

Association Between Quality Improvement for Care Transitions in Communities and Rehospitalizations Among Medicare Beneficiaries

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MANY MEDICARE BENEFICIARIES have serious illnesses and disabilities and receive services from multiple clinicians and health care settings, engendering risks of errors in transitions¹⁻³ and rehospitalizations.⁴ Models for improving care transition quality have reduced short-term rehospitalizations.⁵⁻¹¹

The Centers for Medicare & Medicaid Services (CMS) piloted various strategies for improving care and reducing costs in 2006-2007, including one that tested having Quality Improvement Organizations (QIOs) lead improvements in care transitions. Medicare's QIOs serve each state and territory, aiming to improve the value of services.¹² Some hospitals reduced rehospitalizations substantially and quickly, leading to CMS in 2008 initiating the project reported herein.

In this project, we evaluated whether QIO-facilitated community-wide quality improvement (QI) could engage a variety of clinical and social service practitioners and organizations to improve care transitions for geographi-

Importance Medicare beneficiaries experience errors during transitions among care settings, yielding harms that include unnecessary rehospitalizations.

Objective To evaluate whether implementation of improved care transitions for patients with Medicare fee-for-service (FFS) insurance is associated with reduced rehospitalizations and hospitalizations in geographic communities.

Design, Setting, and Participants Quality improvement initiative for care transitions by health care and social services personnel and Medicare Quality Improvement Organization staff in defined geographic areas, with monitoring by community-specific and aggregate control charts and evaluation with pre-post comparison of performance differences for 14 intervention communities and 50 comparison communities from before (2006-2008) and during (2009-2010) implementation. Intervention communities had between 22 070 and 90 843 Medicare FFS beneficiaries.

Intervention Quality Improvement Organizations facilitated community-wide quality improvement activities to implement evidence-based improvements in care transitions by community organizing, technical assistance, and monitoring of participation, implementation, effectiveness, and adverse effects.

Main Outcome Measures The primary outcome measure was all-cause 30-day rehospitalizations per 1000 Medicare FFS beneficiaries; secondary outcome measures were all-cause hospitalizations per 1000 Medicare FFS beneficiaries and all-cause 30-day rehospitalizations as a percentage of hospital discharges.

Results The mean rate of 30-day all-cause rehospitalizations per 1000 beneficiaries per quarter was 15.21 in 2006-2008 and 14.34 in 2009-2010 in the 14 intervention communities and was 15.03 in 2006-2008 and 14.72 in 2009-2010 in the 50 comparison communities, with the pre-post between-group difference showing larger reductions in rehospitalizations in intervention communities (by 0.56/1000 per quarter; 95% CI, 0.05-1.07; $P=.03$). The mean rate of hospitalizations per 1000 beneficiaries per quarter was 82.27 in 2006-2008 and 77.54 in 2009-2010 in intervention communities and was 82.09 in 2006-2008 and 79.48 in 2009-2010 in comparison communities, with the pre-post between-group difference showing larger reductions in hospitalizations in intervention communities (by 2.12/1000 per quarter; 95% CI, 0.47-3.77; $P=.01$). Mean community-wide rates of rehospitalizations as a percentage of hospital discharges in the intervention communities were 18.97% in 2006-2008 and 18.91% in 2009-2010 and were 18.76% in 2006-2008 and 18.91% in 2009-2010 in the comparison communities, with no significant difference in the pre-post between-group differences (0.22%; 95% CI, -0.08% to 0.51%; $P=.14$). Process control charts signaled onset of improvement coincident with initiating intervention.

Conclusions and Relevance Among Medicare beneficiaries in intervention communities, compared with those in uninvolved communities, all-cause 30-day rehospitalization and all-cause hospitalization declined. However, there was no change in the rate of all-cause 30-day rehospitalizations as a percentage of hospital discharges.

JAMA. 2013;309(4):381-391

www.jama.com

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cally defined community populations of Medicare beneficiaries and whether this work would correlate with reduced rehospitalizations.

METHODS

The CMS designed this QI project to achieve whole-system enhancement within dynamic settings.^{13,14} The QIOs and their partners (hospitals, nursing facilities, home care agencies, hospices, social service agencies, Area Agencies on Aging, and clinicians) were expected to implement evidence-based improvements, track progress, and modify approaches as needed, learning from experience throughout the project, with rehospitalizations serving as the overall monitor of success. Supplementary details concerning definitions, methods, technical assistance, and implementation are given in the eAppendix (available at <http://www.jama.com>).

This project was a quality improvement activity, monitored closely by the clinically responsible professionals, and abiding by HIPAA, HITECH, and other constraints to protect patient privacy. The CMS determined that, as a quality improvement project in ordinary operations, this initiative was not classified as research on human subjects and therefore the CMS did not seek review by an institutional review board.

Selection of QIOs and Intervention Communities

Quality Improvement Organizations competed for contracts to improve care transitions and thereby to reduce rehospitalizations for fee-for-service (FFS) Medicare beneficiaries in a specific community. Each QIO designated a geographic community with enough discharges for power (80% likelihood) to detect a 2% reduction in the percentage of hospitalized patients readmitted within 30 days, a change the CMS thought would merit replication and that ensured sizable intervention communities. The CMS selected 14 intervention sites based on application quality and the community's contribution

to geographic, market, and utilization diversity. The project defined intervention community populations as Medicare FFS beneficiaries residing in specific contiguous zip codes (eAppendix).

