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CMS Hospital 30-Day Risk Standardized Mortality Ratings and Patient Outcomes

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Background and Significance

- Community acquired pneumonia (CAP), a leading cause of hospitalization and death in patients, age 65 years or older, remains the subject of intensive quality improvement efforts by the Centers for Medicare and Medicaid Services (CMS).
- CAP accounts for more than $10 billion annually in hospital expenditures and is responsible for three percent of all inpatient hospitalizations annually.[1]
- CMS uses hospital 30-day risk standardized mortality rating (RSMR) to assess hospital quality for patients admitted with CAP, with lower ratios indicative of better quality.[2]
- In 2012, CMS rated three hospitals, within an integrated healthcare system, as performing worse than expected on the 30-day RSMR and publically reported these findings on the *Hospital Compare* website.
- Hospital executive leaders questioned why CMS ratings differed from other benchmarks used internally to measure mortality expectancy.
- The notion that occurrence of death indicates poor quality suggests hospitals with more risk-adjusted deaths could have prevented the marginal differences in mortality.[3]
- Risk-adjustment models, such as the 30-day RSMR model, fail to take into account other proven factors, like palliative care, that explain additional unique variance in patient mortality. Instead, these risk-adjustment models attribute the remaining variation in mortality to poor patient care.
- In 2013, CMS implemented a hospital value-based purchasing program that includes incentives and penalties for hospital performance measured against national benchmarks.
- Failure to meet the national average estimate on 30-day RSMR could have a negative impact on hospitals from a consumer and financial perspective.

Objectives and Research Questions

This study aimed to explore the predictive power of 30-day RSMR as a quality measurement for assessing hospital efficacy and patient outcomes for CAP admissions. Research questions included:

- Are there differences in quality care (CMs, IQIs, HACs), patient safety measures (PSIs), patient[4] and inpatient[5] characteristics, mortality expectancy, and patient deaths[6] for patients treated at hospitals rated as performing worse than expected compared to hospitals rated as performing no different than expected on 30-day RSMR?
- Does 30-day RSMR predict 30-day readmissions and patient deaths, adjusting for patient and inpatient characteristics?

[1]Agency for Healthcare Research and Quality. 2011. "Healthcare Cost and Utilization Project: HCUP Facts and Figures 2009." [accessed on August 28, 2013]. Available at: http://www.hcup-us.ahrq.gov/reports/factsandfigures/2009/section1_TOC.jsp.
[2]Bernheim, S.M., Y. Wang, S. Spivack, K. Bartczak. 2012. "2012 Measures Maintenance Technical Report: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Mortality Measures." Yale School of Public Health. Contract HHSM-500-2008-0025I/HHSM-500-T0001, Modification No. 000007 from the Centers for Medicare & Medicaid Services.
[3]Cassell, J. B., Jones, A. B., Meier, D. E., Smith, T. J., Spragens, C. H., & Weissman, D. (2010). Hospital mortality rates: How is palliative care taken into account. *Journal of Pain and Symptom management, 40*(6), 914-925. doi:10.1016/j.jpainsymman.2010.07.005
[4]Age, Gender, Marital Status, Ethnicity, and Geographic Location
[5]RSMR, ED Status, ICU Status, Palliative Care Status, SNF Status, and Unique Consults
[6]Death within 30-days of admission, death during admission, and post-discharge death

Statistical Analyses

***Table 1*. Patient Characteristics by 30-Day RSMR Rating**

Patient Characterisitcs	30-Day RSMR Rating: No Different Than Expected *n*=1336			Worse Than Expected *n*=1075			Total *N*=2411		Test of Association[1]		
Age	M= 80.13, 95% *CI* [79.70, 80.56]			M= 79.94 95% *CI* [79.47, 80.41]					*t* (2409) = 0.558, *p* = 0.577		
Age Distribution	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	-	-	-
65-70	0.145	0.118	0.172	0.143	0.113	0.173	348	14.4			
71-75	0.165	0.138	0.191	0.175	0.145	0.205	408	16.9			
76-80	0.200	0.173	0.227	0.208	0.178	0.238	492	20.4			
81-85	0.217	0.190	0.244	0.217	0.187	0.247	520	21.7			
86-90	0.169	0.142	0.196	0.162	0.132	0.192	402	16.6			
91+	0.104	0.077	0.131	0.095	0.065	0.125	241	10			
Race	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
White	0.775	0.749	0.802	0.714	0.685	0.744	1804	74.8	13.641	0.357	0.572
African American	0.163	0.136	0.190	0.221	0.192	0.251	456	18.9			
Other	0.061	0.035	0.088	0.064	0.034	0.094	151	6.3			
Geographic Location	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
Urban	0.559	0.532	0.586	0.557	0.527	0.587	1346	55.8	0.008	0.000	0.996
Suburban/Rural	0.440	0.413	0.467	0.442	0.412	0.472	1063	44.1			
Marital Status	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
Married	0.470	0.443	0.497	0.455	0.425	0.485	1117	46.3	0.072	0.106	0.755
Widowed	0.381	0.354	0.408	0.378	0.348	0.408	915	38			
Gender	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
Male	0.464	0.437	0.491	0.466	0.436	0.496	1121	53.5	0.009	0.006	0.941
Female	0.536	0.509	0.563	0.534	0.504	0.564	1290	46.5			

