



# Evaluation of Hospital-Setting HCIA Awards

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Addendum to the Third Annual Report  
*Final*

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### 1. Introduction

The following report is an Addendum to the Third Annual Report of the Evaluation of Hospital Setting Health Care Innovation Awards (HCIA), submitted to the Centers for Medicare & Medicaid Services (CMS) on December 7, 2016. The Third Annual Report is our final evaluation report, and presents analyses through Quarter 3 2015 (September 30, 2015); one quarter beyond the end of the HCIA program (June 30, 2015). This Addendum extends analyses through Quarter 2 2016 (June 30, 2016), a full year after the end of the HCIA program. This was the last quarter in which HCIA funding was used by any of the Awardees.

Six of the ten hospital setting programs received no-cost extensions (NCE) to continue their programs beyond the final date of the original HCIA awards. The Third Annual Report included final analyses for the four programs that did not receive NCEs (Christus Health System, High Value Healthcare Collaborative, Mayo Clinic, and University of Chicago). The Third Annual report also included final analyses for four of the six NCE programs, who used the last of their HCIA funding by September 30, 2015 (Emory University, Henry Ford Health System, Mt. Sinai School of Medicine, and St. Luke's Regional Medical Center eICU). Two NCE programs, Methodist Hospital Research Institute - Delirium (Methodist Delirium) and Methodist Hospital Research Institute – Sepsis (Methodist Sepsis), had sufficient HCIA funding remaining to continue into 2016 and their results are updated here: The Methodist Sepsis program continued through March 31, 2016 and the Methodist Delirium program continued through June 30, 2016. This Addendum extends the results presented in the Third Annual Report and contains all final results for the Methodist Sepsis and Methodist Delirium programs.

#### 1.1 Technical Appendix

Technical Appendix B to the Third Annual Report describes our methods for secondary data analyses, including specifying intervention and comparison groups, sample size considerations, and the difference in differences (DD) multivariate regression approach through which we test whether each Awardee intervention achieved its intended objectives. This Addendum extends the time period of the analyses for the Methodist Delirium and Methodist Sepsis programs, and the methodological approach has not changed. Please refer to Technical Appendix B of the Third Annual Report for methodological details.

## 2. Individual Awardee Results

### 2.1 Methodist Hospital Research Institute—Delirium

#### 2.1.1 Introduction

The Houston Methodist Hospital (HMH) System received HCIA funding to implement the Delirium Detection and Prevention across the Continuum program (Methodist Delirium program), which was designed to detect and reduce delirium in the HMH and four community hospitals in the Houston Methodist system. The program included a nurse-administered Delirium Screening Tool, and an algorithm-based automated calculation of a Delirium Risk Assessment, to be used as screening tools twice daily for all patients aged 70 and older, with the exception of those in ICUs. Details on the Delirium program can be found in the third Annual Report.

#### 2.1.2 Summary of Quantitative Findings

##### Core Measures

The four core measures that CMS specified for the HCIA evaluations include three measures of utilization (admissions, readmissions, and emergency department [ED] visits) and one measure of cost (total episode spending). In this section we present estimated changes in Medicare spending and utilization through June 30, 2016, four quarters beyond the initial three year HCIA intervention period. The sections below show results for all patients screened by the program, and separately for those patients who screened positive and received subsequent interventions (the treated population). The results below are for the following measures:

- Total Medicare episode spending for 60 days, including the index admission and all Medicare spending for 60 days after discharge. Index admission was defined as an admission for a patient eligible for the screening innovation, in either an intervention or comparison hospital.
- Thirty-day (all cause) readmissions to an Acute Care Hospital (ACH) following an index admission
- Thirty-day post-discharge (all cause) visits to an ACH ED following an index admission
- Inpatient length of stay (LOS)
- Discharge destination

Please see Technical Appendix B to the Third Annual Report for a description of how each outcome measure was specified, our methods for the DD regression analyses, and how we selected a comparison group for total Medicare episode spending, 30-day hospital readmissions and ED visits, LOS, and discharge destination. The tables below show a single DD estimate for the overall effect of the program for each outcome, averaged across all episodes occurring during the intervention period. For each outcome we also present graphs of DD estimates for each calendar quarter during the intervention. Additionally, we report median regression estimates of 60-day Medicare episode spending.

Program implementation did not begin on the same day in all participating hospitals. In the graphs below, the red dotted vertical line shows the beginning of the intervention period, and the black dotted vertical lines indicate the quarters when various participating hospitals began their program implementation. In this report, we use graphs to show results first for the Methodist Delirium screened population (all patients 70 years or older, with some exclusions), and then for the Methodist Delirium prevention intervention sub-population (patients screened as being at intermediate or high-risk). Estimated changes in cost and utilization are based on 15 quarters of post-implementation data.

**Summary of Core Measures**

Exhibit 2.1A summarizes the average effect of the Methodist Delirium screening program on total 60-day Medicare spending (including the inpatient stay and all claims in the following 60 days), 30-day inpatient readmissions, and 30-day ED visits per episode.<sup>1,2</sup> The exhibit also presents the estimated effect of the program on spending aggregated across all episodes that occurred during the intervention period. Exhibit 2.1B summarizes the same measures for patients who were identified as intermediate or high-risk for delirium and received additional intervention.

There were no statistically significant differences between intervention and comparison patients in the broader screened population. However, there was a statistically significant increase of \$344 in average spending per episode among the high-risk subset of patients, relative to the comparison group (p<0.10). Although this increase was small, roughly 2.5 percent, the cumulative effect of the increase was an estimated \$8.23 million increase in overall Medicare spending. This was despite a significant decrease of 1.06 percentage points in the rate of ED visits within 30 days after inpatient discharge among the subpopulation of patients at risk for delirium, relative to the comparison group (p<0.05).

**Exhibit 2.1A Core Measures Summary—Methodist Delirium: Screened Patients**

Outcome	Estimate	90% CI
<b>Aggregated results</b>		
Total spending (in millions)	7.26	(-0.94, 15.47)
<b>Per episode: (N = 34,787)</b>		
Total 60-day spending	208.77	(-27.07, 444.60)
Thirty-day inpatient readmissions	0.37	(-0.15, 0.89)
Thirty-day ED Visits	-0.34	(-0.91, 0.23)

The estimated change in outcomes spans the entire intervention period from 2012Q4 through 2016Q2. Source: Abt Associates, January and February 2017.

**Exhibit 2.1B Core Measures Summary— Methodist Delirium: Treated Patients**

Outcome	Estimate	90% CI
<b>Aggregated results</b>		
Total spending (in millions)	8.23*	(0.26, 16.21)
<b>Per episode: (N = 23,955)</b>		
Total 60-day spending	343.71*	(10.80,676.62)
Thirty-day inpatient readmissions	0.09	(-0.62, 0.80)
Thirty-day ED Visits	-1.06**	(-1.83, -0.29)

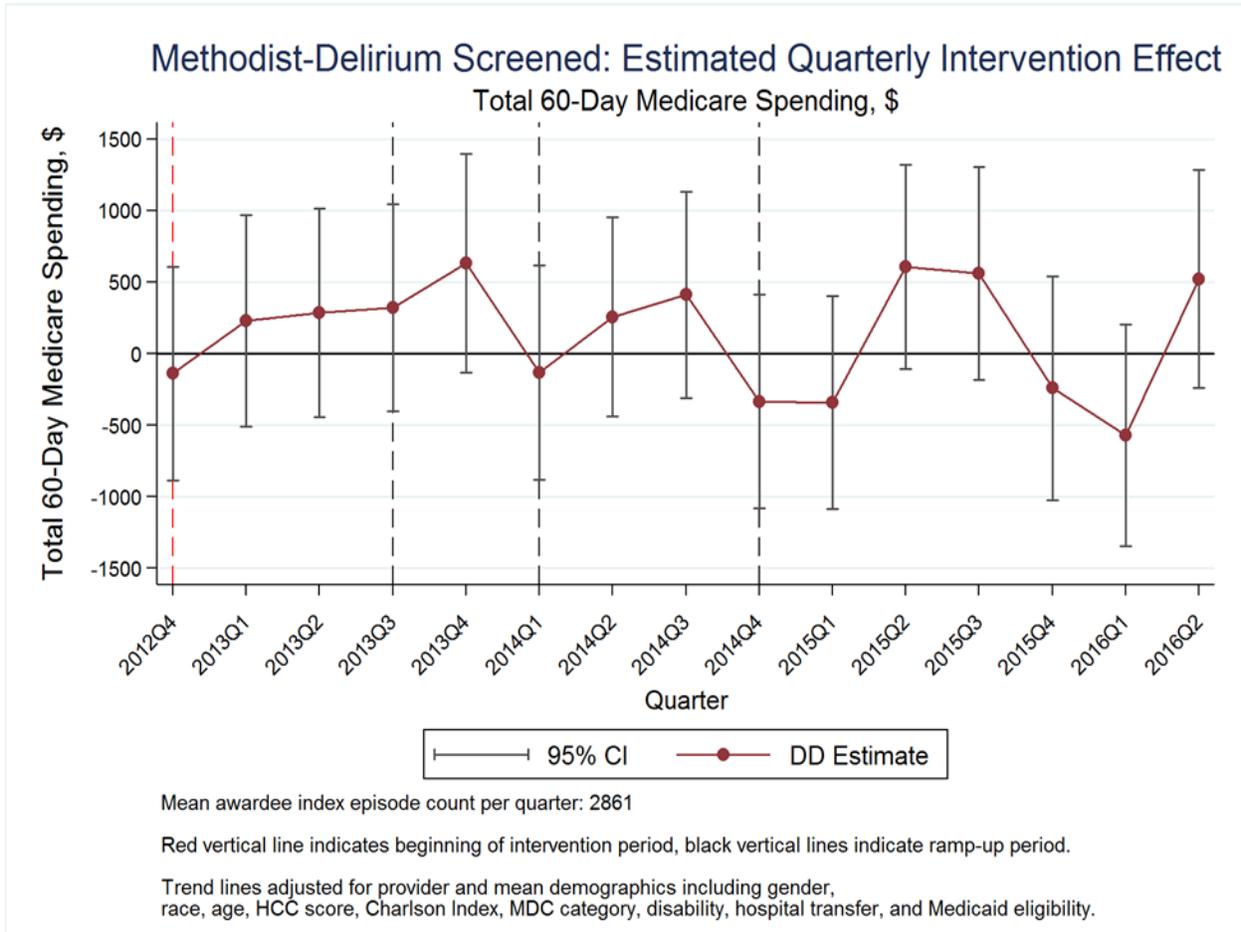
The estimated change in outcomes spans the entire intervention period from 2012Q4 through 2016Q2  
 \*p<0.1 \*\*p<0.05 \*\*\*p<0.01  
 Source: Abt Associates, January and February 2017.

<sup>1</sup> We did not adjust for inflation in measures of Medicare spending. The DD regression estimates are accurate, as inflation applies equally to both intervention and comparison groups.

<sup>2</sup> As a robustness check we also estimated changes in 60-day inpatient readmissions and 60-day ED visits. The direction and magnitude of the effects were similar to the 30-day values, and statistically insignificant.

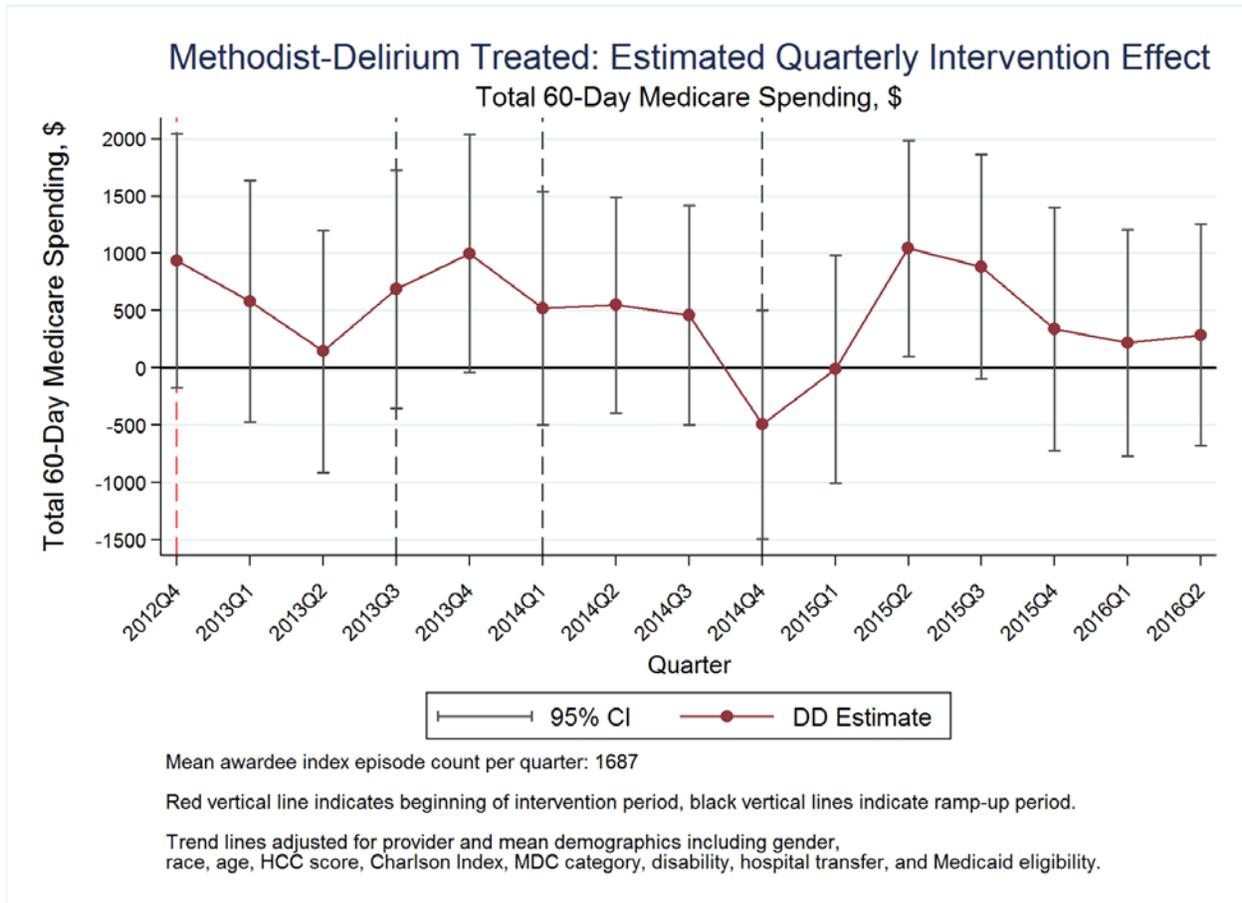
Quarterly estimated changes in total Medicare spending for the screened and treated populations are presented in Exhibits 2.1C and 2.1D, respectively. In most quarters after the start of the intervention, average Medicare episode spending increased more among patients screened and treated by intervention hospitals than among those in comparison hospitals, although none of the quarterly point estimates were statistically significant.

