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Operational and Quality Outcomes of a Mobile Acute Care for the Elderly Service

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BACKGROUND: The traditional acute care for the elderly (ACE) unit has demonstrated improved functional outcomes without increased costs or changes in length of stay (LOS). It is, however, limited in scope to patients cared for on a fixed geographical unit.

OBJECTIVE: To compare operational and quality outcomes for patients cared for on a mobile ACE (MACE) service to those cared for on a unit-based ACE service and matched controls on other general medical services.

DESIGN: Retrospective cohort study with propensity-score matching.

SETTING: An urban academic medical center.

PATIENTS: A total of 8094 hospitalized adults >64 years old admitted to an ACE, MACE, and general medical services from July 2006 to June 2009.

INTERVENTION: An interdisciplinary MACE service composed of a geriatrician-hospitalist, fellow, nurse coordinator, and social worker.

MEASUREMENTS: LOS, total cost, 7- and 30-day readmission rates, and in-hospital mortality.

RESULTS: Mean LOS and total cost were significantly lower for patients in the MACE service compared with the ACE unit service (5.8 vs 7.9 days, $P < 0.001$, and \$10,315 vs \$13,187, $P = 0.002$) and compared with propensity-score matched controls during the second year of operation (5.6 vs 7.2 days, $P < 0.001$, and \$10,693 vs \$15,636, $P < 0.001$). In-hospital mortality and 7- and 30-day readmission rates were similar in all groups.

CONCLUSIONS: A mobile ACE service may result in reduced LOS and lower costs with no change in in-hospital mortality or 7- or 30-day readmission rates when compared with standard medical service and a traditional unit-based ACE service. *Journal of Hospital Medicine* 2011;6:358–363.

The traditional acute care for the elderly (ACE) unit has demonstrated improved functional outcomes without increased costs or changes in length of stay (LOS).[1–5] It is, however, limited in scope to only those patients cared for on a fixed geographical unit. This structural limitation is of increasing relevance in times of high hospital bed occupancy rates, as during such times, many appropriate older patients are admitted elsewhere. In our experience with a traditional ACE unit-based model, only 52% of our geriatrics practice patients were admitted to an ACE unit bed, while the remainder were admitted to various medical units throughout the hospital. We therefore abandoned our traditional unit-based ACE service in July 2007 in favor of a mobile ACE (MACE) service, bringing the interdisciplinary, patient-centered team approach to our hospitalized older adult patients admitted throughout the hospital.

The purpose of this study is to compare the operational and quality outcomes for patients cared for on the MACE service to those cared for on a unit-based ACE service and matched controls cared for on other general medical services. We hypothesized that the MACE service would be associated with lower lengths of stay, reduced costs, and decreased rehospitalization rates.

METHODS

The MACE team was composed of a geriatrician-hospitalist, geriatric medicine fellow, social worker, and nurse coordinator. The geriatric medicine attending on the MACE service was in the hospital providing patient care during regular working hours from Monday through Friday, while the weekends were covered by a rotating group of all geriatric medicine faculty. During the first and second years of MACE, there were 7 and 4 attendings, respectively; all fellowship-trained geriatricians. Three of the 4 geriatric medicine hospitalists during year 2 had been in practice between 1 and 3 years postfellowship and also had

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TABLE 1. Elements of the MACE Team Intervention

Team member(s)	Roles
Team (MD, fellow, NC,SW)	Scheduled daily meetings at 8 am (or 8 am and 2 pm if needed) to discuss each patient's care and discharge plan
NC	Introduces the team to the patient/caregiver upon admission
	Obtains prehospitalization information on cognitive and functional status
	Acts as a 'hospital coach' educating the patient/caregiver
	Completes PRIs necessary for discharge to other institutions
	Completes medication reconciliation prior to discharge
	Initiates post-discharge phone call and communicates with PCP via EMR
	Provides experiential one-to-one geriatric nursing education
SW	Arranges family meeting, when indicated, with the team early in the hospitalization
	Provides patient and family psychosocial support on an as needed basis
	Responsible for discharge planning
MD	Attending physician of record
	Communicates with PCP upon admission of the patient
	Assures discharge communiqué to PCP via EMR within 24 hours of discharge

