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Are hospital process quality indicators influenced by socio-demographic health determinants

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Background: This population-level health service study aimed to address whether hospitals assure the same quality of care to people in equal need, i.e. to see if any associations exist between social determinants and adherence to four hospital process indicators clearly identified as being linked to better health outcomes for patients. **Participants:** This was a retrospective cohort study based on administrative data collected in the Veneto Region (northeast Italy). We included residents of the Veneto Region hospitalized for ST-segment elevation myocardial infarction (STEMI) or acute myocardial infarction (AMI), hip fracture, or cholecystitis, and women giving birth, who were discharged from any hospital operating under the Veneto Regional Health Service between January 2012 and December 2012. **Method:** The following quality indicator rates were calculated: patients with STEMI-AMI treated with percutaneous coronary intervention, elderly patients with hip fractures who underwent surgery within 48 h of admission, laparoscopic cholecystectomies and women who underwent cesarean section. A multilevel, multivariable logistic regression analyses were conducted to test the association between age, gender, formal education or citizenship and the quality of hospital care processes. **Results:** All the inpatient hospital care process quality indicators measured were associated with an undesirable number of disparities concerning the social determinants. **Conclusion:** Monitoring the evidence-based hospital health care process indicators reveals undesirable disparities. Administrative data sets are of considerable practical value in broad-based quality assessments and as a screening tool, also in the health disparities domain.

Introduction

Equity in health care is concerned with the distributional fairness of health services delivered to different subgroups of a population and poses a major, persistent public health challenge across industrialized nations. Procedural equity refers to the extent to which the structural and process features of health service delivery result in an equitable distribution of services for individuals and population subgroups with comparable needs and wants.[1] In the context of quality assurance, the report 'Crossing the Quality Chasm'[2] challenges all health care organizations to pursue six major health care improvement goals, one of which is equity. As a consequence, assessing health care quality has become increasingly important worldwide in response to the demand for greater transparency and accountability, and better quality,[3] and accountability for an equitable delivery of the best quality of care a health system can offer is an important dimension to monitor and report in health service research.[4] The Declaration on Social Determinants of Health[5] emphasizes that research and experiences of implementing policies on social determinants of health point to some common features of successful actions, which include monitoring progress and increasing accountability for health system equity. A study revealing treatment disparities can enhance strategies to tackle inequalities in affordable and modifiable aspects.

The contribution of race, citizenship, gender and age on the provision of hospital health care is well documented,[6–8] while the literature has focused more rarely on the role of formal education in generating disparities in the delivery of treatment,[9] although educational level is a clear determinant of inequalities.[10]

The aim of the present population-level health service study was to see whether hospitals assure the same quality of care to people in equal need. In particular, this study analysed whether there is any association between social determinants and adherence to four hospital process indicators clearly linked to better health outcomes for patients.

Methods

This was a retrospective cohort study based on administrative data collected in the Veneto Region (northeast Italy).

Study population and data source

We focused on four patient cohorts representing common conditions to generate stable estimates.

We included hospital admissions involving residents for ST-segment elevation myocardial infarction (STEMI) or acute myocardial infarction (AMI), hip fracture, cholecystitis and delivery of pregnant women, who were discharged from any hospital operating under the NHS (National Health System) in the Veneto Region between January 2012 and December 2012, who fulfilled the following inclusion criteria:

- for cases of STEMI-AMI: International Classification of Diseases Ninth Revision, Clinical Modification (ICD-9-CM) code 410.xx, except for codes 410.7x and 410.9x, as a first diagnosis or as a secondary diagnosis providing the primary diagnosis was compatible with the diagnosis of AMI (codes 411, 413, 414, 423.0, 426, 427 [except for 427.5], 428, 429.5 429.6 429.71,

