Impact of Predictive Model–Directed End-of-Life Counseling for Medicare Beneficiaries

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*I*ndividuals nearing the end of life need support in navigating the choices available to help them maximize the quality of their remaining time. Research shows that the conventional medical system often fails to provide sufficient education and counseling on relevant topics such as palliative care.[1-3] Barriers to more widespread end-of-life support in primary and specialty care settings include limited time and resources, discomfort with the topic, and reluctance to give up hope of recovery.[1,4] Finding complementary means for this support could overcome these barriers and provide substantial value.

In the absence of documented care choices, life-sustaining measures are provided by default, often contrary to the patient's wishes.[5] These measures, such as artificial ventilation and feeding, are responsible for considerable economic strain, especially for the Medicare program, which uses more than a quarter of its funds for end-of-life care.[6-8] Compared with the costs for survivors in a given year, decedent costs are 6 times higher[9] and are increasing at a faster rate.[8] The value of expenditures for aggressive care at the end of life is questionable, because higher end-of-life costs are associated with poorer quality of life in its final stages[10] and more difficult bereavement adjustment for caregivers.[2] Alternatively, programs that deliver end-of-life support have been shown both to improve quality of life and reduce costs associated with unwanted care.[2,5,10]

Reducing end-of-life costs can be achieved not by denying care, but by facilitating informed, thoughtful, and documented decisions about the value of intensive therapy, often decreasing the demand for aggressive care and life-prolonging measures while increasing hospice enrollment and improving quality of life.[2] Advance directives have shown to improve the quality of remaining life and ease family member stress[2] while also reducing inpatient expenditures.[5] Despite these advantages, a study of Medicare decedents found that less than a third had documentation of advance directives,[5] although 70% of patients would opt against life-sustaining treatment in the case of incapacitation and poor prognosis.[1,11] Hospice care, similarly underutilized, is associated with better patient quality of life,[2] decreased likelihood of dying in a hospital,[7,12] and decreased Medicare expenditure.[13] Unfortunately, only 19% of Medicare decedents use hospice prior to their death,[9] and, among all hospice enrollees, 30.8% receive care for 7 days or less.[14]

Objectives: To validate a predictive model for identifying Medicare beneficiaries who need end-of-life care planning and to determine the impact on cost and hospice care of a telephonic counseling program utilizing this predictive model in 2 Medicare Health Support (MHS) pilots.

Study Design: Secondary analysis of data from 2 MHS pilot programs that used a randomized controlled design.

Methods: A predictive model was developed using intervention group data (N = 43,497) to identify individuals at greatest risk of death. Model output guided delivery of a telephonic intervention designed to support educated end-of-life decisions and improve end-of-life provisions. Control group participants received usual care. As a primary outcome, Medicare costs in the last 6 months of life were compared between intervention group decedents (n = 3112) and control group decedents (n = 1630). Hospice admission rates and duration of hospice care were compared as secondary measures.

Results: The predictive model was highly accurate, and more than 80% of intervention group decedents were contacted during the 12 months before death. Average Medicare costs were $1913 lower for intervention group decedents compared with control group decedents in the last 6 months of life (*P* = .05), for a total savings of $5.95 million. There were no significant changes in hospice admissions or mean duration of hospice care.

Conclusions: Telephonic end-of-life counseling provided as an ancillary Medicare service, guided by a predictive model, can reach a majority of individuals needing support and can reduce costs by facilitating voluntary election of less intensive care.

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Take-Away Points

Using a randomized controlled design, we found that telephonic end-of-life counseling guided by a predictive model successfully reached a majority of Medicare beneficiaries needing end-of-life support and had an impact on care delivery.

■ Predictive modeling and telephonic delivery allow for the effective widespread provision of end-of-life counseling outside of the physician's office.

■ Nurse-delivered counseling and education about provisions available to improve quality at the end of life can reduce costs in the last 6 months of life among Medicare beneficiaries.