Geographic location proportions do not sum to 1 due to missing data (n=2). Race (n = 151) and Martial Status (n=379) categories were grouped under Other and were not included in the analyses.
[1]Adjusted F is a variant of the second-order Rao-Scott adjusted chi-square statistic. Significance is based on the adjusted F and its degrees of freedom.

***Table 2*. Inpatient Characteristics by 30-Day RSMR Rating**

Inpatient Characteristics	CMS 30-Day RSMR Rating: No Different Than Expected *n*=1336			Worse Than Expected *n*=1075			Total *N*=2411			Test of Association[4]	
Patient Death	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1, 6)	*p*
Died within 30 Days	0.124	0.097	0.151	0.197	0.167	0.227	378	15.7	23.984	28.97	0.002
Died Index Admission	0.074	0.047	0.101	0.119	0.089	0.149	227	9.4	14.123	8.291	0.028
Died Post Discharge	0.050	0.023	0.077	0.078	0.048	0.108	151	6.3	7.949	10.948	0.016
Mortality Expectancy	*M (SD)*	Lower 95% *CI*	Upper 95% *CI*	M (SD)	Lower 95% *CI*	Upper 95% *CI*	*M*	*SD*	*t*	*df*	*p*
RAMI (0-100%)[1]	0.06 (0.13)	0.053	0.068	0.09 (0.16)	0.076	0.095	0.07	0.15	-3.851	1753.99	0.0001
APR-DRG Risk of Mortality	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1.340, 8.038)	*p*
Mild	0.051	0.022	0.080	0.050	0.017	0.082	106	5.04	1.247	0.279	0.678
Moderate	0.379	0.350	0.407	0.363	0.331	0.395	782	37.18			
Major	0.386	0.357	0.414	0.409	0.377	0.442	833	39.61			
Extreme	0.185	0.156	0.213	0.178	0.146	0.210	382	18.16			
ED Status	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1, 6)	*p*
Admitted via ED	0.910	0.883	0.937	0.953	0.924	0.983	2241	92.9	17.048	6.017	0.05
ICU Status	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1, 6)	*p*
Admitted to ICU	0.106	0.079	0.132	0.151	0.121	0.181	303	12.6	11.056	4.889	0.069
Palliative Care Status[2]	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1, 6)	*p*
Recived Palliative Care	0.071	0.044	0.098	0.132	0.102	0.162	237	9.8	24.995	18.016	0.005
SNF[3] **Status**	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1, 6)	*p*
Discharged to SNF	0.223	0.195	0.251	0.247	0.215	0.279	510	21.2	1.731	0.807	0.404
Unique Consults	*M (SD)*	Lower 95% *CI*	Upper 95% *CI*	*M (SD)*	Lower 95% *CI*	Upper 95% *CI*	*M*	*SD*	*t*	*df*	*p*
Average Consults	0.57 (1.06)	0.513	0.627	0.6 (1.03)	0.538	0.662	0.58	1.03	-0.819	2409	0.413
Core Measures Compliance[5]	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F* (1, 6)	*p*
PN2	0.960	0.923	0.996	0.978	0.935	1.020	1215	96.7	3.186	0.908	0.378
PN3b	0.977	0.930	1.024	0.981	0.929	1.032	776	97.9	0.132	0.114	0.747
PN5c	0.956	0.912	1.001	0.970	0.918	1.021	810	96.2	1.008	0.396	0.552
PN6	0.946	0.887	1.005	0.986	0.919	1.053	474	96.3	5.472	4.662	0.074
PN7	0.968	0.921	1.015	0.964	0.911	1.018	743	96.6	0.066	0.036	0.856

[1]RAMI data are available for patients admitted between 2009 and 2011.
[2]Palliative Care = Palliative Care Team documented the Palliative Care Protocol or ICD9-CM code V66.7 on medical record
[3]Skilled Nursing Facility (SNF)
[4]Adjusted F is a variant of the second-order Rao-Scott adjusted chi-square statistic. Significance is based on the adjusted F and its degrees of freedom.
[5]Compliance indicated protocols were followed.
PN2 = Pneumococcal vaccination; **PN3b** = blood cultures performed in the emergency department prior to initial antibiotic received in the hospital; **PN5c** = initial antibiotic received within 6 hours of hospital arrival; **PN6** = initial antibiotic selection for community-acquired pneumonia (CAP) in immunocompetent patients according to guidelines; **PN7** = Influenza vaccination.
Note. Percentages are calculated from reported data and may not add to total group sample sizes.

