Computer-Prompted Diagnostic Codes

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Background. The purpose of this study was to develop and evaluate a computer system that would translate patient diagnoses noted by a physician into appropriate International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes and maintain a patient-specific up-to-date problem list.

Methods. The intervention consisted of a computerized list (dictionary) of diagnoses, including practice-specific synonyms and abbreviations, linked to their corresponding ICD-9-CM codes. To record the diagnoses for the office visit before the intervention, physicians used International Classification of Health Problems in Primary Care (ICHPPC-2) codes. After the intervention, physicians used their own words or checked previously identified diagnoses on the computer-generated problem list. The computer then identified the correct ICD-9-CM code. Accuracy of coding was compared before and after the new computerized system was implemented.

Results. Visits in which all diagnoses matched increased from 58% to 76% ($P<.001$) with use of the computer system. Visits in which no computer diagnoses matched the chart decreased from 22% to 8% ($P<.001$). Errors of omission declined from 38% to 18% ($P<.001$). Errors of commission decreased from 19% to 11% ($P=.006$). Overall accuracy increased from 62% to 82% ($P<.001$).

Conclusions. Outpatient medical diagnosis coding can be simplified and accuracy improved by using a computerized dictionary of practice-specific diagnoses and synonyms linked to appropriate ICD-9-CM codes. Such a system provides a computer-generated problem list that accurately reflects the chart and assists with prompted coding on subsequent visits.

Key words. Diagnostic coding; diagnosis; computers; medical records. (*J Fam Pract 1995; 40:257-262*)

Primary care currently has no national system for evaluating either the quality or the cost-effectiveness of medical care. The absence of an accurate ambulatory care database is related to the inherent barriers to studying primary care, such as limited access to privately owned practices, the diffuse geographic distribution of these practices, and the expense and time commitment needed for chart review or primary data collection.[1-4] Consequently, there is little information available to use in the evaluation of the quality and cost-effectiveness of provider groups.[5] Some large health maintenance organizations, federally funded clinics, and insurance companies have developed internal systems to monitor medical care; however, these systems are often time-consuming to use and not generalizable. Computerized databases have been proposed as a solution to overcome some of the barriers to the evaluation of primary care.[1,4,6-9]

One national computer database that is currently available is the diagnostic information submitted to payers to support reimbursement claims. While this database, which utilizes the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM),[10] contains information on the use of services as well as diagnoses and billing charges, there has been skepticism concerning its accuracy in reflecting the actual clinical conditions cared for by primary care physicians.[1] This criticism stems from the recognition that many ambulatory care visits do not result in an obvious diagnosis for the patient's complaints, and that translating the physician's understanding of the patient's problem into a

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highly structured coding system is both costly and time-consuming for physicians and office staff.

Numerous commercial systems are being marketed to assist physicians and staff in accurately translating diagnoses into ICD-9-CM codes. These systems are primarily computer-based versions of the ICD-9-CM manual to which sophisticated cross-indexes have sometimes been added.[11] These are imperfect solutions for primary care, however, as they mirror the ICD-9-CM classification system and do not include all the acronyms, synonyms, and abbreviations used by primary care physicians. Thus, the ICD-9-CM database does not provide the variety or specificity required for the evaluation of ambulatory care.

In theory, it is possible to develop a computer-based system that will capture the diagnoses and problems listed by a physician on a patient, and then translate these detailed descriptions into the correct ICD-9-CM codes for billing purposes. Once developed, such a system could provide both the brevity needed for billing and the richness required for quality improvement and research. This paper describes the development and incorporation of such a system into a highly computerized family practice. We also evaluated the accuracy of the new system by comparing it with the previous billing system and the literature.

