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A cross-sectional, nationwide population-based study

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Abstract
Geographic variation in admission to the intensive cardiac care unit (ICCU) might question about the efficiency and the equity of the healthcare system. The aim was to explain geographic variation in the rate of admission to ICCU for coronary artery disease (CAD) or heart failure (HF) in France.

We conducted a retrospective study based on the French national hospital discharge database. All inpatient stays for CAD or HF with an admission to an ICCU in 2014 were included. We estimated population-based age and sex-standardized ICCU admission rates at the department level. We separately modeled the department-level admission rates for HF and CAD using generalized linear models.

In all, 61,010 stays for CAD and 27,828 stays for HF had at least 1 ICCU admission. The ICCU admission rates were explained by the admission rate for CAD, by the diabetes prevalence, by the proportion of the population >75 years, and by the drive time to the ICCU.

This work sheds light on the finding of substantial geographic variation in the ICCU admission rates for CAD and HF in France. This variation is explained by both the age and the health status of the population and also by the drive time to the closest ICCU for HF. Moreover, ICCU admission for HF might be more prone to unwarranted variations due to medical practice patterns.

Abbreviations: AMI = acute myocardial infarction, CAD = coronary artery disease, CV = coefficient of variation, DRGs = diagnosis-related groups, HF = heart failure, ICCU = intensive cardiac care unit, SD = standard deviation.

Keywords: access to healthcare, geographic variation, intensive care

1. Introduction

Intensive cardiac care units (ICCUs) or acute cardiac care units are managing patients admitted for isolated or combined organ dysfunction,[1] including heart failure (HF) and coronary artery disease (CAD). HF patients admitted to ICCUs have a high (17%) in-hospital mortality risk.[2] Timely access to invasive procedures and an ICCU is associated with an improvement in survival.[3,4]

Although there is limited information, real-world evidence from registries[5,6] and hospital discharge databases[2,7,8] show considerable variations in ICCU admission rates between and within countries. These variations might be explained by patient severity,[2] facility availability,[5,6] or hospital or physician-level practice differences (including triage decision, experience, and local protocols).[2,9,10] Hence, understanding what drives ICCU utilization through the analysis of its geographic variation is of paramount interest to both cardiologists and policy makers. A better understanding of ICCU admissions and their hospital or physician-level motivators may indeed contribute to improving the quality, the equity, and the efficiency of the healthcare system through the dissemination of clinical guidelines and through improved access to facilities. As it specifically regards the ICCUs, the Acute Cardiovascular Care Association is on the verge of publishing guidelines that underline the importance of networks to improve the management of patients admitted to ICCUs for different levels of care.[11]

Heart failure and CAD are 2 frequent conditions that are managed in ICCUs and that involve 2 distinct populations (eg, as it regards age), but also different admission criteria.

We therefore aimed to explain geographic variations in the rates of admission to the ICCU for CAD or HF in France in 2014.

2. Methods

2.1. Data

This was a nationwide, observational population-based cross-sectional study.

The French national hospital discharge database (Programme de Médicalisation des Systèmes d'Information) includes data from all public and private hospitals for all patients. These data include diagnoses (encoded using the International Classification of Diseases, Tenth Revision), procedures (encoded using the French Classification Commune des Actes Medicaux), age, sex, admission and discharge status, provider, and French diagnosis-related groups (DRGs). Because hospitals receive additional service coverage, all ICCU admissions are recorded in the discharge database.

All consecutive inpatient stays for CAD or HF with at least 1 admission to an ICCU during the year 2014 for France at the exclusion of overseas territories were included. Inpatient stays for CAD or HF were identified in the acute care programme de medicalisation des systemes d'informatio database in 2014. CAD was defined based on DRG codes (05C04, 05C05, 05C14, 05K05, 05K24, 05M04, and 05M21), that is, admissions for angina pectoris, acute myocardial infarction (AMI), or other acute ischemic heart diseases with coronary artery bypass grafting, stent implantation, or balloon angioplasty. HF admissions were defined using the 05M09 DRG group, that is admissions for HF with or without cardiogenic shock. Any admission with cardiogenic shock complicating acute CAD was classified in the CAD category.

