Chapter 2: Analyzing Economic Outcomes in Advanced Practice Nursing

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The trend toward older adults making up a growing proportion of the United States population, improvements in health care technology, direct to consumer advertising for a long list of pharmaceuticals, increasing costs of doing business besides health care, and international competitive pressures on wages and benefits have drawn greater attention to the costs of health care over time. The focus on cost is not the only factor raising the importance of studying and considering the cost-effectiveness of health care in the United States. Other relevant factors include (1) the scientific recommendations related to the conduct of cost-effectiveness analyses that have been issued in the United States, (2) a format for formulary submissions offered by the Academy of Managed Care Pharmacy, (3) other recommendations around the globe that are recognized by parties in the United States, (4) conferences related to cost-effectiveness sponsored by the National Institute of Nursing Research, and (5) an increasing focus on comparative effectiveness more generally.

In 2006, US healthcare spending increased 6.7 percent (greater than the rate of inflation), to a total of $2.1 trillion or 16.0 percent of the gross domestic product (Catlin et al. 2008). This increasing level of expenditure and increasing proportion of the gross domestic product being spent on healthcare, forces policy makers to consider the costs as well as the effectiveness of new treatments, devices, or interventions. Health policy makers increasingly request analyses including projected economic outcomes prior to the approval of funding for or reimbursement of these new activities. In the current health care environment, advanced practice nurses (APNs) need to be knowledgeable about the interpretation of cost and effectiveness data, particularly when they are combined in a cost-effectiveness study.

The increased demand for economic information has resulted in a number of economic evaluations in the literature specific to nursing (examples include Spetz 2005; Crowther 2003; Anderson et al. 2002; Brooten et al. 2002) and an overall plethora of cost-effectiveness studies

(Neumann et al. 2005). In addition to being able to read about the results of studies related to the services provided, APNs and other clinicians are being asked to participate in these analyses or review published reports of economic evidence for the appropriateness regarding implementation into practice (examples include Chummun & Tiran 2008; Chiu & Newcomer 2007; Subramanian et al. 2007; Lee et al. 2007).

A number of different methods are employed to address economic outcomes of health care. The purposes of this chapter are to present an overview of five different types of economic evaluations an APN may encounter, discuss appropriate outcome measures for each type of analysis, present and critique published examples of each type of economic evaluation, and discuss methodological issues of importance to economic evaluations.

Types of Economic Evaluations

Five different methods of economic evaluations are commonly used in assessing the economic impact of new health care interventions and technology. Table 2.1 presents a brief overview of these methods (Drummond et al., 2005). In all of these economic outcome evaluations, alternative strategies are compared, and the incremental cost of the competing strategies is computed according to the following formula:

$$\text{Incremental Costs} = C_1 - C_2$$

where C_1 represents the cost of the new intervention and C_2 represents the cost of the comparator (e.g., the next best strategy). There is more variation between methods regarding how effectiveness is measured, although the focus remains on incremental changes in effectiveness (i.e. comparing the outcome of one intervention with another).

Cost Minimization Analysis

In a true cost-minimization analysis (CMA) only the costs are evaluated, and the alternatives are assumed or have been found to offer equivalent outcomes. Many of these studies begin as cost-effectiveness studies (discussed in more detail below) in which the investigators expected one intervention to be both more effective and more expensive. As a result, in most published economic evaluations labeled as CMAs, some level of effectiveness of the strategies being compared is measured (examples include Goodman et al. 2007; Patel, Duquaine, & McKinnon 2007). In each study, clinical outcomes were measured prior to the study being published as a cost minimization analysis. In the Goodman et al. (2007) study, the authors measured a number of outcomes of a fitness for life program and found no statistically significantly differences between groups; in the Patel, Duquaine & McKinnon (2007) study, outcomes associated with changes in the dosing of meropenem were found to be similar prior to the study being published as a cost minimization study.

Cost Consequence Analysis

A cost-consequence analysis (CCA) is a study in which the costs and the consequences of two or more alternatives are measured, but costs and consequences are listed separately. This methodology is often chosen when there is no obvious summary measure for the outcomes applicable to the interventions being studied. In a CCA, the analyst expects the decision makers to form their own opinions about the relative importance of the findings. To facilitate decision making, the analysts provide an array of consequences applicable to each strategy. Two studies serve as examples of this methodology being used in the nursing literature. Sørensen & Frich (2008) analyzed the consequences of a nurse follow-up intervention for chronic non-malignant pain patients and described outcomes in terms of the eight SF-36 subscales. Dawes et al. (2007) compared nurse supported early discharge for women receiving major abdominal or pelvic surgery with usual care. In addition to studying costs,

Dawes et al. examined results from the SF-36, complications, length of hospital stay, readmissions, and satisfaction.

Cost-Effectiveness Analysis

Cost-effectiveness analysis (CEA) also measures incremental costs. In CEA, incremental consequences are measured in a single common natural unit, such as life-years gained or cases avoided. In addition, costs and effects are summarized in an incremental cost-effectiveness ratio, which is calculated using the following formula:

$$\text{Cost-effectiveness ratio} = (C_1 - C_2)/(E_1 - E_2)$$

where C_1 equals the cost of the new intervention, C_2 equals the cost of the comparator, E_1 equals the effect of the new intervention, and E_2 equals the effect of the comparator. For CEA, analysts often attach the resource utilization data collection process to a randomized trial (usually powered on something other than the cost-effectiveness result) (e.g. Paez & Allen, 2006, examined nurse management of hypercholesterolemia patients) or employ a decision analytic approach and model the problem through the use of a decision tree (e.g. Honkanen et al., 2005, modeled external hip protectors being used in nursing homes). A sample decision tree is diagrammed in Figure 2.1. The decision is between choosing alternative 1 or alternative 2. Both alternatives have associated probabilities of good and bad outcomes. In addition, there are the associated costs of each strategy. The use of decision analysis and decision trees is a defined mathematical modeling technique; it is suggested that anyone interested in using this technique seek training opportunities. There are a number of texts that share a high degree of readability and are available to the APN wishing to understand this approach better (Muennig, 2008; Drummond et al., 2005; Haddix, Teutsch, & Corso 2002; Petitti, 2000).

