

The current clinical practice for management of post-infarction ventricular septal rupture: a European survey

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Aims

Many historical and recent reports showed that post-infarction ventricular septal rupture (VSR) represents a life-threatening condition and the strategy to optimally manage it remains undefined. Therefore, disparate treatment policies among different centres with variable results are often described. We analysed data from European centres to capture the current clinical practice in VSR management.

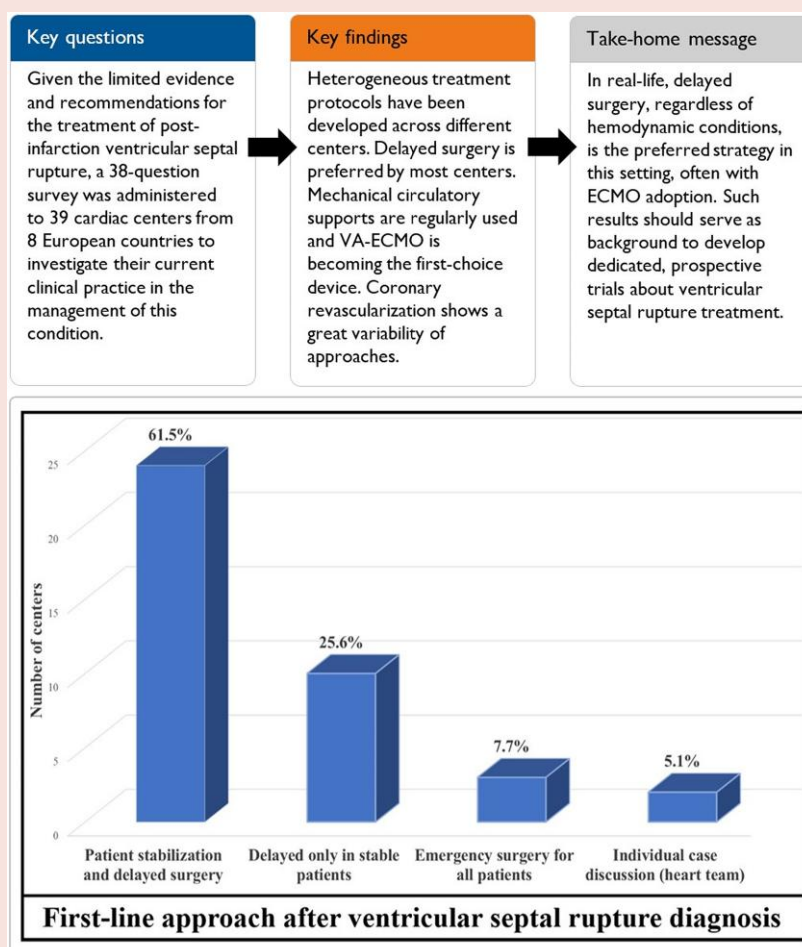
Methods and results

Thirty-nine centres belonging to eight European countries participated in a survey, filling a digital form of 38 questions from April to October 2022, to collect information about all the aspects of VSR treatment. Most centres encounter 1–5 VSR cases/year. Surgery remains the treatment of choice over percutaneous closure (71.8% vs. 28.2%). A delayed repair represents the preferred approach (87.2%). Haemodynamic conditions influence the management in almost all centres, although some try to achieve patients stabilization and delayed surgery even in cardiogenic shock. Although 33.3% of centres do not perform coronarography in unstable patients, revascularization approaches are widely variable. Most centres adopt mechanical circulatory support (MCS), mostly extracorporeal membrane oxygenation, especially pre-operatively to stabilize patients and achieve delayed repair. Post-operatively, such MCS are more often adopted in patients with ventricular dysfunction.

Conclusion

In real-life, delayed surgery, regardless of the haemodynamic conditions, is the preferred strategy for VSR management in Europe. Extracorporeal membrane oxygenation is becoming the most frequently adopted MCS as bridge-to-operation. This survey provides a useful background to develop dedicated, prospective studies to strengthen the current evidence on VSR treatment and to help improving its currently unsatisfactory outcomes.

Graphical Abstract



First-line approach for management of post-acute myocardial infarction ventricular septal rupture according to interviewed centres.