Abbreviation: MACE, mobile acute care for the elderly unit; EMR: electronic medical record; NC: nurse coordinator; PCP: primary care physician; PRI: Patient Review Instrument; SW: social worker; MD, physician.

training in palliative medicine, although were not board-certified in the latter. The fourth hospitalist had been in practice for 5 years postfellowship. The interdisciplinary team met daily to discuss the care of all patients and used a transitional care model based on The Care Transitions Program[6] adapted to our institution, with a focus on reducing the risks of hazards of hospitalization. Care coordination with the outpatient practice, early family meetings, discharge planning, patient and caregiver education, and postdischarge follow-up phone calls were some of the key hallmarks of the service (Table 1).

We conducted a retrospective cohort study with propensity-score matching in an urban academic medical center. Study subjects comprised 5 distinct groups. First were community-dwelling older adults cared for at our outpatient geriatrics ambulatory practice who were discharged from our traditional ACE unit-based acute care service at the Mount Sinai Hospital from July 1, 2006 through June 30, 2007 (N = 450). Second and third were patients from the same practice discharged from our MACE service during the first 2 years of operation (N = 556 from July 1, 2007 through June 30, 2008, and N = 501 from July 1, 2008 through June 30, 2009). Fourth and fifth were control cohorts of hospitalized older adults discharged from other medical services at the Mount Sinai Hospital during these same 2 years (N = 4863 and N = 4777, respectively). The average daily census on all services was 10–12 patients.

Some patients on all 3 services are co-managed with house staff, who are responsible for writing physician orders. Control cohort patients were cared for by a mix of private attendings (approximately 75%) or hospitalists (25%), and in contradistinction to MACE patients, their typical care did not include daily interdisciplinary team rounds, a nurse coordinator, or geriatrics fellow. Social work and case management were unit- as opposed to team-based. Care on the ACE unit-based service differed from care for matched control patients by having daily interdisciplinary team rounds, a prepared environment, and nursing-led protocols for the patients on the ACE unit.

Because the ACE unit-based service admitted both patients who were and were not cared for in our ambulatory practice, while the MACE service admitted only patients cared for in the ambulatory practice, we deleted from the study sample the patients who did not have a visit to our outpatient practice before the index hospitalization. This allowed us to isolate the effect of the model of care itself as opposed to the effect of simply changing the patient base for admissions. We then merged the files with the hospital's administrative database and electronic billing system to obtain demographic and claims data.

Additional demographic data were obtained through chart review of the MACE patients during year 1. The chart review process was standardized using a data abstraction instrument and by determining inter-rater reliability of the individual data abstractors (comprised of author B.K. and 4 MACE team members).

Costs were assigned to individual admissions by the hospital's cost reporting system and include a combination of traceable costs (such as imaging, laboratory, and pharmacy) and applied costs (nursing; allocated based on geographic location in the hospital) to arrive at direct and total costs.

We made 3 distinct comparisons of operational and quality outcomes using the above 5 groups, first comparing patients cared for on our traditional ACE unit-based service to those cared for on the MACE service, and second and third comparing patients on the MACE service to propensity score-matched controls during the first and second year of operations. Specifically, we hypothesized that the MACE service would be associated with reduced LOS, costs, and readmission rates compared with the ACE unit-based service and the matched control groups. We used multivariate logistic regression to estimate the association of binary quality outcomes (mortality during the hospital stay, 7- and 30-day readmission rates) with the existence of MACE while adjusting for confounding variables which included patient demographic and clinical characteristics such as age, gender, race, total number of comorbidities (calculated by Elixhauser method that includes 30 categories of comorbid illnesses identified by secondary diagnosis codes and discharge diagnosis-related groups [DRGs]).[7] We considered the clustering effect due to the same attending physician into the model as well. While adjusting for the same covariates, we used generalized linear models with a gamma distribution and log link to estimate the association of continuous variables (costs and LOS) with the existence of MACE.

