

**Online Table 1: Measure adherence for all eligible AMI, HF and pneumonia discharges**

	Measures	Total	Adherence (%)
<b>Acute Myocardial Infarction</b>			
Individual measure	Aspirin at arrival	788	781 (99.1)
	β blocker at arrival	630	621 (98.6)
	PCI < 90 minutes	207	153 (73.9)
	Aspirin (D/C)	1890	1882 (99.6)
	β blocker (D/C)	2395	2381 (99.4)
	ACEI/ARB for LVSD	424	360 (84.9)
	Smoking counseling	753	724 (96.2)
Arrival measure	Aspirin at arrival, β blocker at arrival, PCI < 90 minutes	940	871 (92.7)
Discharge measure	Aspirin at discharge, β blocker at discharge, ACEI/ARB for LVSD, Smoking counseling	2879	2767 (96.1)
Overall measure	All-or-None	2926	2747 (93.9)
<b>Heart Failure</b>			
Individual measure	ACEI/ARB for LVSD	934	800 (85.7)
	LV assessment	3017	2993 (99.2)
	Discharge instruction	2348	1619 (68.9)
	Smoking counseling	374	317 (84.8)
Patient information	Discharge instruction and smoking counseling	2405	1651 (68.7)
Overall measure	All-or-None	3020	2149 (71.2)
<b>Pneumonia</b>			
Individual measure	Antibiotic <4 hours	1126	845 (75.0)

	Blood culture timing	1215	1044 (85.9)
	O <sub>2</sub> assessment	1566	1566 (100)
	Antibiotic selection	849	741 (87.3)
	Influenza vaccine assessment	723	396 (54.8)
	Pneumonia vaccine assessment	1276	855 (67.0)
	Smoking counseling	431	303 (70.3)
Arrival measure	Antibiotic < 4hrs, blood culture timing, O <sub>2</sub> assessment, antibiotic selection	1568	1070 (68.2)
Health maintenance	Influenza vaccine assessment, pneumonia vaccine assessment	1437	796 (55.4)
Overall measure	All-or-None	1955	939 (48.0)

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- Discharges were based on mortality outcome cohort.

AMI: acute myocardial infarction

HF: heart failure

PN: pneumonia

ACEI/ARB: angiotensin converting enzyme inhibitor/angiotensin receptor blockade

LVSD: left ventricular systolic dysfunction

**Online Table 2: Univariate characteristics**

<b>MORTALITY COHORT</b>									
	<b>Acute Myocardial Infarction</b>			<b>Heart Failure</b>			<b>Pneumonia</b>		
	<b>100% adherence</b>	<b>Less than 100% adherence</b>	<b>P value</b>	<b>100% adherence</b>	<b>Less than 100% adherence</b>	<b>P value</b>	<b>100% adherence</b>	<b>Less than 100% adherence</b>	<b>P value</b>
<b>Demographic characteristics</b>	<b>N=2622</b>	<b>N=179</b>		<b>N=1423</b>	<b>N=745</b>		<b>N=770</b>	<b>N=931</b>	
Age, year, mean (SD)	66.8 (13.9)	65.6 (13.9)	0.27	73.0 (13.9)	73.4 (12.9)	0.61	67.0 (17.7)	69.1 (16.2)	0.01
Male, n (%)	1749 (66.7)	124 (69.3)	0.48	812 (57.1)	403 (54.1)	0.18	414 (53.8)	522 (56.1)	0.34
White, n (%)	2121 (92.9)	152 (91.0)	0.38	1192 (88.6)	630 (86.5)	0.16	637 (86.6)	819 (90.5)	0.01
Primary payer: Medicare, n (%)	1284 (49.0)	96 (53.6)	0.33	1018 (71.6)	566 (76.0)	0.08	477 (62.0)	633 (68.0)	0.02
Medicaid/Free care	178 (6.8)	14 (7.8)		104 (7.3)	50 (6.7)		83 (10.8)	96 (10.3)	
Other	1160 (44.2)	69 (38.6)		300 (21.1)	129 (17.3)		210 (27.3)	202 (21.7)	
Lowest 25% SES, n (%)	613 (24.7)	51 (30.2)	0.11	332 (24.4)	190 (26.8)	0.24	203 (27.5)	207 (23.4)	0.06
<b>Clinical characteristics</b>									
Elixhauser comorbidities, mean (SD)	2.0 (1.3)	2.1 (1.4)	0.08	2.5 (1.4)	2.7 (1.5)	0.08	3.1 (1.6)	3.0 (1.5)	0.03
Transferred to MGH, n (%)	1733 (66.1)	74 (41.3)	<.0001	255 (17.9)	78 (10.5)	<.0001	42 (5.4)	38 (4.1)	0.18

