with or without mention of antepartum condition	No	7
658.11	Premature rupture of membranes, delivered, with or without mention of antepartum condition	No	6
659.61	Elderly multigravida, delivered with or without mention of antepartum condition	No	5
658.21	Delayed delivery after spontaneous or unspecified rupture of membranes, delivered, with or without mention of antepartum condition	No	4
649.31	Coagulation defects complicating pregnancy, childbirth, or the puerperium, delivered, with or without mention of antepartum condition	No	4
647.61	Other viral diseases in the mother, delivered, with or without mention of antepartum condition	No	3
648.41	Mental disorders of mother, delivered, with or without mention of antepartum condition	No	3
656.51	Poor fetal growth, affecting management of mother, delivered, with or without mention of antepartum condition	No	3
658.01	Oligohydramnios, delivered, with or without mention of antepartum condition	No	3
659.41	Grand multiparity, delivered, with or without mention of antepartum condition	No	2
648.81	Abnormal glucose tolerance of mother, delivered, with or without mention of antepartum	No	2
656.81	Other specified fetal and placental problems, affecting management of mother, delivered, with or without mention of antepartum condition	No	2
658.41	Infection of amniotic cavity, delivered, with or without mention of antepartum condition	No	2
649.11	Obesity complicating pregnancy, childbirth, or the puerperium, delivered, with or without mention of antepartum condition	No	1
655.71	Decreased fetal movements, affecting management of mother, delivered, with or without mention of antepartum condition	No	1
654.92	Other and unspecified abnormality of organs and soft tissues of pelvis, delivered, with mention of postpartum complication	No	1
647.81	Other specified infectious and parasitic diseases of mother, delivered, with or without mention of antepartum condition	No	1
652.81	Other specified malposition or malpresentation, delivered, with or without mention of antepartum condition	No	1
642.51	Severe preeclampsia, delivered, with or without mention of antepartum condition	Yes	2
642.91	Unspecified hypertension, complicating pregnancy, childbirth, or the puerperium, delivered, with or without mention of antepartum condition	Yes	2
645.21	Prolonged pregnancy, delivered, with or without mention of antepartum condition	Yes	1
659.81	Other specified indications for care or intervention related to labor and delivery, delivered, with or without mention of antepartum condition	Yes	1
660.01	Obstruction caused by malposition of fetus at onset of labor, delivered, with or without mention of antepartum condition	Yes	1
669.21	Maternal hypotension syndrome, delivered, with or without mention of antepartum condition	Yes	1

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