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CLINICAL RESEARCH

Identifying key factors leading to the optimal care pathway for patients with ST-segment elevation myocardial infarction: Results from the RESCAMIP registry

Facteurs associées à un parcours de soin optimal pour les patients porteurs d'un SC ST+ : résultats du registre RESCAMIP

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KEYWORDS
ST-segment elevation myocardial infarction;

Summary
Background. — In France, when someone presents with chest pain, it is recommended to call a health emergency number. The patient talks with an emergency doctor at a medical dispatch centre, who decides whether (or not) to send a Mobile Intensive Care Unit (MICU). Patients with

Abbreviations: CI, confidence interval; CICU, Cardiology Intensive Care Unit; CVD, cardiovascular disease; ICC, intraclass correlation coefficient; MDC, medical dispatch centre; MICU, Mobile Intensive Care Unit; OR, odds ratio; ORUMIP, Observatoire Régional des Urgences de Midi-Pyrénées (Regional Observatory of Emergencies in Midi-Pyrénées); STEMI, ST-segment elevation myocardial infarction.

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Emergency care;
Mobile Intensive Care Unit

an ST-segment elevation myocardial infarction (STEMI) should have an MICU as their first medical contact, to speed up confirmation of diagnosis and enable them to benefit from reperfusion therapy as quickly as possible.

Aim. — To evaluate the proportion of patients with STEMI benefiting from an optimal care pathway, and to identify the key factors leading to this pathway.

Methods. — RESCAMIP was a multicentre registry conducted between May 2015 and May 2017 in Midi-Pyrénées. All patients treated for STEMI within 12 hours of symptoms onset, without initially going into cardiac arrest, were included.

Results. — Data from 1371 patients with STEMI were analysed; 60% had an MICU as their first medical contact. In-hospital mortality was 4%. Factors associated with calling the medical dispatch centre when presenting chest pain were: age > 65 years (odds ratio [OR] 1.37, 95% confidence interval [CI] 1.02—1.83), personal history of cardiovascular disease (OR 1.9, 95% CI 1.22—2.96) and having cardiovascular risk factors (OR 1.84, 95% CI 1.35—2.5). Factors associated with sending an MICU as first medical contact were: male sex (OR 2.11, 955 CI 1.49—2.99) and personal history of cardiovascular disease (OR 1.69, 95% CI 1.07—2.65).

Conclusions. — The proportion of patients with STEMI going through non-optimal pathways was 40% in our area. We note that there are sex-based inequalities in accessing MICUs.

MOTS CLÉS
Syndrome coronarien avec élévation du segment ST ;
Urgences ;
SAMU

Résumé

Contexte. — En France, un individu présentant une douleur thoracique est encouragé à appeler le 15. L'appel est ensuite traité par un médecin régulateur du SAMU qui décidera (ou non) d'envoyer une équipe SMUR. Les patients présentant un syndrome coronarien ST+ (SCA ST+) devraient bénéficier d'un SMUR, afin de réduire leur délai jusqu'à la reperfusion coronaire.

Objectif. — Évaluer la proportion et les facteurs associés de prise en charge optimale pour les patients présentant un SCA ST+.

Méthodes. — RESCAMIP est un registre multicentrique réalisé entre mai 2015 et mai 2017 en Midi-Pyrénées. Tous les patients traités pour SCA ST+ évoluant depuis moins de 12 heures ont été inclus.

Résultats. — Un total de 1371 SCA ST+ ont été analysés. Un total de 60 % ont bénéficié d'un SMUR. La mortalité intra-hospitalière était de 4 %. Les facteurs associés avec le fait d'appeler le SAMU lors d'une douleur thoracique pour les patients SCA ST+ étaient: avoir plus de 65 ans (*odds ratio* [OR] 1,37, intervalle de confiance à 95 % [IC95 %] 1,02—1,83), avoir des antécédents cardiovasculaires (CV) (OR 1,9, IC95 % 1,22—2,96) ou des facteurs de risques CV (OR 1,84, IC95 % 1,35—2,5). Les facteurs associés avec l'envoi d'un SMUR lors de l'appel étaient : être un homme (OR 2,11, IC95 % 1,49—2,99) et avoir des antécédents CV (OR 1,69, IC95 % 1,07—2,65).