**Exhibit 2.1C: Medicare Episode Spending—Screened Patient Population**



Source: Abt Associates analysis of Registry and Medicare Claims, February 2017.

Exhibit 2.1D: Medicare Episode Spending—Treated Patient Population



Source: Abt Associates analysis of Registry and Medicare Claims, February 2017.

Estimated changes in median Medicare spending pooled across all quarters (Exhibits 2.1E) are \$92 (not significant) for screened patients and \$390 ( $p < 0.01$ ) for treated patients. The similarity of the estimated change in cost for the average episode versus the median episode among the subset of high-risk patients suggests that costs were not primarily driven by outliers. Rather, spending increased similarly across the entire distribution.

**Exhibit 2.1E: DD Estimated Effect of Intervention on Median Total 60-Day Medicare Costs**

Methodist Delirium: Screened		
Intervention effect (\$)	Estimate	91.85
(Median regression)	Standard error	(69.86)
	Sample size	[245,719]

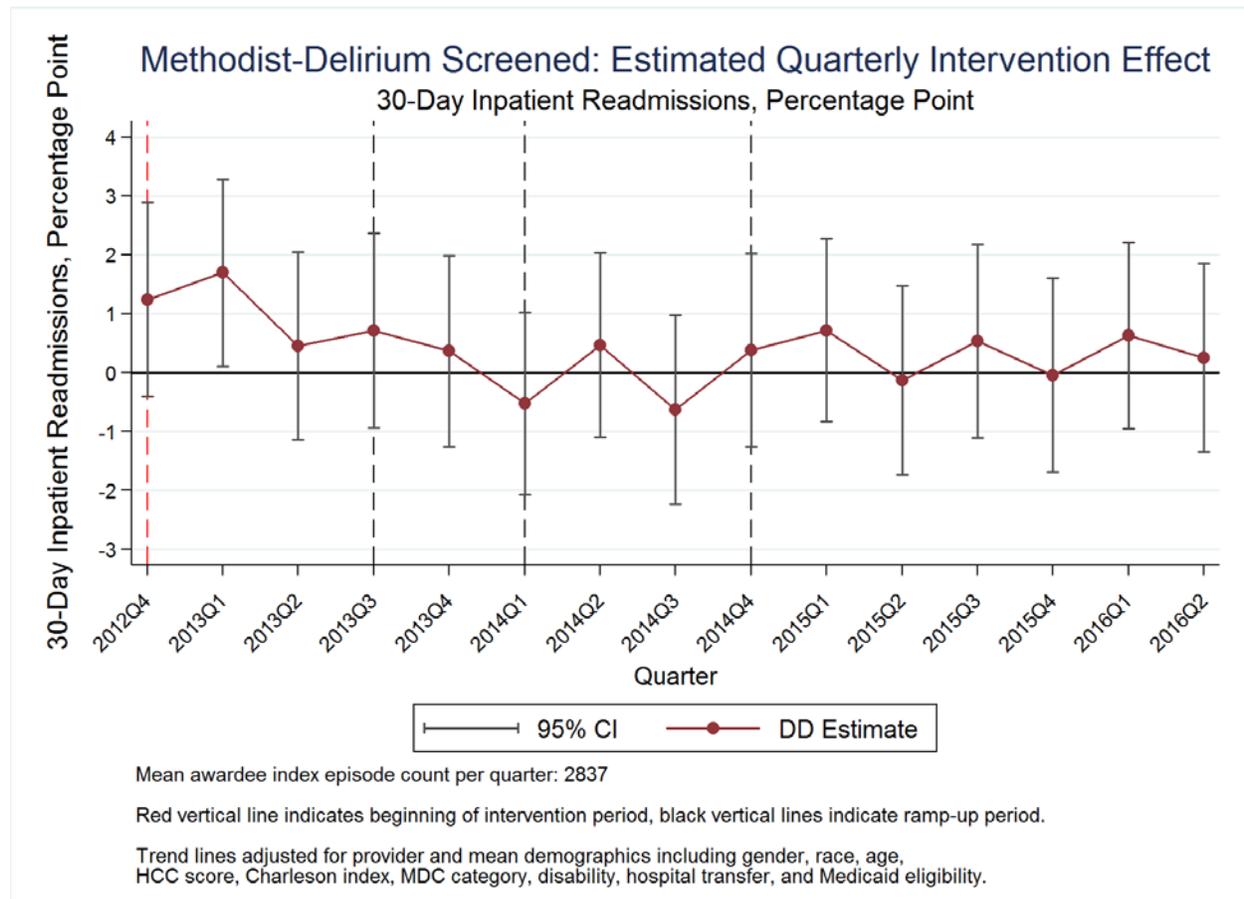
Methodist Delirium: Treated Subpopulation		
Intervention effect (\$)	Estimate	390.15***
(Median regression)	Standard error	(113.74)
	Sample size	[122,979]

\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates, February 2017.

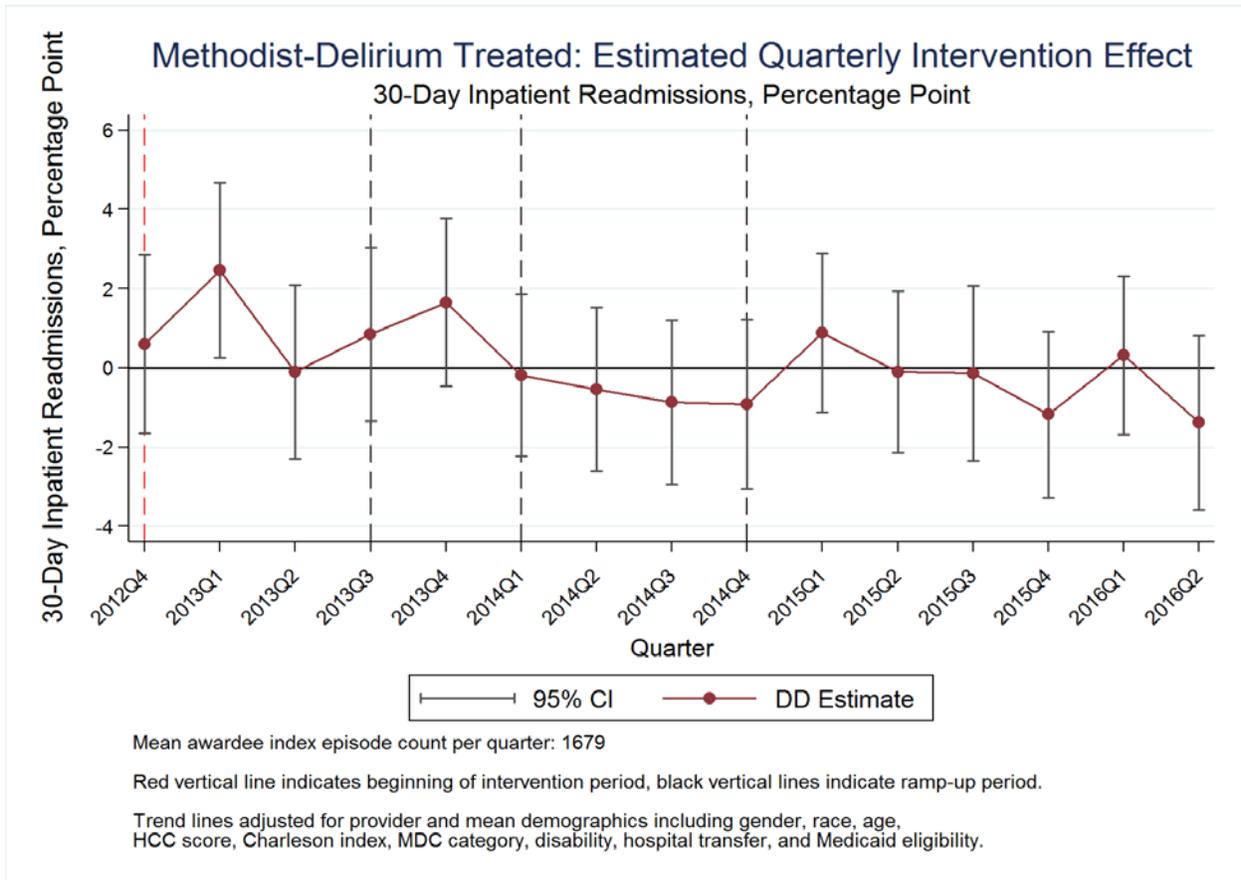
Exhibits 2.1F and 2.1G show hospital discharges followed by a readmission within 30 days. There was no consistent relationship between the intervention and readmission rates among either the screened population or the at-risk treated subpopulation. Likewise, there was no trend of changes in the rate of ED visits among either the screened or treated populations (Exhibits 2.1H, 2.1I).

**Exhibit 2.1F: Readmissions—Screened Patient Population**



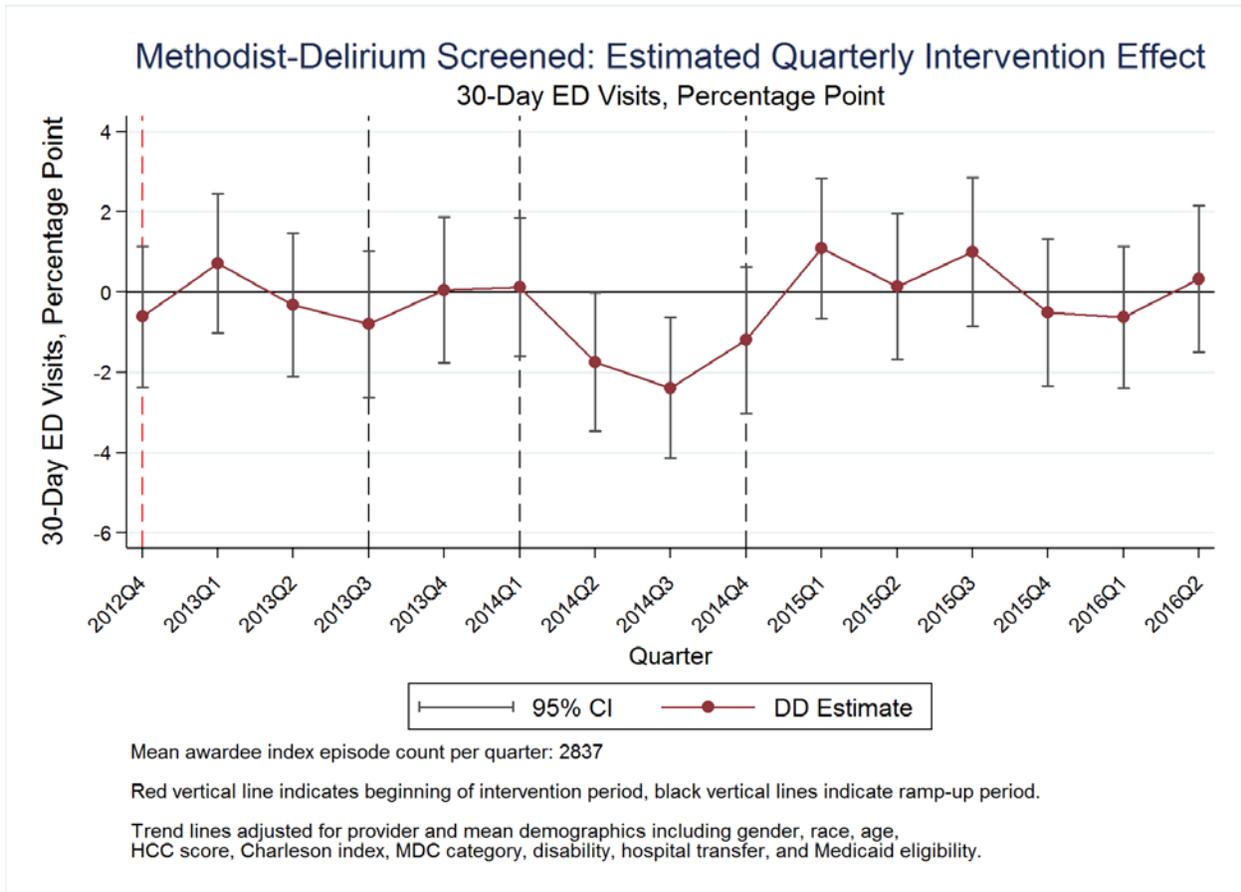
Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.1G: Readmissions—Treated Subpopulation