429.79, 429.81, 518.4, 518.81, 780.01, 780.2, 785.51, 799.1, 997.02, 998.2) and age from 18 to 100 years old. Main exclusion criteria: hospitalizations lasting under 48 h;
- for hip fractures: ICD-9-CM codes 820.0–820.9, age 65–100 years, residents of the Veneto Region, fracture treatment (code ICD-9 CM: 81.51, 81.52, 79.00, 79.05, 79.10, 79.15, 79.20, 79.25, 79.30, 79.35, 79.40, 79.45, 79.50, 79.55). Main exclusion criteria: admission for multiple trauma (Diagnosis-related group [DRG] 484–487); diagnosis of cancer (ICD-9-CM 140.0–208.9 or V10) during the hospital stay (suggesting that surgery was unfeasible due to severe clinical conditions);
- deliveries of pregnant women: DRG 370–375, age 10–55 years. Main exclusion criteria: any listed ICD-9-CM diagnostic codes for abnormal presentation, preterm, fetal death or multiple gestation; and for breech as coded in the Agency for Healthcare Research and Quality (AHRQ) IQI #21.[11]
- for cholecystectomies: ICD-9-CM procedure codes: 5122–5123. Only discharges involving uncomplicated cases were considered: cholecystitis and/or cholelithiasis in any diagnostic field. ICD-9-CM Uncomplicated cholecystitis and/or cholelithiasis diagnostic (codes: 5 7400, 5 7401, 5 7410, 5 7411, 5 7420, 5 7421, 5750, 5751, 5 7510, 5 7511, 5 7512), as suggested in the AHRQ IQI #23 [12];

During the study period, we identified 40 524 admissions of pregnant women for delivery, 7786 admissions for cholecystectomies, 5643 admissions for surgery in elderly patients with hip fractures and 3837 admissions for STEMI-AMI. The record fields for gender, date of birth (from which the patient's age at the time of admission was calculated) were always completed, and nationality was almost always specified (>99%), whereas the formal education variable was recorded for only 58% (23 657) of the women giving birth, 53% (4148) of the patients undergoing cholecystectomy, 43% (2438) of the elderly patients operated for hip fracture and 40% (1558) of the patients with STEMI-AMI.

Quality indicators

For this study we examined a limited set of well-established quality-of-care indicators selected on the strength of clear evidence in the international literature of their association with better health outcomes.

We excluded indicators concerning hospital admissions for chronic respiratory diseases, diabetes or other diseases, because they reflect population and primary health care rather than hospital care factors.[13]

Thus, the following indicators of processes associated with a worse outcome were included as a dependent variable in the regression analysis:

- patients with STEMI-AMI not treated with percutaneous coronary intervention (PCI)—PCI is associated with a lower mortality rate after AMI[14];
- older patients with hip fractures undergoing surgery more than 48 h after being admitted to hospital—earlier surgery reduces the related mortality and morbidity[15];
- open cholecystectomies—laparoscopic cholecystectomy (LC) achieves more favorable results in terms of mortality, complications and length of hospital stay[16];
- women undergoing cesarean section—high cesarean delivery rates are medically unjustified and associated with maternal and neonatal mortality and morbidity.[17]

We used the following ICD-9-CM procedure codes to define PCI: 00.66, 36.01, 36.02, 36.05, 36.06 and 36.07. Cesarean sections were identified on the basis of the following DRG 370–371. The 48-h interval elapsing before any treatment was measured from the patient's first arrival at the hospital (index admission). The Regional Hospital Information System reports the date, but not the exact time when procedures are performed so, for the purpose of this study, hip fracture surgery was assumed to have been performed within 48 h if it was done on the day of admission to hospital or within the next day. A previous study had conducted a sensitivity analysis comparing time to surgery in days and hours. The study defined timely surgery for hip fractures as when Cohen's Kappa = 0.83.[18]

Statistical methods

Information on patients' clinical characteristics, risk factors and comorbidities was obtained from the Regional Hospital Information System on the basis of their ICD-9-CM codes recorded for the index hospitalization and hospital stays during the previous 2 years. An automatic record linkage procedure was adopted.[19] For each indicator, numerous potential comorbidity factors were drawn from a previous methodological document concerning these indicators, produced by the Italian National Agency for Regional Health Care Services,[20] except for cholecystectomy, for which the comorbidities indicated by the AHRQ were considered.[12]

As a first step, we ran an unconditional exploratory logistic regression analysis with each indicator as a dependent variable and all comorbidities as independent variables to see which comorbidities to retain as covariates. Variables associated with process indicators were included in the subsequent multivariate regression models in which we introduced the socio-economic independent predictors thought to be associated with the process indicators. Potential comorbidity confounders were retained if $P < 0.20$ in order to protect against potential residual confounding effects.

