Inpatient Diagnosis Clusters: Analyzing Hospital Care in Family Practice

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Hospital care is an important component of family practice in the United States, but the study of this area has been impeded by the lack of a simple and clinically meaningful method of categorizing the diagnostic problems that make up the inpatient workload. This paper extends the method of diagnosis clusters—first used in the analysis of ambulatory care—to the hospital setting. Using the University of Southern California Medical Activities and Manpower Study of office-based general and family physicians, 52 clinically discrete diagnosis clusters were developed that include 78 percent of all principal diagnoses recorded in the hospital during the study interval. Fifty percent of all hospital encounters can be incorporated in only 15 clusters.

Data clustered using this technique demonstrate that clinical problems such as ischemic heart disease and malignant neoplasms represent a major part of the family physician's hospital workload, a fact that has important implications for training and practice. Diagnosis clustering should facilitate further study of the hospital activities of primary care physicians.

This article presents a classification scheme for analyzing the content of hospital care, building upon the recent development of diagnosis clusters as a tool for handling diagnostic data in the ambulatory setting.[1] The clustering method facilitates logical and efficient manipulation of the large number of individual coding rubrics used in the medical system, and has been useful in previous studies of family practice.[2] In addition, clustering tends to reduce the extent to which idiosyncratic labeling and coding behavior on the part of providers and medical records technicians blurs the analysis of the medical care process.

Until 1979 the coding scheme used almost universally for hospital diagnoses in the United States was the eighth revision of the International Classification of Diseases, generally known as ICDA-8; the version adapted for use in the United States includes more than 3,000 discrete diagnostic categories.[3] Subsequent revisions of this classification

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scheme, such as ICD-9[4] and ICD-9-CM,[5] are based on a hierarchical structure similar to ICDA-8, with an even larger number of available diagnostic rubrics. This complex coding scheme allows precision in the assignment of diagnostic labels to the clinical conditions presented by hospital patients. Although this specificity is a useful characteristic when indexing the medical record, retrieving specific diagnoses, or reimbursing hospitals and physicians, it becomes a liability when attempting to describe the content of medical care. It is particularly cumbersome when analyzing the inpatient experiences of a physician or group of physicians or in comparing the hospital role of different groups of physicians.

One method being widely adopted for the classification of inpatient conditions is that of diagnosis-related groups (DRGs).[6] The major purpose of the DRGs is to control for variations in case mix and intensity of services in order to improve prospective reimbursement of hospitals. Although the DRG approach appears to be promising for reimbursement, the extensive data requirements of the technique (eg, whether a procedure was performed or whether a co-morbid condition is present) limit its utility when dealing with existing data sources. Moreover, the relatively large number of discrete categories (more than 400 in the most recent revision) make it unwieldy for descriptive purposes.

The diagnosis-clustering approach was developed in response to these limitations. The objective of diagnosis clusters is to construct a classification method that is simple, clinically relevant, and compatible with the ICD coding scheme and its derivative applications. Diagnosis clusters have been designed to be used with existing encounter data that are routinely recorded in most medical settings without requiring additional data, sophisticated equipment, or highly trained personnel. The ambulatory diagnosis clusters were derived using the National Ambulatory Medical Care Survey (NAMCS) data[7] and can be applied to any of the 28 medical specialties sampled in that ongoing survey. The clusters themselves and the techniques used to derive them have been published separately.[1]

This paper extends the diagnosis-clustering approach to inpatient problems, using a data set that captures the hospital workload of a national sample of general and family physicians. In doing so, this paper presents an intermediate step in the development of an all-purpose inpatient set of diagnosis clusters. Unlike the ambulatory clusters, which were derived from a data base that incorporated virtually all types of physicians in ambulatory clinical practice, the classification scheme presented here was derived from a national sample of general and family physicians. As NAMCS does not include information on hospitalized patients, it was impossible to use that source as a vehicle for creating inpatient clusters. Focusing on the hospital experience of general and family practice as the foundation for inpatient clusters is a rational first step because this discipline represents the largest group of physicians by specialty and because the diagnostic spectrum of this group of physicians is very broad. The relative frequency of the individual clusters is therefore applicable only to general and family physicians, although the clusters themselves should be meaningful in other contexts as well. Further development of the clusters, however, should be geared to encompass other specialty groups and thereby facilitate interspecialty comparisons. It is to be expected that each specialty will have its own characteristic profile of inpatient diagnoses, similar to the dramatic differences that are apparent when the ambulatory diagnosis clusters are applied in the ambulatory setting.[8]

Materials and Methods

The data for the inpatient clusters were derived from the University of Southern California Medical Activities and Manpower Study (MAMP) performed in 1977.[9] Like NAMCS, the MAMP study was based on a multistage probability sample of physicians in the United States. MAMP differs from NAMCS in that inpatient activities were also recorded by the participating physicians, using log-diary encounter forms that were completed by each participating physician following each encounter with a hospitalized patient.