Conclusions. — Le taux de parcours non optimaux pour les patients présentant un SCA ST+ est de 40 % dans notre région. On note une inégalité à l'accès au SMUR selon le genre.

Background

Ischaemic heart disease is one of the leading causes of death in Europe, accounting for about 20% of all deaths in 2016 [1]. ST-segment elevation myocardial infarction (STEMI) is the deadliest ischaemic heart disease event, with an in-hospital mortality rate ranging from 4% to 12% [2]. A shorter delay between chest pain and reperfusion therapy usually leads to a higher chance of survival [3,4]. The European Cardiology Society [5,6] went so far as to design schematics in their guidelines, stating that patients with STEMI with chest pain evolving for < 12 hours, and who did not initially go into cardiac arrest, should receive reperfusion therapy within 120 minutes of diagnosis by electrocardiogram. Moreover, these guidelines recommend that healthcare systems set up regional emergency medical networks to facilitate identification of patients with STEMI and reduce the delay to reperfusion therapy [7]. The efficiency of these networks must also be evaluated [8].

In France, the chosen strategy [9] is to inform people that they should call a medical dispatch number (i.e. ''15'') when feeling chest pain. The patient talks with a medical dispatch centre (MDC) emergency doctor, who then decides whether (or not) to send a Mobile Intensive Care Unit (MICU) if the probability of STEMI is deemed high. The goal is to transport the patient as quickly as possible to a Cardiology

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Intensive Care Unit (CICU) with a catheterization laboratory. Patients with STEMI who do not benefit from this optimal course of action usually go to the emergency room before going to the CICU (Fig. 1), resulting in longer time periods before reperfusion. In 2015, results from population-based registries estimated that 40% of patients with STEMI arrived at the emergency room via non-optimal pathways in France [10]. However, there are very few data on the factors that lead patients with STEMI to follow a non-optimal pathway before arriving at a CICU.

The objective of this study was to evaluate the proportion of patients with STEMI benefiting from an optimal care pathway, and to identify the key factors leading to this pathway.

Methods

Study design and setting

This study is based on the RESCAMIP registry; the RESCAMIP investigators are listed in Appendix A. RESCAMIP was a multicentre, prospective, multidisciplinary registry completed between May 2015 and May 2017 in Midi-Pyrénées by the Observatoire Régional des Urgences de Midi-Pyrénées (ORUMIP; Regional Observatory of Emergencies in Midi-Pyrénées), to evaluate the performance of the STEMI network. At the time of the study, Midi-Pyrénées was the second largest region in France (45,348 km^2 in area), covering both urban and rural areas. However, it has however a low density of inhabitants (about 3 million). The Midi-Pyrénées region includes one university hospital, eight MDCs, 24 MICUs, 36 emergency rooms and 12 CICUs, nine of which have interventional facilities. Among the eight administrative units of the Midi-Pyrénées region (each with its own MDC), ''Haute-Garonne'' represents 44% of the population, and has 45% of the catheterization laboratories.

Population

All patients treated for STEMI who met the inclusion and exclusion criteria were included in the study by the emergency practitioner who acted as the first medical contact. The STEMI was identified by electrocardiogram, not taking into account whether it was diagnosed during the prehospital period in an MICU or in an emergency room. Follow-up was carried out by the cardiologist in the CICU, with or without interventional facilities. Inclusion criteria were age $\geq$ 18 years and chest pain lasting for > 20 minutes, with ST-segment elevation on a 12-lead electrocardiogram > 0.1 mV in at least two peripherals leads or > 0.2 mV in at least two precordial leads or presumed new left bundle-branch block. Exclusion criteria were cardiac arrest at MICU arrival or during emergency room admission, unknown pathway/first medical contact and chest pain evolving for > 12 hours.

