The need to incorporate the present on admission (POA) indicator in claims-based mortality measure

By Richard L. Fuller, John S. Hughes, Graham Atkinson and Gongmei Yu

Abstract:

The Centers for Medicare and Medicaid Services (CMS) redistributes over $2 billion of hospital payments based on comparative measures of hospital mortality. Mortality measures are intended to provide quality guidance for consumers and contribute to overall value-based purchasing (VBP) incentives for hospitals. Several studies have raised doubts over the fairness and reliability of hospital mortality models and the resulting payment adjustments made under the VBP. In our study we look at the effect of the failure of the CMS mortality model to account for the effect on hospital performance rankings of variations in Do Not Resuscitate (DNR) orders and major comorbidities present at the time of admission (POA).

We use Medicare claims data to review the impact of the failure to adjust for variation in diagnoses and DNR orders coded POA to provide an estimate of impact upon hospital performance rankings. In keeping with prior studies, we find the inclusion of cases coded as Do Not Resuscitate on admission, which should logically not be allowed to influence quality assessment, as well as the failure to include major comorbid conditions coded POA in the risk model, which should logically be allowed to impact quality assessment, to both significantly change relative hospital rankings in mortality performance.

Conclusions: Our study demonstrates how adjustments for both DNR orders and diagnoses identified at the time of admission will affect both hospital mortality rankings and the likelihood of positive or negative VBP payment adjustments

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The need to incorporate the present on admission (POA) indicator in claims-based mortality measures

Background

Every year the Centers for Medicare and Medicaid Services (CMS) redistribute over $2 Billion of hospital payments based on comparative measures of hospital quality within the hospital value-based purchasing (VBP) program. These measures are also intended to provide quality guidance for consumers selecting hospitals for care by providing an overall CMS endorsed rating of relative quality. In this study we focus upon the use of Present on Admission (POA) information in one of those measures, the CMS mortality measurement. This measure is calculated for hospitals subject to the inpatient prospective payment system (IPPS) and reported annually through the Hospital Compare Website[1].

Mortality rates published for heart attack (Acute Myocardial Infarction, AMI), heart failure (HF) and pneumonia (PN) are significant contributors to the clinical care domain (worth 25 percent of a hospital's total performance score) in the hospital value-based purchasing (VBP) initiative. The VBP is intended to reward high quality care by redistributing two percent of hospital payments (over $2 billion) across hospitals in accordance with their measured performance. The public posting of mortality rates and accompanying financial incentives are intended to focus hospital attention and encourage patients to select higher quality care since "high-quality care during their hospitalizations and their transition to the outpatient setting will likely have improved outcomes, like survival rate"[2]. Full details of the CMS risk adjustment model for 2020 can be found on the Quality Net website[3].

The Present on Admission (POA) indicator field became a required reporting element for both principal and secondary diagnoses on hospital claims submitted to CMS for payment after October 1, 2007. The POA indicator distinguishes significant patient risk factors present at admission from those arising after admission that may have resulted from poor quality hospital care[4].

The CMS model does not incorporate POA information in its risk adjustment. It therefore omits allowance in risk adjustment for two potentially valuable predictors of hospital mortality. First, patient instructions at admission to allow a natural death, or Do Not Resuscitate orders [ICD10-CM code Z66] are omitted as risk factors in the CMS model. Second, the CMS model incompletely adjusts for the risk contributed by serious comorbid conditions and complications present at admission. For example, the mortality risk model for heart failure does not include factors such as "cardio-respiratory failure and shock" or "acute myocardial Infarction" when reported as being present at the time of the index admission, unless they were also previously recorded in separate instances during the prior 1-year "lookback" period before the current hospitalization[5].

It has been shown that Do Not Resuscitate orders at time of admission have significant influence on subsequent hospital mortality [6–10] rankings. It is also expected that severe coexisting conditions, or comorbidities, present at the time of admission will affect patient outcomes, which if not accounted for will adversely affect the ranking and perception of hospitals that routinely care for patients with major illness[11].

Our study analyzes the impact upon hospital mortality rankings using a 30-day fixed mortality window (in keeping with the CMS design) when patients with a DNR order POA are excluded from the mortality calculation. We also examine the frequency with which discharge diagnosis codes that were POA would not be included as a risk-adjustment variable in the current CMS model.

