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## SCIENTIFIC EDITORIAL

# Can we still die from acute myocardial infarction in 2020? Reflex mobile cardiac assistance unit or local team for ECMO implantation?



*Peut-on encore mourir d'infarctus du myocarde en 2020 ?*

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## Background

Whereas mortality as a result of acute myocardial infarction (MI) continues to decrease in France and developed countries, and MI is close to being considered a “benign” disease in many cardiac intensive care units, the mortality rate for acute MI still exists. In the FAST-MI registry [1], refractory cardiac arrest (RCA) often occurred during the acute phase of an MI. Although revascularization has lowered mortality rates considerably, the occurrence of early RCA is associated with a significantly high mortality rate of almost 100%. Apart from MI, acute myocarditis and takotsubo syndrome can also be associated with very rapid and severe heart failure, leading to RCA.

*Abbreviations:* Cathlab, catheterization laboratory; ECMO, extracorporeal membrane oxygenation; MI, myocardial infarction; MICU, mobile intensive care unit; RCA, refractory cardiac arrest; UMAC, unité mobile d'assistance circulatoire (mobile cardiac assistance unit).

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The initial strategy proposed to decrease the risk of mortality in these cases is the “load and go” strategy, in which the patient is transferred as soon as possible to a tertiary centre for implementation of extracorporeal life support. This strategy has shown good results in severe cardiogenic shock in some expert centres [2,3]. However, there are several limitations: only patients very near the tertiary centre can benefit from this technique and the question of quality of cardiopulmonary resuscitation and safety during transportation is problematic. Furthermore, if many patients go directly to the hospital’s emergency unit, availability can be a problem in the cardiac surgical centre. In addition, the cardiac surgical centre can be far away, delaying reperfusion therapy in the case of MI, which may lead to a significant time loss. Cardiogenic shock can appear a few hours after an MI, and can be related to failure of reperfusion therapy. Finally, in the case of RCA, extracorporeal membrane oxygenation (ECMO) should be implanted without delay.

Therefore, alternative strategies have been proposed for RCA: (1) mobile units where ECMO is implanted by an experienced team who go to the patient immediately; and (2) a trained team, usually including an interventional cardiologist, implanting ECMO directly on-site—made possible because the device is now compatible with transcatheter insertion.

These two solutions are appealing. However, organization is mandatory, and there are several limitations [4]. The purpose of this editorial is to present the advantages and disadvantages of each approach, and to help to determine the best solution for each centre.

## Implantation of ECMO in a non-surgical centre

The implantation of ECMO has progressed significantly. Although the surgical approach was mandatory before, the technical progression of the device now allows implantation of venoarterial ECMO to be considered outside the operating theatre. Since 2005, ECMO has been implanted in patients with RCA using surgical cannulation, performed by medical doctors who have been trained in this technique by vascular surgeons [2]. In France, we have substantial experience of medical transfer in mobile intensive care units (MICUs) for very serious patients, coordinated by the Services d’Aide Médicale Urgente (SAMU). The concept, which allows a specific ECMO team (unité mobile d’assistance circulatoire [UMAC]; mobile cardiac assistance unit) to be sent to hospitals without ECMO capacity, was developed in order to insert ECMO and immediately transfer the patient to a tertiary centre. Since 2012, patients with RCA have received cannulation for ECMO support by the percutaneous technique, performed by interventional cardiologists [5,6].

Table 1 shows the advantages, disadvantages and potential gap that needs to be filled when considering ECMO implantation in a centre without cardiac surgery.

## Direct implantation by the catheterization laboratory team

ECMO can be implanted through a “classical” Seldinger technique, using the femoral approach. However, the cannula size is large, with a 21–23 French for the venous route and a 15–16 French for the arterial route. After initiation of ECMO support, distal perfusion of the cannulated femoral artery is generally insured by an antegrade catheter, as a result of usual chronic low flow in the distal limb. The technique has now improved, with a delay between decision and ECMO of approximately < 15 minutes in an experienced centre [7]. If coronary angiography and/or angioplasty is needed, it can be performed at the same time, without any delay and without moving the patient.

