Caregiving Effectiveness Model Evolution to a Midrange Theory of Home Care: A Process for Critique and Replication

A clinically relevant model, grounded in nursing theory, has evolved to become a midrange theory. This article describes the processes used to derive, validate, revise, and test the Caregiving Effectiveness Model. Testing of this midrange theory used prospective longitudinal research with family members caring for patients requiring lifelong, complex, technology-based home care. It presents the conceptual critiques and statistical procedures and discusses derivation of model-generated nursing interventions and implications for use of these validation processes in developing nursing knowledge. The article summarizes limitations of the model and presents recommendations for future research. Key words: *caregiving effectiveness, family, home care, model testing*

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THE CAREGIVING Effectiveness Model was developed to explain and predict outcomes of technology-based home caregiving provided by family members.[1–3] Technology-based treatment is defined as dependence on in-home nursing care and technical devices to sustain body function or life.[4] Numbers of home technology-dependent patients continue to increase dramatically with advances in medical technology, consumer demand, and the aging population.[4] Treatments include parenteral

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nutrition and pharmacologic infusions, mechanical ventilation, renal and peritoneal dialysis, and monitoring for apnea and cardiac or fetal distress. The model was designed to identify concepts that are consistently associated with outcomes of home caregiving and to help nurses develop relevant nursing interventions to support positive patient and caregiver outcomes.

This article describes the processes used to derive, validate, revise, and test the Caregiving Effectiveness Model. The first section contains descriptions of the model assumptions, concepts, measures, and the analyses of logical adequacy and criterion-related validity. The second section reviews empiric procedures used in model testing across multiple populations and testing of nursing interventions derived from this model. The last section describes implications for future research.

The Caregiving Effectiveness Model is based on four explicit assumptions that serve as the foundation for the model, yet are separate from the model tenets. First, it is assumed that caregiving with complex technological home care is stressful and disruptive to usual family activities.[5–7] Home care of patients using technology is centered on daily care procedures and stringent treatment schedules. Patients dependent on technology repeatedly experience acute exacerbations of their chronic conditions and side effects of treatment requiring acute hospitalizations and numerous and multiple home care services.

Second, it is assumed that families prefer home technological care as opposed to institutional care.[8] Patients and families select home care in spite of demanding caregiving and learning requirements, intense fears of making mistakes with technology, and home remodeling required for a safe environment for maintaining the complex equipment and supplies.[8]

The third assumption is that model concepts are clinically relevant for nursing practice with patients and their caregivers.[9] Concepts and relationships in the model were derived from interview data about the lived experience of caregiving for persons dependent on technology. Concepts included caregiver and family characteristics that were known correlates of both patients' and caregivers' quality of life and health status.[10,11] Nurses can influence interactions between caregivers and patients, and ultimately, influence the outcomes of family caregiving through nursing and other professional interventions.[12,13] This assumption emphasizes the importance of home care nurses developing interventions that are designed to address concerns specific to supporting positive caregiving and patient outcomes.

The fourth assumption is that theories or models about caregiving of terminally ill and frail or cognitively impaired older persons are not directly applicable to technology-dependent patients.[14,15] Unlike individuals who are terminally ill or frail older adults, persons placed on technology because of chronic illness have dramatic improvements in health and longevity, and they often participate in their own care and decision making.[16] To date, no other models of technology family caregiving have been found in the literature.