Methods

Setting

The Department of Community and Family Medicine at Duke University Medical Center in Durham, North Carolina, operates a large, free-standing family practice clinic. The family practice clinic is open to all employees of Duke University and their families, Duke University students, and the greater Durham community. From 1987 through 1990, the clinic saw an average of 55,000 patient visits per year and served as a teaching site for family practice fellows and medical and physician assistant students. In 1987 and 1988, there were 24 physicians, 4 physician assistants, and 2 nurse practitioners on staff. In 1989 and 1990, the practice was staffed by 22 physicians, 5 physician assistants, and 3 nurse practitioners. Sixty-seven percent of the clinicians were common to both groups, and the main clinicians were in place throughout the 4 years. Since the late 1970s, the practice has used a comprehensive computerized medical office system called The Medical Record (TMR).[12,13] This system was developed at Duke Medical Center, and the family practice clinic acts as a development site for applications in primary care.

Before January 1989, when this intervention began, the clinicians manually maintained an active problem list in a conspicuous place in the chart and manually recorded the diagnosis or diagnoses for each office visit on a computer-generated billing sheet (the encounter form) using International Classification of Health Problems in Primary Care-2 (ICHPPC-2) codes.[14] The encounter form included patient demographics, appointment time, and some laboratory, radiography, and pharmacy data, as well as a place for entering the ICHPPC-2 codes for the office visit. A separate list of the most commonly used ICHPPC-2 codes and a manual containing the complete listing of ICHPPC-2 codes were available in the clinic to help the clinician determine the proper ICHPPC-2 codes. As the patient left the office, the ICHPPC-2 codes were entered into the computer as the official diagnoses for the visit by the reception staff. If an appropriate ICHPPC-2 code could not be found in either of the available ICHPPC-2 sources, a "free-text" diagnosis could be recorded. The free-text diagnosis was recorded in the computer as an "unknown diagnosis" by the reception staff, and was later manually converted by the business office to the ICHPPC-2 code and entered into the computer.

Intervention

A list of all the diagnoses used by the practice was developed in 1988 from a computer-generated list of all ICHPPC-2 coded diagnoses seen by the practice. This list of diagnoses was circulated among the clinicians, who added additional diagnoses, symptoms, synonyms, acronyms, and abbreviations. In all, 717 separate diagnoses and problems were initially identified. This list was used to design the new computer system.

The entire practice database of patient diagnoses was converted to a computerized alphabetized list of all symptom descriptions and diagnoses used in primary care. Each diagnosis was linked to a TMR code, and multiple TMR codes were linked to the appropriate ICD-9-CM code. Thus, one ICD-9-CM code could automatically be identified for multiple related synonyms, acronyms, and abbreviations recorded by the clinician. Because the computer preserved the initial synonym, acronym, or other designation listed by the clinician, the specificity of the initial evaluation was retained.

Patient computer records that contained ICHPPC-2 codes and problems that could not be converted to ICD-9-CM were deleted, and a computerized notation was made to indicate that there was a conversion problem and a deleted diagnosis. Examples of problems that were deleted include "all other infective and parasitic diseases" (ICHPPC-2 136) and "all other symptoms, signs, and ill-defined conditions" (ICHPPC-2 7889). No attempt was made during the conversion process to identify cor-

ONSET	RESOLVED	SEEN	CODE	ACTIVE PROBLEMS
07/26/89	_____	____	960	BALANITIS - CANDIDA
06/13/90	_____	____	903	POSITIVE VARICELLA HISTORY
06/13/90	_____	____	15	HSV
08/08/91	_____	____	681	CONTUSION - ABRASION RT LEG
10/29/91	_____	____	91	DIABETES MELLITUS
10/30/91	_____	____	96	OBESITY - ABDOMENAL DISTRIBUTION
08/06/92	_____	____	678	ABRASION - R INDEX FINGER
03/19/93	_____	____	695	HEALTH MAINTENANCE
06/23/93	_____	____	643	ELEVATED BLOOD PRESSURE
_____	_____	____	___	_____
_____	_____	____	___	_____

Figure. Lower portion of the postintervention encounter form. Computer-generated patient-specific problem list includes all diagnoses, acronyms, problems, and other notations in the computer system for a given patient. Instead of recording the actual ICHPPC-2 or ICD-9-CM codes, the physician records the diagnosis by checking an item already included on the list or by writing in a new diagnosis.

rect ICD-9-CM codes for these deleted diagnoses through chart audit or other methods.