A number of examples of CEA can be found in the recent nursing literature (Paez & Allen, 2006; Ganz, Simmons, & Schnelle, 2005; Honkanen et al., 2005; Rost et al. 2005). Paez & Allen

(2006) provide an excellent example of deriving a cost-effectiveness analysis from a randomized trial. The study included 228 consecutive adults with hypercholesterolemia and CHD who were hospitalized. The intervention was follow-up care regarding lipid management including lifestyle modification with services being provided by a nurse practitioner; this was compared with usual care enhanced with a small amount of extra information on lipids. The results were expressed as the extra dollars spent per unit of LDL-C change at one year or per percentage point of LDL-C change at one year. While this is an acceptable health outcome, it only facilitates comparison with other studies that are focusing on interventions for hypercholesterolemia. In contrast, Ganz, Simmons, & Schnelle used a Markov simulation cohort (i.e. simulating what happens to a cohort of individuals over multiple periods through time) to estimate the cost-effectiveness of having recommended staffing levels. This group used data from the literature, showed the sources very clearly, and expressed their results in dollars per quality adjusted life year (discussed in more detail below).

The quality adjusted life year is a common outcome unit at this point in time as it has been recommended by a number of organizations around the world and facilitates comparisons among different studies. More generally, many economic analysts recommend using a standard outcome measure, such as dollars per life year ($/LY), because it is appropriate to different health care situations. Consequently, results can be compared across a variety of patient populations and settings. While easy to understand, an outcome measure of $/LY considers only survival, but not suboptimal health states, and/or quality of life. This is a concern since quality of life is often considered an important issue to individuals considering different health care treatments. This leads directly into the more detailed discussion of quality adjusted life years (QALY) and their application below.

Cost Utility Analysis

Cost-utility analysis (CUA) considers both the effectiveness of the interventions on the quantity and quality of life in a single multidimensional measure, QALYs. The QALY is a measure of the quantity of life gained weighted by the quality of that life. Quality of life is measured by a utility, which is a measure of preference for a given health state rated on a scale where 0 equals death and 1 equals perfect health. Because dollars spent to gain a QALY is not disease specific, it is a useful measure to inform health policy decisions and is recommended for such use by the U.S. Public Health Service's Panel on Cost-Effectiveness in Health and Medicine (Gold, Siegel, Russell, & Weinstein, 1996). However, at a recent meeting of the International Society of Pharmacoeconomics and Outcomes Research a speaker highlighted that there is variance in the interpretation of what QALYs are actually measuring (2006) and there is not universal agreement as to what society should be willing to pay to gain a QALY (Ubel, Hirth, Chernew & Fendrick, 2003; Hirth et al., 2000), although the figure of $50,000/QALY is still often cited.

One group of researchers considered a nursing intervention to increase adherence to antiretroviral therapy among HIV patients (Freedberg et al, 2006). The design of this study illustrates how data from a randomized clinical trial can be combined with a computer modeling exercise to conduct the cost-effectiveness analysis. The authors modeled the associated change in virologic suppression as well as changes in cost and quality adjusted survival. Comparing these results with the costs of the intervention and the therapy, the authors found the intervention to be highly cost-effective with a ratio of $14,100 per QALY gained compared with standard therapy.

Cost-Benefit Analysis

Cost-benefit analysis (CBA) is a form of economic evaluation in which consequences are measured according to some monetary unit. In CBA, a single dollar figure representing costs

minus benefits is calculated. As long as the decision maker agrees with the methods used to place a dollar value on outcomes, this provides the decision maker with a direct indication of whether the value of the benefits is greater than the cost. Simon et al. (2007) determined the net economic benefit of a nurse specialist led program for patients with depression and diabetes. Their study use a randomized trial design and compared with intervention with usual care. The care provided included psychotherapy and pharmaceutical treatment. A sufficient amount of other health services utilization was saved so that if a day without depression were counted as $10 (the type of assumption necessary for a cost-benefit analysis), the total positive economic benefit per patient was $952. The authors also conducted a statistical analysis to demonstrate that the 95% confidence interval around the point estimate of economic net benefit did not include zero.

COMMON ISSUES IN ALL ECONOMIC EVALUATIONS

The basic steps in conducting economic evaluations are illustrated in Figure 2.2. In addition, because this is essentially a new language to many APNs, Table 2.2 defines some of the concepts and common terminology used in these analyses.

Selecting the Type of Economic Evaluation

The first step is to select the appropriate type of analysis to conduct. Considerations should include: the goal of the analysis (e.g. whether to compare only interventions affecting a single disease with a well defined most important symptom or to compare interventions for different diseases or interventions for a condition with a complex set of symptoms); whether the interventions' effectiveness is equivalent (if so, suggesting a cost minimization analysis); the effectiveness measures available (e.g. can QALYs be generated); the potential impact of the interventions on either quality or quantity of life (if both, then a cost utility analysis is most appropriate); the availability of data; the expertise available; and ethical issues.

