

# Methodological Issues in Nursing Research on Cost-Effectiveness Analysis

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Cost effectiveness is a recent and newly emerging approach in nursing evaluation studies. Nursing is in a unique position among health care providers to respond to these efforts and is ready to provide evidence of its cost-effectiveness because nurses has long advocated a holistic view of patient care, that means, nurses are unique position to identify the full range of costs and effects. The cumulative evidence showed that nurses provided cost-effective care that substituted for physician services in many situations and new and important services in long-term care and nursing homes. The purpose of this article is to review, critique, and synthesize research on the cost-effectiveness of nursing care from the research methodology perspective. Two major problems are apparent from this review. First, there is no uniform approach to identifying and valuing resources used in producing nursing intervention options. Second, although it is not difficult to find reports of cost savings, the cost to effect ratio was not used to evaluate the relationship between the cost and effects of alternative options. Based on my analysis, the nursing CEA literature seemed to have huge variation in methods, so that it is not easy to compare the CEA methods among studies. There are still such methodological problems as we found in the literature review. Many of the studies reviewed here would have profited from improved designs. Therefore, future cost-effectiveness analyses should include methodological progress in the context of nursing area application such as the definition and quantification of multi-attribute effectiveness measures, employment of sensitivity analysis, a concept of discount. Nurse and nurse researchers should consider cost-effectiveness questions when addressing other research questions. Because these efforts are forcing policy makers to consider the economics of nursing, nurses should demonstrate and document the value of nursing as compared to other uses of society's health care resources.

**Key words:** Cost-effectiveness; Nursing; Methodology

## INTRODUCTION

In the era of heightened awareness of the constraints on health care resources, health care administrators and policy makers at all levels are increasingly confronting questions regarding the cost of health care. Concern about the high and rising costs of health care has prompted a wide variety of cost-containment efforts in both the public and private sectors. Underlying all of these efforts is the search for the appropriate balances between the costs of care on the hand and the quality of

care on the other. Given the limits on resources, it is not surprising that research on the cost-effectiveness of health care is in great demand (Siegel, 1998). This demand is reflected in the rapid growth of the literature on cost effective analysis in health care. According to Elixhauser and colleagues (1993), cost-effectiveness analysis (CEA) studies represented 64% of all the health care economic evaluation studies that examined both cost and outcomes of an intervention, technology, program, or services from 1985-1990.

Why nurses should do CEA? Nursing is in a unique position among health care providers to respond to

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these efforts and is ready to provide evidence of its cost-effectiveness. The cumulative evidence showed that nurses provided cost-effective care that substituted for physician services in many situations and new and important services in long-term care and nursing homes (Fagin, 1994). Perhaps most important, nurses have long advocated a wholistic view of patient care, that means, nurses are in a unique position to identify the full range of costs and effects (Siegel, 1998). The purpose of this article is to review, critique, and synthesize research on the cost-effectiveness of nursing care from the research methodology perspective. It focuses on research articles published in the academic journals for nurses, health care administrators, and health services researchers.

### **COST-EFFECTIVENESS ANALYSIS AND RESEARCH DESIGN**

CEA is a method of economic evaluation in which the outcome of two or more service options is compared in relationship to the costs associated with each alternative. (Allred, Arford, Mauldin, & Goodwin, 1998). As CEA's popularity has increased, inadequate methodology and technically low-quality analyses have been noted in some of the literature (Warner & Hutton, 1980). In the 1990's, although CEA is gaining widespread acceptance in health care, a lack of consensus about CEA principles and methodologies resulted in health care CEA studies of varying quality and limited comparability (Stone, 1998). To solve these problems, the U.S. Public Health Service convened the Panel on Cost-Effectiveness in Health and Medicine in 1993 (Weinstein, Siegel, Gold, Kamlet, & Russell, 1996; Russell, Gold, Siegel, Daniels, & Weinstein, 1996). The panel reviewed the theoretical foundations of CEA, current practice, and alternative methods used in analyses. As conclusions, they recommend the methodologies regarding (1) components belonging to a cost effectiveness ratio; (2) measuring resource use in the numerator of a C/E ratio, (3) valuing health consequences in the denominator of a C/E ratio; (4) estimating effectiveness of interventions; (5) incorporating time preference and discounting; (6) handling uncertainty.