French departments (hereafter, departments) are administrative divisions (n = 94). For each department, we calculated the ICCU admission rates for CAD and HF by dividing the number of inpatient stays by the population of the department. These rates were directly standardized based on age and sex using the 2014 French national population as a reference. We separately analyzed admissions for CAD and for HF.

The categories of explanatory variables that were considered are as follows: epidemiologic measures (prevalence of diabetes, mortality, cardiovascular mortality, premature mortality, proportion of the population aged >75 years, overall hospital admission rates for CAD or HF); drive time to the closest ICCU; and socioeconomic variables (income, education, unemployment, proportion of the population eligible for the social insurance scheme social complementary health insurance). Socioeconomic and epidemiological data were retrieved for the year 2014 at the department level from the French National Institute of Statistics and Economic Studies.[12] Diabetes prevalence data were obtained from the Institut National de Veille Sanitaire database for the year 2013.[13] We used the Odomatrix software to calculate drive times between the patients' zip code of residence and the closest ICCU (Odomatrix v2013, INRA, UMR1041 CESAER, Dijon, France from IGN Route500, BD ALTI 500, RGC).

This research has been approved by the Commission Nationale Informatique et Liberté (Reference number CNIL/DE-2014-134). Because the database is anonymous, obtaining consent to participate is not applicable.

2.2. Statistical analysis

Preliminary descriptive analyses included frequencies for categorical variables and means ± standard deviation (SD) for continuous variables. Admission rates to the ICCU for HF or CAD were calculated at the department level (n = 94) and were normally distributed. Four measures were calculated to quantify variation: the extremal ratio as the ratio of variation between the minimum and maximum admission rates; the interquartile ratio as the ratio between the 25th and 75th percentiles of the admission rates; the SD; and the coefficient of variation (CV) as the ratio between the mean and the SD.

Times were log-transformed and trimmed above the third quartile to avoid bias due to non-normality and extremely high values. Pearson or Spearman product-moment correlation coefficients were estimated to assess the association between admission rates and quantitative variables. The linearity of the association between admission rates and continuous measures was checked graphically by plotting each independent variable against the admission rates.

We separately modeled the department-level admission rates for HF and CAD. A linear regression model was used to evaluate independent variables explaining the variance in the admission rates. Variables with a P value ≤ .2 in the univariate analysis and the factors that had a theoretical impact on the rate of use of the ICCU were introduced in the multivariate analysis. Only significantly and linearly associated variables were entered into the model. The final model was determined using a stepwise selection with a removal level of .05. No collinearity between predictors was detected with variance inflation factors.

All analyses were conducted using the SAS statistical software (SAS version 9, SAS Institute, Cary, NC).

3. Results

In 2014, a total of 277,548 patients were admitted in ICCUs in France. In addition, there were 96,340 inpatient stays for CAD and 202,428 stays for HF. Among them, 61,010 stays for CAD (63.3%) and 27,828 stays for HF (13.7%) had at least 1 ICCU admission and were included in the analysis. The length of stay was significantly shorter for stays with ICCU admission related to CAD than for HF (7.2 vs 10.6 days; P < .001), whereas the drive time was longer (49 vs 23 km; P < .001). The descriptive statistics for potential explanatory variables defined at the department level are summarized in Table 1.

The average national admission rates to the ICCU for CAD and HF were equal to 0.96 admissions per 1000 population per year (95% confidence interval [CI] 0.58, 1.91) and 0.40 admissions per 1000 population per year (95% CI 0.067, 1.243), respectively. At the department level (n = 94), the age and sex-standardized admission rate varied between 0.54 and 1.64 for CAD, and between 0.04 and 1.24 for HF. The CV of the admission rate for CAD and HF were equal to 22% and 60%, respectively. All the other measures aimed to quantify the variation between departments were at least 2 times higher for

Table 1

Characteristics of department-level variables (n = 94).