DERIVATION OF THE CAREGIVING EFFECTIVENESS MODEL

Caregiving effectiveness is defined as the provision of technical, physical, and emotional care by family members that results in outcomes of optimal patient condition,

yet maintains caregivers' well-being.[1] Initially, the model structure and concepts reflected Roy's adaptation model. The model was then circumscribed through concept analyses on caregiving and further delineated using findings from preliminary descriptive studies.[3,17–19] Interview data from descriptive studies of technology-dependent patients and their caregivers offered greater specificity for model concepts beyond Roy's model.[1] For example, Roy's interdependence model focused on "interactions related to the giving and receiving of love, respect, and value."[19] Interdependence in technology-based caregiving was evident; yet, the caregiving/care-receiving interaction themes identified in descriptive studies were more specific than Roy's global psychological concepts.[20] Observations of family members' varying motivations to help the technology-dependent patient with daily physical care also went beyond Roy's environmental concept definition.[21,22] The original model evolved over time to include concepts and relationships based on adaptation in the technology caregiving context.[23]

CONCEPTS AND RELATIONSHIPS OF THE CAREGIVING EFFECTIVENESS MODEL

As illustrated across the top of Fig 1, concepts in the original model were organized into a linear, explanatory structure: Care-

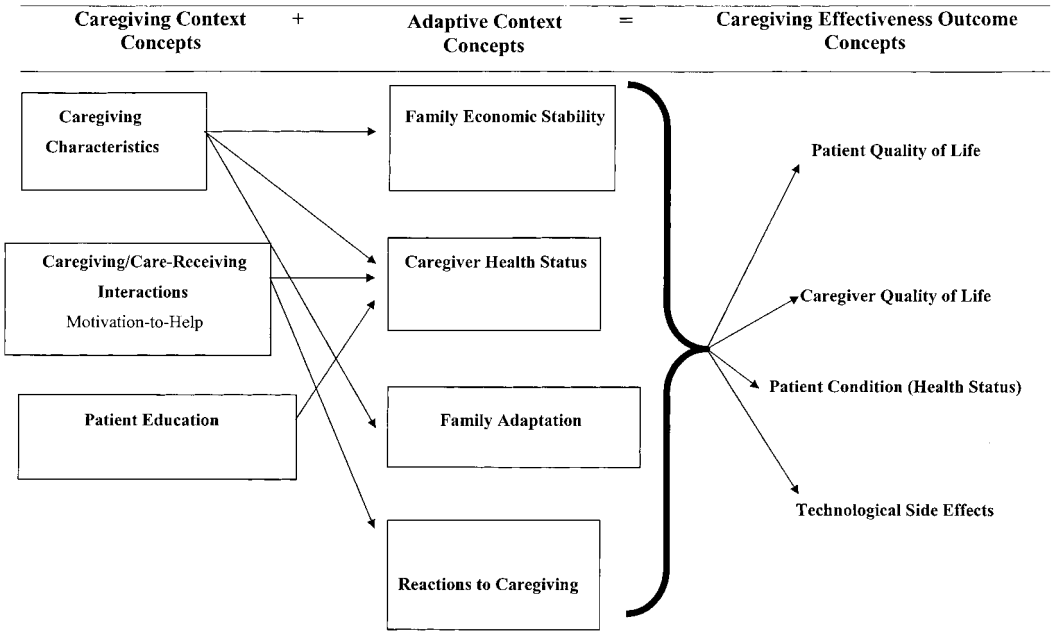

Fig 1. The original Caregiving Effectiveness Model from Smith. Arrows represent relational statements; the bracket signifies the effects of all concepts on the outcomes confirmed in statistical testing; and the rectangles enclose model concepts. *Source:* Adapted from CE Smith, A Model of Caregiving Effectiveness for Technologically Dependent Adults Residing at Home, *Advances in Nursing Science,* Vol 17, No 2, p 31, © 1994, Aspen Publishers, Inc.

giving Context Concepts + Adaptive Context Concepts = Caregiving Effectiveness Outcomes Concepts. The model concepts were arranged by categories and labeled Caregiving Context Concepts (left column) and Adaptive Context Concepts (center column), with caregiver/patient clinical measures serving as Caregiving Effectiveness Outcomes Concepts (right column). Specifically, outcomes of caregiving effectiveness in the original model were patient and caregiver quality of life, patient condition (health status), and technological side effects. The concepts in the right column are commonly measured patient and caregiver outcomes that contribute to the clinical utility of the model.