Keywords

Ventricular septal rupture • Acute myocardial infarction • Mechanical complication • Mechanical circulatory support • Extracorporeal membrane oxygenation • Cardiogenic shock

Introduction

Ventricular septal rupture (VSR) represents a life-threatening complication occurring in about 0.5% of acute myocardial infarction (AMI) cases.¹ Even with prompt treatment, either surgical or percutaneous, it is characterized by an in-hospital mortality approaching 40%, which is even higher in patients presenting with cardiogenic shock (CS).^{1,2}

Given its low incidence and high mortality, evidence about VSR treatment is limited to small, single-centre experiences or national registries, probably justifying the weak and, sometimes, controversial recommendations provided by the current guidelines.^{2–5} The Mechanical Complications of Acute Myocardial Infarction: an International Multicenter Cohort (CAUTION) study has provided further insights about VSR.⁶ Nevertheless, such limits have led to highly heterogeneous management protocols across different centres, especially concerning the timing of repair and possible adoption of mechanical circulatory support (MCS).^{7,8}

We sought to investigate the modern clinical practice about VSR management by running a survey across European centres.

Methods

From April to October 2022, we invited 46 cardiac centres to conduct a descriptive survey on their clinical practice for post-infarction VSR management. Centres were identified from the CAUTION database and extended to a large group of Spanish centres coordinated by A.A.S. Thirty-nine (84.8%) centres from 8 countries responded (Figure 1). Thirty-eight questions have been administered through a web form, automatically collecting the replies regarding general information about the centres, and any aspect of their current treatment protocols for VSR. Questions referred to all patients aged >18 years admitted with a post-AMI VSR diagnosis, independently from the treatment provided. Moreover, we sought to investigate

the willingness of each centre to participate to a prospective trial, addressing key, controversial aspects of VSR management.

Given the nature of the survey and the lack of individual patient data, neither ethical committee approval nor patient informed consent was required.

Results

The answers were 100% complete from all centres. Most centres were Spanish (51.3%) and Italian (20.5%). Table 1 enlists the main questions of the survey. Although most involved centres had large patients referral, the vast majority steadily managed 1–5 VSR cases/year. The shock team was involved in 41.0% of centres.

Once admitted, patients were almost equally transferred either into intensive care or coronary care units. As a general policy, most centres preferred an initial patient stabilization followed by delayed surgery (61.5%). In >70% of centres, surgery represented the first-line treatment for all patients, although the remaining considered percutaneous closure, when feasible. The timing of surgery was widely variable, although most centres agreed that a 7–10-day delay to schedule VSR repair would be ideal.

In most centres, haemodynamic stability impacted on timing of surgery. Indeed, while stable patients underwent delayed surgery in almost all centres, in subjects presenting with impending haemodynamic instability, still two-thirds of centres generally instituted MCS to reach patients stabilization and delay surgery anyway. Moreover, even with CS, almost 75% of centres preferred a first attempt of MCS to revert CS and reach delayed repair.

Coronarography was performed routinely in two-thirds of the centres, regardless of haemodynamic conditions. Figure 2A shows the widely variable preferences concerning coronary revascularization in this setting.

