Cost-Utility Analysis: A Method of Quantifying the Value of Registered Nurses

Patricia M. Vanhook, PhD, APRN, BC

Abstract

Cost-utility analysis is one method of determining the cost effectiveness of nursing interventions. It is heralded by the World Health Organization as the measure to determine allocation of resources. This method of measurement includes calculation of both the cost of quality-adjusted life years (QALY) and the cost of disability-adjusted life years (DALY). The purpose of this article is to present cost-utility analysis as a relevant measure for describing the value of registered nurses. First the article will present a short overview of cost effectiveness, along with a discussion of two cost-effectiveness measures, cost-effective analysis and cost-utility analysis. Then the measurement of quality-adjusted life years and disability-adjusted life years will be presented. The article will conclude by challenging nurses to develop cost-utility analyses into a meaningful and useful methodology that can provide nursing with a process to measure the economic outcomes of our nursing interventions.


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Key words: professional nursing, cost-utility analysis, quality-adjusted life years, QALY, disability-adjusted life years, DALY

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Quality patient care and a reduction in costs through careful management of resources are the expectations consumers, insurers, regulatory agencies, and governmental agencies have for professional nurses. Nurse executives are continually challenged to demonstrate the value of registered nurses (RNs) in providing quality care with limited resources. This article will discuss several different mechanisms used to measure cost effectiveness in health care today.

Nurse-sensitive indicators are one measure of the effectiveness of professional nurses. The endeavor to link nursing care to patient outcomes using nurse-sensitive indicators was undertaken by the American Nurses Association (ANA) in 1994. The ANA efforts resulted in the establishment of the National Database of Nursing
Quality Indicators™ (NDQI®) in 1998, housed at the University of Kansas School of Nursing (ANA, 2007). The definitions and measurement strategies used in the NDQI have been reviewed and accepted by the National Quality Forum and The Joint Commission. In addition, nurse executives have used the information to improve the quality of patient care (Montalto & Dunton, 2007).

The nursing profession has also been challenged to consider using cost-utility analyses, such as quality-adjusted life years (QALY) and disability-adjusted life years (DALY), to demonstrate desired patient outcomes (Bosman & Swink, 2001; Hirsky, 2002; Siegel & Clancy, 2006; Stone, Lee, Giannini, & Bakken, 2004). These methodologies can be employed to further define the impact of nursing practice for such care issues as patient falls, urinary tract infections, hospital-acquired pneumonia, postoperative infections, and hospital-acquired pressure ulcers, that are influenced either directly or indirectly by nursing care. However, this has been challenging for nursing because, although the hospital prevalence rate of these patient care issues is important, the lasting health and economic consequences of these events for the patient post discharge is yet to be fully understood. Using cost-utility analysis will ultimately be most useful to nurses when these analyses are able to provide even clearer advice regarding the allocation of resources for patient care. Yet it is important that nursing begin working now to gather data for cost-utility analyses that will guide resource allocation decisions, even though currently cost-utility analyses are not without controversy.

The purpose of this article is to present cost-utility analysis as a relevant measure for describing the value of registered nurses. First the article will present a short overview of cost effectiveness, along with a discussion of two cost effective measures, cost-effective analysis and cost-utility analysis. Then the measurement of quality-adjusted life-years and disability-adjusted life years will be presented. The article will conclude by challenging nurses to develop cost-utility analyses into a meaningful and useful methodology that can provide nursing with a process to measure the financial outcomes of our nursing interventions.

**Measuring Cost Effectiveness**

In industry, cost-effectiveness is measured by comparing the cost of production with the income from the manufactured product. Production costs include materials, manpower, and management costs, such as manager salaries, facility expenses, and employee benefits. As a product is manufactured and prepared for the consumer, the quality and cost of a manufactured item is amenable to objective measurement. In health care, however, measuring the cost effectiveness of care and the quality of patient outcomes is not as objective. Several common economic evaluations used by both industry and health care are listed in Table 1.