Framing the Analysis

Once the economic method has been selected, the analysis is framed. This includes selecting the appropriate comparator(s) to analyze. For example, the cost-effectiveness of a new educational program offered in a hospital setting may be different from an outpatient focused program as compared to the absence of teaching altogether. At the least, the comparison of new interventions should be to the current practice, *or* status quo. This also emphasizes the fact that analyses do not compare an intervention with “doing nothing”. In addition, often more than one comparator is appropriate to include in the analysis. This is especially true when multiple alternatives have been found to offer similar clinical outcomes *or* there potentially are multiple levels *of* intensity *of* the interventions (e.g., increasing home health visits from 2 times per week to daily).

Boundaries of the study refers to the scope of the study, which delimits the costs and effects that are included in the analysis. Many interventions have some spillover effects that must be considered. The question becomes how far to follow such effects to adequately assess the economic impact of the intervention. For example, if the aim of an educational program for mothers of infants admitted to a neonatal intensive care unit is to decrease the mothers' level of anxiety and improve the physiologic outcomes of the infant, then it logically follows that the boundaries would include both the mother and the infant. This intervention may affect the overall parenting skills of the mother, however, and may have additional positive effects on other children in the family. In theory, all these effects are relevant, but in framing the study it is important to draw the practical and feasible limits around the analysis.

In all types of economic evaluations, the perspective, or viewpoint taken in the analysis also drives the set of costs and benefits included. Studies may be motivated by policy decisions

relevant to specific institutions or individuals. In this case, the perspective of primary interest may be that of a managed care organization, hospital, employer, state health department, or other party. An economic evaluation conducted from the perspective of the hospital (i.e., providing a result most relevant to a hospital decision maker) should not consider costs (or savings) associated with family caregiving in the home. If the goal of the analysis is to affect broad resource allocation and health policy issues, the societal perspective is appropriate and recommended (Gold, Siegel, Russell, & Weinstein, 1996). This perspective incorporates all costs and all health effects regardless of who incurs them. This is advantageous because if a systematic analysis is performed to compared the results of multiple studies and all have used the societal perspective it makes comparison easier. Gathering data for the societal perspective also allows any other perspective to be calculated as a subset of the societal perspective. A general rule of thumb is to take a societal perspective, and then if desired, present the results from a different perspective.

The time horizon refers to the period of time for which the costs and benefits are measured in the analysis. The time horizon may vary from less than one year to the patients' life span. The appropriate time horizon to consider will depend on the probable length of effect of the interventions being compared. Once the framing of the analysis is complete, the analyst is ready to estimate costs. The distinction between the time of the intervention and the time horizon for the analysis must be kept in mind. An intervention that lasts less than one year (e.g. nurses providing counseling to adolescents on high risk behaviors) may have effects that last a lifetime.

Costs

Terminology pertaining to costs of resources has traditionally been divided into "direct" and "indirect" costs (Gold, Siegel, Russell, & Weinstein, 1996) with other labels like “friction costs” sometimes being applied to the cost of hiring a new employee and sometimes being applied to

an entire method of valuing productivity (Brouwer & Koopmanschap, 2005; Gold, Siegel, Russell, & Weinstein, 1996). However, since economists and accountants do not use the same definitions and sometimes even economists have not been able to agree on a universal set of definitions, the terminology has become complicated. In health economics, direct costs have been defined as changes resource use directly attributable to the provision of care, whereas indirect costs have referred to costs associated with the loss of productivity due to morbidity and/or mortality (Liljas, 1998). Accountants, on the other hand, refer to direct costs as variable costs (e.g., supplies) and indirect costs as overhead costs (e.g., rent) (Anthony & Young, 1994). In light of these past inconsistencies in defining and measuring costs, the APN conducting an economic evaluation should be sure to clarify and clearly communicate how the cost terms are defined. The trend in the CEA literature is to avoid the term indirect. Given this trend and potential for confusion we suggest APNs avoid the term indirect.

Economists and analysts often use a “two step” approach to determine the costs attributable to an intervention. The first step is in the estimation is determining the amount of resources attributable or consumed. Once the attributable resources have been determined, the “money” valuation or costs of the resources may be estimated. Using a two step approach increases the clarity and transparency of the analysis and allows readers of the analysis understand how the costs of attributable resources may be similar or different in their own setting.

The resources and associated costs can be categorized as in Table 2.3, which is an adaptation of a grouping that appeared earlier in the literature (Luce, Manning, Siegel, & Lipscomb, 1996). In CEA, financial health care costs are directly related to the intervention itself and associated costs or savings of future health care, which the intervention may impact. For example, financial health care costs associated with a hepatitis B virus (HBV) immunization program should include the costs of obtaining and administering the immunization. In addition, they should

include downstream costs (or savings), such as hospitalizations, outpatient visits, and other treatment costs associated with the diagnosis of HBV itself. Financial costs associated with other related diseases such as cirrhosis or cancer should also be included. Similarly, the value of the time a patient spends seeking care or participating in an intervention constitutes a real use of resources for the individual and society. Relevant patient time costs may include the time receiving the treatment as well as time waiting to receive care.

Consumption of resources other than those associated with the provision of health care also should be considered in economic evaluations conducted from the societal perspective. Financial non-health care costs may include child care costs for a parent attending a smoking cessation program, increase in a family's food expenditure as a result of a dietary prescription, and the cost of transportation to and from the clinic.

Historically, patient time and other non-health care resources have not been consistently included in analyses (Jacobs & Fassbender, 1998; Stone, Chapman, Sandberg, Liljas, & Neumann, 2000). Nonetheless, if an analysis is conducted from the societal perspective, inclusion is recommended (Gold, Siegel, Russell, & Weinstein, 1996). In addition, because health care is becoming more community-based, nursing interventions may directly influence these costs. For example, a home visit by an APN case manager may not only increase the ability of the APN to conduct a holistic assessment, but also save resources related to patient time, transportation, and family care-giving.