Recording diagnoses for reimbursement and the problem list was quite different under the new system. At each patient visit, clinicians were routinely supplied with a patient-specific computer-generated problem list printed at the bottom of the encounter form. The problem list was composed of all the diagnoses, problems, acronyms, and so forth, that were listed for that patient in the computer. Instead of recording the actual ICHPPC-2 or ICD-9-CM number for each diagnosis on the encounter form, the provider recorded the patient's diagnoses either in his or her own words or by checking an item in the problem list (Figure).

For example, if the patient was being seen for several recurrent or chronic conditions already included in the problem list, such as diabetes and chronic foot ulcer–right, the provider placed a check by both diagnoses on the problem list indicating that these problems had been addressed during the office visit. After the patient left the office, the receptionist entered the diagnoses on the encounter form either by the appropriate TMR code or by matching new handwritten diagnoses to the alphabetized computerized list of diagnoses. The computer matched the visit diagnoses with the appropriate ICD-9-CM code and filed the claim with the patient's insurance carrier.

Diagnoses not on the alphabetized computer list were entered word for word as free text. The free-text diagnosis was reviewed by one of the authors to determine whether it represented a simple misspelling, a new diagnosis, or an acronym, synonym, or abbreviation of a diagnosis already in the computer. New diagnoses and synonyms were given a TMR number, which was then matched with the appropriate ICD-9-CM number. Since the clinicians frequently wished to make finer distinctions than ICD-9-CM allowed, identical diagnoses with modifiers were designated as TMR numbers and matched with identical ICD-9-CM code numbers, such as pneumonia (ICD-9-CM 486) and pneumonia–right middle lobe (ICD-9-CM 486). At the next visit, the new diagnosis or synonym and any modifier would automatically be printed on the problem list. If an error was found in the problem list, the clinician could correct or update the list by deleting or adding any diagnosis at the time of the visit.

Two years after the implementation of the new computerized problem list, a study was designed to evaluate whether changing the method of recording diagnoses from the ICHPPC-2 codes to prompted checklists of previous diagnoses would decrease the discrepancy between the chart and the computer problem list and increase the number of times the visit diagnoses in the computer matched the chart note.

Visit Selection

The computer was used to randomly select clinician office visits from the family practice clinic patients in the 2 years before (group I) and the 2 years after (group II) the new computer system was instituted. The sample size of 600 charts selected for this study was calculated on the assumption that the new system would reduce the error rate between the chart and the computer from 20% to 10%. We estimated that our initial error rate was 20%, based on the 17% error rate between chart and computerized record reported by Rice and co-workers[15] (α=.05, β=.20). Some of the visits initially identified by the computer were ineligible because of lack of diagnoses in the chart (group I, 23; group II, 19); lack of a chart available for audit (group I, 3; group II, 0); and an uninterpretable diagnosis in the computer (group I, 59; group II, 3). These ineligible visits (107) were replaced with randomly

identified eligible visits in order to have a sample size of 300 in each group.

Eligibility Criteria

For both groups, an encounter was considered eligible if the chart contained a note of an office visit on the indicated date and if the computer contained at least one encounter diagnosis other than a notation of a conversion problem. Encounters with chart notes that did not include an obvious assessment or diagnosis stated in the note were deemed ineligible because it was impossible to determine the clinician's diagnosis. An encounter with a notation of a conversion problem or one lacking a diagnosis that could be coded was excluded because it was impossible to determine the computer diagnosis.

Data Collection

The charts of eligible encounters were audited by a research assistant, who was blinded to the computer diagnosis. A second assistant re-audited 18% of the charts and found an error rate of 5%.

