

Evaluation of Missed Diagnoses for Patients Admitted from the Emergency Department

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Abstract. **Objective:** To define a quality assurance instrument to evaluate errors in diagnostic processes made by physicians in the emergency department (ED). **Methods:** This was a retrospective clinical investigation of inpatient ED records. Over a six-year period, 5,000 medical records of admitted patients were randomly selected for evaluation. Each record was initially examined by one of five physician evaluators. If the primary ED diagnosis differed from the primary discharge diagnosis, the ED record was inspected to determine reasons for the misdiagnosis. The authors considered several aspects of the diagnostic process, including patient history, tests ordered, interpretation of clinical data, choice and performance of procedures, injury pattern recognition, reasoning, and evaluation. Records that demonstrated errors in the diagnostic process were reevaluated for the same diagnostic process errors by a sixth physician. Disagreements regarding suspected errors in the diagnostic process were settled by discussion. Finally, to determine potential medical consequences of the misdiagnosis, one individual reviewed the complete medical records of patients

whose ED medical records were scored with errors by both evaluators. Interevaluator reliability was assessed using Cochran's Q-test with a selected series of medical records. **Results:** Twenty-eight records (0.6%) were found to contain one or more errors in the diagnostic process that contributed to misdiagnosis. For these patients appropriate diagnosis was not made until one to 16 days after admission. Three patients of 18 whose records were available for detailed review may have suffered complications that resulted, in part, from the delay in diagnosis and subsequent treatment. Significant interevaluator reliability for identification of errors in the diagnostic process was obtained ($p > 0.1$). **Conclusions:** A two-tiered evaluation of ED records selected by inconsistent initial and final diagnoses can be used reliably to screen for errors in the diagnostic process made by emergency physicians (EPs). The rate of physician error contributing to a misdiagnosis is very low, suggesting that EPs are delivering quality patient care. **Key words:** errors, medical; diagnostic errors; quality assurance, health care. ACADEMIC EMERGENCY MEDICINE 2001; 8:125-130

THE focus of emergency medicine (EM) remains delivering high-quality patient care and reducing morbidity and mortality. A fundamental belief in health care is that providers are intrinsically motivated to improve patient safety. However, recent organized analyses of medical errors¹ have focused attention on methods of improving the decisions and practices of health care providers and the organization of the health care delivery system. Specifically designed quality assurance procedures may be used to assess physician performance in the emergency department

(ED) as one aspect of identifying and reporting medical errors. An effective method for detecting and identifying reasons for medical errors also may impact medical-legal consequences and interactions with hospital administrators and insurance agencies.

Methods of evaluating quality assurance and physician performance in the ED are deficient in the literature. Many articles discuss medical audits and patient outcomes, but focus primarily on major trauma systems or primary care facilities and not the entire spectrum of EM practice.²⁻⁵ Two recent studies documented 3-4% medical errors in large numbers of patients tracked through the entire health care system from primary care physician, out-of-hospital and hospital care, and convalescence at home.^{6,7} In a smaller study, errors in diagnosis were found to be a major contributor of mortality in cerebrovascular accidents and pneumonia.⁸

We sought to use a method that would focus the scope of assessment on the emergency physician (EP) diagnostic process. To this end, we created a chart review process that evaluated areas of diag-