In terms of research perspective, CEA is a method which combines evaluation research with cost-accounting to produce a system able to express nonmonetary outcomes of programs relative to cost of programs. Prescott and Sorenson (1978) pointed out that an analy-

sis of costs assumes that the changes in clients between pre and post treatment can be attributed to the effect of the treatment program. Thus, an elegant cost analysis of an innovation evaluated by a poor design may be meaningless. An experimental design generally is agreed to be the desired model for evaluating the impact of new services or techniques. The particular experimental design considered to offer the best possibility of support for the assumption of causality is true experiments (randomized, controlled trial) (LoBiondo-Wood & Haber, 1998). Certain other experimental design is quasi-experimental, 1) a nonrandomized trial in which pretreatment equivalence of the groups may be at risk; 2) a noncontrolled trial, that is, experiments without a control group, are labeled "inadequate" for drawing causal inference by Kerlinger (1973). However, investigators can suggest causal relationships by comparing baseline measures to outcome measures or by comparing outcome measures with available norms. If no deliberate controlled intervention occurs, the study is nonexperimental. Causal attributions can be problematic for such designs. Some reviewers have implied that concerns about design quality might be irrelevant when combining results; others have noted that findings varied according to design quality (Fagin and Jacobson, 1985; Fagin, 1994). Since the issue of whether results of various studies may be combined regardless of design quality has not been settled, this review only focuses on quality issues of research method.

### **INCORPORATING COST EFFECTIVENESS IN NURSING RESEARCH**

In this review, the nursing studies will be grouped into four areas based on Fagin's (1994) works: 1) Nursing in hospitals 2) Testing specific nursing interventions 3) Substitution of nurses for other providers 4) Testing alternative models of practice.

#### *1. Nursing in Hospitals*

Hospital care is the single largest category in health care spending. Thus cost containment pressures now and will continue to focus on inpatient care. Several studies have pointed to the importance of organization of nursing service in patient outcomes. Over the past decade considerable interest has been shown in the concept of primary nursing in many parts of the world. Although results of studies of primary nursing are somewhat mixed as to cost-effectiveness, there appears to be a sizable

body of literature supporting the view that primary nursing is worth trying (Faign, 1994).

Gardner et al.'s (1991) longitudinal, experimental study demonstrated that primary nursing was cost effective relative to team nursing. Cost PPPD (per patient per day) was calculated using nursing personnel costs, patient's length of stay (LOS), and nursing acuity level. In order to assess the outcome, the quality of nursing care was measured by Wandelt's (1974) Quality of patient care. The results of this study revealed that the quality of patient care was significantly higher in the primary nursing units than the team nursing units (t-test used but t, p not stated) while cost PPPD of primary unit was lower than that of team unit, but it was not statistically significant ( $t=1.24$ , n.s.d). However, an average savings of 6.5 % was realized for the duration of the study. There are some methodological issues in this study. First, even though there were some efforts to equate each unit's staffing characteristics (skill mix, education, age, and length of service), the researcher did not assess the difference between pre-treatment groups by the use of statistical techniques. Another weakness is that the author did not also indicate sample size, which threatens external validity of this study. The positive aspect of this study is that patients were randomly assigned by the admitting office to each unit for research purposes.

In contrast with above study findings, Giovannetti's study claimed that primary nursing was not cost effective because quality of care was the same but costs were higher; Betz's study, on the other hand, claimed that both quality of care and costs were lower on primary unit (cited in Fagin & Jacobsen, 1985). These studies were comparative in terms of primary versus team nursing. In each study, evidence for equivalence of the units to assure a valid comparison was either flawed or missing. It is not surprising, then, that results were inconsistent.