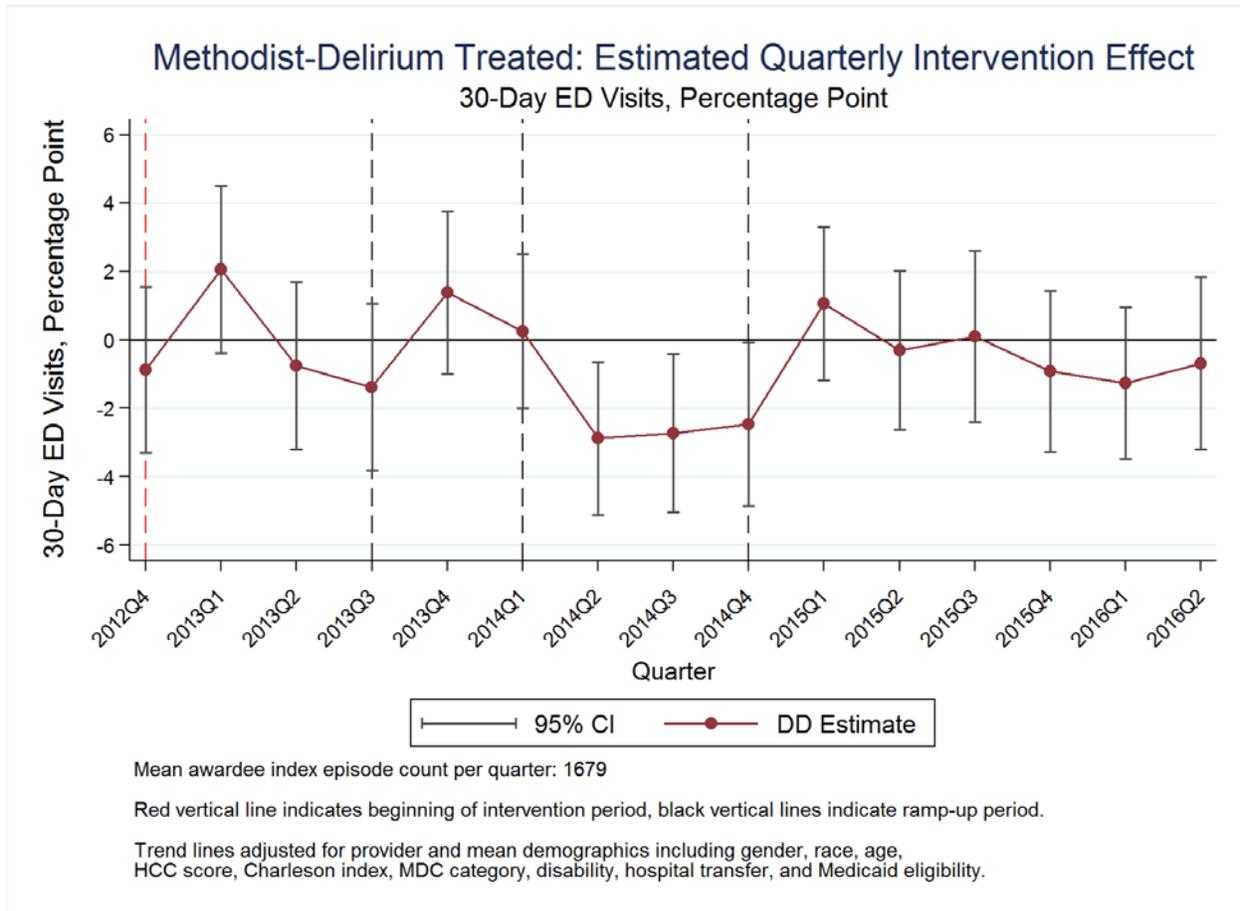
Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.1H: Thirty-Day Post-Discharge ED Visits, Screened Patient Population



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.1I: Thirty-Day Post-Discharge ED Visits, Treated Subpopulation

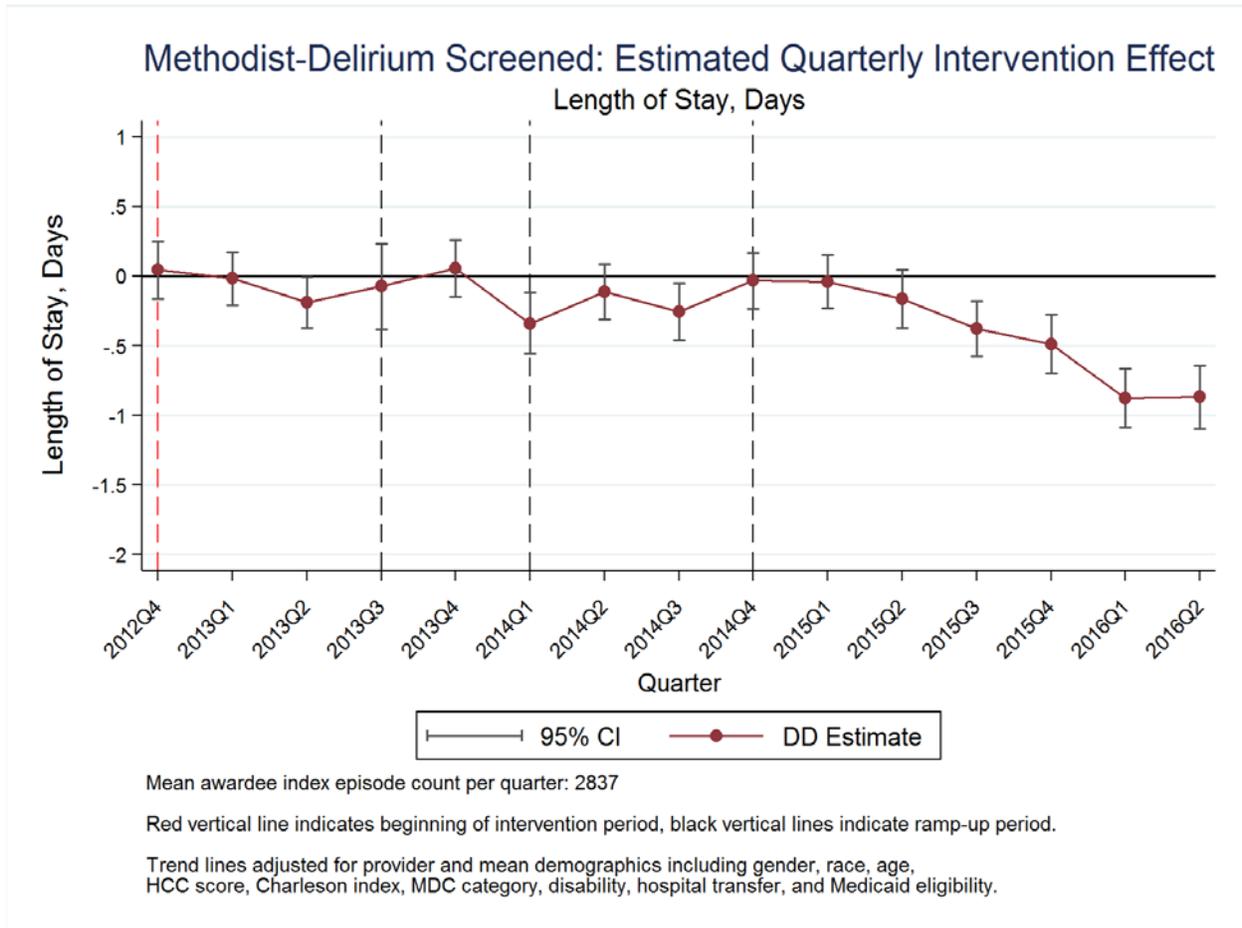


Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Index Admission LOS**

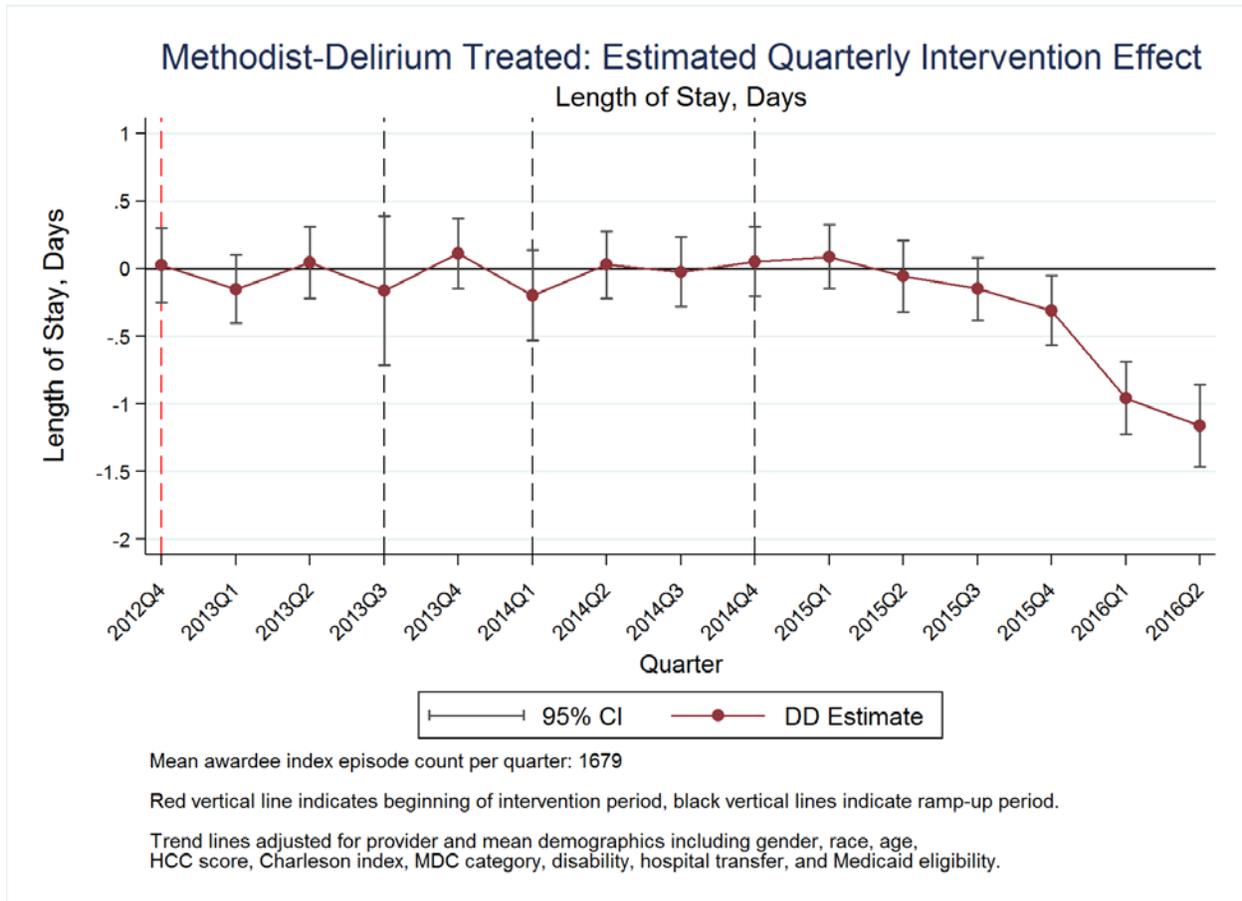
The Methodist Delirium prevention program has the potential to reduce LOS if patient cognitive status does not deteriorate in the hospital or if other clinical problems are noticed and addressed quickly, preventing development or exacerbation of delirium. Exhibit 2.1J indicates that LOS was significantly lower among patients screened at participating hospitals relative to comparison patients starting in Quarter 3 2015. The same pattern was observed among patients in the at-risk treated subpopulation who received additional interventions (Exhibit 2.1K), although the quarterly estimates were not significant until the Quarter 4 2015. Over the entire period, the average decrease in LOS was 0.22 days ( $p < 0.01$ ) for the screened population and 0.13 ( $p < .05$ ) for the treated sub population (Exhibit 2.1L). Recent quarterly estimates suggest that LOS continued to decline and by the last quarter of HCIA funding, LOS had declined by nearly one day, relative to the comparison group.

Exhibit 2.1J: Index Admission Inpatient LOS, Screened Patient Population



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.1K: Index Admission-Inpatient LOS, Delirium Subpopulation



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.1L: DD Estimated Effect of Intervention on Inpatient LOS

Methodist Delirium: Screened		
Intervention effect	Estimate	-0.22***
	Standard error	(0.04)
	Sample size	[242,726]

Methodist Delirium: Treated Subpopulation		
Intervention effect	Estimate	-0.13**
	Standard error	(0.05)
	Sample size	[121,726]

p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates analysis of Registry and Medicare Claims, January 2017

**Discharge Destinations for Acute Care Patients**

Finally, we examined patterns in the settings to which patients were discharged after their index hospitalization. Exhibit 2.1M shows that for the overall screened population, the rate of discharges to home without home health care decreased by 3.67 percentage points (p<0.01) relative to the comparison group. This was primarily driven by a 2.22 percentage point increase in the rate of discharges to home health care (p<0.01) and a 1.16 (p<0.01) percentage point increase in the rate of discharge to “other” PAC settings (e.g., hospice, federal hospital, psychiatric hospital) relative to the comparison group. Among patients screened as being at risk for delirium who received additional interventions, the rate of discharges to home without home health care decreased by 3.63 percentage points (p<0.01) relative to the comparison group. This was the result of a 2.59 percentage point increase in the rate of discharges to home health care (p<0.01) and by a 0.85 percentage point increase (p<0.01) in discharges to “other” PAC settings.