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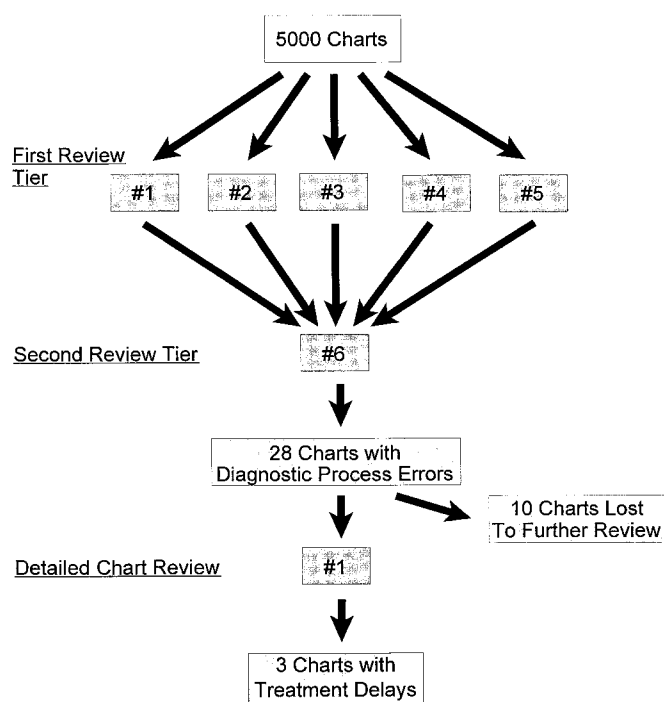


Figure 1. Flow chart of the medical record review process. The number of medical records evaluated at each tier of review is indicated in light gray boxes. Individuals reviewing medical records are indicated by dark gray boxes.

nosis important for quality assurance and that examined resulting patient morbidity. Our objective was to examine the utility of a quality assurance instrument to define errors in diagnostic processes made by physicians in the ED. We used a two-tiered physician evaluation system to review charts of patients admitted to the hospital from the ED. When discrepancies between the admitting and the discharge diagnoses were found, patient data were examined in detail to determine what, if any, mistakes were made by the EP in the diagnostic process, and whether those mistakes affected patient management and outcome.

METHODS

Study Design. We performed a retrospective clinical review of the records of patients admitted from the ED. The study was approved by all relevant institutional review boards.

Study Setting and Population. This study was performed in an urban, trauma level 1 hospital with an annual ED census of more than 70,000. The site is a community hospital and teaching facility affiliated with Wright State University School of Medicine and the Integrated Emergency Medicine Residency Program of Wright State University. Over a six-year period (1992–1998), a total

of 5,000 admissions from the ED were chosen for evaluation (Fig. 1). A convenience sampling was performed by the evaluators who selected days to examine all records of patients admitted over a 24-hour period.

Study Protocol. Each medical record was initially examined by one of five board-certified EP evaluators to determine whether the primary ED admitting diagnosis differed from the primary discharge diagnosis. If a discrepancy was found, the ED record then was reviewed using a set of criteria to determine whether an error in the diagnostic process contributed to the inaccurate initial diagnosis. These criteria were defined from the basic tenets of diagnostic process relevant to the practice of EM.^{9,10} We examined several aspects of the diagnostic process, including history and physical examination, tests ordered, physician judgment and reasoning, injury pattern recognition, procedures performed, and workup (Table 1). These classifications are not exclusive of each other. In general, physician errors were scored when, as determined by review of the medical record, information available or obtainable at the time of ED presentation was not properly used or was ignored. Our criteria developed for this purpose are similar to those classified by Leape et al. as diagnostic or treatment errors.¹¹

Because of the subjective nature of this review process, we used a second tier of evaluation to improve consistency in error reporting. Records that were found in the initial review to contain errors in the diagnostic process were evaluated by a sixth physician using the same criteria. Disagreements between the first and second evaluators were resolved by discussion. Finally, one physician reviewed the complete medical record of patients whose ED charts were scored with an error to determine potential medical consequences of the initial misdiagnosis.

Interevaluator reliability using our criteria for diagnostic process errors was assessed using a selected series of medical records. Forty charts with no errors in the diagnostic process were randomly pulled from the 5,000 previously reviewed. To this pool were added ten that were known to contain errors in diagnostic process. Using the criteria shown in Table 1, the five physician reviewers who participated in the first tier of evaluation independently examined these 50 charts unaware of which ones contained diagnostic errors.

Data Analysis. The number of records containing diagnostic process errors are expressed as a percentage of the total number of records. Reliability was estimated using Cochran's Q-test.