TABLE 2. Baseline Characteristics of Study Subjects

Demographics	ACE (N = 450)	Matched MACE year 1 (N = 545)	Matched controls year 1 (N = 4863)	Matched MACE year 2 (N = 494)	Matched controls year 2 (N = 4777)
Age ± SD	82.6 ± 8.4	83.2 ± 8.3	83.4 ± 8.8	83.6 ± 8.1	83.8 ± 8.5
Female, %	74.4%	75.9%	74.7%	76.7%	77.4%
Race, %					
White	35	37	36	43	42
Black	30	27	28	25	25
Hispanic	33	34	35	28	30
Asian	1	1	1	3	3
Marital status, %					
Married	20	20	21	23	23
Widowed	44	45	44	46	38
Single	25	22	27	21	28
Elixhauser comorbidity index mean (SD)	3.4 (1.8)	3.4 (1.6)	3.3 (1.7)	3.5 (1.7)	3.5 (1.7)
Hypertension, %	61	54	54	49	49
Heart Failure, %	25	27	28	26	27
Diabetes Mellitus, %	26	25	25	24	25
Atrial fibrillation, %	22	23	23	28	27
Chronic obstructive pulmonary disease, %	15	15	15	15	14

Abbreviation: ACE, acute care for the elderly unit; MACE, mobile ACE.

The same statistical methods were applied to the second and third comparisons between patients cared for on the MACE and the propensity score-matched cohorts for the first and second year of the MACE service. First, 2 control cohorts (N = 6148 and 5803 of our hospital discharges from July 1, 2007 to June 30, 2008, and July 1, 2008 to June 30, 2009, respectively, with age > 64 and with the identical DRG and All Patient Refined DRG (APR DRG) Severity of Illness (SOI) score as those of the MACE groups were obtained from our hospital's administrative database to reduce the selection bias. Then, 4863 patients within the first cohort (N = 6148) and 4777 patients within the second cohort (N = 5,803) with the closest propensity score were matched to 545 of 556 MACE patients and 494 of 501 MACE patients, respectively, in which the logit of their propensity score was within ±0.02 standard deviations of the logit of the MACE patient's score.

Propensity scores were determined by logistic regression on whether patients were admitted to the MACE. The covariates for the propensity model were the same as the previously stated adjusting variables. Usual care patients' data were weighted to account for the one-to-many propensity score-matching algorithm.

We similarly conducted a post hoc analysis of MACE compared with a subgroup control cohort of patients cared for by medicine hospitalists in year 1 (N = 1175) and year 2 (N = 1564), with age > 64 and with the identical DRG and APR DRG SOI as those of the MACE group. We then matched 1012 of the 1175 discharges with the closest propensity score to 389 of the 411 MACE discharges who were cared for by 1 of the 4 geriatric medicine hospitalists in year 1 and 1308 of the 1564 discharges to 471 of the 501 MACE discharges in year 2, in which the logit of their propensity score was within ±0.02 standard deviations of the logit of the MACE patient's score, using the same covariates described above.

All analyses were done using Stata software, version 9.2 (StataCorp LP, College Station, TX). This project was exempted by the Institutional Review Board at Mount Sinai School of Medicine, New York, New York.

RESULTS

Table 2 presents the characteristics of the study subjects in all 5 groups. Patients cared for on the ACE unit-based service and the MACE service in years 1 and 2 were very similar, with a mean age of 82.6, 83.2, and 83.6 years; 74.4%, 75.9%, and 76.7% were female; and mean Elixhauser comorbidity scores were 3.4, 3.3, and 3.5, respectively. Patients in the 2 matched control groups were likewise very similar to those in the matched MACE groups with regard to all demographic variables.