Community Quality Improvement Implementation Strategy

Projects started in August 2008 with QIOs examining claims data and recruiting area medical and social service providers into the work. The QIOs supported improvements led by providers (eg, hospitals, social service agencies) throughout the project by convening and facilitating community coalitions and workgroups and supplying QI expertise and tools without offering financial incentives. The QIOs used claims data, medical records reviews, and process assessments (eg, value stream mapping) to identify root causes of rehospitalizations locally, guided participants toward evidence-based best practices, and connected participants with intervention designers and other experts.

The QIOs and their partners tracked implementation progress and the effects of selected interventions using rapid cycle improvement techniques.^{13,15} The QIOs supplied and helped interpret community rehospitalization data, including process control charts. Teams modified or discontinued interventions that did not produce results consistent with improved care transitions. Tests of interventions, spread of proven interventions, and efforts to ensure sustainability continued through July 2011 and beyond. The QIO support contractor (QIOSC) provided technical assistance.

Interventions

An intervention was defined as an activity introduced into clinical care processes that was intended to improve the quality of care transitions. Care transitions were defined as a change in care setting, as determined from Part A claims data, except for same-day transfers from one prospective payment hospital to another.

In each intervention community, at least 1 hospital (most often in a developing coalition with other hospitals, nursing homes, home health agencies, and the Area Agency on Aging) began implementing interventions by January 2009. Community participants selected interventions depending on existing priorities, shared interpretations of the causes of rehospitalizations, and the mix of health care practitioners and organizations actively engaged. The CMS required the QIOs to promote evidence-based approaches¹⁶; however, QIOs had substantial flexibility as to which interventions to support and what adaptations to allow.

Comparison Community Selection

To monitor secular trend, the QIOSC identified an ordered set of candidate comparison communities similar to intervention communities in population, poverty proportion,¹⁷ and hospital care intensity¹⁸ of their largest hospitals without matching on rehospitalization rates. We sought at least 1 in-state and 1 out-of-state comparison without using communities contiguous with intervention communities and those with known initiatives to reduce rehospitalization (eAppendix). Each QIO participated in the final selections to avoid communities facing major changes in population or health care arrangements and to select similar but more distant sites. The 50 comparison communities include 31 that were best matched by the QIOSC's criteria, 13 from lower in the QIOSC list, and 6 from outside the QIOSC list (eAppendix). The comparison communities did not know about their role. The comparison community populations were defined as the Medicare FFS beneficiaries residing in the zip codes comprising the community's main hospital service area(s).¹⁹

Outcome Measures

The main outcome measure was rehospitalization, defined as a hospitalization for any cause within 30 days of dis-

charge from another Medicare-covered short-stay prospective-payment hospitalization. Every hospitalization, including hospitalizations that were rehospitalizations within 30 days, reinitiated the 30-day time period for counting rehospitalization. Hospitalizations were defined as a Medicare FFS beneficiary in the community's population admitted for any cause to any short-stay prospective-payment hospital, as calculated from Part A payment claims. This definition excluded observation stays and emergency department visits.

The CMS planned this initiative in 2007 as a population-based improvement pilot, and the only metrics of rehospitalization then in use tabulated rehospitalizations within a variety of postdischarge periods as a percentage of hospital discharges or home health agency admissions. From the start, CMS project leaders were concerned that this metric might be insufficient for monitoring a change initiative in which the community was the unit of intervention and improvement for that geographically defined population was the goal. Evidence-based transitional care improvement models affect rehospitalizations beyond 30 days,^{6,20,21} and less standardized community interventions such as increased coordination, more effective community social services support, advance planning discussions, and use of palliative and hospice care could have similar effects.

Because a rate that captured improvement in both the numerator and denominator could obscure detection of change, the QIOSC contract included a requirement to assist the CMS in developing metrics for monitoring a community's rehospitalization rates. We established definitions and ranges for 2 population-based metrics: 30-day rehospitalizations per 1000 Medicare FFS beneficiaries living in the community and a parallel metric of hospitalizations per 1000 Medicare FFS beneficiaries living in the community (eAppendix). This initiative aimed to change population utilization over time rather

than holding a particular organization or practitioner accountable, so the metric did not require risk adjustment and counted all rehospitalizations, rather than excluding repeated hospitalizations for some patients or focusing on specific diagnoses, as in publicly reported measures.²²

During the course of this initiative, sites found reductions in rehospitalizations beyond 30 days coincident with reductions of rehospitalizations within 30 days, and some reported that interventions might be reducing the proclivity to hospitalize generally (eg, through enhanced hospice referral). In light of these developments, in February 2010 the main outcome measure for the initiative was changed to rehospitalizations per 1000 FFS beneficiaries. We did not recalculate power for the new metric. Secondary outcomes included communities' rates of hospitalization per 1000 FFS beneficiaries and of all-cause 30-day rehospitalizations as a percentage of hospital discharges. We calculated all 3 metrics from Medicare administrative claims (eAppendix).

Potential Adverse Effects

We monitored patient satisfaction with hospital medication management and discharge information using items from the Hospital Consumer Assessment of Healthcare Providers and Systems survey (HCAHPS) (eAppendix).²³ We also monitored mortality, emergency department visits, observation stays, and utilization of postdischarge settings (skilled nursing facilities, home health, hospice, and home without Medicare services) (eAppendix) using Medicare Part A claims.