Data collection and variables

The following data were collected prospectively by the physician in charge, and recorded on a case report form or on the ORUMIP secured website: demographic data; risk factors (i.e. family history of cardiovascular disease [CVD], smoking, hypertension, diabetes or dyslipidaemia); personal history of CVD (i.e. coronary disease, ischaemic cerebral stroke or distal arteriopathy); clinical data; electrocardiogram; and care timeline. The chosen treatments, reperfusion strategies and adjunctive treatments implemented by the emergency physician were also recorded. For patients admitted to a CICU, the results of coronary angiography and angioplasty, and data on clinical outcomes occurring during hospitalization in the CICU were collected by the cardiologist in charge. A research assistant checked that case report form data were collected thoroughly. Patients were categorized according to whether they called an MDC or not. Patients who called an MDC were also categorized according to whether or not an MICU intervened. The

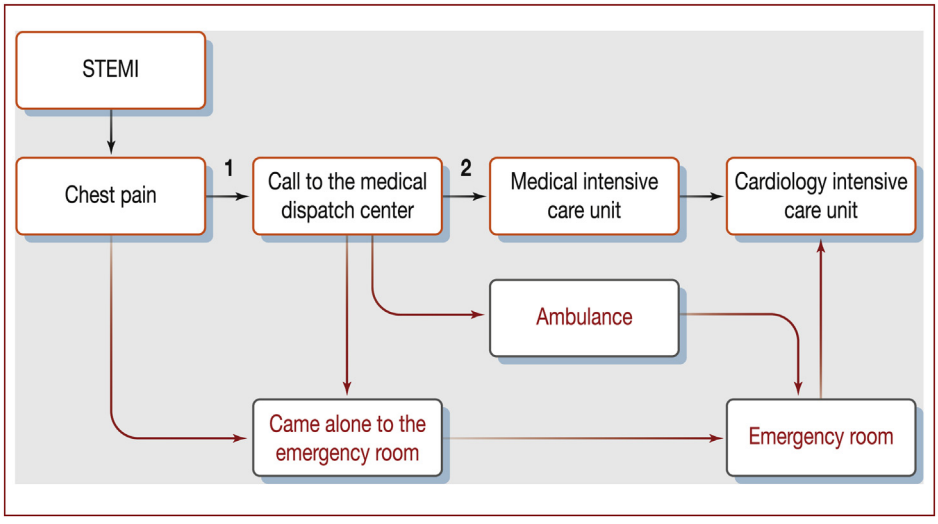

Figure 1. Optimal (black) and non-optimal (red) pathways to the Cardiology Intensive Care Unit for a patient with ST-segment elevation myocardial infarction (STEMI).

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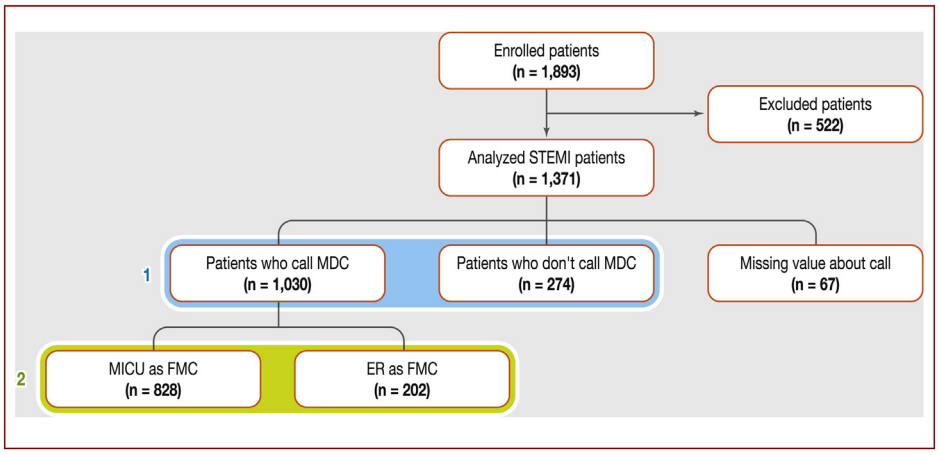