The data for the construction of the diagnosis clusters come from 651 office-based general and family physicians and involve 7,830 separate hospital encounters, of which 7,720 were usable in constructing these clusters. For each hospital en-

counter the diagnosis was coded to the fourth digit using ICDA-8; a total of 721 distinct codes were used to describe the principal inpatient diagnoses recorded by the general and family physicians during the study period. These diagnoses formed the raw data from which the inpatient diagnosis clusters were constructed. Further information about the MAMP study has been published elsewhere.[9,10]

The following criteria were used in constructing the individual diagnosis clusters:

1. Each cluster is clinically homogeneous, bringing together individual diagnostic rubrics that tend to generate similar cognitive processes and clinical responses on the part of clinicians. Thus each cluster includes diagnoses that share common pathophysiological etiologies and expressions.
2. The clusters are broad enough to encompass most discrete diagnostic rubrics that are used in hospital practice yet precise enough so that they do not blur clinically meaningful distinctions.
3. The clusters are designed to decrease the confounding effects of idiosyncratic labeling or coding patterns of individual health care providers or medical records technicians by grouping clinically related conditions into unitary diagnostic entities.

These criteria were applied to the 721 discrete diagnostic inpatient codes recorded in the sample of physicians, and a preliminary roster of clinically coherent clusters was constructed. The entire list of codes was then re-examined to ensure that no major single diagnosis was excluded from the provisional clusters. The list of clusters was then subjected to the scrutiny of a group of family physicians who were asked to examine the clusters for clinical consistency and utility. The clusters were then modified in accordance with the suggestions of the peer-review panel. All discrete diagnoses and clusters with a frequency greater than 0.1 percent were included in the final list.

Results

Table 1 presents the 52 most common inpatient clusters ranked according to their frequency of occurrence in the MAMP general and family practitioner files. As can be seen from this table, 78.1 percent of all principal inpatient diagnoses recorded by a population-based sample of general and family physicians were captured with the use of 52 clusters. Fifty percent of all hospital encounters can be identified with the use of only 15 clusters.

The utility of the clustering method is apparent from a review of this first table. The second most frequent group of diagnostic conditions encountered by family physicians in the hospital is malignant neoplasms, a fact that has been rarely appreciated when considering the hospital workload of this specialty. One reason for this apparent oversight is that this cluster is composed of a very large number of individual diagnostic codes. In a list of hospital diagnoses in individuals treated by family physicians, any individual neoplasm occurs infrequently. Only when the individual diagnoses are grouped does it become evident that family physicians devote a considerable portion of their hospital work to the care of patients with cancer. This finding has obvious implications for residency training and continuing medical education.

Another interesting observation is that the nine most frequent conditions for which general and family physicians render hospital care are medical and obstetric, as opposed to surgical, diagnoses. The most common surgical diagnosis is appendicitis/appendectomy. One limitation of the data that emerges from this sort of analysis is that it is not possible to know whether a specific procedure was performed in relation to any given diagnosis or whether that procedure was performed by the admitting physician or a consultant. It is likely that the majority of patients with the diagnosis of benign diseases of the uterus (cluster 16) underwent hysterectomies and most of those with abnormal menstrual bleeding (cluster 25) were treated with dilation and curettage, although this must remain speculation. This limitation derives from the limited amount of information that can be encapsulated within any given diagnostic rubric and is part of the reality of most data bases available to researchers. Although a more complex and detailed list could be generated, it would destroy one of the most attractive features of this approach, namely its independence from additional data requirements.

