CENTER FOR HEALTH INFORMATION AND ANALYSIS

HOSPITAL-WIDE ADULT ALL-PAYER READMISSIONS

IN MASSACHUSETTS: 2011-2014

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CHIA

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Executive Summary

Unplanned hospital readmissions, many of which are potentially preventable, are costly and affect patient health and experience of care. At the national level, reducing readmissions is at the center of numerous payment and delivery system transformation efforts. In Massachusetts, the Centers for Medicare and Medicaid Services (CMS) is assessing readmission penalties on 78% of the Commonwealth's hospitals for having higher-than-expected readmission rates in federal fiscal year 2016 (October 2015 to September 2016).[1]

This is the second report in the Center for Health Information and Analysis's (CHIA) series of annual reports on acute care hospital readmissions in the Massachusetts all-payer population. The previous report analyzed readmissions for state fiscal years (SFYs) 2011 through 2013 (July 2010 through June 2013). This report updates the findings with SFY 2014 data. As in the previous report, this report uses the Yale/CMS hospital-wide readmissions measure[2] and describes both observed (unadjusted) readmission rates as well as risk-standardized rates that adjust for differences among hospitals in patient case mix and hospital service mix. Due to recent methodological changes in the measure,[3] the rates reported here differ slightly from those in the June 2015 report; CHIA applied the new methodology to prior years for consistency.

The statewide all-payer readmission rate decreased slightly from SFY 2011 to 2013 and remained essentially unchanged from SFY 2013 to 2014. As in prior years, readmission rates in 2014 varied importantly by several factors including patient age, payer type, and discharge setting. CHIA will continue to monitor readmission rates to aid providers, health plans, and policymakers in their continued efforts to increase quality and reduce costs associated with unplanned readmissions.

Notes:

1 Rau, J. (2015). Half of nation's hospitals fail again to escape Medicare's readmission penalties. *Kaiser Health News*, August 3, 2015, available at http://khn.org/news/half-of-nations-hospitals-fail-again-to-escape-medicares-readmission-penalties/.

2 Horwitz et. al. (2012). Hospital-wide all-cause unplanned readmission measure. Final technical report. New Haven CT: Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation. Available from: http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html.

3 Based on findings from a validation study, the Yale/CMS team updated the methodology to improve the identification of planned readmissions. See Section VI and the Appendix for details.

Key Findings

- The all-payer statewide readmission rate declined from 16.1% in SFY 2011 to 15.2% in SFY 2013. The rate for the most recent year, SFY 2014, was 15.3%—essentially unchanged from the 2013 rate.

- Observed readmission rates continued to vary strongly by payer type, with higher rates for patients covered by Medicare and Medicaid (17.4% and 17.0%) and lower rates for the commercially insured (10.3%) in SFY 2014.

- The setting to which patients were discharged was also strongly related to their likelihood of readmission: patients discharged to skilled nursing facilities, home with home health agency care, and rehabilitation had substantially higher observed readmission rates than those discharged to home or hospice (18.3% for the first three settings vs. 12.1% for the latter two).

- Frequently hospitalized patients, defined as those with four or more admissions in any 12-month period between SFY 2011 and 2014, constituted only 7% of the patient population but accounted for 25% of discharges, and 58% of the readmissions.

- After accounting for patient case mix and hospital service mix, few hospitals had readmission rates statistically different from the statewide rate. Of the 62 acute care hospitals included in this analysis, three had risk-standardized readmission rates significantly above the statewide rate, and three had risk-standardized rates significantly below the statewide rate. On an unadjusted basis, readmission rates varied by nearly 40%—from 13% to 18%.

- There is a cohort of seven hospitals that have had consistently high risk-standardized readmission rates (within highest 25%) and another cohort of five hospitals that have had consistently low risk-standardized rates (within lowest 25%) across the four years studied. While the variation in risk-standardized rates among hospitals is small, this pattern indicates that there are consistent differences in hospitals' risk-standardized rates over time.

- Academic medical centers had slightly higher risk-standardized readmission rates than community hospitals (16.1% vs. 15.2%, adjusted for patient case mix and hospital service mix). The risk-standardized readmission rates of disproportionate share hospitals (DSH) and non-DSH hospitals were similar.

- Observed readmission rates—which are influenced by patient burden of illness and other case mix and service mix factors—varied greatly by region, with a high of 18.4% in Fall River and a low of 13.3% on the Cape and Islands. When case mix and service mix are controlled for with risk-standardized rates, the differences among regions narrow considerably.

I. Introduction

Unplanned hospital readmissions, many of which are potentially preventable, are costly and affect patient health and experience of care. Massachusetts has historically had readmission rates higher than the national average.[4] Within the Commonwealth, reducing readmissions has been a focus of reform initiatives by multiple health care players including the Health Policy Commission, the Massachusetts Hospital Association, and commercial insurers. The Centers for Medicare and Medicaid Services (CMS) Hospital Readmissions Reduction Program, implemented as a provision of the Affordable Care Act, has instituted financial penalties for hospitals that have higher-than-expected readmission rates. In federal fiscal year 2016 (October 2015 to September 2016) the program is penalizing the country's acute care hospitals a total of $420 million for higher-than-expected rates.[5] CMS is penalizing 78% of the Commonwealth's hospitals an average of 0.7% of their reimbursements for this period. Both the percentage of hospitals fined and the average level of fines imposed are greater in Massachusetts than in most other states.[6]

To monitor readmissions in the Commonwealth, in 2012 the Massachusetts Statewide Quality Advisory Committee adopted the Yale/CMS Hospital-Wide All-Cause Unplanned 30-day Readmission Measure[7] for the Commonwealth's Standard Quality Measure Set. CHIA adapted the Yale/CMS measure, which was originally developed for use with the Medicare population, for an all-payer population using CHIA's Hospital Inpatient Discharge Database.[8] Evaluating all-payer readmission rates gives providers and policymakers a more comprehensive view of readmissions for identifying options to improve quality and reduce waste.

CHIA reported readmission rates using this measure for the first time in June 2015. That report assessed readmissions in state fiscal years (SFYs) 2011 through 2013. This report, the second in an anticipated annual series of readmission reports, updates the June 2015 report with SFY 2014 data and updates the methodology for all years based on a recent improvement to the measure methodology made by the Yale/CMS team.[9]

Sections II and III of this report describe observed (unadjusted) readmission rates over time and by patient demographics, discharge setting, payer type, discharge diagnosis, and frequent hospitalizations.

Section IV examines risk-standardized readmission rates (RSRRs) for hospitals, and for groups of hospitals categorized by region, system affiliation, tax status, and other factors, as well as trends and patterns in the risk-standardized rates over time. These risk-standardized readmission rates take into account differences among hospitals which may impact readmissions, including patient case mix (patient characteristics including how complicated or seriously ill they are), and service mix (the particular blend of services a hospital provides). These risk-standardized readmission rates allow for a better comparison across hospitals or groups of hospitals.

Section V provides summary conclusions, and Section VI gives information on the methodology used in this report. Further methodological detail is available in Appendix A: Readmissions Methodology.

Notes:

4 Massachusetts Health Policy Commission (2015). 2015 Cost Trends Report. Boston, MA: Health Policy Commission. Available from http://www.mass.gov/anf/budget-taxes-and-procurement/oversight-agencies/health-policy-commission/publications/.

5 See note 1.

6 Massachusetts ranks 7th in the percentage of hospitals penalized and 11th in the average level of penalty imposed. See note 1.

7 See note 2.

8 See Section VI: About the Readmissions Methodology and Appendix A: Readmissions Methodology for details about the methodology and CHIA's adaptations.

9 See note 3.

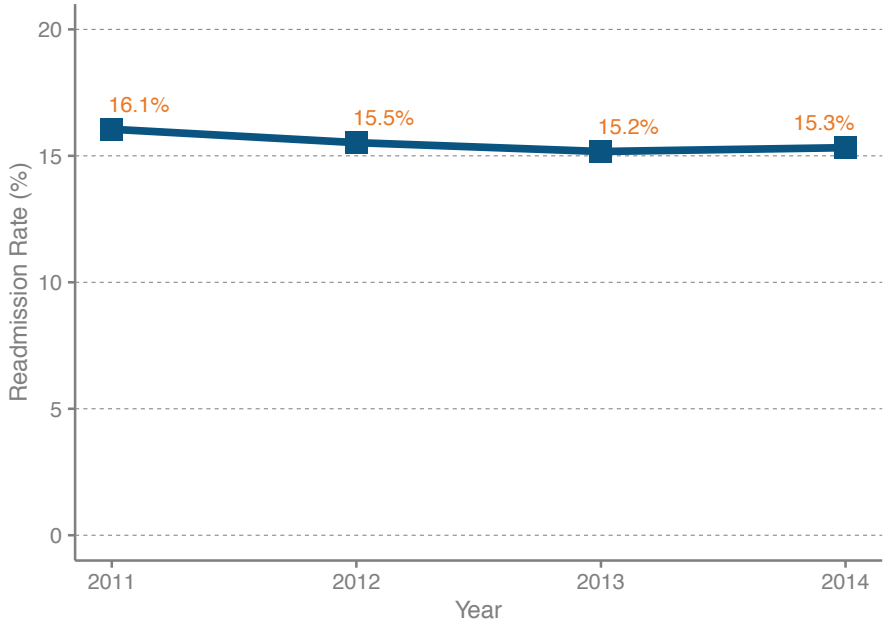
II. Trends in Statewide All-Payer Readmissions

This report is CHIA's second annual report on readmissions and includes data for SFY 2011 to 2014 (July 2010 through June 2014). The information is based on acute care discharges from Massachusetts hospitals among adults aged 18 and over. Obstetric and primary psychiatric hospitalizations are excluded from the calculations.[10]

The observed (unadjusted) statewide readmission rate for SFY 2014 was 15.3%, similar to the SFY 2013 rate (15.2%). This flat trend followed a decline of approximately one percentage point from 16.1% in SFY 2011 to 15.2% in SFY 2013 (Figure 1). This change since SFY 2011 amounts to a 6% relative reduction in the statewide all-payer readmission rate.[11]

1 **Statewide All-Payer Readmission Rate over Time (SFY 2011-SFY 2014)**

In SFY 2014 the statewide readmission rate remained essentially level.



Note: Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2010 – June 2014.

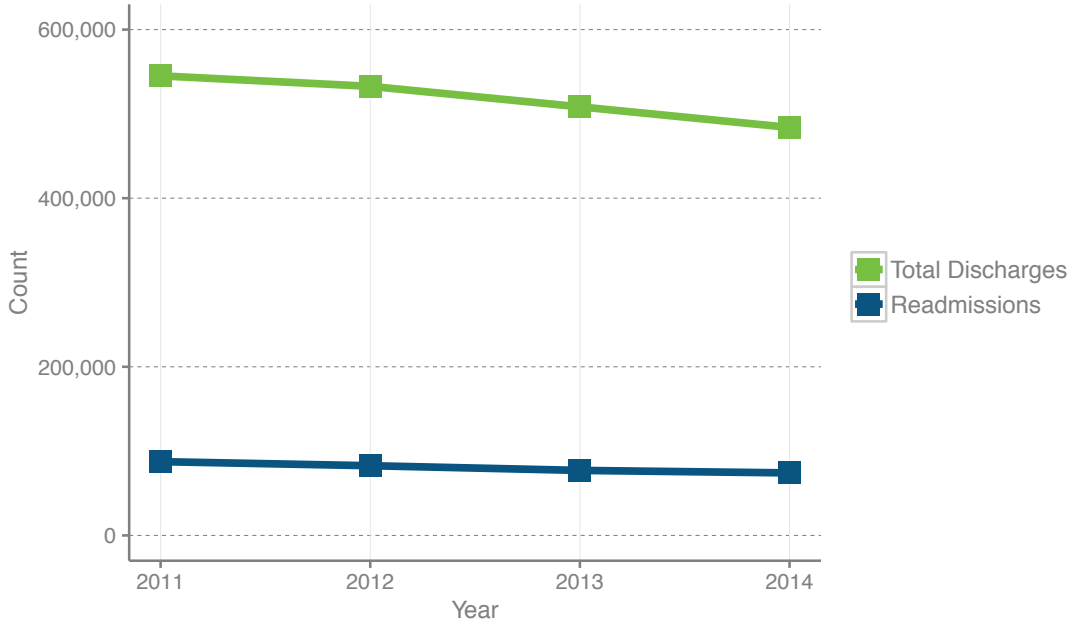
Notes:

10 See Section VI and Appendix A for details on the methodology.

11 Note: The readmission rates reported here for years 2011-2013 differ from the rates reported in CHIA's June 2015 Hospital-Wide All-Payer Readmissions Report for those years. This change is due to an update in the CMS measure methodology to improve the identification of planned readmissions. See Section VI: About the Readmissions Methodology and Appendix A: Readmissions Methodology for details about these changes.

2 Trends in Statewide All-Payer Discharges and Readmissions over Time (SFY 2011-SFY 2014)

The numbers of both discharges from acute care hospitals and readmissions have declined from SFY 2011 levels.



Note: Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2010 – June 2014.

T1 Discharges, Readmissions, and Readmission Rates by Fiscal Year (SFY 2011 to SFY 2014)

State Fiscal Year	Discharges		Readmissions		Readmission Rate
	Count	Pct. Change from Previous Year	Count	Pct. Change from Previous Year	(%)
2011	545,116	--	87,498	--	16.1%
2012	532,666	-2.3%	82,682	-5.5%	15.5%
2013	508,354	-4.6%	77,127	-6.7%	15.2%
2014	483,892	-4.8%	74,144	-3.9%	15.3%

Note: Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2010 – June 2014.

