Clinical update

The organization, function, and outcomes of ST-elevation myocardial infarction networks worldwide: current state, unmet needs and future directions

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The organization of networks in order to better coordinate and to faster offer reperfusion strategies for acute ST-elevation myocardial infarction (STEMI) is an important recommendation of recent versions of international guidelines. This article focuses on similarities and dissimilarities of world-wide networks, highlights essential network components, offers insights into still unmet needs and discusses potential measures to further improve quality of STEMI treatment.

Keywords
Myocardial infarction • STEMI networks • Primary percutaneous coronary intervention • Thrombolytic therapy • Organization

Introduction

After almost three decades of reperfusion therapy and systematic randomized clinical trials of ST-elevation myocardial infarction (STEMI), many pivotal questions regarding the optimal modality and timing of reperfusion therapy and the role of adjunctive therapies have been answered. A welcome shift in emphasis has unfolded away from the choice of therapy towards ensuring that all eligible patients receive therapy efficiently.1 Aligned with this shift has been an evolution away from the concept of a standalone single hospital towards more community/regional approaches that by a hub-spoke model. These regional systems are highly influenced by geographic diversity including weather and transport times, the availability of resources and infrastructure, and the characteristics of healthcare systems and patterns of reimbursement. It was our aim to (i) review current guidelines; (ii) describe essential network components; (iii) illustrate by some examples throughout the world how networks work under different conditions and local situations; and (iv) define unmet needs in order to allow further improvement of STEMI systems of care.

We wish to demonstrate the increasing importance of developing STEMI networks worldwide to offer mechanical reperfusion when feasible and alternatively—when and where necessary—pharmacological reperfusion in order to increase the proportion of STEMI patients treated with reperfusion therapy.

Network organization as central part of optimal ST-elevation myocardial infarction management

Recently releases of ACC/AHA and ESC STEMI guidelines2,3 recommend the need for optimal organization of STEMI systems of care at a community level as a Class I indication in order (i) to offer primary percutaneous intervention (PPCI) to the maximum proportion of patients within the recommended time spans (Figure 1); (ii) to...
provide optimal care for STEMI patients in the pre-hospital setting including rapid and accurate diagnosis, pre-activation of the cardiac catheterization laboratory, initiation of pharmacological reperfusion therapy (fibrinolytic therapy, FT) if PCI cannot be offered in a timely fashion; and (iv) to increase the proportion of patients receiving timely PCI by bypassing closer hospitals without interventional facilities. The clarity of these updated international guidelines galvanizes the need for organization of STEMI care at community, regional, and national levels as has already been advocated in previous guidelines as in the 2008 ESC STEMI guidelines, the ACC/AHA focused update of the 2007 updated STEMI guidelines from 2004, the Canadian perspective of the 2007 ACC/AHA focused update of STEMI guidelines, the ESC myocardial reperfusion guidelines, and the Adendum to the National Heart Foundation of Australia/Cardiac Society of Australia and New Zealand Guidelines for the Management of Acute Coronary Syndromes (ACS) 2006, respectively.

General principles for ST-elevation myocardial infarction networks

A reperfusion network should be built on evidence and on guideline recommendations to enhance the speed and delivery of reperfusion therapy to all eligible patients and be capably led by inspired and respected local champions. A network must respond to local conditions, be simple to follow, gain acceptance from all stakeholders, and include continuous data surveillance and feedback linked with quality improvement and adaptability to new knowledge.