Clusters were constructed for all principal diagnoses that had a combined frequency of more than 0.1 percent of all the principal diagnoses recorded. It would be possible to extend this list further for specific research applications, particularly in dealing with uncommon diseases or entities. A com-

Table 1. Inpatient Diagnosis Clusters Applied to the 1977 University of Southern California Medical Activities and Manpower Project Data for General and Family Physicians

Cluster Rank	Cluster Title	Percent	
		Frequency	Cumulative Frequency
1	Ischemic heart disease (including myocardial infarction)	7.9	7.9
2	Malignant neoplasm	6.2	14.1
3	Pregnancy—normal and complicated	4.4	18.5
4	Back pain, radiculopathy	4.3	22.8
5	Cerebrovascular disease	4.0	26.8
6	Pneumonia	3.1	29.9
7	Diabetes mellitus	3.1	33.0
8	Congestive heart failure	2.7	35.7
9	Chronic obstructive pulmonary disease	2.7	38.4
10	Appendicitis/appendectomy	2.3	40.7
11	Fractures and dislocations (excluding femur, skull, and all late effects)	2.3	43.0
12	Surgical aftercare	2.0	45.0
13	Cholecystitis	1.9	46.9
14	Peptic ulcer disease (without hemorrhage)	1.9	48.8
15	Well-child care	1.8	50.6
16	Benign disease of uterus	1.7	52.3
17	Fracture of femur (excluding late effects)	1.6	53.9
18	Diarrheal disease	1.6	55.5
19	External hernias of abdomen (including with complications)	1.4	56.9
20	Kidney stone	1.4	58.3
21	Disease of urinary tract—ill defined	1.4	59.7
22	Diseases of intestine and peritoneum	1.3	61.0
23	Upper respiratory tract infection (including influenza)	1.2	62.2
24	Essential benign hypertension	1.1	63.3
25	Abnormal menstrual bleeding	1.0	64.3
26	Pyogenic infections of skin and subcutaneous tissue	0.9	65.2
27	Diverticulitis of colon	0.9	66.1
28	Pelvic inflammatory disease	0.8	66.9
29	Gastrointestinal obstruction	0.8	67.7
30	Arthritis	0.8	68.5
31	Anemia	0.7	69.2
32	Abdominal pain	0.7	69.9
33	Gangrene not otherwise specified	0.7	70.6
34	Asthma	0.7	71.3
35	Lacerations and multiple trauma (excluding all late effects)	0.6	71.9
36	Anxiety and depression	0.6	72.5
37	Alcoholism	0.5	73.0
38	Head injury (not associated with multiple trauma)	0.5	73.5
39	Poisoning	0.5	74.0
40	Gastrointestinal bleeding	0.4	74.4
41	Bronchitis	0.4	74.8
42	Pulmonary embolism and infarction	0.4	75.2
43	Burns—all (excluding late effects)	0.4	75.6
44	Syncope	0.4	76.0
45	Cardiac arrhythmias	0.4	76.4
46	Seizure disorder	0.3	76.7
47	Abortion—all	0.3	77.0
48	Chest pain	0.3	77.3
49	Ectopic pregnancy	0.3	77.6
50	Pancreatitis	0.2	77.8
51	Hemorrhoids	0.2	78.0
52	Headache	0.1	78.1

plete list of the 52 most common clusters and their component diagnostic titles and codes derived from ICDA-8 and ICD-9-CM is presented in the Appendix. It is important to note that ICD-9-CM codes do not correspond exactly to the adjacent ICDA-8 rubrics, although the cluster content is identical.

Discussion

The hospital occupies a central position in the health care delivery system. Despite the importance of inpatient care, relatively little is known about the process of care in hospitals, and even simple descriptive data about which physician groups are responsible for the care of specific types of illnesses or what differences exist among various subgroups of physicians are lacking. A major limitation to the expansion of knowledge in this area has been the inability to make ready use of the secondary data available about patterns of hospitalization in this country.

In this paper, the method of diagnostic clustering originally developed for use in the ambulatory setting is extended to inpatient diagnoses. By bringing together diagnoses with similar pathophysiological etiologies that require similar diagnostic and clinical decisions on the part of physicians, it is possible to reduce some of the complexity inherent in standard coding schemes with their thousands of distinct rubrics. The basic purpose of this method is to allow investigators a straightforward, conceptually appealing tool with which to manipulate or aggregate data about hospital diagnoses recorded by different groups of physicians.