**Table 1. Common Economic Evaluations**

<table>
<thead>
<tr>
<th>Economic Evaluation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Cost analysis</td>
<td>Measurement of the cost of a product or service or intervention.</td>
</tr>
<tr>
<td>Cost-benefit analysis</td>
<td>Widely used technique to assist with decision making. The expected benefits of the project are subtracted from the total cost of implementation. The unit of measurement is monetary.</td>
</tr>
<tr>
<td>Cost-effective analysis</td>
<td>Costs spent per outcome achieved.</td>
</tr>
<tr>
<td>Cost-effectiveness ratio</td>
<td>Ratio of total costs to total benefits expressed in both dollars and benefit value.</td>
</tr>
<tr>
<td>Cost-utility analysis</td>
<td>A type of cost-effectiveness analysis that compares different procedures and outcomes relative to a person's quality of life.</td>
</tr>
<tr>
<td>Cost-utility ratio</td>
<td>Comparison of interventions to achieve one quality-adjusted life year</td>
</tr>
</tbody>
</table>

**Cost-Effective Analysis**

The use of cost-effective analysis (CEA) in health care began in the 1960s as a means to determine the impact and/or the cost savings of the decision to use a specific intervention, such as a medication, surgical procedure, or counseling technique (American College of Physicians, 2000). CEA is not only measured in monetary terms but is also calculated using other health measurements, such as head injuries avoided through use of bicycle helmets, sexually transmitted infection reduction through condom use, and blood stream infections avoided by using chlorhexidine gluconate dressings (Crawford, Fuhr, & Rao, 2004).

To calculate the cost of an intervention, monetary assignment is determined by the cost of care provided divided by a measure of the benefits received, as assessed in terms of days, years, or incidence of pathology, symptom management, disease management, or other measurable indicators. This measurement is called the cost-effective ratio (C/E) and is the sum of all benefits divided by the sum of all costs (Dixon & Lundeen, 2004).
The lower the C/E, the more cost-effective is the intervention. Tsal, Chen, and Yin (2005) used cost-effectiveness analysis to compare hospital-based home care with traditional, outpatient therapy for patients with mental illness. Tsal et al. measured outcome indicators of disease, psychotic symptoms, social interaction, and satisfaction with the service to develop an effectiveness score. The cost of care was then divided by the effectiveness score to determine cost-effectiveness ratio (C/E). Thus, the cost of program effectiveness score = the C/E Ratio.

Their findings suggested the cost of home health care (HHC) was more cost effective (C/E ratio 4.3) than traditional outpatient therapy (C/E ratio 13.5) (See Table 2).

<table>
<thead>
<tr>
<th>Comparison Groups</th>
<th>Costs of Care</th>
<th>Effectiveness Score</th>
<th>C/E Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Health</td>
<td>$1,420.60</td>
<td>327.8</td>
<td>4.3</td>
</tr>
<tr>
<td>Usual Care</td>
<td>$3,208.20</td>
<td>238.0</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Tsal, Chen, Yin (2005)

Cost-Utility Analysis

A cost-utility analysis is defined as a type of cost-effective analysis that compares different procedures and outcomes relative to a person’s quality of life. Since the inception in the early 1990s of cost-utility measurements, there has been much controversy over methods used to determine these measures and the usefulness of these measurements. Although over time some standardization of methods and calculations, based on early, rudimentary studies, has been reported, there continues discussion in the literature both for (Higgins & Carr, 2001) and against (McGregor, 2003) using CUA as a method to measure health care costs and interventions. Today cost-utility analysis is recommended for use by the United States Public Health Services (USPHS) Panel on Cost-Effectiveness in Health and Medicine (USPHS Panel) when policies may impact resource allocation (Chapman et al., 2004). In these analyses, patient outcomes are described by a single measurement which reflects the health care outcome in terms of both the quality and the quantity of a life (Malek, 2001). Two measures used to deduce CUA are costs per Quality-Adjusted Life Years (QALY) and costs per Disability-Adjusted Life Years (DALY). Each will be discussed in turn, but first an example of research using cost-utility analysis will be provided.

Recent research has used CUA to demonstrate cost effectiveness in medical and nursing interventions. Pignone, Earnshaw, Tico, and Fletcher (2006) used a meta-analysis of the literature to demonstrate the value of a combined aspirin and statin intervention for primary prevention of coronary heart disease (CHD) in men. Their findings suggested that a combination of aspirin and statin medications are a cost-effective method of preventing heart disease events. In this study, the authors compared the life-time effects of 10 years of either aspirin therapy, or statin therapy, or a combination aspirin and statin therapy, or no therapy in middle-aged men with a 7.5% risk of CHD. Their findings suggested aspirin therapy was less costly than no therapy for men having a CHD risk of 7.5% and greater. The addition of statin therapy increased the cost-utility ratio but proved to be more cost effective only for the men who had a greater than 10% risk of CHD.

