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Authors

Vaduganathan, Muthiah
McCarthy, Cian P
Ayers, Colby
et al.

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Longitudinal trajectories of hospital performance across targeted cardiovascular conditions in the USA

Muthiah Vaduganathan[1†], Cian P. McCarthy[2†], Colby Ayers[3], Deepak L. Bhatt[1], Dharam J. Kumbhani[3], James A. de Lemos[3], Gregg C. Fonarow[4], and Ambarish Pandey[3]*

[1]Brigham and Women's Hospital Heart & Vascular Center, Harvard Medical School, 75 Francis St., Boston, MA 02115, USA; [2]Department of Medicine, Massachusetts General Hospital, 55 Fruit St., Boston, MA 02114, USA; [3]Division of Cardiology, Department of Internal Medicine, University of Texas Southwestern Medical Center, 5323 Harry Hines Boulevard, Dallas, TX 75390, USA; and [4]Ronald Reagan-UCLA Medical Center, 100 Medical Plaza Driveway, Los Angeles, CA 90095, USA

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Aims Thirty-day risk standardized readmission and mortality rates (RSRR, RSMR) are key determinants for hospital performance for cardiovascular conditions such as acute myocardial infarction (AMI) and heart failure (HF). We evaluated whether individual hospitals in the USA perform similarly for HF and AMI over time based on readmission and mortality metrics.

Methods and results A total of 1950 hospitals in the USA with continuous participation in the Centers for Medicare and Medicaid Services (CMS) public reporting programme between 2010 and 2016 were identified. Latent mixture modelling was used to define performance trajectory groups. Overall, there were consistent declines in the RSMR (16.1–14.0%) and RSRR (20.3–16.6%) for AMI from 2010 to 2016. For HF, RSRR declined over time (25.1–21.7%), while there was a modest increase in RSMR (11.3–12.0%); parallel findings were observed across performance trajectory groups. The proportion of best performing centres for HF care that were also best performers for AMI care based on the 30-day RSMR and 30-day RSRR metric was 54% and 35%, respectively. Furthermore, the discordance rate between the best and worst performers for both conditions was low (<2% for both 30-day outcomes).

Conclusion In the USA, despite variation in baseline hospital-level outcomes, hospitals had consistent longitudinal trajectories (worsening or improvement) across conditions and metrics. Hospitals identified as high performing were frequently similar across target conditions and over time, suggesting that performance may be driven by systems of care influencing different disease states in a comparable manner.

Keywords Heart failure • Hospital performance • Myocardial infarction • Quality

Introduction

Hospitals in the USA are increasingly held accountable for their performance related to target cardiovascular conditions. Over the last decade, several value-based programmes have been introduced by the Centers for Medicare and Medicaid Services (CMS) with the intent of improving the quality and/or value of care by rewarding or penalizing hospitals based on their performance. The manner in which CMS adjudicates a hospital's performance is a source of ongoing debate. Currently, one of the main determinants of hospital performance is 30-day risk standardized outcomes for the targeted cardiovascular conditions: acute myocardial infarction (AMI) and heart failure (HF).[1]

National policies are similar regarding value-based penalties for AMI and HF.[2,3] Yet, while both readmission and mortality rates for AMI have declined since implementation of the Hospital

* Corresponding author. Tel: +1 214 645 7521, Fax: +1 214 648 9639, Email: ambarish.pandey@utsouthwestern.edu

† The first two authors contributed equally as co-first authors.

Readmissions Reduction Program (HRRP), a concerning trend of increasing mortality with decreasing readmission rates has been suggested for HF.[4] Given finite resources, hospital systems may be preferentially 'shifting' attention to focus on a specific disease process or outcome metric. These hospital-level practices may introduce heterogeneity in performance across conditions, and potentially worsen quality of care for select conditions. Furthermore, current metrics assess static hospital performance for a given year, and do not capture dynamic changes (improvements or worsening) in care quality. Whether individual hospitals perform similarly over time across each targeted condition and for each performance metric (readmission and mortality) included in these programmes is uncertain. Accordingly, we evaluated whether individual hospitals in the USA perform similarly for HF and AMI over time based on readmission and mortality metrics.

Methods

Data sources

US hospitals participating in the CMS public reporting programme between 2010 and 2016 that reported 30-day risk standardized mortality rates (RSMR) and 30-day risk standardized readmission rates (RSRR) for both AMI and HF were identified using Hospital Compare, which is a component of the CMS Hospital Quality Initiative.[3] Hospital Compare provides publicly available data regarding various quality metrics, including readmission and mortality metrics. Thirty-day mortality encompasses all-cause mortality within 30 days of date of admission and 30-day readmission refers to unplanned, all-cause readmission within 30 days of hospital discharge to the same or another acute care hospital. Both metrics are measured among patients above the age of 65 years with a principal discharge diagnosis of a target condition. The expected rates of these outcomes are estimated based on an 'average hospital' in the USA with that particular case mix, defined by age, sex, and certain comorbidities present in the 12 months prior to hospitalization. The RSMR and RSRR are calculated as a ratio of predicted/expected outcomes multiplied by the overall national unadjusted rate of 30-day mortality and 30-day readmission, respectively. Further details regarding the exact HRRP risk adjustment approach can be found on https://www.qualitynet.org.