Productivity costs are the costs associated with morbidity or mortality. Morbidity costs are those associated with lost or impaired ability to work or to engage in leisure activities (e.g., loss of income due to time for recuperation or convalescence after coronary bypass surgery). Mortality costs are related to loss of life, and are usually measured according to what the individual would

have been capable of earning. Two issues are important to note concerning the productivity costs. First, the U.S. Public Health Service's Panel on Cost-Effectiveness in Health and Medicine recommended that productivity costs be excluded from CUAs (Gold, Siegel, Russell, & Weinstein, 1996). The authors expressed concern that including both productivity costs and QALYs would represent a double counting because people may considering productivity and earning potential when responding to tradeoffs involving health and quality of life. Thus, when QALYs are used, productivity is already included in the denominator of the cost-effectiveness ratio. Second, this assumption is controversial and has been debated by experts in the field (Brouwer, Koopmanschap, & Rutten, 1997a, 1997b; Weinstein & Manning, 1997; Weinstein, Siegel, Garber, et al., 1997). In light of this controversy, some analysts have presented results both with and without the inclusion of productivity costs (Krahn, Guasparini, Sherman, & Detsky, 1998). APNs conducting CUAs may also wish to present results with and without the inclusion of productivity costs as well as continue to monitor recommendations made in the United States and elsewhere.

Some interventions extends life, e.g. a successful smoking cessation program. Costs related to resource consumption in "added life-years" are recommended for inclusion in economic evaluations. Added life-year costs are related to the consumption of health care resources (financial health care costs) and other types of consumption (all other cost categories). Because not all analyses increase life expectancy (e.g., use of cochlear implants or an educational intervention program aimed at decreasing parental anxiety), resource consumption in added life-years is not always applicable. Sometimes, living longer and healthier can cost less annually but more over time (van Baal et al., 2008).

Finally, income transfers, such as social security payments, are redistributions of money and are therefore, not real costs to society. Consequently, although these "transfer costs" may be

tracked and may be important for analyses from the government's perspective, they should not be included with other societal costs. What should be included in a societal cost analysis are the costs of administering an income transfer program.

When trying to determine which costs to include, the process should begin with an outline of the categories of costs that included, using the list in Table 2.3. Once this is complete, a researcher should consider the cost "ingredients" that the intervention impacts under each category (Drummond et al., 2005). After the ingredients are identified, discussions about which costs are most relevant and which are important to measure can take place. Moreover, the perspective of the analysis will drive the decisions about which cost component to include. The treatment of the cost component (e.g., productivity costs captured in quality of life adjustments) is determined by the specific economic analytic method chosen.

Once the consumption of resources has been estimated, the resource must be assigned a dollar value. Economists use the term "opportunity costs," which reflects the value of the next best alternative use of the resources. Determining the actual opportunity cost of a resource is difficult. Some general guidelines follow for assigning a dollar value to a resource.

In many markets, market prices (or charges) do not equate to costs. This does not apply in health care as often as in other fields. This incongruence is particularly notable for charges associated with hospitalizations, due to institutional "cost shifting." Health care delivery institutions charge an amount to patients when sending out bills. Cost shifting is the practice of obtaining higher costs from payers that are willing to pay higher levels of reimbursement or unable to negotiate lower levels of reimbursement. Therefore, for these institutional categories, an adjustment to prices is necessary. However, many customers, such as large insurance organizations, pay only a fraction of these charges. Large payers negotiate payment rates for

services rendered based on the cost of the service and allowed profit margins (or excess revenues for not-for-profit institutions). Payers with the least market power, e.g. uninsured individuals, are the only ones who are likely to pay anything near the cost. If a hospital were just to break even based on the negotiated rates, then it is clear that the actual amount charged does not represent anything close to the actual cost.

Instead of using charges, a common source of valuation for hospital costs is the hospital's cost-accounting systems. For researchers internal to the institution, these will often be easy to access. These cost-accounting systems are developed by finance departments to help administrative decision making and are based on past accounting studies and algorithms. While the market price of medical care often does not represent costs, the market prices of the goods in the cost accounting system are expected to represent the relevant cost. If a cost-accounting system is available, the APN can usually determine the specific monetary health care cost components, such as variable costs (e.g., staffing and supplies), and fixed overhead costs (e.g., rent and percentage of administration costs).

Another alternative is to use hospital cost-to-charge ratios (CCRs), which is calculated by dividing the total costs in a cost center by the total charges for the same resource. CCRs are recognized as a gross adjustment to charges. This type of adjustment is better than using charges alone, but is not preferred to cost-accounting systems when they are available. Published sources also are often used as the source of valuation of the resource (Stone, Chapman, Sandberg, Liljas, & Neumann, 2000). Governmental fee schedules are also often used to represent costs of particular procedures (Armstrong, Malone, & Erder, 2008).

