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Quantity and Quality of Economic Evaluations in U.S. Nursing Research 1997–2015: A Systematic Review

Wendy A. Cook, PhD, RN, CCNS,

U.S. Navy Nurse Corps Nurse Scientist, Naval Medical Center San Diego, San Diego, CA

Affiliate Assistant Professor, School of Nursing, University of Washington, Seattle, WA

Megan L. Morrison, PhD, ARNP, FNP-BC, ACHPN,

Palliative and Supportive Care Attending Nurse Practitioner, Northwest Hospital and Medical Center, Seattle, WA

Linda H. Eaton, PhD, RN, AOCN,

Project Director, Pain and Symptom Management in Rural Communities, School of Nursing, University of Washington, Seattle, WA

Post-Doctoral Research Fellow, University of Utah College of Nursing, Salt Lake City, UT

Brian R. Theodore, PhD, and

Research Assistant Professor, Department of Anesthesiology and Pain Medicine, University of Washington, Seattle, WA

Ardith Z. Doorenbos, PhD, RN, FAAN

Professor, School of Nursing and School of Medicine, University of Washington, Seattle, WA

Abstract

Background—The United States has a complex healthcare system that is undergoing substantial reformations. There is a need for high-quality, economic evaluations of nursing practice. An updated review of completed economic evaluations relevant to the field of nursing within the U.S. healthcare system is timely and needed.

Objectives—The purpose of this study was to evaluate and describe the quantity and quality of economic evaluations in nursing-relevant research performed in the U.S. between 1997 and 2015.

Methods—Four databases were searched. Titles, abstracts, and full-text content were reviewed to identify studies that analyzed both costs and outcomes, relevant to nursing, performed in the U.S.,

Corresponding Author: Wendy A. Cook, 34800 Bob Wilson Drive, San Diego, CA, 92134 (wacook@uw.edu).

Wendy A. Cook, PhD, RN, CCNS, is U.S. Navy Nurse Corps Nurse Scientist, Naval Medical Center San Diego and Affiliate Assistant Professor, School of Nursing, University of Washington.

Megan L. Morrison, PhD, ARNP, FNP-BC, ACHPN, is Palliative and Supportive Care Attending Nurse Practitioner, Northwest Hospital and Medical Center.

Linda H. Eaton, PhD, RN, AOCN, is Project Director, Pain and Symptom Management in Rural Communities, School of Nursing, University of Washington, and Post-Doctoral Research Fellow, University of Utah College of Nursing

Brian R. Theodore, PhD, is Research Assistant Professor, Department of Anesthesiology and Pain Medicine, University of Washington.

Ardith Z. Doorenbos, PhD, RN, FAAN, is Professor, School of Nursing and School of Medicine, University of Washington.

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and used the quality-adjusted life year (QALY) to measure effectiveness. For included studies, data were extracted from full-text articles using criteria from U.S. Public Health Service's Panel on Cost-Effectiveness in Health and Medicine.

Results—Twenty-eight studies met the inclusion criteria. Most ($n = 25$, 89%) were published in the last decade of the analysis, from 2006 to 2015. Assessment of quality, based on selected items from the panel guidelines, found that the evaluations did not consistently use the recommended societal perspective, use multiple resource utilization categories, use constant dollars, discount future costs and outcomes, use a lifetime horizon, or include an indication of uncertainty in results. The only resource utilization category consistently included across studies was healthcare resources.

Discussion—Only 28 nursing-related studies meeting the inclusion criteria were identified as meeting robust health economic evaluation methodological criteria, and most did not include all important guideline items. Despite increases in absolute numbers of published studies over the past decade, economic evaluation has been underutilized in U.S. nursing-relevant research in the past two decades.

Keywords

Affordable Care Act; cost-effectiveness; economic evaluation; nursing; nursing economics; quality-adjusted life years (QALY); resource utilization

Financial resources available for healthcare must be used judiciously while still achieving the desired and optimal outcomes. Choices must be made in the prioritization and selection of interventions, programs, or approaches to patient care that will provide the greatest possible benefit within a fixed budget. Economic evaluation is the use of analytic tools to compare the costs and outcomes of alternative courses of action (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2005). The aim of economic evaluation is to provide decision-makers with evidence to support decisions to invest in, or not invest in, alternative options for interventions, programs, and approaches to care.