Statistical Analyses

We assessed changes in the main outcome measure of rehospitalizations per 1000 beneficiaries and in the secondary outcome metrics of hospitalizations per 1000 beneficiaries and rehospitalizations per discharge with pre-post, intervention-comparison, and difference-of-differences analyses. We calculated the difference in rates for the

12 quarters of 2006-2008 and the 8 quarters of 2009-2010 for each intervention and comparison community. The rates relied on large numbers of beneficiaries and therefore were treated as numerical outcomes. We used paired *t* tests to estimate significance of changes within the intervention set of 14, the QIOSC's comparison set of 31, and the full comparison set of 50, comparing 2006-2008 against 2009-2010, to check for any potential bias introduced by QIOs selecting some of their comparison communities.

For the measures of rehospitalizations per 1000 and hospitalizations per 1000, where pre-post testing showed a potential reduction, we then formed a mixed model to account for correlation between each set composed of an intervention community and its comparison communities to assess difference of differences between the set of 14 intervention communities and the 50 comparison communities. For all 3 measures, we also compared the means of the intervention communities with the comparison communities using a *t* test with the Satterthwaite approximation for unequal variances.

Process Control Analyses. We used process control methods to detect and understand changes in system performance by analyzing variation in outcome indicators (eAppendix). We plotted seasonally adjusted quarterly rehospitalizations per 1000 and hospitalizations per 1000 for each community and then for the mean of intervention communities and for the mean of comparison communities. For each graph, we calculated upper and lower control limits based on 12 quarters from 2006-2008.

We used 2 conservative rules to detect a signal worth investigating and understanding: (1) any data point in 2009-2010 beyond the control limits and (2) 8 sequential points on one side of the 2006-2008 mean.^{24,25} Those signals are labeled *special-cause variation* in QI, a term that reflects their utility in directing attention to important changes in the pattern of variation rather than attributing causation.

Potential Adverse Events. We assessed potential adverse effects to patient satisfaction with pre-post comparisons using paired *t* tests. We calculated the difference in rates for July 2007 to December 2008 compared with January 2009 to June 2010 (based on data availability).

Mortality rates were calculated in 3 different ways (eAppendix). We report potential changes in community mortality rates with pre-post comparisons using paired *t* tests and difference of differences using a *t* test with the Satterthwaite approximation for unequal variances. We calculated the difference in rates for the 12 quarters of 2006-2008 compared with the 8 quarters of 2009-2010 for each intervention and comparison community.

We used the discharge status code as a proxy for postdischarge utilization. To

monitor for potential changes, we compared the discharge status code distribution for 2006-2008 with the distribution from January 2009 through June 2010.

For emergency department visits and observation stays per 1000 Medicare FFS beneficiaries, we assessed changes from 2007-2008 to 2009-2010. We did not include observation stays that converted to inpatient stays or emergency department visits that resulted in observation or inpatient stays.

All analyses were conducted using SAS software version 9.2 (SAS Institute Inc). Statistical significance was set at $P \leq .05$ by 2-tailed test.

RESULTS

Communities and Interventions

Characteristics of the intervention communities included Medicare FFS beneficiary populations ranging from 22 070

to 90 843; 6.8% to 29.5% of the dominant county population living below the poverty level¹⁷; from 0.53 to 1.83 on the Hospital Care Intensity Index, where the national score is 1.0.¹⁸ (TABLE 1). Characteristics of the comparison communities are given in the eAppendix.

The communities' main interventions (TABLE 2) included the Care Transitions Intervention, which coaches patients toward activation and self-care⁶; the Best Practices Intervention Package, which organizes an array of improvements in home health²⁶; INTERACT, which provides a tool kit to help manage worsening status of nursing home residents⁹; medication management improvements, which aim to define optimal medication regimens and assist patients to adhere to the medication plan¹¹; Project RED and other protocols, which enhance the

Table 1. Intervention Community Characteristics^a

Characteristics	Mean of 12 Quarters in 2006-2008 (Preintervention)													
	Tuscaloosa, AL	Denver, CO	Miami, FL	Atlanta, GA	Evansville, IN	Baton Rouge, LA	Lansing, MI	Omaha, NE	Camden, NJ	Albany, NY	Pittsburgh, PA	Providence, RI	Harlingen, TX	Whatcom County, WA
Poverty, % in dominant county ^{b,c}	16.5	6.8	18.9	8.2	16.4	16.4	12.7	10.8	8.35 ^d	8.95 ^d	9.4	14.4	29.5	13.0
Hospital Care Intensity Index in dominant county ^{c,e}	1.28	0.68	1.86	0.99	0.77	1.02	0.98	1.10	1.13 ^d	1.001 ^d	1.18	0.95	1.32	0.53
Zip code overlap, % ^f	81.9	53.0	54.2	55.6	61.4	83.8	75.8	69.7	46.2	68.9	62.1	72.4	85.9	81.4
Medicare Part A population, No. ^g	37 401	40 825	78 981	55 768	65 888	64 994	40 848	66 657	78 001	68 968	28 057	90 843	55 856	22 070
Targeted inpatient hospitals, No.	7	3	8	4	3	5	2	7	2	6	5	7	6	1
Targeted skilled nursing facilities, No.	13	25	32	12	16	4	5	27	12	28	20	58	16	9
Targeted home health agencies, No.	12	12	140	5	11	7	5	21	7	6	8	20	60	2
2009 Inpatient hospital live discharges	14 869	9386	27 376	13 922	19 838	19 210	12 660	20 472	24 108	19 501	11 059	25 358	17 892	4781

^aSpecific definitions of the sites are given by zip code in the eAppendix. Herein, sites are designated by the city or county that generally designates their locations.