These modest changes in the statewide readmission rate over the past four years are occurring in the context of an overall decline in inpatient volume within the Commonwealth.[12]

From SFY 2013 to 2014, the number of both discharges and readmissions declined (Figure 2). The number of discharges declined at a greater rate than the number of readmissions (4.8% vs. 3.9%), resulting in a slightly higher readmission rate for SFY 2014 (Table 1).

Notes:

12 Center for Health Information and Analysis (2015). Acute hospital utilization report, FY2009-FY2013. Boston, MA: CHIA. Available from: http://www.chiamass.gov/utilization-analysis/.

III. Statewide All-Payer Readmissions

This section reports observed readmissions in SFY 2014 by several factors including patient demographics, discharge setting, discharge diagnosis, and payer type. Readmission patterns of patients who frequently use hospital services are also provided.

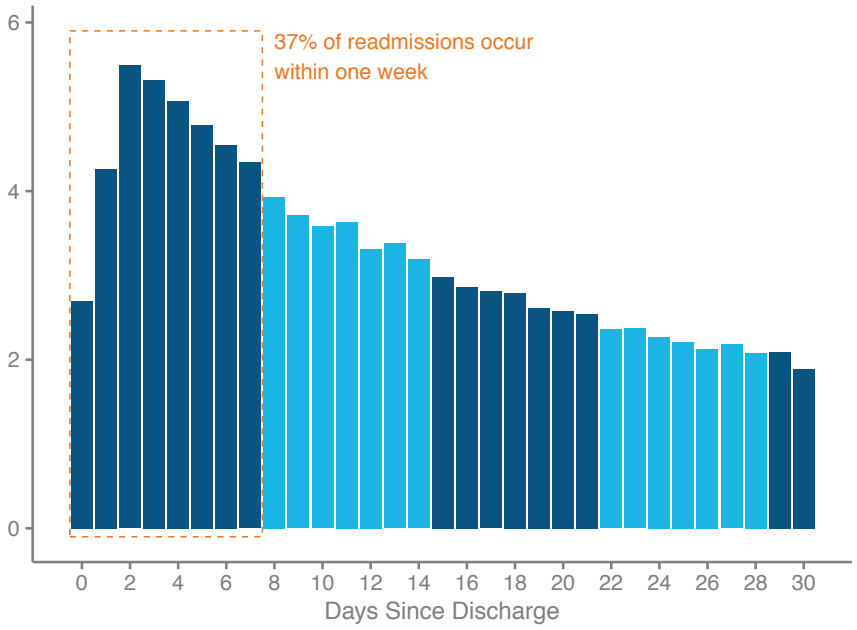
1. Timing of Readmissions

In this analysis, any unplanned admission within 30 days of an eligible discharge[13] is counted as a readmission. Therefore, readmissions can occur at any point within the 30-day period following an eligible discharge.

Readmissions peak at two days since the initial discharge and show a steady decline thereafter (Figure 3). More than one-third (37%) of all readmissions occur within 7 days of discharge, and the majority of readmissions (61%) occur within two weeks of discharge.

3 **All-Payer Readmissions by Days since Discharge (SFY 2014)**

Readmissions peaked two days after discharge but occurred throughout the 30-day period.



Note: Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

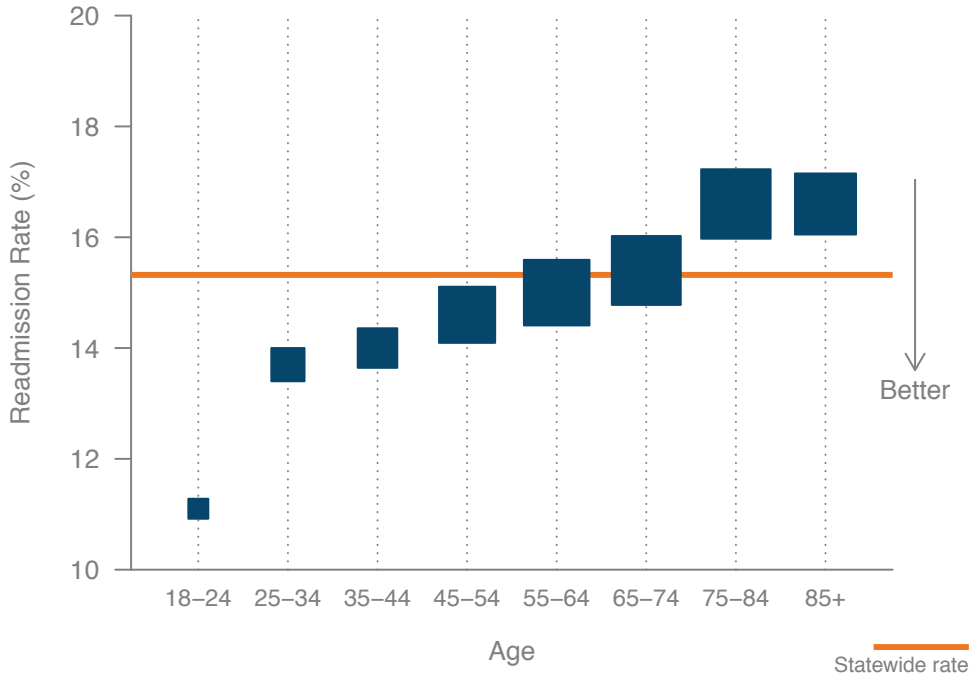
Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

Notes:

13 A specific set of criteria is applied to define the set of eligible "index" admissions, which may or may not subsequently result in a readmission. For details see Section VI: About the Readmissions Methodology, and Appendix A: Readmissions Methodology.

4 **All-Payer Readmission Rates by Patient Age (SFY 2014)**

Readmission rates increased with patient age.



Note: The size of the squares in the figure is proportional to the number of readmissions. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

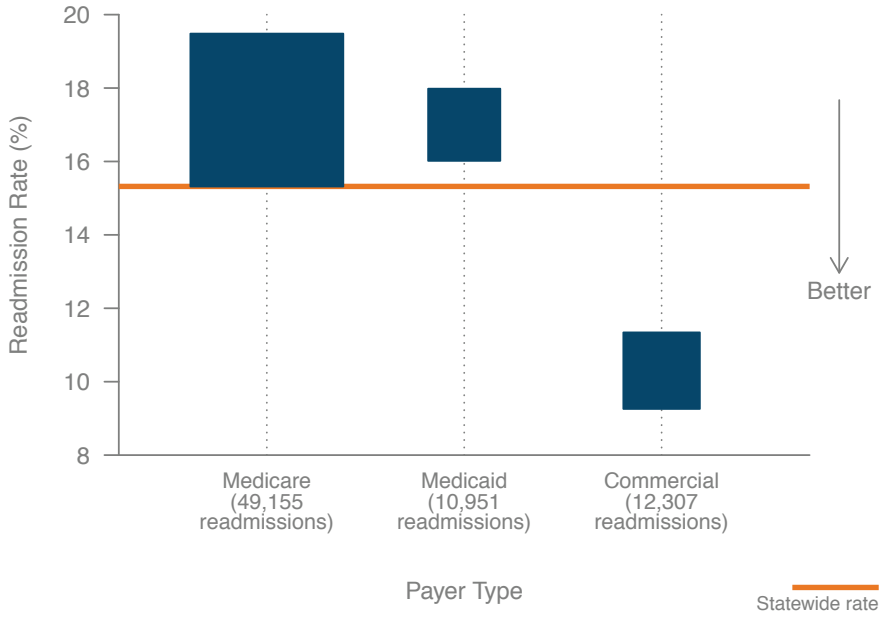
2. Readmissions by Demographics

Readmissions are associated with patient age: rates increase with age, from 11.1% in young adults (age 18-24) to 16.6% in those aged 75 and older. Elderly patients (age 65+) account for 53% of hospital discharges and 56% of readmissions.

Readmissions are more common among men (16.1%) than women (14.6%); women account for a slightly higher proportion of discharges (52.2%) but a lower proportion of readmissions (49.7%). Obstetric discharges, which typically have a low readmission rate, are excluded from the calculations in this report.

5 **All-Payer Readmissions by Payer Type (SFY 2014)**

Patients with commercial payers had lower readmission rates than those with public payers.



Note: The size of the squares in the figure is proportional to the number of readmissions. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

T2 **All-Payer Readmission Rates by Payer Type (SFY 2014)**

	Number of Discharges	Percent of Discharges	Number of Readmissions	Percent of Readmissions	Readmission Rate
Commercial	119,549	24.7%	12,307	16.6%	10.3%
Medicare	283,122	58.5%	49,155	66.3%	17.4%
Medicaid	64,554	13.3%	10,951	14.8%	17.0%
Total	**483,892**	**100.0%**	**74,144**	**100.0%**	**15.3%**

Note: Figures in the table rows do not sum to the Total values because they exclude Self-Pay and Other payer categories, which together account for 4% of discharges, as well as a small number of discharges missing payer type information. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

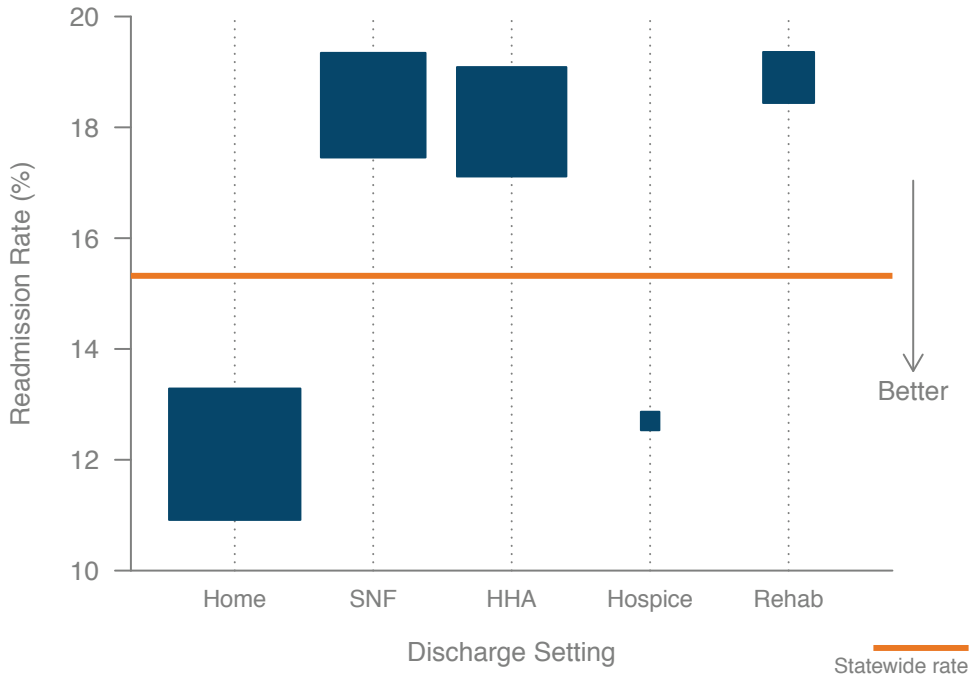
Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

3. Readmissions by Payer Type

Readmissions funded by public payers comprised 81% of all readmissions in the state in SFY 2014. Medicare and Medicaid readmission rates were higher and similar (17.4% and 17.0%, respectively), while the readmission rate for discharges covered by private plans was lower (10.3%). As Medicare, Medicaid, and commercially insured patient populations differ widely on demographic, socioeconomic, and clinical characteristics, these differences in readmission rates by payer type likely reflect multiple factors.

6 **All-Payer Readmission Rates by Discharge Setting (SFY 2014)**

Patients discharged to home (without home health agency care) and hospice had lower readmission rates than those discharged to post-acute care.