■ Telephonic end-of-life counseling is a promising approach for improving quality and reducing costs in the Medicare program.

The Centers for Medicare & Medicaid Services (CMS) is charged with evaluating new approaches to improve the quality of care, increase satisfaction, and reduce cost in the Medicare program. One such evaluation, Medicare Health Support (MHS, formerly Voluntary Chronic Care Improvement Program),[15] focused on care management interventions delivered to high-cost Medicare fee-for-service (FFS) beneficiaries with chronic disease, specifically diabetes and/or heart failure, sources of disproportionate spending.[16,17]

As a focused intervention within the context of the chronic care management programs in 2 MHS pilot programs, we developed and delivered telephonic end-of-life counseling. Initial experience with the pilot population validated the prepilot projections of a high death rate[18] and the challenges inherent in timely identification of participants in need of end-of-life support. Because the MHS study design encouraged innovations in the applied solution, we developed and subsequently refined a predictive model to identify individuals in the MHS population who were most likely to be in their last year of life. The final validated predictive model proved to be both sensitive and specific, enabling us to prioritize MHS participants in greatest need of end-of-life support and counseling. Furthermore, a follow-up cost analysis found that decedents in the intervention group had significantly lower Medicare expenditures in their last 6 months of life compared with controls. This outcome demonstrated that an end-of-life intervention delivered as part of a coordinated-care program can reach and engage the appropriate patients successfully, and enact change.

STUDY DATA AND METHODS

Development of End-of-Life Predictive Model

A neural network predictive model was developed to identify individuals in the MHS intervention population at greatest risk of death. The development of the model was a staged process, allowing for refinements during the pilot. The model was built with SAS Enterprise Miner, version 4.3 (SAS Institute Inc, Cary, NC), using demographic data and 2 years of Medicare claims data from the MHS intervention cohort (N = 43,497). From the data were extracted 130 predictive modeling factors, classified into demographic, pharmaceutical, utilization, diagnosis, medical procedure, and financial groupings, then refined to the set of independent variables significantly associated with death in the following year. The model functions to predict which individuals are likely to die over the next 12 months based on an evaluation of these variables in data from the previous 12 months.

The first iteration of the end-of-life model was developed to predict likely decedents among beneficiaries who had an inpatient claim because hospitalizations are a correlate of mortality.[19] This preliminary model was implemented in conjunction with the initiation of the focused end-of-life intervention in June 2006. Further development of the model expanded the focus to the entire population, eliminating the hospitalization requirement. The optimized, population-based, end-of-life predictive model was deployed in November 2007 and was used through the remainder of the pilot programs (see the eAppendix at **www.ajmc.com**).

Model Validation

A cross-validation data sampling technique was used during model development that involved holding aside a dataset from the model training and calibration phases to test the model against novel data. This approach was used to identify multiple potential models for consideration, from which the final population-based predictive model was chosen based on performance data from the entire MHS intervention group (N = 43,497). Performance was evaluated through a comparison of model output generated from 12 months of data (predicted risk of death) with the actual decedents in the subsequent 12 months. Predictive power was quantified using receiver operating characteristic (ROC) C statistic and sensitivity analyses.

End-of-Life Intervention

Each beneficiary prioritized by the model was assigned a designated nurse trained in end-of-life counseling. Prioritization by the model was designed to augment identification of participants needing end-of-life support and did not supersede the clinical judgment of nurses during patient interactions. The intervention was delivered telephonically to the patient and/or the caregiver via outbound or inbound calls. Interactions included, but were not limited to, education and

counseling about advance directives; the choice of palliative versus aggressive care, and hospice enrollment; facilitation of interactions with physicians and hospice agencies and referrals to hospice when appropriate; and caregiver support. The intervention was a focused element of the chronic care management provided to MHS participants that addressed standards of care, appropriate healthcare utilization, and self-efficacy. Under all circumstances, patients were advised to remain adherent to their physician's care plan and recommended chronic care management. Issues with connectivity (eg, no answer, wrong phone number) prevented successful contact with all identified participants. Similarly, phone call duration and frequency were variable as a function of the participant's needs.

