THE CLINICAL ECONOMICS OF NUTRITION
SUPPORT SERVICES AND ANTIBIOTIC
MEDICATIONS FOR THE CRITICALLY
AND TERMINALLY ILL ELDERLY

Deborah S. Kitz, Ph.D.
Henry Glick, M.A.
John M. Eisenberg, M.D., M.B.A.

From the Center for Research in Day Surgery, Department of Anesthesia;
Leonard Davis Institute of Health Economics; and Section of General
Medicine, Department of Medicine; University of Pennsylvania, Philadelphia,
Pennsylvania

Prepared for the Biological Applications Program, Office of Technology
Assessment, U.S. Congress.

June 2, 1986
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. INTRODUCTION</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>II. ECONOMIC ANALYSIS</strong></td>
<td></td>
</tr>
<tr>
<td>Types of Costs</td>
<td>6</td>
</tr>
<tr>
<td>Cost-Finding Methods</td>
<td>8</td>
</tr>
<tr>
<td>Types of Economic Evaluations</td>
<td>10</td>
</tr>
<tr>
<td><strong>III. NUTRITION SUPPORT SERVICES</strong></td>
<td></td>
</tr>
<tr>
<td>National Expenditures for Nutrition Support Services</td>
<td>12</td>
</tr>
<tr>
<td>Expenses Related to Nutrition Support Services</td>
<td>12</td>
</tr>
<tr>
<td>Side-Effects</td>
<td>15</td>
</tr>
<tr>
<td>Adverse Events Avoided by Use of Nutrition Support</td>
<td>18</td>
</tr>
<tr>
<td>Nutrition Support Services for Critically and Terminally Ill Elderly Patients</td>
<td>20</td>
</tr>
<tr>
<td>Payment for Nutrition Support Services</td>
<td>25</td>
</tr>
<tr>
<td><strong>IV. ANTIBIOTIC MEDICATIONS</strong></td>
<td></td>
</tr>
<tr>
<td>National Expenditures for Antibiotic Medical Use</td>
<td>31</td>
</tr>
<tr>
<td>Cost of Administering Antibiotics</td>
<td>32</td>
</tr>
<tr>
<td>Adverse Reactions and Side-Effects</td>
<td>34</td>
</tr>
<tr>
<td>Methodologic Issues</td>
<td>42</td>
</tr>
<tr>
<td>Antibiotic Medications Used for Critically and Terminally Ill Elderly Patients</td>
<td>43</td>
</tr>
<tr>
<td>Payment for Antibiotic Use</td>
<td>44</td>
</tr>
<tr>
<td><strong>V. DEFINING CRITICAL AND TERMINAL ILLNESS</strong></td>
<td>46</td>
</tr>
<tr>
<td><strong>VI. IMPACTS FROM DIFFERENT POINTS OF VIEW</strong></td>
<td>51</td>
</tr>
<tr>
<td>Patient Point of View</td>
<td>53</td>
</tr>
<tr>
<td>Hospital Point of View</td>
<td>53</td>
</tr>
<tr>
<td>Third Party Payer Point of View</td>
<td>54</td>
</tr>
<tr>
<td>Societal Point of View</td>
<td>55</td>
</tr>
<tr>
<td><strong>VII. ETHICAL ISSUES</strong></td>
<td></td>
</tr>
<tr>
<td>Rationing</td>
<td>56</td>
</tr>
<tr>
<td>Societal Issues</td>
<td>57</td>
</tr>
<tr>
<td>Hospital Issues</td>
<td>57</td>
</tr>
<tr>
<td>Physician Issues</td>
<td>59</td>
</tr>
<tr>
<td><strong>VIII. POLICY IMPLICATIONS</strong></td>
<td>60</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

Concern about health care expenditures during the past two decades has led to a variety of policy initiatives, third party payer regulations and individual research efforts aimed at cost containment. Government and insurer efforts have usually concentrated on high unit-cost medical interventions such as inpatient days of care and high-technology services. Professional Standards Review Organizations (PSROs) were developed through the Medicare program and emphasized efforts to decrease unnecessary inpatient days of care. Blue Cross organizations designated hospitals that could maintain their own utilization review programs, also concentrating on unnecessary inpatient admissions and days of care. Second opinion surgery programs also emphasized high unit cost services to detect and prevent unnecessary ones. Efforts to limit the development of costly, high-technology interventions such as organ transplant programs, CAT scanner facilities and neonatal intensive care units were carried out through health systems agencies (HSAs) and the certificate of need (CON) process.

In contrast, many individual clinical investigators and medical care institutions concentrated their efforts on the use of less costly "little ticket" interventions such as laboratory services, radiologic examinations and the use of specific pharmaceutical products (1). A variety of approaches have been incorporated in these efforts, including education, administrative changes, penalties and rewards (2).

The success of these efforts to improve the use of medical care technology has been limited. Evaluations of PSRO programs, for example, indicate that little change in utilization occurred (3-5), and individual
efforts also met with limited success. Efforts that have resulted in decreased use of services usually have been successful only in the short-term (1, 6). Other investigators (7) have found that the cost of instituting educational programs to change behavior outweighs the savings from decreased utilization.

The limited success of these government, insurer and individual programs may be related less to the rigor of the efforts than to the reimbursement environment that existed when the efforts were implemented. Until recently, cost-based systems were used to pay hospitals. All routine costs for inpatient days, costs associated with high technology interventions and expenses for low cost services were reimbursed by third party payers. This reimbursement system provided little incentive for hospitals to encourage the more efficient use of resources.

The recent implementation of case-mix payment programs such as those based on diagnosis-related groups (DRGs) for Medicare and Medicaid patients encourages hospitals to determine the most efficient use of resources. The predetermined fixed-payment is used to pay hospitals for all components of inpatient care, including routine costs, diagnostic services and therapeutic interventions. When more services are used during a hospitalization, the fixed payment is less likely to reimburse a hospital adequately for those services. However, when a lower level of intensity of services is delivered during a hospitalization, the fixed payment is more likely to cover the hospital's cost for these services. In environment, where the cost of individual services does not determine levels of payment, hospitals have an interest in identifying and encouraging the most efficient mode of care. It is more likely that efforts to decrease the use of both high and low
unit-cost interventions will be successful. It may be that previous programs that were unsuccessful in changing physicians' hospital practices would be successful in the environment of prospectively determined payment levels.

Medicare may modify the fixed payments that are made to hospitals by making periodic adjustments in payment rates. One method calls for adjusting payments for specific DRGs as changes in technology occur or as evaluations of inputs to care become available. Particular DRGs may be selected for review if the clinical efficacy of inputs to care is uncertain, if the individual DRG accounts for a large portion of Medicare outlays, or if unnecessary or inappropriate services seem to be used in caring for these patients. These efforts to adjust hospital payments encourage the use of technologies that have positive effects on clinical outcome for all patients, including severely ill patients, whose care may be particularly expensive.

This approach to adjusting expenditures suggests that care delivered to critically and terminally ill Medicare enrollees may be the subject of such evaluations, especially if their care is particularly expensive. A number of investigators have examined the proportion of Medicare payments allocated to individuals who died within a given time frame (see Section V of this report). Lubitz and Prihoda (8), for example, found that over one-quarter of all Medicare expenditures in 1978 were allocated to the almost 6 percent of Medicare beneficiaries who died in that year. Other investigators have found that the approximately 5 percent of Medicare beneficiaries who die in a year account for one-fifth to one-quarter of all Medicare payments (9-10).
When investigators have characterized high cost hospital patients, they have found that Medicare patients account for a substantial portion of these patients. Fleming and his colleagues (11) found that among discharges from 167 hospitals, 55 percent of the high cost patients were covered by Medicare. In addition, one out of ten Medicare patients was considered high-cost, and these patients accounted for 40 percent of the charges incurred by all Medicare patients discharged from these institutions.

Care delivered to critically ill patients is also likely to be scrutinized by hospitals and by Medicare because of the large capital investments necessary, such as those to build intensive care units or, to purchase high technology monitoring equipment. This scrutiny is particularly likely because of the equivocal evaluations of many interventions applied to critically ill patients. If the services are expensive but contribute little extra to the success of medical care, then the payor will not be interested in supporting them, and with prospectively-set payment levels, neither will the hospital be willing to pay for the services.

Two common medical care interventions, nutrition support services and antibiotic medications, are used frequently in caring for high-cost terminally and critically ill patients. Although the cost of these two services have been evaluated in several recent analyses, these evaluations usually have been limited to expenses for the specific service. The costs of side-effects and other related costs have not been carefully assessed, and expenses avoided by preventing adverse outcomes have not been fully examined.
This document reviews the techniques that are available for assessing the economic impact of medical care interventions, provides a critical review of the studies that have examined the financial consequences of the use of nutrition support services and antibiotic medication, describes how their economic impact may vary from different points of view, proposes the need for further studies and suggests policy implications of the available data.
I. ECONOMIC ANALYSES

Types of Costs

Illness and the medical interventions to diagnose and treat it consume substantial resources. Health economists have developed a classification system for the cost of these resources. Three types of costs - direct, indirect and intangible - are generally used to categorize these costs. The paragraphs below provide brief descriptions and examples of each type of cost.

**Direct costs** are the value of resources that could be allocated to other uses in the absence of disease (12). These direct costs are generally transactions for tangible products and services related specifically to the illness or to the provision of the medical care intervention, and include both direct **medical** and direct **nonmedical** costs. Medical costs for nutrition support services, for example, are generated by ordering the service (e.g., medical and clerical personnel costs), admixture preparation (e.g., solutions, equipment, pharmacy and nursing personnel costs), delivery (e.g., technician and supply or dispatch personnel costs) and the apparatus and labor for administration of the nutritional material (e.g., intravenous pumps and tubing, catheters, syringes and nursing costs). These costs may be incurred in different sites of care, including hospitals, ambulatory care programs and in-home medical care. Nonmedical costs occur as a direct result of the illness and its medical care, but these expenses are not medical in nature. They are other costs that are incurred because of the illness or the care of it. For example, travel costs to a physician's office or for family members to visit hospitalized inpatients, costs for special food items and expenses for homemaker services are all direct nonmedical costs.
Direct costs may be fixed, variable, or semifixed (alternatively called semivariable). Fixed costs do not vary with the volume of the medical service provided. For example, the salary of the director of the hospital pharmacy is not likely to vary with the number of total parenteral nutrition (TPN) solutions prepared. In contrast, variable costs are dependent on the volume of the medical intervention provided. For example, the cost of bottles of intravenous (IV) solution, IV lines and catheters are all variable costs.

Semifixed or semivariable costs have both fixed and variable components, in that they increase only after a substantial increment in services provided. For example, the cost of batch processing amino acids for five or ten bags of TPN solution includes storage of solution, which will not increase until the volume of services increases enough to require additional storage space. Then the storage costs will be fixed until another increase in the number of services provided is large enough to require still more space.