Although this approach is very rapid, there are several warnings that need to be noted (Table 2). The most crucial point is probably the proper selection of patients, because of the potentially widespread availability of the technique. It is unthinkable that patients with no chance of recovery or who cannot access a heart transplant or artificial heart will be selected. This is all the more crucial, as the cost of this technology is high—including both the cost of device and the energy invested by the staff in such an approach. Another limitation is the need for experience; even more so in RCA, where there is less time to prepare implantation. Therefore, a precise protocol needs to be formulated, with a checklist and regular training. After ECMO implantation, the team needs solid experience to care for the patient. A high level of collaboration with motivated intensive care staff is mandatory, because these patients are very unstable and need to be treated adequately (massive filling, inotrope drugs, treatment of vasoplegia, sedation, mechanical ventilation, etc.). For such an approach, two points are essential: local willingness to want to become expert; and split implantation and care of the patient, as they have to be transferred after ECMO implantation.

## Mobile units

This concept was developed in Paris after the decline of the “load and go” strategy, and has now been developed in many centres in France and worldwide. The idea is to send the UMAC team at the time of first-line treatment of the cardiac arrest (conventional cardiopulmonary resuscitation). Initially, the UMAC team comprised a cardiac surgeon, a perfusionist, a theatre nurse and, sometimes, an anaesthesiologist. UMACs have been established in many parts of the country. No major complications have been reported during transportation involving very long transfers (up to 11 hours of flight using a regular airplane company) [8]. One of the main problems is logistical issues, which can be as simple as the permanent need for a power supply. However, several problems did occur during the early stages of implementation. First, the delay to UMAC intervention can be significantly long, especially for very unstable patients. In the cardiac rescue programme, of the 93 UMAC alerts, six patients died before insertion of ECMO [9]. Second, patients can remain

**Table 1** Potential benefits and risks of local implantation of extracorporeal membrane oxygenation.

	Benefit	Risk	Proposition
Selection of patients	Fast	Over selection	Selection process must be written precisely
Time from decision to ECMO	Very short (15–20 minutes); useful in RCA	Does not allow enough time for a response to the usual treatments	Prophylactic transfemoral wire implantation in high-risk patients
Femoral approach	Artery (15–19F); venous (21–23F)	Local atheroma; tortuous iliac; venous cannula is large; failure of cannulation because of lack of training	Local check with echo Doppler and fluoroscopy, if available
Care	Early implantation results in increased survival and less severe patients (acidosis, vasodilation, brain injury, etc.)	Limited experience of intensive care staff	Care protocol must be written precisely; training is mandatory; immediate transfer to level 3 centre usually proposed
Coronary revascularization	Coronary angiography/angioplasty can be done immediately before/after ECMO implantation		

ECMO: extracorporeal membrane oxygenation; RCA: refractory cardiac arrest.

**Table 2** Comparison between local team approach and mobile cardiac assistance unit.

	Local team	Reflex UMAC	Remarks
Selection of patients	Very fast	Fast; UMAC team can help with the decision	Selection process must be written precisely
Time from decision to ECMO	Very short	Short if available and not located too far away	Process to be followed must be written precisely
Place	Cathlab	Anywhere, including cathlab	On site, two cathlabs preferred for better organization
Staff	Cathlab nurses and experienced intensivist; training and formal collaboration with ICU required	UMAC team and intensivist; less dependent on local resources	
Percutaneous femoral approach	Seldinger technique; fluoroscopy can help; minisurgery	Percutaneous or minisurgery	
Limb revascularization	Retrograde femoral puncture can be difficult	Can be difficult; helped by echocardiography	Use echocardiography and fluoroscopy to help
Experience	Training needed with at least five patients; cathlab must be confident with acute MI or CA care (> 100/year)	Trained UMAC team; if instability, treatment can be difficult	Level of local investment?
Care	Immediate transfer	Immediate transfer	Protocol must be written
Coronary revascularization	Coronary angiography/angioplasty can be done immediately after ECMO implantation		

CA: cardiac arrest; cathlab: catheterization laboratory; ECMO: extracorporeal membrane oxygenation; ICU: intensive care unit; MI: myocardial infarction; UMAC: unité mobile d'assistance circulatoire (mobile cardiac assistance unit).

very unstable despite ECMO insertion, without the possibility of a transfer.