RESULTS

Of the 5,000 charts reviewed, 28 were judged by both tiers to have errors in the diagnostic process (0.6%). Five records judged by a first-tier evaluator to contain errors were eliminated following review by the second-tier physician. The list of patients with their admitting and discharge diagnoses are shown in Table 2. Gastrointestinal bleeding/duodenal ulcer was the most common diagnosis missed (5), followed by digoxin toxicity (3), and pneumonia (3).

Following this review of the 5,000 medical charts, 18 of the 28 complete inpatient records were obtained for further review by one of the physicians to determine what consequences may have resulted from the initial diagnostic errors. The other ten records were not reviewed further either because they could not be located due to inconsistencies in medical record numbers or because pertinent files had been lost from the record. Of the remaining 18 records, only three (17%) were found to have suffered delay in proper treatment due to the errors in the diagnostic process made by the EPs. These treatment delays ranged from 24 hours to 16 days. No patient in this group of 16 suffered a long-term complication, and all were discharged to home. One patient (#18) died 24 hours after admission; however, this death was not related to the error in diagnosis. The final diagnosis of this patient was made at autopsy. This detailed review also disclosed that all of the 18 patients reviewed with errors in the diagnostic process arrived to the ED by emergency medical services (EMS). The majority of this group were elders. No errors due to improperly performed procedures were documented in this group of patients.

The assessment of interevaluator reliability for the review of 50 selected charts gave Cochran's Q statistic of 4.89 with $p > 0.1$. Thus, we cannot exclude the null hypothesis that all physician evaluators classified the charts similarly.

DISCUSSION

In this investigation, two levels of physicians reviewing 5,000 charts of patients admitted from a single ED identified only 28 (0.6%) involving significant errors in the diagnostic process. This includes only physician errors that contributed to an error in diagnosis. Conceivably errors may have been made in cases that received the correct diagnosis by the physician. The magnitude of the error rate for this limited population of hospitalized patients is compatible with previous error analyses of the entire health care delivery system, which documented error rates in 3–4% of patients.^{6,7}

The most common missed diagnosis was gastro-

TABLE 1. Criteria Used to Detect Errors in the Diagnostic Process*

Errors in the history taken or physical examination performed. This includes errors of omission of key portions of the physical examination relevant to the final diagnosis or missing the findings or importance of historical factors available at the time of presentation.

Errors by way of omitting tests or in the interpretation of tests ordered. These are errors of omission when appropriate tests that would have aided in making the correct diagnosis are not ordered, or errors in performance when results of tests ordered are misinterpreted.

Errors in judgment or reasoning that may lead to a misdirected evaluation. This occurs when physicians neglect to consider all possible diagnoses consistent with available information.

Errors in recognition of a predictable pattern of injury. This includes overlooking medical problems or injuries that are typically associated with the presenting complaint or illness or are documented by findings obtained from the physical examination or history.

Errors due to improperly performed procedures. These errors of performance are limited to those executed by the physician that would have directed the evaluation toward the correct diagnosis if the procedure had been performed properly.

*Satisfying one criterion was sufficient to document an error in the diagnostic process.

intestinal bleeding, initially diagnosed as chest pain. Though both complaints necessitate a workup for cardiac etiologies, this review demonstrated that gastrointestinal etiologies can easily be missed if not considered by the EP. We found that incomplete histories and physical examinations, as well as errors in reasoning, led to many of the identified diagnostic errors. Other diagnoses that were inappropriately made upon admission, such as a perforated diverticulum diagnosed as a pneumomediastinum, resulted from errors in the workup and thought processes of the physician. Our audit further confirmed that more common diagnoses that can manifest as ambiguous signs and symptoms, such as urosepsis and digoxin toxicity, can be easily missed if the appropriate tests are not ordered and the diagnoses not considered.

Review of inpatient charts for those patients who were admitted found three of 18 (17%) who may have suffered complications from the delay in diagnosis. Of those charts reviewed, the correct diagnosis and treatment (assuming the discharge diagnosis as the criterion standard) were usually instituted within 24 hours of admission. In many of these instances, the admitting physicians performed a more complete history and physical examination, thus eliciting information to enable a more accurate diagnosis. Our study confirms that significant consequences to patient care may result from information missed during the initial ED evaluation.