The 30-day RSMR and RSRR metrics are calculated for each year using 3 years of data. Hospitals with fewer than 25 eligible cases for AMI or HF during the 3-year assessment period are excluded from reporting of these metrics on Hospital Compare. Since the focus of the present study is to evaluate longitudinal performance of hospitals, those with missing data on 30-day RSMR or 30-day RSRR for HF or AMI for any of the study years were excluded from the analysis. Of the 3719 hospitals registered with Hospital Compare, 2741 had available data on 30-day RSMR and RSRR for HF and AMI in 2010 and 2337 had these performance metrics available in 2016. The final cohort included 1950 hospitals who consistently reported 30-day RSMR and 30-day RSRR for both AMI and HF in each year of the study period. Hospital-level characteristics were obtained from American Hospital Association survey data and were linked to the Hospital Compare data using a unique hospital identifier. The American Hospital Association conducts a nationwide annual survey with a response rate of ~85% that assesses various elements of hospital structure, facilities, staffing, and utilization.

Defining trajectories of hospital performance

Trajectories of 30-day RSRR and 30-day RSMR for AMI and HF were modelled separately among the included hospitals using latent class models with calendar year as the scale for the time to identify mutually exclusive subgroups of hospitals with similar performance trajectories over the study period. As described previously, this semi-parametric, cluster-based modelling approach uses the *SAS Proc Traj* to fit longitudinal data as discrete mixture of more than one latent trajectory via maximum likelihood function.[5–7] The model assumes that the study cohort has multiple trajectory groups and estimates the probabilities for multiple trajectories simultaneously. For the present analysis, a quadratic trajectory model function with four classes yielded the best model convergence. For each participating hospital, the predicted probability of being a member of each of the four classes was calculated and the hospitals were assigned to the group for which they had the highest predicted probability. Given this approach, individual clusters of hospitals may be of unequal size. Thus, each hospital was categorized into one of the four performance groups for each condition (HF, AMI) and performance metric (30-day RSMR and RSRR). The hospital performance groups were defined based on the observed trajectory such that the group with consistently lowest and highest measures of RSMR or RSRR were identified as best- and worst-performing groups, respectively. Baseline hospital characteristics across the four performance-based groups for each metric (30-day RSMR and RSRR) and condition (AMI, HF) were presented as medians (25th–75th percentiles) for continuous variables and percentages for categorical variables. Hospital characteristics were compared across the best and worst performing groups using Kruskal–Wallis tests for continuous variables and χ^2 test for categorical variables.

Concordance in performance across conditions and metrics

The proportion of best and worst performing hospitals for HF care with concordant performance for AMI care for both 30-day metrics was calculated. Weighted correlations between the predicted probability of being best performer for HF and AMI for 30-day RSRR and 30-day RSMR were calculated. Similar correlations were also calculated between the predicted probability of being the worst performer for HF and AMI for both 30-day metrics. Since the 30-day RSMR and RSRR measures reported by CMS are risk adjusted for case-mix and patient level characteristics, further risk adjustments were not performed. Similar analyses were performed to determine the categorical concordance and correlation between hospital-level performance for 30-day RSMR vs. 30-day RSRR metric for AMI and HF, separately. Finally, temporal trends in 30-day RSMR and RSRR for AMI were assessed for different hospital groups stratified by their performance for HF care using mean regression plots. Trends in 30-day RSRR for AMI and HF were also assessed across hospital groups stratified by their performance based on condition-specific 30-day RSMR. This study was considered exempt from institutional review board or patient consent owing to use of publicly available hospital-level data. All statistical analyses were performed using SAS 9.1 (Cary, NC, USA).

Results

For the present study, we identified 1950 participating hospitals who reported 30-day RSMR and 30-day RSRR for both AMI and HF in