Distinguishing between fixed and variable costs is essential for calculating marginal costs, which should serve as the basis for decisions to change the volume of a medical intervention (or, for the clinician, to offer it to a given patient). Marginal costs are incurred by adding a unit of service or are saved by reducing a unit of service. Thus, the marginal costs of providing additional services in an existing program do not include capital acquisition, training and other fixed costs. Only the additional cost of providing the service, which may include personnel time for that one extra service and supply costs for that service, are included in assessing marginal costs.
It may be useful to distinguish marginal costs from **incremental costs**. Whereas marginal cost is a term that describes the cost of adding units of service to an existing program, incremental costs represent the costs of establishing a program. Using these definitions, a hospital that has no TPN program and is considering the establishment of one is facing incremental costs (for which the hospital hopes to have an incremental benefit). On the other hand, if the hospital already has a TPN program and the clinicians want to provide TPN to more patients, then the hospital faces marginal costs for which it expects to obtain marginal benefits.

**Indirect costs** are the costs of lost opportunities - such as the ability to earn income - that are due to morbidity and mortality. These costs are experienced by the patient, family, friends and society because of the lost patient's contribution to society. Indirect costs are incurred because of limitations on an individual's ability to continue his or her normal routine. One method of measuring these costs - the human capital approach - is to estimate foregone earnings due to morbidity and premature death. Another method of assessing indirect costs - the willingness to pay approach - relies on patients' reports of how much they would pay to reduce the likelihood of an adverse event.

**Intangible costs** include pain, suffering and other undesirable outcomes of illness that are difficult to measure directly. Investigators who assess these costs usually determine the frequency of the events, but rarely are able to assign costs to them. However, methods such as willingness-to-pay have been used to ascribe monetary values to the intangible outcomes.

**Cost-Finding Methods**

Direct costs of medical care may not equal their price because: 1) there are widespread imperfections in the medical care "market" (including
cross-subsidies of services and lack of information about true costs upon which the calculated costs could be based), and 2) the point of view from which a study is conducted may affect the cost factors that are included in the analysis and the methods used to estimate the cost of the interventions. To address these issues, a number of methods have been developed to estimate costs, including component enumeration, cost to charge ratios and multiple regression techniques.

In component enumeration, the cost of an intervention is "built up" by summing the costs of its elemental tasks. For the first step of this method, a list is developed of the elemental tasks of each intervention. Second, the resources consumed for each component are estimated using techniques such as time and motion studies or activity diaries. These resource estimates are then multiplied by their cost (prices may be used if they are the true cost to the decision maker) to calculate the cost of each task in the third step. In the fourth step, the costs of all tasks are summed to calculate the total cost of an intervention (13).

Alternatively, cost to charge ratios use a top-down approach, starting with the charge for an intervention and adjusting it to estimate its true cost. This adjustment is usually made by multiplying the charge by the proportionate "mark-up" of costs in a department. In many hospitals, there is wide variation in the charges used by different departments. In part this relates to the way that hospitals allocate costs to different departments by an accounting algorithm called "step-down" accounting. However, it is also related to cross-subsidies by parts of the hospital that can generate income (e.g., pharmacy) to parts of the hospital that generate little or no income (e.g., social work department). To control for this variation in charges, the cost to charge ratios reported to the federal
government in hospitals' cost reports may be applied to charges.

The third approach, **multiple regression techniques**, requires data on the variety of resources that are consumed (e.g., number of inpatient days, ancillary services, pharmaceuticals and nutrition support services) by a group of patients. Total cost data for these patients must also be available. Traditional regression techniques are then used with the volumes of the different services serving as the independent variables and with total cost as the dependent variable, to determine the contribution of each service to total costs. The y-intercept computed in the regression equation identifies the fixed component of total costs. The regression equation may also be used to determine the contribution of providing a unit of a specific service to total costs.

**Types of Economic Evaluations**

The results of economic evaluations of health care interventions may provide valuable information to policy-makers, hospital administrators and providers concerned with delivering medical care in an environment in which financial resources are constrained. There are three common types of economic evaluations: 1) cost identification studies; 2) cost-effectiveness analysis; and 3) cost-benefit analysis.

Cost identification simply requires that all the costs associated with an intervention be estimated and tabulated. Outcomes from the intervention are not assessed, the goal is limited to calculation of the cost of alternative approaches to patient care. This type of evaluation is valuable in determining the economic impact of an intervention on a hospital but does not consider its clinical effectiveness. It is also sometimes called a "cost-minimization" analysis because the goal is often simply to minimize cost among alternative approaches.
For cost-effectiveness analyses, an outcome is defined and the costs of achieving that outcome via alternative approaches are compared. The outcome may be lives saved, cases of disease prevented, or other relevant clinical outcomes, but it must be explicit. For example, a cost-effectiveness analysis might be conducted of the alternative approaches to maintaining patients' blood volume intraoperatively, such as transfusion, patient homologous transfusion, and donor transfusion. The cost of all ancillary services required by each method, the incidence and cost of treating any adverse reactions associated with each method, and the cost of obtaining blood would be summed. In addition, clinical outcomes would be determined, and the cost per unit of outcome for each intervention could be compared. Since many medical services have multiple outcomes (e.g., lives saved, cases detected or cured, improved quality of life, patient satisfaction), the determination of a single unit of outcome can be difficult. One approach to solving this problem is called utility analysis, in which the value of each outcome is assessed and the different values are added as units of utility.

Cost-benefit analyses require that all facets of the intervention, including the resources they consume and the value of the outcomes, also be measured in the same units, usually dollars. For example, the outcome of an intervention may be lives saved. In a cost-effectiveness analysis, the results would be expressed as dollars spent per life saved. In a cost-benefit analysis, the value of all resources consumed in providing the intervention and of the life saved would be expressed in dollars. The net cost or net benefit could be determined, thereby balancing the dollar value of the lives saved against the dollar cost of all resources used to provide that intervention.
III. NUTRITION SUPPORT SERVICES

National Expenditures for Nutrition Support Services

Nutrition support services are provided to approximately 15 percent of all hospitalized patients each year; 11.4 percent receive oral supplement services, 2.1 percent receive enteral feedings and 1.5 percent receive TPN. (14,15). In 1984, almost $1 billion was spent on TPN solutions and equipment, and $360 million was spent on enteral equipment and solutions. Including physician fees and administration costs, approximately $3 billion was spent on TPN for hospitalized patients in 1984 (15).

A number of investigators have examined the economic impact of nutrition support services - usually TPN and enteral nutrition (EN). However, the studies usually have been descriptive in nature and oriented toward one type of service in patients with specific diagnoses (16), have concentrated on pre- or postoperative nutrition support services (16-22) and have been limited to expenses for solutions and equipment. For inpatients, reports of the cost of per day solution and equipment per day range from approximately $150 (Canadian) to $485 (US) (17-18).

Expenses Related to Nutrition Support Services

Economic evaluations of nutrition support services have usually been limited to expenses for solutions and equipment. However, other components of providing nutrition to patients may also increase medical care expenditures, such as prolonged hospital stay, professional services and additional monitoring or diagnostic testing. Table 1 lists the components of these expenses. For example, in their trial of preoperative nutrition support for patients undergoing surgery for esophageal or stomach cancer,
<table>
<thead>
<tr>
<th>Component of Cost</th>
<th>Estimated Expense</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Solution and Equipment</td>
<td>a) $150/day</td>
<td>a) 17</td>
</tr>
<tr>
<td></td>
<td>b) $250-$185/day</td>
<td>b) 18</td>
</tr>
<tr>
<td>2) Insertion (one-time)</td>
<td>a) $200-$100/day</td>
<td>a) 18</td>
</tr>
<tr>
<td>3) Laboratory Tests</td>
<td>a) $25-$210/day</td>
<td>a) 18</td>
</tr>
<tr>
<td>4) Nutrition Support Service</td>
<td>a) $0-$140/day</td>
<td>a) 18</td>
</tr>
<tr>
<td>5) Side Effects/Complications</td>
<td>a) $150-$275/day</td>
<td>a) 17</td>
</tr>
<tr>
<td></td>
<td>b) $0-$100/day</td>
<td>b) 18</td>
</tr>
</tbody>
</table>

Table 1: Components of Total Additional Cost of Inpatient Total Parenteral Nutrition
Heatley and colleagues (23) performed periodic diagnostic testing of immune status and multiphasic biochemical testing of patients receiving preoperative TPN. Although expenses for this diagnostic testing were not enumerated, they may have been substantial, particularly since some patients were tested periodically for up to one year after discharge.

McArdle, et al, (22) also used additional laboratory tests to monitor patients' responses to parenteral and enteral nutritional support. They included laboratory tests of protein, albumin, ammonia, urea, glucose and total iron binding capacity determinations, and a variety of hormone assays. Of course, some of these studies may have included tests that were done for the purpose of research rather than patient care. It is difficult to know whether these costs would be incurred in typical practices. If they are performed outside of research studies for nonstudy patients receiving of nutritional support, they are costs that should have been included in an economic analysis of parenteral and enteral nutrition.

Twomey and Patching (18) do report expenses for factors other than solutions and equipment. Based on charge data from five California hospitals, they found that physician fees, radiologic examinations, laboratory tests and nutrition support team consultations constituted about 32 percent of the average total daily expenses for nutrition support services. Based on this charge information and the estimated number of patients receiving parenteral nutrition support (550,000) (14), national expenses for components of nutrition support other than solution and equipment may be as high as $89.1 million. Thus, these factors are important to consider in assessments of the economic impact of nutrition support services.
Steinberg and Anderson, in their report to the American Society for Parenteral and Enteral Nutrition, also list unpublished estimates of the cost of administering TPN from single institutions (15), ranging from $50 for solutions alone to $75 at a VA hospital, to $90 (Canadian) for solutions and labor at a Canadian hospital, to an estimate from a pharmaceutical company with a maximum of $400 per day, including lab tests. Estimates of the cost of providing enteral nutrition also included personal communications and ranged from $18-$30 per day.

Side-Effects

The development of side-effects and complications is another component of the cost of nutrition support that has received limited attention. Investigators who have addressed this issue usually have focused on catheter-related problems and, even so, have not examined the financial impact of these problems.

Miller, et al, (24) examined complications and side-effects that occurred in children receiving TPN during two time periods. The complications included catheter-related infections, metabolic complications such as jaundice and metabolic acidosis, and problems arising from solution administration (such as pleural effusion and venous thrombosis). In the latter data collection period, they found that 1.9 percent of patients receiving TPN experienced complications. Problems associated with administration of the solution accounted for almost all of the complications in the group receiving TPN by peripheral vein. Infections and metabolic complications accounted for most of the complications in the group receiving TPN by central vein. Increased expenses for these complications were not assessed by Miller and his colleagues.
Detsky and his colleagues (25) estimated the frequency of iatrogenic complications from both TPN and EN. Pneumothorax, air embolus, infection, and phlebitis, among others, were the adverse events included in the analysis of TPN. Complications of EN services included aspiration pneumonia, electrolyte and metabolic abnormalities and the dumping syndrome. Based on previously published studies, Detsky, et al, estimated that six percent of patients who receive TPN through a central line and three percent of patients who receive EN develop significant complications. These data were used in a decision analytic model of nutrition support services. However, no cost information was incorporated for the complications of TPN or EN in developing the decision tree.

Detsky and Jeejeebhoy (17) did include cost information in a later study. However, they assumed that the impact of iatrogenic complications of preoperative TPN would be limited to four days of hospital stay. Moreover, they estimated expenses for the prolonged stay to be $150 (Canadian) per day. Several elements of this study are unclear. For example, it is not clear which resources were included in arriving at this cost estimate; whether the occurrence of a complication would contribute to an increase in total length of stay; and whether true costs were used to arrive at the $150 estimate.