In a descriptive study, Flewellyn and Gosnell (1987) compared competency-based with traditional RN orientation program. Of the convenience sample of the 110 orientee nurses (61 with Diploma, 27 with Associate Degree, 21 with baccalaureate and 1 with Masters) participating in the study, 61 were in traditional programs and 49 in the competency-based programs which consisted of selected structured classes, self-learning packages, and specific learning experiences to meet an orientee's learning need. Data were collected by orientee completion of a self-rated competency questionnaire at

the time of pre- and post orientation. In this study, competency-based programs were found to cost 1.7 times more than traditional programs. The t-test revealed that the two groups were found not to be

significantly different on post-orientation scores (t and p unstated). However, since there was significant difference in pre-scores of self-rated competency, the findings suggested that there was greater learning in the competency-based orientees. The limitation of the study is the lack of equivalency to assure valid comparison because the groups were found to be significantly different on pre-tested self rated competency scores. Second, the researcher did not actually observe any changes in performance or test within the hospital setting to verify any differences in competency level, but did rely on subjects' self rating using a non-validated investigator-generated questionnaire. Due to these study limitations, findings of this study did not conclusively identify the most effective orientation method.

Mooney et al.'s (1988) pilot study of 13 orientee nurses was another cost-effectiveness approach to RN orientation program particularly in the intensive care unit. They found that the new orientation program had not only resulted in an approximate \$1,600 cost savings per orientee, but greatly improved the quality of the orientation program. This study has conflicting result with Flewellyn & Gosnell's study (1987) in terms of cost findings. However, this study is extremely limited for lack of external validity due to its research design: no control group, sampling method and small sample size. Also, because they had no control group, it does not make sense to conclude that the new program is more cost-effective than the old one. Furthermore, it is not clear what data were used to determine costs and the quality of the program.

## 2. Testing Specific Nursing Interventions

In an experimental study comparing nursing costs for preterm infants receiving conventional (n=61) versus developmental care (n=63), Petryshen, Stevens, Hawkins, and Steward (1997) assessed costs of nursing care and the hospital length of stay. A comparison of the infants in the conventional and developmental care groups according to gestational age, weight, and head circumference revealed no significant differences between the groups at birth. The cost of nursing care was determined by obtaining the actual salaries of the nurses and the support staff. The average hospital length of stay was

measured as an outcome variable. The results indicated that the developmental care group spent less time in the NICU acute care unit than did the conventional care group ( $=20.79$ , and  $=24.58$ , respectively). The total NICU acute and transitional care costs for the developmental care group were lower than the conventional care group ( $=\$22,853$  vs.  $=\$27,193$ , respectively). The strengths of this study were as follows: (1) they used an experimental design that included a treatment and control group; (2) they included at least 50 individuals in each study groups; (3) they controlled the equality of the two groups by employing careful consideration of inclusion criteria for subjects.

An experimental study with a three-treatment group was conducted by Bergner et al. (1988) to assess efficacy and cost of sustained home nursing care for patients with chronic lung disease. 301 patients were randomly assigned to a respiratory home care group (RHC, 99) that received care from respiratory home care nurses, a standard home care group (SHC, 102) that received care from regular home care nurses, or an office care group (OC, 100) that received whatever care they needed except for home care. Patients were followed for 1 year. Patient outcomes were measured on behavioral dysfunction, severity of debility and exercise tolerance. The major method for obtaining the data was detailed interviews with patients. The results indicated that there was no difference in patient outcomes among the three groups. The average annual health care costs for in the RHC group was \$9,768; for those in the SHC group, \$8,058; and for those in the OC group, \$5,051 ( $F=6.45$ ,  $p=.02$ ). Within the context of cost-effectiveness analysis, a finding of no difference between programs on the dimensions chosen as indicators of effectiveness leads to the choice of the least costly program as the most cost-effective (Prescott, 1978). But what may be wrong with this conclusion is that it ignores the total dimensions of roles and makes comparison, which determines effectiveness on a very limited basis.