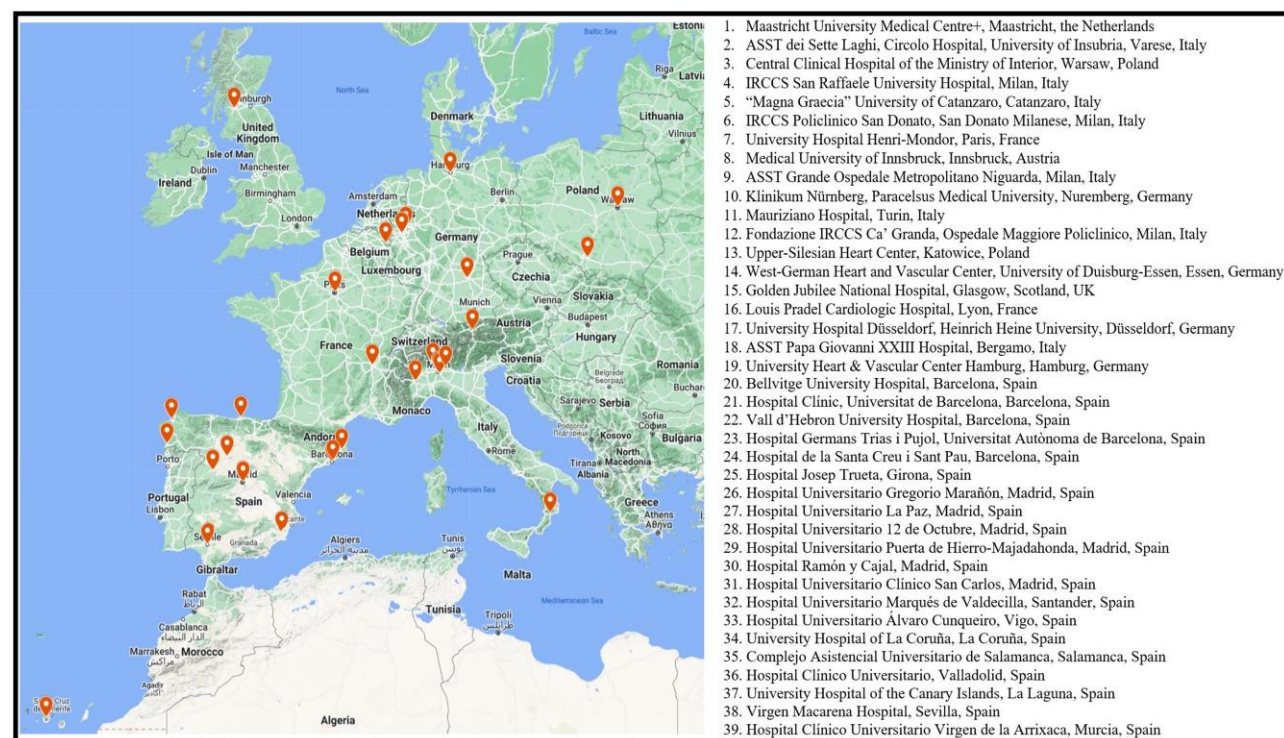


Figure 1 Distribution of European centres participating to the survey.

Table 1 Main questions about the management of ventricular septal rupture patients

Questions	Answers
<i>General management</i>	
How many cases do you usually encounter per year?	
• 1-To-5	28 (71.8%)
• 6-To-10	9 (23.1%)
• More than 10	2 (5.1%)
What is your opinion about the trend of incidence in the last years?	
• Increase	10 (25.6%)
• Stable	23 (59.0%)
• Decrease	6 (15.4%)
Do you always involve the Shock Team?	
• Yes	16 (41.0%)
• Never	10 (25.6%)
• Not always	13 (33.3%)
If the patient is awake, where do you hospitalize him/her?	
• ICU	19 (48.7%)
• CCU as long as haemodynamically stable	19 (48.7%)
• CCU and ICU are shared	1 (2.6%)
Which is your approach for a patient with VSR diagnosis?	
• Patient stabilization and delayed surgery	24 (61.5%)
• Delayed surgery only in stable patients	10 (25.6%)
• Emergency for all	3 (7.7%)
• Individual cases (Heart Team discussion)	2 (5.1%)
Which is the first-line treatment you offer to VSR patients?	
• Surgery for all	28 (71.8%)
• Percutaneous for non-surgical candidates	7 (17.9%)
• Percutaneous, when feasible	4 (10.3%)
In case of delayed surgery, which is the timing by which you operate?	
• After 5 days, preferentially	9 (23.1%)
• After 7 days, preferentially	12 (30.8%)
• After 10 days, preferentially	6 (15.4%)
• After 14 days, preferentially	2 (5.1%)
• As stability is reached	3 (7.7%)
• As soon as cardiogenic shock recovers	5 (12.8%)
• If MCS fails haemodynamic recovery	2 (5.1%)
Which do you think is the ideal timing for surgery?	
• Delayed surgery for 7–10 days	28 (71.8%)
• Delayed surgery for 2 weeks	7 (17.9%)
• Immediate surgery anyway	4 (10.3%)
Do you perform coronary angiography in all patients?	
• Yes	26 (66.7%)
• No, only in haemodynamically stable patients	13 (33.3%)
<i>Patients subgroups</i>	
Does haemodynamic stability impact on the timing of surgery?	
• Yes	33 (84.6%)
• No	6 (15.4%)
Which is your preferred approach for stable patients?	
• Delayed surgery with MCS to unload ventricles for all patients	19 (48.7%)
• Delayed surgery without MCS, if not needed	16 (41.0%)
• Delayed surgery with MCS in some patients	1 (2.6%)