In a second step, four logistic regression models (Model 1) were applied with each quality indicator as a dependent variable (attributing a value of 1 for each indicator corresponding to the process associated with a worse outcome, as defined earlier) and considering the following as independent variables: formal education [classified as: university, high school (reference), middle school, primary school or no schooling], gender, age quartile, citizenship (classified as: Italian, other European, non-European), without any covariates for adjustment; then four logistic regression models (Model 2) were applied with each quality indicator as a dependent variable, adjusted for the previously described independent and other covariates, and the comorbidities found significantly associated with the dependent variable (quality indicator) in the first step of the logistic model.

As a final step, multilevel logistic regression models (Model 3) were applied with each indicator as a dependent variable, the above-described independent variables and—on a second level—the hospital admitting the patient.

As a sensitivity analysis on the cohort of mothers admitted for delivery (the largest cohort), the same analyses were repeated using citizenship, classified as: Italian, Eastern European, Western European, Asian, African, Northern-Central American, South American and others (stateless and Oceania).

To select the most informative model, we tested each one using Akaike's information criteria (AIC), and the area under the Receiver operating characteristic (ROC) curve (AUC) was calculated to obtain an overall measure of the models' fit. To take multiple testing issues in each process indicator assessment into account, a conservative P value of 0.006 was adopted as a cutoff for statistical significance in the multivariate analysis because we drew eight comparisons between four different independent variables (age, sex, level of education and citizenship) to assess each indicator (0.05 divided by $8 = 0.00625$).

All analyses were performed using Stata 12 software. The study complied with the Helsinki Declaration and Italian privacy legislation (n. 196/2003). Resolution n. 85/2012 of the Guarantor for the protection of personal data has also recently confirmed that anonymized personal data may be processed for medical, biomedical and epidemiological research purposes, and data concerning health status may be used in aggregate form in scientific studies.

Results

Table 1 shows the characteristics of the sample by group. Table 2 shows the bivariate analyses with the unadjusted associations between social determinants and quality indicators. Table 3 shows the results of our analysis for the purpose of selecting the most appropriate model, with the AUC and AIC values. The multilevel model proved more informative for each process indicator and fitted the data better (see Table 3), so the results obtained with this model are shown in figure 1. The results of the fully adjusted unconditional logistic model and the multilevel logistic model were consistent, however, except for the role of formal education in the No PCI for STEMI process indicator, which showed a significantly higher risk for poorly educated people in the unconditional logistic regression model (OR 1.5 CI 95% 1.1–2.1) (data not shown), but not in the multilevel model (OR 1.3 CI 95% 0.9–2.0).

Using more detailed citizenship categories, a further multilevel logistic regression analysis performed on the cohort of pregnant women admitted for delivery indicated that North Americans, South Americans and Africans had higher odds of having a cesarean section [Eastern Europeans OR = 0.9 (95% CI 0.8–1.0); Western Europeans OR = 1.1 (95% CI 0.7–1.7); Asians OR = 1.3 (95% CI 1.1–1.5); Africans OR = 1.4 (95% CI 1.3–1.6); Northern/Central Americans OR = 1.8 (95% CI 1.3–2.4); South Americans OR = 0.6 (95% CI 0.03–15.2)] than Italian women.

Discussion

All the inpatient hospital care process quality indicators measured were associated with undesirable disparities relating to social determinants, although the reasons for these associations may differ between the various quality indicators.