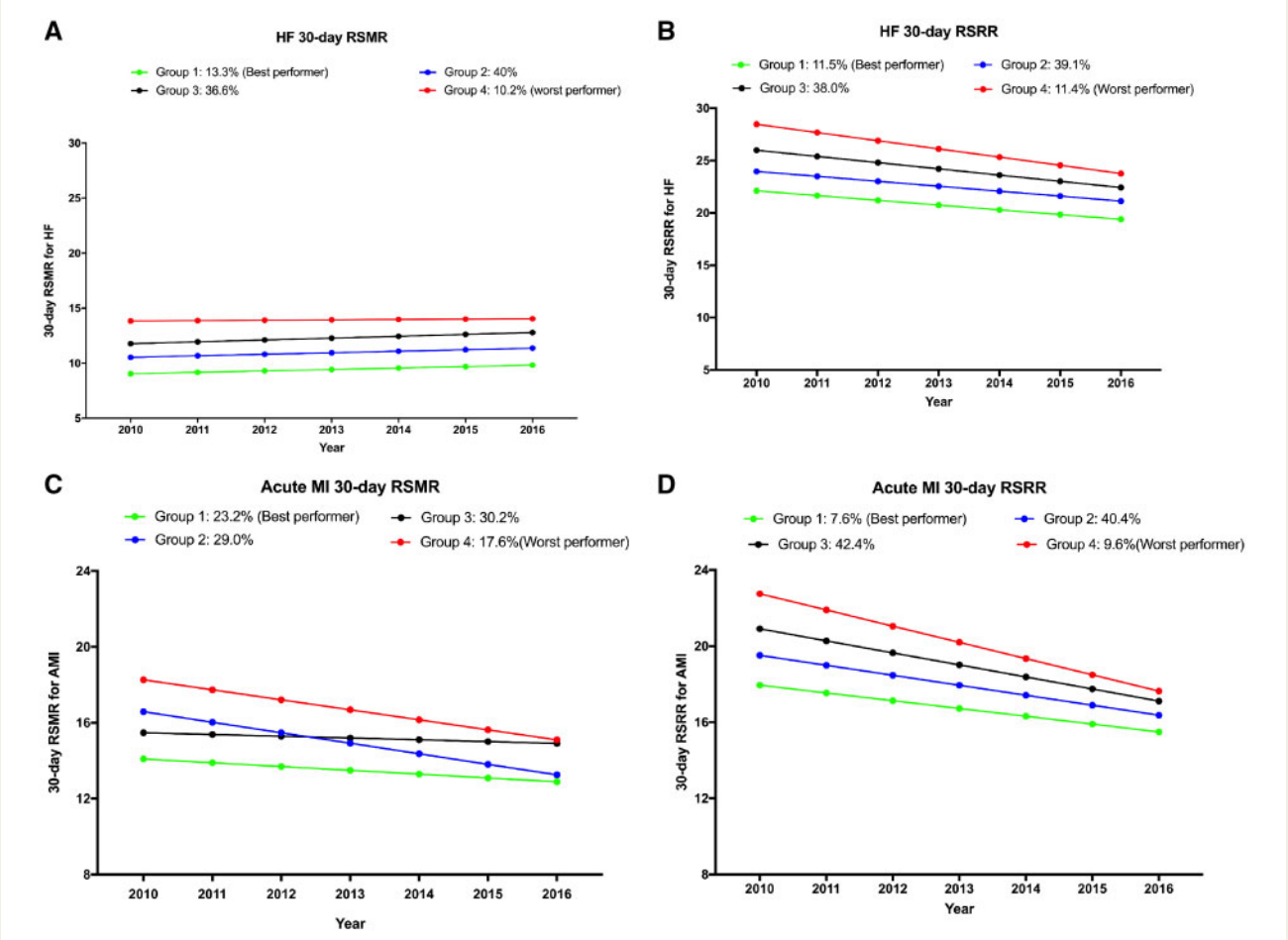

Figure 1 Trajectories in hospital-level 30-day risk standardized mortality rate and 30-day risk standardized readmission rates for heart failure and acute myocardial infarction over 7 years (2010–2016). The trajectory classes identified hospital groups according to their performance over time for risk standardized mortality rates for heart failure (*A*), risk standardized readmission rates for heart failure (*B*), risk standardized mortality rates for acute myocardial infarction (*C*), and risk standardized readmission rates for acute myocardial infarction (*D*). AMI, acute myocardial infarction; HF, heart failure; RSMR, risk standardized mortality rates; RSRR, risk standardized readmission rates.

each year of the study period. Trajectories of 30-day RSRR and 30-day RSMR for AMI and HF among the hospitals included in the study are shown in *Figure 1*. For HF, there was a consistent but modest increase in 30-day RSMR (11.3–12.0%) and a consistent decline in 30-day RSRR (25.1–21.7%) from 2010 to 2016 across all trajectories. Overall, 13.3% and 10.2% hospitals were identified as best and worst performing based on 30-day RSMR trajectories (*Figure 1A*), and 11.5% and 11.4% hospitals were identified as best and worst performing, respectively, based on 30-day RSRR trajectories during the study period (*Figure 1B*). For AMI, there was a consistent decline in 30-day RSRR over time across all 30-day RSRR trajectories (20.3–16.6%). In contrast, while overall 30-day RSMR for AMI declined over time (16.1–14.0%), this differed by trajectory group: a consistent decline in 30-day RSMR over time was noted in 3 trajectory-based groups while one group had stable 30-day RSMR over time. Overall, 23.2% and 17.6% hospitals were identified as best and worst performing based on 30-day RSMR (*Figure 1C*) and 7.6% and 9.6% hospitals were identified as best and worst performing, respectively, based on 30-day RSRR trajectories during the study period (*Figure 1D*).