The strengths of this study are large sample size ( $N=301$ ), random assignment in order to equalize the groups with respect to the extraneous variables and the use of measures with adequate validity and reliability. The weakness of this study is a possibility of inter-interviewer bias due to their interpersonal skills when collecting data. Another weakness is that because of their sampling method (convenience sampling), generalization was limited even though the sample size was large

enough.

### 3. *Substitution of Nurses for Other Providers*

Despite limited research on the topic, advanced practice nurses appear to be cost-effective providers of health care services. Many researchers, as well as physicians, view nurse practitioners as both complementary and substitutive because nursing and medical functions overlap in many areas including primary care.

In a descriptive study with comparison groups of 156 women who had delivered within 48 hours of the interview, Graveley et al. (1992) retrospectively reviewed the quality of prenatal care among three prenatal clinic staffing models: physician based (MDC), mixed staffing (MSC), and clinical nurse specialist with physicians available for consultation (RNC). Cost was calculated on per visit basis using number of staffs, hourly wages and number of prenatal appointments made and kept. Patient outcomes were measured by The Kessner Index for physiological outcome and Patient Satisfaction Tool for maternal satisfaction. The ANOVA revealed that RNC subjects indicated significantly higher satisfaction than MDC and MSC subjects in overall maternal satisfaction ( $F$  and  $p$  unstated) while there was no significant difference among clinics on physiologic outcome. The ANOVA also showed that MSC had the lowest cost per visit among clinics ( $F=28$ ,  $p=.000$ ). However, the author stated that the actual cost of MSC was lower than that of RNC because costs were based on 15 minutes per visit at the MSC and 30 minutes per visit at the RNC. The author concluded that the clinic staffed by clinical nurse specialists had the greatest client satisfaction and the lowest cost per visit. One methodological problem here is that researcher's cost calculation is a little problematic because cost per clinic visit is probably not a good reflection of the true cost of providing care to different patients (Kovner, 1989). The author did not also indicate adequate validity of each instrument. The positive aspect of this study is adequate sample size ( $\alpha=.05$ , effect size $=.25$ , power $=.8$ ; 3 groups) and employing Chi-square to assess homogeneity between groups.

In other experimental study of 1420 adults in two health facilities, Thompson et. al (1982) evaluated the effects of the family nurse practitioners (FNPs): program at clinic A ( $N=735$ ) which consisted of two nurse practitioners and MDs comparing it with the preexisting conventional pattern in another clinic B ( $N=685$ ) which was mainly operated by MDs. There were no significant dif-

ferences within two groups in terms of patients' demographic and health status data. The evaluation showed 1) diminished waiting times at Clinic A; 2) no diminution in quality of examinations performed by FNPs: rather the chi-square test revealed that the rate of detection of clinically significant new findings was significantly higher at Clinic A than Clinic B at .05 level; 3) lesser total costs per exam in clinic A and total costs per exam by FNPs were 26 percent less than for Clinic A MDs; 4) greater patient satisfaction at Clinic A than Clinic B, and for those examined by FNPs, compared with those by MDs.

The limitation of the study is, as the authors admitted, the initial difference of MDs at two clinics: 1) since patient load per full-time MD equivalent was greater at Clinic B, patient access was clearly more limited in Clinic B. 2) the MDs at clinic B were older and they were out of training longer. Another limitation is a possibility of Hawthorn effect because the providers at both clinics were aware that audits of their activities were being compared. Thus, it affects the external validity of this study.

On the other hand, Leroy (1982) has compiled the most comprehensive review article on CEA of nurse practitioner program. She also stated that any analysis of NPs must be broader than a strict CEA because NPs and MDs are not interchangeable. Each provider is able and willing to do only some of the tasks that the other is trained to provide. The most serious problem, here, has been "... the dearth of information specifically defining what medical tasks nurse practitioners are qualified to perform. Without this data, comparative analysis between them and physicians is limited" (p.297).