A new version of the UMAC team (reflex UMAC) comprises a trained emergency physician, a nurse and a paramedic. This team can very rapidly insert ECMO at the place of the cardiac arrest (in the street or in a hospital without ECMO capability). The patient is then transferred under ECMO to the catheterization laboratory (cathlab) or intensive care unit. Some publications have shown the feasibility, safety and positive results of this technique [10]. It is important to note that the proper selection of patients is probably less of a problem with reflex UMAC, as the team plays the role of an external advisor.

## How to deal with this issue in French territory

Every person in France is located within 120 minutes of the nearest cathlab. Although 180/230 French centres with high-volume cathlabs are open 24 hours a day, 7 days a week, they do not offer on-site cardiac surgery and a specialized cardiac resuscitation unit. However, they still have to care for seriously ill patients with MI and severe cardiogenic shock. In the cathlab, these patients are particularly prone to RCA before or during percutaneous coronary intervention.

Patients requiring ECMO implantation should ideally be transported to the cardiac surgical hospital before they become critically haemodynamically unstable. However, if a patient deteriorates rapidly, and experiences RCA, it is preferable to implant the ECMO in the local cardiac cathlab. The question of the care of these patients must be addressed at each centre.

Centres should contemplate developing a strategy of "ECMO reflex implantation", and the following points must be considered: (1) discussion of potential strategies among cardiac surgeons and intensivists, including MICU organization, is mandatory and needs to be formalized; (2) the interventional cardiologists and a trained local ECMO team need to be ready to implant ECMO if a local team is preferred or, if reflex UMAC is preferred, the protocol needs to be shared; and (3) for local ECMO, the full set of ECMO equipment (hardware for cardiopulmonary circulation, incorporating a portable centrifugal pump with a membrane oxygenator and percutaneous cannulae) needs to be available in the cathlab without delay.

The choice between local ECMO implantation by the cardiologist team and reflex UMAC needs to be discussed (Table 2), and there is no unique solution. A local team seems preferable when the cathlab deals with a large number of acute MIs (> 100/year), with an experienced 24/24 catheterization team. A motivated and experienced intensivist team is also mandatory. Reflex UMAC may be preferred in lower-volume centres, if UMACs and MICUs are not very far away, and when it appears difficult to motivate enough people on site. We can imagine a local team and a UMAC co-existing in the same place according to each case. Indeed, we can imagine that some indications could be more suited to local ECMO (e.g. acute MI followed by RCA during coronary angiography or angioplasty) or to reflex UMAC (e.g. RCA outside the cathlab). However, the multiplicity of solutions can also create confusion and inexperience in both approaches.

The cost of the two approaches is very similar, as the same system is used in each situation. Considering the global cost of the ECMO system, the consumables are between €2000 and €6000, and the ECMO machine from €10,000 to €45,000, but can be rented. In the local approach, the ECMO machine is probably used less frequently. In the reflex UMAC approach, the ECMO machine is used more frequently, but the cost of the physician and nurse on duty has to be taken into account.

Centres without cardiac surgery departments, but with ECMO experience, may help other centres that do not have such experience. This collaborative aspect of our specialty needs to be emphasized. Proctoring is particularly suitable to practice, and can help with the writing of protocols on the selection of patients, technical issues and formal organization. Formal networks can be used to spread the technique. Although such strategies need time and effort to be organized, they could save many lives.

Our propositions are in line with the recent French Expert Consensus advocating for better organization of ECMO implantation in cardiac shock [4]. However, this consensus does not consider RCA, which requires immediate ECMO implantation with dedicated organization.

The time has come to think about it.

## Disclosure of interest

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