Note: Note: SNF = Skilled nursing facility. HHA= Home with home health agency care. The size of the squares in the figure is proportional to the number of readmissions. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

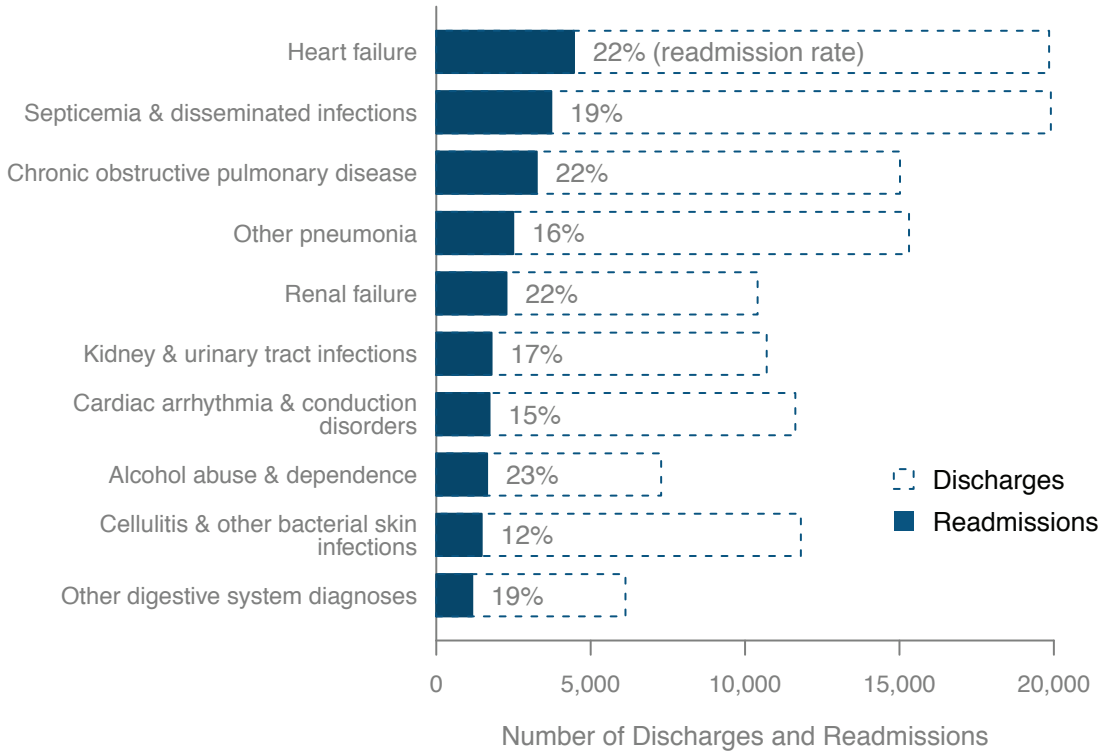
Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

4. Readmissions by Discharge Setting

Patients initially discharged to skilled nursing facilities, home with home health agency care, and rehabilitation had substantially higher rates of readmission than those discharged to home or hospice (collectively 18.3% vs. 12.1%, Figure 6). Discharges to home were the most prevalent (49%) but accounted for a smaller proportion of readmissions (39%). These differences in readmission patterns between settings are likely due to multiple factors including the characteristics of patients that tend to be discharged to different settings.

7 **Discharge Diagnoses Resulting in the Highest Number of Readmissions (SFY 2014)**

The top 10 diagnostic conditions each accounted for between 1,000 and 4,500 readmissions.



Note: The percentage figure in each bar gives the readmission rate for that diagnosis. Diagnostic categories are defined by the All-Payer Refined Diagnosis-Related Group (APR-DRG). Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

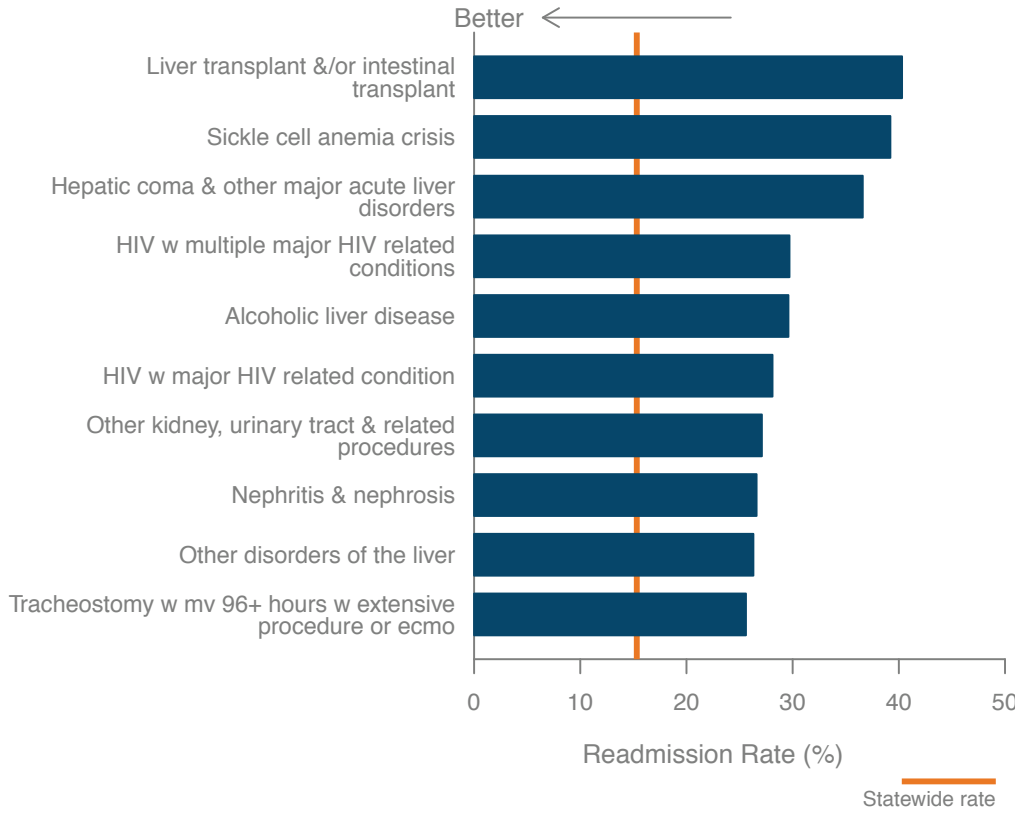
Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

5. Readmissions by Discharge Diagnosis

Understanding the diagnoses that result in the highest *numbers* of readmissions and those that result in the highest *rates* of readmissions can both be useful for improving care. Figure 7 shows the top 10 diagnoses associated with the highest numbers of readmissions, while Figure 8 shows those associated with the highest readmission rates. The single condition associated with the largest number of readmissions, heart failure, accounted for 4,460 readmissions in SFY 2014, or 6% of all readmissions. Together, the top 10 conditions account for 26% of the discharges and 32% of the readmissions in SFY 2014. There is substantial stability in the most frequent diagnoses over time; nine of the 10 conditions were also among the top 10 conditions for SFY 2013.

8 Discharge Diagnoses Resulting in the Highest Rates of Readmissions (SFY 2014)

The top 10 conditions by readmission rate all had rates above 25%.



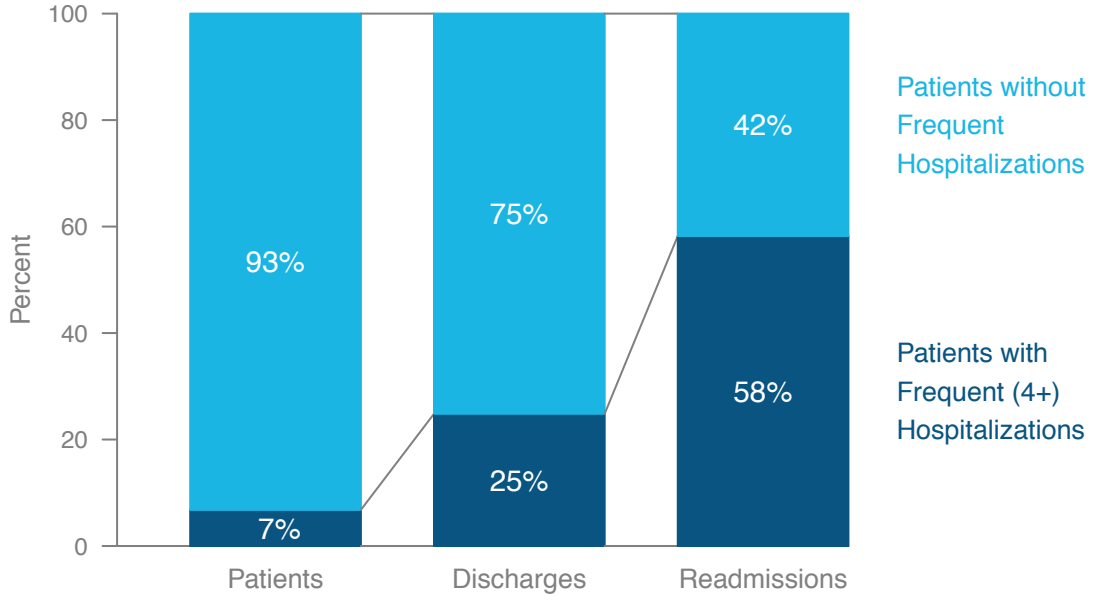
Note: Diagnostic categories are defined by the All-Payer Refined Diagnosis-Related Group (APR-DRG). Diagnoses with fewer than 100 discharges are excluded from the analysis. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

In addition to examining the diagnoses that resulted in the highest *numbers* of readmissions, it is also informative to identify the diagnoses associated with the highest *rates* of readmission. These latter diagnoses account for few total readmissions, but the high rates of readmission make them potentially fruitful areas of focus since resources could be targeted at high-risk groups. Figure 8 shows the ten conditions associated with the highest readmission rates. Diagnoses associated with liver disease, kidney disease, and HIV dominate the list, which are highly complex conditions. The rates for the 10 conditions range from 25.6% for tracheostomy to 40.3% for liver transplant. Despite these high rates however, these conditions account for only 3% of the total number of readmissions. The 10 conditions shown here are broadly similar to those associated with the highest readmission rates in SFY 2013: eight are among the top 10 for SFY 2013.

9 **All-Payer Readmissions Among Frequently-Hospitalized Patients (SFY 2012-SFY 2014)**

People who were frequently hospitalized made up only 7% of the population but accounted for 58% of readmissions.



Note: Frequently hospitalized patients are defined as those with four or more discharges within any 1-year period between July 2011 and June 2014. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2011 – June 2014.

6. Readmissions among Patients with Frequent Hospitalizations

Readmission patterns were examined among the subgroup of individuals who were frequently hospitalized. Frequently hospitalized patients (frequent users) are defined as those with *four or more* hospitalizations within a 12-month period at any point during the three years from July 2011 to June 2014. During the three-year span, 7% of patients (approximately 55,000) were in this high-utilization group. This group accounted for 25% of all hospitalizations and 58% of all readmissions in the state. The readmission rate among this frequently hospitalized cohort was 36.0%, more than double the statewide rate.

Notably, the 93% of people hospitalized three or fewer times in a 12-month period accounted for only 42% of all readmissions. The readmission rate among this large proportion of the hospitalized population in Massachusetts was only 8.5%, approximately half of the statewide readmission rate.

T3 All-Payer Readmissions Among Frequently Hospitalized Patients (SFY 2012-SFY 2014)

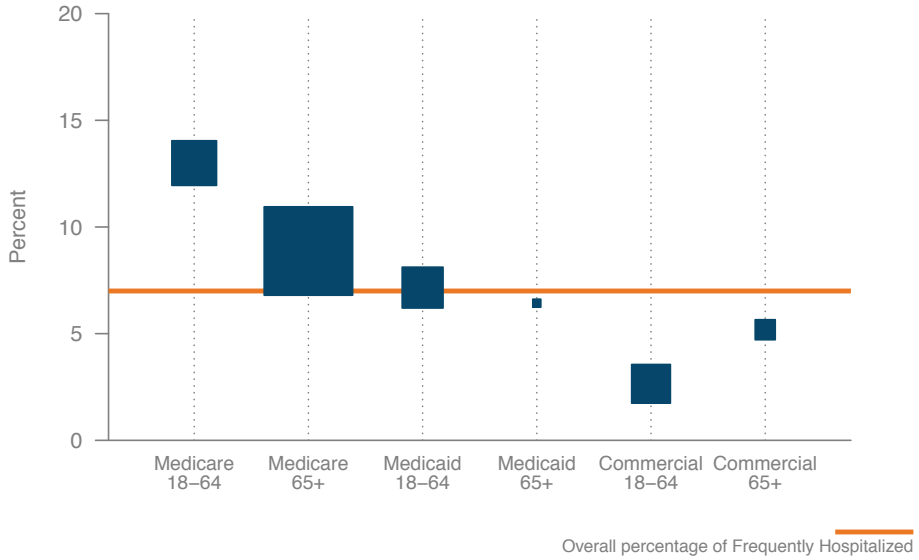
	Patients		Discharges		Readmissions		Readmission Rate
	Count	%	Count	%	Count	%	%
Frequently Hospitalized Patients	55,389	6.8%	378,762	24.8%	136,207	58.2%	36.0%
Commercial	7,692	13.9%	54,156	14.3%	19,343	14.2%	35.7%
Medicare	39,671	71.6%	261,421	69.0%	92,386	67.8%	35.3%
Medicaid	7,021	12.7%	55,140	14.6%	21,640	15.9%	39.2%
Other Patients	760,436	93.2%	1,145,939	75.2%	97,717	41.8%	8.5%
Commercial	252,634	33.2%	337,249	29.4%	20,342	20.8%	6.0%
Medicare	378,592	49.8%	623,371	54.4%	63,193	64.7%	10.1%
Medicaid	91,467	12.0%	134,712	11.8%	10,906	11.2%	8.1%
All Patients	815,825	100%	1,524,701	100%	233,924	100%	15.3%

Note: Frequently hospitalized patients are defined as those with four or more discharges within any 1-year period between July 2011 and June 2014. Figures within the Frequently Hospitalized group and the Other Patients group do not sum to totals because the table excludes Self-Pay and Other payer categories, which together account for 4% of discharges. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2011 – June 2014.

10 Percentage of Frequently Hospitalized Patients by Payer Type and Age (SFY 2014)

Younger (age 18-64) Medicare patients are the most likely to be in the frequently hospitalized group.