Methods

We obtained Medicare fee for service (FFS) claims data and the Medicare Master Beneficiary Summary File (MBSF) for calendar year 2016 (CY2016). Analysis was restricted to acute-care hospitals subject to the inpatient prospective payment system (IPPS), which includes hospitals in the FY2018 IPPS provider impact file generated by CMS in final rule making. The impact file is based on claims submitted by providers in the FY 2016 (October 1, 2015 through September 30, 2016) period [12].

We identified the three VBP mortality cohorts (AMI, HF and PN) among the FFS claims using the risk of mortality logic published[13] by CMS. A patient was flagged as having died within 30 days of admission if either the discharge status reported on the inpatient hospital claim was 20 (died) with length of stay less than 30 days, or death was recorded in the MBSF within 30 days of the admission date. To provide a consistent 30-day window for CY2016 admissions, patients admitted in December of 2016 were excluded from counts.

We excluded claims from analysis if the patient was transferred in from an acute hospital or hospice facility or was recorded as leaving against medical advice. These exclusions approximate those of the CMS model with the substitution of excluding claims transferred in from hospice in place of excluding patients with hospice use in the preceding year, a more detailed measure that was unavailable to us.

We identified claims with a DNR order in place through the presence of ICD-10-CM code Z66. The Present on Admission (POA) indicator allowed us to differentiate between instances where a patient had a DNR order at the time of admission, and was therefore unlikely to receive aggressive treatment, as opposed to a patient with a DNR order that was issued after the time of admission, potentially resulting from a failure in quality of care.

To assess the impact upon hospital mortality rankings of retaining DNR cases we created a risk adjusted ranking of hospitals with and without admissions that have a DNR code present on admission. Due to data limitations, we were unable to fully replicate the CMS risk adjustment model which requires the availability of data to look back 1 year to adjust for patient risk including linked carrier and hospice claims files and 3 years of patient outcomes to complete hospital comparisons (3 years complete linked patient data in total). Instead, we approximate the impact upon hospital rankings using the All Patient Refined Diagnosis Risk Group Risk of Mortality (APR DRG ROM) at admission for the VBP cohorts. The All-Patient Refined Diagnosis Risk of Mortality algorithm is used by multiple researchers to compare hospital mortality rates. The Medicare Payment Advisory Commission (MedPAC), for example, uses APR DRG ROM to assess hospital mortality within the Medicare FFS payment system[14].

We assigned admissions to a total of 1,167 mutually exclusive APR DRG ROM groups. The APR DRG ROM provides the baseline risk adjustment for mortality from which sensitivity to the use or exclusion of POA information on hospital rankings is measured. We assigned diagnosis codes to the condition categories (CCs) used for risk adjustment in the CMS mortality model and identified patient cohorts consistent with the CMS model. CCs are a derivation of hierarchical condition categories (HCCs) used in the Medicare Advantage program, and each contains a list of mutually exclusive related diagnosis and procedure codes. The complete list of CCs and associated ICD-10-PCS and ICD-10-CM codes are available for download and inspection from the Quality Net website[3]. Condition categories for Heart Failure (CC 87), AMI (CC 74) and PN (CC 75) form distinct cohorts within the CMS mortality model.

We computed the ratio of deaths to admissions for each of the admission APR DRGs and their ROM levels. This rate was applied to every admission in the same APR DRG ROM level for each hospital within the analysis thus providing an expected rate of mortality (APR DRG ROM based) for every admission through indirect rate standardization. The calculated mortality rates for all admission APR DRGs and ROMs are given in Appendix 1. By summing the expected rate of mortality for each admission we calculated three ratios of actual to expected mortality rates for each hospital, one for each of the VBP mortality cohorts (HF, AMI, and PN). The calculation was repeated after excluding admissions where DNR was reported as POA. The performance (relative ratio) of each hospital was ranked and we measured the correlation between hospital rankings with and without the DNR cases by calculating a rank correlation coefficient.