Essential components of networks are a single telephone emergency number for entry into the respective emergency system, ambulance vehicles or helicopters depending on the geographical situation of networks that are equipped with 12-lead ECGs and defibrillators, a system to obtain and interpret pre-hospital ECGs for accurate diagnosis of STEMI, ability to call a single number to activate the catheterization laboratory at the time diagnosis is made, ambulances staffed with physicians and/or paramedics trained for basic and advanced life support, and initiation of FT in case of long distances or expected time delays. Further requirements are a clear definition of hospital capabilities and protocols to guide standardized care for emergency medical services (EMS), for hospitals without PCI capability including transfer protocols, and for PCI centres. An experienced and respected cardiologist or emergency physician should lead the network, and a nurse or paramedic coordinator at each PCI centre has been a hallmark of many regional systems. Active involvement of healthcare authorities will help overcome financial barriers, facilitate organizational infrastructure and data collection as well as legislation change when necessary. Standardized data collection and feedback are essential elements. Moreover, a consistent strategy of public information campaigns, education of emergency physicians and paramedics, and regular meetings of the involved parties to discuss performance and to improve outcomes are cornerstones of a well-functioning network. For a summary of essential components of well-organized STEMI networks see Table 1.

Primary percutaneous intervention is the preferred, but not the only reperfusion strategy

In accordance with the ‘time is muscle’ principle, PCI is recommended in all international guidelines as first-line therapy if coronary device deployment can reliably occur within 90 min of first medical contact (FMC), generally defined as when the first EMS personnel arrive at the patient’s and the diagnosis is made by ECG recording.
In the situation in which patients are transferred from a non-PCI capable to a PPCI hospital, an expected FMC to intervention time (first balloon inflation in the infarct-related artery) of maximal 120 min is considered to be acceptable to warrant a strategy of transfer for PPCI for many patients. However, depending on the duration of symptoms and presumed stage of infarction evolution, this may need modification, e.g. patients with a short onset of pain (2–3 h before FMC) benefit most from rapid reperfusion, the faster acting pharmacological reperfusion strategy may be preferred (Figure 1). As about one-third of patients are non-responders to FT, a combined pharmacoinvasive approach is the optimal strategy, as indicated in the recent guidelines.2,3 At a later stage on the ‘flat’ part of the curve describing the relationship between duration of ischaemia and salvage, time is less of a critical component of the strategy which revolves around opening the infarct-related artery and establishing effective myocardial perfusion. At this later stage, a mechanical approach of PPCI is generally preferred over a fibrinolytic drug given the attenuation of efficacy of the latter and less favourable risk/benefit ratio.

The recommendation for PPCI as first-line therapy, however, cannot be universally implemented worldwide as this is critically dependent upon the availability of PCI capable facilities 24 h a day and 7 days per week, and within a distance that can achieve guideline recommended transport times. In many countries and regions, where distance and resources preclude provision of guideline-based PPCI, the guidelines recognize the appropriateness and proven benefits of an effective alternative option, i.e. prompt administration of FT. As shown by several registries of local or national STEMI networks, major delays persist in a significant number (7–25%) of patients despite well-established STEMI networks and are associated with an increase in early and late mortality.10,16,24–27 Accordingly, the option of pharmacological reperfusion, including in the pre-hospital phase, should still be available in well-organized STEMI networks. Unfortunately, many networks believe that all patients can be treated with PPCI within the target times, but this does not always prove to be the case. As stated by Mark Twain when hearing of his obituary in the New York Times, ‘rumours of my death are premature’, and this also applies to pharmacological reperfusion therapy. As aptly summarized by Williams almost a decade ago: ‘Treatment delayed is treatment denied’.28

Table 1 Essential for ST-elevation myocardial infarction systems of care

<table>
<thead>
<tr>
<th>Single telephone emergency number</th>
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<tr>
<td>Ambulances (vehicles, helicopters, planes), equipped with 12-lead ECGs and defibrillators, and staffed with physicians or well-trained paramedics, capable of basic and advanced life support</td>
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<tr>
<td>Occasionally automatic ECG interpretation or ECG telemetry</td>
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<td>Direct telephone access to the cath lab</td>
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<td>Protocols for standardized care (diagnosis, therapy, and transfer)</td>
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<tr>
<td>Cardiologist or intensive care specialist as a network leader</td>
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<td>Involvement of healthcare authorities</td>
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<td>Public information campaigns</td>
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<td>Regular meetings of involved parties</td>
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<td>Prospective registry</td>
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The continued role of pharmacological reperfusion

