Infectious Diseases Consultation: Impact on Outcomes for Hospitalized Patients and Results of a Preliminary Study

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In the absence of detailed and specific data on outcomes, specialists are thought to contribute excessively to the cost of care. Infectious diseases physicians are at further risk of heavy utilization of medical resources because their patients often are those with serious complications or expensive underlying diseases (e.g., AIDS). By using readily available information in a sophisticated computer database, we examined the crude economic impact of an inpatient infectious diseases consultation and identified important matching variables for more refined analysis. The study was performed at LDS Hospital (Salt Lake City), a tertiary care facility with four full-time infectious diseases physicians. A total of 496 cases (patients who were seen by an infectious diseases consultant) were matched with 3,117 controls (patients who were not seen by an infectious diseases consultant). Matching was performed on the basis of age, sex, exact discharge diagnosis–related group, minimum length of hospital stay equal to the interval from admission to consultation for cases, and measures of the severity of illness (nursing acuity score and the number of secondary diagnoses). Cases had longer lengths of hospital stays, longer intensive care unit lengths of stays, and higher antibiotic costs than did matched controls, and if the consultation occurred in the last one-third of hospitalization, cases had shorter lengths of hospital stay and lower antibiotic costs than did controls.

Infectious diseases practitioners are concerned and uncertain about their future roles. As market forces radically alter the landscape of the American health care system, the coeditors of the Annals of Internal Medicine [1] recently discussed the future of internal medicine and its subspecialties; they outlined the ongoing changes that will dramatically reduce the need for highly specialized physicians who comprise a large proportion of the medical work force.

Infectious diseases practitioners may be potentially shielded from these changes because of their value-added services beyond direct patient care and consultation, but only if they can demonstrate the value of these contributions. These services include management of infection control programs, microbiology laboratories, and antibiotic utilization programs throughout their institutions. However, infectious diseases physicians often are not reimbursed for these activities, a clear sign of the currently perceived value of these services. Yet, each of these programs will offer significant potential cost savings in increasingly common managed health care plans [2].

New areas of medical investigation have arisen, including outcome research and outcome management; the exponential growth of these areas has not only increased research on health care delivery but also strengthened programs measuring the quality of care and the cost-effectiveness of care [3]. Some health care institutions and physicians are wary of these research areas, knowing that they will be expected to provide detailed data on outcomes associated with their care of patients to maintain health care contracts and assure adequate reimbursement. Several large employers are already demanding this information for referral of patients to physicians and hospitals; similar information will also be used by the health care networks that are rapidly forming as well as by third party payers in determining physician eligibility as a provider [4].

Outcome data are being used to evaluate the contributions of specialists as more attention is focused on cost containment. Several studies have suggested that resource use is higher with medical specialists than with generalists, only further emphasizing the impression that specialists are too costly for managed care organizations [5–8]. Several specialty organizations have responded by conducting their own studies of the economic impact of their care [9–11]. Unfortunately, infectious diseases physicians are usually evaluated by managed care organizations on the basis of the cost of their direct patient care alone rather than their economic contribution in other areas. Infectious diseases physicians are said to be at special financial risk because they often care for patients with serious complications or expensive underlying diseases (e.g., AIDS). Recently, one study demonstrated the favorable impact of infectious diseases consultation on the risk of hospitalization for patients with AIDS [12].

Without further studies, the credential process used by managed care organizations will likely be mainly economic, thus leading inevitably to a foregone conclusion that patient care...
by infectious diseases specialists is more expensive than that by generalists. An organized effort is necessary to conduct scientifically valid studies that evaluate the impact of infectious diseases practitioners on the outcome for patients. In this preliminary study, we have attempted to examine the crude impact of an inpatient infectious disease consultation on the use of resources and the length of stay in the hospital.

**Methods**

The LDS Hospital is a 520-bed teaching hospital affiliated with the University of Utah School of Medicine in Salt Lake City. The present study was performed by using a hospital information system known as HELP (health evaluation through logical processing), which has been described in detail in an earlier report [13]. The hospital information system has been clinically operational at the hospital for >15 years. The hallmark of the system is a computerized medical record containing an integrated patient database drawn from numerous sources, including pharmacy, laboratory, surgery, radiology, and admitting services among others [13].

Costs were calculated with use of the Standard Cost Manager, a microcomputer software system designed and developed by Intermountain Health Care and Ernst and Whinney [14]. This system, which uses time and motion studies to examine the actual cost at the transaction level, is electronically linked to the HELP system and has been described in more detail in previous reports [13–16]. In addition, we have developed an institutional severity adjustment system based on nursing acuity [17]. The nursing acuity score is calculated for all patients for each nursing shift; the nursing acuity score correlates well with other severity measures, and the scoring system provides the ability to measure the severity for each nursing shift as well as the total hospitalization. The nursing acuity score also serves as a severity matching marker for intervals of the hospital stay (i.e., for the period from admission to a specific event).

We can match patients by using an average nursing acuity score for their complete admission or by using the average score for the period from admission to an infectious diseases consultation, for instance. The total nursing acuity score for each nursing shift in combination with the primary discharge diagnosis-related group (DRG) has been found to predict the length of hospital stay ($r^2 = .58$), the cost of hospitalization ($r^2 = .69$), and the mortality rate (98.1% of variation) [16]. The raw nursing acuity score was used to assign patients to one of four categories in the matching procedure to adjust for severity.