In a separate analysis, we reviewed the frequency with which risk variables identified as complications of care (defined separately in the CMS mortality logic), are coded POA for the index admission but are not included within the risk adjustment model. As with cohort identification, complications of care codes are identified by the CMS CC group to which they are assigned within the mortality measure logic. Under the current CMS calculation, “The models do not adjust for risk factors present on an index admission if the conditions may represent complications of care.” [15] Many of these potential complications of care could have been preexisting chronic conditions recorded in the 1-year lookback period. However, since the CMS model does not utilize POA coding it does not distinguish between conditions that could have been complications that arose during the admission from those that were present at the time of admission.

Results

In Table 1 we summarize the counts of admissions and deaths for our claims data period. After applying the hospital, patient and claim type exclusions, the data consisted of a total 8,117,823 admissions from 3,156 hospitals with 8.19 percent (665,120) dying within 30 days. Of the 665,120 deaths, 36.5 percent (242,520) died during the hospital admission with the majority (422,600) dying after discharge within the 30-day window (not shown in Table1). The three VBP cohorts together accounted for 1,032,942 admissions (12.7 percent of total admissions) and 116,315 deaths (17.5 percent of total deaths).

Table 1: Analysis of DNR present on admission status for Medicare FFS Admissions and 30-day mortality for Heart Failure, Acute Myocardial Infarction and Pneumonia, CY 2016

		Acute MI	Heart Failure	Pneumonia	Subtotal	All Patient Admissions
All DNR Order Status (No Order, DNR POA, DNR After Admission)	Admissions	190,642	470,196	372,104	1,032,942	8,117,823
	Deaths	22,127	48,047	46,141	116,315	665,120
	Mortality Rate	11.61%	10.22%	12.40%	11.26%	8.19%
	Mortality Rate excl DNR POA	8.83%	7.65%	8.59%	8.21%	5.83%
No DNR order	Admissions	166,785	393,982	301,128	861,895	7,177,779
	Deaths	11,939	25,832	21,283	59,054	334,311
	Mortality Rate	7.16%	6.56%	7.07%	6.85%	4.66%
DNR order Present on Admission	Admissions	19,018	66,105	61,476	146,599	785,838
	Deaths	6,967	17,151	19,456	43,574	237,840
	Mortality Rate	36.63%	25.95%	31.65%	29.72%	30.27%
	% All Admissions	9.98%	14.06%	16.52%	14.19%	9.68%
	% All deaths	31.49%	35.70%	42.17%	37.46%	35.76%
DNR order after admission	Admissions	4,839	10,109	9,500	24,448	154,206
	Deaths	3,221	5,064	5,402	13,687	92,969
	Mortality Rate	66.56%	50.09%	56.86%	55.98%	60.29%

Source: Medicare FFS claims data CY 2016; DNR – Do Not Resuscitate identified by ICD-10-CM code Z66; POA – Present on admission

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Table 1 shows the mortality rate inclusive of patients with DNR present on admission to be 25-30 percent higher than the mortality rate when DNR POA admissions are excluded. That relationship is consistent across the three VBP cohorts and holds when considering all admission types. DNR orders are coded as POA for 80-85 percent of admissions where a DNR order is reported (once again with consistency across the VBP cohorts and "all" admission types). Admissions with a DNR order coded POA have an associated mortality rate of 29.72 percent across the VBP cohorts while those with DNR coded after admission have a mortality rate of 55.98 percent. We also observe that DNR orders are abundant in the Medicare FFS data with 9.68 percent of all admissions having a DNR order at the time of admission rising to 14.19 percent of the VBP cohort. The elevated rate of DNR orders within the VBP cohort is to be expected given that medical conditions such as acute MI, heart failure and pneumonia are strongly associated with the frail elderly and end of life care.

Impact of DNR present on admission on hospital rankings

To gauge the sensitivity of hospital rankings to the method by which DNR orders are handled in the mortality measure algorithm we report correlation coefficients for hospital mortality rankings for the VBP cohorts before and after excluding DNR POA cases. As described under Methods, we applied risk adjustment using APR DRG ROM classification to adjust for patient mix variation when calculating relative hospital rankings.

In calculating hospital ranks we excluded hospitals with fewer than 25 admissions within the cohorts (in keeping with CMS model guidelines) and then repeated the analysis with an increased limit of 100 cases (to enforce additional rank stability). We tested the increased limit after noting that many hospitals with low volumes had performance statistics (Actual / Expected) at extremes of high and low and considered 100 cases to be a suitable cutoff for stability.