#### 4. Testing Alternative Models of Practice

Rice et al. (1993) found that annual costs of caring for a person with Alzheimer's disease in the two settings, community care (n = 93) or nursing home (n = 94), were not significantly different. Data were collected from both subjects and their primary caregivers and staff of the institutions about subjects' mental status, and ADLs and IADLs. In terms of estimating cost of care, both formal and informal care services were estimated. Included in formal care costs were expenditures for hospital and nursing home care, physician services, social services, medications, and others. Informal care was estimated using a replacement cost approach by imputing a market value for services performed. The results were that average annual formal care costs amounted to \$12,572 per

patient in the community and \$42,049 per institutionalized patient. Average annual cost of informal care of \$34,517 was estimated for patients residing in the community and \$5,542 for patients in institutions. When formal and informal care costs are combined, annual costs of caring for a person with the disease in the two settings were not significantly different. For the severely demented, the total cost of care for people in the community was \$52,667 - 9% higher than for institutionalized patients. However, the small sample size for mild to moderately demented persons in institutions precluded rigorous statistical comparison.

In an experimental study of 40 matched pairs of patients in foster family and nursing homes (matching criteria were age, functional ability, and disease extensiveness), Braun & Rose (1988) found that foster family patients had more improvement in well-being (t not stated,  $p=.000$ ) and there was no difference in activities of daily living skills. The findings also showed that the mean service cost per month of foster family care was 61% that of nursing home care. The costs were calculated based on placement, services (physician, PT/OT and X-ray/lab), products (Drugs/supplies) and transportation. These results encouraged public support of foster family placement as a cost-effective alternative to nursing home care. There are several limitations in the methodology of the present study. First, even though the researcher used matching method to deal with extraneous variables, there still remains confounding variables to reduce internal validity: ethnicity, gender, patient's mental status and family relationship which could affect patient's well-being. Another weakness is the small sample size relative to the number of variables studied.

In an experimental study of patients (N unstated) with coronary artery disease or a fracture of the femoral head or neck, Alfano (1982) compared the alternative nursing care given at a rehabilitation center to that offered in a general hospital environment with an randomized control group design. She found that the average cost of control group exceeded the experimental group in which nurses provided patients with interim care during the post-critical phase of their illness and prepared them for discharge into the home, with physician consultation available because the cost per day was half that of the cost per day at a hospital. Measures relating to quality of care indicated comparable or better quality of care at the rehabilitation center: 1) hospital readmission 2) nursing home admission and 3) mortality. First weakness of this

study is that although patients were assigned at random to each group, no evidence was given for the initial similarity of groups. Second weakness is a threat of external validity since the author did not describe sample size and characteristics of the sample. In addition to, neither mention of the comparability of the existing cost data was made, nor the information provided in sufficient detail to allow assessment of how costs were determined.

## SYNTHESIS

In the literature review, all of the researchers used the approach of cost-effectiveness analysis. In each study some change in practice was compared with another form of practice from the standpoint of costs; most investigators also measured quality of care. The first group of studies focused on primary versus team nursing and traditional versus new RN orientation. The topics of the second and fourth group of projects were dealing with specific nursing interventions and alternative modes of care. The third group of studies was reviewed in the category of substitution; even though there exist some methodological problems in these studies, most investigators judged their results as providing evidence of the positive economic value of the nurse practitioner.

Through this literature review, any of these studies, unfortunately, did not present appropriate theoretical rationales of CEA, which are designed to help analysts structure their studies; identify needed components; and generate replicable, meaningful, and credible results. Two major problems are apparent from this review. First, there is no uniform approach to identifying and valuing resources used in producing nursing intervention options. Second, although it is not difficult to find reports of cost savings, the cost to effect ratio was not used to evaluate the relationship between the cost and effects of alternative options. Based on my analysis, the nursing CEA literature seemed to have huge variation in methods, so that it is not easy to compare the CEA methods among studies. Therefore, the synthesis of the literature review is more focusing on general methodological issues in nursing research that involved measurement of cost effectiveness.