Chart review of the year 1 MACE discharges revealed that 70% spoke English as their primary language and 46% had cognitive impairment. Most lived at home alone (49%) or with family members (41%) while receiving some paid caregiver help (59%). The remaining 10% were admitted from either an assisted living facility (5%) or subacute rehabilitation (5%). Only 12% were wheelchair or bed-bound, while 21% ambulated without and 67% with an assistive device. Their functional status was limited, with 58% dependent for both ADLs and IADLs, 22% dependent for IADLs only, and 20% independent in both. They had relatively high prescription medication burdens,

TABLE 3. Adjusted Results Comparing MACE to ACE, and MACE to Propensity Score-Matched Controls, Years 1 and 2

	MACE to ACE			MACE to matched controls, year 1			MACE to matched controls, year 2		
	MACE (N = 556)	ACE (N = 450)	*P* value	MACE (N = 545)	Matched controls (N = 4863)	*P* value	MACE (N = 494)	Matched controls (N = 4777)	*P* value
LOS, days	5.8	7.9	<0.001	5.8	6.5	0.15	5.6	7.2	<0.001
Costs, $									
Total	10315	13187	0.002	10311	12764	<0.001	10693	15636	<0.001
Direct	4777	5871	0.016	4778	5620	0.03	4967	7048	<0.001
Nursing	2361	3210	<0.001	2356	2749	0.026	2143	3080	<0.001
Imaging	342	332	0.61	344	349	0.73	382	471	0.06
Laboratory	206	243	0.079	206	245	0.029	213	281	<0.001
Pharmacy	598	835	0.002	597	662	0.63	563	786	0.03
In-hospital mortality,%	3.3	3.9	0.66	2.9	2.6	0.3	5.3	3.6	0.053
7-day readmission,%	9.3	10.2	0.55	9.7	11.8	0.3	4.8	5.5	0.71
30-day readmission, %	23.6	25.9	0.5	23.8	24.3	0.65	21.1	20.9	0.62
90-day readmission, %	40.9	38.7	0.1	41.3	38.4	0.005	38.0	36.5	0.74

Abbreviation: ACE, acute care for the elderly unit; MACE, mobile ACE; LOS, length of stay.

TABLE 4. Adjusted Results Comparing MACE Patients and Propensity Score-Matched Controls Cared For By Hospitalists, Years 1 and 2

	MACE, year 1 (N = 389)	Matched controls, year 1 (N = 1012)	*P* Value	MACE, year 2 (N = 471)	Matched controls, year 2 (N = 1308)	*P* Value
LOS, days	6.0	6.0	0.34	5.7	6.9	0.001
Costs, $						
Total	10663	11599	0.049	10681	13493	<0.001
Direct	4952	4704	0.98	4956	5618	0.055
Nursing	2394	2454	0.19	2124	2744	<0.001
Imaging	349	322	0.63	387	390	0.82
Laboratory	213	199	0.49	212	225	0.47
Pharmacy	647	616	0.85	547	654	0.22
In-hospital mortality,%	2.9	2.3	0.77	2.6	3.4	0.005
7-Day readmission,%	8.1	6.4	0.17	3.9	4.1	0.97
30-Day readmission, %	22.0	17.1	0.013	20.9	20.8	0.75
90-Day readmission, %	40.2	32.4	0.013	39.1	38.7	0.86

Abbreviation: MACE, mobile acute care for the elderly unit; LOS, length of stay.

with 10% taking 0–5, 34% taking 6–10, 38% taking 11–15, and 18% taking >15 medications.

Patients cared for by the MACE service had an adjusted 2.1 days shorter LOS ($P < 0.001$) when compared with patients cared for on the ACE unit service. Additionally, there was a net savings of $2872 in total costs per hospitalization ($P = 0.002$), $1094 in direct costs ($P = 0.016$), $849 in nursing costs ($P < 0.001$), and $237 in pharmacy costs ($P = 0.002$). Imaging and laboratory costs between the 2 groups were not statistically different. There was no significant differences in in-hospital mortality, 7-day, 30-day, or 90-day readmission rates between the 2 groups (Table 3).