Hospital characteristics across performance categories

Hospital-level characteristics across performance groups based on 30-day RSMR and 30-day RSRR for HF and AMI are shown in *Table 1* and Supplementary material online, *Table S1*. The best performing hospitals over time based on 30-day RSMR trajectories for both targeted conditions were significantly larger, located in urban regions, more likely to participate in bundled payment programmes, and have teaching affiliations when compared with the worst performing hospitals. For 30-day RSRR, the best performing hospitals for both conditions had greater availability of cardiac surgery, percutaneous coronary intervention capabilities, and cardiac rehabilitation. In contrast, hospital size, location, teaching affiliation, and bundle payment participation did not differ significantly between the best vs. worst

Table 1 **Hospital-level characteristics by performance for HF mortality and readmission**

	Hospital performance groups based on 30-day RSMR for HF					Hospital performance groups based on 30-day RSRR for HF				
	Decreasing performance					Decreasing performance				
	Group 1 (*N* = 251) (best performer)	Group 2 (*N* = 781)	Group 3 (*N* = 725)	Group 4 (*N* = 193) (worst performer)	*P*-value (best vs. worst)	Group 1 (*N* = 215) (best performer)	Group 2 (*N* = 764)	Group 3 (*N* = 749)	Group 4 (*N* = 222) (worst performer)	*P*-value (best vs. worst)
Hospital beds (*n*)	338 (200–514)	243 (153–384)	212 (134–339)	205 (130–321)	<0.001	300 (167–444)	221 (138–350)	221 (150–354)	297 (176–461)	0.72
For profit ownership (%)	18.4	21.5	18.2	20.3	0.68	12.6	18.1	22.1	24.1	0.005
Rural hospital location (%)	5.1	14.7	20.2	24.7	<0.001	13.7	17.9	16.9	13.8	1.00
Fully implemented EHR (%)	86.8	86.7	89.8	89.3	0.59	92.5	90.3	84.8	86.2	0.09
Physician-owned hospital (%)	2.8	4.2	3.8	5.8	0.25	7.2	4.9	2.3	3.9	0.22
Teaching hospital (%)	78.1	63.5	59	61.4	<0.001	74.3	60.4	61.5	68.7	0.25
Available cardiac surgery (%)	73.3	55.6	54.4	65.2	0.13	75.4	59.6	53.4	52.5	<0.001
Available PCI (%)	88.9	80.3	77.3	87.7	0.86	89.8	82.6	78.5	74.4	<0.001
Participation in bundle payment programme (%)	44.6	30.8	28.0	28.0	0.004	39.1	27.6	30.8	38.2	0.90
Cardiac rehab available (%)	82.8	82.7	82.8	89.9	0.08	92.8	88.0	80.0	69.2	<0.001

EHR, electronic health record; HF, heart failure; PCI, percutaneous coronary intervention; RSMR, risk standardized mortality rates; RSRR, risk standardized readmission rates.

Table 2 High and low performing hospitals for HF outcomes with concordant performance for AMI

Concordant high performance across conditions		
Metrics	**% high performing for HF with high performance for AMI**	**Weighted *r* (*P*-value) between probabilities for high performance for AMI and HF**
30-day mortality	53.8 (135/251)	0.31 (<0.001)
30-day readmission	35.4 (76/215)	0.50 (<0.001)
Concordant low performance across conditions		
Metrics	**% low performing for HF with low performance for AMI**	**Weighted *r* (*P*-value) between probabilities for low performance for AMI and HF**
30-day mortality	39.4 (76/193)	0.16 (<0.001)
30-day readmission	36.0 (80/222)	0.47 (<0.001)

Correlations (weighted for hospital size) are presented between the probabilities of low or high performance between each cardiovascular condition.
AMI, acute myocardial infarction; HF, heart failure.

performing hospitals based on 30-day RSRR trajectories for either condition.

Concordance in hospital performance between conditions

The proportion of best performing centres for HF care that were also best performers for AMI care based on the 30-day RSMR and 30-day RSRR metric was 54% and 35%, respectively (*Table 2*). Similarly, more than one-third of the worst performing hospitals for HF care were also worst performers for AMI care based on both readmission and mortality metrics (*Table 2*). There was a significant correlation between the predictive probabilities of being the best performers for AMI and HF for both 30-day RSMR (weighted $r = 0.31$; $P < 0.001$) and 30-day RSRR (weighted $r = 0.50$; $P < 0.001$) when weighted for hospital size.

Concordance in hospital performance across conditions was also supported by temporal trend analyses showing that better performing hospitals based on 30-day RSMR and RSRR trajectories for HF had consistently lower 30-day RSRR or RSMR for AMI throughout the study period (*Figure 2*).

The proportion of best performing hospitals for HF care that were discordantly worst performers for AMI was very low (2% for 30-day RSMR and 1.4% for 30-day RSRR). Similarly, the worst performing hospitals for HF were infrequently the best performers for AMI care based on both 30-day RSMR (6.2%) and 30-day RSRR (0%) metrics.