According to the guidelines, FT should be started within 30 min of FMC when PPCI cannot be performed within an acceptable period of delay. Moreover, the recent guidelines also recommend pre-hospital initiation of FT and immediate transfer to a tertiary centre.3

The recently published STREAM trial reinforces the pharmacoinvasive strategy of combining pre-hospital FT with immediate transfer of the patients to a tertiary centre for rescue-PCI in patients who do not properly respond to pharmacological reperfusion and for early diagnostic angiography and, if appropriate, secondary PCI within 6–24 h after the initiation of FT.22 Thirty-day composite event rates (death, shock, heart failure, and re-MI) were non-significantly lower compared with PPCI in these patients who presented within 3 h of symptom onset, however, at the costs of a 1% intra-cerebral bleeding rate including also elderly patients (vs. 0.2% in patients directly referred for PPCI; P < 0.04). Most importantly, the dosage of the used therapeutic agent (TNK-tPA) was halved in the elderly (>75 years) during the study when signs of increased intracranial bleedings became evident. The reduced dose in the elderly appeared to attenuate the increased risk of intra-cerebral haemorrhage. This prospective, randomized study is of special importance as it shows that a pharmacoinvasive approach (pre-hospital FT followed by angiography with/without PCI) is effective and safe in patients who cannot achieve PPCI within 60 min of FMC. In the STREAM trial, the potential benefits of a pharmacoinvasive strategy were perhaps underestimated since the delays to PCI were relatively short with PCI being performed a mean of 77 min after randomization. As expected, in STREAM median times from symptom onset to TNK were 100 min and to PCI 178 min, respectively. It is possible that the outcomes would have been experience strongly supports improved access and application of PPCI as a key opportunity in regional efforts to improve survival. In many regions, when STEMI is diagnosed in the pre-hospital setting, the preferred strategy is to direct patients to PCI capable centres, even if a closer non-PCI capable centre exists.23 The cornerstone of therapy, however, is the delivery of some reperfusion therapy within the recommended time periods and to all who are eligible (Figure 1). Since unexpected system delays occur in any system, which may include traffic and/or weather-related delays or lack of transportation availability, alternative plans must be available, including FT. As shown by several registries of local or national STEMI networks, major delays persist in a significant number (7–25%) of patients despite well-established STEMI networks and are associated with an increase in early and late mortality.10,16,24–27

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more favourable with the pharmacoinvasive strategy if compared with ‘real-world’ patients in whom delays to PPCI would be anticipated to be considerably longer. The pharmacoinvasive reperfusion strategy should, therefore, be an integral component of STEMI networks: this includes patients in whom transfer delays for PPCI fall outside current guideline recommendations, particularly when presenting early after the onset of symptoms. In regions in which this is feasible, the presence of PCI capable facilities that are open 24 h a day and 7 days a week is the central feature of a reperfusion network. The emphasis is upon minimizing system delays that include the time from FMC onwards. Interestingly, a continuous shortening of door-to-balloon time, defined as the interval from the patient’s arrival at the hospital to inflation of the balloon to restore flow, from 83 to 67 min in the CathPCI registry and a parallel increase of the percentage of STEMI patients with a door-to-balloon time of $\leq 90$ min from 59.7 to 83.1% was not associated with lower in-hospital or 30-day mortality. While this study has limitations including failure to adjust for the increasing proportion of patients treated with primary PCI who have suffered cardiac arrest, it seems clear that more emphasis should be placed on shortening total ischaemic time, i.e. the patient-dependent delay and the transportation-dependent delay times.