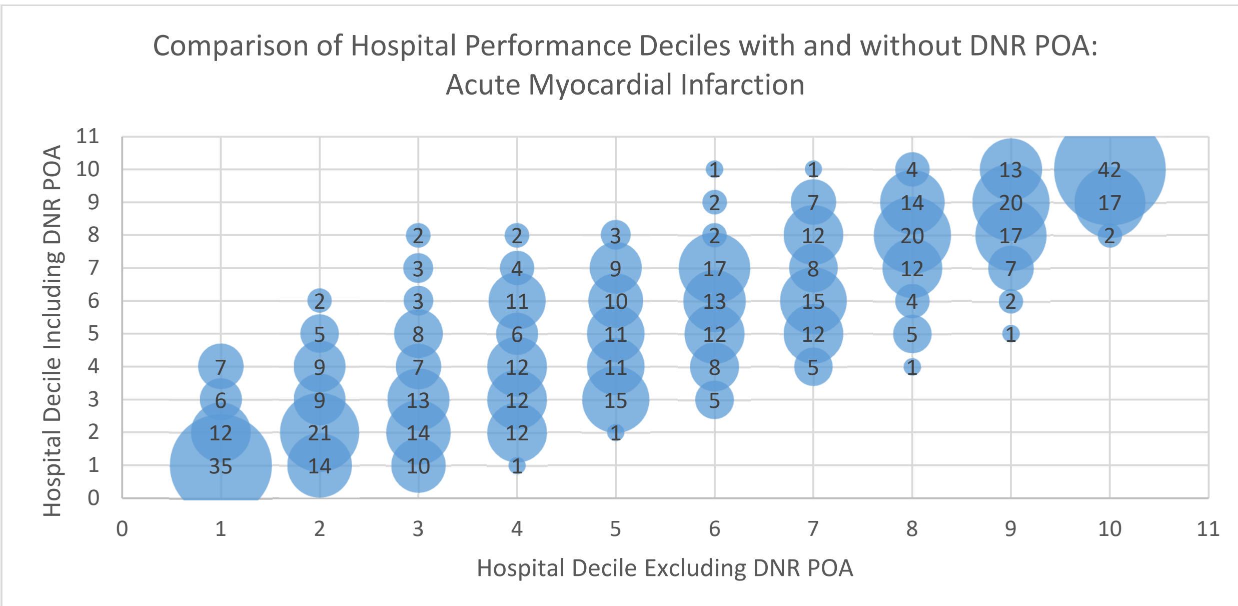
Table 2: Correlation between hospital rankings before and after excluding DNR POA

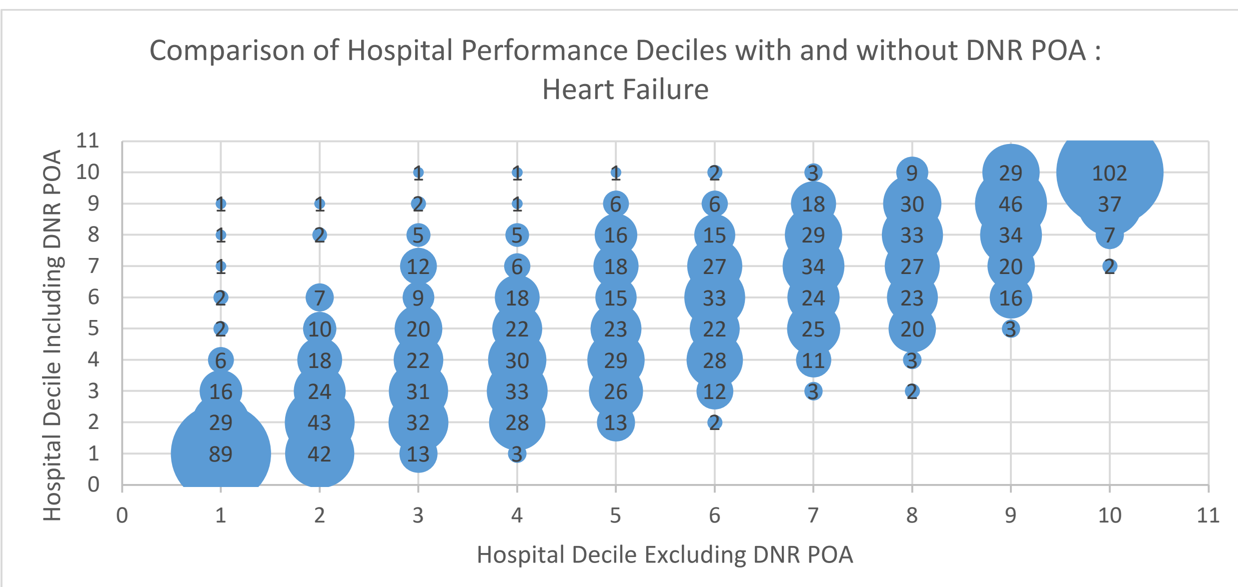
	Acute MI	**Heart Failure**	**Pneumonia**
	Hospitals; r	Hospitals, r	Hospitals, r
Exclusion level 25	1,776; .86	2,594; .84	2,654; .80
Exclusion level 100	601; .88	1,472; .83	1,209; .80
Hospitals (No Exclusion)	2,834	2,988	3,011