Figure 2. Study flowchart. ER: emergency room; FMC: first medical contact; MDC: medical dispatch centre; MICU: Mobile Intensive Care Unit; STEMI: ST-segment elevation myocardial infarction.

optimal pathway was confirmed when a patient called an MDC and had an MICU as first medical contact (Fig. 1). The other pathways were deemed non-optimal. The study was conducted by the ORUMIP, in accordance with the principles outlined in the Declaration of Helsinki. This study received the authorization of the French Data Protection Authority (CNIL) (registered number 914329).

Statistical analysis

Statistical analyses were conducted using STATA software, release 14 (StataCorp LP, College Station, TX, USA). Statistics are reported using means ± standard deviations and medians [interquartile ranges] for delays. Means were compared using Student's *t*-test or the non-parametric two-sample Mann-Whitney rank sum test. Percentages were compared using Pearson's χ^2 test or Fisher's exact test.

We proposed a two-step analysis to identify factors associated with an optimal care pathway (Fig. 1). First, we identified factors associated with calling the MDC when presenting chest pain (binary variable: call versus no call [referent]) (Fig A.1 in the Appendix); then we identified factors associated with the MDC sending an MICU (binary variable: MICU sent versus MICU not sent [referent]) (Fig A.2 in the Appendix).

We used multilevel logistic models [11], i.e. generalized linear mixed models with random intercepts, to allow the probability of calling an MDC (analysis 1) or of sending an MICU (analysis 2) to vary between the different MDCs. Indeed, each MDC belongs to a limited geographic area, with its own characteristics in terms of MICU availability and territory. We estimated the intraclass correlation coefficient (ICC), to assess the contribution of the between-MDC variance to the whole variance of the variable response. In other words, the ICC allows us to estimate how much of the probability of calling an MDC or sending an MICU variance is caused by the MDC effect, i.e. the differences between 1MDCs. We constructed an empty model to assess the crude MDC effect for analyses 1 and 2. These models were adjusted progressively for inferior level (patient) variables to test for compositional and contextual effect. Our models included all variables associated with these outcomes in bivariate analyses using the 0.2 threshold as the alpha risk (Tables A.1 and A.2 in the Appendix for details). Odds ratios (ORs) are reported with 95% confidence intervals (CIs).

Results

Characteristics of study population

Fig. 2 shows the study flowchart. A total of 1893 patients were registered between May 2015 and May 2017, and 522 patients were excluded for the following reasons: cardiac arrest at MICU arrival ($n = 24$); chest pain evolving for > 12 hours ($n = 157$); no STEMI on electrocardiogram ($n = 175$); and unknown pathway ($n = 166$). The baseline characteristics of the STEMI population ($n = 1371$) are presented in Table 1. Overall, 543 patients (40%) had a non-optimal pathway (Table A.3 in the Appendix). Patients with non-optimal pathways seem to have a longer period before receiving reperfusion therapy (median 101 minutes [interquartile range 64—160 minutes] vs 75 minutes [58—92 minutes]; $P < 0.05$), with 537 missing values.

Key factors leading to a call to the MDC

The first multilevel analysis (of factors associated with patients with STEMI calling the MDC) is shown in Table 2. Age > 65 years (OR 1.37, 95% CI 1.02—1.83), personal history of CVD (OR 1.9, 95% CI 1.22—2.96) and having cardiovascular risk factors (OR 1.84, 95% CI 1.735—2.5) were significantly associated with calling the MDC when presenting chest pain. Male sex seemed to be associated with not calling the MDC (OR 0.76, 95% CI 0.53—1.07). The ICC did not decrease when the model was adjusted for population variables, indicating that this difference was not caused by variability in population characteristics between the different administrative areas. We did not find any interactions between age and risk factors or history of CVD.