In the left column of the model in Fig 1, the caregiving context concepts for providing complex home care to patients were divided into caregiving characteristics, caregiving/care-receiving interactions, and patient education from the nurse. The caregiving context concepts were considered intrinsic to caregivers and, therefore, were antecedent to and meditated by the adaptive context concepts.[24–26] The adaptive context (center column in Fig 1) contained concepts of family economic stability, caregiver health status, family adaptation, and reactions to caregiving. Concepts in the adaptive context, such as the financial factors and family adaptation to technology, were evident as repeating themes in everyday care noted in interview data.[23] Each of these concepts was judged in other caregiving research to be germane to outcomes of home care.[1,2,6,7,11,15]

The arrows in Fig 1 illustrate the relationships between the context concepts with the bolded bracket, indicating the effects of all context model concepts on the outcomes. These arrows also represent the hypotheses that were initially substantiated in preliminary studies and then repeatedly confirmed throughout model testing.[3,18,19] Data from caregiving and adaptive context measures were obtained from caregivers, whereas outcome data (except caregiver quality of life) were obtained from patients. The model, then, depicts the effects of caregiving on patient outcomes (quality of life, condition, and technological side effects) and on caregiver quality of life.

EMPIRICAL REFERENTS FOR MODEL CONCEPTS

Empirical referents (measures or instruments) were selected to define the concepts operationally. Empirical measures were selected based on the criteria of being well established, psychometrically sound, and practical (brief and easy to administer to decrease response burden). Families' home care experiences described in interviews were reflected in instrument items, which substantiated their conceptual validity.

Based on preliminary studies, salient caregiver characteristic concepts were length of time required for caregiving and caregivers' motivation to provide home care. The motivation to help measure was chosen based on extensive social psychology research to predict type of care given.[27] The caregiving/care-receiving interactions concept, defined as the quality of relationships between caregivers and patients, was measured as mutuality.[28] Mutuality had predicted caregiver role strain in studies of other populations such as frail older adults.[14,15] Patient education for home care was measured by caregivers' preparedness for managing patients' physical

and emotional needs, home services, and stress from caregiving.[28] Measures of each adaptive context concept were drawn from the research literature; examples are provided in Table 1. Except for the three patient outcomes, all referents measure caregiver responses and attributes, as this model was designed to capture the caregiving impact on patients.

The outcome concept of technology side effects was measured according to the population under study, lending clinical specificity for each model testing. For example, technology side effects for home parenteral nutrition infusion were measured as central venous catheter infections, whereas technology side effects for home ventilator populations were episodes of respiratory infec-

Table 1. Example relational statements, propositions verified, and empirical referents used in model testings

Relational statements of the model concepts	Propositions of statistically verified relationships	Empirical referents (measures or instruments) for testing the propositions
Caregiving Effectiveness Outcomes are the result of variables in the Caregiving Context being mediated by Adaptive Context variables	Caregiver quality of life is explained by length of time providing care, quality of the caregiver/care-receiver relationship (mutuality), and mediated by family adaptation	Quality of Life Index[10] Mutuality Scale[28] Family Coping Scale[21]
Caregiving characteristics (eg, age) mediated by the caregiver mental health status (depression) affects Caregiving Effectiveness Outcomes	The greater the caregivers' depression, the lower their and their patients' quality of life and the greater the technological side effects	Depression Score (CES-D Scale)[11] Motivation to Help[22] Quality of life[8] Technological side effects (eg, catheter infections)
Home care management strategies (preparedness) mediated by reactions to caregiving influence patient condition	Caregivers' preparedness to manage home care mediated by their reactions to caregiving affects patient condition	Preparedness Scale[28] Caregiver Reactions Scale[15] Patient condition (health status)
Caregiving Effectiveness Outcome of Efficient Use of Resources is influenced by caregiving and adaptive context variables	Efficient use of resources is explained by caregiver preparedness and resource management, which are mediated by health care services use and problem solving	Health care services use cost[15] Problem solving use[29] Efficient use of resources—DEA coefficient[30] Preparedness Scale[28]

tions. Use of outcome measures specific to each technology attests to clinical utility and generalizability of the model. Clinical health status markers measured patient condition. Relational statements among model concepts were generated from themes identified in the preliminary study interview data and correlations between concepts found in initial descriptive studies.[3,18,20,22] The model relational statements are represented in Fig 1 as arrows connecting concepts. Examples of propositions and the measures used to empirically test them are listed in Table 1.