	Mean (SD)
Yearly income per household (Euros)	37 031 (5 033)
Eligible for CMUc (%)	6.4 (2.1)
Unemployment (%)	9.9 (1.9)
Education level (%)	
Below upper secondary	26.2 (2.2)
Upper secondary	42.4 (5.1)
Tertiary	31.4 (3.5)
75 years of age or greater (%)	10.4 (2.1)
Mortality rate per 100,000 population	9.5 (2)
Premature mortality (%)	1.9 (0.3)
Cardiovascular mortality per 100,000 population	2.5 (0.7)
Diabetes prevalence	4.8 (0.7)

CMUc = couverture maladie universelle complementaire, SD = standard deviation.
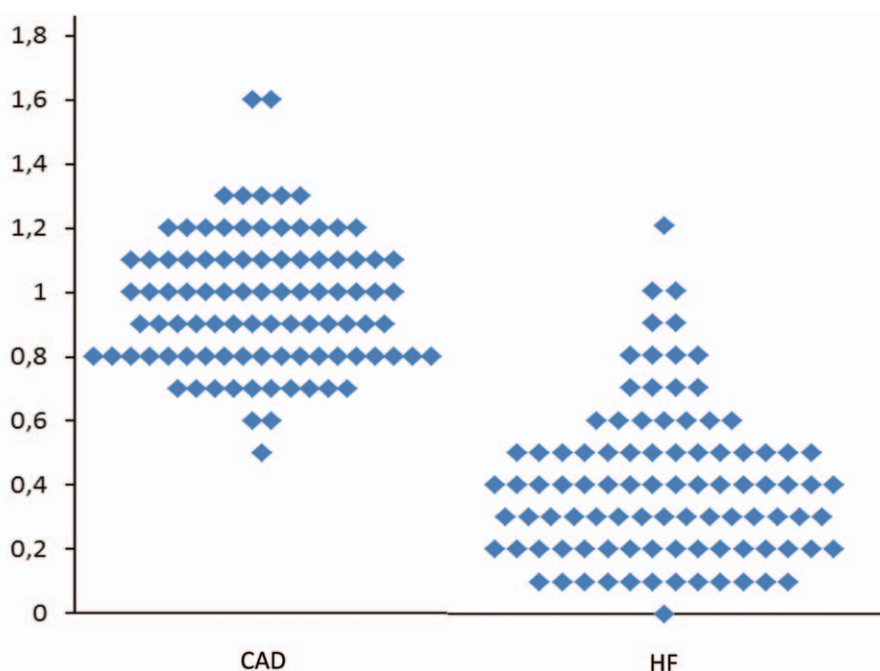
Figure 1. Standardized admission to intensive cardiac care unit rate by Department for Coronary Artery Disease and Heart Failure.

HF than for CAD. Figure 1 confirms the higher, but less variable, admission rate for CAD than for HF.

After adjustment, the standardized ICCU admission rate for CAD was positively associated with the admission rate for CAD, but negatively associated with the proportion of the population >75 years of age (Table 2). A 1-unit increase in the admission rate for CAD was associated with a 4.9-unit increase in the ICCU admission rate for CAD ($P < .001$). By contrast, a 1-percentage point increase in the proportion of people ≥75 years of age was associated with a decrease of 0.04 units in the ICCU admission rate for CAD ($P < .001$). The overall between department

variability of the ICCU admission rate for CAD was well-explained by this model ($R^2 = 0.67$).

Regarding HF, the standardized ICCU admission rate was positively associated with diabetes prevalence and was negatively associated with the proportion of the population ≥75 years of age and with the drive time to the ICCU (Table 3). A 1-unit increase in the prevalence of diabetes was associated with a 0.12-unit increase in the ICCU admission rate for HF ($P < .001$). A 1-minute increase in the drive time to the ICCU was associated with a 0.11-unit decrease in the ICCU admission rate for HF ($P = .001$). Lastly, a 1-percentage point increase in the proportion

Table 2

Variables associated with the admission rate to an intensive cardiac care unit for coronary artery disease.

	Univariate		Multivariate[*]	
	Correlation coefficient	P	Estimate	P
Income per household (Euros)	−0.23	.03		
Eligible to CMUc (%)	0.13	.2		
Unemployment (%)	0.26	.01		
Education level (%)				
Below upper secondary	0.25	.01		
Upper secondary	0.43	<.001		
Tertiary	−0.27	.01		
Drive time to the ICCU (min)	−0.04	.65		
75 years of age or greater	0.254	.01	−0.04	<.001
Mortality rate per 100,000 population	0.3	.003		
Premature mortality (%)	0.25	.01		
Cardiovascular mortality per 100,000 population	0.24	.02		
Diabetes prevalence	0.42	<.001		
Overall admission rate for CAD	0.72	<.001	4.9	<.001

CAD = coronary artery disease, CMUc = couverture maladie universelle complementaire, ICCU = intensive cardiac care unit.