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Table 1 Baseline characteristics of patients with ST-segment elevation myocardial infarction who were analysed ($n = 1371$).

Men	1046 (76)
Age (years)	65 ± 15
Age < 65 years	700 (51)
No cardiovascular risk factors	388 (28)
Personal history of CVD	254 (19)
Time since symptom onset (minutes)[a]	91.5 [50—190]
First medical contact	
Cardiology	28 (2)
MICU	828 (60)
Emergency room	502 (37)
STEMI location[b]	
Anterior	508 (42)
Lateral	67 (6)
Inferior	607 (50)
Reperfusion strategy[c]	28 (2)
Primary PCI	1022 (81)
Thrombolysis	176 (14)
No reperfusion therapy	59 (5)
Delay from first medical contact to reperfusion therapy (minutes)[d]	80 [59—107]
< 120 minutes	663 (80)
In-hospital mortality	56 (4)

Data are expressed as number (%), mean ± standard deviation or median [interquartile range]. CVD: cardiovascular disease; MICU: Mobile Intensive Care Unit; PCI: percutaneous coronary intervention; STEMI: ST-segment elevation myocardial infarction.
[a] 251 missing values.
[b] 158 missing values.
[c] 114 missing values.
[d] 537 missing values.

Key factors leading to an MICU being the first medical contact

The second multilevel analysis (of factors associated with the MDC sending an MICU) is shown in Table 3. Male sex (OR 2.11, 95% CI 1.49—2.99) and having a personal history of CVD (OR 1.69, 95% CI 1.07—2.65) were significantly associated with having an MICU as the first medical contact. Age and cardiovascular risk factors did not seem to be associated with the decision to send an MICU, except for hypertension, which was associated with not sending an MICU (OR 0.68, 95% CI 0.47—0.97). As with the first analysis, the ICC did not decrease when the model was adjusted for lower level variables. We did not find any interactions between age, history of CVD and risk factors.

Discussion

Population, mortality and reperfusion strategy

The demographic characteristics of the patients included in this study were similar to those for patients with STEMI described in previous studies carried out in Midi-Pyrénées [12], in France [13] and in other European countries [14]. The 1-month mortality rate is unknown, but our in-hospital mortality rate estimation of 4% may be seen as an indicator of an acceptable performance of our STEMI network in light of data from European countries [2]. The proportion of patients receiving reperfusion therapy seems to have increased in our region between the ESTIM Registry [12] (2001—2003) and the RESCAMIP Registry (2015—2017): 10.7% of patients had no access to reperfusion therapy in 2001—2003 compared with only 5% now. However, the number of unknown reperfusion therapies has to be considered. Similarly, primary PCI is now the more common reperfusion therapy chosen: its use has increased from 37.3% during the ESTIM Registry to 68% during the RESCA+ Registry [15] (2008—2010 in an area of Midi-Pyrénées) to 81% now. Meanwhile, the proportion of patients with STEMI following an optimal pathway for reperfusion therapy has varied: the first medical contact was an MICU for 52.1% of patients in the ESTIM Registry (2001—2003); this proportion increased to 80% in the RESCA+ Registry (2008—2010), but decreased to 60% in the RESCAMIP Registry, which is similar to national tendencies [10]. Choosing to define ''having an MICU as first medical contact'' as the optimal pathway is relevant, as it usually leads to a shorter delay between diagnosis and reperfusion therapy. In our study, patients on the optimal pathway were treated in a median 75 minutes [interquartile range 58—92 minutes] versus 101 minutes [64—160 minutes]

Table 2 Multilevel analysis of factors associated with calling the medical dispatch centre.