LOGICAL ADEQUACY AND CRITERION-RELATED VALIDITY ANALYSES PROCESSES

Logical adequacy was chosen to examine whether model concepts are structured in coherent relationships and if all concepts fit within the theory.[9] Nurse reviewers familiar with home care, including a past National Association for Home Care representative, evaluated logical adequacy of the model. Research consultants on caregiving theory and statistical model testing evaluated the retroductive or iterative processes used across model development and determined these were accurately reflected in the proposition formulations written for each statistical testing.[31–33] At separate times across model development and testing studies, different reviewers judged model concepts to be consistently used.

Criterion-related validation was selected to attest to the accuracy of outcomes desired in nursing practice.[9] Criterion-related validation also evaluated the congruence between measured caregiving outcomes and clinical nurses' ratings of overall adaptation to technology home care. Master's and doctorate-prepared nurses, blinded to outcome scores, rated each caregiver's adaptation based on a structured interview, using rating scales that generated an overall score for adaptation to home care (Calhoun J. 1993. Unpublished research). This rating instrument had established content and construct validity and reliability (alpha coefficient of .88). Results indicated that the greater the clinical nurses' overall adaptation ratings were, the greater the caregiver and patient quality-of-life scores and the fewer the technological side effects noted. Caregivers who had poor nurse ratings for adaptation also had the lowest preparedness scores and greatest health services use. The congruence between caregiving effectiveness outcomes and nurses' overall adaptation ratings supported criterion-related validity. The research team agreed the model was ready for empirical testing as a midrange theory based on confirmation from the critical reflection criteria.[9]

EMPIRICAL TESTING OF THE MODEL

The relationships among all outcomes and model concepts were tested in three studies of families with patients at home on lifelong mechanical ventilation, total parenteral nutrition, or inotropic infusions for congestive heart failure published in detail in *Advances in Nursing Science*[1,34] and elsewhere.[2,4,35] All studies used a descriptive correlational design, and quantitative and qualitative methodologies approved by Institutional Review Boards. Model testing studies included prediction procedures and analyses from prospective longitudinal data, and smaller studies used economic analysis

techniques to test model propositions in cross-sectional samples.[30,36,37] Sample sizes in all model testing studies achieved acceptable power (≥.80) for the statistical techniques used. All statistical model testing used hierarchical multiple regression analyses, with caregiving context and then adaptive context concept measures (variables) entered per model specification by forward inclusion onto each outcome measure as the dependent variables.[38,39] According to Becker,[40] multivariate regression procedures can detect the posited additive effects across concepts. Criteria were established a priori for colinearity and residual analyses.[41]

Study 1: Validation of model concepts and relationships

The purpose of the study was to validate original model concepts and relationships using a randomly drawn national sample of caregivers of adult patients dependent on daily, 8- to 12-hour infusions of parenteral nutrition using electronic pumps for treatment of nonmalignant bowel disease.[1] Multiple regression results indicated model concepts sufficiently explained variance in each outcome. Specifically, variance in caregivers' and patients' quality-of-life scores, patients' physical condition scores, and technological side effects (measured as infusion catheter infections) were explained by model concepts (Table 2).