When cost estimations come from various sources, standardization of all costs to the same currency and year is important. For example, non-U.S. currency figures may be converted into

U.S. dollars using the appropriate foreign exchange factor for that year (Federal Reserve Bank of St. Louis, http://www.stls.frb.org/fred/data/exchange.html). A study of stoma therapy nurses demonstrates the concept of exchange rates (Becker et al., 1999). The concept of purchasing power parity that accounts for not only the exchange rate but attempts to yield the capacity to purchase the same quantity of goods is also commonly used (Urdahl et al., 2003). In addition, because $1 in 1988 does not have the same purchasing power as $1 in the year 2008, the costs from different years must be adjusted into a standard year format by the use of the consumer price index (CPI) (data are available from the Bureau of Labor Statistics (BLS) website (www.bls.gov) and a single year-to-year calculation can be done using the inflation calculator provided at that website http://data.bls.gov/cgi-bin/cpicalc.pl). This inflation calculator is based on general market goods inflation. Because the costs of healthcare are rising more quickly than other markets, the BLS also calculates a medical inflation rate, which is often used to inflate costs that pertain only to healthcare resources. A recent study of the costs of nurse turnover demonstrates inflation adjustment for calculations that could serve as an input to cost-benefit analyses related to retention efforts (Jones, 2008). Finally, there is discussion as to whether to use the consumer price index or the producer price index for inflation adjustment in general.

Discounting

Once all costs and benefits have been calculated, future costs and benefits are discounted to present value. Discounting reflects the principle that suggests people place greater value on something they have today than on something they will have in the future. Interest rates are an example of this principle. Future costs and benefits are discounted to present value using the following formula:

$$F/(1 + r)^n$$

where *F* =the future value (which is usually measured in dollars given today's value), *r* = the discount rate, and *n* =the number of years in the future (Stone, 1998). Currently, in the United States, experts recommend using a *3%* discount rate to discount both costs and effects (Gold et al., 1996). However, because prevention interventions are aimed at improving future health, by discounting future benefits, the intervention may not seem as beneficial. Therefore, some analysts are uncomfortable discounting future health benefits and only discount costs (Stone et al., 2000). However, to increase the comparability of analyses, APNs in the US should discount both costs and effects at 3%, and if desired, the results without discounting may also be presented (Gold et al., 1996). In addition, prior to the recommendations being issued by the United States Panel on Cost-Effectiveness in Health and Medicine in 1996, many analysts used a 5% discount rate. As a result, this was suggested as an additional discount rate to use for comparison (Gold et al., 1996).

Analysis

In conducting economic evaluations, data gathered may include resource utilization, value of resources, effectiveness of treatment, and preferences regarding health outcomes. Based on the data gathered the "base-case" analysis is computed. If the recommendations made by the U.S. Public Health Service's Panel on Cost-Effectiveness in Health and Medicine are followed, this initial analysis is labeled a "Reference Case" (Gold et al., 1996). A best practice when presenting results (whether they represent the reference case or not) is to include a table listing all parameters, the value assigned to the parameter, and the source of the value.

Sensitivity Analysis

Many of the data points gathered include some assumptions or uncertainty in the parameter. For clarification, the analysis based only on the best point estimates is referred to as the 'base

case' regardless of whether the recommendations of the Panel are followed. Thus, any cost effectiveness analysis includes a base case but not all base case analyses are reference case analyses.

The assumptions that are made in the base case should be clearly stated clearly before the results are presented to increase the transparency of the analysis. In addition, sensitivity analyses should be conducted to explore the implications of alternative assumptions. Sensitivity analysis is an important element of a sound economic evaluation (Drummond et al., 2005; Gold et al., 1996).

Sensitivity analyses are calculations in which a parameter is varied; these analyses indicate the degree of influence the particular value has on the analysis. The range use for a parameter should be specified along with the point estimate in the table describing parameters that was included in the previous section.

A univariate sensitivity analysis examines the degree to which changing a single assumption changes the outcome of the entire analysis. By varying the value of the variable over a reasonable set of parameters, the investigator is able to determine how that variable may impact the results under different assumptions. The impact on the results has multiple interpretations. One is how the magnitude of the cost-effectiveness ratio changes. In other words, whether the ratio changes from spending $10,000/QALY gained to $30,000/QALY gained. However, a second level of interpretation is whether the decision to implement a new intervention or not changes. If a decision maker believes that any program costing less than $50,000 is a candidate for implementation, then the change from $10,000/QALY to $30,000/QALY will not change the decision on whether to consider a new intervention for implementation. Ganz, Simmons, and Schnelle (2005) used a series of univariate sensitivity

analyses to explore which parameter led to the greatest change in the incremental cost-effectiveness of raising nurse staffing to the recommended level rather than the median level in skilled nursing facilities. The authors found that the parameter leading to the largest changes was the probability of admission to acute hospital from the nursing home. They also described the relationship between the incremental cost-effectiveness ratio and other variables.

Although univariate sensitivity analyses are insightful, looking at one source of uncertainty by itself is usually inadequate. The alternative is multivariate sensitivity analysis. A multivariate sensitivity analysis examines multiple sources of uncertainty at one time and may generate a more accurate understanding of the uncertainty of the cost-effectiveness results. This can be done by changing all parameters to their most of least favorable levels—but still working with predetermined levels of the values for each variable. A second approach makes use of the fact that variables can sometimes be expected to change together; in this case, the analyst might explore how the cost-effectiveness ratio changes as the two variables are varied over their ranges. Finally, an analyst can conduct what is referred to as a probabilistic sensitivity analysis. In this case, the analyst must define distributions from which the values for parameters may be drawn. A random draw is then taken from each distribution and the results of the analysis are calculated. The results of the first analysis are recorded and the process is repeated—at least thousands and sometimes tens of thousands of times. The analyst must then describe the range of results by describing the distribution of ratios. Honkanen et al. (2007) use this technique to describe the distribution of cost-effectiveness results in a study of hip protector use intended to prevent fractures in a community dwelling geriatric population. One result this group found was that the incremental cost-effectiveness ratio was less than $50,000/QALY in 68% of repeated random results for women initiating hip protector use at age 75. A decision maker faced with this information would have to determine whether being 68% certain of a favorable economic result is sufficient to move forward with a policy change.