Twomey and Patching (18) assessed the impact of pneumothorax, systemic sepsis and subclavian vein thrombosis for patients receiving TPN through a central line. Based on charge data from a small sample of California hospitals, they calculated the charges per episode to be $1,400 for systemic sepsis, $830 for pneumothorax requiring chest tube insertion, and $200 for symptomatic subclavian vein thrombosis. They estimated average charges for the complications to be $12.50 per patient day during a ten day course of
TPN. Metabolic complications were not included because "(they) seldom generate major additional cost . . ." Other complications, such as air embolus and overwhelming sepsis, were also omitted because they occur rarely. Despite the low likelihood of these near fatal complications (e.g., air embolus), expenses for treating them actually may be very high. Therefore, the estimates of average per patient day charges for complications described by Twomey and Patching may be low since the high charges for treatment of these complications were excluded when per patient day charges were calculated.

Schattenkerk, et al, (21), in their study of post-operative nutrition support via needle catheter jejunostomy for patients undergoing laparotomy, found that 70 complications were experienced by the 210 patients. One-quarter of all patients experienced diarrhea and 3.3 percent of patients developed symptoms of ileus. Intraperitoneal leakage occurred in four of 210 patients. Although some cost data are reported, it is unclear whether expenses for treating the complications were included in these estimates.

Page, et al, (20) also examined the use of needle-catheter jejunostomy for providing postoperative nutrition support. Five complications (2.5 percent) occurred among the 199 patients. The catheter became dislodged for two patients, who subsequently underwent reoperation. Expenses for treatment of these complications were not included in the cost calculations.

Hinsdale and his colleagues (19) also examined the use of feeding jejunostomies in surgical patients. The overall complication rate was eight percent. These investigators also excluded expenses for treatment of complications from their cost analysis.

In an early study, Ryan, et al, (26), found that the complication rate was 4 percent among catheters placed and 6 percent among patients in the
trial. The most common catheter complication was pneumothorax; the next most common was thrombophlebitis. Among the 355 catheters placed, catheter sepsis that was confirmed bacteriologically occurred in 20 cases. No economic analyses were included in this study.

Complications of nutrition support, particularly TPN, may be serious and require additional diagnostic services, therapeutic interventions, and inpatient days. Nevertheless, few investigators have included the additional incurred expenses in diagnosing and treating the complications, the true cost of the additional services, or the expenses for factors other than inpatient days.

Adverse Events Avoided by Use of Nutrition Support

In addition to the importance of assessing the total costs of the side effects of nutritional support, its benefits (especially with regard to adverse events avoided) should also be included in economic evaluations. A number of investigators have examined the incidence of postoperative complications in patients who have received nutrition support services and in those who did not receive any nutritional intervention. However, few have examined the economic implications of avoiding these adverse events.

Mullen and colleagues (27-29) report differences in complication rates among patients who received preoperative TPN and among patients who did not receive TPN. They considered complications such as sepsis and phlebitis, which are difficult to attribute definitely to TPN or to the surgical intervention. In general, however, patients who did not receive TPN perioperatively had a complication rate that was 1.5 to almost 3.0 times as great as that for patients who did receive nutrition support services.
In a small study of postoperative TPN and needle catheter jejunostomy, Muggia-Sullam (30) and his colleagues found no difference in the rate of surgical complications. No economic data regarding expenses for either therapeutic modality or adverse events were included in the report.

Twomey and Patching (18) acknowledge the methodologic deficiencies of their approach, including using charges rather than costs, and combining data from several secondary sources to estimate the savings (benefits) from adverse events avoided with preoperative TPN for gastrointestinal cancer patients. They estimate that each wound infection avoided because of TPN saves $2,000 in treatment expenditures and that each major complication (e.g., death) avoided results in savings of $50,000.

Detsky and Jeejeebhoy (17) used decision-analytic methods to calculate the cost of postoperative complications avoided by a program of screening and administering TPN preoperatively. They conclude that from a pure cost-minimization perspective, no preoperative nutrition treatment should be undertaken for any group of patients, although testing patients for nutritional deficiencies and treating patients at risk reduced the postoperative complication rate. Therefore, while there were clinical benefits from preoperative nutritional therapy, there were no savings. However, the cost data used in these calculations seem conservative. For example, they seem to have assumed that patients experiencing postoperative complications would stay in the hospital for an additional 28 days. Moreover, they use the figure of $275 (Canadian) to estimate the average per diem expense for these days. It is unclear what treatment interventions and expenses beyond "hotel" costs were included in this estimate. Additionally, Detsky and Jeejeebhoy do not state whether expenses were derived through budget allocations (as is applied in the payment of Canadian hospitals) or
through a cost-identification effort. Another limitation of their study is that they assume that iatrogenic complications and nutrition associated complications are mutually exclusive.

Examinations of the economic impact of nutrition support services have not included thorough analyses of the potential savings from complications avoided. The economic value of these benefits may be substantial and may offset a portion of the expenses of nutrition support services. Well controlled, prospective studies have not yet assessed the incidence of the benefits and their true cost (the savings from avoiding complications). In addition, these studies have focused on surgical patients and have not examined adverse events avoided for other groups of patients.

Nutrition Support Services for Critically and Terminally Ill Elderly Patients

We were unable to identify any reports that focused specifically on nutrition support services for the critically and terminally ill elderly. Data from our institution indicates that 21 percent (82 patients) of all Medicare patients who died in the hospital in fiscal year 1985 (July-June) (390 patients) received TPN or EN. Forty-one of these patients were on the Medicine service and 28 were on the Surgery service. The remainder were on the Gynecology, Neurosurgery, Neurology, Otorhinolaryngology, and Thoracic Surgery services. Thirty-seven of these patients were in the medical, surgical or neurologic intensive care unit during their hospital stay.

The average length of stay was approximately 41 days for the 82 patients who died and received TPN or EN and was 20 days for the 308 patients who died but did not receive these services. Average per patient total charges for patients who received TPN or EN were twice the charges for
patients who did not receive TPN or EN. However, average daily charges (average total charges - average length of stay) for patients who received TPN or EN were only nine percent greater than the daily charges for patients who did not receive nutrition support services. Thus, these charges and length of stay may have reflected severe underlying disease which necessitated the nutritional support in the first place.

The reader should consider several factors and be cautious about the possibility of over-interpreting or generalizing the information presented above. First, the economic information is based on charges. As noted in Section II, charge data do not always accurately reflect the value of the institution's resources used to provide services. Moreover, charges do not reflect the Medicare payment to the institution for providing these services. Second, our institution is a large, urban, university-owned, teaching hospital. Several authors (31, 32) have suggested that patients cared for at teaching hospitals are more severely ill than their counterparts at nonteaching hospitals. Therefore, the use of TPN and EN, and length of stay at our institution may reflect the severity of illness among the particular patient population and not be generalizable to Medicare patients at all hospitals. Third, charges at a large urban teaching hospital may be greater than charges at other types of institutions. In fact, Eisenberg and Kitz (33) found that hospital charges for patients with osteomyelitis were two to thirteen times greater at two major urban teaching hospitals than at other hospitals. These differences may in part reflect differences in severity of illness within a diagnostic category, but also may reflect differences in both institutional charge structures as well as in the intensity of the care provided. As discussed below, charge data from one institution may be useful for raising issues for further investigation.
Policy decisions, however, should be based on cost information gathered from a representative sample of institutions.

Our analysis of the data presented by Steinberg and Anderson (15) lead to similar conclusions. Data from fiscal year 1984-1985 at Johns Hopkins Hospital indicate that of the 220 patients receiving TPN (excluding the 12 patients in DRG 468), 48 percent were in DRGs specifically designated for patients whose age was greater than 69 and/or who had complications or comorbidities (c.c.). Twelve percent of the total were in DRG 148 (major small and large bowel procedures age > 69 and/or c.c.), 10 percent were in DRG 154 (stomach, esophageal and duodenal procedures age > 69 and/or c.c.), four percent were in DRG 110 (major reconstructive vascular procedures without pump age > 69 and/or c.c.) and three percent were in DRG 442, (other OR procedures for injuries age > 69 and/or c.c.) These estimates of TPN use for elderly patients contain conflicting biases: they overstate use of TPN by the elderly, because, by using the number of people in the DRG, they include younger people who receive TPN and who qualify for the DRG by having complications and comorbidities rather than just people who qualify by being elderly. However, they also underestimate the number of elderly patients receiving TPN, because they do not count older patients who have conditions in other DRGs that do not have as one of their branching criteria age greater than 69.

As with the data from The Hospital of the University of Pennsylvania (HUP), average length of stay for Johns Hopkins patients was substantially longer for patients who received TPN than for those patients who did not. The mean length of stay for patients in DRGs 110 and 154 who received TPN were 45.2 and 41.5, respectively, while the mean lengths of stay for patients in these DRGs who did not receive TPN were 22.5 and 17.6.
respectively. (Note, the average length of stay for TPN and non-TPN patients in DRG 148 was 26.6 and 25.4).

Similarly, although charges were substantially higher for TPN patients than for non-TPN patients ($27,190 vs. $13,522), this difference may be misleading. In an attempt to evaluate these differences, we performed a multiple regression analysis on the secondary data reported in Steinberg's and Anderson's report. We constructed a data set made up of three variables, the mean charges for each DRG, the mean lengths of stay for these DRGs and a 0/1 dummy variable representing whether the charge and length of stay information stemmed from patients who received TPN or those who did not. We weighted this data set using the number of patients receiving TPN in each DRG (e.g., because 8 patients in DRG 110 received TPN, we created 8 observations with the DRG 110 TPN patients mean charge and mean length of stay data and 8 observations with the DRG 110 non-TPN patient data; because 20 patients in DRG 154 received TPN, we created 20 observations with the DRG 154 TPN patient means and 20 observations with the DRG 154 non-TPN means). We first regressed length of stay (independent variable) on total charge (dependent variable); the R-square equalled .913, indicating that 91.3 percent of the variation in total charges is explained by length of stay alone. We then added the TPN dummy variable in a second regression, which only increased the R-square to .926, indicating that TPN adds little explanatory power to the prediction of total charges. We found it particularly interesting that the TPN coefficient was negative (-$3754; p < .05), indicating that TPN might even correlate with lower total hospital charges.

We feared that the T-statistics might be affected by the high multicollinearity between the length of stay and TPN variables (.74). To
correct for this potential problem we transformed the TPN dummy variable to remove this correlation by regressing the length of stay variable on the dummy variable and then using the residuals from this regression in the total charge regression (this transformation assumes that TPN does not substantially affect length of stay). The relationships among the variables and the T-statistics in this regression remained consistent with those we uncovered in the second regression reported above.

One criticism that might be leveled against this analysis is that - as it is constructed - the length of stay variable assumes that all hospital days cost the same amount of money while conventional wisdom indicates that later days are less resource intensive than early days of hospital care. Thus, the negative coefficient on the TPN variable likely is reflective of the fact that TPN patients, who remain in the hospital longer than non-TPN patients, have smaller charges later in their stay. It does not, the critics would argue, indicate that TPN reduces the cost of hospitalization. Without more data, we cannot answer such a criticism; however, anecdotally we note that in the one DRG for which we have data where patient lengths of stay were similar for TPN (26.6) and non-TPN patients (25.4), total charges for TPN patients exceeded those of non-TPN patients by only $228 ($15,052 vs. $14,824).