TABLE 2. Diagnostic Error Summary

	Admission Diagnosis	Discharge Diagnosis	Criteria for Errors
Patient 1	Abdominal pain	Gastrointestinal bleeding, gastritis	N/A‡
Patient 2	Back pain	Multiple myeloma, fractures	N/A
Patient 3	*Bronchiectasis	Ureteral colic	History and physical exam
Patient 4	Congestive heart failure, urinary tract infection	Pneumonia	N/A
Patient 5	*Chest pain, rule out myocardial infarction	Duodenal ulcer	Physical exam
Patient 6	Chest pain, rule out myocardial infarction	Dissecting thoracic aneurysm	History and physical exam
Patient 7	Chest pain, rule out myocardial infarction	Ulcer disease, gastrointestinal bleeding	History and physical exam
Patient 8	Chest pain, rule out myocardial infarction	Congestive heart failure, digoxin toxicity	N/A
Patient 9	Chest pain, angina	Duodenal ulcer, gastrointestinal bleeding	History and physical exam
Patient 10	Chronic obstructive pulmonary disease exacerbation	Pneumonia	History and physical exam
Patient 11	Confusion	Hypocalcemia, hyperglycemia	N/A
Patient 12	Dehydration, acute renal failure	Digoxin toxicity	Omitted tests, reasoning
Patient 13	Dizziness, anemia	Gastrointestinal bleeding	N/A
Patient 14	Elbow, face abrasion	Elbow, face abrasion and sternal fracture, rule out cardiac contusion	Physical exam, omitted test
Patient 15	Febrile illness	Pseudomembranous colitis	Omitted tests, predictable pattern of injury
Patient 16	Gastroenteritis, chronic renal failure	Pancreatitis	History and physical exam, omitted test, predictable pattern of injury
Patient 17	*Hypotension	Urosepsis	Omitted test, reasoning
Patient 18	†Mental status change	Pulmonary embolus, death	Reasoning
Patient 19	Mental status change	Urosepsis	N/A
Patient 20	Pelvic fracture	Bronchogenic carcinoma	Omitted tests, misinterpreted test
Patient 21	Pneumomediastinum	Perforated diverticulitis	History and physical exam
Patient 22	Pulmonary edema	Atrial fibrillation, theophylline toxicity	N/A
Patient 23	Scalp, face lacerations	Scalp, face lacerations, and pneumothorax	N/A
Patient 24	Shortness of breath	Congestive heart failure, anemia, leukemia	Misinterpreted test, physical exam
Patient 25	Vomiting	Pancreatitis	History and physical exam, omitted test, predictable pattern of injury
Patient 26	Weakness, anemia	Gastrointestinal bleeding	Reasoning, workup, predictable pattern of injury
Patient 27	Weakness	Pneumonia	Misinterpreted test
Patient 28	Weight loss	Digoxin toxicity	N/A

*Denotes three patients whose delay in diagnosis may have resulted in complications for the patient.

†Denotes one patient who died 24 hours after admission.

‡N/A denotes medical records unavailable for review of outcome following diagnostic errors.

The number of subsequent complications was low at our institution partly because of reassessments by in-hospital resident physicians and staff. The risk of not identifying the correct diagnoses and instituting proper treatment may be higher in nonteaching hospitals. This problem may be exacerbated if attending physicians admit patients by telephone and do not perform a diagnostic evaluation until the next day. The possibility of complications from errors in diagnosis is even larger for those patients whom we discharge to home. Thus, future studies of errors in the diagnostic process might include a review of patients discharged from the ED.