Results of this original testing of the model supported the hypothesized relationships among concepts (arrows in Fig 1) but identified four measures that explained less than 5% of the variance in outcomes or did not meet the 0.05 level of significance.[38,39] These four, all in the adaptive context, were eliminated. The retained measures explained significant amounts of variance in outcomes; thus they were judged sufficient to capture adaptive context concepts. A trimmed regression model resulted from eliminating the four nonsignificant measures. This was more parsimonious yet captured concepts with measures most significant of technology home caregiving.

Study 2: Validation of revised caregiving effectiveness

The model was tested in a second study with another parenteral nutrition sample.[2] In

Table 2. Results of regression analyses (adjusted R^2) for the caregiving effectiveness outcomes from patients receiving home parenteral nutrition and from patients with congestive heart failure (CHF) receiving constant infusion and monitoring

Caregiving effectiveness dependent variables outcomes	Original model testing adjusted R^2, $p < .05$	Revised model testing adjusted R^2, $p < .05$	CHF sample model* testing adjusted R^2, $p < .05$
Caregiver quality of life	.33	.44	.49
Patient quality of life	.42	.32	.30
Patient physical condition	.17	.24	
Technological side effects	.27	.26	

*Testing by Scott[34] did not include data on physical condition or technological side effects.

this second study, the model concepts also explained significant amounts of variance in all outcomes. Overall, results of the original and revised model testing accounted for similar amounts of variance in the outcomes (Table 2). In each testing of the model, concepts in the two explanatory home care context columns were found statistically and significantly related to the caregiving effectiveness outcomes, as indicated by the figure bracket. In terms of the model configuration, the significant effects in both studies were in the expected direction and conformed to the model proposition statements relating the caregiving and adaptive context concepts to caregiving effectiveness outcomes. Even the smallest amount of variance explained (.17 for patient's physical condition measure) represents a clinically significant improvement.

Further evidence for model validity came from being able to predict long-term patient and caregiver quality-of-life outcomes from model concepts in both parenteral nutrition studies. Toward this end, beta weights from regression analyses performed with baseline measures were used to generate predicted outcome scores for each subject.[30] These predicted scores then were correlated with subjects' actual outcome scores collected 18 months after baseline in each study. There were moderately strong associations (Pearson product-moment, ranging from .49 to .78) between the predicted scores and actual quality-of-life scores for both caregivers and patients (Table 3) in both studies. There was a moderate correlation between predicted and actual patient condition scores, and the frequency of the technology side effect (hospitalization for infection) was accurately predicted in the revised model testing (Table 3). Data collection over 18 months in these prospective longitudinal studies provided ample testing for strength of association. Thus, in two different parenteral nutrition samples, measures of model concepts explained significant amounts of variance in quality of life at

Table 3. Correlation of predicted caregiving effectiveness outcomes scores with actual longitudinal score in original model and revised model testings

Caregiving effectiveness outcomes	Correlation* between predicted and actual scores
Caregiver quality of life	Original: $r = .49$, $p = .001$ Revised: $r = .78$, $p = .02$
Patient quality of life	Original: $r = .53$, $p = .001$ Revised: $r = .66$, $p = .008$
Patient condition	Original: Not collected longitudinally in original model testing Revised: $r = .40$, $p = .035$
Technological side effects	Original: Not collected longitudinally in original model testing Revised: Predictive for frequency of hospitalization for infection ($p \leq .05$)

*Pearson product-moment correlations.

baseline and were moderately correlated with longitudinal quality-of-life scores. It was concluded that model concepts were associated with and predictive of patient and caregiver quality-of-life outcomes over time.

Study 3: Validation of outcomes and generalizability

The third study validated model concepts and generalizability. Scott[35] studied a sample of caregivers of patients requiring constant infusion of inotropic medication at home due to congestive heart failure. Scott employed principal components analysis and conceptual congruence to combine model measures to enhance statistical power and conducted multiple regression analyses on quality-of-life outcomes. These procedures are detailed in a recent *Advances in Nursing Science* article.[34] Significant amounts of variance in these patient and caregiver quality-of-life outcomes were explained by model concepts. Table 2 displays results from all studies and illustrates similar amounts of variance explained in patients' and caregivers' health-related quality-of-life outcomes. Notably, Scott's triangulated interview data confirmed that concepts were components of this technology-dependent caregiving population's lived experience.[35] Scott's data also identified a theme of powerlessness that was reflected in daily caregiving experiences. The theme of economic powerlessness related to costs of health services and home caregiving activities also was identified by caregivers of technology-dependent patients.