The results of analyses of the HUP and Hopkins data suggest that the apparently excessive lengths of stay and charges that are associated with TPN may reflect differences in the severity of the underlying disease which necessitate the nutritional support in the first place. In neither case were we able to determine the additional costs that were the immediate result of nutritional support rather than reflecting these severity differences.
Several investigators have examined the use of TPN for patients who may be considered critically or terminally ill. Goodgame (34) reviews the literature regarding the use of TPN for patients with different diagnoses. He concludes that acute renal failure patients, a group that may be considered seriously ill, benefit from TPN and that TPN is an effective therapy for some of the complications of renal failure. The effectiveness of TPN in patients with hepatic failure is equivocal. With regard to TPN for cancer patients, Goodgame concludes that TPN is appropriate only when evidence of nutritional deficiency exists; he does not support its use prophylactically in these patients.

DeWys and Kubota (35) reviewed the technical aspects and clinical trials of nutrition support for cancer patients. They suggest that several studies have demonstrated the feasibility of administering TPN to cancer patients but have not reported on clear benefits of this approach. They also note that results of some controlled trials have demonstrated decreased complication rates for patients undergoing surgical therapy and increased tolerance to radiation and chemotherapy, while others have demonstrated decreased tolerance of therapy.

Payment For Nutrition Support Services

Inpatient: None of the available studies reports information about reimbursement for nutrition support services. Third party payer coverage is important to consider in estimating patients' out-of-pocket expenses for TPN and EN, and in determining whether payments accurately reflect institutional costs for providing the services. Currently, all three major third party payers (Medicare, Medicaid, Blue Cross) at our institution provide fixed-price payment for inpatient care. Therefore, institutional costs for TPN and EN services are not specifically reimbursed. In as much as expenses
for these services were included in the historical data bases (1982 data) used to develop the fixed-price payment, institutional costs for TPN and EN are incorporated in the current payment levels. However, as Steinberg and Anderson (15) suggest, it is unlikely that any current fixed payment systems cover the hospital costs of patients receiving TPN.

First, as noted earlier, the Johns Hopkins mean charges for TPN patients in DRGs 110, 148, and 154 were $46,262, $15,052, and $32,914 respectively. The reimbursement weights for these DRGs are 3.3215, 2.9407, and 2.6880. Thus, even if Hopkins' reimbursement rate for a DRG with a weight of 1.0 had been $4,000 (far above the $3,000 average urban hospital rate), even if their charges had been significantly inflated, and even if there had been substantial outlier payments (outlier payments are generally relatively small compared with charges), two of these DRGs would have remained large reimbursement losers. Second, Steinberg and Anderson indicate that 33 of the 40 TPN patients at the Middlesex General Hospital, New Brunswick, New Jersey were outliers as defined by the New Jersey System and charges for six of the remaining TPN patients were substantially above the New Jersey DRG reimbursement rates.

Based on these data, Steinberg and Anderson have concluded that patients in need of TPN are at risk of losing this service. They base their conclusion on the premise that an underlying assumption of DRGs and other case-mix-based payment systems is that there is no identifiable type or category of patient who will tend predominantly toward being a gainer or loser; however, TPN patients do seem to be an identifiable group of losers, they suggest. Because, as has just been indicated, TPN is associated with high cost patients, they argue that "profit maximizing" hospitals will provide these patients with less costly, lower quality care. They posit
three potential hospital responses:

a. total discontinuation of TPN at the hospital,

b. discouragement of physicians from using TPN, and

c. discouragement of admitting patients who might require TPN,

and argue that option (a) may be adopted because it will concomitantly
fulfill option (c) and will allow the transfer of patients who need TPN.

We disagree that this problem is related to TPN; if it exists at all,
it is generic to a case-mix-based reimbursement system. As we have already
argued, it is unclear that TPN is causing TPN patients' high medical care
costs; rather these costs seem to stem from the underlying severity of the
patient's condition. Thus, if we assume that profit maximizing
administrators actually exist (it can be argued plausibly that
administrators base their decisions on the average return for a DRG or the
average return for all DRGs), they will want to avoid treating these
patients in their hospitals.

Steinberg and Anderson's argument likely would hold if the onset of
TPN were the only signal that a patient was a high cost type. However, it
is not. The same information that is used to determine if TPN is necessary
can also be used to identify patients who are likely to lie at the upper end
of the cost spectrum. Thus, if administrators are likely to behave
opportunistically towards these patients, they will have the information
needed to do so independent of a TPN program. Hence, an argument that
administrators will respond by eliminating TPN programs depends on two
underlying tenets: that the additional increment in costs resulting from the
patient's receiving TPN will cause the administrator to act more
opportunistically than he would if the patient's losses did not include TPN;
and that the administrator's ability to deny admission or to transfer

27
patients is significantly increased by the absence of a TPN program. We believe that TPN programs, per se, are not the problem; it is the patient's underlying ill health that may affect access to adequate health care.

Even if we are correct, some administrators may adopt the approach Steinberg and Anderson fear, and attempt to undermine TPN programs. One means of avoiding such an outcome is to adjust DRG-like payment systems to reimburse for TPN; however, this suggestion has the drawback that it may create incentives to place patients on TPN simply as a means of increasing reimbursement. This latter danger is enhanced because there are few well defined clinical criteria than can be used to judge whether TPN is appropriate therapy.

To overcome this problem, research should be targeted towards defining quantitative indicators for TPN use within a few selected DRGs. While some authors (15) have disagreed with the idea that these DRGs with high use of TPN can be identified, the fiscal year 1984 Johns Hopkins data indicates that 22 percent of all TPN was provided in DRGs 148, 154, and 468; 32 percent were concentrated in six DRGs (the three already mentioned plus 107, 110, and 204). In addition, while no denominator is presented, in 1983, the Cleveland Clinic provided TPN to 84 patients in DRGs 148 and and 154, and an additional 30 patients in DRG 149 - identical to 148 except for the age of the patient - received TPN as well (15). We conclude, then, that a strategy of targeting research into these DRGs is feasible. We note that adequate payment for a small set of DRGs with high use of TPN may have the concomitant advantage of providing incentives for profit maximizing administrators to retain TPN programs, thus making TPN therapy available to patients in DRGs that do not have additional reimbursement for TPN use.

Outpatient: Payment for services delivered in other settings should
also be considered because terminally ill patients who are not acutely ill may be discharged to nursing homes or home, where they may continue to receive TPN. Members of the Department of Social Work at our institution indicated that Medicare patients who require TPN but who do not have supplemental insurance for nursing home care are "unplaceable" in nursing homes. Nursing homes do not receive supplemental payment for any of the equipment necessary for TPN. Major medical insurance, at least through Blue Shield, usually does cover TPN and EN services in the nursing home but require the patient or their family to pay a deductible and copayment.

Medicare covers the equipment, solutions, and nursing services used for home TPN, assuming the patients meet particular clinical criteria. To meet these criteria, a patient must have a diagnosis that is considered "severe pathology of the alimentary tract" and must be expected to require TPN for 90 days or more. Eighty percent of charges are reimbursed for supply, equipment and professional services for home TPN as part of the prosthetic device benefit program (personal communication, "Status of Medicare Home Health Coverage for Antibiotic Therapy and Nutritional Therapies," Health Care Financing Subcommittee, American College of Physicians, Spring, 1986). Medicaid coverage for home TPN varies by state. In Pennsylvania, such services may be approved on an individual basis. Major medical plans also cover these costs, although patients are responsible for deductibles and copayments. However, patients frequently are unable to meet this financial burden. Two home health care companies with which we spoke indicated that in order to meet regulatory requirements, home health care companies must bill patients for these copayments for two consecutive months. After that time period, home care providers may continue to provide services, need not bill patients for the copayments, but must absorb these expenses. These
patient, family and corporate expenses for nutrition support services may create disincentives to discharging terminally ill patients who require TPN to nursing homes or home. Future studies should identify the factors that contribute to these expenses, the magnitude of these expenses and their impact on decisions to discharge patients.

In summary, estimates suggest that substantial funds are allocated to nutrition support services. However, these estimates rarely have included comprehensive assessment of all the components of delivery of nutrition support services, particularly for TPN and EN. Moreover, charge data rather than true costs have been used in these analyses. True costs are the value of the resources used in providing the services. Charges bear no consistent relationship to costs (36). In addition, components of total cost, such as direct nonmedical factors and indirect expenses, have not been included in these analyses. The limitations of the available data make it difficult to describe completely and accurately the economic impact of nutrition support services from the point of view of patients, insurers, hospitals or society-at-large. Further research is needed before accurate estimates may be made of the potential implications of policy intervention for nutrition support services.
IV. ANTIBIOTIC MEDICATIONS

National Expenditures for Antibiotic Medications

Approximately one-fifth of all prescriptions in the United States are for antibiotic medications (37). Nationally, about $3.5 billion is spent on drugs for hospital inpatients and 26 percent of the total, or $900 million, is spent on antibiotic drugs (38). Antibiotics also account for large portions of hospital pharmacy budgets. Kunin and his colleagues (39) found that antibiotics consumed 19 to 34 percent of the pharmacy budgets at three hospitals in Madison, Wisconsin. Cephalosporin antibiotics alone account for approximately 1 percent of hospitals' total budgets (40).

While these expenditures are substantial, results of studies that have evaluated inpatient antibiotic use have found that as much as one-half of the antibiotics were used unnecessarily. In an early study, Scheckler and Bennett (41) reviewed the charts of patients on surgical wards and found that 30 to 60 percent of patients receiving antibiotics had no evidence of infection. The authors postulate that the drugs were being used prophylactically against surgery-related infections. However, prophylaxis may be provided inappropriately. Gleckman and Gantz (42), for example, identified seven surgical procedures for which antibiotics are routinely used prophylactically despite a lack of controlled studies demonstrating the clinical efficacy of this practice.

The potential savings from eliminating the unnecessary use of antibiotics are large. Several authors have estimated that total spending on antibiotics could be reduced by about one-quarter to one-half if unnecessary use were eliminated (39, 42-44). Most of these estimates are limited to drug expenditures alone and do not include expenses for other factors that are important to consider in assessing the cost of antibiotic use. Some of these additional costs are described in the following paragraphs.
Costs of Administering Antibiotics

Estimates of expenses and potential savings from antibiotic use are conservative if they are limited to drug expenses. Other costs, such as those that are related to drug-administration, side-effects of treatment and adverse events avoided should also be considered in these evaluations (See Table 2).

Expenses associated with the administration of drugs are particularly relevant for hospitals that are paid by case-mix based systems, such as DRGs. Fixed-price case payment encourages institutions to identify and reduce their operating expenses, including personnel and supplies. These expenses (other than purchasing the drug) have not usually been included in economic evaluations of antibiotic medications.

Eisenberg and his colleagues (13) identified the components of hospital costs incurred in administering the drugs. They measured the cost of the non-drug variable elements associated with intravenous administration of cephalosporin antibiotics. Among the four hospitals studied, they found that the average variable cost per dose for delivering cephalosporins was $2.24. Nearly 60 percent of this cost was supply and material costs, which included syringes, alcohol swabs and other items for which the frequency of use varied with the frequency of drug administration. The other, approximately 40 percent of the variable costs, were personnel expenses. Nursing time for delivering and mixing the drugs, and pharmacy staff time for reconstituting drugs were included in these cost estimates.