**Exhibit 2.1M: DD Estimated Change in Episode Discharge Destination**

**Methodist Delirium—Screened Patient Population**

	2012 Q4	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4	2015 Q1	2015 Q2	2015 Q3	2015 Q4	2016 Q1	2016 Q2	Overall
<b>Home</b>																
DD	0.69	-1.63	-3.47***	-3.99***	-3.15***	-3.26***	-3.77***	-5.51***	-2.70***	-3.65***	-5.24***	-4.07***	-3.33***	-6.16***	-4.08***	-3.67***
SE	1.01	1.01	1.03	1.05	1.04	1.00	1.02	1.04	1.02	0.98	1.01	1.04	1.04	1.00	1.03	0.39
<b>Home Health</b>																
DD	-1.05	-0.14	0.59	1.77*	3.19***	2.00***	0.86	4.02***	1.08	2.59***	2.24**	2.46***	1.74*	1.52*	2.31**	2.22***
SE	0.80	0.81	0.86	0.93	0.95	0.89	0.87	0.99	0.88	0.89	0.92	0.91	0.92	0.87	0.93	0.34
<b>Skilled Nursing Facility/Inpatient Rehabilitation Facility/Long-Term Care Hospital/Other Nursing Home</b>																
DD	-1.75*	-1.66**	0.51	1.51	-0.25	0.31	1.33	-0.13	-0.58	0.04	0.29	-0.64	-0.07	-0.00	0.70	0.29
SE	0.95	0.96	1.01	1.04	0.98	0.95	0.99	0.98	0.96	0.94	0.98	0.99	1.00	0.98	1.01	0.38
<b>Other</b>																
DD	2.11***	3.43***	2.37***	0.72	0.21	0.94	1.58**	1.62**	2.20***	1.02*	2.71***	2.25***	1.66**	4.64***	1.07*	1.16***
SE	0.67	0.74	0.71	0.66	0.56	0.59	0.65	0.68	0.66	0.61	0.69	0.70	0.65	0.79	0.63	0.23

**Methodist Delirium—Treated Subpopulation**

	2012 Q4	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4	2015 Q1	2015 Q2	2015 Q3	2015 Q4	2016 Q1	2016 Q2	Overall
<b>Home</b>																
DD	-1.00	-1.35	-5.16***	-2.58*	-2.31*	-3.58***	-2.52*	-5.95***	-4.57***	-2.96**	-5.12***	-3.07**	-4.91***	-6.49***	-2.71**	-3.63***
SE	1.40	1.38	1.37	1.38	1.33	1.28	1.30	1.32	1.31	1.23	1.29	1.38	1.31	1.23	1.37	0.53
<b>Home Health</b>																
DD	-0.43	-0.99	1.29	0.79	3.95***	2.66**	0.07	4.80***	4.12***	0.90	3.08**	2.10*	1.73	1.37	2.38*	2.59***
SE	1.18	1.10	1.25	1.19	1.28	1.18	1.08	1.34	1.27	1.06	1.24	1.21	1.20	1.10	1.29	0.47
<b>Skilled Nursing Facility/Inpatient Rehabilitation Facility/Long-Term Care Hospital/Other Nursing Home</b>																
DD	-0.40	-0.17	2.24	2.18	-0.35	0.59	1.78	-0.20	-1.58	0.40	-0.50	-1.07	1.26	0.58	-0.58	0.19
SE	1.41	1.42	1.48	1.42	1.33	1.30	1.34	1.36	1.30	1.27	1.32	1.40	1.39	1.33	1.44	0.54
<b>Other</b>																
DD	1.83**	2.51***	1.63	-0.40	-1.30*	0.32	0.66	1.35	2.04**	1.66*	2.54***	2.03**	1.92**	4.55***	0.91	0.85***
SE	0.92	0.97	1.02	0.84	0.70	0.77	0.82	0.90	0.88	0.85	0.93	0.97	0.91	1.05	0.92	0.32

\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

### Conclusions

- The primary finding was a statistically significant increase in average Medicare spending for the subset of patients offered additional services due to risk for delirium (\$344 ;  $p<0.10$ ), relative to the comparison group. Median Medicare spending also increased by \$390 ( $p<0.01$ ). These results are consistent with the findings in the third annual report.
- An additional finding of interest was a statistically significant decrease in the average LOS for the screened population (-0.22 days;  $p<0.01$ ) and for the subset of patients offered additional services due to risk for delirium (-0.13 days;  $p<0.05$ ), relative to the comparison group. For both populations, the reduction was approximately 1 day by the final quarter of the intervention. The reason for the substantial decline in LOS beginning in 2015 is uncertain, particularly since it does not appear to coincide with any other major changes in spending or utilization. We are confident that the results are not primarily driven by one late-joining hospitals that started in Quarter 4 2014, as this hospital's cases comprised only about 20-25% of the Awardee sample.
- Patients in both samples were significantly more likely to be discharged to home health or "other" PAC settings rather than directly home, relative to the comparison group. However, there does not appear to be any shift in patterns of discharge that coincides with the accelerated decline in LOS observed beginning Quarter 3 2015.
- Despite being discharged from the hospital earlier, patients were not more likely to return to the inpatient or ED setting within 30 days of discharge. Rather, for patients receiving additional intervention beyond the screening, the rate of 30-day ED visits declined by 1.06 percentage points ( $p<0.05$ ).

The cause of increased spending among the treated subpopulation is unclear. There were no increases in the rate of inpatient admissions relative to the comparison group, and the rate of ED visits within 30 days of hospital discharge declined relative to the comparison group. The result might be attributable to the significant and substantial increase in the rate of home health use relative to the comparison group.<sup>3</sup>

It is also unclear what was responsible for the substantial decline in inpatient LOS observed for both study populations in the last three quarters although this may also be attributable to changes in patterns of discharge destination. It is also possible that there was a shift in the approach to delirium screening that decreased LOS more in later quarters than it had in prior quarters. We don't know why the intervention effect increased over time, because we did not collect additional qualitative information from the Awardee in 2016.

The increase in post-discharge care was evident before the decline in LOS, but the two may be related. Patients discharged sooner might be more in need of post-discharge care, especially in the home, than those who spend an extra day in the hospital. It is also possible that careful screening identifies needs for additional post-acute services that would have gone unnoticed without screening.

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<sup>3</sup> The screened population also experienced an increased rate of discharge to home health relative to the comparison group. Changes in average spending for the broader population may be smaller and insignificant due to the smaller rate of increase in home health use.

## 2.2 Methodist Hospital Research Institute—Sepsis

### 2.2.1 Introduction

The Houston Methodist Hospital (HMH) System, in partnership with the Texas Gulf Coast Sepsis Network, received HCIA funding to identify and treat sepsis before it progresses to severe sepsis or septic shock. The Sepsis Early Recognition and Response Initiative (SERRI) targeted patients who were admitted to participating ACHs, long-term care hospitals (LTCHs), SNFs, and rehabilitation facilities, including but not limited to Medicare and Medicaid beneficiaries. Through improved staff training, adherence to evidence-based guidelines, systematic screening, and more-timely treatment, HMH and its partners hoped to identify sepsis cases early and prevent progression of the disease, resulting in reduced rates of organ failure, mortality, and LOS, improved patient outcomes, and lower Medicare spending. HMH received a NCE and operated its program with HCIA support through June 2016. Details on the HMH Sepsis program can be found in the third Annual Report.

### 2.2.2 Summary of Quantitative Findings

#### Core Measures

The four core measures that CMS specified for the HCIA evaluations include three measures of utilization (admissions, readmissions, and ED visits) and one measure of cost (total episode spending). The Methodist Sepsis program received a one-year NCE beyond June 30, 2015, but all HCIA funding was expended as of March 31, 2016. We therefore present estimated changes in utilization and Medicare spending updated through March 31, 2016, three quarters beyond the original HCIA intervention period. We first present results for all patients screened by the program, and then for those patients who screened positive for potential sepsis and received subsequent interventions (the treated population).

For Methodist Sepsis patients whose sepsis screening began in an ACH, the results presented below are for the following core measures:

- Total Medicare spending for 60 days including the index admission and all spending for 60 days after discharge.
- Thirty-day (all cause) readmissions to an ACH following an index admission. Index admission was defined as an admission for a patient eligible for the screening innovation, in either an intervention or comparison hospital.
- Thirty-day post-discharge (all cause) visits to an ACH ED following an index admission.

The following core measures results are presented for Methodist Sepsis patients whose sepsis screening began in an SNF, in-patient rehabilitation facility (IRF), or LTCH:

- Total Medicare episode spending for 60 days including the index admission and all spending for 60 days after admission. Index admission was defined as an admission for a patient eligible for the screening innovation, in either an intervention or comparison SNF or LTCH.
- Admission (transfers) from SNF or LTCH to ACH.
- Thirty-day post-admission (all cause) visits to an ACH ED following an index admission.

The Methodist Sepsis program also aimed to reduce hospital LOS and avoid complications for patients with sepsis. We therefore present results for the following additional measures for patients in the acute care setting:

- Inpatient LOS
- Discharge destination

Please see Technical Appendix B to the Third Annual Report for a description of how each outcome measure was specified, methods for the DD regression analyses, and how we selected a comparison group for total Medicare episode spending, 30-day hospital readmissions and ED visits, LOS, and discharge destination. Below we present tables with a single DD estimate for the overall effect of the program for each outcome, averaged across all episodes occurring during the intervention period. For each outcome we also present graphs of DD estimates for each calendar quarter during the intervention. Additionally, we report median regression estimates of 60-day Medicare episode spending.

Implementation did not begin on the same day in all participating facilities. In the graphs below, the red dotted vertical line shows the beginning of the intervention period, and the black dotted vertical lines indicate the quarters when various participating facilities began their program implementation. Estimated changes reported below are based on 13 quarters of post-implementation data for the acute care component of the intervention, and 11 for the LTPAC component.

**Summary of Core Measures—Acute Care Setting**

Exhibit 2.2A summarizes the average effect of the Methodist Sepsis ACH screening program on total 60-day spending (including the inpatient stay and all claims in the following 60 days), 30-day inpatient readmissions, and 30-day ED visits per episode, pooled across all quarters.<sup>4</sup> The exhibit also presents the estimated effect of the program on spending, aggregated across all episodes that occurred during the intervention period. Exhibit 2.2B summarizes the same measures for patients diagnosed with sepsis. We did not estimate any significant differences between intervention and comparison patients across any of the measures in either group.

**Exhibit 2.2A: Core Measures Summary—Methodist Sepsis: Screened Patients**

Outcome	Estimate	90% CI
<b>Aggregated results</b>		
Total spending (in millions)	2.19	(-10.36, 14.75)
<b>Per episode: (N = 74,640)</b>		
Total 60-day spending	29.40	(-138.79, 197.60)
Thirty-day inpatient readmissions	-0.04	(-0.40, 0.33)
Thirty-day ED Visits	0.01	(-0.39, 0.41)

The estimated change in outcomes spans the entire intervention period from 2013Q1 through 2016Q1.

<sup>4</sup> We did not adjust for inflation in measures of Medicare spending. The DD regression estimates are accurate, as inflation applies equally to both intervention and comparison groups.

**Exhibit 2.2B Core Measures Summary— Methodist Sepsis: Septic Patients**

Outcome	Estimate	90% CI
<b>Aggregated results</b>		
Total spending (in millions)	3.85	(-2.61, 10.32)
<b>Per episode: (N = 7,602)</b>		
Total 60-day spending	506.98	(-343.95, 1357.91)
Thirty-day inpatient readmissions	-0.69	(-1.88, 0.50)
Thirty-day ED Visits	-0.89	(-2.13, 0.36)

The estimated change in outcomes spans the entire intervention period from 2013Q1 through 2016Q1.