CONCLUSIONS

The checklist in Table 2.4 may be useful when reporting or reading a report of an economic evaluation. This checklist draws on criteria for high quality cost-effectiveness studies draws on a number of sets of criteria that have been specified over the past decade (Drummond et al., 2005; Tarn & Dix Smith, 2005; Gold et al., 1996).

With the continuing development of new treatments, technologies and models of care delivery, health economic evaluations have become increasingly important. The demand for economic outcome research is growing as is the number of published analyses. In this chapter we have introduced various methods used in economic evaluation and have described the concepts and terminology used in these analyses.

The quality of studies has been variable and not necessarily improving. As more studies are conducted and submitted for peer-reviewed publication, editors are not always able to find reviewers with the appropriate expertise and studies that are poorly conducted in general or for which specific elements are poor can make their way into print. APNs who plan to read these analyses need to understand methodology enough to recognize what makes a good study and what makes a study that is only acceptable or even fails the test of acceptability. APNs interested in exploring this type of outcome evaluation are encouraged to seek additional training in these methods.

If APNs participate in and conduct economic evaluations concerning the care they provide, the cost-effectiveness of APN care may be demonstrated. When the analysis uses a standard methodology and the assumptions are transparent, the results are more easily interpreted. If the outcome measure is a standard ratio, such as dollars per QALY gained, the results may make a

strong argument to health policy decision makers concerning the funding and continued recognition of APNs as cost-effective health care providers.

REFERENCES

(2006) Determinants of Health Economic Decisions in Actual Practice: The Role of Behavioral Economics. *Value in Health,* 9, 65–67.

Anderson, P.J., Walsh, J.M., Louey, M.A., Meade, C., & Fairbrother, G. (2002). Comparing first and subsequent suprapubic catheter change: complications and costs. *Urological Nursing*, 22(5), 324-5, 328-30.

Anthony, R. N., & Young, D. W. (1994). *Management control in nonprofit organizations* (5th ed.). Boston: Irwin McGraw-Hill.

Armstrong, E.P., Malone, D.C., & Erder, M.H. (2008). A Markov cost-utility analysis of escitalopram and duloxetine for the treatment of major depressive disorder. *Current Medical Research and Opinion*, 24,1115-21.

Becker, A., Schulten-Oberbörsch, G., Beck, U., Vestweber, K.H.. (1999). Stoma care nurses: good value for money? *World Journal of Surgery*, 23, 638-42.

Brooten, D., Naylor, M.D., York, R., Brown, L.P., Munro, B,H,, Hollingsworth, A.O., Cohen, S.M., Finkler, S., Deatrick, J., & Youngblut, J.M. (2002). Lessons learned from testing the quality cost model of Advanced Practice Nursing (APN) transitional care. *Journal of Nursing Scholarship*, 34, 369-75.

Brouwer, W.B., & Koopmanschap, M.A. (2005). The friction-cost method : replacement for nothing and leisure for free? *Pharmacoeconomics*, 23, 105-11.

Brouwer, W. B., Koopmanschap, M. A., & Rutten, F. F. (1997a). Productivity costs measurement through quality of life? A response to the recommendation of the Washington panel. *Health Economics,* 6, 253-259.

Brouwer, W. B., Koopmanschap, M. A., & Rutten, F. F. (1997b). Productivity costs in cost-effectiveness analysis: Numerator or denominator: A further discussion. *Health Economics,* 6, 511-514.

Catlin, A., Cowan, C., Hartman, M., Heffler, S., & National Health Expenditure Accounts Team. (2008). National health spending in 2006: a year of change for prescription drugs. *Health Affairs (Millwood)*, 27(1), 14-29.

Chiu, W.K. & Newcomer, R. (2007). A systematic review of nurse-assisted case management to improve hospital discharge transition outcomes for the elderly. *Professional Case Management*, 12, 330-6

Chummun, H. & Tiran, D. Increasing research evidence in practice: a possible role for the consultant nurse. (2008). *Journal of Nursing Management*, 16, 327-33

Crowther, M. (2003). Optimal management of outpatients with heart failure using advanced practice nurses in a hospital-based heart failure center. *Journal of American Academic Nurse Practice*, 15, 260-5.

Dawes HA, Docherty T, Traynor I, Gilmore DH, Jardine AG, Knill-Jones R. (2007). Specialist nurse supported discharge in gynaecology: a randomised comparison and economic evaluation. *European Journal of Obstetrics, Gynecology, and Reproductive Biology*, 130, 262-70.

Drummond, M., Sculpher, M.J., Torrance, G. W., O'Brien, B. J., & Stoddart, G. L. (2005). *Methods for the economic evaluation of health care programmes*. *(3rd ed.)*. New York: Oxford University Press.

Freedberg KA, Hirschhorn LR, Schackman BR, Wolf LL, Martin LA, Weinstein MC, Goldin S, Paltiel AD, Katz C, Goldie SJ, Losina E. (2006). Cost-effectiveness of an intervention to improve adherence to antiretroviral therapy in HIV-infected patients. *Journal of Acquired Immune Deficiency Syndrome*, 43 Suppl 1, S113-8.

Ganz DA, Simmons SF, Schnelle JF. (2005). Cost-effectiveness of recommended nurse staffing levels for short-stay skilled nursing facility patients. *BMC Health Services Research*, 5, 35.

Gold, M. R., Siegel, J. E., Russell, L. B., & Weinstein, M. C. (1996). *Cost Effectiveness in Health and Medicine.* New York: Oxford University Press.

Haddix, A.C., Teutsch, S.M., & Corso, P.S. (2002). *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation. (2nd Edition).* New York: Oxford University Press.