The primary measure of success for the intervention was the deliberate election of less aggressive care as evidenced by reduced medical spending in the last 6 months of life. Secondary measures of success were an increased rate of hospice enrollment and duration of hospice care prior to death.

Study Population

The study population was derived from participants in the pilot programs of 2 MHS organizations that were randomized by CMS into intervention and control groups; MHS study design and eligibility requirements are outlined in the eAppendix.[16] Briefly, MHS participants were Medicare FFS beneficiaries with diabetes and/or heart failure, and with Hierarchical Condition Category (HCC) scores ≥1.35. Participants were randomized based on heart failure diagnosis, HCC risk score category, and dual Medicare/Medicaid eligibility. The MHS pilot programs and evaluation met institutional review board exemption criteria for research and demonstration projects on public benefit and service programs [Protection of Human Subjects, 45 CFR §46.101(b)(5)]. The Secretary of Health and Human Services communicated to each targeted beneficiary that participation was voluntary and could be terminated at any time.[15]

With respect to the end-of life intervention, all CMS-defined intervention group participants were eligible and were prioritized for this intervention using the predictive model. Control group participants were not eligible for the intervention and were not entered into the predictive model. For this analysis, these CMS-defined intervention and control groups were subject to additional eligibility requirements. Individuals eligible for this analysis were those who died during the final year of their respective pilot programs (decedents), who were not enrolled in hospice at the start of the final year of the pilot, who were enrolled from the beginning of the pilot until death or entry into hospice, and who had 1 or more medical claims during the pilot. Based on these requirements, 3112 and 1630

individuals were subject to analysis in the intervention group and control group, respectively. This intention-to-treat analysis included data from all participants eligible for the analysis, irrespective of whether end-of-life interactions occurred.

Outcomes Analysis

The cost analysis included all medical claims incurred during the 6 months prior to death with the exception of those incurred after hospice enrollment. These costs were excluded because MHS eligibility ended at the point of hospice enrollment, and complete claims data were not available after this point.[16] Costs were calculated according to the CMS modified protocol[18] for financial performance evaluation of the MHS pilots and included both outlier adjustment and baseline adjustment to compensate for a divergence in Medicare costs between intervention and control groups that emerged from the time of randomization to the start of the pilot. Nonparametric statistical testing was used (Mann-Whitney-Wilcoxon test) to determine the significance of the adjusted costs because the financial data were not normally distributed. Statistical analyses were performed using SAS statistical analysis software version 9.1.3. Analysis of hospice care was based on the total number of hospice enrollments during the last 6 months of life and the average duration of hospice care among hospice enrollees. This study was a privately funded analysis of data from the MHS pilots, and all authors are employees of the funding institution.

RESULTS

Evaluation of the end-of-life predictive model was performed by comparing model output generated from a historical dataset (N = 43,497) with actual deaths using ROC analysis, a statistical method to assess model accuracy based on sensitivity and specificity. The first iteration of the model was 71% accurate (ROC C statistic = 0.712). This accuracy rate was improved upon in the final model, which was 90% accurate (ROC C statistic = 0.899). The sensitivity of the final model was further tested by determining the percentage of actual deaths in a 12-month time frame that were predicted by the model at defined predicted death score stratification levels (Table 1). For example, individuals with scores in the top 10% accounted for 51.8% of all deaths during this time frame.

As a final validation step, 12-month death rates were calculated by score stratification for all individuals in the dataset (Table 2). This analysis showed that the actual death rates were progressively higher for individuals in the top 30%, 20%, and 10% of predicted death scores.