^bPercentage of individuals living below poverty level.¹⁷

^cDominant county identified as the county represented by the majority of residents of the intervention community based on zip code-level population estimates (2000 US Census) and 2006 Medicare beneficiary claims.

^dMean of the top 2 dominant counties in the community.

^eAge/sex/race/illness standardized ratio of patient days and physician visits (Dartmouth Atlas of Healthcare).¹⁸

^fCalculated as (No. of Medicare Part A beneficiaries admitted to the intervention hospitals and living in the defined community)/(No. of Medicare Part A beneficiaries admitted to the intervention hospitals or living in the defined community).

^gIn December 2009.

Table 2. Interventions and Special-Cause Reduction Evidence on Process Control Charts^a

	AL	CO	FL	GA	IN	LA	MI	NE	NJ	NY	PA	RI	TX	WA
Evidence-based interventions implemented														
Care Transitions Intervention ⁶	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓
BPIP ²⁶			✓	✓			✓		✓		✓	✓	✓	✓
INTERACT ⁹			✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
Medication management/reconciliation ¹¹	✓				✓			✓	✓		✓	✓	✓	✓
Discharge standardization/Project RED ⁸	✓			✓			✓	✓			✓	✓	✓	✓
Transitional care nursing model ⁷									✓	✓				
Control chart shows special-cause reduction consistent with intervention timing														
Hospitalizations per 1000	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
30-Day rehospitalizations per 1000	✓	✓		✓		✓		✓		✓	✓	✓	✓	✓

Abbreviations: BPIP, Best Practices Intervention Package; INTERACT, Interventions to Reduce Acute Care Transfers; RED, Re-engineered Discharge.
^aSpecific definitions of the sites are given by zip code in the eAppendix.

standardization and performance of hospital discharge processes⁸; and the Transitional Care Nursing Model, which provides a skilled nurse to counsel patients and families through transitions and at home.^{7,20} The CMS paid between \$11.7 million and \$13.3 million annually for 3 years to support the QIOs' work in this initiative. A summary of insights from the implementation of interventions is provided in the eAppendix.

Outcomes

TABLE 3 provides primary and secondary outcome data by community. The communities varied substantially at baseline, with rehospitalizations per 1000 beneficiaries ranging from 8.4 to 21.8 and rehospitalizations as a percentage of discharges ranging from 14.6% to 21.9%. Table 2 indicates by community whether process control charts showed a variation qualifying as a special-cause improvement that was consistent with the timing of the intervention.

Rehospitalizations Per 1000 Beneficiaries. The mean rate of rehospitalization per 1000 beneficiaries in the 14 intervention communities was 15.21/1000 per quarter in 2006-2008 and 14.34/1000 in 2009-2010, a decrease of 0.87/1000 (95% CI, 0.47-1.27 per 1000; $P < .001$ by paired

t test). The mean rehospitalization rate in the 50 comparison communities was 15.03/1000 per quarter in 2006-2008 and 14.72/1000 in 2009-2010, a nonsignificant decrease of 0.31/1000 (95% CI, -0.03 to 0.65 per 1000; $P = .08$).

For the difference of differences, the Satterthwaite-estimated community variance components of the mixed model were zero and negative for intervention and comparison communities, respectively, showing that the cluster assignments did not add information. Eliminating these, the original test of differences in the mixed model reduces to an unequal-variance *t* test. The intervention communities' pre-post difference was 0.56/1000 higher than the comparison communities' pre-post difference (95% CI, 0.05-1.07 per 1000; $P = .03$).

The difference of differences in rehospitalizations per 1000 between the 14 intervention communities and the truncated group of 31 best-matched comparisons was similar: the intervention communities' pre-post difference was 0.56/1000 higher than the comparison communities' pre-post difference (95% CI, -0.02 to 1.14 per 1000; $P = .06$), but the difference was not significant.

FIGURE 1 shows rehospitalizations per quarter from 2006 to 2010 for the

means of the 14 intervention communities and of the 50 comparison communities. Both the intervention and the comparison communities show a predictable pattern through the first 12 quarters, followed by reductions inconsistent with the prior pattern, with larger reductions in the intervention communities.

Process control charts (Table 2 and eFigure 1 through eFigure 14) show 10 intervention communities (71%) with important special-cause rehospitalization reductions consistent with the intervention timing, 2 (14%) with special-cause increases, and 2 (14%) that remained stable. The 50 comparison communities' control charts (available at <http://www.cfmc.org/integratingcare/ninthSOWcontrolcharts>) showed 22 (44%) with special-cause reductions in rehospitalization, 13 (26%) with increases, 14 (28%) remaining stable, and 1 with an early increase and later reduction.

Secondary Outcome Measures. Hospitalizations Per 1000 Beneficiaries. The mean rate of hospitalization per 1000 beneficiaries in the 14 intervention communities was 82.27/1000 per quarter in 2006-2008 and 77.54/1000 in 2009-2010, a difference of 4.73/1000 (95% CI, 3.40-6.05 per 1000; $P < .001$). The mean quarterly hospitalization rate in the 50 comparison communities was

82.09/1000 in 2006-2008 and 79.48/1000 in 2009-2010, a difference of 2.61/1000 (95% CI, 1.53-3.68 per 1000; $P < .001$).

For the difference of differences, the estimates of the variance components from the mixed model for intervention and comparison communities were again zero and negative. As with rehospitalizations, elimination of the random effect

resulted in an unequal-variance *t* test. The intervention communities' pre-post difference for hospitalization shows a larger reduction in hospitalizations than the comparison communities' pre-post difference (2.12/1000; 95% CI, 0.47-3.77 per 1000; $P = .01$).