FURTHER RESPECIFICATION

A new model concept emerged from family concerns about costs and the need for strategies to help conserve caregiving resources found repeatedly in interview data from the first two model-testing studies with home parenteral nutrition families. Respecification of the model to reflect these concerns was deemed germane to technology caregiving in relation to the prospective payment environment. Thus a respecified model evolved from adding economic concepts of health care services costs and efficient use of family caregiving resources in response to evidence from all three studies. Also, the concept of patient education was expanded to the concept of home care management strategies, which included teaching and other health professional interventions, such as problem solving and resource management to decrease economic powerlessness (Fig 2). Ellipses in the respecified model enclose interventions generated from the model that were later tested. In the right-hand column of Fig 2, the Caregiving Effectiveness Outcomes still include patient (health status) condition, technological side effects, and patient and caregiver quality of life, with the addition of the economic concept of efficiency. The outcome efficient use of resources, defined as the greatest outcome from the least resource use, was tested using Data Envelopment Analysis (DEA).[30] DEA is a management science and an econometric technique that generates nonparametric coefficient of efficiency ratios from resource use and selected outcomes.[30] DEA advances traditional cost/efficiency analyses in that multiple quality-of-care indicators and well-known cost measures can be examined simultaneously, resulting in a coefficient of efficiency in which families' resources (inputs such as caregiving time, out-of-pocket expenses, and psychoemotional expenditures) and outcomes (outputs such as health benefits saved and quality-of-life perceptions) are analyzed.