The demographic, health, and disease profile of the intervention group was not significantly different from that of

■ Table 1. Sensitivity Analysis of End-of-Life Predictive Model

Score Stratification Level	Actual Deaths Captured by Chance, %	Actual Deaths Captured by Model, %	Capture Rate Relative to Chance
Top 10%	10.0	51.8	5.2 to 1
Top 20%	20.0	78.0	3.9 to 1
Top 30%	30.0	91.9	3.1 to 1

the control group for any of the included measures (**Table 3**). Telephonic intervention via 1 or more successful telephone contacts by a nurse was delivered to 80.3% of intervention group decedents during the 12 months prior to death.

During the study period, the intervention and control groups had similar rates of hospice admissions, but the intervention group trended toward a longer average duration in hospice, although this difference was not statistically significant. Adjusted costs in the last 6 months of life were significantly less on average for the intervention group compared with controls, with a difference of $1913 (4.5%; *P* = .05) (**Table 4**), for a total cost reduction of $5.95 million.

DISCUSSION

This study tested whether a program designed to extend the reach and impact of end-of-life education and counseling, delivered by nonphysicians as part of a chronic care management program, could reduce costs. Our analysis affirmed this hypothesis. The greatest barrier to third-party delivery of end-of-life counseling is the accurate and timely identification of individuals without relying on providers as intermediaries. We used predictive modeling to identify individuals for telephonic end-of-life education and counseling with trained nurses. Our analyses validated both the sensitivity and specificity of the predictive model, which was further verified by our success in reaching the vast majority of decedents in the year prior to their death.

Predictive prioritization of the intervention maximized impact by directing resources to those most likely to have short-term needs; however, in no instance did the results of

the predictive model replace the clinical judgment of the nurses. Allowing for individualized variations in program delivery meant that some identified individuals did not receive the intervention and that some individuals who were not identified by the model did receive counseling. To ensure a realistic assessment of the cost impact of the intervention, we used an intention-to-treat methodology, thereby including all intervention-group decedents irrespective of whether they received end-of-life support. Using this conservative methodology, we found significantly lower healthcare spending during the last 6 months of life in the intervention group compared with the control population. This finding is consistent with the intervention impacting care choices and supports previous reports that patients often prefer less intensive medical care at the end of life when provided with options.[1]

Although increasing hospice enrollment was an anticipated outcome of the intervention, we found no significant difference between the intervention and control groups. The absence of effect on hospice care likely reflects the educational versus prescriptive nature of the program. Improved care coordination with providers could result in greater hospice enrollment. Alternatively, this result may reflect the informed choices of participants or a barrier to hospice care that is outside of the control of participants and the scope of this program. Further study should focus on this aspect of the program.

Counseling has traditionally been a role of physicians or clinicians within the physician's office; however, a majority of decedents lack end-of-life provisions,[5,9] illustrating inadequate engagement in end-of-life planning with physicians and the absence of other means for providing this support.[1,7] This study shows that effective end-of-life interventions can be provided telephonically by nonphysicians and that this

■ Table 2. Death Rates by Score Stratification Using the End-of-Life Predictive Model

Score Stratification Level	No. of Individuals Captured	No. of Actual Deaths	Death Rate per 1000
Top 10%	4350	1448	332.9
Top 20%	8700	2181	250.7
Top 30%	13,050	2572	197.1
Bottom 70%	30,447	226	7.4
Overall	43,497	2798	64.3

complementary route of support can reach more of the appropriate patients, with greater overall impact than standard care as currently provided.

This study has certain limitations that need to be taken into account in evaluating the findings. First, because MHS participation was terminated at the time of hospice enrollment and complete data were not available for hospice claims, this analysis did not capture either the direct costs of hospice care or any healthcare costs that occurred subsequent to hospice entry. It is unlikely that the inclusion of these data would alter the conclusions of the study because there was no significant difference in hospice enrollment between the study group and the control group. Furthermore, previous studies of the cost impact of hospice and other home-based palliative care have demonstrated that these programs are associated with significant cost reductions at the end of life.[13,20] Second, an analysis of the specific sources of cost savings that could elucidate the types of care that were affected by the program was beyond the scope of this study. Future research should expand the financial analysis to include costs incurred after hospice enrollment and specific types of claims.