\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

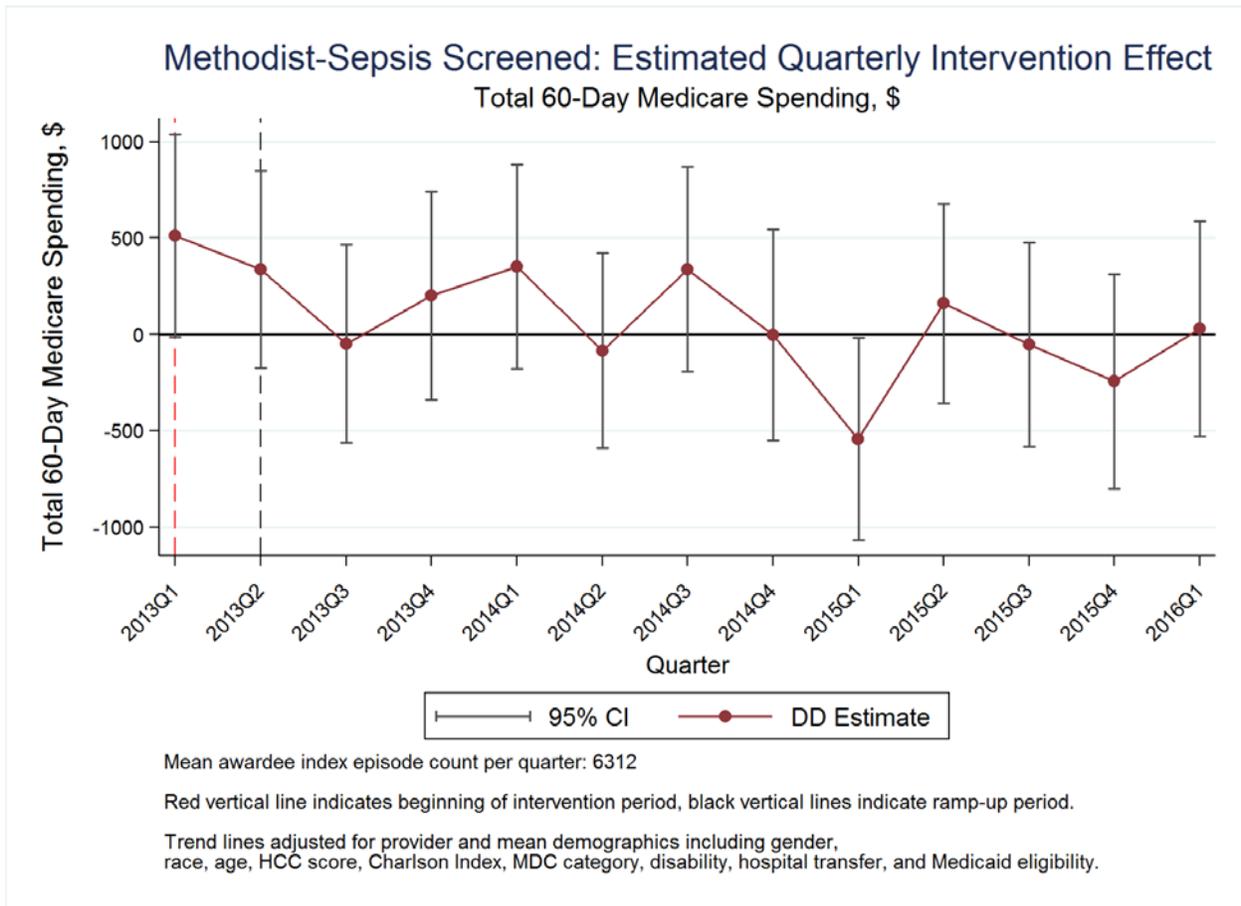
Source: Abt Associates, January 2017.

Exhibit 2.2C (60-day episode Medicare spending) includes the inpatient stay and all claims in the following 60 days, for the entire population that was screened for sepsis by calendar quarter. Exhibit 2.2D shows the average Medicare spending for the 60-day episode for the subpopulation of patients with sepsis coded on their claims, by calendar quarter. In both the larger screened population and the smaller septic subpopulation, there was no correlation between spending and the intervention. This result was consistent with the pooled estimates in Exhibit.2.2A.

Exhibit 2.2E shows that median spending per episode increased by roughly \$107 per episode relative to the comparison group among the entire screened population (p<0.01) and by roughly \$883 per episode among patients with sepsis coded on their claims (p<0.10). These combined results suggest that spending increased for the “typical” patients in both populations but did not change substantially among the most or least expensive patients.<sup>5</sup>

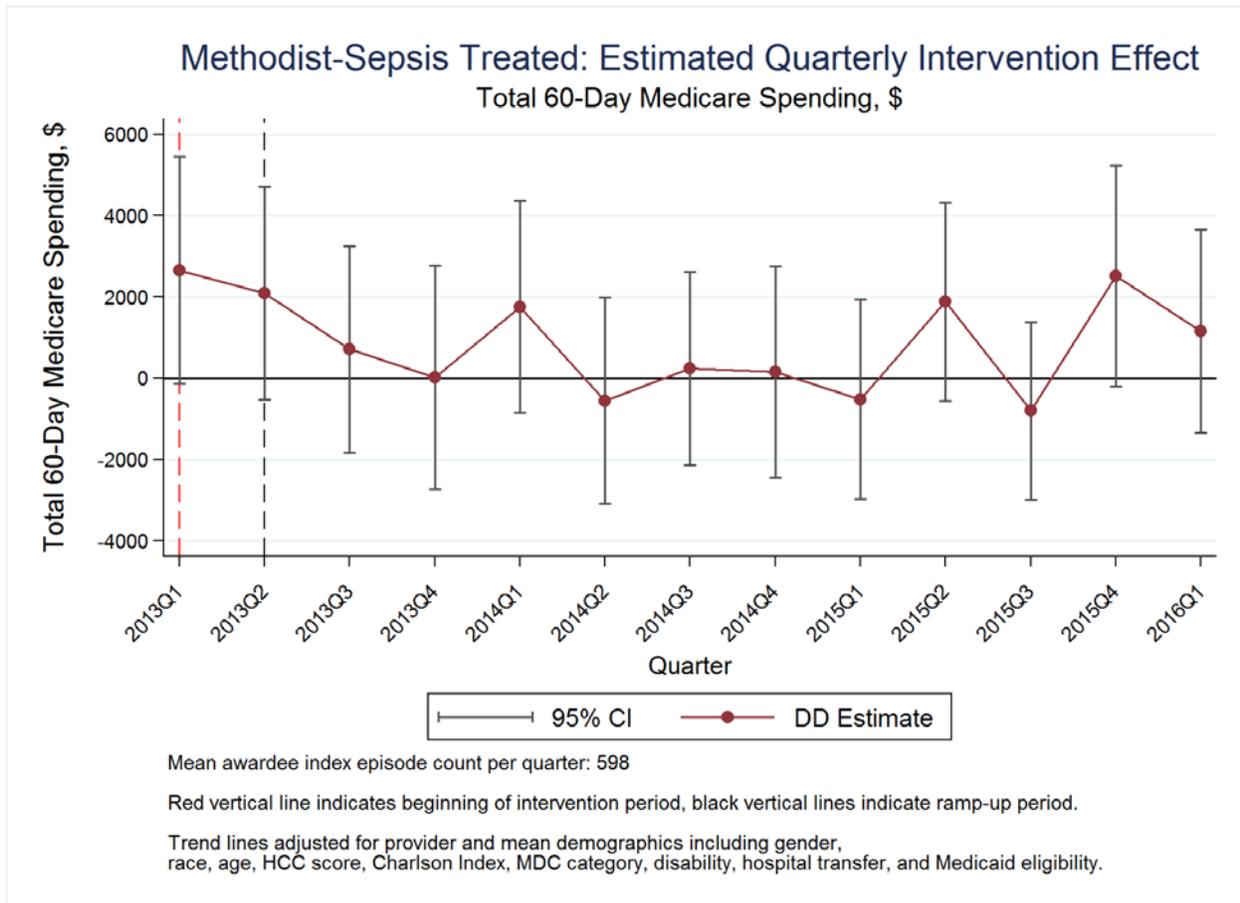
<sup>5</sup> Although patients diagnosed with sepsis are more clinically serious than a typical screened patient, the median cost of a septic patient is less than the 75th percentile of the screened cost distribution. Thus, even the typical septic patient is not an extreme cost case among the general screened population.

**Exhibit 2.2C: Medicare Episode Spending—Acute Care Hospital Patients, Screened Patient Population**



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Exhibit 2.2D: Medicare Episode Spending—Acute Care Hospital Patients, Septic Patient Population**



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Exhibit 2.2E: DD Estimated Effect of Intervention on Median Total 60-Day Medicare Spending for Screened and Septic Acute Care Patient Populations**

Methodist Sepsis: Screened		
Intervention effect (\$)	Estimate	107.43***
(Median regression)	Standard error	(32.78)
	Sample size	[482,477]

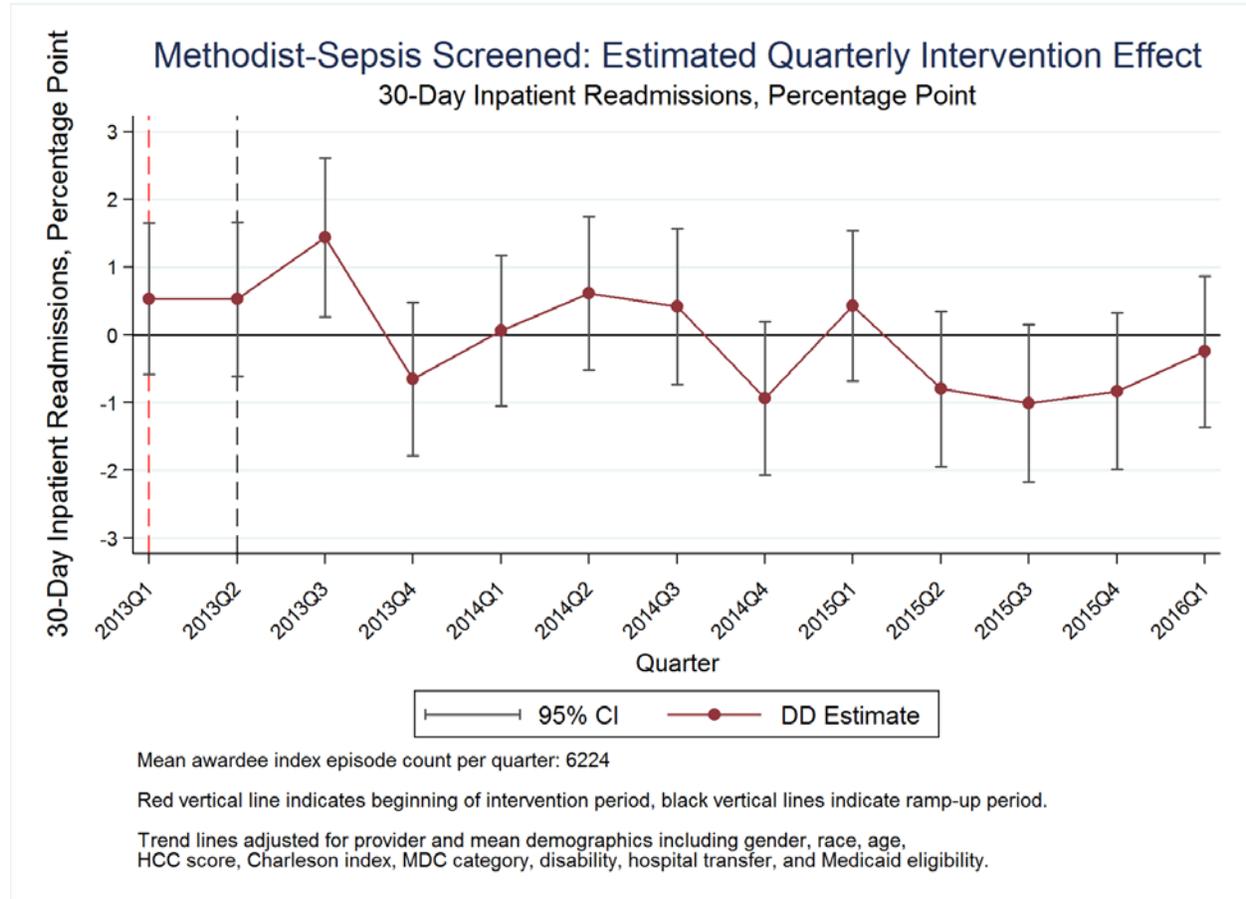
Methodist Sepsis: Received sepsis bundle		
Intervention effect (\$)	Estimate	883.26*
(Median regression)	Standard error	(512.44)
	Sample size	[47,471]

\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates, January 2017.