Continued

Table 1 Continued

Questions	Answers
• Emergency surgery	3 (7.7%)
Which is your preferred approach for patients with impending haemodynamic instability?	
• MCS to reach patient stabilization and delayed surgery	26 (66.7%)
• Emergent surgery after early MCS	9 (23.1%)
• Emergent surgery without MCS	3 (7.7%)
• Pharmacological therapy and emergent surgery if failed	1 (2.6%)
Which is your preferred approach for patients with cardiogenic shock?	
• MCS to reverse shock and reach delayed surgery	29 (74.4%)
• Emergent surgery early after MCS implant	6 (15.4%)
• Emergent surgery without MCS	4 (10.3%)
<i>Pre-operative MCS</i>	
Do you routinely use IABP?	
• Yes	26 (66.7%)
• No	7 (17.9%)
• Only in stable patients, for protected bridge to delayed surgery	5 (12.8%)
• Only in unstable patients, as alternative to emergent surgery	1 (2.6%)
Do you routinely adopt other MCS devices?	
• Yes	19 (48.7%)
• No	20 (51.3%)
Do you routinely adopt MCS devices as bridge to surgery?	
• Yes	28 (71.8%)
• No	11 (28.2%)
For which patients?	
• All patients	9 (23.1%)
• Patients with impending haemodynamic instability	21 (53.8%)
• Patients with overt cardiogenic shock	9 (23.1%)
Which is your first aim of pre-operative MCS? ^a	
• Haemodynamic stabilization/recovery from shock	34 (87.2%)
• Tissue maturation	17 (43.6%)
• Ventricular unloading and protection even in stable patients	13 (33.3%)
Do you prefer some MCS combination?	
• Yes	34 (87.2%)
• No	5 (12.8%)
Which type of MCS combination do you adopt preferentially?	
• VA-ECMO + IABP	21 (53.8%)
• VA-ECMO + Impella	11 (28.2%)
• VA-ECMO + IABP + pulmonary artery cannula	7 (17.9%)
During MCS support, which is the general setting you routinely choose?	
• Intubated patients	23 (59.0%)
• Awake patients with sedation	15 (38.4%)
• It depends on haemodynamic status	1 (2.6%)
Which is your preferred approach for VA-ECMO implantation?	
• Percutaneous	26 (66.7%)
• Surgical	13 (33.3%)

Continued

Table 1 Continued

Questions	Answers
For Impella, which is your preferred device?	
• Impella CP	24 (61.5%)
• Impella 2.5	4 (10.3%)
• Impella 5.0	6 (15.4%)
• Impella 5.5	1 (2.6%)
• No experience with Impella	4 (10.3%)
Post-operative MCS	
Do you generally adopt MC post-operatively?	
• Yes	26 (66.7%)
• No	13 (33.3%)
Which is your indication? ^a	
• Prophylactically	15 (38.5%)
• Significant depression of ventricular function	15 (38.5%)
• Impossible cardiopulmonary bypass weaning	25 (64.1%)
Do you consider inappropriate the routine adoption of post-operative MCS as prophylactic support?	
• Yes	12 (30.8%)
• No	27 (69.2%)
How long should MCS be continued?	
• Remove as soon as possible	20 (51.3%)
• At least for 3–5 days	13 (33.3%)
• At least 1 week, if no complications occur	6 (15.4%)
Do you sometimes consider selective right ventricular support?	
• Yes	19 (48.7%)
• No, we prefer biventricular support anyway	20 (51.3%)

^aMore than one answer allowed.

CCU, coronary care unit; IABP, intra-aortic balloon pump; ICU, intensive care unit; MCS, mechanical circulatory support; RVAD, right ventricular assist device; VA-ECMO, veno-arterial extracorporeal membrane oxygenation; VSR, ventricular septal rupture.

Intra-aortic balloon pump (IABP) was routinely adopted before intervention in two-thirds of centres. Moreover, most centres regularly used other MCS devices as a bridge to surgery, although >50% of them only in case of impending haemodynamic instability. The rationale of pre-operative MCS were shared by most centres, especially concerning haemodynamic stabilization and recovery from CS. *Figure 2B* shows the preferences of pre-operative MCS devices, with extracorporeal membrane oxygenation (ECMO) representing the most diffused one.

Post-operative VSR management showed a wider variability of protocols, starting from the routine adoption of MCS, considered inappropriate by almost one-third of centres, if not necessarily due to failed cardiopulmonary bypass weaning. *Figure 2C* shows the preferences of post-operative MCS devices. Selective right ventricular MCS in case of need was chosen in about half of centres; the preferred devices are shown in *Figure 2D*.

All centres declared their interest for a prospective randomized controlled trial aimed at evaluating pre-operative VSR management, albeit with some distinctions in patients' inclusion criteria.