Concordance in hospital performance between 30-day metrics

For HF, proportions of best and the worst performing hospitals based on 30-day RSMR that were concordantly the best and worst performers based on 30-day RSRR was 4.4% and 6.7%, respectively (Supplementary material online, *Table S2*). Furthermore, there was a modest inverse correlation between the predictive probabilities of being concordantly best performers (weighed $r = -0.12$; $P < 0.001$) or worst performers (weighed $r = -0.09$; $P < 0.001$) based on both 30-day RSRR and 30-day RSMR for HF. The discordance in hospital performance by 30-day RSMR vs. 30-day RSRR metric for HF was also noted in the temporal trend analyses such that the better performing hospitals by 30-day RSMR metric had consistently worse 30-day RSRR (*Figure 3A*). Similar temporal trends were also observed in the 30-day RSMR trajectories across hospitals stratified by their performance based on 30-day RSRR for HF with the best performing centres by 30-day RSRR demonstrating the highest 30-day RSMR throughout the study period (*Figure 3B*). For AMI, the correlation between predictive probabilities of being concordantly best performer or worst performer based on both 30-day RSRR and 30-day RSMR was very weak to not significant (Supplementary material online, *Table S2*, *Figure 3C*).

Discussion

In this national, longitudinal hospital-level analysis, we identified distinct trajectories in hospital performance over time based on 30-day risk standardized outcomes for two targeted cardiovascular conditions. Despite variation in initial risk, consistent and largely parallel declines were observed in the risk-adjusted 30-day outcomes for AMI across risk trajectory groups. For HF, while the RSRR declined over time, a modest increase in RSMR was noted over the same period across the four identified risk trajectories. There was significant correlation between hospital performance based on 30-day risk standardized outcomes for HF and AMI. Best performing hospitals for HF outcomes were often also best performers in AMI care, with similar concordance was observed with the worst performing centres. There was a modest but statistically significant inverse association between hospital performance over time based on 30-day RSMR and RSRR for HF, while such a relationship was not observed between performance metrics for AMI.

Global health policies targeting across medical conditions

We undertook this analysis understanding that hospitals may have differing and potentially competing priorities in care delivery across target conditions of contemporary health policies. We leveraged nationwide US hospital-level data as a case example, but health policy measures are being implemented globally across a range of medical conditions.[8] For instance, a health policy installed in 2004 in Germany

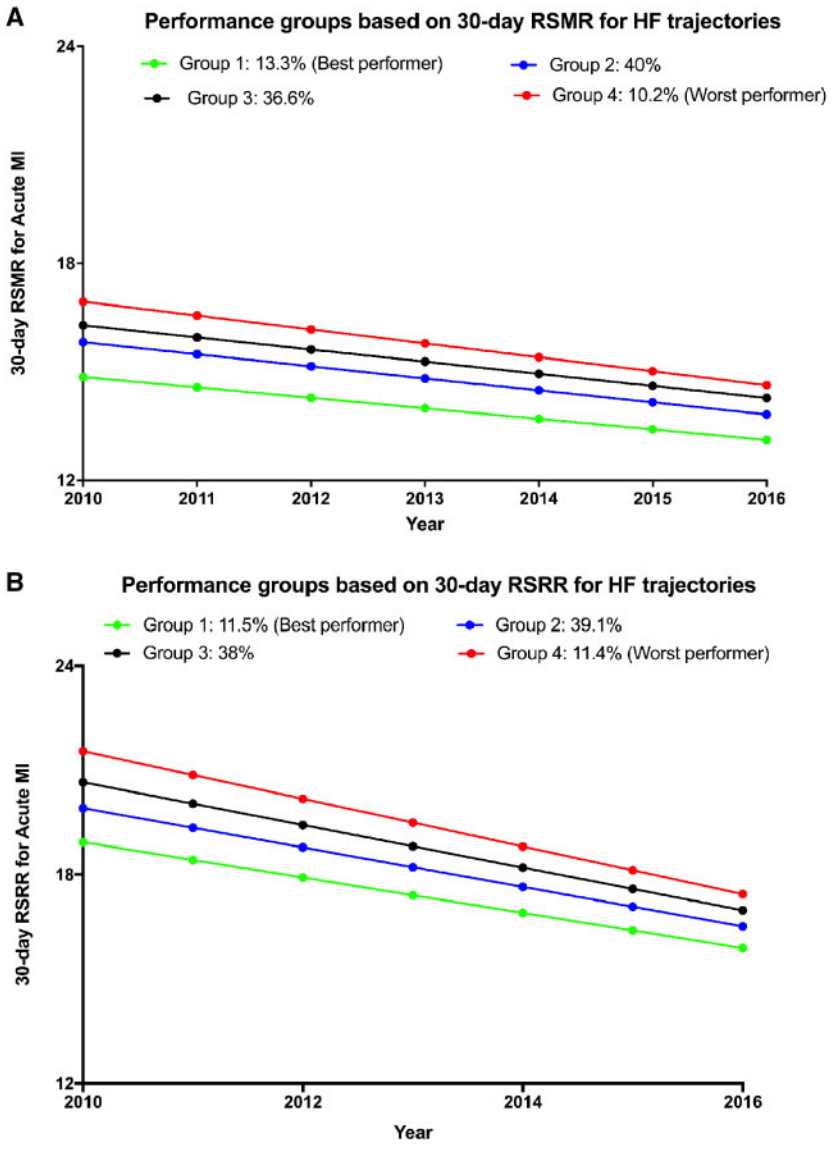

Figure 2 (*A*) Temporal trajectories of 30-day risk standardized mortality for acute myocardial infarction among participating hospitals stratified by their longitudinal performance based on 30-day risk standardized mortality for heart failure. (*B*) Temporal trajectories of 30-day risk standardized readmission rates for acute myocardial infarction among participating hospitals stratified by their longitudinal performance based on 30-day risk standardized readmission rates for heart failure. HF, heart failure; RSMR, risk standardized mortality; RSRR, risk standardized readmission rates.