The difference in differences between the 14 intervention communities and the 31 best-matched com-

parisons shows a larger reduction in hospitalization for the intervention communities' pre-post difference than the comparison communities' pre-post difference (2.00/1000; 95% CI, 0.10-3.90 per 1000; $P = .04$).

FIGURE 2 shows the time series and control charts for hospitalizations in both intervention and comparison communities. Control charts show declining hospitalizations per

Table 3. Measures of Rehospitalization and Hospitalization Before and During Intervention^a

Measures	AL	CO	FL	GA	IN	LA	MI	NE	NJ	NY	PA	RI	TX	WA
Mean of 12 Quarters in 2006-2008 (Preintervention)														
Medicare FFS beneficiaries in defined community, No.	39 745	40 460	77 081	54 572	67 121	68 330	48 455	63 724	76 645	74 778	31 686	90 101	56 072	22 097
30-Day rehospitalizations No. (No./1000 beneficiaries)	798 (20.1)	417 (10.3)	1491 (19.3)	683 (12.5)	888 (13.2)	968 (14.2)	690 (14.2)	927 (14.6)	1207 (15.7)	1 073 (14.3)	691 (21.8)	1406 (15.6)	1040 (18.5)	185 (8.4)
% of live discharges	19.7	16.8	21.9	18.6	17.4	18.5	18.2	18.0	19.8	19.4	21.0	20.8	21.1	14.6
Hospitalizations, No. (No./1000 beneficiaries)	4201 (105.7)	2571 (63.5)	7117 (92.3)	3818 (70.0)	5281 (78.7)	5462 (79.9)	3926 (81.0)	5324 (83.6)	6344 (82.8)	5782 (77.3)	3407 (107.5)	7065 (78.4)	5147 (91.8)	1309 (59.2)
ED visits within 30 d, No. (No./1000 beneficiaries) ^b	230 (5.9)	159 (3.9)	254 (3.3)	238 (4.3)	283 (4.3)	328 (4.9)	223 (4.9)	335 (5.2)	362 (4.7)	357 (4.8)	178 (5.8)	507 (5.6)	275 (5.0)	81 (3.7)
Observation stays within 30 d, No. (No./1000 beneficiaries) ^b	42 (1.1)	35 (0.9)	87 (1.1)	50 (0.9)	93 (1.4)	19 (0.3)	42 (0.9)	46 (0.7)	65 (0.8)	42 (0.6)	29 (0.9)	93 (1.0)	107 (1.9)	29 (1.3)
Community mortality, No. (%)	470 (1.2)	703 (1.7)	1276 (1.6)	638 (1.1)	912 (1.3)	1001 (1.4)	624 (1.3)	813 (1.3)	985 (1.3)	1005 (1.3)	763 (2.3)	1443 (1.6)	596 (1.0)	267 (1.2)
Mean of 8 Quarters in 2009-2010 (During Intervention)														
Medicare FFS beneficiaries in defined community, No.	38 548	40 834	78 116	54 529	65 865	64 628	47 452	66 352	78 427	68 616	28 025	92 068	55 710	21 888
30-Day rehospitalizations No. (No./1000 beneficiaries)	699 (18.1)	376 (9.2)	1512 (19.4)	631 (11.6)	879 (13.3)	862 (13.3)	648 (13.7)	909 (13.7)	1244 (15.9)	934 (13.6)	567 (20.2)	1 341 (14.6)	914 (16.4)	171 (7.8)
% of live discharges	19.4	16.3	22.2	18.4	17.9	18.4	18.1	18.1	20.2	19.4	20.7	20.8	20.3	14.4
Hospitalizations, No. (No./1000 beneficiaries)	3719 (96.5)	2377 (58.2)	7047 (90.2)	3534 (64.8)	5080 (77.1)	4870 (75.4)	3691 (77.8)	5183 (78.1)	6378 (81.3)	5016 (73.1)	2825 (100.8)	6680 (72.6)	4672 (83.9)	1223 (55.9)
ED visits within 30 d, No. (No./1000 beneficiaries)	212 (5.5)	145 (3.6)	305 (3.9)	219 (4.0)	297 (4.5)	329 (5.1)	243 (5.1)	318 (4.8)	377 (4.8)	340 (5.0)	157 (5.6)	498 (5.4)	279 (5.0)	80 (3.6)
Observation stays within 30 d, No. (No./1000 beneficiaries)	53 (1.4)	43 (1.1)	103 (1.3)	58 (1.1)	95 (1.4)	31 (0.5)	49 (1.0)	54 (0.8)	75 (1.0)	46 (0.7)	36 (1.3)	132 (1.4)	98 (1.8)	35 (1.6)
Community mortality, No. (%)	484 (1.2)	701 (1.7)	1287 (1.6)	652 (1.2)	892 (1.3)	962 (1.5)	618 (1.3)	800 (1.2)	991 (1.2)	1008 (1.4)	741 (2.5)	1387 (1.5)	622 (1.1)	267 (1.2)

Abbreviations: ED, emergency department; FFS, fee-for-service.

^aSpecific definitions of the sites are given by zip code in the eAppendix.

^bEmergency department visits and observation stays in the preintervention period incorporated the 8 quarters of 2007 and 2008 only.

1000 beneficiaries throughout 2006-2010 in both sets of communities. The intervention communities had larger declines than the comparison communities, with the timing consistent with the onset of the intervention.