Quality-Adjusted Life Years

Many instruments are readily available to measure quality of life (QOL) globally, such as the Short Form Health Survey (SF-36) developed by Ware, Snow, Kosinski, and Gandek (1993) and the Sickness Impact Profile by Gibson et al. (1972). Additionally, QOL instruments specifically related to disease states include the Arthritis Impact Measurement Scale by Meenan, Gertman, and Mason (1980) and the Asthma Quality of Life Questionnaire by Juniper, Guyatt, Ferguson, and Griffith (1993). Also in common usage are the symptom states scales, such as the Faces Pain Scale (Wong & Baker, 1988), the Fatigue Scale (Chadler et al., 1993), and the Functional Independence Measures Scale (Keith, Grainger, Hamilton, & Sherwin, 1987). Instruments may combine global QOL measures and health-related quality of life measures to capture emotional, social, and physical well-being, along with the effect a certain disease process has on the totality of a life.

While each of these instruments allows researchers to describe and/or quantify quality of life, none of them have expressed their measurement in economic terms. This is not to say the measurements are not important for analyses; nor to state these measurements do not contribute to our understanding of a person’s perception of life as perceived by the individual. It merely says that health care researchers have not yet been able to quantify quality of life in monetary terms. Quality-adjusted life years (QALY) is a mathematical measurement that combines quantity and quality of health to calculate outcomes based on treatment or other activities that influence health (Bandalier, n.d.). QALY has three key standardized components that support validity and reliability. First, actuarial data, experimental data, or

...health care researchers have not yet been able
to quantify quality of life in monetary terms. Modeling is used to study a given population (Graham, 2002). Secondly, healthy life years are weighted the same; and lastly, the weights for health states are derived from studies of individuals with the specific condition in question (Graham). The difference between QALY and QOL measures is the dynamic of measurement. QALY attempts to provide a method of measurement for the impact of disease or treatment on an individual's ability to function which can be equated to an economic scale. QALY measures differ from the QOL measures that provide subjective information describing individuals' self-perception of their health status at a particular point in time (Donald, 2001). The QALY measure describes the cost of producing one year of quality living existence. The scoring range of QALY is from 0 (death) to 1 (perfect health); however, a score that is a negative number may be derived when a person is living with an extremely low quality of life (Malik, 2001).

Jacobson, Lindholm, Walde, and Engstrom (2000) have demonstrated how CUA can be used to evaluate the effect of a nursing intervention on patient outcomes, when one of these outcomes is QOL. Jacobson et al. demonstrated that an eating-training program by nurses for 11 post-stroke patients was a cost-effective intervention that improved health-related QOL (HRQOL). This research team collected data regarding the degree of change of the stroke survivors' feeding and eating habits and the stroke survivors' HRQOL. In all but 2 cases, QALY increased, with an average equal to one year of quality living existence. The average cost per participant in the program was less than $8000. The savings in this program, which resulted from eliminating the need for nursing staff to feed the patient and the cost of the nasogastric or gastrostomy feeding tube, was $15,000 when compared to conventional care. For patients without a feeding tube the cost per QALY gained was $5500. The researchers also compared the cost of their eating-training program for one QALY to the cost of a pharmaceutically managed blood pressure program. When compared to hypertension management, the feeding program for stroke survivors was very cost effective.

This Jacobson et al. study (2000) was very innovative in that it compared use of a nursing process management with a disease process (hypertension) management. A similar evaluation could be done by comparing changes in nursing practice that promote patient safety and health outcomes with changes in blood pressure management or other aspects of medical care. Thus the CUA measure can be used to assess cost utility for both medical interventions and nursing interventions (Siegel & Clancy, 2006). To capture accurate CUA for nursing interventions, current practice and the change in practice need to be compared.

It should be noted, however, that some scholars argue against using the QALY formula. Hirskyj (2002) has argued that the formula for QALY could be considered unjust in a world where there are limited health care dollars and a value is placed on a life. He has added that in affluent nations, where health care resources are readily available and expected by the public, this method of analyzing effectiveness and efficiency could create conflict. Yet, he encourages nurses to explore the potential of using QALY and DALY.

Disability-Adjusted Life Years

Another CUA measure that could be considered by nursing is disability-adjusted life years (DALY) which can be used to measure the effect of ill health (i.e., a hip fracture) in regard to function and premature mortality (Hirskyj, 2007). In other words, one DALY is one lost year of healthy life (Murray & Lopez, 1996, p. 7). The goal of measurement of DALY is to use an assessment of the residual burden of disease and/or injury as an outcome measure (Fox-Rushby & Hanson, 2001). The World Health Organization defines disability-adjusted life years (DALY) as:

a health gap measure that extends the concept of potential years of life lost due to premature death to include equivalent years of healthy life lost by virtue of being in states of poor health or disability (World Health Organization, 2001).