DNR in 1 <sup>st</sup> admit day, n (%)	17 (0.7)	2 (1.1)	0.46	24 (1.7)	18 (2.4)	0.24	14 (1.8)	22 (2.4)	0.44
DNR in entire hospitalization, n (%)	115 (4.4)	9 (5.0)	0.69	181 (12.7)	95 (12.8)	0.98	71 (9.2)	129 (13.9)	0.003
<b>Health Outcomes</b>									
90-day Mortality, n (%)	82 (3.1)	16 (8.9)	<.0001	172 (12.1)	85 (11.4)	0.64	60 (7.8)	96 (10.3)	0.07
1-year Mortality, n (%)	204 (7.8)	27 (15.1)	0.0006	359 (25.2)	194 (26.0)	0.68	130 (16.9)	209 (22.5)	0.004
Mean survival time within 90 days, d	89.4 (9.9)	86.5 (17.1)	0.03	84.9 (18.6)	85.6 (17.5)	0.38	87.0 (15.3)	85.4 (18.0)	0.05
Mean survival time within 1 year, d	349.1 (65.5)	325.4 (102.3)	0.003	305.2 (116.4)	305.5 (114.2)	0.95	325.9 (98.1)	313.7 (110.1)	0.02

### READMISSION COHORT

	Acute Myocardial Infarction			Heart Failure			Pneumonia		
	100% adherence	Less than 100% adherence	P value	100% adherence	Less than 100% adherence	P value	100% adherence	Less than 100% adherence	P value
<b>Demographic characteristics</b>	<b>N=2464</b>	<b>N=163</b>		<b>N=1466</b>	<b>N=640</b>		<b>N=775</b>	<b>N=883</b>	
Age, year, mean (SD)	67.0 (13.7)	65.4 (14.1)	0.15	73.0 (13.8)	73.1 (12.8)	0.85	67.2 (17.7)	69.4 (15.9)	0.008
Male, n (%)	1634 (66.3)	112 (68.7)	0.53	826 (56.4)	361 (56.4)	0.99	416 (53.7)	497 (56.3)	0.29
White, n (%)	2026 (88.0)	140 (89.2)	0.38	1239 (87.6)	546 (86.0)	0.30	650 (86.9)	781 (90.0)	0.03

Primary payer: Medicare, n (%)	1243 (50.5)	88 (54.0)	0.38	1072 (73.2)	486 (75.9)	0.40	490 (63.2)	606 (68.6)	0.05
Medicaid/Free care	157 (6.4)	13 (8.0)		93 (6.4)	35 (5.5)		78 (10.1)	85 (9.6)	
Other	1064 (43.2)	62 (38.0)		300 (20.5)	119 (18.6)		207 (26.7)	192 (21.7)	
Lowest 25% SES, n (%)	572 (24.6)	48 (31.0)	0.08	355 (25.4)	149 (24.4)	0.61	199 (26.9)	199 (23.6)	0.13
<b>Clinical characteristics</b>									
Elixhauser comorbidities, mean (SD)	2.0 (1.3)	2.2 (1.4)	0.08	2.6 (1.4)	2.6 (1.5)	0.64	3.2 (1.6)	2.9 (1.5)	0.0003
Transferred to MGH, n (%)	1612 (65.4)	71 (43.6)	<.0001	267 (18.2)	67 (10.5)	<.0001	40 (5.2)	32 (3.6)	0.13
DNR in 1 <sup>st</sup> admit day, n (%)	16 (0.7)	1 (0.6)	0.96	21 (1.4)	14 (2.2)	0.21	16 (2.1)	17 (1.9)	0.84
DNR in entire hospitalization, n (%)	111 (4.5)	7 (4.3)	0.90	165 (11.3)	69 (10.8)	0.75	74 (9.6)	118 (13.4)	0.02
<b>Health Outcomes</b>									
90-day readmission, n (%)	710 (28.8)	61 (37.4)	0.02	594 (40.5)	268 (41.9)	0.56	250 (32.3)	308 (34.9)	0.26
1-year readmission, n (%)	1155 (46.9)	90 (55.2)	0.04	952 (64.9)	451 (70.5)	0.01	430 (55.5)	518 (58.7)	0.19
Mean time to 90-day readmission, d	73.9 (30.1)	67.5 (33.6)	0.02	67.4 (32.6)	66.6 (33.2)	0.59	72.9 (30.0)	71.0 (31.4)	0.21
Mean time to 1-year readmission, d	240.6(149.8)	208.8(157.3)	0.009	188.4(150.2)	177.8 (146.1)	0.13	219.7 (148.8)	210.6 (150.6)	0.21