First, our data show that, despite guidelines establishing that primary PCI is the recommended reperfusion therapy for both genders rather than fibrinolysis, providing it is performed by an experienced team within 120 min of first medical contact,[14] females were more than twice as likely as males to be treated for STEMI-AMI using methods other than PCI. This gender-related disparity in the administration of the evidence-based best treatment might be partly related to a greater delay in women accessing hospital care, which would prevent the adoption of a PCI approach. Whatever their cause, such disparities are a health system concern. It has been demonstrated that, even if high-quality care were accessible to everyone, there is no guarantee that all patients would benefit equally from the health care services available, so strategies are needed to ensure that patients are all aware of how to make best use of the health care services available. Other studies have consistently demonstrated such gender disparities.[21,22] A framework for action defined six strategies imperative for eliminating disparities in cardiovascular health care.[23] One of these strategies involves collecting health care data by ethnicity and gender to orient program development, implementation and assessment.[24] Our finding about disparities relating to formal education level emerged using a conventional regression analysis, but not when using a multilevel regression analysis, after that a hierarchical structure had been taken into account in the model. It may be that the best-performing hospitals in this sense are the large hospitals in the larger towns and cities, where the population tends to have a higher formal education than people living in the country.

An unexpected result emerged for the time to surgery for hip fractures in the elderly: females and older patients had lower odds of a delay, giving rise to age- and gender-related disparities in this process indicator; there also appeared to be a higher risk of delay for patients who were less well educated. Other studies[25] found socioeconomic inequalities in the wait for surgery after hip fracture in other Italian regions using different aggregate measures of social determinants (a census tract of patients' place of residence), but not when individual data were considered. Here again, these findings confirm that equal access to health care facilities and providers (as guaranteed in Italy by the NHS) is no guarantee of equal quality of care. This means that action is needed to ensure that all patients presenting to the health care system with the same clinical indications receive the same high-quality care.[8]

The topic most often addressed in the published literature on the link between social determinants and hospital processes concerns

Table 1 Characteristics of the sample

	Cholecystectomy *N* = 7.786	Hip fracture surgery *N* = 5.643	Delivery *N* = 40.524	STEMI-AMI *N* = 3.837
Gender				
Male	44.1% (3.437)	22.6% (1.276)	—	66.2% (2.542)
Female	55.9% (4.349)	77.4% (4.367)	100% (40.524)	33.8% (1.295)
Age				
Mean (years)	56.8	82.7	31.9	69.6
1st quartile (years)	45.1	78.1	28.2	58.7
2nd quartile (years)	57.7	83.4	32.1	70.8
3rd quartile (years)	69.3	87.8	35.8	81.6
Citizenship				
Italy	91.2% (7.100)	100% (5.643)	72.4% (29.282)	95.7% (3.668)
East Europe	4.9% (381)	—	12.4% (5.026)	2% (77)
West Europe	0.2% (19)	—	0.5% (183)	0.8% (31)
Asia	0.9% (66)	—	5.5% (2.207)	0.8% (29)
Africa	2% (158)	—	8% (3.223)	0.5% (19)
North/Central America	0.2% (13)	—	0.4% (169)	0.0% (2)
South America	0.6% (45)	—	0.8% (332)	0.2% (7)
Oceania	0.0% (2)	—	0.0% (3)	0.0% (1)
Stateless	0.0% (1)	—	0.0% (3)	—
Formal education				
No education/primary school	32.2% (1.335)	80% (1.950)	6.3% (1.495)	50.4% (785)
Middle school	35.0% (1.451)	12.7% (309)	26.4% (6.241)	28.7% (448)
High school	24.9% (1.032)	5.5% (134)	44.6% (10.553)	15.8% (246)
Bachelor's degree	2% (85)	0.1% (2)	4.7% (1.108)	0.4% (6)
Master's degree	5.9% (245)	1.7% (43)	18% (4.260)	4.7% (73)

Table 2 Bivariate analysis on the association between health care process quality and social determinants