targeted reimbursement for readmissions for the same condition. Similarly, the National Health Service in the UK introduced policies aimed at reducing readmissions for all non-obstetric, non-oncologic medical conditions.[9]

Defining temporal trajectories of hospital performance

Until now, hospital performance has been largely evaluated for individual conditions during defined years. In this temporally integrated analysis, we studied patterns of hospital performance for two common conditions over time. We found that most hospitals clustered in defined performance 'trajectories'. Slopes of changes in post-discharge outcomes were largely similar across these risk groups for both conditions and performance metrics. As such, the same poor-performing hospitals are likely being penalized year after year, despite national health policy efforts to modify these trajectories.

Different target conditions, similar performance

The concordance in hospital-level performance across conditions for both the 30-day outcome metrics suggests that hospital performance across different cardiovascular conditions may be driven by institutional system factors that likely influence AMI and HF similarly. Along these lines, we observed that a similar set of hospital-level

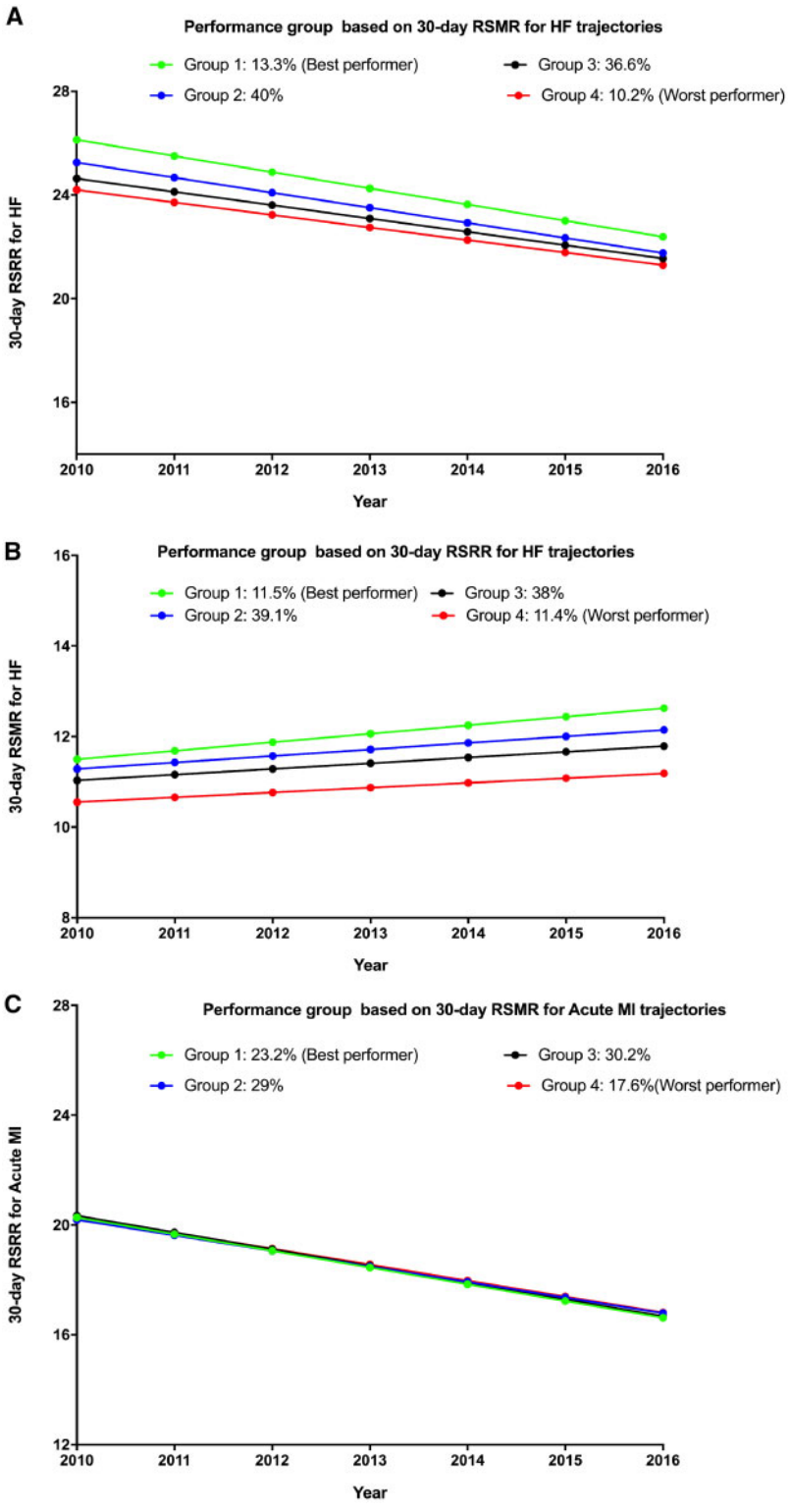

Figure 3 (*A*) Temporal trajectories of 30-day risk standardized readmission rates for heart failure among participating hospitals stratified by their longitudinal performance based on 30-day risk standardized mortality for heart failure. (*B*) Temporal trajectories of 30-day risk standardized mortality for heart failure among participating hospitals stratified by their longitudinal performance based on 30-day risk standardized readmission rates for heart failure. (*C*) Temporal trajectories of 30-day risk standardized readmission rates for acute myocardial infarction among participating hospitals stratified by their longitudinal performance based on 30-day risk standardized mortality for acute myocardial infarction. AMI, acute myocardial infarction; HF, heart failure; RSMR, risk standardized mortality; RSRR, risk standardized readmission rates.

characteristics was associated with the 30-day outcome metric specific performance for AMI and HF. Larger hospital size, urban location, teaching affiliation, and participation in bundled payment programme were associated with better performance based on 30-day RSMR for both conditions. In contrast, greater availability of cardiovascular care resources (such as access to cardiac rehabilitation) was associated with better performance based on 30-day RSRR for both AMI and HF. Another potential explanation for the observed concordance in performance could be the commonality in the patient-level factors beyond the immediate control of hospital systems that drive 30-day outcomes for MI and HF. This is particularly relevant since the current CMS adjustment models for RSMR and RSRR estimation do not completely account for several important patient-level factors such as disease severity, socioeconomic status, frailty, health literacy, home environment, and other social determinants.[10,11] It is plausible that hospitals caring for patients with similar burden of these unaccounted risk factors would have similar outcomes across cardiovascular (and non-cardiovascular) conditions.[10,11] Future studies are needed to determine if the overlap in hospital performance across cardiovascular conditions persist with better accounting for select patient-level social risk factors recently introduced under the revised peer-group based HRRP methodology.[12]

Disease-specific mortality and readmission