***Table 3*. Inpatient Characteristics by Pre or Post Discharge Death**

Patient Characteristics	Patient Death within 30 Days of Admission: Died During Admission *n*=227			Died Post Discharge *n*=151			Total *N*=378		Test of Association[1]		
Age	M= 81.83, 95% *CI* [80.80, 82.86]			M= 83.05, 95% *CI* [81.78, 84.31]					*t* (376) = 1.471, *p* = 0.142		
Inpatient Characteristics											
ED Admission	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
Admitted via ED	0.960	0.895	1.025	0.921	0.841	1.000	357	94.44	2.741	4.868	0.069
ICU Admission	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
Admitted via ICU	0.379	0.314	0.444	0.132	0.053	0.212	106	28.04	27.285	73.525	<.0001
Palliative Care	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*Proportion*	Lower 95% *CI*	Upper 95% *CI*	*n*	%	x^2	*adj F (1, 6)*	*p*
Received Palliative Care	0.630	0.565	0.695	0.278	0.198	0.358	185	48.94	44.914	41.836	0.001
Unique Consults	*M (SD)*	Lower 95% *CI*	Upper 95% *CI*	*M (SD)*	Lower 95% *CI*	Upper 95% *CI*	*M*	*SD*	*t*	*df*	*p*
Average Consults	1.01 (1.29)	0.846	1.181	0.81 (1.22)	0.613	1.003	0.93	1.26	-1.549	376	0.122

[1]Adjusted F is a variant of the second-order Rao-Scott adjusted chi-square statistic. Significance is based on the adjusted F and its degrees of freedom.

***Table 4*. Logistic Regressions Predicting Patient Death**

Predictor	Death within 30 Days of Admission: *OR*	*Wald F (1,6)*	*p*	*Lower 95% CI*	*Upper 95% CI*	Death during Index Admission: *OR*	*Wald F (1,6)*	*p*	*Lower 95% CI*	*Upper 95% CI*	Death Post-discharge: *OR*	*Wald F (1,6)*	*p*	*Lower 95% CI*	*Upper 95% CI*
Age	0.947	16.16	0.007	0.915	0.979	0.962	12.66	0.012	0.937	0.988	0.951	10.94	0.016	0.916	0.987
Gender	1.587	6.15	0.048	1.006	2.503	1.310	2.58	0.160	0.868	1.976	1.571	6.38	0.045	1.014	2.435
CMS 30-Day RSMR	1.406	6.12	0.048	1.004	1.968	1.186	0.61	0.463	0.697	2.018	1.464	5.77	0.053	0.993	2.157
Palliative Care	30.949	243.65	<0.0001	18.070	53.005	32.152	677.01	<.0001	23.199	44.560	3.476	10.52	0.018	1.358	8.896
ICU Admission	2.761	102.14	<0.0001	2.159	3.531	4.840	100.70	<.0001	3.295	7.110	0.726	3.46	0.112	0.476	1.107
Total Unique Consults	0.937	0.96	0.365	0.797	1.102	1.042	0.18	0.688	0.820	1.326	0.869	2.29	0.181	0.693	1.090

Note: Binary predictors were coded as follows: Gender (0=Female, 1=Male); 30-Day RSMR (0=No different than expected, 1=Worse than expected); Palliative Care (0=Not received, 1=Recevied); ICU Admission (0=Not admitted; 1=Admitted)