DALY is a combined measure of years in disability and years of life lost due to premature death (from the disability) (Fox-Rushby & Hanson, 2001). Two mathematical equations are used to calculate DALY, years of life lost (YLL) and years lived with disability (YLD). YLL is the number of years of life lost due to premature death. YLD is the number of healthy years lost due to disability from the condition until remission or death. These are then summed together to provide years living with disability. The DALY scale range is the reverse of the QALY scale, with 1 indicating death and 0 indicating the best possible state of health. Unlike QALY, DALY reverse scaling would not allow for negative values because 0 is equivalent to perfect health.

To better understand DALY, consider this hypothetical example. Assume that 150 eighteen-year-olds die as a
result of motorcycle accidents in a state with no helmet law. The life expectancy for the birth cohort of 1990 is 71.8 years (National Center for Health Statistics, 2006). Therefore, YLL (for the total sample) was 8070 (150 X 53.8 years). For YLD, lets assume these teenagers did not die, but sustained severe brain trauma with disabilities similar to someone with severe cerebral palsy. As a result, their life expectancy, due to this injury, is decreased to 31 years (Hutton & Pharoah, 2005). YLD is the computation of number of incidence X disability weight X average duration of disease or infirmity until death or remission. Suppose the disability is weighted 0.8 (remember 0 is perfect health and 1 is death). The YLD is then 150 X 0.8 X 13 = 1560. Thus DALY (9630) = YLL (8070) + YLD (1560). This is powerful when advocating for policy change. Armed with this information nurses could talk to their legislators about the number of years of lost productivity from their constituents as a result of injuries sustained from motorcycle-related health injuries. Adding disability costs, costs of care, and deducting potential income of the 150 accident victims who would, for their age, be expected to have worked until the age of 65 years if not prevented by their disability, adds additional strength to the case for change of a state no helmet law.

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There is considerable debate about the use of DALY in cost-effective analyses. Much of the debate has been centered on methodology (Fox-Rustby & Hanson, 2001), the lack of recognition of change in disability states over time (improvement or decline) (Jelsma, De Weerd, & De Cock, 2002), and the limitations imposed by a single measurement (Barker & Green, 1996). Additionally, Disability Peoples International (DPI) has issued an opposition statement to DALY use for health policy. They present four points:

1. DALY does not take into account social and environmental causes of disability
2. It assumes that any given disabling condition always has the same outcomes. That is, if you are diagnosed with a certain condition then the outcome must be x, y, or z, whereas the lived experience of disabled people shows clearly that is not the case. Outcomes are dependent on the environment and social impacts on the personal characteristics of the individual
3. The authors of DALY have relied on medical experts and ignored the disability community
4. The DALY puts the blame for low ratings in the global development measurement firmly on disabled people, instead of on the lack of services, health care, equality, and justice. (Disabled People International, March 2006).

Advocates of using DALY argue that egalitarian principles are the hallmark of this measurement. The calculations for DALY consider age and sex when calculating the burden of the disability; there is no consideration for economic status so that disability burden is measured globally for all (Murray & Lopez, 1996). They add that the respectful consideration is given to DPI's position. Because there is no other economic evaluation available to pursue policy avenues to address concerns, such as lack of services, health care, equality, and justice, using DALY to demonstrate the cost of ineffective and inefficient care could provide support to enact policy changes that would lessen the burden of disability.

Conclusion

The Nursing Report Card has shown a reduction in undesired, nurse-sensitive, patient outcomes, such as secondary pneumonia, postoperative infection, hospital-acquired pressure ulcers, and urinary tract infections, in hospitals having a higher proportion of RNs in the nursing staff skill mix (Gallagher, & Rowell, 2003). These findings emphasize the association of costs, processes, and outcomes. This seminal work has fueled nurse executives' abilities to negotiate for a higher RN skill-mix in order to improve patient care outcomes.

Although the use of CUA, a measure which includes QOL, has yet to become the industry standard for health care, it is increasingly being tested (Neumann, Greenberg, Olchanski, Stone, & Rosen, 2002). The methodology is becoming more sophisticated and a trend toward the adaptation and adherence to the U.S. Panel on Cost-Effectiveness in Health and Medicine is being noted in the literature (Neumann et al.). This is encouraging.
...there is a good match between CUA and the impact of nursing on patient care.