Such guidance to support decision-making is needed in the United States healthcare system. In 2013, the United States spent \$2.9 trillion on healthcare, accounting for 17.4% of the nation's gross domestic product. U.S. healthcare expenditures are projected to increase 5.8% annually from 2014 to 2024 (Centers for Medicare and Medicaid Services, 2015). Per capita, the U.S. spent nearly one and a half times more on healthcare in 2013 than the next highest spending developed countries in the world: Norway and Switzerland (\$9,086 vs. \$6,170 and \$6,325, respectively; Squires & Anderson, 2015). While the growth in healthcare costs (at least through employment-based insurance) has slowed down as recently reported by the Kaiser Family Foundation (Claxton et al., 2015), it should also be noted that the past decade's growth in healthcare costs have essentially wiped out any real gains in income for the average American household (Auerbach & Kellermann, 2011).

Despite high spending, U.S. healthcare performance was recently rated fifth out of 11 developed countries, and 11th overall, in terms of quality of care. Poor patient safety and care coordination have been implicated as primary causes of quality-of-care issues in the U.S. (Davis, Stremikis, Squires, & Schoen, 2014). While there has been much debate on

what drives healthcare expenditures, substantially higher prices, duplication of resources, frequent use of expensive diagnostics and pharmaceuticals, and widespread use of inadequately coordinated specialist care within a fragmented health delivery system have been implicated (Squires & Anderson, 2015; Muennig & Glied, 2010). To bring healthcare expenditures down in the U.S., cost containment programs have been developed. The most notable of these are the judiciously planned provisions of the recently implemented Patient Protection and Affordable Care Act (ACA; 2010).

Health Economic Evaluations

The gold standard for economic evaluations in healthcare was published in 1996 by the U.S. Public Health Service-commissioned Panel on Cost-Effectiveness in Health and Medicine (Gold, Siegel, Russell, & Weinstein, 1996). These seminal guidelines have since contributed to the development of more recent guidelines and detailed methodologies for evaluating health economics published by other institutions and organizations, such as the Third U.S. Preventive Services Task Force (Saha et al., 2001), the International Society for Pharmacoeconomics and Outcomes Research (ISPOR; Ramsey et al., 2005; 2015) and the Consolidated Health Economic Evaluation Reporting Standards (CHEERS; Husereau et al., 2013). The original panel reconvened in 2011, and updated guidelines are in the process of being prepared by the Second Panel on Cost-Effectiveness in Health and Medicine (Regents of the University of California, 2013).

The major defining characteristics of economic evaluation are: (a) inputs (costs) and outputs (consequences) of activities are evaluated; (b) two or more alternative courses of action are compared as the basis for making choices; and (c) an appropriate longitudinal time horizon is selected (e.g., lifetime costs and outcomes; Gold et al., 1996; Drummond et al., 2005). The four types of full economic evaluation are: cost-effectiveness, cost-utility, cost-benefit, and cost-consequence analysis. Consideration of costs is common to all types of economic evaluation.

Economic evaluations can also be defined by the type of design used for the evaluation. One method is alongside a clinical trial in which the economic evaluation is built into the design of a clinical trial, and data are collected for actual costs and outcomes during the clinical trial. Another method is quantitative modeling in which software is used to project costs and outcomes that lie outside the study's time horizon. Modeling can be performed using cost information from a variety of data sources, such as completed clinical trials, published literature, organizational historical expenditures, Medicare, and Bureau of Labor Statistics.

In economic evaluations, the consequences of alternatives are measured in a variety of ways. Effectiveness measures may include natural units, such as life years, that are selected as a general measure of intervention effect, as well as more specific measures, such as cases averted for cancer prevention or hospital re-admission rates for postoperative management. Consequences may be measured via utilities and use a broad measure of health benefits designed to reflect the preferences that individuals or society as a whole have for specific health outcomes—where the utilities range from 0 to 1, representing the spectrum from death to best health state. Utilities can then be used to estimate quality-adjusted life years

(QALYs) and incremental cost-effectiveness ratio (Gold et al., 1996). In such economic evaluation, the QALY represents a standardized measure of the burden of a particular disease or illness, and the incremental cost-effectiveness ratio (i.e., cost per QALY) provides a standardized method to compare the relative value of a given medical intervention. The QALY is the consequence metric recommended for health economic evaluation by expert guidelines and consensus (Gold et al., 1996).