[*] The final linear model was adjusted for age and the overall admission rate for CAD.

Table 3

Variables associated with the admission rate to an intensive cardiac care unit for heart failure.

	Univariate		Multivariate*	
	Correlation coefficient	P	Estimate	P
Income per household (Euros)	−0.11	.27		
Eligible to CMUc (%)	0.28	.006		
Unemployment (%)	0.25	.02		
Education level (%)				
Below upper secondary	−0.03	.75		
Upper secondary	−0.04	.69		
Tertiary	−0.16	.11		
Drive time to the ICCU (min)	−0.72	<.001	−0.11	.001
75 years of age or greater	−0.306	.003	−0.04	<.001
Mortality rate per 100,000 population	−0.2	.05		
Premature mortality (%)	−0.02	.84		
Cardiovascular mortality per 100,000 population	−0.21	.04		
Diabetes prevalence	0.26	.01	0.12	<.001
Overall admission rate for HF	−0.14	.2		

CMUc = couverture maladie universelle complementaire, HF = heart failure, ICCU = intensive cardiac care unit.

* The final linear model was adjusted for drive time, age, and diabetes prevalence.

of the population ≥75 years of age led to a 0.04-unit decrease in the ICCU admission rate for HF ($P < .001$). The overall between-department variability of the ICCU admission rate for HF was acceptably explained by this model ($R^2 = 0.35$).

4. Discussion

4.1. Important geographic variations partly explained by disease patterns

In this nationwide French analysis, the standardized ICCU admission rates for CAD and HF exhibit a high between-department variation, with the coefficients of variations equal to 22% and 60%, respectively. A previous study performed using the same database and methods on 11 frequent elective surgeries in France showed that the between-department CV ranked from 11.5% for cesarean sections to 42.3% for bariatric surgeries.[14] In comparison, the ICCU admission rate for HF estimated from our data was much more variable.

The results suggest that this variation is partially explained by patient or population-level factors such as age and epidemiological traits. The probability of CAD and HF-related ICCU admission increases when the health status of the population worsens. This is consistent with previous findings on hospital admission and therapeutic management for CAD,[15] HF,[16] and other conditions,[17,18] and suggests that, to a certain extent, ICCU admissions reflect the underlying medical needs of the served population. Regarding age, CAD and HF-related ICCU admissions were less frequent in our study in departments with a high proportion of the population that was ≥75 years of age. Although this could be regarded as a paradoxical result, similar associations have already been found in the French context for both thrombolysis and coronary angiography for AMIs[19,20] and in the USA for angiotensin-converting enzyme inhibitors for HF at discharge.[21] Whether this should be considered warranted or unwarranted variation is still under debate. On the one hand, ICCU admission and interventional management could be less useful in the older population; on the other hand, this might suggest referral biases favoring patients with fewer comorbidities.[11]