	LC $N=7.786$			Surgery for hip fracture within 48 h $N=5.643$			Cesarean delivery $N=40.524$			PCI for STEMI-AMI $N=3.837$		
	Yes $n=6.956$	No $n=830$	*P*	Yes $n=2.961$	No $n=2.682$	*P*	Yes $n=9.470$	No $n=31.054$	*P*	Yes $n=2.357$	No $n=1.480$	*P*
Gender												
Male	85.6% (2.942)	14.4% (495)	<0.001	47.8% (610)	52.2% (666)	<0.001	–	–		70.1% (1.783)	29.9% (759)	<0.001
Female	92.3% (4.014)	7.7% (335)		53.8% (2.351)	46.2% (2.016)		23.4% (9.470)	76.6% (31.054)		44.3% (574)	55.7% (721)	
Age												
mean (years)	55.4	68.4		83.0	82.3		33.0	31.5		65.6	75.8	
Q_1	97.3% (1.891)	2.7% (53)	<0.001	49% (693)	51.0% (720)	<0.005	18.1% (1.937)	81.9% (8.786)	<0.001	78.5% (754)	21.5% (207)	<0.001
Q_2	94.2% (1.834)	5.8% (113)		52.8% (743)	47.2% (663)		21.3% (2.239)	78.7% (8.282)		74.6% (713)	25.4% (243)	
Q_3	89.2% (1.733)	10.8% (211)		52.2% (732)	47.8% (670)		24.1% (2.037)	75.9% (6.416)		60.6% (581)	39.4% (378)	
Q_4	76.8% (1.498)	23.2% (453)		55.8% (793)	44.2% (629)		30.1% (3.257)	69.9% (7.570)		32.2% (309)	67.8% (652)	
Citizenship												
Italy	88.7% (6.294)	11.3% (806)	<0.001	52.5% (2.961)	47.5% (2.682)	<0.001	23.3% (6.811)	76.7% (22.471)	<0.001	61% (2.238)	39% (1.430)	=0.046
Europe	95.8% (383)	4.2% (17)		–	–		19.2% (998)	80.8% (4.211)		69.4% (75)	30.6% (33)	
Other	97.5% (278)	2.5% (7)		–	–		27.3% (1.621)	72.7% (4.310)		72.4% (42)	27.6% (16)	
Formal education												
No education/ primary school	86.2% (1.151)	13.8% (184)	<0.001	54% (1.053)	46% (897)	=0.251	22.2% (332)	77.8% (1.163)	≤0.001	47.9% (376)	52.1% (409)	<0.001
Middle school	91.6% (1.329)	8.41% (122)		51.5% (159)	48.5% (150)		26.6% (1.659)	73.4% (4.582)		70.5% (316)	29.5% 132)	
High school	93.3% (1.270)	6.7% (92)		59.2% (106)	40.8% (73)		25% (3.974)	75% (11.947)		74.5% 242)	25.5% (83)	

Table 3 Model selection statistics

	AUC	AIC
OC		
Model 1 logistic without comorbidity covariates	0.72	2400
Model 2 logistic with comorbidity covariates (fully adjusted)	0.75	2356
Model 3 multilevel logistic regression (fully adjusted)	0.81	2265
Hip fracture surgery > 48 h		
Model 1 logistic without comorbidity covariates	0.55	3356
Model 2 logistic with comorbidity covariates (fully adjusted)	0.58	3336
Model 3 multilevel logistic regression (fully adjusted)	0.68	3219
Cesarean delivery		
Model 1 logistic without comorbidity covariates	0.58	26250
Model 2 logistic with comorbidity covariates (fully adjusted)	0.70	23611
Model 3 multilevel logistic regression (fully adjusted)	0.73	23000
No PCI for STEMI-AMI		
Model 1 logistic without comorbidity covariates	0.72	1883
Model 2 logistic with comorbidity covariates (fully adjusted)	0.76	1785
Model 3 multilevel logistic regression (fully adjusted)	0.88	1429

cesarean deliveries, probably due mainly to the enormous variability of the rate of cesarean sections performed around the world.[26] One previous report[27] found a higher formal education associated with a higher rate of elective cesarean sections, and another study demonstrated the same education-related disparities for repeat cesarean deliveries too.[28] Judging from our results, on the other hand, women with a middle-school education had significantly higher odds of undergoing cesarean section than those with a higher education. It is likely that the best-educated women benefited more those with a middle-school education from the Italian health system's efforts to implement various organizational strategies to reduce the caesarean section rate. In fact, other studies have shown that preventive strategies can generate disparities within a community.[29]

Our results also indicate that women coming from Asia, Africa and America had higher odds of undergoing cesarean section. This may be due to such patients having a different propensity for, or attitude to cesarean delivery, but physicians should be aware of this disparity and attempt to provide the best care for all women, regardless of their level of education and nationality.