Finally, the perspective of the economic evaluation can be guided by the scope of interest to the end-user. The recommended perspective is often the “societal perspective,” which includes quantification of direct medical costs, as well as other indirect costs that impact society at large—such as productivity, disability payments, family caregiver time, and loss in quality of life (Gold et al, 1996). However, other commonly used perspectives are those that are limited to the scope of interest of health insurance payers, the healthcare system, the healthcare facility (e.g., organizational quality improvements), or the patient.

Economic Evaluations in Nursing

The need for high-quality economic evaluations of nursing practice has been recognized (Henly et al., 2015; Spetz, 2005; Vincent & Reed, 2014). Numerous provisions in the ACA, such as the establishment of the Patient-Centered Outcomes Research Institute, affect nursing practice and nursing research (Luther & Hart, 2014; Newhouse, Barksdale, & Miller, 2015; Vincent & Reed, 2014). At this unique period in the history of U.S. healthcare delivery, there are substantial opportunities for nurses to contribute to and lead efforts to reduce the costs and improve the quality of U.S. healthcare. Clinicians should support clinical decisions with evidence, and economic data is one important component in evidence-based decision-making. By incorporating cost and consequence analysis in clinical research, nurse scientists can generate information that impacts the field of nursing. Together, these complementary roles of nursing practice and inquiry can improve the cost-effectiveness of healthcare.

Research that includes high-quality economic evaluation of both costs and outcomes of alternative courses of action can inform nurse decision-makers seeking to use limited financial resources efficiently and effectively. While systematic reviews of economic evaluations of specific nursing interventions are not uncommon, only two reviews have evaluated the use and quality of economic evaluations in nursing research (Allred, Arford, Mauldin, & Goodwin, 1998; Lämås, K., Willman, A., Lindholm, L., & Jacobsson, C., 2009).

The most recent review of the use of economic evaluations in nursing research covered the period between 1984 and mid-2007, and included 115 studies published in English and Scandinavian languages (Lämås et al. 2009). The authors concluded that despite the increase of studies incorporating economic evaluations of nursing interventions over the last four years of the review, variability and limitations in methodology had a significant impact on their ability to interpret these studies. Furthermore, despite a noted increase in the use of economic evaluation in the field of nursing, its use remained exceptionally small compared to the copious body of nursing research that exists (Lämås et al. 2009).

The first review of the use of economic evaluations in nursing research covered the period from 1992 to 1996 (Allred et al., 1998). This review had direct relevance to the healthcare system in the U.S. as the U.S. Panel on Cost-Effectiveness in Health and Medicine recommendations was used to guide the analysis. The authors identified seven nursing studies during this timeframe that included economic evaluations of costs and outcomes of two or more interventions. They found that most of the economic evaluations used the perspective of the healthcare provider rather than from the recommended societal perspective. The various perspectives taken in the evaluations made it difficult to compare economic evaluations. Overall, the authors were satisfied with the quality of the evaluations, and found design decisions to be well justified when aspects of the evaluations did not align with recommendations.

The U.S. has a complex healthcare system that is undergoing substantial reformations. The national landscape has changed significantly since the Allred et al. (1998) review. An updated review of completed economic evaluations relevant to the field of nursing within the U.S. healthcare system is therefore timely and needed. The period under review, a span of almost two decades, will offer some insight into the quantity and quality of such economic evaluations and could provide guidance for needed improvements in the use of economic evaluations in U.S. nursing research.

Objectives

The purpose of this study was to evaluate and describe the quantity and quality of economic evaluations in nursing-relevant research performed in the U.S., and published in English-language journals between January 1, 1997 and December 31, 2015. For the purpose of this review, nursing-relevant research was defined as, “research of interventions, programs, or approaches to care that were delivered by or ordered by nurses, or included nurses, within the scopes of registered nurse practice or advanced practice nursing.” There was no focus on any particular patient population, health problem, intervention, or outcome. The specific objectives were to determine: (a) the extent to which nursing-relevant research included economic evaluations during this 19-year period; and (b) to determine the extent to which these studies adhered to a core set of recommendations and standards in health economic evaluation.