After the chart audit was complete, two of the physician authors (K.S.H.Y. and J.L.M.) independently compared the diagnoses listed in the computer with the diagnoses in the chart for each encounter, and determined the number of matching diagnoses as well as the number of errors of omission and commission for that encounter.

When the two physician reviewers disagreed on an encounter, they consulted the ICD-9-CM code book and made a decision. If they still could not agree based on joint review, they discussed the case with the third author (W.E.B.) and the final decision was made by consensus of the three physicians.

Definition of a Match

The computer and chart diagnoses were considered a match if the physician reviewers agreed that a match existed and the diagnoses had the same ICD-9-CM three-digit classification. A symptom was not considered the same as a diagnosis, even if the diagnosis often includes that symptom. For example, pharyngitis (462), upper respiratory tract infection (465.9), cough (786.2), and tonsillitis (463) were considered separate diagnoses because they have different ICD-9-CM codes. Likewise, atopic dermatitis (691.8) was considered different from contact dermatitis (692.9), and muscle strain (848.9) was not a match with backache (724.51).

Definition of Analysis Terms

For the purpose of analysis, the following terms were defined. Diagnoses recorded in the chart were considered the reference standard.

- *Accuracy rate*: the number of matching diagnoses in the chart and computer, divided by the total number of diagnoses in the chart
- *Rate of errors of omission*: the total number of diagnoses found only in the chart and not in the computer, divided by the total number of diagnoses in the chart
- *Rate of errors of commission*: the total number of diagnoses found only in the computer and not in the chart, divided by the total number of diagnoses in the chart
- *Error rate*: the number of diagnoses found only in the computer and not in the chart, divided by the total number of diagnoses found in the computer.

Data Analysis

We used the *t* test to compare the mean number of diagnoses per visit in the chart before and after the new system was implemented. The rest of the data analysis involved summarizing and comparing the two computer systems by using *t* tests for means and chi-square for proportions. The accuracy and error rates and errors of omission for each of the two computer systems were calculated with the rate formulas listed above and compared using chi-square analysis. The rates of error of commission were compared using Mantel-Haenszel chi-square test.

Results

A comparison of the patient demographics of group I (preintervention) and group II (postintervention) revealed no statistically significant differences in sex, age, or marital status. The mean number of diagnoses (1.35) recorded in the chart for both groups was the same ($P=.95$).

Measurement of the Accuracy of the New Computer System

VISIT ANALYSIS

We evaluated the accuracy of our computer system by comparing the number of diagnoses recorded in the computer for each office visit with the number of diagnoses in the corresponding chart note, and found that the number of office visits with identical numbers of diagnoses in both

the computer and the chart increased from 236 (79%) in the old system to 252 (84%) with the new system ($P<.001$).

ERRORS OF CODING FOR VISITS

We also calculated the number of visits for which all the diagnoses in the computer record matched all the diagnoses in the chart, and the number of visits for which the computer record had no matching diagnoses as compared with the chart. The number of visits for which all the computer diagnoses matched those in the chart increased from 175 (58%) to 229 (76%) ($P<.001$). Likewise, the number of visits for which there were no matches decreased from 66 (22%) to 25 (8%) ($P<.001$).

ERRORS OF OMISSION AND COMMISSION

The rate of errors of omission using the old computer system was 38% compared with 18% in the new system ($P<.001$). That is, using the new system, it was less likely that the computer record would lack a diagnosis found in the chart note. The rate of errors of commission using the old computer system was significantly higher (19%) as compared with the new system (11%) ($P=.006$); the new system had a lower rate of diagnoses recorded in the computer but not in the chart, as compared with the total number of diagnoses in the chart.

ACCURACY RATE

The new system had a significantly higher accuracy rate (82%) than the old system (62%) ($P<.001$); that is, compared with the old system, the new computer system had a higher percentage of diagnoses per visit that were in both the chart and the computer.