4.2. A differential causal pattern for CAD and HF

Because we analyzed ICCU admission rates for CAD and HF, we were able to identify different patterns of explanatory variables. In our study, the variability across departments was much higher for HF (factor 30, CV = 60%) than for CAD (factor 3, CV = 22%). A longer drive time to the closest ICCU was associated with a lower ICCU admission rate for HF, but not for CAD. According to this finding, ICCU admissions for HF could be dependent on the availability of ICCU beds in the department, but not ICCU admissions for CAD. This suggests that the decision criteria are different and probably more variable for HF than for CAD. Whatever the underlying explanation, it might threaten equitable access to specialized care across the country for HF patients. Moreover, ICCU admissions for CAD are explained by the overall hospital admission for CAD, whereas ICCU admissions for HF are not linked to overall HF admissions. Again, this suggests that ICCU admission criteria would be more variable between settings for HF than for CAD. Lastly, the adjusted R^2 was lower for HF (0.35) than for CAD (0.67), suggesting that the residual and unobserved factors are more important regarding HF. This suggests that a higher proportion of the variation of the admission rate to the ICCU for HF is unwarranted (ie, not explained by the populations' medical needs). Indeed, the second array of possible causes for observed geographic variations in healthcare utilization are defined at the hospital or physician level. Regarding the diagnostic and therapeutic management of HF, the published evidence suggests a wide array of hospital-level variations for echocardiography,[22] intravenous inotrope therapies,[23] drug therapies,[24] and the use of implantable cardioverter-defibrillators.[25] Even though none of these studies assessed the variation in the ICCU admission rate, the body of evidence shows variations that are not reflective of the underlying population needs.[9] For CAD, such variations have been described regarding triage,[26] early administration of drugs,[27] thrombolysis,[28] percutaneous coronary intervention,[29] and coronary artery bypass graft.[15] Although no direct comparison of HF and CAD has been performed, HF could be more prone to hospital-level variations due to local protocols or individual practice patterns.[30]

We found no association between the socioeconomic status of patients and the probability of admission to the ICCU. Because the available published evidence shows that a lower socioeconomic status is a strong independent predictor of HF development, decompensation, and mortality,[31,32] we could hypothesize that it could also be associated with ICCU admission. Again, we believe that specific work based on socioeconomic factors that are defined at the individual level should be conducted.

4.3. Possible steps to reduce the unwarranted variation and to improve access to the ICCU

Reducing the portion of variation in the ICCU admission rates not explained by patient need and improving access to the ICCU for the entire population are the 2 aims. Access to the ICCU for patients in remote areas could be improved by adequate prehospital management and by an improved geographic distribution of ICCUs, with particular attention that is paid to HF patients. The considerable admission rate variability unveiled in this work might be associated with the paucity of ICCU triage guidelines.[33] Future work should strive to assess the impact of the dissemination of risk scores aimed to identify patients who could be directed to the ICCU.[34] Similarly, interventions that favor the implementation of evidence-based clinical guidelines have been proven effective for CAD[35] and HF patients.[36,37] More complex organizational innovations focusing on post-discharge care might be able to reduce unwarranted variation between centers.[38] In France, the aim of the programme de retour a domicile postdischarge program for HF patients is to reduce readmissions by improving transitional care all over the territory.[30] In the near future, technology solutions such as telehealth, home monitoring, and risk prediction might improve access to specialized cardiac care in remote areas.[30] Finally, our results highlight the need for supplementary training for physicians with a particular focus on multidisciplinary team work and subspecialty skills.[39,40]

4.4. Limitations and strengths

This study has some limitations. First, like other administrative discharge databases, our data do not include precise clinical data.[2] This precludes accounting for the initial presentation and the severity of patients in the analysis. In particular, we were able to classify CAD patients according to their ejection fraction. However, it is very unlikely that the observed variation in the admission rate would be solely explained by between-hospital differences in patient severity. Similarly, CAD and HF admissions were defined on the sole base of DRGs. For example, a patient admitted with acute HF complicating CAD was classified into the CAD group, because so does the French DRG grouping algorithm. Hence, we were not able to analyze patients presenting with both HF and CAD, who might have been considered as a specific subgroup. Second, we had to rely on aggregated socioeconomic data because such determinants are not routinely available at the individual level. This might explain why we have not found any association between the socioeconomic status of patients and the variation in admission rate. Future work should focus on the role of socioeconomic factors. Third, our study was not designed to assess hospital or physician-level factors. Nevertheless, departments are large enough to reflect between-hospital variations in France. Lastly, the generalizability of our findings to other countries is not straightforward because of differences in acute care organization and financing.

Nevertheless, this is the first nationwide study based on exhaustive acute care hospital discharge data from all public and private hospitals in France. Performing the statistical analysis at the aggregated department level and separate analyses for CAD and HF-related ICCU admissions allowed us to highlight the specific role of patient- and hospital-level factors.

5. Conclusions

This work sheds light on the finding of substantial geographic variation in the ICCU admission rates for CAD and HF in France. This variation is explained by both the age and the health status of the population, and also by the drive time to the closest ICCU for HF. Moreover, ICCU admission for HF might be more prone to unwarranted variations due to medical practice patterns. Hence, monitoring ICCU admission rates might contribute to a better insight into geographic disparities in access and practice. We recommend that additional research be conducted on the hospital and physician-level motivators of ICCU admission.