Note: The size of the squares in the figure is proportional to the number of patients with frequent hospitalizations. Frequently hospitalized patients are defined as those with four or more discharges within any 1-year period between July 2011 and June 2014. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

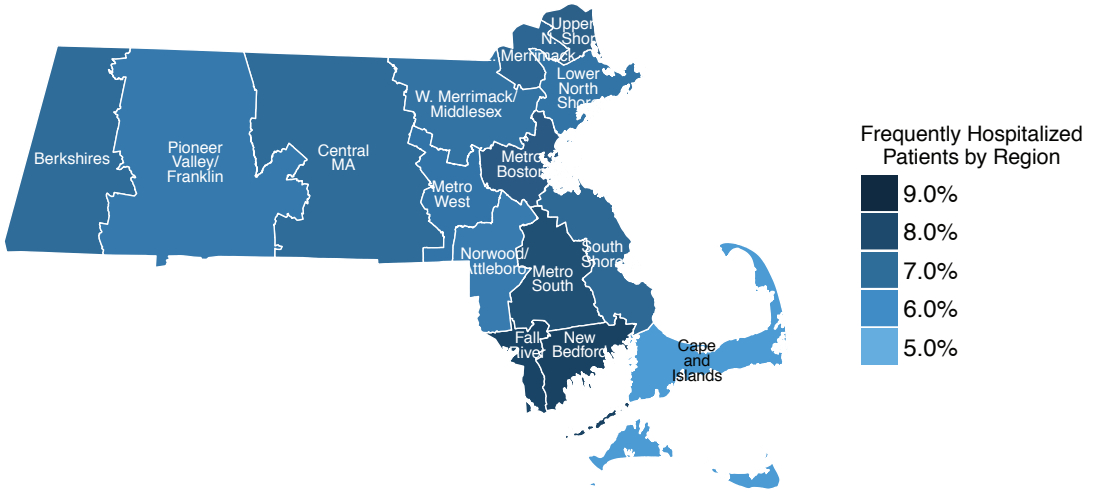
Data source: Massachusetts Hospital Inpatient Discharge Database, July 2011 – June 2014.

Frequently hospitalized patients are on average older than patients hospitalized fewer times; 61% of the frequently hospitalized are age 65 vs. 48% among other patients. Congruently, the frequently hospitalized are also more likely to be enrolled in Medicare and less likely to be commercially insured (Table 3).

Figure 10 shows the proportion of frequent users by age and payer type groups. The cohort of younger (age 18-64) Medicare patients, likely patients with dual eligibility, is notable for having the highest proportion of frequently hospitalized patients. The group of frequently hospitalized patients may present an opportunity for focused readmission reduction efforts across payer types however, since their readmission rates are high regardless of payer type, between 35% and 40% for Medicare, Medicaid, and commercial coverage.

11 Percentage of Frequently Hospitalized Patients by Region of Patient Residence (SFY 2014)

The proportion of high users by region varies from a low of 5.6% on the Cape and Islands to a high of 8.2% and 8.3% in Fall River and New Bedford.



Note: Frequently hospitalized patients are defined as those with four or more discharges within any 1-year period between July 2011 and June 2014. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2011 – June 2014.

There is some variability in the concentration of frequent users geographically. The proportion of patients that are frequent users within each geographic region varies from a low of 5.6% on the Cape and Islands to highs of 8.2% and 8.3% in Fall River and New Bedford, respectively (Figure 11).[14]

Notes:

14 The regions, defined by the Massachusetts Health Policy Commission, are: Berkshires, Pioneer Valley/Franklin, Central MA, West Merrimack/Middlesex, East Merrimack, Upper North Shore, Metro West, Metro Boston, Lower North Shore, Norwood/Attleboro, Metro South, South Shore, Fall River, New Bedford, and Cape and Islands.

IV. All-Payer Readmissions by Hospital

This section of the report contains analyses of both observed and risk-standardized readmission rates (RSRRs) for individual hospitals and for groups of hospitals. The first section presents individual hospitals' risk-standardized readmission rates, the second examines change over time in hospitals' rates, and the third breaks out rates for groups of hospitals defined by five characteristics:[15]

1. Hospital affiliation
2. Hospital cohort (community, teaching, academic, and specialty)
3. Hospital disproportionate share status
4. Hospital tax status
5. Geographic region of the hospital

With observed hospital readmission rates, some portion of differences among hospitals may arise because the hospitals differ in the age or comorbidities of the patients they tend to see, or in the types of conditions they tend to treat. The RSRR adjustments take into account differences across hospitals in patient case mix and hospital service mix, and therefore allow for a better comparison across hospitals.

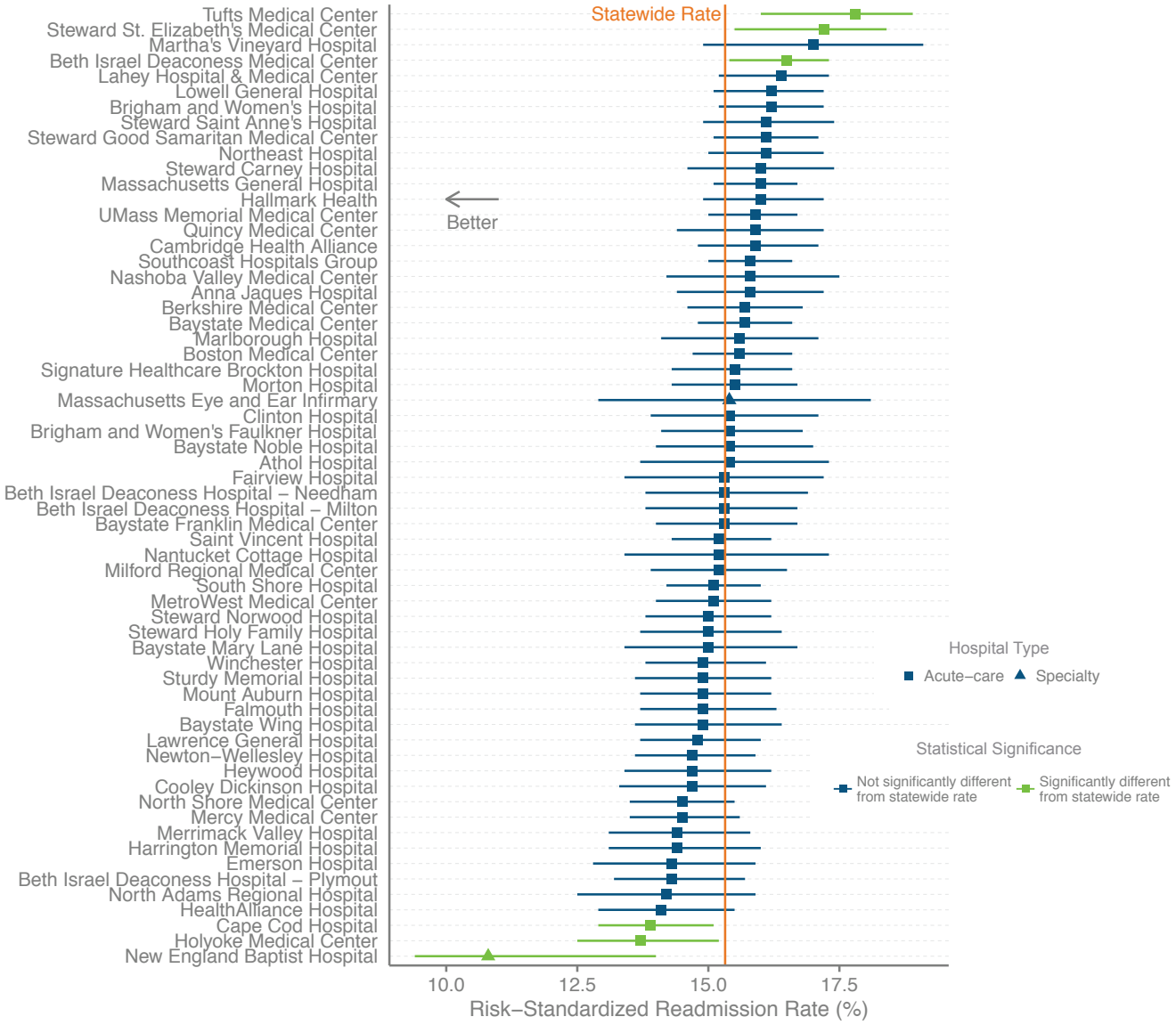
As with all the information presented in this report, these results are based on acute care discharges from Massachusetts hospitals among adults aged 18 and over who were hospitalized for non-obstetric and non-primary psychiatric related reasons.

Notes:

15 In the analyses of RSRRs by hospital characteristics, the RSRRs are weighted using the inverse of the variance of the hospital-specific RSRR, as described by Krumholz et al. (2009). Patterns of hospital performance in acute myocardial infarction and heart failure 30-day mortality and readmission. *Circulation: Cardiovascular Quality and Outcomes, 2,* 407-413.

12 **All-Payer Risk-Standardized Readmission Rates of 62 Acute Care Hospitals (SFY 2014)**

Few hospitals had risk-standardized readmission rates that varied significantly from the state average.



Note: Calculation of the readmission measure is based on discharges as submitted to the Massachusetts Hospital Inpatient Discharge Database. Confidence intervals in the figure are 95% ($p < .05$). Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

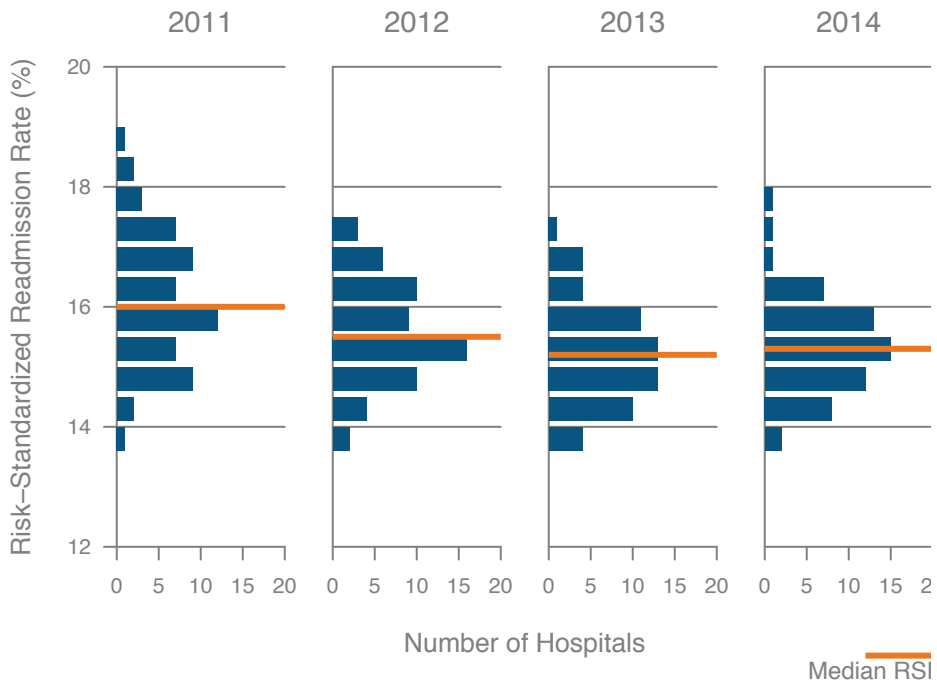
1. Hospital-Specific Risk-Standardized Readmission Rates (RSRRs)

The risk-standardization methodology used in the hospital-wide readmissions measure is designed to provide for more accurate comparisons across hospitals by adjusting for differences among hospitals in patient characteristics and service mix. Figure 12 shows these risk-standardized readmission rates (RSRRs) for hospitals in SFY 2014 along with corresponding 95% confidence intervals.

Excluding the specialty hospitals (New England Baptist Hospital and Massachusetts Eye and Ear Infirmary), the hospitals have a range in risk-standardized readmission rates of just over four percentage points, from Holyoke Medical Center at 13.7% to Tufts Medical Center at 17.8%. In relative terms, the rate at Tufts Medical Center is 30% higher than the rate at Holyoke Medical Center. Despite this wide range however, only six hospitals have risk-standardized rates that are statistically different from the overall statewide rate, three higher and three lower.

13 **Distribution of Risk-Standardized Readmission Rates by Year (SFY 2011-SFY 2014)**

The distribution of risk-standardized rates has consolidated and shifted downward slightly over time.



Note: Figure excludes the two specialty hospitals, Massachusetts Eye and Ear Infirmary and New England Baptist Hospital. Specialty hospitals treat substantially different patient populations and as a group tend to have low readmission rates. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2010 – June 2014.

2. Trends and Patterns in Hospitals' Risk-Standardized Readmission Rates over Time

Section II of the report described the trend in the statewide readmission rate over time. This section contains analyses of trends and patterns in readmission rates at the hospital level over time.

The distribution of risk-standardized readmission rates has shifted downward (readmission rates have declined) from SFY 2011 to 2014 and become more concentrated (Figure 13). In SFY 2014 the hospitals are more tightly grouped around the median value than they were in SFY 2011. In particular, many hospitals that had high rates in SFY 2011 have shifted down (reduced readmissions) over time.

A separate question concerns *consistency* in hospitals' rates over time: Do hospitals with low risk-standardized readmission rates in a given year tend to have low rates in subsequent years? While, as noted in the previous section, differences among hospitals are relatively modest, these differences may nonetheless be persistent. This question is potentially important from both policy and methodological perspectives. From the policy perspective, lessons may be learned from hospitals that have maintained consistently low risk-standardized readmission rates over time. From the methodological perspective, consistency over time indicates that the readmission measure is statistically reliable.