Discussion

The low incidence and high mortality of post-AMI VSR have limited the possibilities to develop dedicated trials, reducing the evidence to

single-centre experiences or national registries.^{1,2} This was mirrored by the weak recommendations provided by the current guidelines.^{4,5} Recent data provided insights about the preferential choice of delayed VSR repair, whenever possible, the adoption of various MCS devices, pre- and post-operatively, and the role of percutaneous closure as an alternative strategy, as shown in the recent American Heart Association statement on the management of post-AMI mechanical complications and UK national registry.^{2,3,6–9} The CAUTION study has contributed to increase the evidence on the surgical treatment of VSR, by analysing 475 patients collected from >25 centres worldwide, albeit with the limits of retrospective studies.⁶

Due to the weak recommendations available, most centres have developed updated, dedicated protocols to manage these patients. The present survey represents a further step to investigate VSR, capturing the real-life clinical practice and providing useful insights on how it is treated nowadays in most European centres, involving cardiac surgeons, cardiologists, and intensivists.

Almost all the centres declared to prefer a delayed treatment, supporting the advantages of such planning over emergent surgery, almost unanimously described by the recent literature.^{2,4,6,9} The different types of presentation deserve great consideration, since most patients are admitted in labile haemodynamic conditions or in CS and a risk profile-based approach could be advisable.^{1,2,6} Nevertheless, some centres still try to achieve patient stabilization and delayed repair, possibly with MCS adoption, even in most critical subjects.^{7,8}

Although evidence is currently lacking to support such wide pre-operative adoption of advanced MCS other than IABP, as in the current survey, progressively more reports showed the central role of MCS to achieve haemodynamic stabilization or prevent deterioration in such a delicate setting, partially justifying their growing adoption.^{4,5,7–9} Thus, it seems reasonable that large European centres who are confident with certain supports developed updated protocols including MCS (especially ECMO) in VSR management. However, it is also important to balance the advantages of MCS utilization to temporize surgery and the potential MCS-related complications that have also been described.⁸ Differently, relatively few centres systematically adopt MCS post-operatively. However, it should be noted that most in-hospital deaths in VSR are due to low cardiac output syndrome, and this may represent a rationale to promote an MCS-based protected peri-operative course, at least in more delicate patients.^{6–8}

Although VSR is traditionally considered a surgical-only condition, percutaneous closure is gaining credits, both for patients deemed inoperable and as first choice in technically feasible cases.^{3,9} The UK national registry has recently shown for percutaneous VSR closure results sometimes comparable to surgery in selected patients.^{3,9} However, data are still limited in this regard, and further investigations are advised to identify the ideal conditions for the percutaneous approach. Unfortunately, we could not retrieve information about whether all centres of this survey have availability to perform percutaneous VSR closure.

Despite the shock team has been shown to be important in this setting, <50% of centres involve such organization, probably because the limited number of VSR cases/year might underscore the importance of structured, multidisciplinary treatment pathways for these patients.⁹

It is also interesting to notice that one-third of centres do not perform coronarography unless patients are haemodynamically stable.¹⁰ This approach inevitably impacts the possibility of planning revascularization in this AMI-related complication and analysing its potential impact on early and late survival.¹⁰ Nevertheless, the revascularization approaches widely vary across the centres.

Given the current evidence and heterogeneous, real-life management of this condition, the present survey represents a first step towards a more comprehensive understanding of applied strategies in post-AMI VSR treatment.^{4,5,9} Its relevance also relies on the number and extension of participating centres.