Our primary outcome, cost reduction, is only a single aspect of actual program success, for which quality is a fundamental element. Previous literature links lower end-of-life expenditure to a higher quality of death,[10] but data were not available for analysis of this measure. It is important that future studies investigate quality-of-life measures, because the opportunity to improve the quality and dignity of death for many Medicare beneficiaries has greater value than cost-saving potential.

Although it is logical that end-of-life counseling created an effect on healthcare spending similar to that previously reported,[10] we were unable to attribute the observed reduction in spending solely to the end-of-life intervention and not to other support available as part of the larger care-coordination MHS pilot. Instead, we conclude that the intervention had an impact within the context of the broader program.

Finally, the use of an intention-to-treat methodology in our analysis, in alignment with CMS methodology for pilot evaluation,[16] limited the conclusions that could be drawn. This methodology is unlikely to support overstated conclusions; however, this approach does not reveal the magnitude of impact among those decedents who actually received the intervention.

■ **Table 3.** Baseline Demographic, Health, and Disease Profile of the Intervention and Control Groups[a]

Characteristic	Intervention (n = 3112)	Control (n = 1630)
Sex		
Female	1486 (47.8)	793 (48.7)
Male	1626 (52.2)	837 (51.3)
Race		
Black	635 (20.4)	293 (18.0)
White	2437 (78.3)	1318 (80.9)
Other	40 (1.3)	19 (1.2)
Average age at pilot start, y	77.1	77.3
HCC score grouping		
Low	767 (24.6)	432 (26.5)
Medium	1100 (35.3)	532 (32.6)
High	1245 (40.0)	666 (40.9)
Mean HCC score	3.13	3.14
Diagnosis		
CHF	842 (27.1)	485 (29.8)
Diabetes	1319 (42.4)	649 (39.8)
Both CHF and diabetes	951 (30.6)	496 (30.4)
Dual eligibility at pilot start	555 (17.8)	286 (17.5)

CHF indicates congestive heart failure; HCC, Hierarchical Condition Category.
[a]Values are number (percentage) unless otherwise indicated.

■ **Table 4.** Comparison of Intervention Group With Control Group With Respect to Hospice Utilization and Costs in the Last 6 Months of Life

Variable	Control	Intervention
No. of decedents	1630	3112
Total hospice admissions	520	981
Mean duration in hospice, days	15.3	16.3
Cumulative adjusted cost	$68,909,121	$125,609,494
Mean adjusted cost	$42,276	$40,363[a]

[a]$P = .05$.

In conclusion, our results demonstrate that a patient-centered end-of-life program, delivered with the purpose of improving quality, successfully reduced costs. Because study participants were older and had a higher disease burden than average Medicare beneficiaries,[16] additional research to determine whether savings could be achieved in a population more representative of all Medicare beneficiaries is warranted. Because studies have shown end-of-life costs to be significantly higher in younger Medicare beneficiaries than older ones,[6,9] a targeted end-of-life intervention such as this one has the potential to generate similar, or even greater, cost reductions if expanded to the entire Medicare population that is primarily under the age of 75 years.[21]

Given the unsustainable growth of healthcare costs in the United States, it is understood that we must diminish demand for medical care by supporting better patient choices. A recent report by The Brookings Institution emphasized that helping patients make choices that will enable them to receive better care at a lower cost is fundamental for successful healthcare reform. The report named improved support for patient preferences with respect to palliative care as a key reform in this category.[22] The study presented here demonstrates that, indeed, supporting patient choices as they near the end of life does impact change that leads to reduced expenditure. Our findings are novel because they were achieved through a program that was ancillary to the services provided within the primary and specialty care setting by using a predictive model to identify patients in need of this support. These results emphasize that complementary modes of end-of-life decision support deserve close consideration by policymakers and leaders in the healthcare industry.

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