T4 Hospitals Consistently in Highest and Lowest Risk-Standardized Readmission Rates Quartiles, SFY 2011 to SFY 2014

RSRR Quartile	Hospitals	Median Risk-Standardized Readmission Rate in 2014
Highest quartile consistently across four years	Beth Israel Deaconess Medical Center Brigham and Women's Hospital Hallmark Health Northeast Hospital Steward St. Elizabeth's Medical Center Tufts Medical Center UMass Memorial Medical Center	16.2%
Lowest quartile consistently across four years	Cape Cod Hospital Emerson Hospital HealthAlliance Hospital Lawrence General Hospital North Shore Medical Center	14.3%

Note: Table excludes specialty hospital New England Baptist Hospital. Specialty hospitals treat substantially different patient populations and as a group tend to have low readmission rates. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

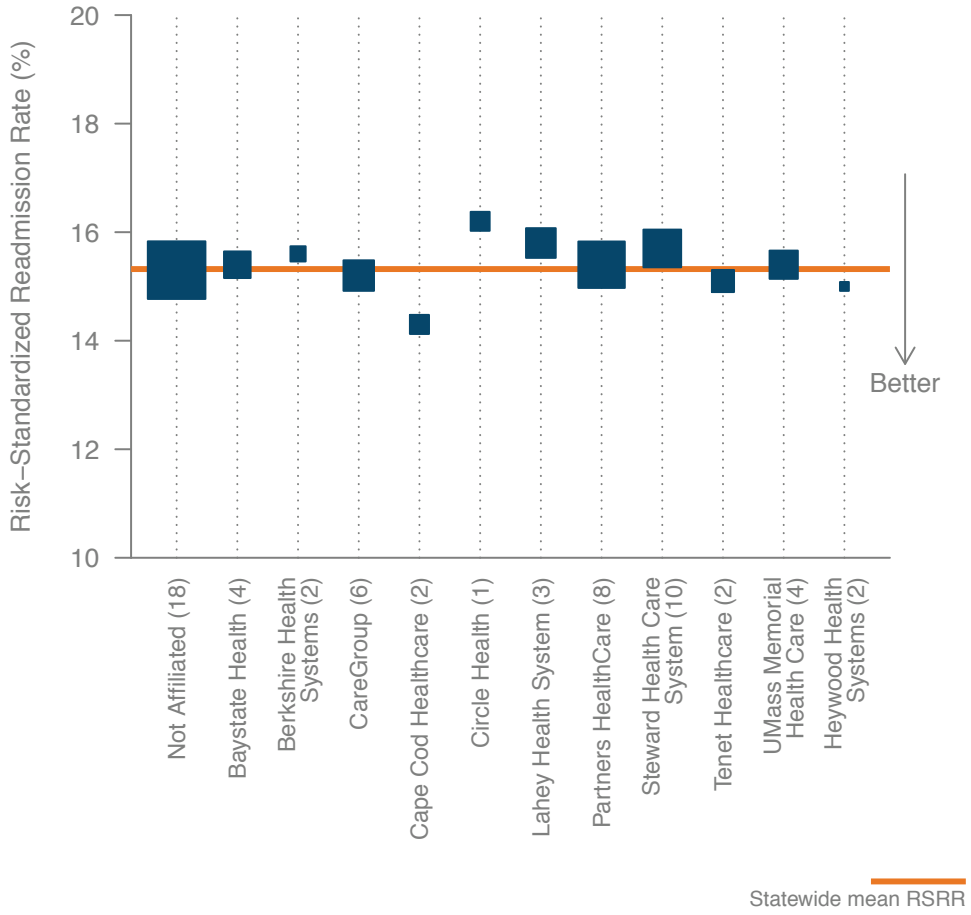
Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

To examine consistency in rates over time, CHIA grouped hospitals into quartiles based on their risk-standardized readmission rates for each of the four study years, from SFY 2011 to 2014. The data indicates a substantial degree of consistency in hospitals' rates over time. Of the 62 hospitals, 35 (56%) fall in the same quartile in SFY 2014 as they did in SFY 2011. Furthermore, seven hospitals stayed in the top quartile (highest rates) across all four years, and five stayed in the bottom quartile (lowest rates) consistently during that time period.

The groups of hospitals with consistently high and consistently low rates are shown in Table 4; academic and teaching hospitals dominate the highest quartile group, while the lowest quartile group includes community hospitals. This pattern may be a consequence of the types of patients these different hospitals tend to treat, despite the risk-standardization procedure.

14 **All-Payer Risk-Standardized Readmission Rates by Hospital Affiliation (SFY 2014)**

Risk-standardized readmissions rates varied by hospital affiliation.



Note: The size of the squares in the figure is proportional to the number of readmissions. The number of hospitals under each affiliation is shown in parentheses. Affiliation is determined as of the most recent status during SFY 2014.[16] Readmission rates are risk-standardized and weighted. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

3. Readmissions by Hospital Characteristics

This section contains breakouts of risk-standardized readmission rates by four characteristics of hospitals: network affiliation, hospital cohort, disproportional share status, and tax status.

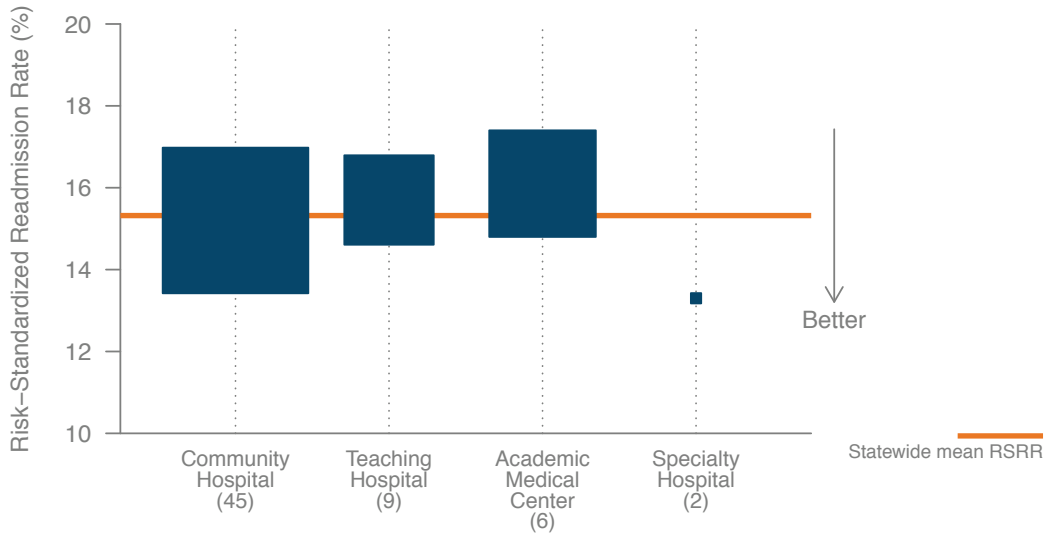
Readmission rates varied by hospital affiliation, ranging from a low of 14.3% in the Cape Cod Health Care System to a high of 16.2% at Circle Health (Figure 14).

Notes:

16 Hospital affiliation information obtained from: Center for Health Information and Analysis (2015). Massachusetts hospital profiles. Boston, MA: Center for Health Information and Analysis. Available from: http://chiamass.gov/hospital-profiles/. This report compiles information submitted by hospitals.

15 All-Payer Risk-Standardized Readmission Rates by Hospital Cohort (SFY 2014)

Academic medical centers had slightly higher RSRRs than teaching hospitals which had higher rates than community hospitals.



Note: The size of the squares in the figure is proportional to the number of readmissions. Readmission rates are risk-standardized and weighted. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

T5 All-Payer Risk-Standardized Readmission Rates by DSH Status and Tax Status (SFY 2014)

	Number of Hospitals	Number of Discharges	Number of Readmissions	Observed Readmission Rate	Weighted Risk-Standardized Readmission Rate
Disproportionate Share Status					
Disproportionate Share Hospital	39	276,391	43,131	15.6%	15.3%
Non-Disproportionate Share Hospital	23	207,501	31,013	14.9%	15.5%
Tax Status					
Non-Profit Hospital	50	409,289	62,071	15.2%	15.3%
For-Profit Hospital	12	74,603	12,073	16.2%	15.5%

Note: Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

Risk-standardized rates vary according to whether a hospital is classified as an academic medical center, teaching hospital, or community hospital (Figure 15). Academic medical centers had slightly higher rates than teaching hospitals, which in turn had higher rates than community hospitals (16.1% vs. 15.7% vs. 15.2%). Specialty hospitals, which in this analysis include New England Baptist Hospital and Massachusetts Eye and Ear Infirmary, treat populations with very different disease profiles, and as a group have low readmission rates.

Once differences in patient case mix and hospital service mix were taken into account via the risk-standardized rates, disproportionate share hospitals (DSH) did not have higher readmission rates than those without DSH status.[17] There was also little difference between non-profit and for-profit hospitals (Table 5).

Notes:

17 The classification of hospitals by disproportionate share status differs from that used in CHIA's previous readmissions report. In the previous report, DSH status was determined only for community hospitals. In this report, hospitals are assigned a DSH status regardless of their cohort classification.

T6 **All-Payer Risk Standardized Readmission Rates by Hospital Region (SFY 2014)**

Region	Number of Discharges	Number of Readmissions	Observed Readmission Rate	Weighted Risk-Standardized Readmission Rate
Berkshires	10,244	1,540	15.0%	15.3%
Pioneer Valley / Franklin	48,180	7,175	14. 9%	15.0%
Central Massachusetts	47,168	7,476	15.8%	15.2%
West Merrimack / Middlesex	46,027	6,693	14.5%	15.6%
East Merrimack	15,730	2,371	15.1%	14.8%
Upper North Shore	4,341	688	15.8%	15.8%
Metro West	14,687	2,308	15.7%	15.2%
Metro Boston	161,295	24,897	15.4%	15.8%
Lower North Shore	24,427	3,668	15.0%	15.3%
Norwood / Attleboro	11,683	1,654	14.2%	14.9%
Metro South	24,136	4,111	17.0%	15.7%
South Shore	24,407	3,578	14.7%	15.1%
Fall River	6,008	1,107	18.4%	16.1%
New Bedford	26,823	4,392	16.4%	15.8%
Cape and Islands	18,736	2,486	13.3%	14.8%

Note: Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

4. Readmissions by Hospital Region

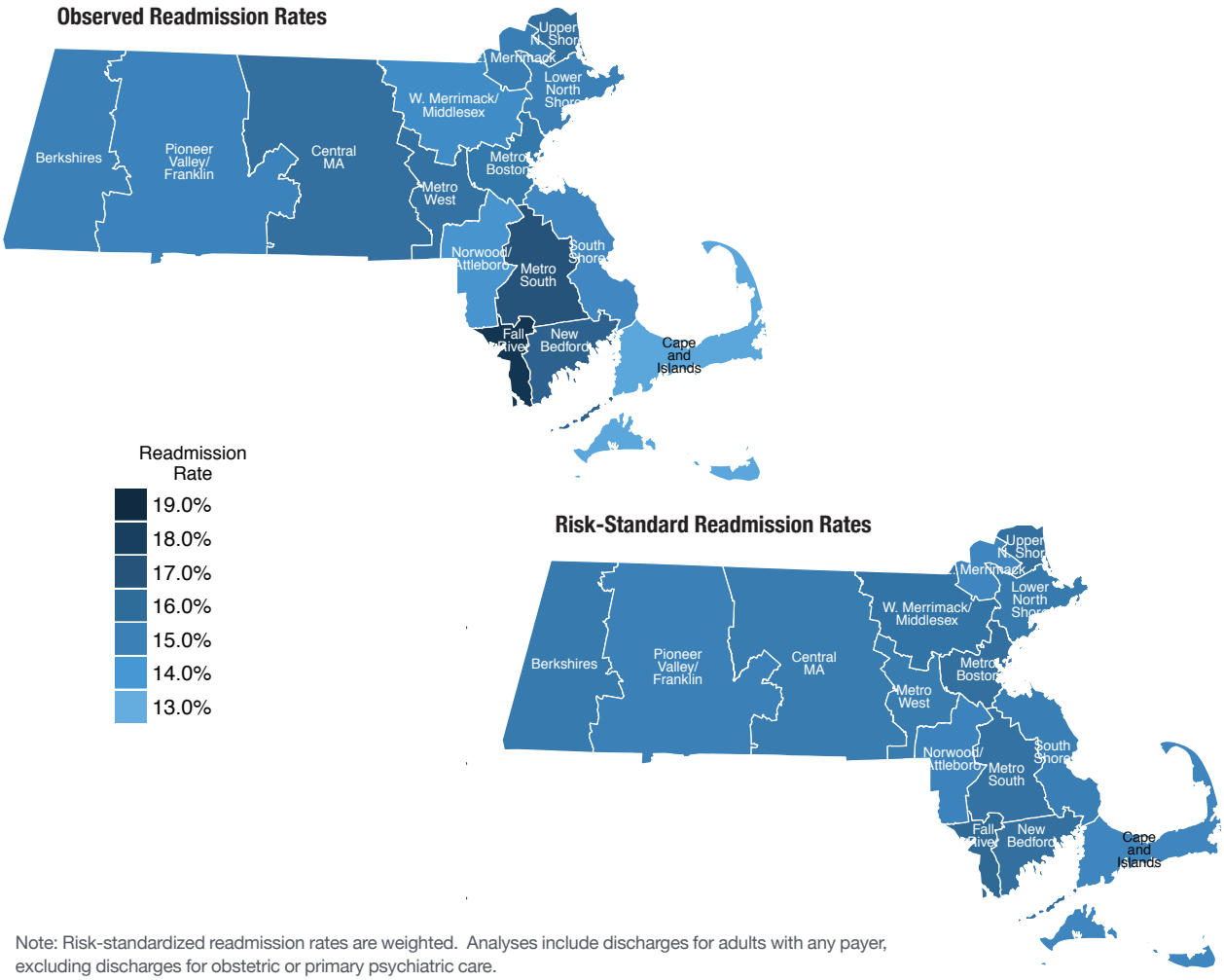
Readmissions are influenced by hospital factors such as care transition practices, the quality of clinical care, and the propensity of providers to admit and readmit patients. They are likely to also be influenced by community characteristics such as the degree of collaboration among post-acute providers and community physicians, the timeliness of information exchange, poverty, community-based clinical and social resources, and community hospital utilization patterns.[18]

Notes:

18 Herrin J., St. Andre, J., Kenward, K., Joshi, M., Audet, A., & Hines, S. (2015). Community factors and hospital readmission rates. *Health Services Research,* 50(1), 20-39.