The question at this time is not whether CUA is a useful measurement to show the value of nursing, but rather under what circumstances it is most beneficial to use CUA to evaluate the benefits of nursing interventions. Because interventions which prevent complications and/or the advancement of an illness, such as managing congestive heart failure and strengthening a diabetic patient's self care skills, have a significant influence on the patient's QOL, CUA could most profitably be studied in these cases to demonstrate in economic terms the value of nursing care.

Murray et al. (2003) have already used CUA to demonstrate the value of nursing interventions related to congestive heart failure. This team assessed the cost effectiveness of interventions to lower blood pressure and cholesterol levels. They demonstrated that a reduction of salt in processed foods could ward off 31 million DALYs annually, worldwide, through the reduction in vascular disease and its sequelae. Their conclusions suggested the incidence of cardiovascular disease could be decreased by 50%.

Nurses could lead the charge to transform DALY into a measurement that accounts for all causes of preventable disability, differentiating disability outcomes and demonstrating how to translate data into action. Nurses could start with small projects, such as defining the costs of patient falls in a hospital and showing the value of a nursing intervention that would prevent these falls. To enlarge their impact, nurses could assist communities at the local, regional, and national levels in using CUA to show the outcomes nurses can have on overall QOL and costs of health care. For example, if the community has a high diabetic population living in public housing, nurses could begin working with the local public housing authority to research the effectiveness of in-home education for diabetes management compared to formal classroom group education that is routinely offered to the general population through community diabetic educators. Using another example, nurses could use the data from the CEA registry to assess the impact of in-school prenatal care for teen pregnancy on premature births and the costs of neonatal intensive care ($47,000/QALY for 0.5 - 1 kg infant and $6,800/QALY for 1-1.5 kg Infant) versus routine care for normal newborns. Other community health problems, such as smoking, motor vehicle accidents, underage drinking, and injuries and falls in the older adult are just a few of the opportunities in which nurses could be involved in terms of assessing nursing interventions and improvement in the health of their communities. See Table 3 for websites that provide information on CUA through QALYs and DALY.

Table 3. Websites offering Information on CUA through QALY and DALY

<table>
<thead>
<tr>
<th>Agency</th>
<th>Website</th>
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The challenge for nurses is develop CUA (using QALY and DALY studies) into a meaningful and useful methodology that can provide the profession with a process to measure the outcomes of nursing's holistic interventions. Short term economic analyses provide information for immediate needs, such as budgetary planning and compliance, meeting established benchmarks, and regulatory compliance. Using a more holistic approach, such as CUA, may assist nurse leaders to demonstrate the unique value of professional nurses that care for patients. For example, acute care nurse leaders could assess the patient costs related to a reduction in man-hours. They could start by exploring the differences between patient outcomes prior to and after the change using CUA. While this may prove to be cumbersome due to the complexity of assessing QALY and/or DALY, it is essential for nurse leaders to embrace the ultimate cost of care over the continuum of life.

In summary, this article presented an overview of cost effectiveness, along with a discussion of two cost-effectiveness measures, cost-effective analysis and cost-utility analysis. Then two CUA measures, quality-adjusted life years and disability-adjusted life years, were discussed. The article concluded by challenging nurses to develop cost-utility analyses into a meaningful and useful methodology that can provide the profession with a process to demonstrate the outcomes of our nursing interventions.

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Dr. Vanhook is an Assistant Professor at East Tennessee State University. She has been in practice since 1973, during which time she has practiced clinically as a bedside nurse and nurse practitioner, served as Magnet Coordinator for the first Magnet Hospital in Tennessee, and spent over twenty-five years in nursing administration in the roles of Nursing Director and Assistant to Chief Nursing Officers. These experiences have provided various opportunities for involvement in both quality outcomes and performance improvement. She recently received her PhD from East Tennessee State University, Johnson City, Tennessee, where her dissertation research focused on Appalachian women stroke survivors. While serving as an acute care nurse practitioner, she observed that hospitals' data interest centered primarily on short term measurements that were linked to financial performance. She quickly realized that short term performance does not demonstrate the full picture of long-term outcomes and costs to either patients or to health care systems. This led to her interest in using the public health model of evaluating outcomes based on quality-adjusted life years or disability-adjusted life years.

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