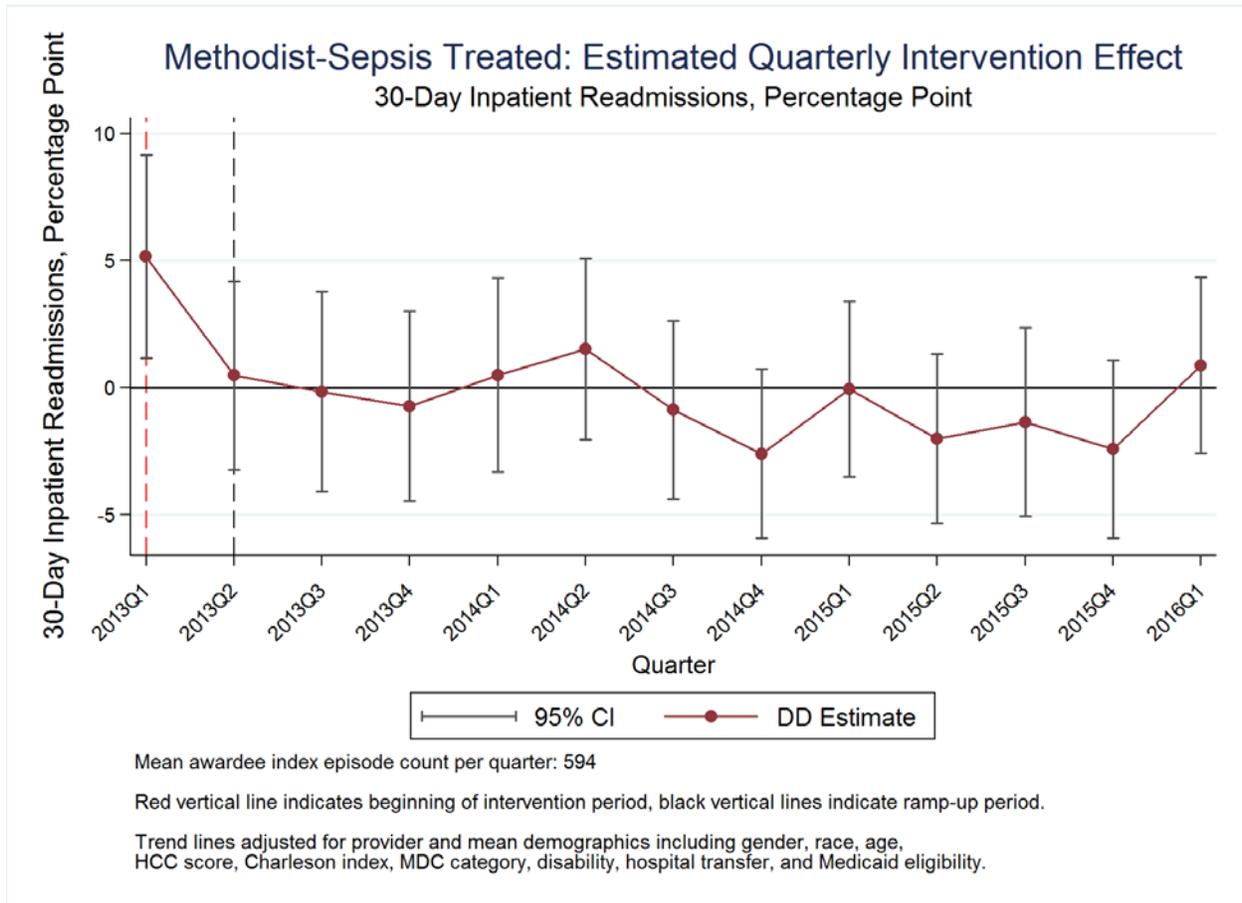
Exhibits 2.2F and 2.2G show the intervention effect on hospital readmissions within 30 days after discharge from an ACH, by calendar quarter. There was no consistent program impact on 30-day readmissions for patients who were first screened for sepsis in an ACH.

**Exhibit 2.2F: Readmissions—Acute Care Hospital Patients, Screened Population**



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

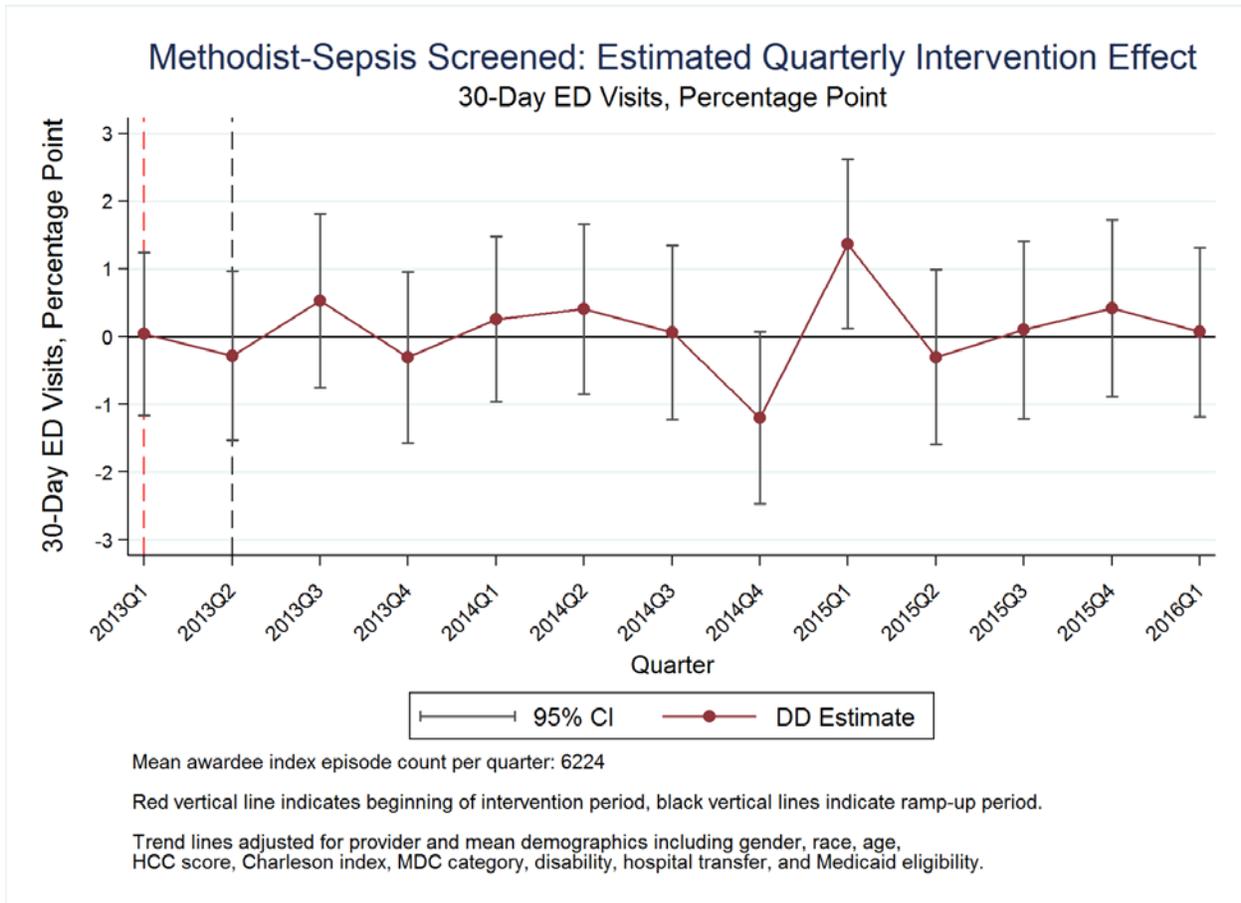
Exhibit 2.2G: Readmissions—Acute Care Hospital Patients, Septic Subpopulation



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

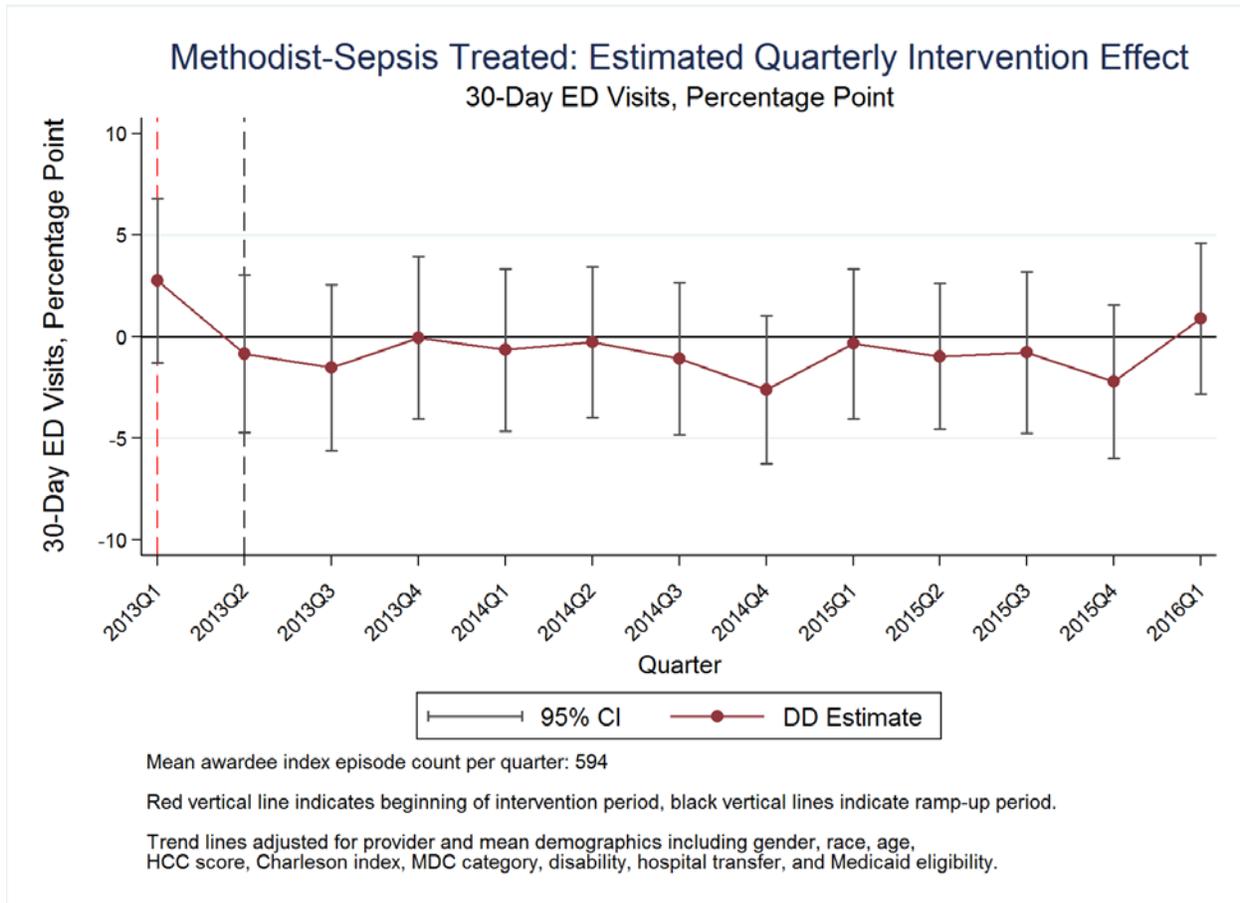
Exhibit 2.2H shows no intervention effect on the rate of post-discharge ED visits among patients screened for sepsis, relative to similar patients in the comparison group. However, Exhibit 2.2I shows that for the subpopulation with sepsis coded on claims, the intervention was consistently associated with lower rates of post-discharge ED visits relative to the comparison group, except for the final quarter of funding. Although the difference was small and no individual quarterly estimate was statistically significant, it is possible that the lack of statistical significance may be due to the small sample size rather than the absence of a true underlying difference.

Exhibit 2.2H: Thirty-Day Post-Discharge ED Visits, Screened Population



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.2I: Thirty-day Post-Discharge ED Visits, Septic Subpopulation



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

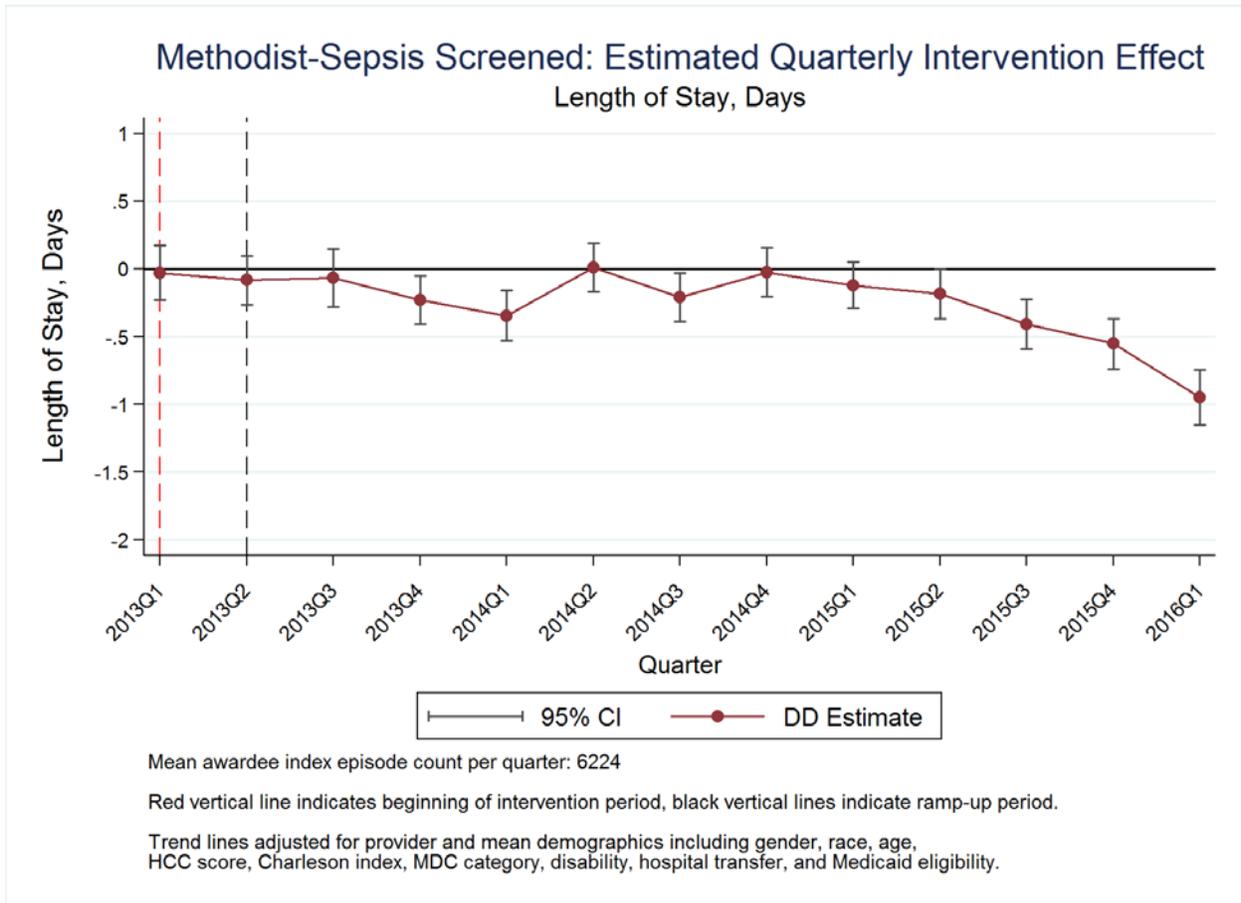
**Index Admission LOS—Acute Care Patients**

The Methodist Sepsis program aimed to detect sepsis early and prevent its progression to severe sepsis. We might expect to see a reduction in LOS if septic patients are identified and treated early, before the disease progresses. Exhibit 2.2J shows that screening reduced inpatient LOS for the population of patients screened in ACHs, relative to the comparison group, particularly starting in Quarter 2 2015. This effect is consistent with Exhibit 2.2K, which shows that over the full course of the intervention, hospital inpatient LOS decreased relative to the comparison group by an average of 0.25 days among patients screened for sepsis (p<0.01).