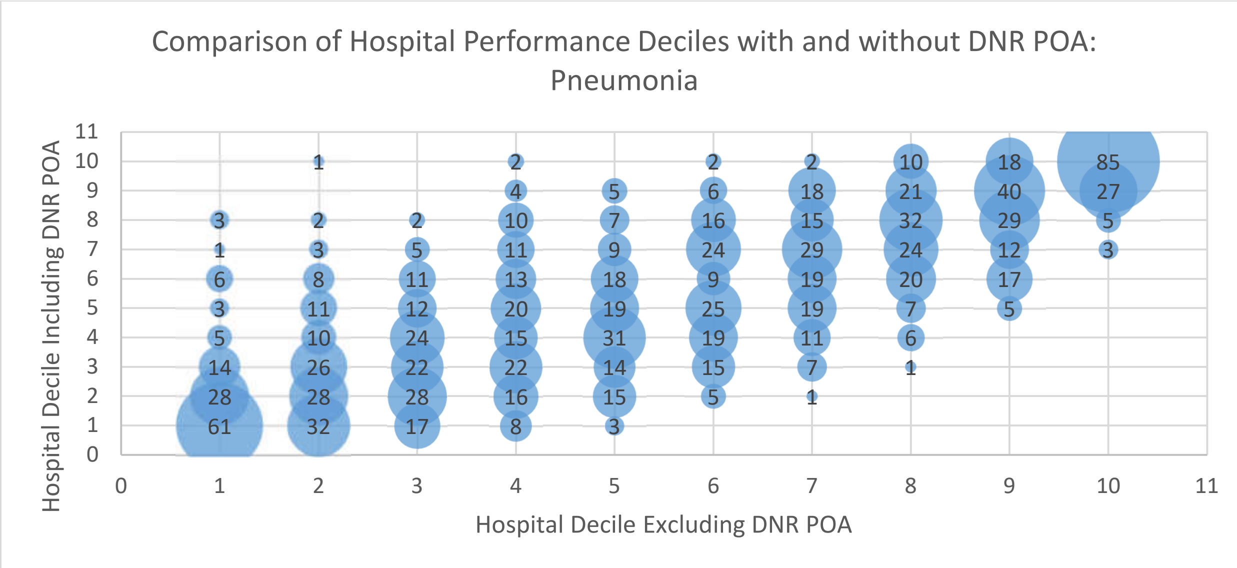
Source: Medicare FFS claims data CY 2016; DNR POA = Y for ICD-10-CM Z66.

It can be seen from Table 2 that while rankings are clearly correlated (minimum Pearson r coefficient of .80) they are not close to 1.0. The increased limit of 100, which should hypothetically increase stability by reducing sensitivity to DNR case exclusion, had very little effect on ranking correlations. Figures 1A through 1C show the redistribution of hospitals across hospital performance deciles (with rank again based on actual to expected mortality rate ratios) for hospitals with at least 100 admissions.