**Case Selection and Matching Methodology**

Inpatients at LDS Hospital who were seen by an infectious diseases consultant were included as cases in our matched cohort study. The study period extended from 1 January 1992 to 31 December 1993. Cases were matched with cohort patients (controls) who were not seen by an infectious diseases consultant. Matching was performed on the basis of sex, age (±10 years), exact discharge DRG, interval from admission to initial consultation for cases, number of secondary diagnoses, and average nursing acuity score for the period from admission to the initial infectious diseases consultation. Up to 10 matched controls were allowed for each case. Importantly, no attempt was made in this preliminary study to match for the exact site of infection (e.g., bloodstream). Furthermore, aside from the use of the nursing acuity score and the number of secondary infections, no other measure of the severity of illness was utilized.

We compared cases and controls on the basis of various outcomes, including mortality rate, length of hospital stay, length of intensive care unit (ICU) stay, cost of antimicrobial use, and duration of antimicrobial use. We also compared the attributable differences in these outcomes by calculating the difference between each case and the average of all controls matched with that case. Then these differences were summed and averaged for the various outcomes of interest [18].

**Results**

We identified 806 hospitalized patients who as inpatients were seen by an infectious diseases consultant at LDS Hospital during the study period. The consultations were performed by a total of four board-certified infectious diseases physicians. Of the 806 patients, matches were found for 496. The 496 cases were matched with 3,117 cohort patients (controls). The mortality rate among the cases was 11%, and the mortality rate among the controls was 4%. Mean lengths of hospital stays were 14.7 days for the cases and 8.97 days for the controls. Mean lengths of ICU stays also differed (4.59 days for cases vs. 2.6 days for controls). Antibiotic use was also different (mean number of different antibiotics: 2.7 for cases vs. 1.26 for controls). The average antibiotic duration and the average antibiotic cost were 10.69 days and $1,448, respectively, for the cases and 4.4 days and $446, respectively, for the controls.

The attributable differences in outcomes between the cases and controls paralleled the group differences but were less pronounced. The crude differences in costs and lengths of hospital stays revealed that on average cases stayed in the hospital 4.12 days longer and also spent 1.83 more days in the ICU than did controls. Antibiotic use was also greater among the cases than among the controls (crude increase in extra antibiotics, 1.1; extra days, 4.78; extra cost, $689.95).

Similar comparisons were made between the cases and the controls on the basis of the period during the hospitalization that the initial consultation was performed. An analysis of the first and second one-third of hospitalization revealed trends similar to those of the overall analysis. However, an analysis of consultations performed during the last one-third of hospitalization showed an opposite trend. Within this period, there were 22 cases and 135 controls; the length of hospital stay for the cases was 7.23 days fewer than that for the controls, and...
the length of ICU stay for the cases was 3 days fewer than that for the controls. The average antibiotic duration and the average antibiotic cost for the cases were 2.85 days shorter and $510 less, respectively, than those for the controls.

**Discussion**

This preliminary study attempted to evaluate a critical issue for infectious diseases physicians: the crude impact of inpatient infectious diseases consultations on the use of medical services and the quality of care delivered. The results should be viewed with great caution because the methodology includes some important shortcomings. Infectious diseases consultation may well be a marker for a more severely ill patient, and severity of illness could not be adequately controlled for with this approach.

We attempted to adjust for the severity of illness by using two previously validated matching criteria: the number of secondary diagnoses and the average nursing acuity score for the period from admission to the time of the initial infectious diseases consultation. The number of secondary diagnoses is a crude reflection of severity that depends on the coding practices of each individual coder, and nursing acuity is limited because it does not include important physiological information. Nevertheless, these data were readily available in the computer database, and our crude analysis gave us experience in approaching this issue. In the future, we would recommend adding to our current methodology the following matching criteria: APACHE II or III scores for ICU patients, exact sites of infections, and possibly exact pathogens.

We did not separately analyze resource use and complications in the periods before and after the infectious diseases consultation (which may show a different outcome), nor did we examine the effect of each of the four infectious diseases consultants. These considerations will be important in a more detailed and more refined future analysis. We did observe an interesting paradox: overall, an infectious diseases consultation was associated with a longer length of hospital stay, but if the consultation was obtained in the last one-third of hospitalization, it was associated with a shorter length of hospital stay. We have no good explanation for this finding; however, it may be partially explained by the helpful role an infectious diseases consultation may play in discharging patients in a timely fashion to home where they will receive intravenous antibiotic regimens.

Increasingly, medical specialists are under pressure by managed care organizations to define their value (quality per unit of cost). In a positive light, this value might be defined as improved quality of care and decreased cost of care. Obviously, infectious diseases practitioners contribute in many ways to patient care (e.g., by managing microbiology services, infection control programs, and antibiotic use). However, the largest portion of their effort is in direct patient care. Data evaluating the positive impact of infectious diseases consultation on the use of hospital services for patients with AIDS have already been reported [12]. These types of studies have been commissioned and funded by a variety of specialty organizations to help their members demonstrate the impact of their care [9–11].

Unfortunately, most managed care organizations, whose overriding interest is to cut costs, will not be influenced by the view of the infectious diseases practitioners that they are indispensable until carefully obtained data are available showing their impact on resource utilization or cost. Infectious diseases practitioners, as all specialists, will be under increasing pressure to demonstrate the value of their services in an era when the specialist is viewed as too common, too expensive, and too dispensable. In this study, we began the analysis of variables necessary for carrying out such an investigation.

**References**