Exhibit 2.2L shows no consistent relationship between inpatient LOS and the intervention for the subpopulation of patients with sepsis coded on claims. The pooled estimate reported in Exhibit 2.2K was positive but not statistically significant.

This combination of results indicates that the effect of the intervention on inpatient LOS was more apparent for the overall screened population than for the subpopulation with sepsis. This may suggest that the additional screening identified emerging and serious health conditions other than sepsis, which might otherwise have resulted in longer stays.

**Exhibit 2.2J: Index Admission Inpatient LOS, Screened Population**



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Exhibit 2.2K: DD Estimated Effect of Intervention on LOS for Acute Care Patients**

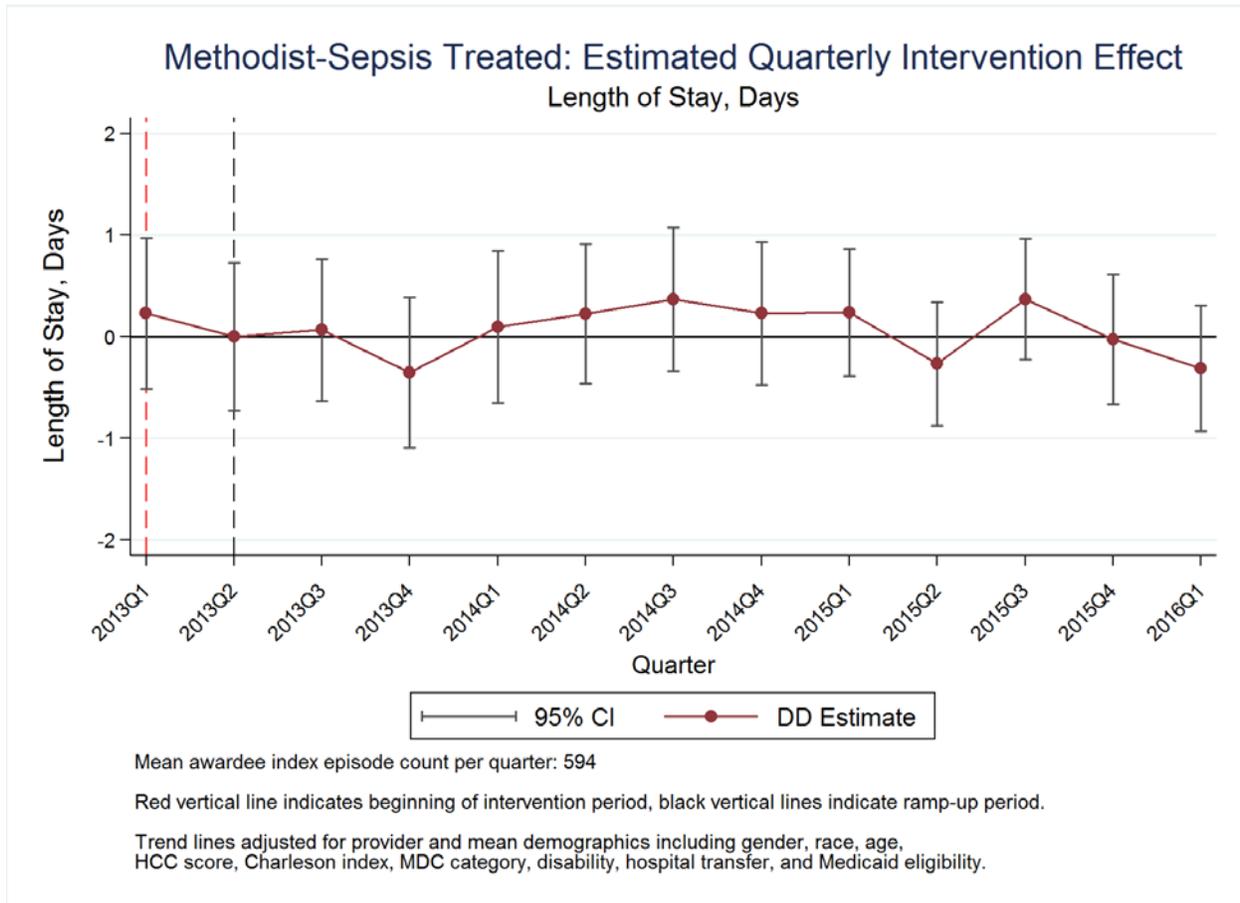
Methodist Sepsis: Screened		
Intervention effect	Estimate	-0.25***
	Standard error	(0.05)
	Sample size	[474,188]

Methodist Sepsis: Received Sepsis Bundle		
Intervention effect	Estimate	0.03
	Standard error	(0.14)
	Sample size	[47,303]

\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.2L: Index Admission-Inpatient LOS, Septic Subpopulation



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Discharge Destinations for Acute Care Patients**

We examined patterns in the settings to which patients were discharged after their index hospitalization. Exhibit 2.2M shows that among hospitalized patients screened for sepsis, the rate of discharge to home without home health care declined by 2.52 percentage points ( $p < 0.01$ ) relative to the comparison group, while the rate of discharge to LTPAC institutions (IRF, SNF, LTCH) declined by 0.40 percentage points ( $p < 0.05$ ). The rate of discharge to home health care increased by 0.84 percentage points ( $p < 0.01$ ), while the rate of discharge to “other” PAC settings (e.g., hospice, federal hospital, psychiatric hospital) increased by 2.08 percentage points ( $p < 0.01$ ).

Among the subpopulation of septic patients, there was a significant 1.37 percentage point decrease in patients discharged home without home health care ( $p < 0.10$ ) driven by a 1.67 percentage point increase in the rate of discharge to “other” PAC settings ( $p < 0.05$ ).

**Exhibit 2.2M: DD Estimated Change in Episode Discharge Destination**

**Methodist Sepsis—Screened Population**

	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4	2015 Q1	2015 Q2	2015 Q3	2015 Q4	2016 Q1	Overall
<b>Home</b>														
DD	-2.93***	-3.28***	-2.49*	-4.02***	-1.91***	-3.21***	-2.96***	-2.65***	-1.78**	-2.67***	-1.54**	-2.50***	-2.91***	-2.52***
SE	0.70	0.72	0.73	0.72	0.70	0.72	0.73	0.71	0.69	0.72	0.73	0.74	0.71	0.27
<b>Home Health</b>														
DD	1.33**	1.42**	1.16**	2.23***	1.51***	-0.07	1.11*	0.92*	-0.02	0.94*	0.22	0.43	0.60	0.84***
SE	0.54	0.56	0.57	0.59	0.56	0.53	0.57	0.56	0.53	0.57	0.55	0.56	0.54	0.21
<b>Skilled Nursing Facility/Inpatient Rehabilitation Facility/Long-Term Care Hospital/Other Nursing Home</b>														
DD	0.24	-0.37	-0.35	0.28	-1.00*	1.14*	-1.09*	-0.96	-1.53***	-0.97	-0.93	0.40	-0.33	-0.40*
SE	0.61	0.62	0.63	0.62	0.59	0.64	0.61	0.60	0.59	0.62	0.62	0.65	0.62	0.24
<b>Other</b>														
DD	1.36***	2.23***	1.69***	1.51***	1.40***	2.14***	2.94***	2.69***	3.33***	2.69***	2.24***	1.67***	2.65***	2.08***
SE	0.41	0.46	0.44	0.41	0.39	0.43	0.48	0.44	0.48	0.45	0.44	0.42	0.44	0.16

**Methodist Sepsis—Septic Subpopulation**

	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4	2015 Q1	2015 Q2	2015 Q3	2015 Q4	2016 Q1	Overall
<b>Home</b>														
DD	-3.37	-0.43	-2.38	-1.10	0.69	-0.15	-1.56	-2.19	-3.61**	0.62	-1.75	-4.87***	-0.39	-1.37*
SE	2.16	2.18	2.14	2.06	2.13	1.98	1.90	1.86	1.81	1.81	1.91	1.75	1.80	0.81
<b>Home Health</b>														
DD	1.86	0.59	0.85	-2.74**	1.86	-1.82	0.81	0.80	0.27	-1.64	0.01	0.68	-1.28	-0.01
SE	1.79	1.62	1.65	1.28	1.66	1.32	1.57	1.51	1.53	1.25	1.47	1.50	1.27	0.59
<b>Skilled Nursing Facility/Inpatient Rehabilitation Facility/Long-Term Care Hospital/Other Nursing Home</b>														
DD	0.68	-2.33	1.62	4.15*	-3.27	3.57	-3.94*	-2.18	-1.84	-3.72*	0.11	4.07*	0.46	-0.30
SE	2.46	2.45	2.48	2.42	2.39	2.32	2.36	2.27	2.28	2.24	2.41	2.31	2.17	0.94
<b>Other</b>														
DD	0.83	2.17	-0.10	-0.31	0.71	-1.60	4.70**	3.57**	5.18***	4.74***	1.64	0.12	1.21	1.67**
SE	1.65	1.73	1.65	1.55	1.66	1.38	1.90	1.69	1.80	1.77	1.71	1.46	1.43	0.66

\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Summary of Core Measures—LTPAC Setting**

Exhibit 2.2N summarizes the average effect of the LTPAC component of the Methodist Sepsis screening program on total 60-day spending (including the inpatient stay and all claims in the following 60 days), 30-day inpatient admissions, and 30-day ED visits per episode, pooled across all quarters.<sup>6,7</sup> It also presents the estimated effect of the program on spending aggregated across all episodes that occurred during the intervention. There were no differences between screened patients and comparison patients in any of the three core measures, nor was the effect on total spending statistically significant, for patients in LTPAC settings.

**Exhibit 2.2N LTPAC Core Measures Summary**

Outcome	Estimate	90% CI
<b>Aggregated results</b>		
Total spending (in millions)	-1.72	(-5.51, 2.07)
<b>Per episode: (N = 5,088)</b>		
Total 60-day spending	-261.70	(-838.44, 315.04)
Thirty-day inpatient admissions	0.15	(-0.96, 1.26)
Thirty-day ED Visits	-0.18	(-1.23, 0.87)

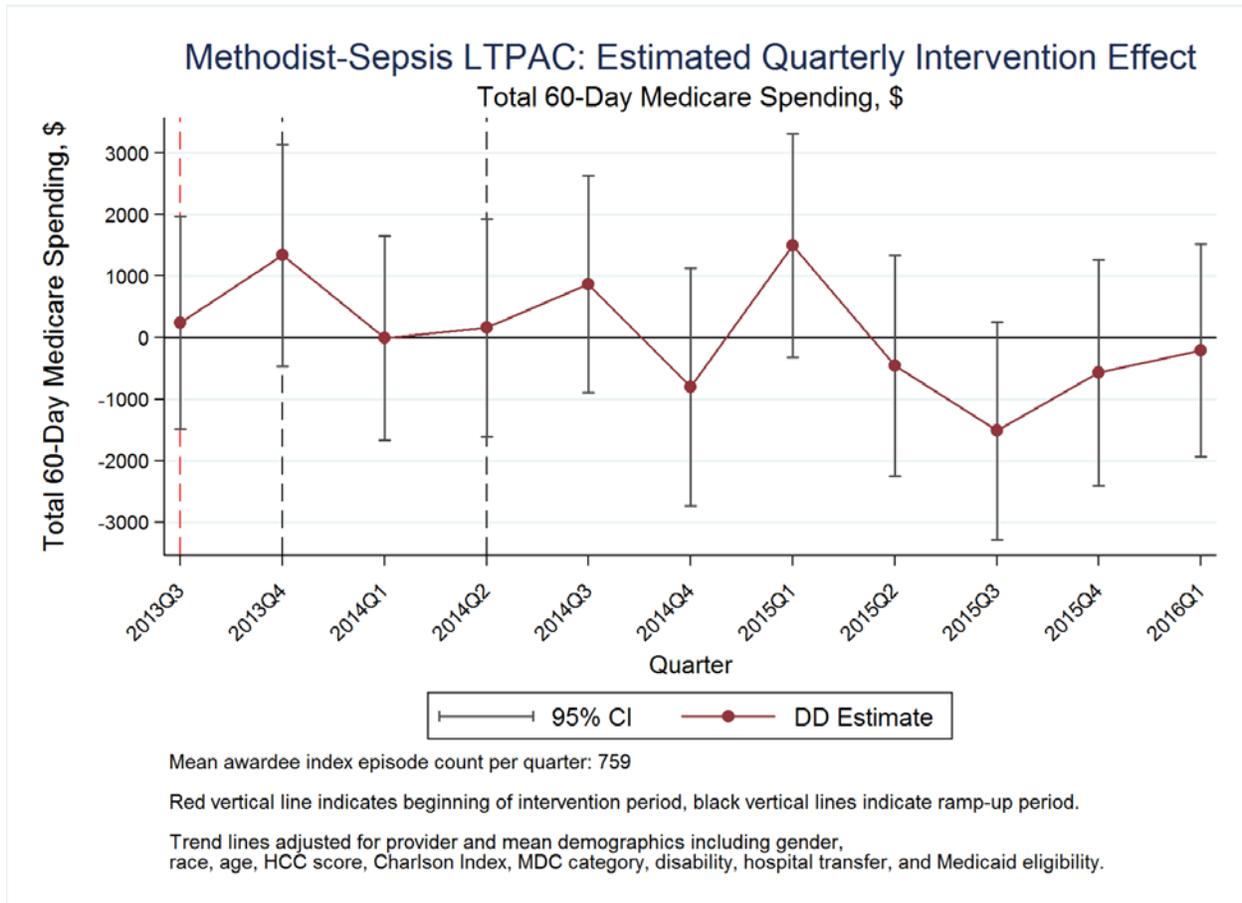
The estimated change in outcomes spans the entire intervention period from 2013Q3 through 2016Q1.  
 \*p<0.1 \*\*p<0.05 \*\*\*p<0.01  
 Source: Abt Associates, January 2017.