Methods

This study evaluated and described the overall quantity and quality of economic evaluations in nursing-relevant research. The criteria and methodology used to define the review parameters and execute the search strategy, screening, evaluation, and selection of studies in this qualitative review adhered to “The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration” (Liberati et al., 2009; Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Search Strategy

Four healthcare literature databases—Cochrane Central Register of Controlled Trials (CENTRAL), Medline (EBSCO), Embase (Elsevier), and Cumulative Index to Nursing and Allied Health Literature (CINAHL, via EBSCO)—were searched. These four databases provide a comprehensive indexing of articles published in the fields of medicine, health sciences, and nursing.

Search terms were nurs* (which included nursing or nurse) and cost effectiveness, cost utility, cost benefit, cost consequences, economic evaluation, economic analysis, or economic model. The year of publication was limited to 1997 through 2015, and the search was limited to English-language publications. To narrow the search for relevance, search terms were limited to the search fields of journal title, publication title, or abstract.

Duplicate publications that appeared in two or more searches were removed. For individual studies that were reported in more than one publication, the most thorough report was used for further review. The goal was to identify original, complete economic evaluations, therefore, systematic reviews and conference abstracts were not included in this analysis.

Publications were evaluated for four inclusion criteria:

- an analysis of both costs and consequences of two or more alternatives (interventions, treatment options, modes of delivery, etc.; usual care could be one of the alternatives considered);
- relevant to nursing, as defined above in Objectives;
- performed in the U.S.; and
- cost per QALY was the measure of effectiveness.

First, the titles of all identified publications were screened independently by four reviewers (three doctoral candidates, each with extensive nursing experience, and one health economist) to ascertain whether the publication related to the first three criteria. Publications that could be excluded based on title alone were excluded. Throughout the review, where disagreements existed between the reviewers, the health economist was the final arbitrator. Next, the abstract of each remaining publication was thoroughly reviewed to confirm study eligibility based on the first three criteria.

Finally, the four reviewers each independently reviewed the full-text article for all of the remaining publications. The first three inclusion criteria were again assessed to determine a study's eligibility. The fourth inclusion criterion was evaluated in the full-text review stage. It was not possible to determine use of the QALY during the title or abstract review, as this specific information is often found only within the full-text content.

Data Collection Instrument

The team's health economist developed a 49-item data collection tool (see Table, Supplemental Digital Content 1) based on items from the guidelines for economic evaluation in health and medicine (Gold et al., 1996). The major components of the data collection tool are broadly divided into: (a) characteristics of the studies evaluated (e.g., topic of evaluation,

healthcare setting, and type of analysis); and (b) adherence to guidelines for economic evaluations. These components are further divided into several categories that include: specification of a reference case or comparator to the intervention; inclusion of comprehensive resource utilization in the numerator and denominator in the economic evaluation, inclusion of the principle of discounting costs and outcomes over the analytical timeframe; estimates of uncertainty in estimation of cost-effectiveness ratios; study design; and quality of reporting of the results.

Data were extracted from the full-text articles of the included studies independently by each of the four reviewers using the data collection tool. Several key elements from the guidelines for reporting evaluation quality were selected to report in this review. These included use of the recommended societal perspective for accounting for costs, use of multiple resource utilization categories (i.e., healthcare resources, non-healthcare resources, patient time, and informal caregiver time), use of constant dollars, discounting of future cost and outcomes, and inclusion of an indication of uncertainty in results using 95% confidence or uncertainty intervals.

Results

Studies of Economic Evaluations

Twenty-eight studies met all four criteria for inclusion in the review (Figure 1; Table 1; see Table, Supplemental Digital Content 2, which summarizes the reviewed studies). Overall, reviewer agreement on the four inclusion criteria for these 28 studies was approximately 87%. Fifteen studies (54%) were modeling-based, four studies (14%) were clinical trials, and nine (32%) were a combination of clinical trials and modeling. Conditions and topics of interest included depression ($n = 7$; 25%), injury prevention ($n = 5$; 18%), HIV ($n = 4$; 14%), staffing patterns ($n = 3$; 11%), cardiovascular disease ($n = 3$; 11%), diabetes ($n = 2$; 7%), infection prevention ($n = 1$; 4%), sepsis monitoring ($n = 1$; 4%), vaccinations ($n = 1$; 4%), and wound care ($n = 1$; 4%).