Process control charts for the 14 intervention communities (Table 2 and eFigure 15 through eFigure 28) showed 13 (93%) with a special-cause reduction in hospitalizations per 1000, consistent with the intervention timing, as did 31 (62%) of the 50 comparison communities (see <http://www.cfmc.org/integratingcare/ninthSOWcontrolcharts>). None of the intervention communities showed increased hospitalizations and only 1 (7%) was stable; while 8 comparison communities (16%) increased, and 11 comparison communities (22%) stayed stable.

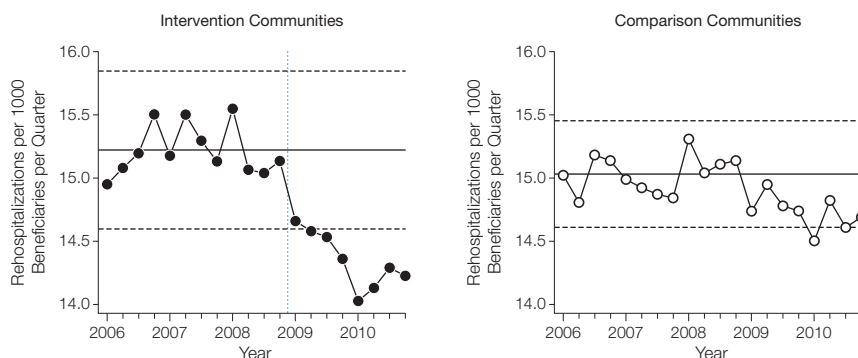
Rehospitalizations Per Discharges. The mean rates of all-cause 30-day rehospitalizations as a percentage of hospital discharges in the 14 intervention communities were 18.97% (range, 14.60%-21.86%) in 2006-2008 and 18.91% (range, 14.42%-22.23%) in 2009-2010, a reduction of 0.06% (95% CI, -0.13% to 0.26%; $P=.50$). The mean quarterly rehospitalization rate per discharge in the 50 comparison communities was 18.76% in 2006-2008 and 18.91% in 2009-2010, a pre-post difference of -0.16% (95% CI, -0.39% to 0.08%; $P=.18$); ie, an increase of 0.16%.

The difference in differences between intervention and comparison communities for the rehospitalization rate per discharge was 0.22% (95% CI, -0.08% to 0.51%; $P=.14$). The difference in differences between the 14 intervention communities and the 31 best-matched comparisons was 0.23% (95% CI, -0.13% to 0.59%; $P=.20$).

Potential Adverse Effects

Intervention communities' HCAHPS items reflected no significant change in satisfaction with medication and significant improvement in satisfaction

Figure 1. Process Control Charts for 30-Day All-Cause Rehospitalizations per 1000 Medicare Beneficiaries per Quarter, 2006-2010



Means (solid lines) and upper and lower control limits (dashed lines) set by the experience of 2006-2008. Vertical dotted line indicates start of quality improvement in the intervention communities.

with hospital discharge. For July 2007 through December 2008, the mean medication satisfaction score was 75.94% compared with a score of 76.86% in January 2009 through July 2010, a difference of 0.92% (95% CI, -0.33% to 2.17%; $P=.14$). For the same periods, scores of hospital discharge satisfaction improved from 78.44% to 80.46%, a difference of 2.02% (95% CI, 0.75%-3.29%; $P=.004$).

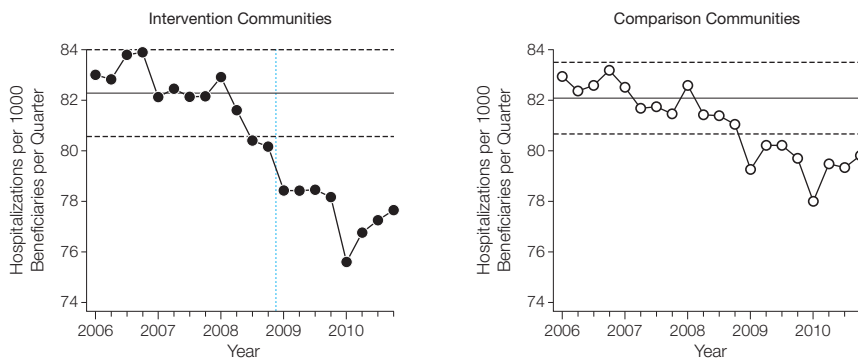
Community mortality rates remained stable (Table 3). Expressed as the percentage of FFS beneficiaries living in the community who died each quarter, the mean mortality rate of the intervention communities in 2006-2008 was 1.40% compared with 1.42% in 2009-2010 ($P=.31$). The mean mortality rate in 2006-2008 for the 50 comparison communities was 1.30% compared with 1.31% in 2009-2010 ($P=.25$). The difference in differences was 0.01% ($P=.60$).

Changes in intervention communities' utilization of emergency department visits and observation stays varied but were modest overall (Table 3). On average for the 14 intervention communities, discharge to home without Medicare-covered services decreased 1.8%, discharge to home health care increased 0.8%, discharge to skilled nursing facilities increased 0.5%, and discharge to hospice increased 0.3%.