Hirth RA, Chernew ME, Miller E, Fendrick AM, Weissert WG. (2000). Willingness to pay for a quality-adjusted life year: in search of a standard. *Medical Decision Making*, 20, 332-42.

Honkanen, L.A., Mushlin, A.I., Lachs, M., & Schackman, B.R. (2007). Can hip protector use cost-effectively prevent fractures in community-dwelling geriatric populations? *Journal of the American Geriatrics Society*, 54, 1658-65.

Honkanen, L.A., Schackman, B.R., Mushlin, A.I., & Lachs, M.S.. (2005). A cost-benefit analysis of external hip protectors in the nursing home setting. *Journal of the American Geriatrics Society*, 53, 190-7.

Jacobs, P., & Fassbender, K. (1998). The measurement of indirect costs in the health economics evaluation literature: A review. *International Journal of Technology Assessment in Health Care,* 14, 799-808.

Jones, C.B. (2008). Revisiting nurse turnover costs: adjusting for inflation. *Journal of Nursing Administration*, 38, 11-8.

Krahn, M., Guasparini, R., Shennan, M., & Detsky, A. S. (1998). Costs and cost effectiveness of a universal, school-based hepatitis B vaccination program. *American Journal of Public Health,* 88, 1638-1644.

Lee, A., Chan, S., Chen, P.P., Gin, T., & Lau, A.S.. (2007). Economic evaluations of acute pain service programs: a systematic review. *Clinical Journal of Pain*, 23, 726-33.

Liljas B. (1998).How to calculate indirect costs in economic evaluations. *PharmacoEconomics,* 13, 1-7.

Luce, B. R., Manning, W. G., Siegel, 1. E., & Lipscomb, J. (1996). Estimating costs in cost-effectiveness analysis. In M. Gold, J. Siegel, L. Russell, & M. Weinstein (Eds.), *Cost-effectiveness in health and medicine* (pp. 176-213). New York: Oxford University Press.

Meunnig, P. (2008). *Cost-Effectiveness Analyses in Health Care: A Practical Approach. (2nd Edition).* San Francisco, CA: Jossey-Bass.

Neumann, P.J., Greenberg, D., Olchanski, N.V., Stone, P.W., & Rosen, A.B. (2005). Growth and quality of the cost-utility literature, 1976-2001. *Value Health*, 8, 3-9.

Paez, K,A,, Allen JK. (2006). Cost-effectiveness of nurse practitioner management of hypercholesterolemia following coronary revascularization. *Journal of the American Academy of Nurse Practitioners*, 18, 436-44.

Patel, G.W., Duquaine, S.M., McKinnon, P.S. (2007). Clinical outcomes and cost minimization with an alternative dosing regimen for meropenem in a community hospital. *Pharmacotherapy*, 27,1637-43.

Petitti, D.B. *Meta-analysis, Decision Analysis, and Cost-Effectiveness Analysis: Methods for Quantitative Synthesis in Medicine. (2nd Edition).* New York: Oxford University Press.

Rost, K., Pyne, J.M., Dickinson, L.M., & LoSasso, A.T. (2005). Cost-effectiveness of enhancing primary care depression management on an ongoing basis. *Annals of Family Medicine*, 3, 7-14.

Simon GE, Katon WJ, Lin EH, Rutter C, Manning WG, Von Korff M, Ciechanowski P, Ludman EJ, Young BA. (2007). Cost-effectiveness of systematic depression treatment among people with diabetes mellitus. *Archives of General Psychiatry*, 64, 65-72.

Sørensen, J., & Frich, L. (2008). Home visits by specially trained nurses after discharge from multi-disciplinary pain care: a cost consequence analysis based on a randomised controlled trial. *European Journal of Pain*, 12, 164-71.

Spetz, J. (2005) The cost and cost-effectiveness of nursing services in health care. *Nursing Outlook*, 53, 305-9.

Stone, P. W. (1998). Methods for conducting and reporting cost-effectiveness analysis in nursing. *Image: Journal of Nursing Scholarship, 30,* 229-234.

Stone, P. W., Chapman, R. H., Sandberg, E., Liljas, B., & Neumann, P. I. (2000). Measuring costs in cost-utility analyses: Variations in the literature. *International Journal of Technology Assessment in Health Care,* 16, 111-124.

Subramanian, S., Hoover, S., Gilman, B., Field, T.S., Mutter, R., & Gurwitz, J.H. (2007). Computerized physician order entry with clinical decision support in long-term care facilities: costs and benefits to stakeholders. *Journal of the American Geriatrics Society*, 55, 1451-7.

Tarn, T.Y.H., & Dix Smith, M. (2004). Pharmacoeconomic guidelines around the world. *ISPOR CONNECTIONS*, 10(4), 5-15.

Ubel PA, Hirth RA, Chernew ME, Fendrick AM. (2003). What is the price of life and why doesn't it increase at the rate of inflation? *Archives of Internal Medicine*, 163, 1637-41.

Urdahl, H., Knapp, M., Edgell, E.T., Ghandi, G., Haro, J.M. & SOHO Study Group. (2003). Unit costs in international economic evaluations: resource costing of the Schizophrenia Outpatient Health Outcomes Study. *Acta Psychiatrica Scandanavica. Supplementum*. 416, 41-7.

van Baal PH, Polder JJ, de Wit GA, Hoogenveen RT, Feenstra TL, Boshuizen HC, Engelfriet PM, Brouwer WB. (2008). Lifetime medical costs of obesity: prevention no cure for increasing health expenditure. *PLoS Med.* 5,e29.

Weinstein, M. C., & Manning, W. G. (1997) Theoretical issues in cost-effectiveness analysis. *Journal of Health Economics,* 16, 121-128.