Over the 19-year timeframe, there appeared to be a possible trend toward an increasing quantity of published articles that adhered to the guidelines for economic evaluation methods (Figure 2). The earliest study that met all four inclusion criteria was published in 2001 ($n = 1$). Most of the studies ($n = 23$; 82%) were published in the last 10 years of the analysis. An average of two studies were published per year from 2006 to 2015 (0–4/year), versus only five studies (0–2/year) between 1997 and 2005.

Quality of the Reviewed Evaluations

Assessment of study quality was based on selected items from guidelines. The studies included in the review did not consistently use the recommended societal perspective for accounting for costs, use multiple resource utilization categories, use constant dollars, discount future costs and outcomes, use a lifetime horizon, or include an indication of uncertainty in results using 95% confidence or uncertainty intervals (Table 2). Garcia, Liu, & Victorino (2014) and Freedberg et al. (2006) incorporated the most guideline recommendations in their studies compared to other studies included in the review.

Perspectives—Fourteen studies (50%) reported using the recommended societal perspective. Six studies (21%) reported only the payer perspective, and eight studies (29%) reported only the healthcare system perspective. Six studies (21%) reported both societal perspectives and payer or health system perspectives. No studies took the perspective of the patient as payer.

Resource utilization categories—While all studies (100%) incorporated healthcare costs, only eight studies (29%) included patient time; an important component of the resources to be included when taking a societal perspective. Nine studies (32%) incorporated non-healthcare costs. Only one study (4%) incorporated the broadest perspective that also included costs of non-healthcare resources and informal caregiver time, in addition to patient time and healthcare costs.

Other quality indicators—The majority of studies used constant dollars corrected for inflation using metrics such as the Consumer Price Index ($n = 18$, 64%), but fewer than half ($n = 12$; 43%) discounted future costs and outcomes to accurately estimate the future value of both healthcare costs and the value of health effects over longer timeframes. Only eight studies (29%) used a lifetime time horizon; and only 14 studies (50%) reported the uncertainty in the estimates of cost-effectiveness ratios using confidence or uncertainty intervals. All 28 studies evaluated were consistent on the other quality indicators specified in the data collection tool.

Discussion

Based on the search strategy and criteria used for this review, only 28 economic evaluations relevant to nursing—that were both performed in the U.S. and published between 1997 and 2015—met the robust methodological criteria of this analysis. Of the 28 studies meeting inclusion criteria and undergoing full review, only one study incorporated all four recommended resource utilization categories (healthcare resources, non-healthcare resources, patient time, and informal caregiver time); informal caregiver time was the category most frequently excluded. Economic evaluations that do not account for non-healthcare costs, patient time, and informal caregiver time may underestimate the true costs of interventions, as productivity losses, disability payments, and other indirect costs often impose a staggering impact on the health economy (Institute of Medicine, 2011). When studies do not incorporate a truly societal perspective and a full range of resource utilization categories, cost estimates and subsequent cost-effectiveness ratios may therefore be underestimated. Granted, there may be valid reasons for a much more narrow perspective (e.g., focus on direct medical costs only), given the scope of interest for the end-user or the decision-maker (e.g., insurance payers).

Within the context of the previous two published reviews of economic evaluation in nursing research, the findings from the present study indicate a more consistent use of the societal perspective. For example, Lämås et al. (2009) found that 75% of the studies included in their review did not specifically state a perspective for the economic analysis. In their review, the most common specified perspective was the healthcare perspective ($n = 16$ out of 115), followed by the societal ($n = 9$ out of 115), and patient perspectives ($n = 8$ out of 115).

Allred et al. (1998) noted in their review that the use of the healthcare provider perspective had been used more often than the recommended societal perspective. As summarized in Table 2, all studies included in this current review specifically stated the perspective or perspectives taken, with half of the studies using the societal perspective.