**Pre-hospital treatment strategies:** not always state-of-the-art

Patients who are directly transferred for PPCI usually are treated for pain relief, with aspirin and unfractionated or low-molecular-weight heparin and medical measures for haemodynamic or arrhythmic complications. Some STEMI networks add glycoprotein IIb/IIIa-inhibitors (GPIs) pre-hospital enroute to the catheter laboratory, a strategy that was discouraged in the last myocardial reperfusion guidelines, but is now again recommended with a IIb classification due to the fact that registries and post hoc analyses have suggested benefit in patients with early presentation. Without existing data from registries or prospective randomized trials, STEMI networks also have started to use pre-hospital the novel antiplatelet P2Y$_{12}$-receptor inhibitors prasugrel or ticagrelor in this situation, while prasugrel has never been tested in the pre-hospital setting in STEMI patients, the ACCOAST trial in patients with NSTEMI showed that initiation of prasugrel prior to coronary angiography was associated with twice the rate of major bleeding and no lower rate of thrombotic events than starting prasugrel at the time of PCI. Ticagrelor is currently being tested in a randomized clinical trial in STEMI, in which 1700 patients are being randomly assigned to pre-hospital vs. hospital initiation of ticagrelor. The primary outcome is initial TIMI 3 flow or ST segment resolution (ATLANTIC).

Most interestingly, recent studies have shown that the early use of the new and more potent oral P2Y$_{12}$-receptor inhibitors do not necessarily lead to an optimal inhibition of platelet function at time of PPCI with up to 40% of patients being non- or low-responders. This highlights the potential value of fast acting i.v. antiplatelet agents such as GPIs or cangrelor.

The EUROMAX trial randomized 2218 patients with STEMI to bivalirudin monotherapy or to heparin/LMWH with GPI according to routine practice in the ambulance setting. The primary outcome was death or non-CABG-related major bleeding over 30 days. The pre-hospital use of bivalirudin resulted in about half the rate of major bleeding and a comparable mortality rate compared with in-hospital bivalirudin, but it was associated with a higher rate of acute stent thrombosis within 24 h of PPCI. This is in context of the HORIZONS trial that showed less bleeding but also lower cardiovascular mortality with bivalirudin in STEMI, in which over half the patients initially received heparin. Also in HORIZONS there was a higher stent thrombosis rate with bivalirudin in the early phase of treatment but no impact on short and long-term mortality. Thus, when using bivalirudin, it may be reasonable to initiate it in the ambulance or to use unfractionated heparin up front and bivalirudin in the catheterization lab. Whether a combined use of bivalirudin and the fast-on/fast-off P2Y12 inhibitor cangrelor might help to reduce early stent thrombosis effectively and safely is topic of a currently ongoing investigation (HORIZONS AMI-2 trial). Whether other pre-hospital strategies will further improve STEMI treatment by reducing thrombotic events without increasing bleeding complications remains to be determined.

**Examples of international ST-elevation myocardial infarction networks**

A comprehensive analysis of different STEMI networks is beyond the scope of this review. Rather we discuss selected examples of few, well-organized but differently acting systems of care in different regions of the world.

**Europe**

Although most STEMI networks are organized according to the ESC guidelines, which ask for close co-operation between EMS and tertiary centres with catheter facilities around-the-clock national and regional networks underlie specific dissimilarities: For example, the VIENNA STEMI network is based on a rotational system between tertiary centres; while during day times all centres are available, during night duty, only two active centres are available. This guarantees that only experienced interventionists are on duty during usual catheterization ‘off-times’ (3:00 p.m. to 7:00 a.m. in Vienna). In Vienna, pre-hospital fibrinolysis is usually part of the reperfusion strategies if patient transfer to the active catheter centre exceeds 90 min (but nowadays only performed in ~3% of STEMI patients).

In other networks that are mainly based and organized in large cities and surrounding rural areas with short transfer times (e.g. Munich), or when open catheter facilities can be found well-distributed over the country (Denmark, Netherlands, Germany, Poland, and Czech Republic), the utilization of FT has virtually and understandably disappeared.