COMMENT

Our results provide evidence of a background national decline in hospitalizations and rehospitalizations for Medicare beneficiaries since 2008 and an additional significant association between care transitions improvement interventions initiated by 14 QIOs and reductions in rehospitalizations and hospitalizations. The 14 intervention communities had a mean reduction of 5.70% in rehospitalizations per 1000 and of 5.74% in hospitalizations per 1000 for FFS Medicare beneficiaries over the 2-year intervention period, with progressive improvement throughout. During the same period, the 50 comparison communities had smaller mean reductions in rehospitalizations (2.05%) and hospitalizations (3.17%). Process control charts confirmed signals of important changes with the onset of the intervention. However, the widely used measure of rehospitalizations as a percentage of hospital discharges did not change during the study period, with a difference of 0.06% in the intervention communities and a difference of -0.16% in the comparison communities. The diversion to other Medicare-covered services was small, and mortality and patient-reported quality either did not change or improved.

Figure 2. Process Control Charts for 30-Day All-Cause Hospitalizations Per 1000 Medicare Beneficiaries per Quarter, 2006-2010



Means (solid lines) and upper and lower control limits (dashed lines) set by the experience of 2006-2008. Vertical dotted line indicates start of quality improvement in the intervention communities.

Several considerations and insights should be taken into account in interpreting these findings. First, this project was conducted during only 3 years in 14 communities, and the interventions implemented were multifactorial and complex. Although the intervention sites implemented many proven components, the experience from the initiative can only begin to guide predictions about effective combinations of context and interventions, optimal replication strategies, and effective plans for sustainability. Local community context was clearly relevant, since broad improvement depended substantially on features such as political or clinical leadership, existing partnerships, or a culture of collaboration and improvement activities.

Second, the intervention communities might have been unusual in unmeasured but important ways. Intervention communities began with slightly higher average rehospitalization rates per 1000 FFS beneficiaries compared with the comparison communities but varied substantially and were similar to the comparison communities with regard to Hospital Care Intensity Index and poverty prevalence. Allowing QIOs to select some comparison communities might have introduced some bias. However, matching communities by these predefined characteristics turned out to be irrel-

evant in the analyses, underscoring both the absence of known predictors of community improvement capability and the ongoing need to understand the environment in which programs are implemented.²⁷

Third, the quality of care transitions across intervention populations was not measured directly; instead we used the proxy of rehospitalization. Many communities used the Care Transitions Measure²⁸ for patients receiving transitions coaching services, but no community evaluated progress with population-based measures of transitional care quality. Measuring rehospitalization as the outcome may have led sites to focus on interventions that could quickly reduce rehospitalization risk while deemphasizing other approaches for improving care transitions, such as establishing medical homes or using health information technology.

Fourth, this quality improvement initiative targeted an entire community and its social service and health care practitioners and organizations. Although we used evidence-based interventions, implementation was context dependent, complicated, and iterative.²⁹ Complex systems such as communities are dynamic before, during, and after intervention tests, and any system characteristic might or might not endure throughout the intervention pe-

riod. We selected comparison communities to monitor secular trend, and they were similar to intervention communities in characteristics plausibly related to communities' capability to change rehospitalization rates. However, in the absence of defined and stable variables that predict community change capability, we could not sample and match controls using a meaningful array of static characteristics.¹⁴ Instead, monitoring and analyzing variation in processes and outcomes served to help identify important changes.^{30,31}

Fifth, the quality improvement methods used in this project combined elements of community-based participatory research and conventional continuous quality improvement. Some elements were common to all sites (eg, evidence-based interventions, community organization, technical assistance for QI methods, collaborative problem-solving, and shared data analyses for monitoring progress), but the implementation was quite flexible. This method had the strength of engaging coalitions of multiple health care and social service practitioners and organizations, even without financial incentives. Consistent use of more formal and rigid improvement methods or more rigorous adherence to methods used in successful research projects might have altered the effectiveness or sustainability of the initiative.

Sixth, the main outcome measure for this initiative, rehospitalizations per 1000 FFS beneficiaries, proved to be informative in pre-post and difference-of-differences analyses, to galvanize local coalitions, and to be responsive to interventions. We included all hospitalizations and rehospitalizations in our metric, unlike the current Hospital Compare²² measures, which require a period of 30 days out of the hospital before counting a hospitalization as an index stay, after which a readmission may occur. To be used for comparing communities or holding particular clinical provider organizations accountable, our metric would need to be risk adjusted, incorporating local community fac-

tors (such as adequacy of social support network and intensity of local care patterns) in addition to patient, organization, and professional factors. However, to our knowledge, no such risk adjustment method currently exists, nor was it included with this initiative's design, which relied on pre-post, difference of differences, and process control charts. The secondary measure of hospitalizations per 1000 beneficiaries provided additional important insight into the population experience and the costs, with many of the same merits and concerns.

Seventh, in this initiative, we did not find a significant reduction in the rates of rehospitalizations as a percentage of hospital discharges. Although this widely used measure was initially designated as the main outcome measure for this project, reassessment during the course of the initiative resulted in changing this measure to a secondary outcome. In this project, the reductions coincident with the QI work were equal for rehospitalizations and hospitalizations, thus reducing the numerator and denominator equally and leaving the rate unchanged. Improvements that reduce rehospitalizations can reduce the likelihood of hospitalization, a correlation also reported in a recent small-area variation study.³²

The more familiar metric of rehospitalizations as a percentage of discharges was first used in randomized trials within a hospital's population and was later applied to hospital accountability and comparison. In these settings, the population from which hospitalized patients come has not been measured, and improvement strategies emphasize reducing the risk of rehospitalization arising from preventable problems in the transition, such as instability at discharge, incomplete inpatient care, unavailability of medications, or inadequate referral mechanisms. This makes all live discharges a reasonable denominator for measuring performance and monitoring changes. However, the approaches that the communities took in this project included many elements that affect the

likelihood of hospitalization at any time and that are less firmly tied to the activities of hospitals, such as enhanced support from elder care services in the community, more counseling about palliative care options including hospice, activation of patients and families to take more control of their disease management, and more attention to workable longitudinal care plans for persons with chronic disease.