There was no difference in LOS between the MACE patients during the first year of service compared with propensity score-matched control patients (5.8 vs 6.5 days). There was, however, a net savings of $2453 in total costs per hospitalization ($P < 0.001$), $842 ($P = 0.03$) in direct costs, $393 in nursing costs ($P = 0.026$), and $39 in laboratory costs ($P = 0.029$). Imaging and pharmacy costs between the 2 groups were not statistically different. There was no significant differences in in-hospital mortality, 7-day or 30-day readmission rates between the 2 groups. However, the 90-day readmission rate was higher in MACE patients (Table 3).

During the second year of the MACE service, however, there was a significant reduction in LOS of 1.6 days ($P < 0.001$), a net savings of $4943 in total costs per hospitalization ($P < 0.001$), $2081 ($P < 0.001$) in direct costs, $937 in nursing costs ($P < 0.001$), $68 in laboratory costs ($P < 0.001$), and $223 in pharmacy costs ($P = 0.03$). There were no significant differences in imaging costs, in-hospital mortality, and 7-day, 30-day, or 90-day readmission rates between the 2 groups (Table 3).

A subgroup analysis of the first and second year comparisons including only those patients in the control groups cared for by medicine hospitalists demonstrated reductions in the MACE in total cost in year 1 and LOS, mortality, total, and nursing costs in year 2. However, in year 1, the 30-day and 90-day

readmission rates were increased in the MACE compared with the control group (Table 4).

We found no differences in a separate post hoc subgroup analysis assessing whether a 3-month nurse coordinator's leave of absence during year 1 affected year 1 results. The service size was unaffected by her absence, and all patients continued to receive daily visits by the attending and fellow. During this time, other team members took over many of the nurse coordinator roles, except for the postdischarge phone calls.

DISCUSSION

Older adults constitute a disproportionate share of hospital admissions and hospital days. They typically have multiple comorbid conditions, higher rates of cognitive impairment and functional dependence, and complex social situations that all increase their risk of adverse outcomes. Current efforts for national healthcare reform focus on the combined economic and quality imperatives to improve the care of hospitalized older adults. Given the increasing representation of this fastest growing segment of the population in the acute care setting, the geographical unit-based model for care delivery is untenable in many circumstances. Therefore, we developed a mobile ACE service in an effort to provide the geriatric-focused acute care found on ACE units to older adults admitted to any medical unit in the hospital.

Our study compared operational and quality outcomes for older patients cared for by our mobile ACE service to those cared for on the unit-based ACE service and other general medical services. We found a significant reduction in both LOS and costs in all 3 comparisons, except for LOS during the first year of the mobile ACE service. This heightened efficiency was not associated with changes in the quality measures of in-hospital mortality and 7- and 30-day readmission rates, though the 90-day readmission rate was slightly higher for the MACE in year 1.

The adjusted total cost savings per admission in years 1 and 2 of approximately \$2400 (\$12,764 vs \$10,311) and \$4900 (\$15,636 vs \$10,693), respectively, translate into an overall annual savings of roughly \$1,200,000 (500 patients $\times$ \$2400/patient) in year 1 and \$2,450,000 (500 patients $\times$ \$4,900/patient) in year 2. The only relevant cost of the MACE service model compared with the comparison groups is the nurse coordinator salary and benefits, which are paid for by the hospital (as job responsibilities include participation in nursing department quality improvement projects and nursing education) and would not meaningfully offset these savings. The team social worker is a re-allocation of existing hospital resources, whose salary line is likewise paid for by the hospital.