We also observed a poor-to-inverse correlation between 30-day readmission and 30-day mortality. There was little to no overlap in the hospital-level factors that identified best vs. worst performers for 30-day RSMR and 30-day RSRR outcomes. The discordance in performance for readmission and mortality outcomes was most apparent for HF. These findings are particularly relevant considering that ongoing debate about the contribution of HRRP on the 30-day mortality rates among patients hospitalized with HF. Some recent studies have raised concerns for an increase in 30-day mortality rates for HF with a concurrent decline in 30-day readmission since the implementation of HRRP.[13–16] In contrast, others have demonstrated that the modest increase in 30-day RSMR for HF over the past few years is not related to implementation of HRRP or associated declines in readmission rates. In a recent study from the CMS cohort, Khera *et al.*[17] demonstrated a modest but significant increase in 30-day RSMR for HF since 2007 with no association between HRRP implementation and the increase in mortality. Similarly, Dharmarajan *et al.*[18] demonstrated that hospitals with the highest reductions in 30-day readmission rates for HF over time had greatest improvements in mortality rates arguing against a potential adverse impact of efforts to reduce readmission on mortality risk. Future studies are needed to better understand the factors underlying the modest increases in 30-day RSMR for HF across the US hospitals and how hospital-level care patterns for hospitalized HF patients may have differentially affected readmission and mortality outcomes.

Health policy implications—a need for cross-condition performance evaluation

Our study has important health policy implications. Significant concordance in hospital performance across cardiovascular conditions suggests that a hospital-wide as opposed to disease-specific metric may be more appropriate.[19,20] Indeed, a move to a hospital-wide approach has received support from several stakeholders including the Medicare Payment Advisory Commission (MedPAC) and the National Quality Forum.[19,21] Current value-based programmes are targeting a limited number of specific conditions and may not be broadly representative across conditions. Since the introduction of HRRP, while there has been a reduction in readmissions for both targeted and non-targeted conditions, there has been a greater reduction in readmissions among patients with targeted disease states suggesting opportunity to improve quality for other conditions by moving to a hospital-wide programme. Furthermore, our findings of poor to inverse correlation between performance based on readmission vs. mortality metric adds to the ongoing debate about the optimal 30-day outcome metric that would be most meaningful from patient outcome and hospital performance perspective.[4,13,22,23] The current 30-day readmission based performance metric has poor to inverse associations with process of care measures, other clinically meaningful outcomes such as mortality and is associated with a disproportionately higher burden of penalties among the hospitals that care for socioeconomically disadvantaged patients.[13,24–28] Similar trends have also been noted with use of a hospital-wide readmission approach.[29] A hospital-wide metric that better accounts for both readmission and mortality outcomes may provide a superior indicator of quality and long-term outcomes and has been under development in recent years.[22,30,31] Whether such a hospital-wide metric would also worsen disparities for safety-net hospitals warrants investigation.