The finding from this project that hospitalizations declined, on average, at the same rate as rehospitalizations suggests that future initiatives using the metric of the percentage of rehospitalizations among hospital discharges should consider tracking the numerator and denominator separately to enable meaningful interpretation of changes. Evidence for the relationship between improved care transitions (from the hospital setting to other settings) and rehospitalizations has arisen in the current context of high rates of errors and shortcomings in care transition processes. As the transition process becomes more reliable, the relationship between improvements in care transitions and rehospitalizations is likely to become more complicated, underscoring the need for direct measures of transitional care quality. Further studies will also be needed to understand whether changes in rehospitalizations and hospitalizations arise from market factors affecting a hospital's utilization generally, from improvements in hospital discharge practices, from improvements in community support for persons in fragile health, or from other causes.

Other countries usually have local governmental authorities that address priorities, standards, and performance of health care services; but the United States generally does not. The modest investment in external funding, staffing, and expertise from the QIOs served this role, providing an anchor to form community coalitions capable of joint action and just-in-time learning.

Efforts to build on this work are under way, both private³³⁻³⁵ and public.

The Partnership for Patients³⁶ provides support for widespread improvement activity, aiming to reduce rehospitalization by 20% within 3 years. Care transitions improvement efforts benefit from tools and strategies made available by compilations of the early work³⁷⁻³⁹ and by incentives created by the Accountable Care Act.⁴⁰ The CMS's 2011-2014 QIO contract⁴¹ asks every QIO to foster coalition-based approaches to rehospitalization reduction in numerous communities within every state. The Community-based Care Transitions Program⁴² provides Medicare payment for community-based organizations providing care transitions services at hospital discharge. Delineating the causal mechanisms of individual improvement efforts and matching strategies with community situations may become possible as more communities become involved in these and other programs.

CONCLUSION

This CMS QIO initiative demonstrated that Medicare beneficiaries in communities in which QI initiatives were implemented to promote evidence-based care transitions, compared with Medicare patients in communities without this QI implementation, had lower all-cause 30-day rehospitalization rates per 1000 and all-cause hospitalization rates per 1000 but no significant reductions in the rates of all-cause 30-day rehospitalizations as a percentage of hospital discharges.

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Statistical analysis: Mitchell, Stevens, Lynn.
Obtained funding: Brock, Goroski, Lynn.
Administrative, technical, or material support: Brock, Irby, Archibald, Goroski, Lynn.
Study supervision: Brock, Irby, Archibald, Goroski.
Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Brock reports receiving payment for lectures from the Alliance for Home Health Quality and Innovation, Ramona VNA and Hospice, and the Lewin Group and honoraria from CHRISTUS St Vincent Regional Medical Center, George Washington University, and the Hebrew Home of Greater Washington; Ms Irby reports receiving payment for lectures from the Wisconsin Hospital Association, LeadingAge Wisconsin, and Kauffman & Associates Inc; Ms Goroski reports receiving travel/meeting expenses from the Institute for Healthcare Improvement, Texas Medical Foundation, Lilly, Insignia Health, National Quality Forum, and Health Insight and an honorarium from Lilly; Dr Lynn reports receiving travel/meeting expenses from the CMS, payment for writing or reviewing the manuscript from Colorado Foundation for Medical Care, consultancy fees from the CMS as well as from the Centre for Organizational Effectiveness, Valley Health System, and Institute for Healthcare Improvement (to her institution), and payment for lectures from numerous sources (hospitals, home health agencies, regional coalitions, VA medical centers, and national organizations).
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Funding/Support: This project was funded through the CMS.
Role of the Sponsor: The CMS paid for its staff and contractors, who were responsible for the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, and approval of the manuscript. The CMS leaders reviewed the manuscript and provided helpful comments.
Independent Statistical Analysis: Gary Grunwald, PhD, Department of Biostatistics and Informatics, University of Colorado School of Public Health, supervised and reviewed the final analyses reported here, which were performed by Jason Mitchell, MS, and Beth Stevens, MS, both masters-level statisticians employed by the Colorado Foundation for Medical Care, the QIO for Colorado and the QIOSC in this project.
Online-Only Materials: The eAppendix and eFigures 1 through 28 are available online at <http://www.jama.com>.
Additional Contributions: This project depended on the coordinated efforts of hundreds of participants in the government, the QIOs, and the communities. The writing team is grateful to Thomas Nolan, PhD, Associates in Process Improvement and the Institute for Healthcare Improvement, who provided guidance in the construction and interpretation of process control charts, and Gary Grunwald, PhD, Department of Biostatistics and Informatics, University of Colorado School of Public Health, who provided statistical consultation. The implementation teams are grateful for the creative engagement of Eric Coleman, MD, MPH, University of Colorado School of Medicine, and Mary Naylor, PhD, RN, University of Pennsylvania School of Nursing, in teaching their methods and helping with adaptations. The work depended critically on leaders at the Department of Health and Human Services and the CMS, and clinicians and managers in the communities. Dr Nolan's guidance was provided without compensation. Dr Grunwald's guidance was compensated through a contract with the Colorado Foundation for Medical Care.

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