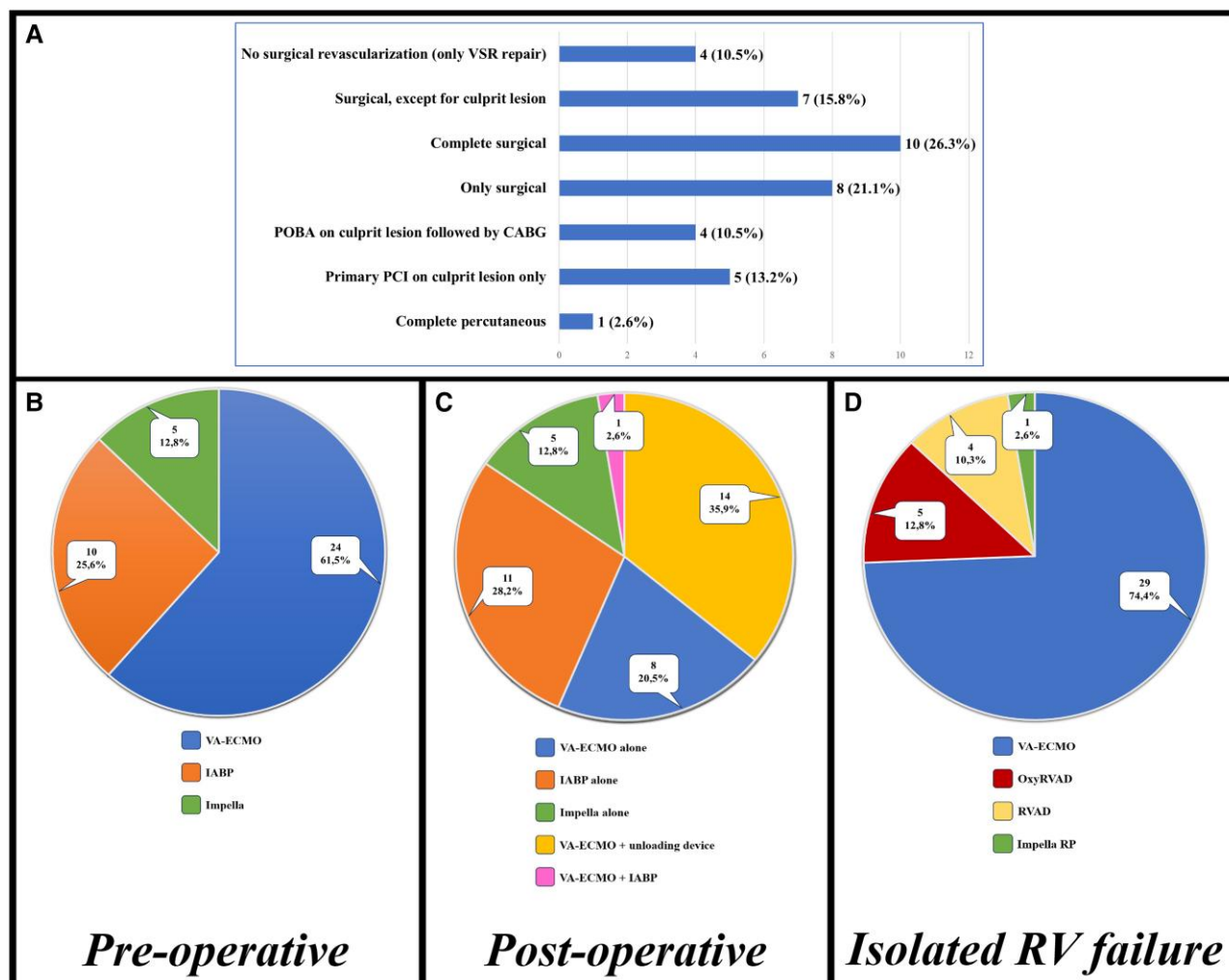


Figure 2 (A) Preferred approach for coronary revascularization. (B) Pre-operative MCS of choice. (C) Post-operative MCS of choice. (D) MCS for isolated right ventricular failure. Numbers and percentages of interviewed centres are presented. CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention; POBA, plain old balloon angioplasty; RVAD, right ventricular assist device; VA-ECMO, veno-arterial extracorporeal membrane oxygenation; VSR, ventricular septal rupture; IABP, intra-aortic balloon pump.

Finally, this survey may serve as a useful background to develop prospective studies, taking into consideration the most advanced technologies available nowadays, possibly contributing to strengthen evidence and improve the still unacceptably unfavourable outcomes of VSR.

Limitations

This survey presents the limitations of retrospective data collection. Relying on self-reporting and collecting generalized information from each centre, the results may not represent the exact procedures applied to all patients, but rather provide a hint of their preferred approach. Although involving 39 European centres provided useful insights on the current VSR treatment, the uneven centres distribution (mostly from Spain and Italy) limits the generalizability of the results. Moreover, most centres manage 1–5 VSR cases/year, thereby limiting the validity and efficacy testing of management protocols. Therefore, the current results should be only considered as

hypothesis-generating, despite providing a relevant report about real-life VSR management across Europe.

Conclusions

The present survey shows an updated picture of the heterogeneous clinical practice characterizing post-AMI VSR management among 39 European centres. Such data provide interesting insights about the ongoing adoption of advanced technologies and treatment protocols to optimize the outcomes of VSR, independently from the current guidelines recommendations, which still rely on outdated data and weak evidence. This study represents a useful background to develop dedicated, prospective studies to better understand the most effective management options for VSR patients, to possibly support an update in the international recommendations, and hopefully improve the currently unsatisfactory survival.

Lead author biography



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Data availability

The data underlying this article are available in the article.

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