In one of two similar studies, Tanner (45) estimated personnel and supply costs and found them to be $2.75-$4.48 per dose, depending on the specific parenteral system that was used. In the other, the Veteran's Administration Pharmacy Service Study Group (46) estimated that the average nondrug variable cost per dose at six Veterans Administration Medical Centers was $2.95 (ranging from $1.01 to $6.11 for the 16 different combinations of preparation and
<table>
<thead>
<tr>
<th>Component of Cost</th>
<th>Estimated Expense</th>
<th>Reference</th>
</tr>
</thead>
</table>
| 1. Personnel Time (Reconstitution and Preparation, Delivery) | a) $0.80-$1.09/dose  
b) $0.61-$0.86/dose | a) 13  
b) 44          |
| 2. Supplies                      | a) $0.57-$2.08/dose  
b) $1.89-3.87/dose | a) 13  
b) 44          |
| 3. Laboratory Tests              | Variable with agent, diagnosis |           |
| 4. Solution                      | Variable with a antibiotic agent, nephrotoxicity |           |
| 5. Side Effects/Complications     | a) $238/case           
b) $167/patient day for nosocomial infections | a) 45  
b) 47          |

Table 2: Components of Total Cost For Inpatient Antibiotic Therapy
administration that were studied). On a national basis, the findings from these three studies, when applied to total doses of comparable cephalosporins, indicate that $74-$233 million may be spent on preparation and administration of these parenteral cephalosporins alone. The three groups of investigators, in fact, found that total expenses for preparation and administration often exceed the purchase cost for drugs.

Adverse Reactions and Side-Effects

Side-effects of antibiotic treatment and adverse reactions to the drug are also important components of total costs but have rarely been included in economic evaluations of antibiotic medication use. Treatment for side-effects may require increased monitoring with additional laboratory tests, extended inpatient hospital stay and administration of additional medications. For example, ototoxicity and nephrotoxicity have been examined in relation to the use of aminoglycoside antibiotics (47). These investigators estimate that per patient expenses for patients who experienced nephrotoxicity were $238. However, these authors assumed that no patient would require renal dialysis and that there would be no increase in length of stay for patients who became nephrotoxic. Results of studies conducted in the 1970's indicate that expenses for renal dialysis were about $155 per session (48). Therefore, cost of renal dialysis for those patients with severe nephrotoxicity could add significantly to expenses for the side-effects and adverse events associated with aminoglycoside use. In another study of the cost of adverse events due to antibiotics, Kunin (39) points out that as the incidence of antibiotic-resistant infections increases, there will probably be an increase in the use of antibiotic sensitivity testing so that specific (rather than broad spectrum) and potentially more expensive, but also potentially less expensive, antibiotic therapy may have to be selected.
The development of antibiotic-resistant infections, which usually account for a large portion of nosocomial (hospital acquired) infections is an important side-effect to consider as a potential cost of antibiotic prescription. In 1974, the Centers for Disease Control estimated that five percent of all patients admitted to general hospitals acquired nosocomial infections (49).

Dixon (50) used data from the Comprehensive Hospital Infections Project and the National Nosocomial Infections Study to develop national estimates of the number of nosocomial infections, the impact of these infections on inpatient hospital days, and the financial consequences of the infections. He estimated that over two million nosocomial infections occur each year, that more than six million additional patient days are associated with treatment of these infections, and over one billion dollars in direct hospital expenditures are related to care of patients with nosocial infections.

A number of other authors have made additional estimates of the burden of hospital based nosocial infection. Freeman and McGowan (51) analyzed 85 pairs of patients, one with a nosocomial infection the other without, and found that these infections add 7.3 days to patient length of stay (2,000,000 x 7.3 = 14,600,000 excess patient days per year). Green, Rubinstein, and Amit (52) studied 57 pairs of matched patients and found that nosocomial urinary tract infections add 4.5 days to a patient's hospital stay, surgical wound infections add 11.9 days, and double infections add 25 days to the patient's stay (lower bound: 2,000,000 x 4.5 = 9,000,000 excess patient days per year; upper bound: 2,000,000 x 11.9 = 23,800,000 patient days per year). Finally, Spengler and Greenough (53) estimate that in their 81 matched pairs of patients, nosocomial bacteremia caused an excess of $3,600 in direct hospital costs; 24 percent of the total excess costs of the hospital patients with infections were preventable; and mortality rates were 14 times greater for patients with the infection than they were for those without the infection.
Nosocomial infections are also a serious problem in long-term care facilities for the elderly. In a study of a 432 bed Veterans Administration chronic care facility, Farber and his colleagues (54) found that UTIs had an attack rate of .22 infections per 100 patient days, Pneumonias were .19 per 100 patient days, and upper respiratory tract infections occurred at a rate of .18 per 100 patient days.

Magnussan and Robb (55) found an 18 percent nosocomial infection rate in a 400-bed Veterans Administration long-term care facility; 71.6 percent of these infections were urinary tract infections, 13.5 percent were respiratory tract infections, 11.1 percent were skin infections, and 2.5 percent were bacteremias. A survey of VA long-term care psychiatric facilities in the northeastern US had similar rates of respiratory and urinary tract infections (55).

Garibaldi, et al., (56) found that the prevalence of infections in a population of 532 patients in seven Salt Lake City skilled-care nursing homes was 16.2 percent. There were a total of six percent infected decubitus ulcers, 3.4 percent conjunctivitis, 2.6 percent symptomatic urinary tract infections, and 2.1 percent lower-respiratory-tract infections.

These infections induce treatment costs in the nursing home, and they also induce hospital costs. In a study of the causes of hospitalizations of 128 nursing home patients, Irvine, et al., (57) found that infections accounted for 27 percent of all these patients' hospital admissions. We estimate that the current DRG reimbursement rates for urban hospitals, standardized to remove the effects of labor markets and teaching status, are as follows: DRG 89 (Simple pneumonia age > 69 and/or c.c.) $3,500, DRG 277 (Cellulitis age > 69 and/or c.c.) $2,637, and DRG 320 (Urinary tract infections age > 69 and/or c.c.) $2,567. Thus hospitalization for these conditions likely creates a heavy Medicare financial burden.
While wide-spread antibiotic usage certainly does not cause all nosocomial infections, it does tend to lead to the development of antibiotic resistant strains of infections and to superinfection in patients whose normal flora are altered. Thus, improper antibiotic use probably makes nosocomial infections both more common and harder and more expensive to treat.

**Economic Evaluations of Antibiotic Use**

Despite the widespread use of antibiotic medications and the economic impact of the use of these pharmaceutical agents, relatively few rigorous economic evaluations of antibiotic use have been conducted. The studies that are available concentrate on surgical prophylactic use of antibiotics, non-surgical prophylactic use of antibiotics, the appropriate use of these agents and on alternative modes of parenteral antibiotic therapy.

**Surgical Prophylaxis:** Stone, et al (58), conducted a prospective, randomized study of the use of prophylactic intramuscular cefazolin given to 400 patients undergoing elective gastric, biliary or colonic surgery. Patients were randomly allocated to one of three treatment groups or to a placebo group. The incidence of wound infections among the 200 patients who received the antibiotic preoperatively was four percent and 11 percent among patients who received the antibiotic post-operatively only or who received the placebo. The investigators also found that patients who had an incisional wound infection were in the hospital for over 15 days more than patients who did not have infections. Based on per diem charges, Stone and his colleagues calculated that excess charges for the extra inpatient days alone were over $12,000 per infected patient. Charges for the preoperative prophylactic antibiotic dose were $13.47 per patient. In this way, preoperative prophylaxis may prevent patients from becoming severely or critically ill and save hospital resources.

The economic aspects of using preoperative cefazolin for prophylaxis in
patients undergoing clean vascular surgery were examined by Kaiser, et al (59). In a prior clinical study, they found an infection rate of 5.5 percent among 237 patients who received a placebo and no infections among 225 patients who received cefazolin preoperatively. Based on this clinical study, they calculated excess hospital charges for patients who developed a wound infection. These excess charges were $3600 - $8100, depending on the specific surgical procedure and the severity of the infection.

The costs and benefits of antibiotic prophylaxis for women undergoing abdominal and vaginal hysterectomies were evaluated by Shapiro and his colleagues (60). The economic evaluation was based on the results of a previous prospective randomized clinical study. In that study, investigators found that patients who received cefazolin had significantly lower infection rates than patients who received placebos in both vaginal and abdominal hysterectomy groups. Charge data from one hospital were used to determine the financial impact of the infections. The only factors included in the analysis were excess hospital days, microbiology cultures, antibiotic medications and extra physician visits for patients who received outpatient care. The investigators did not include expenses for extra medications or laboratory tests used to treat the infections. Results of the economic analyses indicated that per patient savings were $492 for vaginal hysterectomy patients and $102 for abdominal hysterectomy patients who received prophylaxis when compared with the placebo groups. Shapiro, et al, used national data about the annual number of abdominal and vaginal hysterectomies to estimate potential national savings from prophylactic therapy. They calculated that $100 million could be saved in a year if appropriate prophylactic regimens were used for vaginal hysterectomies and $40 million for abdominal hysterectomies.

The use of prophylactic antibiotics for patients undergoing appendectomy has also been evaluated (61). The wound infection rate was 9.6 percent among
patients who received a placebo, but patients who received cefoxitin prophylactically had no infections. Hospital charges for excess inpatient days among patients with infections were $7,316 while charges for antibiotic prophylactic drugs were $2,884. On a per patient basis, savings of $84 could be achieved with the use of prophylactic cefoxitin sodium.

Busuttil, et al, (62) also examined the use of prophylactic antibiotics among patients undergoing appendectomy. Charge data were applied to excess hospital days, prophylactic medications and therapeutic antibiotics used to care for patients with wound infections. Charges were $96 less for patients who received cefamandole and carbenicillin and $248 less for patients who received cefamandole alone, when compared with patients in the placebo group.

Each of these studies found that the prophylactic use of antibiotics in surgical patients is justified from an economic perspective. Unfortunately, these studies usually were based on charge data, did not account for differences in the severity of the patients' underlying illness, commonly limited antibiotic expenses to their purchase price and usually assessed expenses for infections by calculating extra days of inpatient hospital care. Critically and terminally ill elderly patients may be candidates for surgical prophylaxis, but these patients have not been particularly examined in these studies.

**Nonsurgical Prophylaxis:** Nonsurgical prophylactic use of antibiotics may be particularly relevant when considering elderly, terminally, and critically ill patients. Terminally ill cancer patients, those with compromised immunity, or those particularly likely to become infected may benefit from prophylactic antibiotics or from early empirical treatment of undocumented infections. However, economic evaluations of nonsurgical prophylactic use of antibiotics have not focused on these areas. Rather, studies have examined the use of antibiotics for prophylaxis of less serious infections. Nevertheless, the
methods used in these studies may be used in studies of prophylactic antibiotic use against more serious infections.