6. Data availability

The data that support the findings of this study are available from the Agence Technique de l'Information sur l'Hospitalisation (ATIH, http://www.atih.sante.fr/) but restrictions apply to the availability of these data, which were used under research agreement for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of ATIH.

Author contributions

All authors contributed to the design of the study. GM and AR analyzed the data. GM and FR drafted the manuscript. All authors read and approved the final manuscript.

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References

[1] Hasin Y, Danchin N, Filippatos GS, et al. Recommendations for the structure, organization, and operation of intensive cardiac care units. Eur Heart J 2005;26:1676–82.

[2] Chioncel O, Mebazaa A. Characteristics of intensive care in patients hospitalized for heart failure in Europe. Heart Fail Clin 2015;11:647–56.

[3] Chalfin DB, Trzeciak S, Likourezos A, et al. DELAY-ED Study GroupImpact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. Crit Care Med 2007;35:1477–83.

[4] Epstein AJ, Polsky D, Yang F, et al. Geographic variation in implantable cardioverter-defibrillator use and heart failure survival. Med Care 2012;50:10.

[5] Adhikari NK, Fowler RA, Bhagwanjee S, et al. Critical care and the global burden of critical illness in adults. Lancet 2010;376:1339–46.

[6] Rhodes A, Ferdinande P, Flaatten H, et al. The variability of critical care bed numbers in Europe. Intensive Care Med 2012;38:1647–53.

[7] Follath F, Yilmaz M, Delgado J, et al. Clinical presentation, management and outcomes in the acute heart failure global survey of standard treatment (ALARM-HF). Intensive Care Med 2011;37:619–26.

[8] Zannad F, Mebazaa A, Juilliere Y, et al. Clinical profile, contemporary management and one-year mortality in patients with severe acute heart failure syndromes: the EFICA study. Eur J Heart Fail 2006;8:697–705.

[9] Dondo T, Hall M, Timmis A, et al. Geographic variation in the treatment of non ST-segment myocardial infarction in the English National Health Service: a cohort study. BMJ Open 2016;6:e011600.

[10] Guadagnoli E, Hauptman PJ, Ayanian JZ, et al. Variation in the use of cardiac procedures after acute myocardial infarction. N Engl J Med 1995;333:573–8.

[11] ACCA. The ACCA Clinical Decision-Making Toolkit; 2016. Available at: http://www.escardio.org/Education/Practice-Tools/ACCA-Toolkit. Accessed September 1, 2017.

[12] INSEE. Populations legales 2011; 2014. Available at: www.insee.fr/fr/ppp/bases-de-donnees/recensement/populations-legales/default.asp. Accessed July 5, 2014.

[13] INVS. Prevalence et incidence du diabete en France; 2016. Available at: http://invs.santepubliquefrance.fr/Dossiers-thematiques/Maladies-chroniques-et-traumatismes/Diabete/Donnees-epidemiologiques/Prevalence-et-incidence-du-diabete. Accessed September 9, 2016.

[14] IRDES. EcoSante; 2014. Available at: www.ecosante.fr. Accessed July 5, 2014.

[15] Pilote L, Merrett P, Karp I, et al. Cardiac procedures after an acute myocardial infarction across nine Canadian provinces. Can J Cardiol 2004;20:491–500.

[16] Chen J, Normand S-LT, Wang Y, et al. National and regional trends in heart failure hospitalization and mortality rates for Medicare beneficiaries, 1998-2008. JAMA 2011;306:1669–78.

[17] Corallo AN, Croxford R, Goodman DC, et al. A systematic review of medical practice variation in OECD countries. Health Policy 2014;114:5–14.

[18] Skinner J. Causes and consequences of regional variations in health care. Handb Health Econ 2011;2:45–93.

[19] Ecochard R, Rabilloud M, Colin C, et al. Unjustified variations in patient management for acute myocardial infarction in the Rhone-Alpes region of France. Int J Technol Assess Health Care 2000;16:885–95.