	Model 1 empty ($n = 1304$)	Model 1A ($n = 1304$)	Model 1B ($n = 1304$)	Model 1 full ($n = 1304$)
Factors				
Age > 65 years		1.40 (1.06—1.85)		1.37 (1.02—1.83)
Male sex		0.79 (0.56—1.12)		0.76 (0.53—1.07)
Personal history of CVD			2.03 (1.31—3.12)	1.9 (1.22—2.96)
History of cardiovascular risk factors			1.74 (1.29—2.35)	1.84 (1.35—2.5)
Variance (SE) between MDCs	0.34 (0.12)	0.35 (0.13)	0.36 (0.13)	0.37 (0.13)
ICC (SE)	0.034 (0.02)	0.036 (0.02)	0.038 (0.03)	0.04 (0.03)

Data are expressed as odds ratio (95% confidence interval) unless otherwise indicated. CVD: cardiovascular disease; ICC: intraclass correlation coefficient; MDC: medical dispatch centre; SE: standard error.

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Table 3 Multilevel analysis of factors associated with sending a Mobile Intensive Care Unit for chest pain in patients with ST-segment elevation myocardial infarction.

	Model 2 empty ($n = 1030$)	Model 2A ($n = 1030$)	Model 2B ($n = 1030$)	Model 2 full ($n = 1030$)
Age > 65 years		0.83 (0.6—1.15)		0.82 (0.56—1.2)
Male sex		2.21 (1.57—3.11)		2.11 (1.49—2.99)
Personal history of CVD			1.8 (1.15—2.81)	1.69 (1.07—2.65)
Cardiovascular risk factors				
Family history of CVD			1.23 (0.75—2.01)	1.21 (0.73—2)
Smoking			1.1 (0.78—1.56)	0.91 (0.62—1.33)
Hypertension			0.62 (0.44—0.87)	0.68 (0.47—0.97)
Diabetes			0.83 (0.52—1.32)	0.82 (0.52—1.31)
Hyperlipidaemia			1.35 (0.89—2.05)	1.41 (0.92—2.16)
Variance (SE) between MDCs	0.32 (0.19)	0.34 (0.19)	0.34 (0.2)	0.35 (0.2)
ICC (SE)	0.03 (0.03)	0.03 (0.04)	0.03 (0.04)	0.04 (0.04)

Data are expressed as odds ratio (95% confidence interval) unless otherwise indicated. CVD: cardiovascular disease; ICC: intraclass correlation coefficient; MDC: medical dispatch centre; SE: standard error.

for patients on non-optimal pathways ($P < 0.05$). This is in accordance with previous results [16—18].

Who calls the MDC?

In France, prevention campaigns advocate dialing ''15'' (i.e. the unique number for MDCs) when presenting chest pain. These campaigns were prominent during the 2000s, and resulted in a reduction in the delay to reperfusion therapy [19]; they are performed by the different French administrative units. We saw in analysis 1 that the ICC between MDCs (i.e. between administrative units) was not corrected by the adjustment for population characteristics, suggesting that there was an MDC effect, albeit a small one. This effect may be linked to the difference in prevention campaigns and population education between regions. Having a history of CVD or known risk factors was, as expected, associated with calling the MDC, showing that patients are aware of the risk they have of presenting cardiovascular events. Younger patients were less prone to dial ''15'' when feeling chest pain, independent of risk factors and CVD history. New p1revention campaigns should also pay special attention to this younger population without known risk factors, e.g. at their workplace.

Why send an MICU?

It is important to note that STEMI accounted for only 4.5% of the calls for chest pain answered by French MDCs in a study carried out in 2013 [20]. We tried to evaluate the factors associated with miscalculations in the evaluation of the STEMI probability. The increase in the number of calls to MDCs over the past decade [21] affected the MDCs in our study area differently [22]. This may explain, in part, the variation between MDCs in the crude propensity to send an MICU for a patient presenting chest pain.

In our study, women with STEMI were more at risk of not having an MICU as their first medical contact, compared with men. This might be explained by the ''atypical'' presentation of STEMI chest pain in women [23], leading to an underestimation of the probability of STEMI by the MDC doctors.