Stamm and his colleagues (63) for example, conducted a cost-effectiveness study based on the results from their clinical study of prophylactic treatment of women with a history of urinary track infections. In that study, Stamm, et al, found that among women who had two or more infections per year, those who did not receive prophylaxis developed an average of three urinary track infections annually. Patients who received antibiotic prophylaxis only had 0.15 infections per year. Hospital charges for laboratory and radiologic services for other diagnostic services and for physicians visits were included in the analysis. Costs for drugs were also included. Expenses for prophylaxis were nearly $86 annually and expenses were approximately $490 for the treatment of patients who had infections and did not receive any prophylaxis, thus suggesting substantial savings from antibiotic prophylaxis.

Wong, et al, (64) also examined the economic aspects of treatment for urinary track infections. They included expenses for therapeutic agents, treatment of adverse reactions and treatment of infections in their analyses. Among patients receiving prophylactic treatment, expenses were $256 per year. Expenses for intermittent self-therapy were $239 per year. Each of these strategies was less costly than a 10 day antibiotic therapeutic regimen.

Alternative Modes of Antibiotic Care: Some economic evaluations of antibiotics have studied the potential savings from substituting outpatient for in-hospital parenteral antibiotic therapy. Poretz, et al, (65), estimated savings based on hospital room charges for inpatient days of care that were avoided for 150 patients aged 2-86 years with osteomyelitis and other serious infections. In another study, Poretz, et al, (66) administered questionnaires to 79 patients to assess costs for training patients to administer the antibiotics, supplies, professional services, inpatient days of care avoided
(equal to duration of outpatient therapy), transportation (actual expenses or mileage x $.20) and lost days of work avoided (if hospitalized for antibiotic therapy). Average total cost was approximately $1,800 for outpatient care and average total benefits (excess inpatient expenses avoided) were about $6,600.

Stiver and his colleagues (67-68) have reported the results of their program designed to establish outpatient parenteral antibiotic therapy. Largely based on avoided inpatient days, they found savings of $97 per day for outpatient care when compared with inpatient parenteral therapy for a pilot group of patients aged 4-81 years with osteomyelitis, septic arthritis, infective endocarditis or other serious infection. Four years later they reported the results of a more comprehensive evaluation of the outpatient program. Expenses for outpatient care included visiting nurse services, other professional services, drugs and intravenous line supplies. Expenses for inpatient care included daily fees paid to Canadian hospitals and fees for physician services. Total savings were estimated to be over $315,000 for the 95 patients who underwent outpatient therapy.

Kind and his colleagues (69) reported on a small (14 patients) outpatient parenteral antibiotic therapy program for patients with osteomyelitis, endocarditis or septic arthritis. Based on charges for routine inpatient days and physician fees, Kind, et al, estimated per patient savings from outpatient care to be over $1,600.

Eisenberg and Kitz (33) recently estimated the potential savings from outpatient parenteral antibiotic therapy for osteomyelitis. They found that potential national savings are substantial, but that estimated savings are sensitive to the reimbursement mechanism used as the basis for calculating inpatient care expenses (the alternative mode of care). The variation in savings was related both to differences in the average length of stay for each
source of data about length of stay and to differences in expenses for each source. Per patient savings from the early discharge mode of care varied from $510 to over $22,000.

The findings from these studies may be relevant for terminally ill patients who do not require acute care. Home parenteral antibiotic therapy may be a cost-effective way of delivering antibiotics for prophylactic or therapeutic purposes.

Methodologic Issues

Economic evaluations of antibiotic use have concentrated on four areas: surgical prophylaxis, nonsurgical prophylaxis, appropriate use and alternative site of care. Despite the scope of these efforts, there are methodologic weaknesses with most of these efforts.

First, most studies have used charge information to assess the economic impact of a treatment modality. For example, the studies that examined use of antibiotics in surgical prophylaxis used charges for inpatient days, pharmaceuticals, physician services and other factors to determine the economic impact of different prophylactic therapy regimens. The true cost of these factors was not assessed. Fixed costs were not distinguished from the variable costs that could be saved. Therefore, real savings to the hospital cannot be assessed. To determine the savings for third party payers, it would be necessary to have data on both the cost and payment rates for each service.

A second concern with these studies is that only charges for pharmaceutical agents were included in many of the studies. Hospital expenses for reconstituting drugs, for nursing time allocated to delivering the drugs and for supplies used in delivering the drugs usually were not assessed. The studies by Eisenberg, et al, (13), Tanner (45), and the Veterans Administration Pharmacy Service Study Group (46) indicate that labor and supply expenses for inpatient
parenteral therapy may be substantial. Personnel and supply expenses were included in Poretz' earlier (65) evaluation of an outpatient intravenous antibiotic therapy program; per patient personnel expenses were approximately $150 and supply expenses were about $325. Additionally, except for Holloway, et al, (47) no studies comprehensively included side-effects in the economic evaluations.

A third issue is that these economic assessments usually were generally limited to direct medical expenses, including inpatient hospital days, pharmaceuticals, ancillary services and professional services. Nonmedical direct factors, such as transportation expenses by patients and their families and the indirect cost of time lost from work, usually were not included in these studies. However, results of studies conducted by Kind, et al, (69) (in which all patients returned to their normal routines) and Poretz, et al, (66) (in which 96 percent of patients were able to return to their normal routines) suggest that indirect costs may be relatively low.

A fourth issue is that studies usually have focused on inpatient hospital care. Potential cost-savings for care delivered in other settings, particularly nursing homes, is important to consider for Medicare and Medicaid. Approximately one million individuals (70), or 90 percent of all nursing home patients are over 65 years of age (71). Moreover, the severity of illness among these patients may be rising as hospitals discharge patients earlier in response to incentives created by the DRG-based payment program.

**Antibiotic Medications Used for Critically and Terminally Ill Elderly Patients**

Despite the recognition of antibiotic costs, the costs of their side-effects, the high cost of terminal illness, and the burden of disease in the elderly, there has been little specific attention to the cost of antibiotic medications for the critically and terminally ill elderly. Overall, however,
elderly patients account for one-quarter of all expenditures for drugs and sundries while they comprise only 12 percent of the population (72, 73).

Antibiotic use by nursing home residents has not been well-studied, but may be particularly relevant because of the high proportion of elderly patients in this setting. From the point of view of insurers, it would be important to determine the extent of costs such as those incurred by unnecessary prophylactic use of antibiotics and the financial impact of side-effects of antibiotic therapy among elderly patients. Elderly patients may have a higher rate of multi-system disease, and also may be more likely to be susceptible to side-effects of antibiotic therapy than are other patients.

**Payment for Antibiotic Use**

In determining patient and insurer expenses for antibiotic use, it is important to consider the mechanism of payment for these services. For Medicare, antibiotic expenses for hospital inpatients are not particularly relevant since the DRG-based payment covers all inpatient services. This is also true for Medicaid programs in the states that have implemented DRG programs. At our hospital, these expenses are also irrelevant for patients covered by Blue Cross, which in Philadelphia also pays on a fixed-price basis, though not using DRGs. Patients are likely to bear a larger part of the financial burden of therapy as reimbursement policies incorporate higher copayment levels and higher deductibles.

Despite the apparent savings, outpatient parenteral antibiotic therapy is not usually included in third party payment programs. Poretz, et al, (65, 66) found that three private insurers who covered 20 percent of the patients, completely reimbursed the hospital for laboratory charges and paid the hospital 80 percent of charges for medications and supplies. However, the insurers only reimbursed the hospital for 80 percent of reasonable charges for all components.
of outpatient care. The local Blue Cross plan agreed to pay 100 percent of expenses for outpatient therapy after it was noted that patients would be unlikely to opt for this mode of care if they had to bear the financial burden of the difference between hospital charges and the reimbursement rate.

Kind, et al, (69) surveyed 18 insurance companies about their payment policies for outpatient antibiotic therapy. They found that (in 1976-1977) two local health maintenance programs would cover expenses fully, 14 private payers would reimburse 80 percent of expenses; and two payers - Medicare and a private payer - would not cover any expenses. Social workers at our institution also indicated that Medicare does not cover home parenteral antibiotic therapy, because it is considered a self-administered drug. Most Medicaid programs do provide payment (as per a fee schedule) for home parenteral antibiotic therapy, usually as part of traditional drug benefit programs. However, payment for equipment particular supplies, and professional services is problematic in some states (personal communication, "Status of Medicare Home Health Coverage of Intravenous Antibiotic Therapy with Nutritional Therapies," Health Care Financing Subcommittee, American College of Physicians, Spring, 1986). Major medical plans will usually cover 80 percent of expenses for these services, after a deductible is paid.

Information about third party payer expenses is important to consider in assessing the potential impact of cost-savings programs. Although outpatient parenteral antibiotic therapy may yield cost-savings for hospitals, patients may incur greater expenses if they must pay out-of-pocket for a portion of their outpatient care. Patients who may be reimbursed completely for inpatient care but only partially for outpatient care are less likely to select the outpatient mode of therapy. Terminally ill patients, who may be candidates for outpatient therapy, may avoid this mode of care because of its economic impact, regardless of the potential quality of life benefits.

45
V. DEFINING CRITICAL AND TERMINAL ILLNESS

Rigorous evaluations of the economic impact of medical care interventions require detailed descriptive information about the populations who actually receive or are candidates for the intervention. However, no standard diagnosis, clinical characteristic or therapeutic regimen has been established to define the concept of critical illness.

Investigators have used several approaches to define critical and terminal illness. One alternative has been to define critically ill patients as those who have intensive care unit stays or patients who have extended intensive care unit stays. Modoff, et al, (74), for example, focused on patients who were in the surgical intensive care unit for seven or more consecutive days. Almost 60 percent of patients survived to discharge from the hospital and one-third of all patients survived for at least one year after discharge. Unfortunately, no data are reported to indicate that the seven day stay criterion distinguishes between patients who have higher or lower expected survival rates.

Several factors make defining critical illness as that requiring intensive care difficult to apply in assessing the economic impact of health care technologies. First, it is not useful for prospective studies; extended intensive care unit stay can only be identified concurrently or retrospectively. Thus, patient populations for prospective economic analyses cannot be identified with this definition of critical illness.

Second, this method of defining critical illness does not distinguish between patients who require intensive care services for treatment of the most acute phases of a single disease and those patients who have multiple diseases that, together, require intensive care. This issue would also prevent investigators from examining the use of services in a well-defined patient population. For example, investigators might use this approach to identify
patients for a study of parenteral antibiotic use among critically ill patients with pneumonia. However, if extended intensive care unit stay were used to identify patients (retrospectively), only patients with a diagnosis of pneumonia and patients with multiple diagnoses, including pneumonia, would be included. For these patients, it would be difficult to distinguish between services used solely to monitor and treat side-effects of the pneumonia, and antibiotic therapy and services used to monitor and treat the other diseases. Thus, the economic impact of the antibiotic therapy alone would not be assessed adequately.

Finally, intensive care is sometimes reserved for patients who are thought by the physicians caring for them to potentially gain from the intensive care unit. Some terminally ill patients are not transferred to the intensive care unit even if they have critical episodes, because the limited number of intensive care beds may be full or may be saved for more "salvageable" patients.

A second approach has been used by other investigators; letting high cost serve as a surrogate for critical illness. Fleming, et al, (11) defined high-cost as the top 25 percent of patients based on hospital charges among patients discharged from 167 hospitals across the country. Over 50 percent of these high-cost patients were over 65 years of age and, 10 percent of all Medicare patients were high-cost, accounting for 40 percent of total Medicare charges. This approach also requires retrospective analysis, does not adequately identify specific patient populations for economic studies and is sensitive to the charge-allocation procedures used by individual hospitals. Particular services may be "overcharged" at an institution and patients who receive these services may be identified as critically ill, regardless of their clinical condition.