16 All-Payer Observed and Risk-Standardized Readmission Rates by Hospital Region (SFY 2014)

Observed (unadjusted) readmission rates varied extensively, by 5 percentage points (a 38% relative difference) whereas risk-standardized have little variation.



Note: Risk-standardized readmission rates are weighted. Analyses include discharges for adults with any payer, excluding discharges for obstetric or primary psychiatric care.

Data source: Massachusetts Hospital Inpatient Discharge Database, July 2013 – June 2014.

There is about one and one-half percentage points of variation in the risk-standardized rates, which range from the Cape and Islands and East Merrimack at 14.8% to Fall River at 16.1% (Figure 16).[19] This range amounts to a 10% relative difference in rate between the highest and lowest regions. The unadjusted readmission rates vary from 13.3% on the Cape and Islands to 18.4% in Fall River. CHIA has previously documented important regional differences in patient demographics and regional variation in readmissions likely reflects these factors.[20]

Notes:

19 The regions, defined by the Massachusetts Health Policy Commission, are: Berkshires, Pioneer Valley/Franklin, Central MA, West Merrimack/Middlesex, East Merrimack, Upper North Shore, Metro West, Metro Boston, Lower North Shore, Norwood/Attleboro, Metro South, South Shore, Fall River, New Bedford, and Cape and Islands.

20 Center for Health Information and Analysis. (2015). Acute hospital utilization trends in Massachusetts FY2009-FY2013. Boston, MA: Center for Health Information and Analysis. Available from: http://chiamass.gov/utilization-analysis/.

V. Conclusions

This is the second in CHIA's annual series of reports on all-payer readmissions in the Commonwealth. The analysis provides information on statewide trends over time, hospital-specific readmission rates, and examination of readmission rates by multiple factors including patient age and diagnosis, payer type, discharge disposition, and geographic region, as well as among patients with a history of frequent hospital utilization.

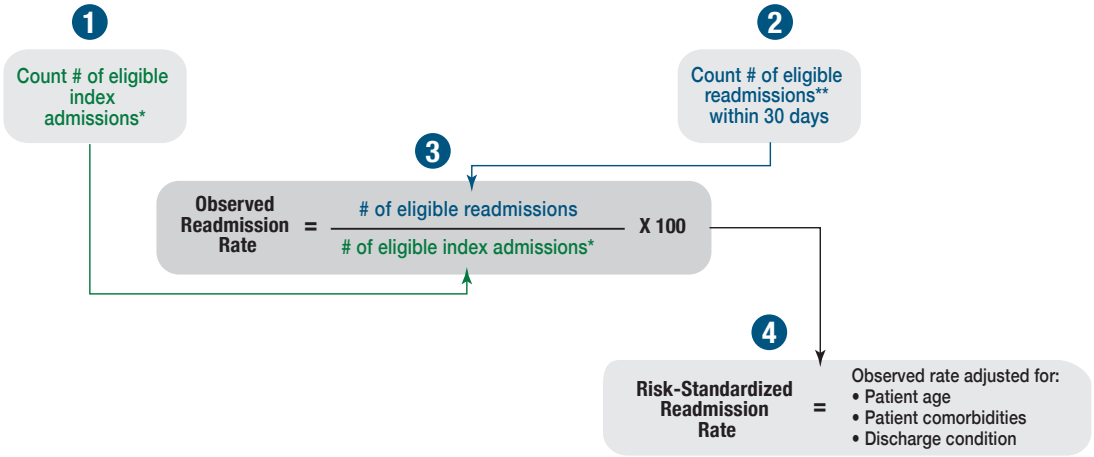
After two modest declines from SFY 2011 to 2013, the statewide readmission rate for SFY 2014, at 15.3%, was essentially unchanged from the SFY 2013 rate of 15.2%. While few hospitals had risk-standardized readmission rates statistically significantly different from the statewide rate, there are hospitals that have had consistently high or consistently low risk-standardized readmission rates over the four years studied. Overall, the range of risk-standardized readmission rates has declined and narrowed since SFY 2011.

Readmission rates vary by many of the factors studied including age, payer type, discharge setting, and geographic region. Often, differences between groups (e.g., hospitals or regions) narrow when readmission rates are adjusted for patient case mix and hospital service mix. Differences in unadjusted rates are nevertheless useful for highlighting potential areas for further opportunities to reduce readmissions. As was true last year, a small group of patients who are frequently hospitalized (7%) account for the majority of readmissions (58%). By assessing both the clinical and socio-demographic characteristics of frequently hospitalized patients, hospitals may be able to tailor readmission reduction initiatives to address the needs of this group. CHIA will continue to report annually on all-payer hospital readmissions to help inform providers and policy makers as they work to improve health care and reduce wasteful spending in the Commonwealth.

VI. About the Readmissions Methodology

CHIA has adapted the Hospital-Wide All-Cause Unplanned 30-day Readmission Measure developed by CMS and the Yale Center for Outcomes Research and Evaluation,[21] and applied the measure to CHIA's Hospital Inpatient Discharge Database, which is collected from all acute hospitals in Massachusetts. Figure 17 gives a high-level overview of how the readmission rates are calculated. First, eligible index admissions are defined. Then, from among this set of admissions, the number of eligible readmissions within 30 days is derived. The latter divided by the former and turned into a percentage gives the readmission rate. In a final step, we use hierarchical statistical models to standardize the readmission rates, accounting for patient age, patient comorbidities, and patient discharge condition, an indicator of hospital service mix.

17 Overview of Readmissions Methodology



Notes:

* Eligible index admissions are admissions for adults during the study period to non-Federal acute-care hospitals in Massachusetts. Analyses exclude obstetric and primary psychiatric discharges. Nine further exclusions are made (see Appendix A Methodology).

** Eligible readmissions are admissions for any reason that occur within 30 days of an index admission and are not planned.

Notes:

21 For the original measure technical report see: Horwitz et. al. (2012). Hospital-wide all-cause unplanned readmission measure. Final technical report. New Haven, CT: Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation. For the updated 2015 v. 4.0 specification see: Yale New Haven Health Services Corporation/ Center for Outcomes Research & Evaluation (YNHHSC/CORE). (2015). 2015 Measure updates and specification report: hospital-wide all-cause unplanned readmission measure - version 4.0). New Haven, CT: YNHHSC/CORE. Both available from: http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html.

The target population for the calculations, before specific categories are excluded, is all-payer adult patients aged 18 years or older discharged from acute care hospitals in Massachusetts. All discharges, if included by a hospital in data submitted to CHIA, including disharges from swing beds, may be included in the analysis. Similarly, discharges from acute care and subsequent readmissions to general inpatient practice for inpatient hospice services, if included in the data submitted to CHIA, may be included. Therefore, the rates reported here may differ from rates calculated without these discharges.

Cohorts of discharges for analysis were formed by Massachusetts fiscal years, which run from July 1 to June 30, for years 2011 to 2014. For example, the fiscal year 2014 cohort includes discharges from acute care hospitals in the Commonwealth from July 1, 2013 to June 30, 2014.

An index admission is a discharge from an acute care hospital in Massachusetts for a patient aged 18 and over during the study period. From this base set of admissions, CHIA excluded specific defined sets of admissions, including those relating to obstetric care, psychiatric conditions, and rehabilitation care. Also, about 7% of the discharges for adults without a Unique Health Identification Number, usually an encrypted Social Security Number, were excluded from the analysis. For the full specification describing how the study cohort was defined, please see Appendix A: Readmissions Methodology.

Readmission is defined as an unplanned admission that occurred within 30 days of an index admission. A planned readmission is an admission within 30-days of discharge from an acute hospital that is a scheduled part of the patient's plan of care. Planned readmissions are identified using an algorithm developed by the Yale/CMS team and are excluded from the readmission analysis in this report. For 2014 public reporting, the Yale/CMS team updated the planned readmissions algorithm slightly in light of findings from a chart-review validation study. In that study, the researchers found that the previous specification was misclassifying certain sets of readmissions as planned when in fact the majority of them were not. The procedures and diagnoses affected by the change include therapeutic radiation, cancer chemotherapy, hypertension with complications, acute pancreatitis, and biliary tract disease.

Since a patient can have a sequence of multiple admissions, a particular admission may serve in the calculations as both an index admission and as a readmission for a prior index admission.

As mentioned above, CHIA reports two types of rates: observed (unadjusted) readmission rates and risk-standardized readmission rates (RSRRs). The observed readmission rate is defined as the percentage of index admissions with a readmission.

CHIA followed the Yale/CMS methodology to calculate risk-standardized rates at the hospital level. There are differences in patient demographics and comorbidities (case mix), and the specific conditions hospitals tend to treat (hospital service mix). The goal of the standardization procedure is to control for these differences in case mix and service mix, and allow a more valid and fair comparison among hospitals. CHIA first grouped discharges into five condition categories using the Clinical Classification System (CCS):[22] medicine, surgery/gynecology, cardiovascular, cardiorespiratory, and neuropathy. CHIA then employed a hierarchical generalized linear model to adjust for differences in hospital case mix and to account for the clustering of patients within hospitals for each of the five discharge cohorts. Please see Appendix A: Readmissions Methodology for details.

Notes:

22 Elixhauser A, Steiner C, Palmer L. (2014). Clinical Classifications Software (CCS), 2014. Washington, DC: U.S. Agency for Healthcare Research and Quality. Available at: http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp.

Appendix A: Readmissions Methodology

History of the HWR Measure

Since 2009, CMS has been publicly reporting a set of 30-day disease-specific readmission measures for hospitals. Realizing the need for a broader measure that could capture a greater proportion of readmissions than these disease-specific measures, CMS contracted with the Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (YNHHSC/CORE) to develop a hospital-wide all-cause unplanned readmissions measure (the HWR measure). The Yale team, building on the methodology of the disease-specific measures, in 2011 developed the hospital-wide measure based on claims data for fee-for-service Medicare enrollees age 65 and older. The hospital-wide measure was endorsed by the National Quality Forum (#1789) and CMS started reporting the measure publicly in 2013. For the 2013 public reporting, the Yale team updated the measure slightly (to version 2.0) and released an updated specification report and accompanying SAS software to facilitate measure calculation. For 2014 public reporting, the Yale team updated the planned readmissions algorithm slightly, and made no substantive changes in 2015. The measure used in this report follows this 2015, version 4.0, specification.[1]

Overview of the Methodology

The logic of the HWR measure requires the specification of a denominator, the number of eligible hospital admissions during a given time period that might possibly have resulted in a readmission (termed "index" admissions), and a numerator, the number of actual readmissions that occurred during the time period. The first two steps in the calculations are to identify these two sets of records. Dividing the number of readmissions by the number of index admissions and multiplying by 100 gives the readmission rate as a percentage. This rate is called an "observed" readmission rate because it is derived directly from what was observed during the study period. In the fourth step, observed rates calculated for each hospital under study are standardized to control for background factors that might influence readmission rates, but not be indicators of healthcare quality. The risk-standardized readmission rate (RSRR) controls for differences among hospitals in patient age, patient comorbidities, and hospital service mix.

This report includes observed and risk-standardized readmission rates calculated separately by Massachusetts fiscal years, which run from July 1 to June 30, for the 2011, 2012, 2013, and 2014 fiscal years (i.e., the 2014 data includes discharges from July 1, 2013 through June 30, 2014).

Notes:

1 For the original measure technical report see: Horwitz et. al. (2012). Hospital-wide all-cause unplanned readmission measure. Final technical report. Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation. For the updated 2015 v. 4.0 specification see: Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). (2015). 2015 Measure updates and specification report: hospital-wide all-cause unplanned readmission measure (version 4.0). YNHHSC/CORE. Both available from: http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html.

Data Source

In the original development of the HWR measure, Mathematica Policy Research (MPR) prepared the required input data from CMS Medicare claims data.[2] The MPR team developed processing algorithms to produce three types of input data that are required by the HWR measure:

- A main "index" file that contains a record for each index admission (used primarily to calculate the measure's denominator).
- A "follow-up" file that includes admissions that occurred within 30 days of an index admission and might therefore be deemed to be readmissions if they are not categorized as planned (forms the measure numerator).
- A "history/diagnosis" file that includes information on patients' diagnoses within the year prior to an index admission, which is used to form measures of comorbidities for the risk-standardization procedure.