In contrast, especially in France, pre-hospital thrombolysis performed within the SAMU system plays still an important role in revascularization, despite a well-distributed system of tertiary centres. Since 1995 (with intermediate calculations every 5 years), cohorts of patients hospitalized for STEMI have been followed through the FAST-MI programme in order to determine whether regional differences exist in the management of the patients suffering from STEMI. These prospective registries include ~60% of all French institutions.
and the SAMU organization (as medical dispatching centre and physician-stuffed mobile intensive care units). The particular aim of FAST 2010 was to assess the correlations between management strategies of networks and in-hospital outcomes and to document the long-term (up to 10 years) clinical outcome of STEMI patients at the end of 2010. The median time from symptom onset to first call was 74 min. Seventy-three per cent of patients were transported by the SAMU. The median time from qualifying ECG to PPCI was 110 min and time from ECG to FT was 22 min. By considering the 15 years period of the FAST-MI programme the crude 30-day mortality decreased from 13.7 to 4.4%. During the same period reperfusion therapy increased from 49.4 to 74.7% driven by PPCI (11.9–60.8%). The proportion of younger patients increased particularly in women under the age of 60 years.13,44,45

In Norway with its long transfer distances12 or in other European countries, in which at this point in time, the ability to provide PPCI to patients in rural areas is not optimal (Austria, Hungary, Slovakia, Spain, Sweden, and UK), FT, particularly pre-hospital FT,43 remains an important reperfusion strategy although this may change over time. In these countries short- and long-term mortality from STEMI has dropped considerably with implementation of routine PPCI included within regional networks although still many patients are well beyond ideal reperfusion times and this is especially important for early high-risk presenters, as total ischaemic time (onset of pain until balloon) is critical in this group of patients.

North America

The vast size of the USA and Canada and its geographic diversification has lent itself to the development of networks with similar therapeutic goals but differing methods of achieving them. In large urban centres with an abundance of catheterization laboratories, the optimal system has been to transfer patients to the nearest PCI capable centre but competition between hospital systems has created barriers. Nallamothu et al.26 have shown that despite logistical constraints in regard to distance, 79% of individuals within the USA are within <60 min driving time in a PCI capable hospital and among patients admitted to a non-PCI capable facility 34% are within 30 min driving time to a PCI capable facility. This means that despite formidable geographic obstacles, the majority of patients in the USA should be able to be treated with PPCI and within the guideline-based time constraints. The focus therefore has been on the logistics of rapid transport and decision-making and a more recent focus upon door-in to door-out (DIDO) times. Another contributor to delay in patients being transferred is the transportation from the first hospital to a hospital with catheter laboratory facility (between hospital transfer).46,47 The focus on DIDO times also places a burden of responsibility upon the referring as well as the referral centre. Despite Herculean efforts the most recent registry data demonstrate a failure to achieve timely PCI in the majority of patients who do not present directly to a PCI centre.25

In certain areas of the North America, e.g. parts of the Mid-West, the Rocky Mountain States, North Carolina and large sections of Canada, the relative paucity of catheter laboratories, and the vast distances encompassing the rural areas in addition to the exigencies of inclement weather have dictated a variety of protocols that fall under the umbrella of the ‘pharmaco-invasive strategy’ with some patient subsets receiving FT prior to transfer for ‘rescue’ or routine angiography and others with a longer duration of symptoms undergoing transfer for PPCI. This approach is driven by the realization that in ‘early’ presenters who face a considerable transport delay, ‘time to the initiation of reperfusion therapy is critical’ and the impact of delay prior to PPCI may be detrimental to outcomes. The RACE system developed in North Carolina is an excellent example of extending reperfusion therapy across the state by adapting different systems to specific areas, e.g. PPCI and the pharmaco-invasive strategy and an elegant analysis by Fosbol et al.23 helps to define the relationship between driving times to a PCI capable centre for PPCI as opposed to an initial therapy with a fibrinolytic followed by transfer.