Note: Demographic and clinical information in mortality cohort were presented based on patient's last discharges.

Readmission cohort included patient's first discharges after applying CMS pre-defined exclusions.

Missing was not included in percentage calculation

## Online Appendix 1

To estimate the exponential decay rate used in time-weighted analyses, we first estimated the adherence coefficient for the last discharge by regressing adherence to all-or-none measures against survival time until the end of the study. We then assessed the same coefficient for admissions that occurred within one month prior to the last discharge, 2 months prior to the last discharges, and up to 4 years if there were sufficient discharges. Once we had estimated the coefficients at  $n$  time points, the exponential smoothing function  $Coefficient = \exp(Rate * Time)$  was applied to estimate the weighting rate. Our data suggested that the half-life impact period was 1.8 years for HF and 0.88 years for pneumonia, with corresponding weighting rates of -0.0321, -0.0655. Since there were few AMI failures, we did not have sufficient power to calculate the AMI half-life period. We used the average of HF and pneumonia results as the AMI half-life period (1.34 years, weighting rate: -0.0488).

In order to validate this method, we performed sensitivity analyses using  $\frac{1}{2}$  and 2 times half life to evaluate the change in hazard ratio. Minimal changes were found for all three diseases, suggested that our weighting rate estimates were robust.

## Online Appendix 2

### TIME-WEIGHTED AVERAGE ADHERENCE FOR MULTIPLE ADMISSIONS (MORTALITY COHORT)

#### General formula

$$\frac{\sum_1^n Adherence * \exp(rate * time)}{\sum_1^n \exp(rate * time)}$$

where Adherence = 0 for measures fulfilled and 1 for measures failed

Time is calculated in months from current admission to last admission, and zero time refers to the last admission.

**Example 1:** There were three consecutive HF admissions for a patient on 4/1/05, 7/1/05, and 9/21/05. Left ventricular ejection fraction was assessed on the 1<sup>st</sup> admission, it was missed on the 2<sup>nd</sup> admission, and the patient was ineligible on the 3<sup>rd</sup> admission. Thus, the 7/1/05 admission is the last admission for this analysis.

$$\frac{0/1 * \exp(rate * 90/30.5) + 1/1 * \exp(rate * 0/30.5)}{\exp(rate * 90/30.5) + \exp(rate * 0/30.5)}$$

**Example 2:** A patient had 3 HF discharges on 1/1, 4/1, and 5/1 of 2006. Non-adherence to all eligible measures (number of non-adherence divided by the total number of eligible measures) at each discharge was 3/4, 1/4, and 0/3 respectively.

$$\frac{3/4 * \exp(rate * 120 / 30.5) + 1/4 * \exp(rate * 30 / 30.5) + 0/3 * \exp(rate * 0 / 30.5)}{\exp(rate * 120 / 30.5) + \exp(rate * 30 / 30.5) + \exp(rate * 0 / 30.5)}$$

Time-weighted average score for group measures used the same approach.