Figure 1A-1C: Comparison of hospital rankings by decile with and without DNR POA for AMI, HF and PN for hospitals with > =100 observations







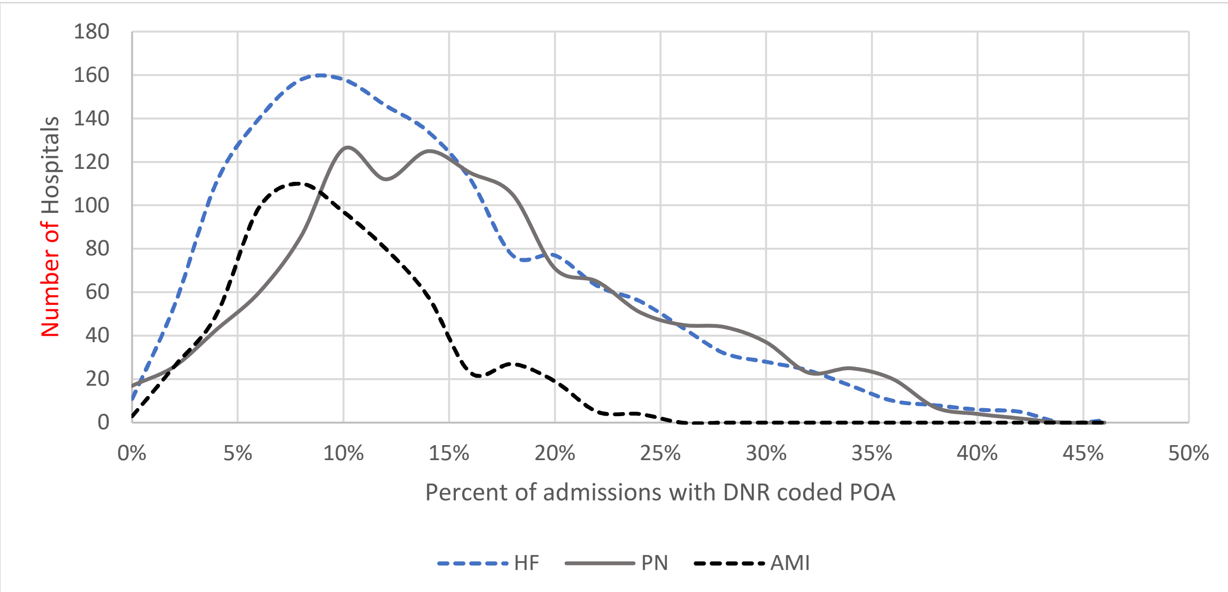
Source: Medicare FFS claims data CY 2016; Excludes admissions where DNR POA = Y for ICD-10-CM Z66; Excluded complications are cohort specific.

Figure1 A-C captures the shift of hospitals across performance deciles when excluding admissions with DNR orders POA. The hospital performance decile including all cases is shown on the vertical axis while the hospital decile excluding the DNR POA cases is shown on the horizontal axis. A hospital that, for example, changes from decile 5 to decile 4 after excluding DNR POA cases, is counted in the bubble centered on a coordinate (4,5). Relative bubble size represents the count of hospitals within each bubble. Hospitals with unchanged performance rankings appear on the 45˚ axis (1,1; 2,2 etc.) with those appearing below the axis improving in relative decile rank and those above worsening after excluding DNR POA cases. We consider the change in hospital mortality rankings to be substantial, with 14.3 percent of hospitals in the VBP cohorts (AMI:9.3%; HF:13.5%; PN:17.7%) moving +/- 3 or more relative performance deciles when excluding admissions with DNR POA from the analysis.

For substantial numbers of hospitals to shift across performance deciles when excluding DNR orders that are POA requires that the frequency of DNR orders in place at time of admission must vary considerably across hospitals. In Figure 2 we report the underlying distribution of DNR admissions coded POA across hospitals for the VBP cohorts once more restricting reporting to the hospitals with at least 100 admissions within the individual cohort (AMI, HF, PN).

By hospital, the percentage of admissions with DNR orders POA mirrors the observed shift in performance deciles ranging from 0 to 24 percent for AMI (N=601) ; 0 to 42 percent for PN (N=1,209); and 0 to 46 percent for HF (N=1,472). We observe in Figure 2 a more pronounced rightward skew in the distribution for HF and PN where 25 percent (HF) and 33 percent (PN) of hospitals have over 20 percent of admissions with a DNR order in place at the time of admission compared to 5 percent for AMI.