Although having cardiovascular risk factors has been associated with sending an MICU when a patient feels chest pain in the literature [24], in our study, only hypertension was associated with not sending an MICU.

This study shows the difficulty of evaluating the probability of STEMI over the telephone.

Study limitations

The principal limitation of our study concerned the analysis of factors associated with sending MICUs. We lacked information about the organization of the MDCs, such as the number of available MICUs at the time of the call, or the number of calls answered by emergency practitioners or medical dispatching assistants [25]. Those factors may help to explain the variance between centres. Factors linked to the patients should also give us a better understanding of potential miscalculations regarding sending an MICU. Chest pain characteristics and the existence of associated dyspnoea are important variables in identifying STEMI [26] and STEMI with risk of cardiac arrest [27], and could be researched when the patient is calling the MDC. We had many missing values in terms of delays and distances between the patient and the MICU and CICU, which means that we must use the information provided by those variables carefully.

Conclusions

Compared with previous results, the proportion of patients with STEMI undergoing a non-optimal pathway to reperfusion therapy has increased, reaching 40% in our area. Patients who did not have an MICU as first medical contact seemed to have to wait longer before receiving reperfusion therapy. We must remind young patients without CVD or risk factors to call the unique emergency number (i.e. ''15'') when presenting chest pain. MDC emergency practitioners should also be more careful when women call about chest pain. Strategies for sending MICUs when a patient calls for

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chest pain must be reconsidered, because of the difficulty in identifying STEMI using only data about known risk factors.