There are some important limitations to the classification scheme presented here. The actual clusters emerge from a national study of only one physician discipline—family practice. Although family physicians have a fairly wide hospital practice, touching on most areas of medicine, there are definitely major areas with which they have little contact. To the extent that the family physicians in this sample did not record diagnoses in specific areas, there will be important inpatient problems that are not captured in these clusters. Examples of such problems are neurosurgical procedures and rehabilitation medicine diagnoses.

A more definitive list of diagnosis clusters requires a data base that involves all types of physicians who admit patients to hospitals. Unfortunately, there is no inpatient data base that is analogous to the National Ambulatory Medical Care Survey. In the absence of a more inclusive data set, the clusters presented here represent a first step toward the efficient and meaningful analysis of inpatient data and should facilitate study of the hospital activities of primary care physicians.

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Appendix

Inpatient Diagnosis Clusters for Family and General Physicians, Based on the University of Southern California Medical Activities and Manpower Project (MAMP)

	ICDA-8	ICD-9-CM*
1. Ischemic Heart Disease (including myocardial infarction)		
Acute myocardial infarction	410	410-414
Other acute and subacute forms of ischemic heart disease	411	
Chronic ischemic heart disease	412	
Angina pectoris	413	
Asymptomatic ischemic heart disease	414	
2. Malignant Neoplasm		
Of lip	140	140-208
Of oral cavity and pharynx	141-149	
Of digestive organs and peritoneum	150-159	
Of respiratory system	160-163	
Of bone, connective tissue	170-171	
Of breast	174	
Of genitourinary organs	180-189	
Of other and unspecified sites	190-199	
Of lymphatic and hematopoietic tissue	200-209	
Malignant melanoma	172	
Other malignant neoplasms of skin	173	
3. Pregnancy—Normal and Complicated		
Hemorrhage of pregnancy (including threatened abortion)	632	640-641 650
Delivery without complication	650	651-654
Delivery complicated by placenta previa and antepartum hemorrhage	651	656-659 660-669
Delivery complicated by retained placenta	652	V22, V23
Delivery complicated by postpartum hemorrhage	653	V24
Delivery complicated by abnormality of pelvis	654	
Delivery complicated by cephalopelvic disproportion	655	
Delivery complicated by malpresentation	656	
Delivery complicated by prolonged labor	657	
Delivery with laceration of perineum	658	
Rupture of uterus	659	
Other obstetric trauma	660	
Delivery with other complications	661	
Prenatal care	Y6	
Postnatal care	Y7	

	ICDA-8	ICD-9-CM*
9. Chronic Obstructive Pulmonary Disease		
Chronic bronchitis	491	491, 492
Emphysema	492	494, 496
Bronchiectasis	518	
10. Appendicitis/Appendectomy		
Acute appendicitis	540-542	540-542
11. Fractures and Dislocations	805-808	805-809
(excluding femur, skull, and all .9 late effects)	810-819	810-819
	822-838	822-829
	839.0-839.8	830-839
12. Surgical Aftercare	Y-10	V51-V58 V67
13. Cholecystitis		
Cholelithiasis with cholecystitis	574.0-574.1	574.0 574.1
Other and unspecified cholelithiasis	574.9	574.3
Cholecystitis and cholangitis	575	574.4 575.0 575.1 576.1
14. Peptic Ulcer Disease (without hemorrhage)		
Esophagitis	530.1	530.1
Ulcer of stomach	531.1	531.1
	531.9	531.3
Ulcer of duodenum	532.1	531.5
	532.9	531.7
Peptic ulcer not otherwise specified	533	531.9
Gastrojejunal ulcer	534.1	532.1
	534.9	532.3
	535	532.5 532.7 532.9 533.1 533.3 533.5 533.7 533.9 534.1