Our study has several important limitations. First, we lack data on readmissions to other hospitals. Our readmission rates are high compared with the national 19.6% 30-day Medicare readmission rate cited in a recent study, and we failed to show significant reductions in in-hospital mortality or 7- or 30-day readmission rates.[10] This lack of benefit may be related to control group patients, some of whom receive their community care outside of our institution, being more likely to be readmitted to other hospitals compared with our MACE patients, who were all receiving their ambulatory care in our associated faculty practice. In addition, the high readmission rate on the MACE service may be driven by a relatively small number of patients who are frequently admitted. For example, of the 363 unique MACE patients from year 2, 22 had 3 and 11 had 4 or 5 admissions. We are currently evaluating these 33 patients who accounted for 22% of the admissions to better understand the causes.

A second limitation of the study is selection bias. While patients were very well-matched through propensity scoring and had identical DRG and DRG-SOI levels (the latter having been demonstrated in a previous study's regression analysis to be the leading correlate of LOS and cost),[9] there may be unaccounted for differences between the patients cared for on the MACE and in the control group. A third limitation is the external validity of our study, which took place in a single large academic medical center in New York City. While the MACE model may very well be readily adaptable elsewhere, numerous studies have demonstrated wide variation in medical practice patterns and healthcare use which may influence the exportability of the model.[11,12] However, our LOS of 5.8 and 5.6 days in years 1 and 2 of the MACE service, respectively, are similar to national data of 5.6 days for hospitalized adults >74 years of age.[13]

Benefits in cost and LOS reductions may be, in part, due to the hospitalist nature of the model as hospital medicine literature has demonstrated similar reductions for Medicare patients of approximately \$1000 and 0.5 days per admission.[8,9] Our findings support this hypothesis as the LOS reduction was not present during the first year of our MACE service during which the hospitalist model was not fully implemented. During this transition phase from the unit-based ACE to the mobile ACE service, there were 4 physicians who covered more than 75% of on-service time (10 of the 13 annual 4-week rotations), while the remaining 25% was covered by 3 physicians (each working 1 block). The following year (July 2008 to June 2009), during which an LOS reduction was demonstrated, a full geriatric medicine hospitalist model was in effect, with patients on the MACE service cared for 100% of the time (excluding weekends) by 1 of 4 geriatric medicine hospitalists. By comparison, 22% and 29% of control group patients were cared for by medicine hospitalists during years 1 and 2, respectively. In addition to this transition to a hospitalist model, there may have been other undefined

service improvements over the first year which contributed to the LOS and total cost reductions achieved in year 2 in the hospitalist subgroup analysis. Likewise, the increased 90-day readmission rates seen in year 1 but not in year 2 in both the main and hospitalist subgroup analyses may be related to MACE service improvements over time. A more vigorous proactive intervention beyond the follow-up phone call is likely needed to impact 90-day readmissions.

LOS reductions may also have been related to the interdisciplinary team-based approach in which a need for family meetings to address goals of care or assess and attempt to resolve complex family/living situations was identified early in the course of hospitalization. Likewise, in New York State, the application process for discharge to a postacute care setting begins with the completion of a Patient Review Instrument (PRI), which contains detailed information on the patient's physical, medical, and cognitive status. The MACE model circumvents the traditional case manager's role of completing the PRI by having the MACE nurse coordinator trained and certified to do so. The daily or twice daily MACE team meeting may have enabled more timely initiation of this early step in the discharge process for these patients, ultimately resulting in a reduced LOS.

An important concern this study is not able to address is whether LOS reductions are achieved at a price of impaired functional status. A prospective longitudinal study on the outcomes of patients cared for by a MACE service that includes detailed assessments of functional status based upon information gathered during admission and postdischarge during follow-up phone calls is needed to properly evaluate this possibility.

Given the lack of wide-spread adoption of the traditional ACE unit-based model of care and its inherent limitations in the setting of high occupancy rates, a mobile ACE service may prove useful in providing high quality clinical care with reduced LOS and costs. This team-based, as opposed to unit-based, approach benefits from having low entry costs, as hospital administration can re-allocate existing resources to fit the model and avoid costly capital investments in specialized unit design and outfitting. Further research should include metrics on functional status, all-hospital readmission rates, and patient/caregiver satisfaction to better assess the feasibility of this acute care model.

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