Sources of funding

None.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.acvd.2019.01.004.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] Townsend N, Wilson L, Bhatnagar P, Wickramasinghe K, Rayner M, Nichols M. Cardiovascular disease in Europe: epidemiological update 2016. Eur Heart J 2016;37:3232—45.
[2] Kristensen SD, Laut KG, Fajadet J, et al. Reperfusion therapy for ST elevation acute myocardial infarction 2010/2011: current status in 37 ESC countries. Eur Heart J 2014;35:1957—70.
[3] Nallamothu BK, Normand SL, Wang Y, et al. Relation between door-to-balloon times and mortality after primary percutaneous coronary intervention over time: a retrospective study. Lancet 2015;385:1114—22.
[4] Terkelsen CJ, Sorensen JT, Maeng M, et al. System delay and mortality among patients with STEMI treated with primary percutaneous coronary intervention. JAMA 2010;304:763—71.
[5] Ibanez B, James S, Agewall S, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 2018;39:119—77.
[6] Windecker S, Kolh P, Alfonso F, et al. 2014 ESC/EACTS Guidelines on myocardial revascularization: The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). Developed with the special contribution of the European Association of Percutaneous Cardiovascular Interventions (EAPCI). Eur Heart J 2014;35:2541—619.
[7] Kalla K, Christ G, Karnik R, et al. Implementation of guidelines improves the standard of care: the Viennese registry on reperfusion strategies in ST-elevation myocardial infarction (Vienna STEMI registry). Circulation 2006;113:2398—405.
[8] Schiele F, Gale CP, Bonnefoy E, et al. Quality indicators for acute myocardial infarction: A position paper of the Acute Cardiovascular Care Association. Eur Heart J Acute Cardiovasc Care 2017;6:34—59.
[9] Haute Autorité de, Santé. Recommandations Professionnelles: Prise en charge de l'infarctus du myocarde à la phase aiguë en dehors des services de cardiologie; 2007, https://www.has-sante.fr/portail/upload/docs/application/pdf/2012-11/05c01_conf_consensus_infarctus_myocarde_recos_courtes.pdf [accessed date 9th June 2018].
[10] Belle L, Cayla G, Cottin Y, et al. French Registry on Acute ST-elevation and non-ST-elevation Myocardial Infarction 2015 (FAST-MI 2015). Design and baseline data. Arch Cardiovasc Dis 2017;110:366—78.
[11] Merlo J, Chaix B, Ohlsson H, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. J Epidemiol Community Health 2006;60:290—7.
[12] Charpentier S, Sagnes-Raffy C, Cournot M, et al. Determinants and prognostic impact of compliance with guidelines in reperfusion therapy for ST-segment elevation myocardial infarction: results from the ESTIM Midi-Pyrenees Area. Arch Cardiovasc Dis 2009;102:387—96.
[13] Puymirat E, Simon T, Steg PG, et al. Association of changes in clinical characteristics and management with improvement in survival among patients with ST-elevation myocardial infarction. JAMA 2012;308:998—1006.
[14] Pedersen F, Butrymovich V, Kelbaek H, et al. Short- and long-term cause of death in patients treated with primary PCI for STEMI. J Am Coll Cardiol 2014;64:2101—8.
[15] Sandouk A, Ducasse JL, Grolleau S, et al. Compliance with guidelines in patients with ST-segment elevation myocardial infarction after implementation of specific guidelines for emergency care: results of RESCA + 31 registry. Arch Cardiovasc Dis 2012;105:262—70.
[16] Le May MR, So DY, Dionne R, et al. A citywide protocol for primary PCI in ST-segment elevation myocardial infarction. N Engl J Med 2008;358:231—40.
[17] Steg PG, Cambou JP, Goldstein P, et al. Bypassing the emergency room reduces delays and mortality in ST elevation myocardial infarction: the USIC 2000 registry. Heart 2006;92:1378—83.
[18] Terkelsen CJ, Lassen JF, Norgaard BL, et al. Reduction of treatment delay in patients with ST-elevation myocardial infarction: impact of pre-hospital diagnosis and direct referral to primary percutanous coronary intervention. Eur Heart J 2005;26:770—7.
[19] Chevalier V, Alauze C, Soland V, Cuny J, Goldstein P. [Impact of a public-directed media campaign on emergency call to a mobile intensive care units center for acute chest pain]. Ann Cardiol Angeiol (Paris) 2003;52:150—8.
[20] Charpentier S, Beaune S, Joly LM, et al. Management of chest pain in the French emergency healthcare system: the prospective observational EPIDOULTHO study. Eur J Emerg Med 2018;25:404—10.
[21] Pittet V, Burnand B, Yersin B, Carron PN. Trends of prehospital emergency medical services activity over 10 years: a population-based registry analysis. BMC Health Serv Res 2014;14:380.
[22] ORUMI.P. Panorama 2015 de la région Midi-Pyrénées; 2016, https://www.orumip.fr/2016/06/panorama-2015-de-la-region-midi-pyrenees/[accessed date: 9th June 2018].
[23] Regitz-Zagrosek V, Oertelt-Prigione S, Prescott E, et al. Gender in cardiovascular diseases: impact on clinical manifestations, management, and outcomes. Eur Heart J 2016;37:24—34.
[24] Manzo-Silberman S, Assez N, Vivien B, et al. Management of non-traumatic chest pain by the French Emergency Medical System: Insights from the DOLORES registry. Arch Cardiovasc Dis 2015;108:181—8.
[25] Goix L, Petrovic T, Reuter P-G, et al. [Correlation between a Samu-Center 15 response quality and medical dispatching assistants workforce — The QRAARM Study]. Ann Fr Med Urgence 2018;8:108—12.
[26] Goodacre S, Locker T, Morris F, Campbell S. How useful are clinical features in the diagnosis of acute, undifferentiated chest pain? Acad Emerg Med 2002;9:203—8.
[27] Karam N, Bataille S, Marijon E, et al. Identifying Patients at Risk for Prehospital Sudden Cardiac Arrest at the Early Phase of Myocardial Infarction: The e-MUST Study (Evaluation en Medecine d'Urgence des Strategies Therapeutiques des infarctus du myocarde). Circulation 2016;134:2074—83.

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