4. Back Pain, Radiculopathy		
Sciatica	353	720.1-
Osteoarthritis of spine	713.1	720.9
Lumbago	717.0	721, 722
Displacement of intervertebral disc—all sites	725	724, 846
Lumbalgia	728.7	847
Backache not otherwise specified	728.9	
Sprains and strains of other and unspecified parts of back	847	
5. Cerebrovascular Disease		
Malignant hypertension with cerebrovascular involvement	400.2	430-438
Subarachnoid hemorrhage	430	
Cerebral hemorrhage	431	
Occlusion of precerebral arteries	432	
Cerebral thrombosis	433	
Cerebral embolism	434	
Transient cerebral ischemia	435	
Acute but ill-defined cerebrovascular disease	436	
Generalized ischemic cerebrovascular disease	437	
Other and ill-defined cerebrovascular disease	438	
6. Pneumonia		
Viral pneumonia	480	480-486
Pneumococcal pneumonia	481	487.0
Other bacterial pneumonia	482	
Other specified organism, eg, mycoplasma	483	
Acute interstitial pneumonia	484	
Bronchopneumonia unspecified	485	
Pneumonia unspecified	486	
7. Diabetes Mellitus	250	250
8. Congestive Heart Failure		
Hypertensive heart disease with failure	402	428
Congestive heart failure	427.0	402.01
Left ventricular failure	427.1	402.11
Acute heart failure	782.4	402.91
		534.3
		534.5
		534.7
		534.9
		539
15. Well-Child Care		
Well-baby and well-child care	Y0.5	V20, V30-
Classification of liveborn infants and fetal death	Y20-Y30.2	V39
16. Benign Diseases of Uterus		
Uterine fibroma	218	218, 219
Other benign neoplasm of uterus	219	618
Uterovaginal prolapse	623	
17. Fracture of Femur (excluding .9 late effects)	820-821	820-821
18. Diarrheal Disease		
Intestinal infectious disease	000-008	001-009
Diarrheal disease	009	
19. External Hernias of Abdomen (including with complications)		
Inguinal hernia	550	550
Femoral, umbilical, and ventral hernias	551.0-551.2	551.0-551.2
Inguinal hernia with complication	552	552.0-
Femoral, umbilical, and ventral hernia with complication	553.0-553.2	552.2 553.0-553.2
20. Kidney Stone		
Renal calculi	592	592
Pain referable to urinary system (including renal colic)	786.0	788.0
21. Diseases of Urinary Tract—Ill Defined**		
Psychogenic genitourinary disorders	305.6	306.5
Other urinary tract disease	599	599
Symptoms referable to genitourinary system	786.1-786.9	788.1-.9

*ICD-9-CM codes do not correspond exactly to the adjacent specific ICDA-8 rubrics, although the cluster content is identical
**This cluster, although ill defined, included rubrics with a high reported frequency and was therefore included

Appendix (Continued)

Inpatient Diagnosis Clusters for Family and General Physicians, Based on the University of Southern California Medical Activities and Manpower Project (MAMP)

	ICDA-8	ICD-9-CM*
22. Diseases of Intestine and Peritoneum (not elsewhere classified)**		
Other diseases of intestines and peritoneum (including proctitis, prolapse of rectum, other rectal disease, fistula of intestine, perforation of intestine, and other diseases)	569	569.1 569.4 569.81
23. Upper Respiratory Tract Infection (including influenza)		
Streptococcal sore throat	034.0	034, 460
Acute nasopharyngitis	460	462, 463
Acute pharyngitis	462	464, 465
Acute tonsillitis	463	487
Acute laryngitis/tracheitis	464	
Acute upper respiratory infection not otherwise specified	465	
Influenza	470	
24. Essential Benign Hypertension	401	401
25. Abnormal Menstrual Bleeding		
Abnormal menstrual bleeding	626.0-626.9 excluding 626.3	626
Vaginal bleeding	629.5	
26. Pyogenic Infections of Skin and Subcutaneous Tissue		
Inflammatory conditions of jaws	526.4	526.4
Perirectal abscess	566	566
Boil and carbuncle	680	680-686
Cellulitis of finger and toe	681	
Other cellulitis and abscess	682	
Acute lymphadenitis	683	
Impetigo	684	
Infected pilonidal cyst	685	
Other local infections of skin and subcutaneous tissue	686	
27. Diverticular Disease of Colon	562.1	562.1
28. Pelvic Inflammatory Disease		
Salpingitis, oophoritis	614	614
Multiple dislocations, simple	839.7	
Multiple dislocations, compound	839.8	
Internal injury of chest, abdomen, and pelvis	860-869	
Lacerations and open wounds of head, neck, and trunk	870-878	
Multiple lacerations of head, neck, and trunk	879	
Lacerations and open wounds of limbs	880-897	
Laceration and open wound multiple sites	900-907	
36. Anxiety and Depression		
Involutional melancholia	296.0	296-298
Manic-depressive psychosis	296.1-296.8	300.0 300.4
Psychotic reactive depression	298.0	
Depressive neurosis	300.4	
Alcoholism		
Alcoholic psychosis (including delirium tremens)	291	291, 303 571.0-.4
37. Alcoholism	303	
Alcoholic cirrhosis	571.0	
38. Head Injury (not associated with multiple trauma)		
Fracture of skull	800-801	800-803
Fracture of facial bones	802	850-854
Skull fracture not otherwise specified	803 excluding .9 late effect	
Concussion	850	
Cerebral laceration and contusion	851	
Subarachnoid/subdural hemorrhage following injury	852	
Intracranial hemorrhage following injury—unspecified	853	
Intracranial injury not otherwise specified	854	
39. Adverse and Toxic Effects		
Adverse effects of medicinal agents	960-979	960-979
Toxic effects of nonmedical substance	980-989	980-989