In terms of quantifying and including specific resource categories, Allred et al. (1998) noted that none of the economic evaluations in their review had accounted for patient time or informal caregiver time as resource utilization categories; as previously mentioned, an omission of such resource costs does not fully capture the economic burden of a particular option. In the present study, we observe that the inclusion of patient time and informal caregiver time are also not well represented among the studies reviewed.

Although recommendations for a standard set of methodological practices designed to improve the comparability of economic evaluations were available throughout the period reviewed, there was a lack of consistent use of these practices. These limitations, of course, are not confined to the field of nursing research, but have been similarly reported in other areas of healthcare research (Furlan et al., 2012; Kepler et al., 2012). Perhaps with the reinforcement of health economic evaluation guidelines through more recent initiatives like CHEERS (Husereau et al., 2013), a greater number of studies with more robust health economic evaluation methodology (that specifically improve on quantifying a more inclusive set of costs) will be observed in coming years.

Many of the authors of the included studies acknowledged that the inability to obtain accurate cost estimates had presented limitations in the design or findings of their economic evaluations. Weaver et al. (2009) specifically noted that the inability to include patient and family costs had been a limitation in their study. Other authors noted that cost estimates used for the societal perspective were likely undervalued (Honkanen, Mushlin, Lachs, & Schackman, 2006) and reported that limited data were available for cost estimates when evaluating from the societal perspective (Handley, Shumway, & Schillinger, 2008; Middleton et al., 2008). Cost data are not always available or able to be generated, which sometimes limits the options a researcher has when selecting perspective or deciding which resource utilization categories to include. (Limitations reported by the authors of each study are included in Supplemental Digital Content 2.)

Despite the noticeable increase in nursing-relevant economic evaluations published over the last decade, this review underscores the relative scarcity of economic evaluations in U.S. nursing research since the original guidelines were published in 1996. In the review immediately preceding this one, Lämås et al. (2009) also noted an increase in the number of studies from 2003 through the end of their review in mid-2007, a period which included nearly half of the studies in their 23-year review. However, with the increase in the exposure of nurse clinicians and nurse scientists alike to reviews and publications of economic evaluations relevant to their field, there is also an opportunity to advance and improve the quality of such economic and cost-effectiveness studies in the field.

First, nurse researchers who evaluate the effectiveness of nursing interventions need to develop economic evaluation skills and incorporate rigorous economic evaluation

methodology when designing studies. Gaps in knowledge can be narrowed by fostering collaboration with health economists and health services researchers who have skills and experience in economic evaluation. Several authors (Grosse, Teutsch, & Haddix, 2007; Guest, 2013; McFarland, 2014) have provided useful and accessible introductions to economic evaluation. For example, a recent publication (Bensink et al., 2013) can help nurse researchers apply the methodology of economic evaluation—specifically, cost-effectiveness analysis, alongside a randomized controlled trial.

Second, nurses in leadership positions at institutions of higher learning can provide the opportunity for deeper training in methodology relevant to health economics through structured training programs focusing on implementation science across the spectrum of healthcare delivery (i.e., from primary care to specialty settings). Allred et al. (1998) recommended that economic evaluation should be a component in all graduate nursing curricula. This has also been recently highlighted in recommendations for improving nursing doctorate programs, with one such recommendation being the incorporation of health economics in the training of future nurse scientists (Henly et al., 2015).

Finally, taking advantage of learning and self-training resources could be a first step towards familiarization with the most up-to-date methodology and state of the science in health economics. For example, the U.S. National Library of Medicine (2014) offers a free online self-study course on health economic evaluation. This will also help in the critical evaluation of published studies and provide valuable inputs for nursing research.

Limitations

As with any large-scale review of published literature going back several years, there are some potential limitations. First, it is possible that the search strategy used led to some economic evaluations that would otherwise have met inclusion criteria being inadvertently excluded. For example, limiting search terms to specific fields, such as title or abstract, may have resulted in the exclusion of studies that contained search terms only in other parts of the publication.

Second, it is possible that miscategorization of articles may have occurred. Defining and differentiating what is and is not relevant to nursing is particularly challenging. Lämås et al. (2009) noted in their review of economic evaluations in nursing that in some cases, other reviewers would have decided differently on some of their categorizations pertaining to nursing relevance. We acknowledge that this is a possibility in our analysis as well. However, it is unlikely that many articles were miscategorized or inadvertently omitted, due to independent review by four researchers during all stages of the selection process.