Weinstein, M. C., Siegel, J. E., Garber, A. M., Lipscomb, J., Luce, R., Manning, W. G., & Torrance, G. W. (1997). Productivity costs, time costs and health related quality of life: A response to the Erasmus group. *Health Economics,* 6, 505-510.

Type of Study	Definition	Effect Measurement
Cost-minimization analysis (CMA)	An analysis that computes the incremental costs of alternatives that achieve the same outcome.	Not measured
Cost-consequences analysis (CCA)	An analysis in which incremental costs and effects are computed, without any attempt to aggregate them.	Natural occurring units*
Cost-effectiveness analysis (CEA)	An analysis in which incremental costs and effects are presented in a ratio.	Natural occurring units
Cost-utility analysis (CUA)	A special type of cost-effectiveness analysis, in which quality of life is considered.	Quality-adjusted life years
Cost-benefit analysis (CBA)	An analysis in which incremental costs and effects are computed, and all benefits and costs are measured in dollars	Dollars

Table 2.1 Types of Economic Evaluations
*Examples of natural occurring units are life-years gained, disability-days saved or cases avoided.

Table 2.3. Cost Components To Consider for Inclusion

Cost Components
Financial, Health Care
Intervention
Hospitalization
Outpatient visits
Long-term care
Other health care
Financial, Non-Health Care
Transportation
Social services
Value of Time and Lost Productivity
Patient Time Receiving Care
Family/Informal Caregiver time
Patient Loss of Productivity Due Only to Morbidity or Mortality*
Other

*Not recommended for inclusion in cost-utility analyses by the United States Public Health Service's Panel on Cost-Effectiveness in Health and Medicine (Gold, Siegel, Russell & Weinstein, 1996).

Table 2.2. Common Terminology in Economic Evaluations

Term	Definition
Boundaries of the study	The scope of the study.
Comparator(s)	The alternative(s) to which the new intervention is compared.
Consumer Price Index (CPI)	A measure of average change in price over time. This is used to adjust costs that are estimated in different years.
Discounting	The process of converting future costs and effects to the present value.
Incremental cost-effectiveness ratio	The ratio of the difference of the costs of two alternatives to the difference in effectiveness between the same two alternatives. Used in cost-effectiveness and cost-utility analyses.
Perspective	The viewpoint from which the analysis is conducted.
Sensitivity Analysis	Calculations in which a parameter is varied and indicates the degree of influence it has on the analysis. Often used when a parameter is uncertain.
Probabilistic Sensitivity Analysis	Calculations in which one or more parameters are varied randomly using a defined distribution to determine the proportion of times that an intervention is economically favored in comparison with other interventions.
Time Horizon	The period of time for which the costs and effects are measured.

Table 2.4: CEA Checklist for Journal Report (Adapted from Gold et al., 1996)

1. Framework

- Background of the problem
- General framing and design of the problem
- Target population for the intervention
- Other program descriptors
- Description of comparator programs
- Boundaries of the analysis
- **Time horizon**
- Statement of the perspective of the analysis

2. Data and Methods

- Description of event pathway
- Identification of outcomes of interest in the analysis
- Description of model used
- Modeling assumptions
- Diagram of event pathway/model
- Software used
- Complete information about the sources of effectiveness data, cost data, and preference weights
- Methods for obtaining estimates of effectiveness, costs, and preferences
- Critique of data quality
- Statement of year costs
- Statement of method used to adjust costs for inflation
- Statement of type of currency
- Sources and methods for obtaining expert judgment
- Statement of discount rates

3. Results

- Results of model validation
- Reference Case results (discounted and undiscounted): total costs and effectiveness, incremental costs and effectiveness, and incremental cost-effectiveness ratios
- Results of sensitivity analyses
- Other estimates of uncertainty, if available
- Graphical representation of C/E results
- Aggregate cost and effectiveness information
- Disaggregated results, as relevant
- Secondary analyses using 5% discount rate
- Other secondary analyses, as relevant

4. Discussion

- Summary of Reference Case results
- Summary of sensitivity analysis assumptions having important ethical implications
- Limitations of the study
- Relevance of the study results for specific policy questions or decisions
- Results of related CEAs

- Distributive implications of the intervention

5. Technical report in appendix or available upon request

Figure 2.1 Example of a Decision Tree

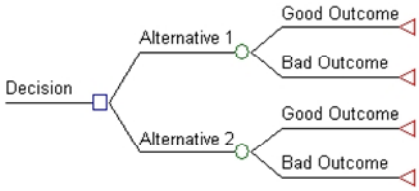
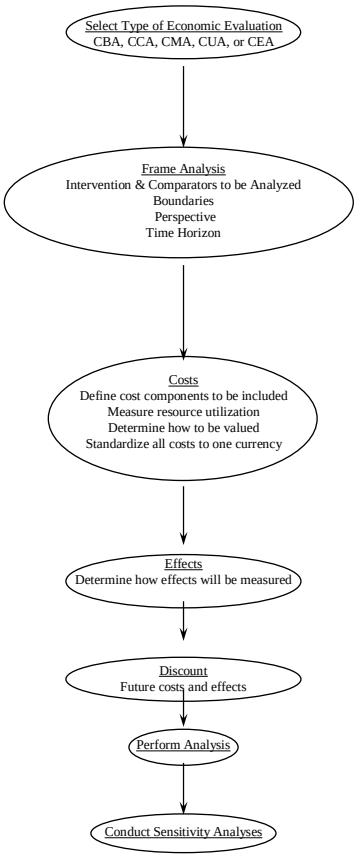
Figure 2.2.
Basic Steps in
Economic Evaluations