As documented in a study conducted on an earlier period,[30] the odds of having open (instead of laparoscopic) cholecystectomy were lower for females than for males, higher for older than for younger patients and also higher (nearing statistical significance) for patients with a lower formal education than for better-educated patients. Other studies have reported a significant disparity between elderly and younger patients in the use of LC.[31] The tendency to restrict its use to older patients is not justified by the findings of a study on the safety and efficacy of such procedures in the elderly,[32] which demonstrated that LC offers the same advantages—fewer complications, a shorter hospital stay and lower costs—as open cholecystectomy (OC) in the elderly as in younger people. Another study found the morbidity rates after LC in the elderly no different from those reported for patients under 65 years old.[33] Our study also showed that patients who underwent LC instead of OC were more likely to be female than male: this same gender-related disparity was seen in a population of patients in the United States undergoing cholecystectomy for acute cholecystitis.[34]

Our study has several limitations. First, it was an observational study, which limits our ability to draw causal inferences. In

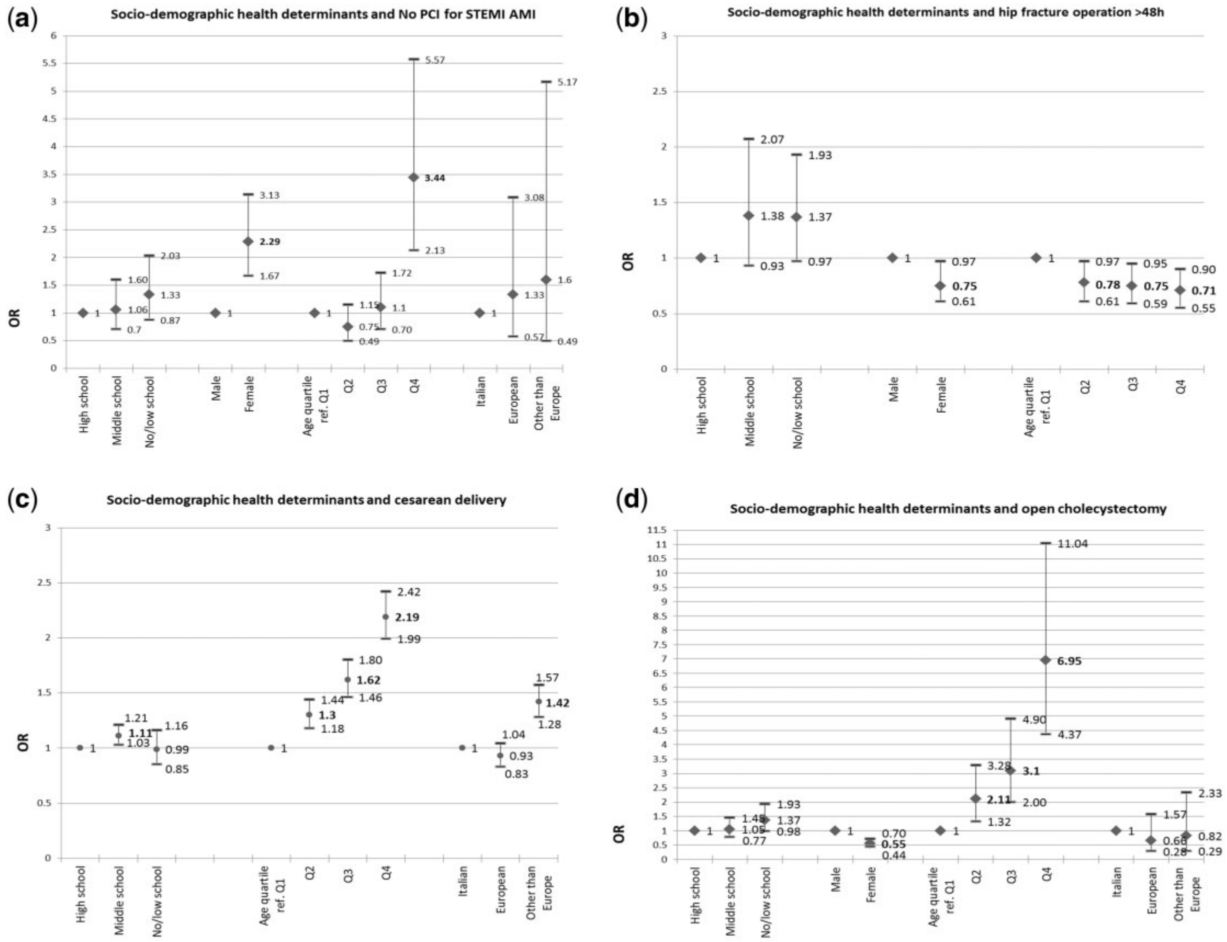

Figure 1 Results of multilevel logistic regression analysing associations between socio-demographic determinants and four process quality indicators: estimated odds ratios and 95% confidence intervals. Adjusted for comorbidities during the same admission: (a) cancers, cardio-rheumatic diseases, hematologic diseases, cerebrovascular diseases, vascular diseases, chronic nephropathies, chronic diseases, previous coronary angioplasty, other venous catheterization, number of previous admission; and comorbidities during a previous admission: lipid metabolism, chronic nephropathies, previous AMI, hypertension, cerebrovascular diseases, arrhythmias, hematologic diseases, heart failure, diabetes, coronary angioplasty, cardio-rheumatic diseases; (b) nutritional deficit, hematologic diseases, cardio-rheumatic diseases, chronic nephropathies, dementia; and comorbidities during a previous admission: dementia, rheumatoid arthritis, chronic nephropathies, chronic diseases, other ischemic heart diseases, COPD, arrhythmias, cerebrovascular diseases, cardiologic diseases unspecified; (c) fetal distress, rhesus-incompatibility, number of previous admissions, acute lung diseases, hypertension, eclampsia, diabetes, cardiovascular diseases, blood loss, gravidic steatosis, membrane rupture, fetal abnormalities, abnormal position of fetus, fetal disproportion, fetal growth retardation, HIV, thyroiditis, nephropathies; and comorbidities during a previous admission: cardiac diseases, hypertension, anemia,