To use the HWR measure for public reporting in Massachusetts, CHIA modified MPR's processing logic to draw upon discharge summary data from CHIA's Acute Hospital Case Mix Charge Database, specifically the Hospital Inpatient Discharge Database, as the source data.

This Case Mix discharge dataset is a stay-level file including patient socio-demographics, diagnostic information, treatment and service information, and hospital charges. The data is submitted quarterly by all Massachusetts acute care hospitals, and undergoes a cleaning and verification process at CHIA that includes the feedback of verification reports to hospitals for confirmation of their information. Once quarterly data has been processed and verified, CHIA produces and makes available annual files.

CHIA modified the MPR processing logic, which was designed for claims and enrollment data, to adapt the measure for use with hospital discharge data as the source data. The primary modifications were around the merging of patient demographic information with visit information. The original CMS data for which the HWR measure was developed included information on Medicare eligibility. The MPR processing logic limits eligible index admissions to those for patients with at least 12 months of enrollment in Medicare Part A before an index admission, so as to have adequate diagnosis data for case-mix adjustment, and at least 30 days of enrollment in Medicare after the index admission, so as to have had the possibility of experiencing a readmission that would appear in the data. For the CHIA measure, which is based on hospital discharge summaries, all patients seeking inpatient care at any acute care hospitals in Massachusetts are included in the calculation.

Calculation Steps

Calculating the CMS/Yale Hospital-Wide All-Cause Unplanned 30-day Readmission measure involves four steps:

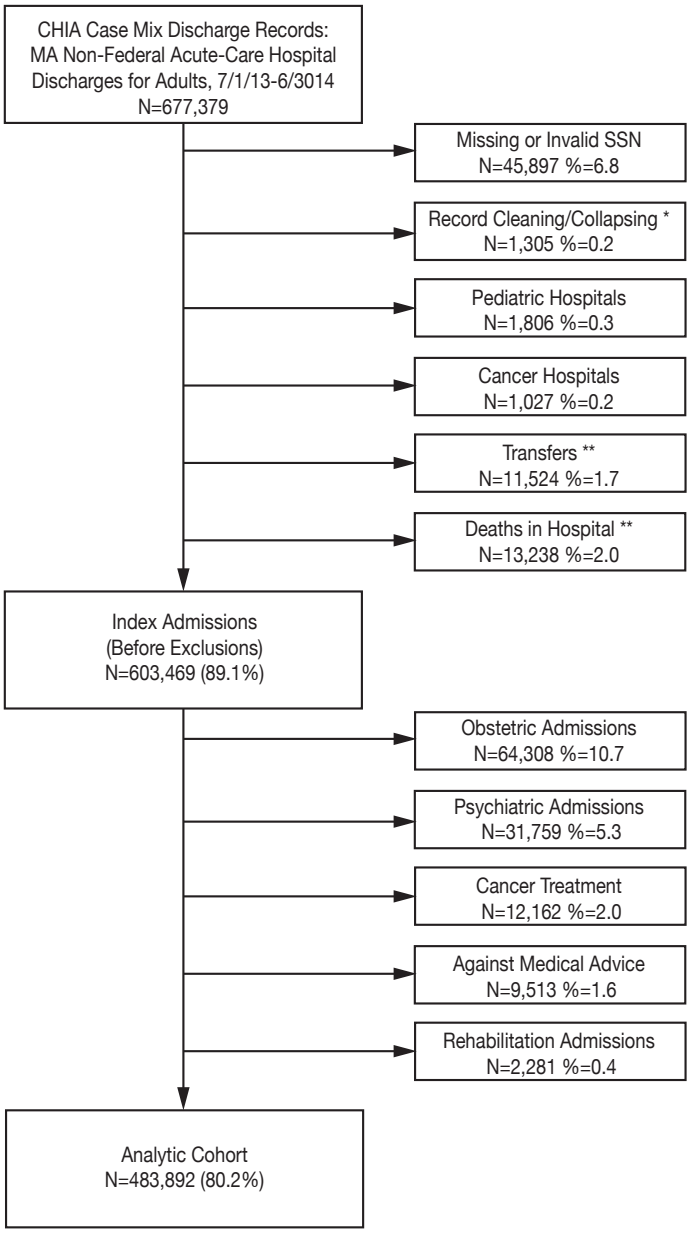
1. Identifying the set of index visits during the designated time period,
2. Identifying readmissions,
3. Calculating observed readmission rates, and
4. Calculating risk-standardized readmission rates.

The section of the report titled About the Readmissions Methodology describes these four steps briefly. This Methodology Appendix describes the steps in greater detail.

Notes:

2 The Mathematica Policy Research programs and documentation are available by request from the CMS Readmission Measures Mailbox at cmsreadmissionmeasures@yale.edu.

A-1 Construction of the Analytic Cohort



Note: Exclusions are not mutually exclusive.

* Cleaning/collapsing includes: Removing duplicate records, collapsing overlapping stays, removing stays > 1 year, and combining adjacent admissions.

** The exclusions for transfer and death were implemented after making the exclusions above them in the figure.

Step 1: Definition of Index Admissions

Figure A-1 illustrates the construction of the readmissions analytic cohort for the July 2013 to June 2014 study period. The processing for the other study years is parallel. The data preparation involves two conceptual steps, 1) preparation of a base "index admission" cohort (top portion of the figure, originally developed by both the MPR team and the Yale team), and 2) application of a series of exclusions to refine the cohort to a final analytic file used for calculations (bottom portion of the figure, developed by the Yale team).

The base index admission cohort, produced at the end of the first broad step of processing, comprises:

- Discharges from non-federal acute-care hospitals in Massachusetts,
- for adults,
- within the study time period, which is July 1, 2010 to June 30, 2014,
- that had valid SSN information on the record (so that matching across records could be attempted),
- were not from pediatric or cancer hospitals,
- were not transfers to other acute hospitals, and
- in which the patient did not die while in the hospital.

This set of records constitutes the conceptual base on which the measure may be calculated and excludes records which are incompatible with the logic of the measure (e.g., if a patient dies in the hospital they are not at risk of having a subsequent readmission). There were 677,379 discharge records in CHIA's Hospital Inpatient Discharge Database for adults (age 18+) during the time period from July 1, 2013 to June 30, 2014. Of the exclusions applied in this first phase of processing, the exclusion due to the lack of a valid SSN was the most significant (45,897 records, 6.8%). The exclusions because of in-hospital death (n=13,238, 2.0%) and transfer to another acute care hospital (n=11,524, 1.7%) also applied to a sizable number of records. The final base cohort includes 603,469 discharges, or 89.1% of the original adult discharges during the time period.

In the second stage of processing, records meeting any of five specific criteria were excluded from the calculations to produce the final analytic dataset. The five exclusion criteria applied were:

- **Admissions for obstetric care**: The Yale team recommends removing obstetric admissions when working with an all-payer population because the rate of readmission for obstetric cases is substantially lower than that for other admissions, and therefore distorts overall readmission rates. This was the largest exclusion, accounting for 64,308 records (10.7%).
- **Admissions for psychiatric conditions:** Since patients admitted primarily for psychiatric conditions (n=31,759, 5.3%) are typically treated in different types of facilities from acute-care hospitals, they are excluded from the measure.
- **Treatment for cancer:** Because cancer patients' showed different readmission and mortality profiles from other patients during the preliminary measure development research, the Yale team determined that they should not be included in the final measure. This exclusion resulted in 12,162 (2.0%) records being dropped.
- **Against medical advice:** Patients discharged against medical advice (AMA) are excluded because they did not necessarily receive the full care the hospital intended to provide. This criterion resulted in the exclusion of 9,513 (1.6%) records.
- **Admissions for rehabilitation care:** Patients admitted for rehabilitation (n=2,281, 0.4%) are typically not served in acute-care hospitals and are excluded.

Once these exclusions are applied to the 2013-2014 data, the final resulting analytic cohort includes 483,892 eligible index admissions. The process for constructing the analytic cohorts for other years is identical.

This definition of the analytic cohort differs from the original Yale specification in the following respects:

- The Yale/CMS measure includes admissions for those enrolled in Medicare fee-for-service coverage; the CHIA Massachusetts measure includes admissions covered by all payers.
- The Yale measure includes patients age 65 and older; this measure includes patients age 18 and over.
- The CHIA measure explicitly excludes obstetric cases.
- As described under Data Source above, the Yale measure limits eligible index admissions based on Medicare eligibility; the CHIA measure does not.

TA1 **Formation of Analytic Cohort for 2014**

Processing Step	Count	% of Adult Discharges	% of Index Admissions Before Exclusions
All discharges for adults in CHIA Case Mix Dataset, 7/1/13 to 6/30/14	677,379	100.0%	--
Index admissions, before exclusions	603,469	89.1%	100.0%
Analytic cohort	483,892	71.4%	80.2%

Table A1 shows the overall counts and percentages for the dataset creation process for the SFY 2014 data.

Step 2: Definition of Readmissions

The second step of the HWR calculations is to count the number of readmissions. Once the index admissions have been identified, it is relatively simple to quantify the number of readmissions. Under the HWR algorithm, readmissions are defined as any admissions that occur within 30 days of an index admission, excluding those that are deemed to be planned (see below). Note that under this definition a particular hospital stay may count both as an index admission and as a readmission in relation to an earlier index admission. Patients may have multiple readmissions if they cycle in and out of the hospital with a frequency less than or equal to 30 days.

The CMS/Yale methodology includes an algorithm for excluding from the calculations those readmissions that are likely to have been planned. Yale researchers developed a list of inpatient procedures that are usually planned (e.g., knee arthroplasty, hip replacement), and revised the list following a public comment period. A readmission is classified as planned, and therefore excluded from the readmission rate calculations, if it includes one of these procedures and the discharge condition for the readmission is a non-acute condition. For the 2014 reporting year the Yale team updated the algorithm for determining planned readmissions in light of findings from a chart-review validation study. In that study, the researchers found that the previous specification was misclassifying certain sets of readmissions as planned when in fact the majority of them were not. The procedures and diagnoses affected by the change include therapeutic radiation, cancer chemotherapy, hypertension with complications, acute pancreatitis, and biliary tract disease.

Step 3: Calculation of Observed Readmission Rates

The observed readmission rate for a hospital, or for some other defined group of patients or visits, is simply the number of readmissions that occurred during the designated time period (plus 30 days thereafter), divided by the base number of index admissions within the period, and multiplied by 100 to produce a percentage. The report features readmission rates calculated for hospitals as well as by other patient-level and visit-level characteristics such as patient age, patient gender, payer type, and discharge status.

Step 4: Calculation of Risk Standardized Readmission Rates (RSRRs)

The Yale team designed the risk-standardization procedure to adjust hospitals' observed readmission rates by potentially confounding background factors that might influence readmissions. The RSRR accounts for differences in background factors among the patients served by different hospitals so that more meaningful comparisons among hospitals' readmission rates can be made.

Cohort Assignment

The risk-standardization procedure is carried out separately on five clinically-defined cohorts of patients. By standardizing separately for different groups of patients, the procedure allows the adjustments made to be different for different types of patients, rather than assuming that one adjustment works well for all patients. Also, patients who have the same broad category of illness are likely to be treated by the same broad provider team, and care for patients within these groups is likely to be more homogeneous than care provided to patients across groups. The measure assigns patients to one of five clinically-defined cohorts:

- Surgery/gynecology
- Cardiorespiratory
- Cardiovascular
- Neurology
- Medicine

Assignment to these five cohorts is based on the AHRQ Clinical Classifications Software (CCS) grouper that aggregates ICD-9-CM procedure and diagnosis codes into a much smaller number of clinically coherent categories (approximately 230 procedures and 280 diagnoses). Cohort assignment proceeds first by procedure code, and then by diagnosis code. First, patients with a procedure code indicative of having had a major surgery while in the hospital are assigned to the surgery/gynecology cohort. Then, remaining patients are assigned to one of the four other cohorts based on their principal discharge condition. Patients are assigned to the Medicine cohort when their condition does not correspond to any of the three more narrowly defined cohorts (cardiorespiratory, cardiovascular, neurology).

Statistical Models

Once patients are assigned to cohorts, a separate risk-adjustment model is fit for each cohort. The HWR methodology uses hierarchical logistic regression models, with discharges nested within hospitals, to estimate hospitals' impact on readmissions, controlling for patient case mix and hospital service mix.

The hierarchical logistic regression models predict readmission at the discharge level (coded 0/1) from discharge-level and hospital-level factors. At the discharge level, three factors are controlled for:

- **Patient age:** Age is measured in years.
- **Patient case mix:** Patient case mix is operationalized as a set of 31 indicators for comorbid conditions based on diagnosis information from the 12 months preceding the index hospitalization and the index hospitalization itself. The comorbidity indicators are based on the CMS Condition Categories grouper. The Yale team selected conditions by starting from those used in previous hospital-specific readmissions measures, and then conducting a clinical review and a statistical modeling process to identify conditions that were both predictive of readmission as well as clinically meaningful. The comorbidity indicators include conditions such as metastatic cancer/acute leukemia, diabetes mellitus, end-stage liver disease, drug and alcohol disorders, and congestive heart failure.
- **Hospital service mix:** Hospital service mix is operationalized as a set of variables indicating the patient's specific discharge condition within each of the five clinical cohorts. These measures are based on the AHRQ Clinical Classifications Software (CCS) grouper, the same classification system used to define overall cohort membership. The Yale team reasoned that different conditions will have different base probabilities of readmission, that hospitals are likely to differ in the mix of conditions that they tend to treat, and therefore specific discharge condition should be controlled.