First, in this literature review, four studies were quasi experimental, randomized or nonequivalent control group pretest-posttest design (Petryshen et al., 1997; Gardner & Tilbury, 1991; Bergner et al., 1988; Braun & Rose, 1986) while 5 studies employed pre-experimental

design: four of them were nonequivalent control group posttest only design (Thompson et al., 1982; Alfano, 1982); one of them was posttest only-no control group design (Mooney et al., 1988). Only one study employed descriptive design (Flewlynn & Gosnell, 1988).

In addition to concerns about research design, the equivalency of subjects should be considered. On condition that there is no basis on which to judge the initial equivalence of two groups, we cannot be confident that posttest differences are a result of a program of treatment rather than a result of other factors. The inability to insure pre-treatment equivalency is a serious threat to internal validity of any study. In above studies, there were only six studies which tried to establish equivalency of pre-treatment groups using random assignment (Gardner & Tilbury, 1991; Bergner et al., 1988; Alfano, 1982), matching (Braun & Rose, 1986) and statistical technique such as Chi-square test (Petryshen, 1997; Gravely & Littlefield, 1992; Thompson et al., 1982).

Second, in sampling, six of 10 studies did not indicate adequate sample size or criteria for sample selection (Mooney et al., 1988; Braun & Rose, 1986; Gardner & Tiblury, 1991; Alfano, 1982). In addition most of 10 studies except one that did not indicate sampling method employed convenience sampling. Because of the sampling method, the generalization of most studies above is limited.

Third, in comparison of programs, decisions about which of two or more programs is more (the most) cost effective are generally made using statistical tests of significance such as analysis of variance or analysis of covariance. However, while some studies employed ANOVA or t-test in order to compare costs between groups (Bergner et al., 1988; Gardner & Tilbury, 1992), most of studies did not use appropriate statistical methods, but compared costs by the use of raw data. In the long run, some studies failed to relate the costs systematically to the effectiveness (outcomes) of the program.

Finally, there is no consistent method that has reliability and validity to calculate the cost of nursing care or the program cost in this literature review. Kovner (1989) states, "At present there is no valid and reliable scale or instrument to measure the cost of nursing care. The dilemma facing the researcher who is interested in measuring costs of nursing programs is how to make a reasoned and informed choice" (p. 6). Therefore, it is not easy to compare cost calculations among these studies due to their variety of costing. In addition, most of the

10 studies provided insufficient detail on how program costs were calculated and it is not clear what data were used to calculate program costs.

In summary, methodological issues involved in conducting a cost-effectiveness analysis are the same issues involved in conducting any nursing research. These issues involve the reliability and validity of client outcome measures and the costing procedures, the equivalence of pre-treatment groups, the representativeness of the study sample, and the adequacy of the research design to support the assumption of causality.

### CONCLUSIONS/IMPLICATIONS FOR FUTURE STUDIES

Cost effectiveness is a recent and newly emerging approach in nursing evaluation studies. It is important that some authors such as those cited above have recognized the need to identify and incorporate cost data as part of a comprehensive program evaluation. But there are still such methodological problems as we found in the literature review above studies. Many of the studies reviewed here would have profited from improved designs. Greater control of pertinent variables is needed so that meaningful cost comparison can be made. In before-and-after studies, multiple measures of costs before the innovation begins as well as afterwards would be helpful in establishing better baselines.

Therefore, future cost-effectiveness analyses should include methodological progress in the context of nursing area application; examples include 1) the definition and quantification of multi-attribute effectiveness measures, 2) employment of sensitivity analysis, e.g., identification of the key variables that may drastically change the results, 3) a concept of discount, e.g., costs for more than a one-year time horizon must be restated in terms of discounted present value dollars. Finally, Fagin & Jacobsen (1985) suggest the value of qualitative research in studying the effectiveness of various innovations. Then cost effectiveness analysis would benefit from both quantitative and qualitative research. Nurse and nurse researchers should be encouraged to become specialists in cost-effectiveness research. In addition, they should consider cost-effectiveness questions when addressing other research questions. Because these efforts are forcing policy makers to consider the economics of nursing, nurses should demonstrate and document the value of nursing as compared to other uses of society's health care re-

sources.

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