Kobrinski and Matteson (75) used a threshold of $4,000 in hospital charges to identify high cost patients. Among their sample of patients discharged from 58 hospitals in 1977, 6.6 percent were considered high cost. Nearly one-half of
the high cost patients were covered by Medicare.

Schroeder, et al., (76) characterized patients who had yearly hospital charges that exceeded $4,000. Depending on the sponsorship and teaching status of the institution, 4-24% of patients discharged met this criterion. Over 13 percent of all high cost patients died in the hospital during the year.

Berki and his colleagues (77) characterized the top 5 percent of patients based on charges among all patients discharged from a large group of hospitals. They found that approximately 45 percent of all patients over 65 years of age were considered to be high cost patients.

Robert A. Harootyan, writing for the Office of Technology Assessment (Robert A. Harootyan, OTA, February, 1986), uses the following definition of critical illness: "Critically ill patients are those who are experiencing serious physiological dysfunctioning, often with multiple diseases that present themselves in unusual or unexpected patterns. These patients are highly likely to be on a downward trajectory, to have lowered physiologic reserve, and to suffer from complications of treatment regimens, thereby reducing certainty regarding life-and-death outcomes and making treatment decisions more complex and difficult." (p 2-48). This definition of critical illness does consider a variety of factors in identifying a group of patients. However, no explicit criteria are available to identify "lower physiologic reserve," "serious physiologic dysfunctioning" or "downward trajectory," and the definition does not lend itself to operational application without further definition of the terms and the review of a large number of hospital charts. Hospital data bases could be used to limit the number of cases reviewed, but not to identify the critically ill patients.

Whereas critically ill patients require highly intensive, acute care services regardless of their likelihood of survival, terminally ill patients are
expected to die within a given time period, regardless of the intensity of services delivered. Although we would seek a more clinically relevant definition for terminal illness, one that would reflect the biologic phenomenon, no single, widely-accepted set of characteristics is used to identify terminally ill patients. Bayer and his colleagues (78) recognized this problem in their discussion of the use of limited resources for terminally ill patients. They note that "though widely used, it [terminal illness] is not a standard technical term with clear and precise criteria" (p. 1491). Although some definitions use "a high likelihood of imminent death," the probability that defines "high likelihood" and the duration of "imminent" are not established. The Office of Technology Assessment uses six months as the time period in which death is expected.

Spector and Mor (79) used death certificates to identify patients in a study of charges generated by cancer patients. As discussed above regarding intensive care unit use to identify critically ill patients, this approach is only useful for retrospective studies of patients who died. This approach does not facilitate prospective studies of patients likely to die within a given time period.

Scitovsky (80) notes that this approach of retrospectively identifying expenditures for patients who died necessarily identifies expenditures for patients who were clearly terminally ill. Patients who died are often selected for the analyses, without comparison to costs for patients with similar diagnoses and severity of illness who lived. Therefore, this approach yields information about the cost of dying, but not necessarily the cost of being terminally ill. Scitovsky's review of information about Medicare enrollees indicates that more than five to six percent of Medicare enrollees die in a year and account for about one-fifth to one-quarter of all Medicare expenses.

The lack of explicit criteria to identify terminally ill patients also
compromises efforts to examine the economic impact of health care interventions for this group of patients. For example, particular interventions may delay death in a small portion of a group of gravely ill patients, most of whom are expected to die within a given time period. By excluding the people who survived from the analysis, the additional direct medical and direct nonmedical expenses incurred by these patients would not be included as a cost associated with the intervention. In addition, any direct or indirect costs avoided (benefits) from extended life would not be included in the analysis.

In essence, no clear-cut, widely used definitions for critical and terminal illness are available. Critical illness has not been explicitly defined, and high cost or intensive care unit use often has been used as a proxy measure. Because it is difficult to predict accurately which patients are likely to die within a given time period, terminal illness is usually assessed retrospectively from the time of death. To assess accurately the economic impact of antibiotics and nutrition support services for critically and terminally ill patients, definitions must be developed that allow prospective identification of these patients according to explicit criteria. Otherwise, the assessments may be highly dependent on modes of care at different institutions (e.g., use of intensive care services), may not be specific to the use of an intervention, and may not clearly be applicable to a defined patient population.
VI. IMPACTS FROM DIFFERENT POINTS OF VIEW

In assessing the economic implications of health care interventions, it is important to consider the point of view from which the analysis is conducted. The point of view reflects the group whose resources are being consumed, and the relative impact of this resource consumption given the total resources available. Four points of view—those of patients, providers, third party payers, and society—may be considered in these analyses.

Often the point of view is also that of the decision maker, but frequently the provider (doctor or hospital) makes the decision while the patient or third party payer is the one whose limited resources are being used. Ironically, a cost for the patient or third party payer may actually be income for the decision maker. Ideally, the physician will make the decision, in large part on behalf of the patient. If the physician is also concerned about societal expenditures for medical care, he or she will be in the difficult position of making a decision by considering the patient's viewpoint as well as his or her own and that of society. In some cases the doctor may also be expected to take the perspective of the hospital or the third party payer into account. The necessity for the physician to consider several viewpoints simultaneously means that conflicts of interest are inherent in clinical decision-making.

Considering the point of view is important for four reasons. First, the components of total cost that are incurred by each group are different. For example, direct nonmedical expenses for transportation and homemaker services are important to patients. Hospitals, however, do not incur expenses for these factors and may not be concerned with their cost. In addition, third party payers rarely cover direct nonmedical expenses and thus will be unconcerned with expenditures for transportation and homemaker services. From the point of view of society, direct nonmedical costs are important; expenditures for these factors contribute to the nation's expenditure of resources related to illness.
and medical care for it.

The second reason to consider the point of view that has been selected for an economic analysis is that the actual cost may differ from different points of view. For example, patients covered by Medicare will not incur any additional expenses for inpatient antibiotic drugs because they are included as part of the DRG payment. From the hospital's point of view, the cost of the drugs includes expenses for personnel, salaries, employee benefits and training, pharmacy equipment and purchase of the drug. From the insurer's point of view, the cost of the drug is the reimbursement paid for these services. From the point of view of patients not covered by Medicare, the cost of the drug is the amount of money the patient must pay for it. From society's point of view the cost of the drugs is any resource that is consumed in its provision (similar to the hospital's cost) plus costs incurred by other parties (e.g., patients receiving outpatient drugs who incur nonmedical costs).

The third reason for considering the point of view is that different data are needed to use the findings from specific studies to estimate expenditures on a national level. For example, certain epidemiologic data such as the number of individuals expected to receive an intervention and the socioeconomic and clinical characteristics of the patient population would be needed to estimate societal expenses. On the other hand, to estimate expenses for all patients, the necessary data would include factors such as patients' third party coverage, employment status, length of hospital stay and expenses for direct nonmedical services.

Fourth, the policy implications that may be drawn appropriately from evaluations will also vary with the point of view used in the evaluations. For example, it may be inappropriate to use the results of an economic evaluation conducted from the patient's perspective to develop policies for hospital
administrators. Patients fully covered by medical insurance will not themselves incur expenses for hospital care. Thus, for example, the results of an evaluation of the cost of a prophylactic antibiotic coverage from a patient's point of view, would not include covered hospital costs.

The following paragraphs present details about the elements of total cost that are relevant for each point of view, the cost of these elements, the data needed for economic evaluations and the potential policy implications. Understanding each point of view is important for evaluating studies that have been conducted, for designing future studies and for identifying priority areas for future research.

**Patient Point of View**

The elements of total cost that are likely to be important to patients are direct nonmedical factors, insurance co-payments and time lost from work (indirect expense). Patients who do not have health insurance or other coverage will also be concerned about direct medical care factors, which are charges and represent patients' out-of-pocket costs. Foregone wages are patients' indirect expenses.

To conduct a thorough economic evaluation of a health care intervention from a patient's perspective, a diary or questionnaire could be administered regarding patients' direct nonmedical expenditures. For example, transportation to and from the hospital, and to a provider's office for ambulatory care could be included in this questionnaire. Similarly, information about a patient's employment status, sick leave policies and salary would be important to calculate foregone wages.

**Hospital Point of View**

From a hospital's point of view, the relevant cost components are generally related to direct medical care factors. In particular, routine inpatient days,
intensive care days, operating room time, pharmaceuticals, ancillary services and staff professional services (e.g., social workers, physical therapists) would be important considerations for hospitals. The volume of services used would be dependent on the intervention itself as well as on the secondary effects of the intervention such as adverse outcomes that require further diagnostic and therapeutic measures (leading to additional impatient days for example).

True costs to the hospital for these factors would include the additional personnel expenses allocated to delivering the additional routine days of care as well as the additional specific services. Supply costs and expenses for overhead factors such as heat and light, capital depreciation and administration salaries would also be included in the cost calculations, but only if the hospital's overhead is influenced by the clinical decision being evaluated.

To conduct an evaluation from a hospital's point of view, data are necessary about the number of patients receiving the intervention of interest and the hospitals' services consumed by these patients. These data might be collected through retrospective chart review to identify the services used by patients. Cost data would be applied to the volume data. Alternatively, concurrent prospective service utilization and cost-finding efforts could be conducted.

**Third Party Payer Point of View**

For third party payers, the economic impact of a health care intervention may be assessed by gathering data regarding the number of subscribers expected to receive the intervention. Data on payment rates for specific services would be used to assess insurer costs for these services. For Medicare and other third party payers who have implemented case-mix-based, prospectively set levels of payment, specific services used during the course of hospitalization are of
interest in that they may influence the hospital's cost, but they do not
influence the cost to the third party payer, at least in the short term. In the
long run, insurers may adjust the fixed payment rates if historical data about
costs are used to determine payment rates, or if services used for those
patients have been found to be unnecessary or inappropriate.

Societal Point of View

From the point of view of society as a whole, any resource that is consumed
or opportunity to produce that is lost represents a cost. Therefore, the true
cost of providing inpatient care (which is also important from the hospital's
perspective), out-of-pocket costs to the patient, and indirect costs would all
be available for alternative uses. Therefore, the opportunity to use them for
alternatives is lost and a cost is incurred. From the perspective of society as
a whole, its options are more limited because of the resources having been
consumed or because the individual's contribution to the economy has been
foregone.
VII. ETHICAL ISSUES

Rationing

Decisions to limit resources for health care require that health care services be rationed at some level. On a national level, the proportion of a country's income used for health care may guide decisions about the proportion of funds allocated to technology development, research support, capital investments and therapeutic interventions. At the level of medical decision-making, data about cost, benefit and effectiveness may increasingly become part of the calculus of clinical practice.