particular, we cannot disentangle whether the disparities arose because social determinants influenced patients' attitudes to treatment or physicians' attitudes to patients. In fact, such disparities could depend on the knowledge, skills, preferences, perceptions, attitudes and prejudices of both patients and health care providers.[35] On the other hand, studies on disparities can only be observational and, where an evidence-based best practice exists, physicians are in any case responsible for encouraging patients to opt for the best possible care whatever their social status.

The other main shortcoming of our study lies in the missing data on the sample's formal education. Where this information is not provided, it is probably not by chance but associated with a certain category of education level, and this could lead to a differential-misclassification of this variable and consequently to a bias in our results. Nonetheless, even if the missing data lead to a non-differential misclassification error could lead to a bias that is not always toward the null, mainly when a polytomous exposure is collapsed down to fewer categories in the analysis.[36] On the other hand, a previous study examined the validity of data on formal education derived from hospital discharge records in another Italian region and found a good-excellent validity for patients hospitalized for cholecystectomy and coronary heart disease, and a sufficient validity for hip fracture cases.[37]

Finally, another shortcoming of our study could relate to the fact that, although a very large set of comorbidities were considered to adjust our process indicators, some residual confounders could still bias our results due to comorbidities not considered but likely to be linked both to outcome and to exposure.

In conclusion, access to good-quality evidence-based hospital health care is characterized by undesirable disparities. Current administrative data sets have considerable practical value for the purpose of broad-based quality assessments, and serve as a useful screening tool—also in the health disparities domain—for identifying quality problems and targeting areas that might require more in-depth investigations based on more reliable data. Just as monitoring quality indicators has led to improvements in hospitals' efficiency and outcome performance,[18] data and indicators derived from current administrative data sets can likewise support health system planning and policies, also as regards strategies to contain remediable inequalities in health care delivery.

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Conflicts of interest: None declared.

Key points:

- Age, gender, citizenship and formal education could be associated with quality of health care delivered to patients, undermining the equity of evidence-based quality health care provision.
- Administrative data sets are of considerable practical value for broad-based quality assessments and as a screening tool, also in the health disparities domain.

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