Limiting the scope of the review to research performed in the U.S. reduces the generalizability of the findings. However, given the recent and ongoing changes in U.S. healthcare reform, and the relevance of economic evaluation in adapting to such changes, this review offers important insights into recent trends relevant to nursing and nursing research in the U.S. Further research evaluating use of economic evaluation in international nursing research would be beneficial—particularly reviews that include studies published in non-English language journals.

Despite these limitations, a notable strength in this study was the interdisciplinary team of reviewers who performed the data collection and analysis, comprising three nurse reviewers from a variety of clinical backgrounds, including critical care, palliative care, oncology care, and an experienced health economist. This broad spectrum of expertise was a strength of the study as the team composition offered multiple perspectives when reviewing and evaluating each study.

Conclusion

Nurses have opportunities to contribute, if not lead, efforts to reduce costs and improve the quality of U.S. healthcare. Providing evidence of the cost-effectiveness of such efforts through economic evaluation will be critical to showing the value provided by nurses and supporting the widespread adoption of cost-effective alternatives to current care. However, if the methodological rigor of economic evaluations is found lacking, the opportunity to influence healthcare reform and the healthcare delivery system of the future will be missed.

Overall, this review identified relatively few methodologically robust and nursing-relevant economic evaluations in published U.S. healthcare literature between 1997 and 2015. Although the absolute number of published studies has seen an increase in the last half decade, there is more room for improvement and adherence to best practice guidelines and methodological considerations. For now, the results do suggest that economic evaluation is a valuable, yet, greatly underutilized source of information for evidence-based decision-making in the field of nursing. With the introduction of accountable care models of reimbursement, robust health economic evaluation methodology will be an increasingly important addition to nursing research.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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FIGURE 1.
Flow of publications through the review process.

FIGURE 2.

Number of studies meeting the final inclusion criteria, by publication year ($N=28$).

TABLE 1

Features of Studies Included in the Review

Year	Study ^a	Patient problem	Design	Horizon ^c	N	Group	Outcome	
							Cost ^b	QALY
2015	Chong	Violence	Modeling	5.0	155	I C	3,574 3,515	4.64 4.62
2015	Harrison	ICU: infection	Modeling	1.0	10,000	I C	-65 Referent	+0.0002 Referent
2015	Nelson	ICU: central lines	Modeling	Lifetime	10,000	I1 I2 C	-400 -860 Referent	+0.05 +0.13 Referent
2015	Tannenbaum	Insomnia	Modeling	5.0	12,699	I1 I2 C	19,422 32,452 33,853	0.59 0.55 0.52
2014	Donohue	Depression	CT/modeling	1.0	189	I C	-2,068 Referent	.70 .65
2014	Garcia	Trauma	Modeling	Lifetime		I C	930,446 929,883	25.44 25.44
2014	Pizzi	Depression	CT/modeling	0.3	129	I C	-491 Referent	.0076 Referent
2013	Beil	Depression	Modeling	3.0	1,000	I C	+2,887 Referent	+0.21 Referent
2013	Bicki	Clinic care	CT/modeling	Lifetime	265	I C	-1,189,523 Referent	+25.10 Referent
2013	Herman	Diabetes	CT	10.0	2,011	I1 I2 C	-1,126 -1,130 Referent	0.15 0.09 Referent
2013	Slade	Screening	CT	0.5	202	I C	423 24	
2012	Katon	Care model	CT/modeling	2.0	214	I C	-594 Referent	+0.335 Referent
2011	Dy	Hip fracture	Modeling	1.0	10,000	I1 I2	25 470	1.0 1.0
2011	Ladapo	AMI Smokers	Modeling	10.0	327,600	I C	68,650 69,550	
2010	Chapman	Med adherence	Modeling	Lifetime	5000 ^x	I1 I2	4,984 6,358	1.0 1.0
2010	Pyne	Depression	CT/modeling	1.0	395	I C	85,634 76,056	1.0 1.0