In their examination of health care resource allocation decisions, Aaron and Schwartz (81) compared spending for health care services in Britain and the United States. At that time about 10 percent of the gross national product (GNP) of the United States was spent on health care while just over five percent of Britain's GNP is allocated to health care. Moreover, in Britain, the national government determines the funds that will be allocated to health care and to what categories of health spending they will be applied. Additionally, health care funds are allocated differently in the two nations. In the United States, for example, almost 70 percent of all health care expenditures are for direct health care services such as hospital care and physician visits. Thirty percent of expenditures are for capital, research, administration and other non-service factors. In contrast, Britain allocates 93 percent of expenditures to direct health care services. These data suggest that the United States has placed a higher priority on research and facility development than has Britain. Britain also allocates relatively more funds for hospital care than does the United States. Fifty-six percent of per capita expenditures in Britain are for hospital care, while 38 percent of per capita expenditures are for these services in the United States (81).
Societal Issues

Decisions to ration services, particularly by withholding them at the clinical level, are difficult in the United States where providing additional services has been encouraged and has come to be expected. This parallels physicians' usual training to do whatever is necessary for diagnosing or treating patients. Thus, all parties participating in decisions about service delivery have traditionally encouraged increased use of services in the United States. However, particular services, including out-of-hospital parenteral therapy (e.g. nutrition, antibiotic, cancer chemotherapy), have not been routinely covered by health insurance programs. Thus, the use of these services in the outpatient setting has been inhibited without regard to the clinical appropriateness of the service.

Hospital Issues

The societal decision to ration services is often implemented at the level of the provider. Butler and his colleagues (82) examined length of medical intensive care unit stay, DRG, and clinical course for all patients cared for in the intensive care unit at their hospital during the period of July 1, 1982-June 30, 1983. They estimated DRG payments for these patients, including base-payments, pass-through expenses, indirect education expenses and outlier payments in their estimates. Butler, et al, went on to assess costs of care by applying Medicare cost-to-charge ratios to patients' billed charges. Calculated costs and DRG reimbursement rates were compared and losses were estimated. Overall, in one year, 446 Medicare patients who received medical intensive care generated an estimated loss of $4.7 million dollars for the hospital. According to the authors, the findings suggest that "extensive utilization (of medical intensive care) will jeopardize the financial viability (of hospitals)." These losses from DRG payment force internal management decisions regarding capital
investments in monitoring equipment, nurse staffing for intensive care units and monitoring of physicians' use of intensive care services. Fewer resources may be devoted to delivering intensive care, particularly if financial factors serve as the basis for these capital allocation decisions.

Butler and his colleagues (82) also suggest that it is important to assess factors such as the cost-effectiveness of intensive care units before fully-informed management responses to changes in reimbursement can be formulated. Similarly, economic evaluations of other specific medical care interventions are important for hospital management or medical decisions about the use of these services.

From the hospital's perspective, specific interventions such as nutrition support services and antibiotic medications are farther removed from administrative control than are intensive care units. Little capital investment, which is usually under administrative control, is required for these services. Once the service has been established (e.g. parenteral nutrition), administrators have little control over their cost. Rather, it is the intensity of the use of these resources and the operational costs they generate that are key to control hospital expenditures. This may be achieved by increasing control over hospital formularies, support for pharmacy and nutrition support services and criteria-setting regarding site of service for specific interventions (e.g., only outpatient long-term TPN). On the other hand, administrators may encourage the use of specific resources if their use is associated with decreased lengths of stay and lower complication rates (i.e., cost-benefit ratio is favorable). To control the utilization of these specific resources, hospital administrators will increasingly want to influence physicians' more directly. The independent nature of physician decision-making may be threatened as hospital administrators carefully examine these decisions.
Physician Issues

In this changing environment, Eisenberg (83) points out that physicians are being asked to make decisions that implicitly incorporate assessments of the cost-benefit or cost-effectiveness of individual medical care interventions. Levinsky (84) suggests that physicians' decisions should be based on what is best for the individual patient. However, as responsible members of society, physicians will probably want to consider efficiency in selecting medical care interventions more in the future than they have in the past. They will be torn between the decision to offer something extra to each patient without regard to cost and the decision to balance the effectiveness of an intervention with its cost in order to use society's (or the hospital's or the HMO's) resources most efficiently.

Morreim (85) characterizes this as a "moral challenge." Issues about allocation, such as the percent of GNP that is spent on health care, have seemed far removed from decision-making about individual patients. However, these decisions are now beginning to have an impact on decisions about individual patients. Thus, decisions about individual patients may be based on societal good rather than potential benefit for the individual patient. This is not consistent with physicians' training or patients' expectations, and will cause conflict, tension, and perhaps even re-definition of the physician's responsibility.
VIII. POLICY IMPLICATIONS

The available information about the clinical economics of nutrition support services and antibiotic medications provides some insight into the economic ramifications of the use of these two medical care interventions. Unfortunately, little specific information is available about the use of these two interventions for critically and terminally ill elderly patients. Moreover, there are methodologic weaknesses with many of the available studies, and data are not available about the economic implications that discriminate among the several possible points of view.

Investigators interested in resources used by critically and terminally ill patients have used a variety of definitions to identify the appropriate patient populations. While no one definition has been widely used or well accepted, several investigators have used charges or Medicare payments to identify high cost patients, and the relationship between high cost and critical illness has been established clearly. Other investigators have established that patients who die consume a large portion of third party payments. Nevertheless, the time frame for these analyses has varied and the studies have generally been conducted retrospectively. Therefore, no definition of terminal illness is available that may be applied prospectively. Assessing the economic ramifications of the use of particular interventions can only be conducted when it is possible to define clearly the patient population of interest. Once a definition is available, prospective randomized trials of medical interventions may be conducted to evaluate economic impacts. This first step is necessary to facilitate studies that are valuable for establishing societal, third party payer and institutional policies regarding the use of these services.

Investigations of the economic implications of nutrition support services and antibiotic medications generally have suffered from these and other
methodologic weaknesses. For example, charges rather than true costs usually have been included in these analyses. Many studies have also been limited to resources consumed for delivering nutrition solutions and equipment, or for the antibiotic medications alone. Other real costs, such as those for preparing nutrition support solutions have rarely been included in the economic studies. Total cost information is important to consider as third party payers, including Medicare, adjust payment rates to more closely reflect the cost of delivering services.

Side-effects of nutrition support services and antibiotic medications are also important to consider, but costs for these events have rarely been included in economic assessments. For example, catheter-related infections or embolic events may result from receiving TPN. Different diagnostic and therapeutic interventions may be used to monitor and treat these adverse events. However, the resources consumed for these extra services have rarely be evaluated.

Another aspect of antibiotics and nutritional supplements that has not been included in the economic evaluations is that of adverse events avoided. For example, prophylactic use of antibiotic medications for surgical patients may prevent wound infections. Expenses are obviously incurred for the prophylactic antibiotic medications. However, these expenses may be small relative to the expenses that would be generated in diagnosing, treating and monitoring patients who develop wound infections. This category of costs is important to consider, for example, in a cost-effectiveness or cost-benefit study of the costs generated per wound infection prevented. In this sense, a patient who becomes critically ill because of a surgical complication may have been less expensive to treat if the complication had been prevented with an intervention such as prophylactic antibiotics or preoperative nutrition. For insurers and institutions, results of studies that incorporate these factors may be useful in developing policies that encourage increased use of specific prophylactic
services, based on the lower expected incidence of costly adverse events.

Another weakness of the available literature is that investigators have concentrated on the use of nutrition support services and antibiotic medications for hospitalized patients; few investigators have conducted economic evaluations of the services used by nursing home patients. This component of the patient population should be considered; approximately 1 million elderly individuals are in nursing homes (70) and the overall nursing home patient population is predicted to increase as fixed-price payment programs and their inherent incentives to discharge patients from hospitals become more prevalent. Investigators have not focused on the use of antibiotic or nutrition support services by elderly patients. While individuals 65 years of age and over make up 11 percent of the population, they account for over 30 percent of direct medical expenditures (12). Clinical economic studies should be focused on this segment of the population.

Third party payers may implement policies designed to minimize payments for nutrition support services and antibiotic medications. However, such policies may in fact increase the economic burden on patients, providers or society. For example, an insurer may make parenteral antibiotic therapy available on an outpatient basis, but insurer payments may be lower (and the patient would be responsible for copayment) for such a program than for inpatient care (hospital costs will also be lower and important to consider under fixed payment). Patients may be likely to incur greater expenses, including out-of-pocket expenses for direct nonmedical factors such as transportation to a hospital. Under such circumstances, patients are likely to resist outpatient care. Few data are available about these types of trade-offs. Nevertheless, they are important to consider in establishing payment programs and in estimating savings (to the insurer) that will accrue from the new program.
Methodologic approaches are available to address each of these issues. For example, Eisenberg and colleagues are conducting an economic evaluation as part of a VA cooperative study of preoperative nutrition support services delivered to nutritionally deficient surgical patients. They are assessing the actual hospital costs for acquiring, preparing and delivering nutrition support services. Costs for diagnostic and monitoring services, and consultations are also being included. Eisenberg et al are also assessing the cost of adverse postoperative events avoided, including extended length of stay and complications. Questionnaires and patient interviews are being used to determine patients' out-of-pocket and indirect expenses. The results of this study will include costs from patients', the hospitals' and the payer's (government) point of view.

Results of these types of studies will provide valuable information to policy-makers concerned with the economic impact of the use of specific health care interventions. However, less tangible factors, including equity of resource distribution and ethical issues regarding withholding services, must also be considered by policy-makers. In an economic analysis that uses the human capital approach, elderly patients' lives would be devalued, thus biasing against interventions that prolong or save these patients' lives. As a society, however, it may be desirable to allocate resources to this group of patients. Such decisions, based on intangible factors, are difficult to define explicitly. Nevertheless, policies must be formulated that reflect these decisions.
REFERENCES


2. Eisenberg JM, Williams SV: Cost containment and changing physicians' practice behavior: Can the fox learn to guard the chicken coop? JAMA 1981; 2195-2201.


9. Herbling C: Medicare: Use and reimbursement for aged persons by survival


46. Veterans Administration Pharmacy Service Study Group: Variable cost per dose of preparing and administering small-volume cephalosporin admixtures.
47. Hollaway JJ, Smith CR, Moore RD, et al: Comparative cost effectiveness of

hemodialysis: Dollar comparison and payback period. JAMA 1981; 246:230-
232.

49. Center for Disease Control: Outline for surveillance and control of

89:749-753.

51. Freeman J, McGowan JE: Methodologic issues in hospital epidemiology. III.
Investigating the modifying effects of time and severity of underlying
illness in estimates of cost of nosocomial infection. Rev Inf Dis 1984;
6:285-300.

52. Green MS, Rubinstein E, Amit P: Estimating the effects of nosocomial

53. Spengler RF, Greenough WB: Hospital costs and mortality attributed to

54. Farber BF, Brennen C, Puntereri AJ, Brody JP: A prospective study of


antibiotics: An efficient, cost-effective home care program. CMA Journal
1982; 127:207-211.

68. Stiver HG, Telford GO, Massey JM, et al: Intravenous antibiotic therapy at


70. Reinhardt AM, Quinn MD: The elderly: Health and mental health care, in

71. Wertheimer AI: Pharmacy services in long-term care facilities. Pharmacy

72. Vestal RE: Drug use in the elderly: A review of problems and special

73. Young LY, Leach DB, Anderson DA, Rice RT: Decreased medication costs in a
skilled nursing facility by clinical pharmacy services. Contemporary Pharm


75. Kobrinski EJ, Matteson AL: Characteristics of high cost treatment in acute


83. Eisenberg JM: The physician as guarantor of social good. Chapter 4 in *Doctors Decisions and the Cost of Medical Care*, Health Administration Press, in press.