***Table 5*. Conditional Probability and Relative Risk for Patient Deaths**

Timing of Death		Group Criteria	Conditional Probablity: Statistics for Men: Logit	Odds Ratio; Exp(B)	Conditional Probability	Statistics for Women: Logit	Odds Ratio; Exp(B)	Conditional Probability	Relative Risk: Group Comparisons	Men	Women
Death within 30 Days	1	Hospital performing as expected, patient did not receive palliative care services	-0.848	0.428	0.300	-1.310	0.270	0.213	Group 2 versus Group 1	3.101	4.202
	2	Hospital performing as expected, patient received palliative care services	2.584	13.251	0.930	2.122	8.349	0.893	Group 4 versus Group 3	2.526	3.352
	3	Hospital performing worse than expected, patient did not receive palliative care services	-0.508	0.602	0.376	-0.970	0.379	0.275	Group 4 versus Group 2	1.021	1.032
	4	Hospital performing worse than expected, patient received palliative care services	2.924	18.617	0.949	2.462	11.729	0.921			
Death During Admission	1	Hospital performing as expected, patient did not receive palliative care services	0.047	1.048	0.512	-0.223	0.800	0.444	Group 2 versus Group 1	1.898	2.166
	2	Hospital performing as expected, patient received palliative care services	3.517	33.672	0.971	3.247	25.704	0.963	Group 4 versus Group 3	1.761	1.989
	3	Hospital performing worse than expected, patient did not receive palliative care services	0.217	1.242	0.554	-0.053	0.948	0.487	Group 4 versus Group 2	1.005	1.006
	4	Hospital performing worse than expected, patient received palliative care services	3.687	39.911	0.976	3.417	30.467	0.968			
Post-Discharge Death	1	Hospital performing as expected, patient did not receive palliative care services	1.788	5.976	0.857	1.336	3.803	0.792	Group 2 versus Group 1	1.114	1.174
	2	Hospital performing as expected, patient received palliative care services	3.034	20.776	0.954	2.582	13.221	0.930	Group 4 versus Group 3	1.079	1.122
	3	Hospital performing worse than expected, patient did not receive palliative care services	2.169	8.748	0.897	1,717	5.567	0.848	Group 4 versus Group 2	1.015	1.023
	4	Hospital performing worse than expected, patient received palliative care services	3.415	30.411	0.968	2.963	19.352	0.951			

Note. Age was kept constant at the mean of all cases of death (M=80.04). ICU admission (admitted) and number of consults (M=.58) were kept constant. Only 30-Day RSMR (performing no different than expected or worse than espected) and palliative care were adjusted to explore their predictive effect on death. Documentation for calculation of 95% CI for RR with multiple predictors was not found.

Method

- *Complex samples chi-square tests of independence* were used to explore differences in patient variables between 30-day RSMR designations. *Complex samples logistic regression models* were used to explore the probability of patient death. *Conditional probabilities and relative risks* were used to explore the explanatory power of 30-day RSMR for patient death.

Results

- *Complex samples chi-square tests of independence* revealed the only significant differences in quality care (CMs, IQIs, HACs), PSIs, and patient and inpatient characteristics between hospitals rated as performing worse or no different than expected were ED visits, ICU admission, palliative care, and death (Tables 1-3).
- A *complex samples logistic regression* revealed 30-day RSMR did not significantly predict 30-day readmissions (controlling for age, gender, receipt of palliative care, ICU admission, and total unique consults); palliative care services was the only significant predictor (*Wald's F (1,6)* = 10.287, *p* = .018, *OR* = 1.696, *95% CI* [1.133, 2.537]). An ANCOVA (*Wald F* (2,5) = 188.42, *p*<.001) revealed that 30-day RSMR designation (*t*(6)=-0.93, *p*=.387) was no longer a significant predictor of expected mortality (RAMI) once palliative care (*t*(6)=-19.80, *p*<.0001) was included in the model. Similarly, a *complex samples chi-square test of independence* revealed no significant differences in mortality expectancy (APR-DRG risk categories) by 30-day RSMR (Table 2).
- To determine if 30-day RSMR significantly predicted death within 30 days of admission, death during admission, or death occurring post-discharge, a series of *complex samples logistic regressions* were analyzed controlling for several factors: patient age, gender, receipt of palliative care, ICU admission, and total unique consults (Table 4). All predictors, except total unique consults, significantly predicted death within 30 days of admission. Similarly, patient age, receipt of palliative care, and ICU admission were the only significant predictors of deaths occurring during admission. Patient age, gender, and palliative care were the only significant predictors of death occurring post-discharge. Palliative care was the strongest predictor across all three logistic models for death.

Conclusions and Implications

- Mortality risk in hospitals rated by CMS as performing worse than expected was essentially the same as mortality risk in hospitals rated as performing as expected, adjusting for other variables in the model (Table 5).
- Above all other predictors, palliative care services significantly contributed to the explanation of patient death regardless of whether the hospital was rated by CMS as performing worse than expected or as expected.
- Results demonstrated that deaths occurred even within an environment that delivered quality patient care. Patient care goals, such as palliative care, should be factored into the "death equals poor quality" equation before attributing the remaining variability to hospital quality. Further research to model the statistical effects of palliative care on patient death is warranted.

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