Year	Study ^a	Patient problem	Design	Horizon ^c	N	Group	Outcome	
							Cost ^b	QALY
2010	Sanders	HIV screening	CT/modeling	Lifetime	251	I1 I2 I3	48,650 48,710 48,720	16.27 16.27 16.27
2009	Weaver	Comorbidities	CT	1.0	431	I C	-290 Referent	+0.005 Referent
2008	Handley	Type 2 diabetes	CT	1.0	226	I C	65,167 Referent	+0.012 Referent
2008	Hebert	Heart failure	CT/modeling	1.0	406	I C	22,888 22,134	0.708 0.665
2008	Middleton	Vaccination	Modeling	Lifetime		I C	-2,432 Referent	+0.0078 Referent
2006	Freedberg	Med adherence	Modeling	Lifetime	54	I C	261,300 253,800	
2006	Honkanen	Hip fracture	Modeling	Lifetime	10,000	I C	19,000 50,000	1.0 1.0
2005	Ganz	Staffing	Modeling	0.08		I C	-8,941 Referent	2.281 2.281
2005	Rost	Depression	CT/modeling	2.0	211	I C	+701 referent	+0.049 Referent
2003	Colón-Emeric	Hip fracture	Modeling	1.5		I C	-300 Referent	+0.01 Referent
2002	Macario	Pressure ulcer	Modeling	3.3	10,000	I1 I2 C	-6,630 -15,216 Referent	+0.10 +0.14 Referent
2001	Schoenbaum	Depression	CT/modeling	2.0	1,356	I1 I2 C	419 485 Referent	+0.01 +0.02 Referent

Note: Additional detail about interventions, setting, and limitations for each study is available in Supplemental Digital Content 2. AMI = acute myocardial infarction; C = control or usual care; CT = clinical trial; HIV = human immunodeficiency virus; I = intervention; QALY = quality adjusted life year; USD = United States dollar.

^aFirst author family name.

^bUSD at time paper was published.

^cTime horizon (years).

^dLimitations and biases reported by authors.

^x200 simulated trials of 5,000 patients.

TABLE 2

Quality of the Reviewed Studies

Year	Study ^b	Perspective ^d			Resource utilization categories					Constant dollars	Lifetime horizon	Future costs	95% CI	% ^d
		Societal	Payer ^c	System ^e	HC	NHC	ICT	PT						
2015	Chong			X	X	X								22
2015	Harrison			X	X									11
2015	Nelson			X	X						X	X		33
2015	Tannenbaum			X	X									11
2014	Donohue		X		X	X							X	33
2014	Garcia	X			X	X		X	X		X	X	X	89
2014	Pizzi	X			X	X		X	X					56
2013	Beil		X		X	X			X			X	X	56
2013	Bicki	X		X	X				X		X		X	56
2013	Herman	X		X	X	X		X	X		X			67
2013	Slade		X		X				X				X	33
2012	Katon			X	X	X							X	33
2011	Dy			X	X				X				X	33
2011	Ladapo	X			X	X			X			X		56
2010	Chapman		X		X	X			X		X	X	X	56
2010	Pyne		X		X	X								22
2010	Sanders	X	X		X	X			X		X	X	X	67
2009	Weaver			X	X	X			X				X	33
2008	Handley			X	X									11
2008	Hebert	X	X		X	X		X	X					67
2008	Middleton	X			X				X		X	X		56
2006	Freedberg	X			X		X	X	X		X	X		78
2006	Honkanen	X	X		X		X		X		X	X	X	67
2005	Ganz		X		X		X		X		X	X	X	44
2005	Rost	X		X	X		X		X				X	56
2003	Colón-Emeric	X			X		X							22
2002	Macario	X			X		X		X			X		44

Year	Study ^b	Perspective ^d				Resource utilization categories				Constant dollars	Lifetime horizon	Future costs	95% CI	% ^d
		Societal	Payer ^c	System ^c	HC	NHC	ICT	PT						
2001	Schoenbaum	X			X			X					X	44
	% ^e	50	32	39	100	32	7	29	64		29	43	50	

Note. N = 28. Studies are ordered alphabetically within year, in reverse chronological order. CI = confidence interval; HC = healthcare; ICT = informal caregiver time; NHC = nonhealthcare; PT = patient time.

^aNo studies used a patient perspective.

^bFirst author family name only.

^cPayer and system perspectives are not recommended quality criteria but are provided for reporting purposes.

^d% of criteria met by study.

^e% studies meeting criterion.