Figure 2: Percentage of hospital admissions with DNR POA for AMI, HF and PN for hospitals with > =100 admissions



Source: Medicare FFS claims data CY 2016; DNR POA = Y for ICD-10-CM Z66 AMI N=601; HF N=1,472; PN N=1,209

Potential impact of excluding comorbidities and complications present on admission

Our analysis to this point has focused upon the ***potential*** for DNR orders POA to impact hospital performance ranking. To perform a similar analysis of potential impact of excluding complications/comorbidities from the risk model when POA we would need to assess three things:

i) The interaction of the excluded comorbidities/complications with the mortality model coefficients to assess if the projected risk changes for each CC.
ii) Variation of excluded codes (disallowed CCs) across hospitals to assess the ***relative*** impact of the exclusion across hospitals.
iii) The absolute frequency of disallowed CCs to assess the impact on unmeasured severity in the performance measure.

As previously discussed, we lack full historical linked patient data making it impossible to replicate the existing CMS risk model. We adapted the existing APR DRG ROM risk model to provide indicative results for excluding DNR POA. Assessing the effect of interaction between multiple complications/comorbidities with the existing CMS risk model coefficients is not conducive to a similar process of substitution with the APR DRG ROM model. Without an estimate of relative effect size the variation of excluded complication/comorbidity codes may be misleading. Instead, we simply provide a count of the upper bound of excluded diagnoses per admission as an indicator.

Table 3: Numbers of comorbid condition codes reported as present on admission that would be excluded in the CMS risk adjustment

	Acute MI	Heart Failure	Pneumonia	Subtotal
Admissions	171,624	404,091	310,628	886,343
Comorbidities POA (excluded)	359,799	731,623	797,424	1,888,846
Excluded comorbidities per admission	2.10	1.81	2.57	2.13

Source: Medicare FFS claims data CY 2016; Excludes admissions where DNR POA = Y for ICD-10-CM Z66; Excluded complications are cohort specific.

Table 3 provides counts of comorbidities reported POA that ***could*** be excluded from risk adjustment by the CMS method. Since a patient risk factor is counted as a CC only once, it is possible that the risk factor is captured in patient history and therefore while it is excluded for the index admission under consideration it is included for the patient in the risk model calculations. Without access to the full historical data it is impossible to know how many of the excluded comorbidities would have been picked up as risk factors for individual admissions during the lookback period, and so these numbers would be an upper bound of excluded diagnoses.

The range of excluded complications and comorbidities varies by cohort. Twenty-two condition categories are uniformly excluded across the three cohorts (e.g., cardio-respiratory failure and shock, acute renal failure, major head injury) while some are cohort specific (e.g., septicemia, sepsis, systemic inflammatory response syndrome/shock is excluded for pneumonia; diabetes with acute complications is excluded for AMI and HF). A summary of excluded categories (CCs) is provided in online Appendix 2.

What we observe in Table 3 is that, on average across the 3 cohorts, 2.13 comorbidities/complications per admission were POA and therefore potentially excluded as risk factors by the CMS model. We suggest that these numbers are of sufficient volume to ***potentially*** impact the risk model and hospital performance decile.

Discussion

The POA indicator field has appeared in claims data since 2007. It was introduced to provide a standardized data element, with accompanying documentation and coding guidelines, to generate exactly the type of information that can help differentiate outcomes that are preventable in routine cases from those which are either expected or more likely due to elevated risk at the time of admission. Claims data submitted by hospitals for payment under the Medicare IPPS are audited for accuracy and serves as the basis for subsequent payment adjustment under the hospital-acquired condition (HAC) payment policy.

In keeping with other studies[6–9] we find the exclusion of patients with DNR orders that were present on admission is likely to impact hospital mortality rankings. This is shown graphically in Figure 1 which demonstrates substantial changes in decile rank when DNR POA codes are excluded. The underlying hospital variation in admissions reported as having DNR orders POA are shown in Figure 2. Removing admissions with DNR orders POA reduced rank correlation coefficients to a range between r= .8 and .9. We believe the intent of mortality measures, as put forth by CMS when describing why mortality measures matter in the VBP, is to create a measure of ***preventable*** mortality and, as such, a DNR order present at the time of admission is misleading if used for outcomes evaluation, since heroic life-saving interventions are less likely to be attempted. The same is not true of DNR orders that are not present on admission. These cases have mortality rates double those of DNR orders that are POA (see Table 1) which is in keeping with identifying patients for which care **may** have contributed to an unwanted or unexpected outcome. Alternatively, patients identified as DNR after admission would have been thought initially to benefit from aggressive treatment, and only declared DNR after the aggressive treatments failed. We therefore believe that mortality models should adopt the use of POA status and exclude patients who have a DNR on admission to better align with the concept of ***preventable*** mortality. Excluding patients with DNR orders POA, as opposed to risk adjusting for them, also addresses the potential for physicians that are unaware of, (or otherwise ignore), the DNR order to improve the underlying measure hospital mortality performance at the expense of patient wishes.