[20] Rabilloud M, Cao D, Riche B, et al. Impact of selected geographical and clinical conditions on thrombolysis rate in myocardial infarction in three departments of France. Eur J Epidemiol 2001;17:685–91.

[21] Incalzi RA, Pedone C, Pahor M, et al. Trends in prescribing ACE-inhibitors for congestive heart failure in elderly people. Aging Clin Exp Res 2002;14:516–21.

[22] Welch HG, Hayes KJ, Frost C. Repeat testing among Medicare beneficiaries. Arch Intern Med 2012;172:1745–51.

[23] Partovian C, Gleim SR, Mody PS, et al. Hospital patterns of use of positive inotropic agents in patients with heart failure. J Am Coll Cardiol 2012;60:1402–9.

[24] Steinman MA, Patil S, Kamat P, et al. A taxonomy of reasons for not prescribing guideline-recommended medications for patients with heart failure. Am J Geriatr Pharmacother 2010;8:583–94.

[25] Matlock DD, Kutner JS, Emsermann CB, et al. Regional variations in physicians' attitudes and recommendations surrounding implantable cardioverter-defibrillators. J Card Fail 2011;17:318–24.

[26] Stukel TA, Alter DA, Schull MJ, et al. Association between hospital cardiac management and outcomes for acute myocardial infarction patients. Med Care 2010;157–65.

[27] Ko DT, Krumholz HM, Wang Y, et al. Regional differences in process of care and outcomes for older acute myocardial infarction patients in the United States and Ontario, Canada. Circulation 2007;115:196–203.

[28] Tu JV, Khalid L, Donovan LR, et al. Panel CCORTCCSAMIQI. Indicators of quality of care for patients with acute myocardial infarction. Can Med Assoc J 2008;179:909–15.

[29] Labinaz M, Swabey T, Watson R, et al. Delivery of primary percutaneous coronary intervention for the management of acute ST segment elevation myocardial infarction: summary of the Cardiac Care Network of Ontario Consensus Report. Can J Cardiol 2006;22:243–50.

[30] CNAM-TS. Expérimentation PRADO, le programme de retour à domicile, insuffisance cardiaque; 2013. Available at: http://www.cpambordeaux.fr/prado/PRADO_IC_9et10avril2013-2.pdf. Accessed May 1, 2017.

[31] Díaz-Toro F, Verdejo HE, Castro PF. Socioeconomic Inequalities in Heart Failure. Heart Fail Clin 2015;11:507–13.

[32] Hawkins NM, Jhund PS, McMurray JJ, et al. Heart failure and socioeconomic status: accumulating evidence of inequality. Eur J Heart Fail 2012;14:138–46.

[33] McMurray JJ, Adamopoulos S, Anker SD, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012. Eur J Heart Fail 2012;14:803–69.

[34] Fonarow GC, Adams KF, Abraham WT, et al. Risk stratification for in-hospital mortality in acutely decompensated heart failure: classification and regression tree analysis. JAMA 2005;293:572–80.

[35] Lu CY, Law MR, Soumerai SB, et al. Impact of prior authorization on the use and costs of lipid-lowering medications among Michigan and Indiana dual enrollees in Medicaid and Medicare: results of a longitudinal, population-based study. Clin Ther 2011;33:135–44.

[36] Holland R, Battersby J, Harvey I, et al. Systematic review of multidisciplinary interventions in heart failure. Heart 2005;91:899–906.

[37] Mehra MR, Albert NM, Curtis AB, et al. Factors associated with improvement in guideline-based use of ICDs in eligible heart failure patients. Pacing Clin Electrophysiol 2012;35:135–45.

[38] Jha AK, Perlin JB, Kizer KW, et al. Effect of the transformation of the Veterans Affairs Health Care System on the quality of care. N Engl J Med 2003;348:2218–27.

[39] Gillebert TC, Brooks N, Fontes-Carvalho R, et al. ESC core curriculum for the general cardiologist (2013). Eur Heart J 2013;eht234.

[40] Morrow DA, Fang JC, Fintel DJ, et al. Evolution of critical care cardiology: transformation of the cardiovascular intensive care unit and the emerging need for new medical staffing and training models a scientific statement from the American Heart Association. Circulation 2012;126:1408–28.