By documenting the most common errors made by EPs in the diagnostic process, we determined

specific presentations that could subsequently be used to further physician education and improve the quality of patient care. These presentations then could be correlated with other patient data. Data from our sample suggest that elder patients or those patients arriving to the ED by EMS may be considered high-risk groups for diagnostic errors. In particular, geriatric patients require a more extensive evaluation because this population can little tolerate delays in proper treatment as a result of misdiagnoses. Deficiencies were found in documentation of complete physical examinations, particularly in rectal exams of patients with abdominal pain. In addition, documentation and interpretation of laboratory results, and processes of medical decision making, were found lacking.

To the best of our knowledge, no previous report has documented errors in the diagnostic process made by EPs regarding their admitted patients; however, a variety of areas of medical quality assurance including diagnostic errors have previously been evaluated in clinical settings other than the ED. Three studies from the same institution assessed quality assurance in trauma systems.²⁻⁴ In these studies, trauma nurse coordinators and trauma directors preselected patients to be evaluated from their own initial screening. A committee composed of various members of trauma teams and other related institutions then reviewed the patients' records for complications, delays, and deaths. Morbidity and mortality of trauma patients were analyzed using many different criteria, including errors in diagnoses. A study done by Fischer et al.⁵ looked at errors in diagnosis as one aspect of an overall audit of adverse events from a primary care setting. Two reviewers subjectively categorized the errors into one of four types. Discrepancies were resolved by two of the study authors, who then further evaluated each case using the individual reviewers' comments. The authors reviewed hospital records in only six particularly difficult cases. These reviews focused record analysis on patients who may have had adverse events associated with their medical care. In the present study, we selected records of all patients who were determined to have diagnostic errors, whether or not a significant medical consequence resulted. Thus, a greater range of physician errors may be included in our data.

Kirch and Schaffi¹² studied rates of misdiagnoses over four decades with a hypothesis that advances in diagnostic procedures have reduced misdiagnosis rates. Using a two-tiered review process, these authors identified misdiagnosis using information on death certificates as the criterion standard. They concluded that despite technological advances, the rate of misdiagnosis has remained constant. Similar to our conclusions, they also found that accurate patient histories and physical examinations remain the most important information for reaching an accurate diagnosis.

O'Connor et al.¹³ used two EPs, one consulting physician and one consulting surgeon, to evaluate 400 charts for mistakes in diagnoses of admitted patients. While no specific criteria were used, errors were subjectively classified as minor, moderate, and major. Their misdiagnosis rates (10% and 12%) were much higher than those reported in the present study. Differences in characteristics of the study site and diagnostic tests available to their EPs may have contributed to the higher rate of misdiagnosis. Despite these differences in study design, these authors note diagnostic difficulties in similar categories to those found in the present

study. For example, patients with final diagnoses of pulmonary embolus or congestive heart failure were initially diagnosed as having congestive heart failure or cholecystitis, respectively.

Guly^{14,15} created a numerical scale to measure the severity of diagnostic errors in EDs. The "misdiagnosis severity score" (MSS) combined scores that evaluated treatments that should have been given and the disposition of the patient. Although the MSS was used to describe only the severity of trauma diagnostic errors, the author believed it could be generalized to all areas. Other scales have been designed for specific diagnostic problems, such as radiographic diagnoses.¹⁶

Our main goal was to evaluate EPs' performance by determining their accuracy in the diagnostic process and identifying reasons for diagnostic errors. Our study used a broad population of all patients admitted to the hospital from the ED. We used a specific set of criteria to identify reasons for the diagnostic errors. Although a high degree of interobserver reliability was observed for detection and characterization of diagnostic process errors, our use of a secondary review by one individual provided a greater degree of uniformity. While our method will not identify systematic errors in health care delivery, the method may be broadly applied to ascertain the level of diagnostic process errors made by physicians in a variety of clinical settings.