Study limitations

Several limitations to our study are noteworthy. First, over the study period, there were alterations in the methods used by CMS to calculate 30-day RSMR. However, we envisage participating hospitals to have been affected equally by such policy changes. Second, the risk adjustment method used by CMS does not completely account for all patient-level factors that may have led to some residual confounding. Third, our study findings may not be generalizable to non-CMS patients or to other cardiac or non-cardiac disease states. Fourth, we only included larger hospitals with enough AMI and HF cases to allow for consistent 30-day RSMR and RSRR estimates throughout the study period and our findings may not be generalizable to all other smaller hospitals, or hospitals without a significant CMS-eligible population. Finally, to estimate longitudinal performance trajectories, we only analysed hospitals with data reported for each year during the study period. To increase the sample of analysed data and improve the robustness of the quality signal in Hospital Compare reporting, each year of publicly reported information contains 3 years of data. This may have attenuated observed year-to-year variability in hospital performance and may have biased our results to show inflexible longitudinal trends. This limitation of Hospital Compare precludes us from definitely determining mobility across performance groups. We did not have access to individual CMS hospitalization data which may facilitate more granular assessment of hospital performance trajectory.

Conclusions

We applied cluster-based modelling approach to nationwide data from 2010 to 2016 to define hospital groups that have similar performance over time. Despite variable 'baseline' hospital-level outcomes, these identified groups had similar trajectories (worsening or improvement) over time for both conditions and metrics. In addition, the performance of the best and worst hospitals in AMI care, as determined by 30-day risk metrics, correlated significantly with their performance in the care of HF patients. Hospitals identified as high performing were frequently similar across target conditions and over time, suggesting that performance may be driven by systems of care influencing different disease states in a comparable manner. Future research is needed to determine if assessing hospital trajectories in performance may offer incremental information compared with traditional static, single-year assessments.

Supplementary material

Supplementary material is available at *European Heart Journal – Quality of Care and Clinical Outcomes* online.

Conflict of interest: M.V. was supported by the KL2/Catalyst Medical Research Investigator Training award from Harvard Catalyst | The Harvard Clinical and Translational Science Center (NIH/NCATS Award UL 1TR002541), and serves on advisory boards for Amgen, AstraZeneca, Bayer AG, and Baxter Healthcare. C.A. has received consulting fees from the NIH. D.L.B. discloses the following relationships—Advisory Board: Cardax, Elsevier Practice Update Cardiology, Medscape Cardiology, PhaseBio, Regado Biosciences; Board of Directors: Boston VA Research Institute, Society of Cardiovascular Patient Care, TobeSoft; Chair: American Heart Association Quality Oversight Committee; Data Monitoring Committees: Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute, for the PORTICO trial, funded by St. Jude Medical, now Abbott), Cleveland Clinic (including for the ExCEED trial, funded by Edwards), Duke Clinical Research Institute, Mayo Clinic, Mount Sinai School of Medicine (for the ENVISAGE trial, funded by Daiichi Sankyo), Population Health Research Institute; Honoraria: American College of Cardiology (Senior Associate Editor, Clinical Trials and News, ACC.org; Vice-Chair, ACC Accreditation Committee), Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute; RE-DUAL PCI clinical trial steering committee funded by Boehringer Ingelheim), Belvoir Publications (Editor in Chief, Harvard Heart Letter), Duke Clinical Research Institute (clinical trial steering committees), HMP Global (Editor in Chief, Journal of Invasive Cardiology), Journal of the American College of Cardiology (Guest Editor; Associate Editor), Medtelligence/ReachMD (CME steering committees), Population Health Research Institute (for the COMPASS operations committee, publications committee, steering committee, and USA national co-leader, funded by Bayer), Slack Publications (Chief Medical Editor, Cardiology Today's Intervention), Society of Cardiovascular Patient Care (Secretary/Treasurer), WebMD (CME steering committees); Other: Clinical Cardiology (Deputy Editor), NCDR-ACTION Registry Steering Committee (Chair), VA CART Research and Publications Committee (Chair); Research Funding: Abbott, Amarin, Amgen, AstraZeneca, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, Chiesi, Eisai, Ethicon, Forest Laboratories, Idorsia, Ironwood, Ischemix, Lilly, Medtronic, PhaseBio, Pfizer, Regeneron, Roche, Sanofi Aventis, Synaptic, The Medicines Company; Royalties: Elsevier (Editor, Cardiovascular Intervention: A Companion to Braunwald's Heart Disease); Site Co-Investigator: Biotronik, Boston Scientific, St. Jude Medical (now Abbott), Svelte; Trustee: American College of Cardiology; Unfunded Research: FlowCo, Fractyl, Merck, Novo Nordisk, PLx Pharma, Takeda. D.J.K. receives honoraria from the American College of Cardiology. J.A.L. reports grant support and consulting income from Roche Diagnostics and Abbott Diagnostics, honoraria for Steering Committee from Amgen and DSMB from Regeneron and NovoNordisk, consulting from Ortho Clinical Diagnostics and Jannsen. G.C.F. reports consulting for Abbott, Amgen, Bayer, Janssen, Medtronic, and Novartis. A.P. reports funding from the Texas Health Resources Clinical Scholarship. All other authors declared no conflict of interest.

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