At the hospital level, a random intercept term for hospital is included in each model. This term allows the predicted probability of readmission for all the patients in a hospital to be increased or decreased by a fixed amount. Inclusion of this term has two important effects. First, it properly accounts for the grouping of patients within hospitals. Without this term, the model would violate one of the statistical assumptions of regression analysis, that cases are independent of one-another. Second, since this term represents an increase or decrease in the probability of readmission for the patients in each hospital, controlling for the above patient factors, it directly indexes the impact of hospital on readmissions. Therefore, it plays a central role in the calculations. Each model produces two numbers for each hospital:

- **The *predicted* number of readmissions:** This estimate comes from the full model, including both the discharge-level variables and the hospital term. It represents the model-based prediction of the number of readmissions, including both the background characteristics of the patients, and which hospital they attend.
- **The *expected* number of readmissions:** This estimate is predicted from the model *excluding* the hospital term. It represents the number of readmissions that would be expected given only the patient background factors, and ignoring the effect of hospital.

The ratio of these two numbers, the predicted number divided by the expected number, gives the *standardized risk ratio* (SRR) for each cohort and hospital. This number represents the extent to which a hospital has more (numbers > 1) or fewer (numbers < 1) readmissions for the cohort than one would expect based on the characteristics of the patients they treat.

The final *risk-standardized readmission rate* (RSRR) for a hospital is calculated by combining the standardized risk ratios from the five cohort-specific models. Specifically, the volume-weighted logarithmic mean of the five SRRs is calculated to produce a hospital-wide standardized risk ratio. This weighting procedure allows larger cohorts within a hospital to have a larger impact on the final rate. In a final step, the hospital-wide SRR for each hospital is multiplied by the statewide observed readmission rate to produce the final set of risk-standardized readmission rates.

Calculation of Confidence Intervals for RSRRs

Because the estimated RSRRs are derived by a series of calculations from the output of multiple statistical models, and the variance of the estimates would therefore be difficult to calculate analytically, the HWR measure includes a bootstrapping algorithm for calculating RSRR confidence intervals. Under this algorithm, one draws repeated samples of hospitals, with replacement, from the total population of hospitals under study and calculates the RSRR for each hospital in the sample. A final random sample, with equal number of calculated RSRRs from each hospital, is drawn. The final confidence intervals are found by taking the 2.5% and 97.5% percentiles from the distribution of calculated RSRRs for each hospital.

Weighting of RSRRs for Analyses of Hospital Characteristics

In order to aggregate the risk-standardized readmission rate across hospitals to larger entities such as geographic regions and hospital systems, CHIA averaged the hospital-specific RSRRs for each group and weighted each hospital's RSRR in the average by the inverse of its variance, obtained from the bootstrapping process.[3] This weighting scheme allows hospitals with higher volumes, and more precise estimates, to contribute more to the aggregated rate than those with lower volumes.

Notes:

3 For an example of this technique see: Krumholz et al. (2009). Patterns of hospital performance in acute myocardial infarction and heart failure 30-day mortality and readmission. *Circulation: Cardiovascular Quality and Outcomes, 2, 407-413.*

Appendix B: Hospital Characteristics

Hospital	Cohort	Affiliation	Region	DSH	Tax Status
Anna Jaques Hospital	Community Hospital	Not Affiliated	Upper North Shore	Not Disproportionate	Non-Profit
Athol Hospital	Community Hospital	Heywood Health Systems	Central Massachusetts	Disproportionate	Non-Profit
Baystate Franklin Medical Center	Community Hospital	Baystate Health	Pioneer Valley / Franklin	Disproportionate	Non-Profit
Baystate Mary Lane Hospital	Community Hospital	Baystate Health	Pioneer Valley / Franklin	Not Disproportionate	Non-Profit
Baystate Medical Center	Teaching Hospital	Baystate Health	Pioneer Valley / Franklin	Disproportionate	Non-Profit
Baystate Noble Hospital	Community Hospital	Not Affiliated	Pioneer Valley / Franklin	Disproportionate	Non-Profit
Baystate Wing Hospital	Community Hospital	Baystate Health	Pioneer Valley / Franklin	Disproportionate	Non-Profit
Berkshire Medical Center	Teaching Hospital	Berkshire Health Systems	Berkshires	Disproportionate	Non-Profit
Beth Israel Deaconess Hospital - Milton	Community Hospital	CareGroup	Metro Boston	Not Disproportionate	Non-Profit
Beth Israel Deaconess Hospital - Needham	Community Hospital	CareGroup	Metro Boston	Not Disproportionate	Non-Profit
Beth Israel Deaconess Hospital - Plymouth	Community Hospital	CareGroup	South Shore	Disproportionate	Non-Profit
Beth Israel Deaconess Medical Center	Academic Medical Center	CareGroup	Metro Boston	Not Disproportionate	Non-Profit
Boston Medical Center	Academic Medical Center	Not Affiliated	Metro Boston	Disproportionate	Non-Profit
Brigham and Women's Faulkner Hospital	Teaching Hospital	Partners HealthCare	Metro Boston	Not Disproportionate	Non-Profit
Brigham and Women's Hospital	Academic Medical Center	Partners HealthCare	Metro Boston	Not Disproportionate	Non-Profit
Cambridge Health Alliance	Teaching Hospital	Not Affiliated	Metro Boston	Disproportionate	Non-Profit
Cape Cod Hospital	Community Hospital	Cape Cod Healthcare	Cape and Islands	Disproportionate	Non-Profit
Clinton Hospital	Community Hospital	UMass Memorial Health Care	Central Massachusetts	Disproportionate	Non-Profit
Cooley Dickinson Hospital	Community Hospital	Partners HealthCare	Pioneer Valley / Franklin	Not Disproportionate	Non-Profit
Emerson Hospital	Community Hospital	Not Affiliated	West Merrimack / Middlesex	Not Disproportionate	Non-Profit
Fairview Hospital	Community Hospital	Berkshire Health Systems	Berkshires	Disproportionate	Non-Profit
Falmouth Hospital	Community Hospital	Cape Cod Healthcare	Cape and Islands	Disproportionate	Non-Profit
Hallmark Health	Community Hospital	Not Affiliated	Metro Boston	Not Disproportionate	Non-Profit

Hospital Characteristics (Continued)

Hospital	Cohort	Affiliation	Region	DSH	Tax Status
Harrington Memorial Hospital	Community Hospital	Not Affiliated	Central Massachusetts	Disproportionate	Non-Profit
HealthAlliance Hospital	Community Hospital	UMass Memorial Health Care	Central Massachusetts	Disproportionate	Non-Profit
Heywood Hospital	Community Hospital	Heywood Health Systems	Central Massachusetts	Disproportionate	Non-Profit
Holyoke Medical Center	Community Hospital	Not Affiliated	Pioneer Valley / Franklin	Disproportionate	Non-Profit
Lahey Hospital & Medical Center	Teaching Hospital	Lahey Health System	West Merrimack / Middlesex	Not Disproportionate	Non-Profit
Lawrence General Hospital	Community Hospital	Not Affiliated	East Merrimack	Disproportionate	Non-Profit
Lowell General Hospital	Community Hospital	Circle Health	West Merrimack / Middlesex	Disproportionate	Non-Profit
Marlborough Hospital	Community Hospital	UMass Memorial Health Care	Metro West	Disproportionate	Non-Profit
Martha's Vineyard Hospital	Community Hospital	Partners HealthCare	Cape and Islands	Disproportionate	Non-Profit
Massachusetts Eye and Ear Infirmary	Speciality Hospital	Not Affiliated	Metro Boston	Not Disproportionate	Non-Profit
Massachusetts General Hospital	Academic Medical Center	Partners HealthCare	Metro Boston	Not Disproportionate	Non-Profit
Mercy Medical Center	Community Hospital	Not Affiliated	Pioneer Valley / Franklin	Disproportionate	Non-Profit
Merrimack Valley Hospital	Community Hospital	Steward Health Care System	East Merrimack	Disproportionate	For Profit
MetroWest Medical Center	Community Hospital	Tenet Healthcare	Metro West	Not Disproportionate	For Profit
Milford Regional Medical Center	Community Hospital	Not Affiliated	Metro West	Not Disproportionate	Non-Profit
Morton Hospital	Community Hospital	Steward Health Care System	Metro South	Disproportionate	For Profit
Mount Auburn Hospital	Teaching Hospital	CareGroup	Metro Boston	Not Disproportionate	Non-Profit
Nantucket Cottage Hospital	Community Hospital	Partners HealthCare	Cape and Islands	Not Disproportionate	Non-Profit
Nashoba Valley Medical Center	Community Hospital	Steward Health Care System	West Merrimack / Middlesex	Disproportionate	For Profit
New England Baptist Hospital	Speciality Hospital	CareGroup	Metro Boston	Not Disproportionate	Non-Profit
Newton-Wellesley Hospital	Community Hospital	Partners HealthCare	Metro Boston	Not Disproportionate	Non-Profit
North Adams Regional Hospital	Community Hospital	Not Affiliated	Berkshires	Disproportionate	Non-Profit
North Shore Medical Center	Community Hospital	Partners HealthCare	Lower North Shore	Disproportionate	Non-Profit
Northeast Hospital	Community Hospital	Lahey Health System	Lower North Shore	Not Disproportionate	Non-Profit
Quincy Medical Center	Community Hospital	Steward Health Care System	South Shore	Disproportionate	For Profit

Hospital Characteristics (Continued)

Hospital	Cohort	Affiliation	Region	DSH	Tax Status
Saint Vincent Hospital	Teaching Hospital	Tenet Healthcare	Central Massachusetts	Disproportionate	For Profit
Signature Healthcare Brockton Hospital	Community Hospital	Not Affiliated	Metro South	Disproportionate	Non-Profit
South Shore Hospital	Community Hospital	Not Affiliated	South Shore	Not Disproportionate	Non-Profit
Southcoast Hospitals Group	Community Hospital	Not Affiliated	New Bedford	Disproportionate	Non-Profit
Steward Carney Hospital	Teaching Hospital	Steward Health Care System	Metro Boston	Disproportionate	For Profit
Steward Good Samaritan Medical Center	Community Hospital	Steward Health Care System	Metro South	Disproportionate	For Profit
Steward Holy Family Hospital	Community Hospital	Steward Health Care System	East Merrimack	Disproportionate	For Profit
Steward Norwood Hospital	Community Hospital	Steward Health Care System	Norwood / Attleboro	Disproportionate	For Profit
Steward Saint Anne's Hospital	Community Hospital	Steward Health Care System	Fall River	Disproportionate	For Profit
Steward St. Elizabeth's Medical Center	Teaching Hospital	Steward Health Care System	Metro Boston	Disproportionate	For Profit
Sturdy Memorial Hospital	Community Hospital	Not Affiliated	Norwood / Attleboro	Disproportionate	Non-Profit
Tufts Medical Center	Academic Medical Center	Not Affiliated	Metro Boston	Not Disproportionate	Non-Profit
UMass Memorial Medical Center	Academic Medical Center	UMass Memorial Health Care	Central Massachusetts	Disproportionate	Non-Profit
Winchester Hospital	Community Hospital	Lahey Health System	West Merrimack / Middlesex	Not Disproportionate	Non-Profit

Note: Hospital affiliation, hospital type, share status, and tax status are based on their latest status during state fiscal year 2014: July 2013-June 2014.

Appendix C: Data Categorization and Grouping

All Payer Refined – Diagnosis Related Groups (APR-DRGs)

The All Patient Refined – Diagnosis Related Groups (APR-DRGs, 3M) are a severity and risk adjusted classification system that provides a more effective means of adjusting for patient differences. The 3M APR-DRGs expand the basic DRG structure by adding four subclasses to each illness and risk of mortality. CHIA utilized version 26.1 of the APR-DRG, which was used to group inpatient discharges over the study period of State FY 2011-2014 (July 1, 2010 through June 30, 2014). The 3M APR-DRG grouper was used to analyze readmissions by top discharge diagnoses for this report.

Payer Type

For this analysis, broad payer type categories were created by grouping payer source codes. Payer type categories were grouped as follows:

- Medicare: Fee-for-service and managed care Medicare
- Medicaid: Fee-for-service and managed care Medicaid; Commonwealth Care
- Commercial: Blue Cross and Blue Cross Managed Care, Commercial Insurance and Commercial Managed Care, HMO, PPO/Other managed care plans not elsewhere classified, point-of-service plans, exclusive provider organizations, and other non-managed care plans
- Payer sources not included in the current reporting: Self-pay, Free Care, and Health Safety Net, Worker's Compensation, Other Government Payment, Auto Insurance, Dental Plans, and None (for Secondary Payer)

Discharge Setting

For this analysis, discharge settings were grouped into broader categories. They were grouped as follows:

- Home: home or self-care, rest home, and shelter
- Skilled Nursing Facility (SNF): skilled nursing facilities
- Home with Home Health Agency Care: home under care of organized home health service organization and home under care of a home IV drug therapy provider
- Hospice: home hospice care and hospice medical facility
- Rehabilitation: intermediate care facility, inpatient rehab facility, and Medicare-certified long-term care hospital
- Other: critical access hospital, psychiatric hospital, federal healthcare facility, another short-term general hospital for inpatient care, another type of institution not defined elsewhere, and other discharge settings

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