LIMITATIONS AND FUTURE QUESTIONS

Because we reviewed only patients admitted from the ED, we may have missed errors made during the evaluation of patients who were discharged. A vastly redesigned study would be necessary to study errors in this population due to the lack of a definitive diagnosis and inherent problems with patient follow-up. In this study we assumed the final diagnoses made upon hospital discharge were accurate, and thus, we used this as our criterion standard with which we compared the ED diagnoses. No attempt was made to verify this diagnosis. We would not have selected data from patients if both diagnoses were in error. Our inability to perform a detailed review of all 28 patient records identified to contain errors in the diagnostic process limits the power of our conclusions. However, we anticipate misfiling of data in the medical records occurred randomly and did not introduce a systematic bias to our results. Finally, despite our use of defined criteria to select errors in the diagnostic process, and the high degree of interobserver reliability, there exists some observer-to-observer variability in the choice of patient records with errors in diagnostic process. Thus, some charts may have been dismissed that actually contained errors.

Future studies of errors in the diagnostic process might include a review of patients discharged from the ED.

CONCLUSIONS

Our survey suggests that EPs make diagnostic process errors in only 0.6% of their patients. In a high-volume ED similar to the site of this study, a two-tiered chart audit based on ED and final diagnoses can be a useful instrument for ED quality assurance. Valuable information can be obtained to improve both physician performance and subsequent patient care. This method can be used to evaluate and compare other EP practices.

References

1. Kohn LT, Corrigan JM, Donaldson MS (eds). *To Err Is Human: Building a Safer Health System*. Report of the Institute of Medicine. Washington, DC: National Academy Press, 2000, p 312.
2. Davis JW, Hoyt DB, McArdle MS, et al. An analysis of errors causing morbidity and mortality in a trauma system: a guide for quality improvement. *J Trauma*. 1992; 32:660–6.
3. Davis JW, Hoyt DB, McArdle MS, Mackersie RC, Shackford SR, Eastman AB. The significance of critical care errors in causing preventable death in trauma patients in a trauma system. *J Trauma*. 1991; 31:813–9.
4. Shackford SR, Hollingsworth-Fridlund P, McArdle M, Eastman AB. Assuring quality in a trauma system—the medical audit committee: composition, cost, and results. *J Trauma*. 1987; 27:866–72.
5. Fischer G, Feters MD, Munro AP, Goldman, EB. Adverse events in primary care identified from a risk-management database. *J Fam Pract*. 1997; 45:40–6.
6. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients: results of the Harvard Medical Practice Study. *N Engl J Med*. 1991; 324:370–6.
7. Thomas EJ, Studdert DM, Newhouse JP, et al. Costs of medical injuries in Utah and Colorado. *Inquiry*. 1999; 36:255–64.
8. Dubois RW, Brook RH. Preventable deaths: who, how often and why? *Ann Intern Med*. 1988; 109:582–9.
9. Hamilton GC. Introduction to emergency medicine. In: Hamilton GC, Sanders AB, Strange GR, Trott AT (eds). *Emergency Medicine: An Approach to Clinical Problem-Solving*. Philadelphia: W. B. Saunders, 1991, pp 3–18.
10. Dailey RH. Approach to the patient in the emergency department. In: Rosen P (ed). *Emergency Medicine: Concepts and Clinical Practice*. St. Louis: Mosby, 1992, pp 22–37.
11. Leape L, Lawthers AG, Brennan TA, Johnson WG. Preventing medical injury. *Qual Rev Bull*. 1993; 19:144–9.
12. Kirch W, Schaffi C. Misdiagnosis at a university hospital in 4 medical eras, report of 400 cases. *Medicine*. 1996; 75:29–40.
13. O'Connor PM, Dowey KE, Bell PM, Irwin ST, Dearden CH. Unnecessary delays in accident and emergency departments: do medical and surgical senior house officers need to vet admissions? *J Accid Emerg Med*. 1995; 12:251–4.
14. Guly HR. A scale for measuring the severity and diagnostic errors in accident and emergency departments. *J Accid Emerg Med*. 1997; 14:290–2.
15. Guly HR. The misdiagnosis severity score and doctors' perception of the severity of diagnostic errors. *J Accid Emerg Med*. 1997; 14:293–4.
16. Wardrope J, Chennells PM. Should all casualty radiographs be reviewed? *BMJ*. 1985; 290:1638–40.

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