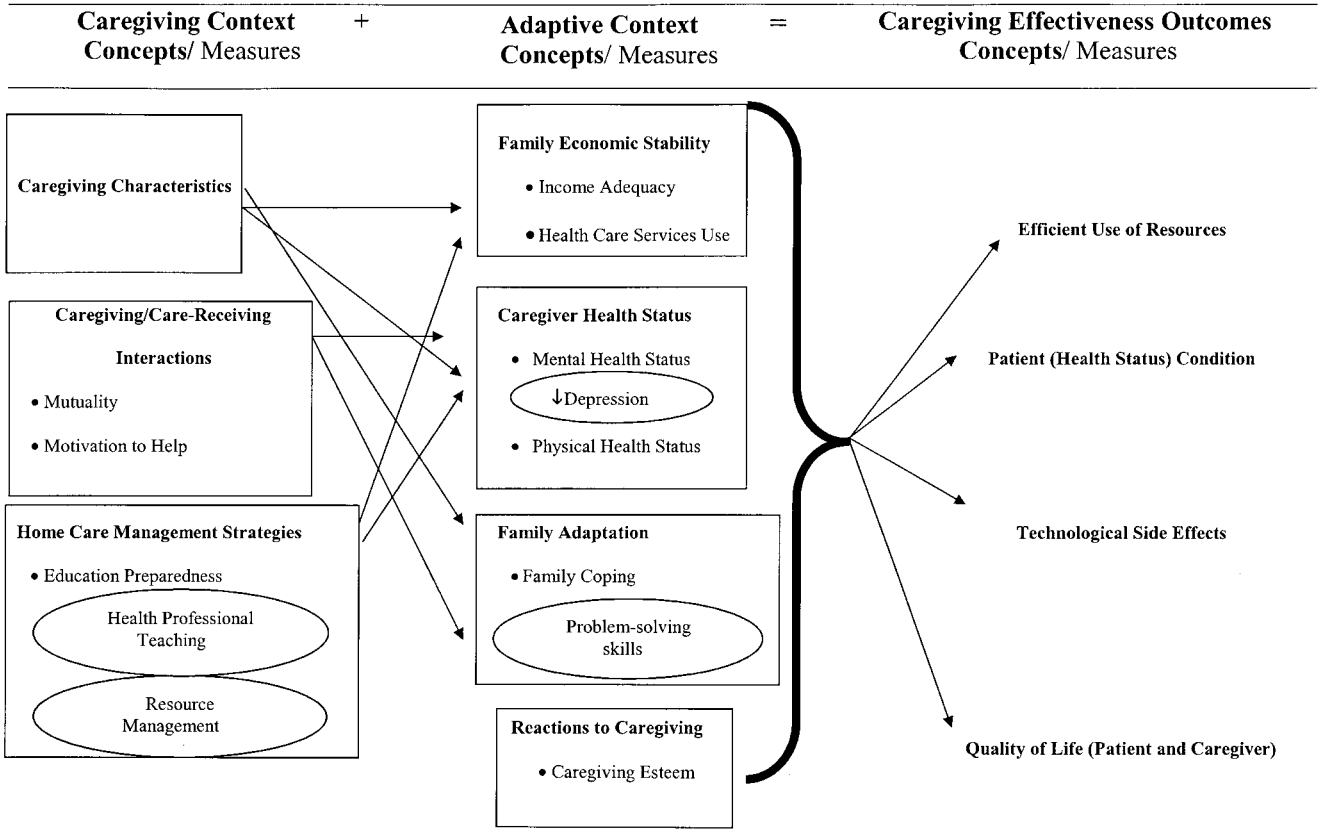

Fig 2. Concepts in the respecified Caregiving Effectiveness Model. Rectangles enclose concepts in the model; ellipses enclose recommended interventions derived from the model and found efficacious in clinical trial; and efficient use of resources is added as an outcome.

TESTING RESPECIFICATION PROPOSITIONS

The economic efficiency outcome was tested in two technology caregiving populations. Proposition statement testing indicated caregiving families with the largest coefficient of efficiency score, measured as the greatest outcome from the least resource use, had the most positive quality-of-life scores and had conserved both caregiving hours per day and health insurance resources.[36] In a longitudinal DEA analysis, the parenteral nutrition families having poor baseline efficiency coefficients used a greater number of emergency and urgent care services and had greater caregiver depression scores in the subsequent year.[37]

Further, efficiency analysis in a home ventilator caregiving population indicated that families with lower DEA efficiency scores had lower quality-of-life outcomes.[37] DEA economic analyses for both studies indicated that the model concepts of caregiving characteristics, preparedness, family economic stability, and adaptation were related to the outcome of efficient use of resources. DEA findings provided further evidence that model concepts were clinically relevant in this prospective payment climate. DEA testings provided replication of the specific economic model propositions and are an example of an incremental approach to model respecification and validity testing.[40,42,43]

Overall, statistical analyses were adequate to test the linear and additive concept explanation of outcomes. However, it is likely that family caregiving experiences also would fit a model where the concepts are interrelated through many feedback loops.[43,44] Sample size, though large in the original, randomly selected sample ($n = 111$), precluded use of structural equation model techniques; however, stability of model relationships is verified by replicated findings and the amount of explained variance across samples (multiple R^2 values).[38] The logic of the model propositions and clinical relevance of those relationships also suggested several nursing interventions could be designed to improve outcomes.[29,44,45]

MODEL-GENERATED NURSING INTERVENTIONS

In a separate review, nurse researchers found it plausible to use the empirically verified relational statements in the model to generate nursing interventions. For example, one proposition statement verified in the economic testing indicated that health services costs could decrease by improving caregivers' preparedness for technological home care problems and ability to manage resources. Consequently, problem-solving and resource-management interventions were developed and tested.[29] Similarly, model testing across all samples had confirmed the relationship between poor mental health status (depression) and low quality-of-life outcome. An intervention strategy, known to decrease depression, was deemed important for nurses to use with these care-