Exhibit 2.2O shows no relationship between changes in the intervention and mean Medicare episode spending for patients who were first screened for sepsis in a LTPAC setting, relative to those in the comparison group. Estimates of median Medicare episode spending from data pooled across all quarters (Exhibit 2.2P) show a small and statistically insignificant difference in spending between intervention and comparison patients.

<sup>6</sup> We did not adjust for inflation in measures of Medicare spending. The DD regression estimates are accurate, as inflation applies equally to both intervention and comparison groups.

<sup>7</sup> We also estimated changes in 60-day ED visits. The direction and magnitude of the effect was similar to the 30-day value, and statistically insignificant.

**Exhibit 2.2O: Medicare Episode Spending—LTPAC Patients**



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Exhibit 2.2P: DD Estimated Effect of Intervention on Median Total 60-Day Medicare Costs for LTPAC Patients**

Methodist Sepsis LTPAC		
Intervention effect (\$)	Estimate	13.01
(Median regression)	Standard error	(401.44)
	Sample size	[126,288]

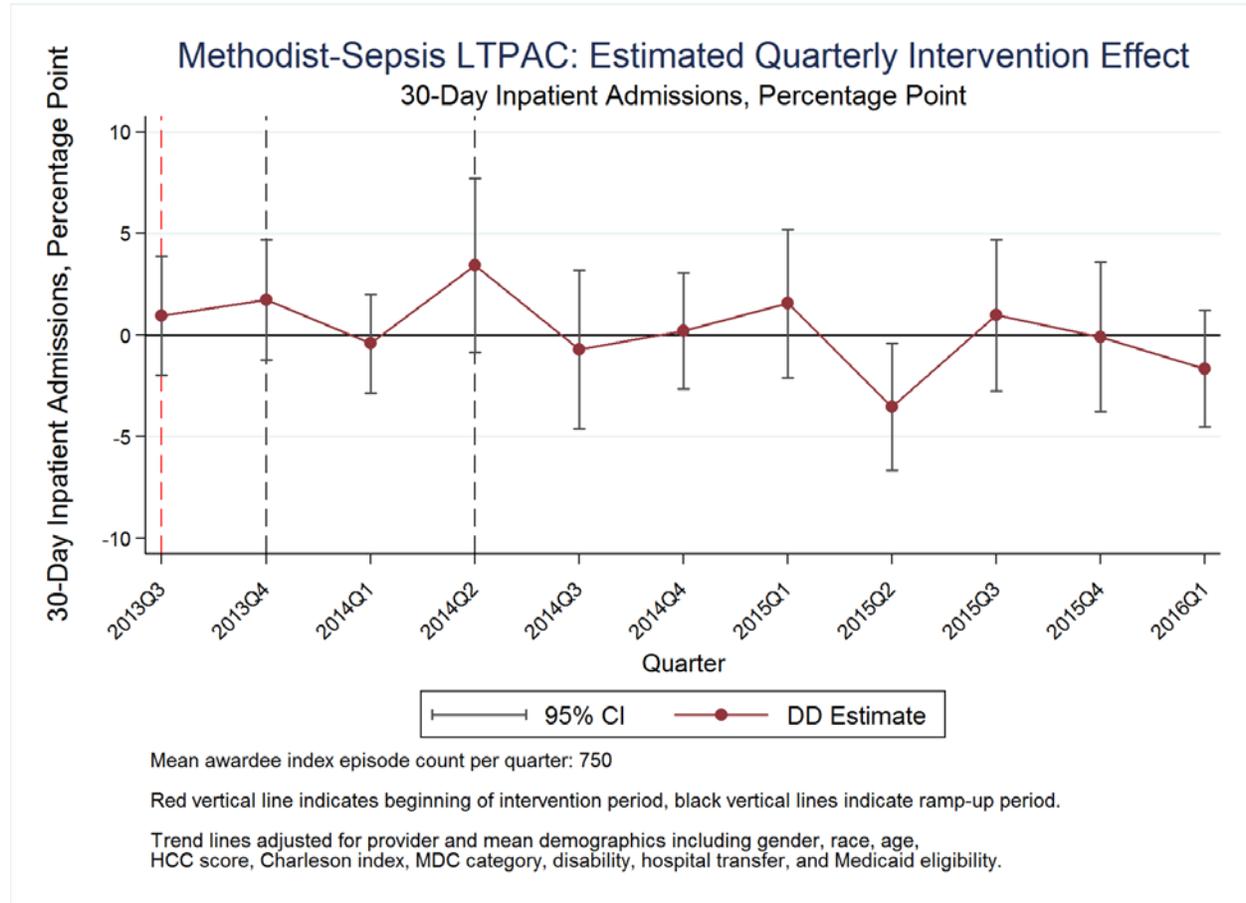
\*p<0.1 \*\*p<0.05 \*\*\*p<0.01

Source: Abt Associates, January 2017.

Exhibit 2.2Q reflects only the patients who were first screened for sepsis while in an SNF or LTCH and shows admissions (transfers) from that facility to an ACH. The episodes reported here are for 30 days after admission to the LTPAC rather than discharge. This is because discharge from the LTPAC may be days or weeks after receipt of the screening. We assume that all intervention patients had at least some sepsis screening during those 30 days. There was no consistent relationship between the intervention and changes in hospital admissions. Likewise, the estimated quarterly intervention effect shown in Exhibit 2.2R shows no consistent relationship between the intervention and change in the rate of 30-day ED

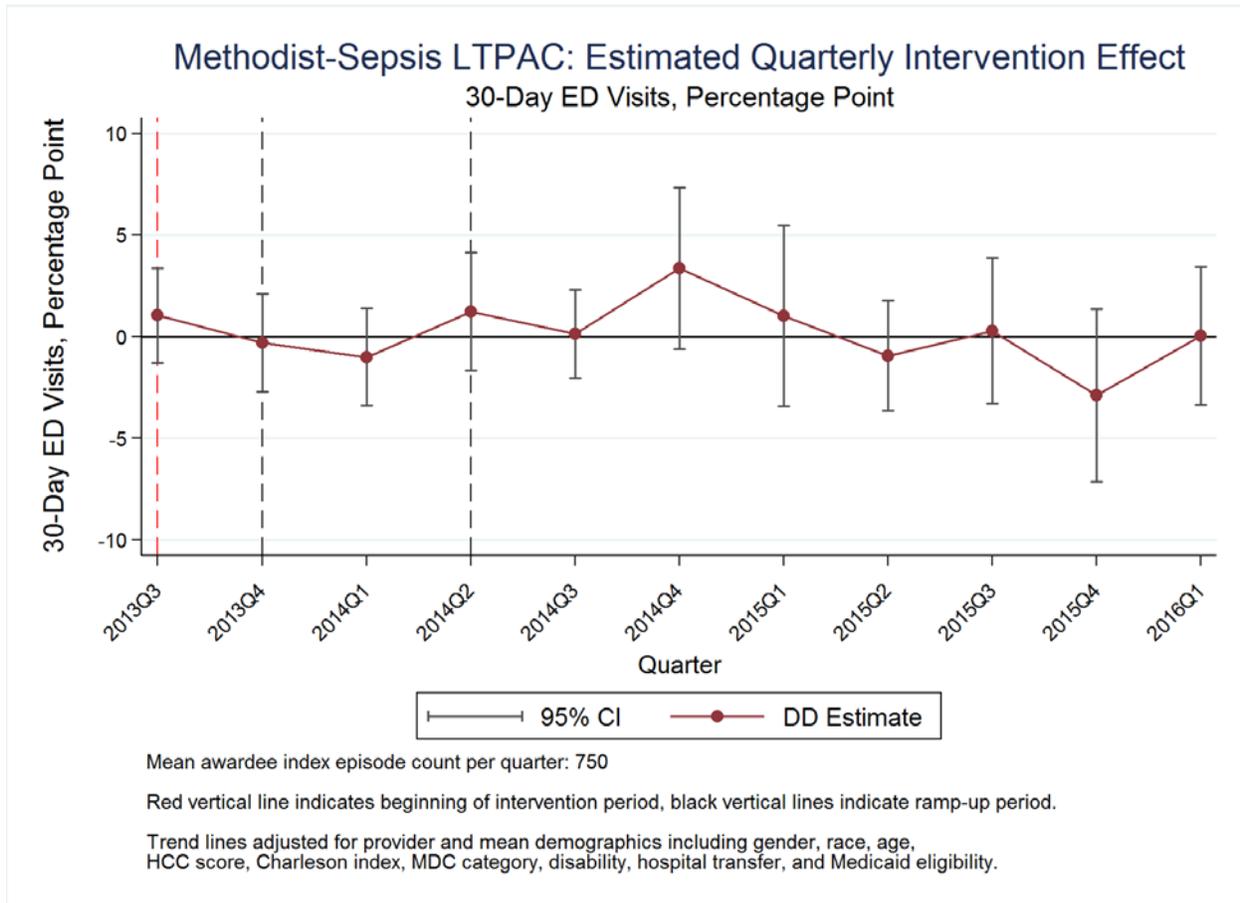
visits. The lack of quarterly trends is consistent with the statistically insignificant pooled estimates reported in Exhibit 2.2N above.

**Exhibit 2.2Q: Hospital Admissions—LTPAC Patients**



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

Exhibit 2.2R: Thirty-Day Post-Admission ED Visits—LTPAC Patients



Source: Abt Associates analysis of Registry and Medicare Claims, January 2017.

**Conclusions**

- The primary finding was a statistically significant decrease in the average LOS for the population screened in the acute-care setting (-0.25 days;  $p < 0.01$ ) relative to the comparison group. There was no effect on LOS for the subpopulation of patients with sepsis identified on their claims.
- We did not estimate any significant differences between the intervention and comparison groups in average Medicare spending, inpatient readmissions, or ED visits, among patients screened for sepsis in the acute-care setting.
- There is evidence of change in discharge destination. Fewer patients were discharged to home or to institutional LTPAC, while more patients were discharged to home health care or “other” LTPAC destinations, relative to the comparison group. However, we did not observe any shifts in discharge destination that coincided with the accelerated decrease in LOS that began in Quarter 3 2015.
- There was no significant impact of the sepsis screening program on average Medicare spending, inpatient readmissions, ED visits, or LOS, among patients treated for sepsis.
- Among patients with sepsis, the program did lead to a small decrease in discharges to home without home care (-1.37 percentage points;  $p < 0.10$ ) and an increase in discharges to “other” post-acute care locations (1.67 percentage points;  $p < 0.05$ ).

- We also estimated a significant \$883 increase in median Medicare spending for the subpopulation with sepsis ( $p < 0.10$ ). The fact that this did not manifest as significantly higher average costs may indicate that the program reduced costs for the most severe septic patients, but increased costs for the more typical sepsis patients.
- The sepsis screening program in the LTPAC setting had no impact on mean or median Medicare spending, inpatient admissions, or ED visits.

As with Methodist Hospital's delirium screening program, the sepsis screening may have taken several years to reach its full potential. This could be due to some shift in the approach to screening or better coordination with the delirium screening program among hospitals working on both initiatives. These suppositions are unsubstantiated, however, because we did not collect additional qualitative information from the Awardee in 2016.

The acute-care sepsis screening program reduced discharges to institutional LTPAC relative to the comparison group, and also decreased discharges directly home without home health care. It is possible that the screening identified additional care needs for some patients, decreasing discharges to home. Earlier identification of signs of sepsis might also have prevented certain conditions from worsening, reducing the need for institutional care after discharge and shifting care from SNFs to home health. The extent to which changing patterns of discharge destination influenced the reduction in LOS is uncertain as there is no obvious change in the pattern that coincides with the accelerated reduction in LOS beginning in 2015Q3. The sepsis screening program was, however, consistently correlated with reduced inpatient LOS, and the changes in discharge patterns were broadly consistent in direction and magnitude over the course of the intervention, suggesting that the two outcomes may be related.