Door-to-balloon times in the USA have shortened dramatically48 and although initially this appeared to be associated with a reduction in mortality,49 this has more recently reached a plateau. At the same time, there are a growing number of reports demonstrating increases in ‘false activation’ of the catheter laboratory due primarily to inaccurate ECG reporting.50 Brodie et al.51 in analysis from the CADILLAC and HORIZONS databases pointed out logically that door/(FMC)-to-balloon times (<90 min) were associated with reductions in mortality only in patients presenting early after symptom onset as opposed to a lack of a relationship in patients presenting later on the ‘flat’ part of the curve. Short door/(FMC)-to-balloon times and overall system delay12,27 are associated with improved outcomes, whether this is a direct cause and effect relationship or as a surrogate for the overall standard of care. Nonetheless, it appears that further reductions in door/(FMC)-to-balloon times may be detrimental and time might be better spent on confirming the diagnosis and an assessment of comorbidities.53 However, the relative increase of 1% in PPCI hospitals shown by Concannon et al.53 cost from $2–4 billion: perhaps a more cost-effective approach might be to invest in integrated systems that deliver pre-hospital care as in France.

A recent analysis based upon the AHA’s Mission Lifeline, identified many performance characteristics that among USA hospitals were performed well. These include single phone call catheter laboratory activation; ED activation of the catheter laboratory without cardiology consultation; data registry participation and patients acceptance at a PCI capable facility regardless of bed availability.17 On the other hand, there remain challenges, which are uniquely associated with the competitive nature of systems of health care in the USA including hospital and cardiology group as well as EMS transport competition and finances. A programme to intensify AHA efforts to develop integrated regional systems of care in selected urban regions around the USA is under way.54

Canada

Canada poses similar challenges to those faced by the USA in regard to the size of the country and the distribution of the population in regard to cities and rural areas plus the vagaries of harsh weather. The Vital Heart network in Alberta which emerged from the WEST trial is an excellent example of a mixed STEMI system of care serving cities and a huge rural area.11 A more city-wide network is successfully run in Ottawa, where pre-hospital diagnosis and immediate transfer to a tertiary centre was for the first time demonstrated to reduce FMC-to-balloon time providing mechanical reperfusion for the majority of STEMI patients within the now
recommended time lines. The Canadian guidelines are closely linked to the updated US guidelines.

India, China, and Russia

From an epidemiological perspective, China, Russia, and India exemplify many of the issues associated the rapidly growing epidemic of cardiovascular disease in the developing world and newly industrialized nations. Dealing with the epidemic including markedly increased frequency of STEMI is hampered by a lack of infrastructure and financial constrains which are highly variable among nations and regions.

Currently, only few STEMI networks are organized based on international guidelines thus leading to a relatively low rate of patients referred for PPCI and the majority of inhabitants in many of these countries do not receive optimal reperfusion treatment in due time. The major problems include the long transfer delays due to the logistics of transportation in large, overcrowded urban centres in which the majority of patients in some arrive in hospital by public or private transport. Accordingly, in China, Russia, and India, PPCI can only be offered to up to 5% of all STEMI patients.

The imperative to improve the delivery of STEMI care to a growing population has become a recognized priority in both countries. A challenge for developing regional systems of care in low- and middle-income countries is a general lack of organized EMS such that currently the development is limited to patients who present to individual or small groups of hospitals in urban settings.

A unique system has been developed in Shanghai in which there is a shortage of interventionists but not physicians. In this REVERSE-STEMI trial, flying physicians to outlying catheter laboratories was preferable to transporting patients to a referral centre. In India the hurdles to be overcome have been identified and the development of networks is a priority.

Australia

In contrast to well-organized STEMI networks in big cities, the huge size of the country with very long transfer times in rural areas, frequently by air transportation, hinders the opportunity to perform timely PPCI timely in many instances. A recent analysis of interventions that would improve access to timely reperfusion in Australia identified improvements in inter-hospital transfer and the use of pre-hospital thrombolytic therapy as the most cost-effective measures. However, as there are no data available at moment about the efficacy of existing networks, there is need for randomized trials of regional clinical networks in the management of ST-elevation MI.

Middle East

The Middle East and the Gulf States are in the throes of an epidemic of diabetes and cardiovascular disease and the GULF registry is addressing regional and national differences in providing reperfusion therapy amidst widespread geographical diversity. Access to hospitals with catheterization facilities, with or without on-site PCI, was associated with a reduction in recurrent myocardial infarction and recurrent ischaemia, but not mortality. Further, efforts are required to target revascularization procedures for higher risk patients as well as to widely implement PPCI programmes.