In addition to DNR orders there are significant numbers of what we would consider to be legitimate risk factors potentially excluded from the CMS risk model simply because the existing model does not recognize POA coding. Although we lack access to the data to replicate the CMS method of risk adjustment, which relies on up to 3 years of historical information, Krumholz and colleagues found that the addition of POA information to the full CMS risk model improved model performance and demonstrated a larger effect size using recent rather than historic diagnoses for risk adjustment[11]. In separate analysis, not shown here, we had similar findings in which a risk factor identified historically had a lesser effect size than one reported at the time of admission. This is intuitively obvious since a significant risk factor necessitating hospital admission reported historically also requires survival of that earlier hospitalization to be included within the risk model.

Comparison of mortality rates is a charged topic. Ignoring information that is available at the time of admission, particularly when the underlying rate of mortality is generally low and therefore highly variable, can result in unfair comparisons with large performance differences across hospitals resting on a handful of cases that may be more appropriately excluded. Retaining cases where survival is not the goal of care may boost the predictive power of the mortality model, but at the cost of understating the health care system's overall effectiveness and appropriateness of care.

Data limitations prevent us from fully replicating the CMS mortality model. To fully replicate the model requires patient linked data from all sources, not just facility, for a period exceeding a single year since it requires a 1-year lookback period for each patient in the target condition cohort, and three years' worth of patients to assess a facility. In our analysis we substituted the use of APR DRG as an indicator of the effect of DNR orders at admission to demonstrate the potential significance of its impact. It is plausible that the increased likelihood of mortality corresponding to a DNR order at admission will be fully or partially accounted for in the full CMS risk adjustment made for comorbidities captured in the patient's preceding 1-year lookback period. The potential for this correlation is untested in our simulation however, while we should expect admissions with DNR orders in place at time of admission to be associated with patients that have a greater frequency of significant comorbid conditions in their patient history, we feel it is unlikely that the measured effect for comorbid conditions distributed across patients with and without DNR orders present at time of admission can fully offset the highly significant impact of DNR orders upon mortality.

The collected articles authored by Walkey, Bruckel and Bradford[6–9] used the California H-CUP state inpatient database which contains a unique "early DNR order" reporting variable. The individual study periods, risk adjustment variables and cohort definition including age ranges varied across the articles, but all indicated that DNR coding was a major contributor to hospital mortality ranking. The Krumholz article acknowledges the need to incorporate POA information in risk adjustment but does not address the potential value of DNR POA coding as identified by ourselves and by Walkey, Bruckel, Bradford et al. In our article we standardize the risk model for the national Medicare FFS program and define the cohort of patients for mortality measurement in accordance with the VBP to demonstrate how an adjustment for DNR orders at the time of admission will affect both hospital mortality rankings and the likelihood of positive or negative VBP payment adjustments. While we concur with Krumholz that including POA information, recency and the potential for heterogeneity in the CC risk adjustment variables is important, we believe that accounting for DNR orders present at the time of admission is both feasible and of equal importance.

How POA information may be used is an open policy question. In the current mortality model hospitals that adhere to patient DNR orders when POA have additional mortality counts while those that act against patient wishes avoid mortality counts in their performance measures. To avoid this inappropriate bias it should be preferable to exclude patients with DNR orders that are POA from mortality rate calculations.

Conclusion

In our analysis we highlight how the current CMS mortality models can be improved by excluding patients with DNR orders POA, and including comorbid conditions known to be present at the time of admission within the risk model as additional risk factors. While the goal of evaluating hospitals based on their mortality outcomes is important, it is also important to reflect those differences fairly when both reputation and sizeable payment distributions can depend upon those publicly reported evaluations.

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