Pelvic inflammatory disease	616.0	
29. Gastrointestinal Obstruction		
Internal abdominal hernias with obstruction	553.3-553.9	550.1 552, 560
Intestinal obstruction without mention of hernia	560	
30. Arthritis		
Gout	274	274, 711-716
Arthritis due to pyogenic organisms	710	
Acute nonpyogenic arthritis	711	
Rheumatoid arthritis and allied conditions	712	
Osteoarthritis	713 (excluding 713.1, of lumbar spine)	
Other specified arthritis	714	
Arthritis not otherwise specified	715	
31. Anemia		
Iron deficiency	280	280-285
Other deficiency	281	
Hereditary hemolytic	282	
Acquired hemolytic	283	
Aplastic	284	
Other and unspecified	285	
32. Abdominal Pain	785.5	789.0
33. Gangrene (not otherwise specified)	445	785.4
34. Asthma	493	493
35. Lacerations and Multiple Trauma (excluding all .9 late effects)		
Multiple fracture of skull or face with other bones	804	804 807
Multiple fracture of trunk	809	817
Multiple fracture of hand bones	817	827
Multiple fracture of upper limb	818	839.8-.9
Multiple fracture of upper limb and other bones	819	860-869
Multiple fracture of lower limb	827	870-897
Multiple fracture of lower limbs and other bones	828	
40. Gastrointestinal Bleeding		
Stomach ulcer with hemorrhage	531.0	531-534 (all -.0, -.2, -.4, -.6)
Ulcer of stomach with bleeding	531.1	
Stomach ulcer with hemorrhage and perforation	531.2	
Duodenal ulcer with hemorrhage	532.0	
Duodenal ulcer with hemorrhage and perforation	532.2	578.0
Gastrojejunal ulcer with hemorrhage	534.0	578.1
Gastrojejunal ulcer with hemorrhage and perforation	534.2	
Hematemesis	784.5	
Melena (not of newborn)	785.7	
41. Bronchitis		
Acute bronchitis and bronchiolitis	466	466
Bronchitis not otherwise specified (presumed to be acute)	490	490
42. Pulmonary Embolism and Infarction	450	415.1
43. Burns—All (excluding .9 late effects)	940-949	940-949
44. Syncope	782.5	780.2
45. Cardiac Arrhythmias		
Cardiac arrest	427.2	427
Heart block	427.3	
Atrial fibrillation/flutter	427.4	
Paroxysmal atrial tachycardia	427.5	
Ventricular fibrillation/flutter	427.6	
Other and unspecified disorders of rhythm	427.9	
46. Seizure disorder		
Epilepsy	345	345
Convulsions not otherwise specified	780.2	780.3
47. Abortion—All	640-645	634-638
48. Chest Pain		
Precordial pain	782.0	786.5
Pleuritic pain	783.7	
49. Ectopic Pregnancy	631	633
50. Pancreatitis	577.0-577.1	577.0-.1
51. Hemorrhoids	455	455
52. Headache		
Cephalalgia (including tension headache)	306.8	307.81
Migraine	346	346
Headache not otherwise specified	791	784.0

*ICD-9-CM codes do not correspond exactly to the adjacent specific ICDA-8 rubrics, although the cluster content is identical
**This cluster, although ill defined, included rubrics with a high reported frequency and was therefore included