Latin America

In the regional system of Salvador, Bahia, Brazil, the telemedicine centre sends each ECG suggestive of STEMI to a regional STEMI alert team, which, together with EMS, offers support for thrombolysis or immediate transfer for primary percutaneous coronary intervention. For those who had an ECG performed within 12 h after symptoms onset, the reperfusion rate was 75.6% (about one-third by FT and two-thirds by PPCI).

South Africa

There are major logistical limitations that limit the applicability of PPCI in the South African context. Facilities that are equipped for PPCI are limited in number and distances from community hospitals are often great. Best results are achieved when a PPCI facility is available 24 h a day, 365 days a year and this is not currently achievable in South Africa due to limited resources, although such networks are being developed in the major urban centres in which sophisticated contemporary cardiac care is available.

Unmet needs of ST-elevation myocardial infarction networks

Based on the experience in well-organized STEMI networks that have continuously improved over time, we summarize here some unmet needs for improvement that still exist in many but not all existing systems of care: As discussed above, even in large cities with well-organized ambulance systems populated by a sufficient number of PCI facilities there is a significant proportion of patients who do not receive mechanical reperfusion within the recommended time interval. Accordingly, a complete renunciation of FT, as already existing in many networks, might harm some patients and should be avoided. On the other hand, a high density of cath labs performing acute interventions might be associated with a reduced case load per centre and a reduced quality of interventional cardiologists. It might therefore, be wise to create a few strategically located tertiary centres per regions or city, which can easily be reached for 24 h/7 days in order to maintain an adequate case load volume for interventional cardiologists at these centres. The permanent around-the-clock presence of a complete interventional team in the tertiary hospital helps to reduce delay times and is preferred over a call-in system. However, this is not feasible in the majority of cases due to financial restraints. Moreover, the financial interests of different transportation systems may lead to lack of co-operation with the closest tertiary centre thereby leading to unacceptable prolongation of transportation delay: clearly, this situation should be avoided. There is still need to organize fixed wing or helicopter transfer in many distant and rural areas.

Recent data confirm that the radial access is advantageous over the femoral access in STEMI patients referred for PPCI. This approach reduces bleeding complications, and there is need to further increase the use of radial access worldwide. Patients with STEMI complicated by cardiogenic shock should be transferred only to special centres, in which extra-circulatory support systems are available. Permanent education of paramedics or physicians on ambulance systems with respect to ECG interpretation (when automatic ECG diagnosis or ECG telemetry is not available), pre-hospital treatment strategies
including FT (if indicated) and life support is essential but not performed everywhere. Regular quality assurance feedback to the ambulance staff regarding timeliness and appropriateness of diagnosis as well as clinical outcomes of the intervention is essential to keep motivation high; however, this is not offered in many STEMI networks. Finally, all STEMI networks should run registries for self-study and quality assurance purposes. This should include regular meetings of representatives of involved hospitals and the pre-hospital/ambulance systems might in order to detect problems and contribute to continuously improving outcomes. Unfortunately, this also is not currently routine in many networks.

Summary

Based on worldwide different regional structures (e.g. distance from the tertiary centre, transfer times, quality of EMS, availability of catheter laboratories and many more) the organization of an optimal STEMI network needs to be customized and refined by each regional health system leaders. There are two currently existing effective strategies and the relationship between them needs careful integration based on local and regional needs and realities. For all networks, there are common components such as a system for early diagnosis, for fast patient transfer, for optimal door-to-device organization, and an experienced team of interventionists. Co-operation and teamwork of emergency physicians, cardiologists, nurses, paramedics, hospital with and without catheter facilities, politicians and other stakeholders will support this process. Data collection and feedback in registries will provide the opportunity to detect problems within the respective systems of care and guide their solutions, step by step. The emergence of these networks provides an ideal template on which to develop further novel advances in the care of STEMI patients.

Conflict of interest: none declared.

References