Nurse researchers found it plausible to use the empirically verified relational statements in the model to generate nursing interventions.

givers to improve quality-of-life outcomes. Thus, the model guided clinically relevant nursing practice.[44,46,47]

Further, clinical nurse specialists, expert in care of home parenteral nutrition (HPN) families, rated the model relevant in terms of suggesting interventions to improve outcomes. Specifically, the model directed development of home care management strategies to decrease septic infections, which are the most life-threatening and costly HPN technology side effect. Accordingly, a nursing intervention for preventing catheter-related infection was taught to caregivers.

These model-derived interventions (infection and depression prevention, as well as problem solving and resource management) were tested in a randomized clinical trial of caregivers of patients on HPN.[29] The treatment versus the control group exhibited a lower incidence of catheter-related infection and reactive depression, greater use of problem-solving strategies, and improved quality of life. In addition, Canadian data[48] reported that the caregiving model was successfully used to guide discharge to home from acute care settings of persons on home ventilators and HPN. Such results illustrate how middle-range practice models can generate studies of specific interventions with evidence indicating they promote positive clinical outcomes.[49]

IMPLICATIONS AND FUTURE RESEARCH

Conceptual models are abstract in nature and broad in scope, and they provide a global perspective of the phenomena of interest.[9] Midrange theories are less broad, have defined boundaries, and guide nursing care for particular populations of patients and make specific propositions about the outcomes of care.[9,47,49] Through iterative processes of critique and replication, model validation, and testing, the Caregiving Effectiveness Model evolved toward a midrange, practice-linked theory. The model was respecified to represent economic challenges of families providing complex care to patients in home settings. Nurses' clinical ratings of each family's overall caregiving effectiveness were used for criterion-related validation of outcomes. Consistent conceptual relationships in the model were confirmed through replicated study of recipients of care, measures of specific clinical outcomes, and study of target areas to assess for interventions. Boundaries of the model were not disease and treatment limited, but included family concepts and outcomes specific to caregiving of patients dependent on technology. As a midrange theory, this model offers nurses a structure for critical thinking, a perspective for assessing families, and suggests interventions relevant for delivering care likely to improve outcomes.[9]

Although efforts were made to consider all factors relevant to family caregiving effectiveness, the authors acknowledge the potential of inadvertently omitting concepts. Concepts related to family developmental stages and to stressors such as powerlessness deserve further examination for knowledge development. Although independent critiques of the model substantiated parsimony and logical structure of concept relationships, continuing independent scrutiny is appropriate.

The model needs to be tested in samples with varying ages and ethnic backgrounds and with families managing other types of technology. Studies with larger samples are

needed to delineate feedback loops among concepts for additional relationship testing. For example, middle-aged caregivers are faced with added stressors when concurrently responsible for children and aging parents. Testing in other groups of patients, such as those having short-term technology requirements, may yield further data on generalizability of the model. Potential populations include patients who manage their own complex care at home, such as home hemodialysis patients, and ambulatory surgery patients who are discharged within hours of their surgical procedures with multiple drains and technologies. It is conceivable that concepts in the model might relate to the rate of recovery of these patients.

SUMMARY

The Caregiving Effectiveness Model, initially grounded on the Roy adaptation model, evolved, through testing, into a midrange theory that directs interventions to improve caregiving and outcomes in families managing home technology care. A variety of validation processes was used in three prospective studies of technology-dependent populations. Redundant or nonsignificant measures of concepts were identified and omitted through repeated testing to improve theoretical parsimony. The revised model illustrates that home care effectiveness does not revolve solely around a disease process; rather, everyday home situations yield many factors beyond the disease, such as caregiver depression, that influence effectiveness outcomes. In conclusion, the Caregiving Effectiveness Model provides a holistic view of home caregiving in technology-dependent patients and families and promotes proactive interventions for maximizing wellness and quality of life.

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