Discussion

The object of this study was to measure the accuracy of the new computerized system. Perfect accuracy was not expected because there will always be some errors in recording, whether in the chart or the computer, and because of the slight time lag between recording the diagnoses on the computer form, which occurs before the patient leaves the office, and the writing of the chart note, which occurs a few minutes to several hours later. We used four different, previously described methods to analyze the accuracy of the new TMR system, which allowed physicians to use prompted checklists of previous diagnoses when recording office visit diagnoses. As a comparison group, we used both an historical control from the same practice and other computer systems reported in the literature.

Our results show that the new system had no effect on the number of diagnoses recorded in the chart. Thus, the number of problems addressed in each encounter was not influenced by the new computer system. Compared with the old system, however, the new system contained a more accurate account of the chart diagnoses and had a lower error rate.

There are only a few other studies of computer system accuracy in the outpatient office setting. Horner and co-workers[16] evaluated the accuracy of computerized billing information in a large university family practice setting. Like TMR, their computer system required the completion of one form for the collection of clinical data and billing information. These investigators measured the accuracy of their computer system by calculating the percentage of visits ($N=1136$) for which all the diagnoses in the computer matched all the diagnoses in the chart, and the percentage of visits for which there were no matches. They found that 60% of the visits had an exact match; in comparison, the new TMR system had a match rate of 76%. In the computer system of Horner and colleagues, there were no matches in 27% of the visits, whereas with the new TMR system, only 8% failed to match.

In 1980, Rice and associates[15] reported on the accuracy and error rate of a computerized research database. Unlike TMR and the computer system of Horner et al,[16] the database of Rice and co-workers was used predominantly for research and required the physician to record diagnostic data on both the billing sheet and the data collection form. An evaluation of the error rate in this database as compared with the chart revealed that 16% of the diagnoses in the computer were not in the medical record and 18% of the diagnoses in the chart were not in the computer. In comparison, using the new TMR system, only 11% of the diagnoses in the computer were not in the chart and 18% of the diagnoses in the chart were not in the computer. Thus, TMR was more accurate than the systems of either Rice or Horner and their respective colleagues, and unlike the Rice system, did not require additional work to capture the data.

There are several sources of potential bias in the current study. Our inability to include some encounters initially selected for analysis because they did not meet eligibility criteria may have introduced bias. The use of an historical control group also can result in bias if factors other than the intervention were responsible for the change. In addition, the problem list generated here may not be applicable to other practices: there may well be regional variances in disease, and there are almost certainly differences in how different physicians describe the same problems, despite using the same ICD-9-CM coding systems.

The TMR system has been shown to meet the needs

of administrators because of its cost-effectiveness,[13] and for the past 5 years, it has been routinely used to maintain problem lists and file insurance claims electronically. A total of 3386 diagnoses, including acronyms, synonyms, and common misspellings, are now maintained in the system and matched to 2481 ICD-9-CM codes.

The discrepancy between computerized databases and patient charts is due in part to the different methods of recording information in the two systems.[4] At every patient visit, many clinicians routinely note diagnostic assessments in two or three places: in a chart note, on a billing form, from which computerized databases are usually drawn, and sometimes on a problem list. The information recorded in each of these three places is seldom identical. It is most specific in the note, highly standardized and coded on the billing form, and often abbreviated or truncated on the problem list. Errors in patient diagnoses found in computerized databases can lead to minor inconvenience, inappropriate treatment, denial of payment, or miscalculation of the prevalence and severity of a health condition. We have demonstrated that a sophisticated computer office system such as TMR can maintain patient problem lists and translate those problems into ICD-9-CM codes for billing. We have also shown that a prompted checklist method of recording diagnoses increases the accuracy of the computer database. Increasing the accuracy of the databases will likely improve health care providers' ability to correctly monitor care and allow a more accurate prediction of the future costs of health care. It may, however, increase the cost of medical care by identifying previously unrecorded additional diagnoses and comorbidity.

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