

## SYSTEMATIC OR INTEGRATIVE REVIEW

### STRATEGIES FOR REDUCING DOOR-TO-BALLOON TIME IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

#### ESTRATÉGIAS PARA REDUZIR O TEMPO PORTA-BALÃO NOS PACIENTES COM INFARTO AGUDO DO MIOCÁRDIO

#### ESTRATEGIAS PARA REDUCIR EL TIEMPO PUERTA-BALÓN EN PACIENTES CON INFARTO AGUDO DE MIOCARDIO

Laura Lopes Nogueira Pinto <sup>1</sup>  
Allana dos Reis Corrêa <sup>2</sup>  
Miguir Terezinha Viecelli Donoso <sup>2</sup>  
Selme Silqueira de Matos <sup>2</sup>  
Bruna Figueiredo Manzo <sup>3</sup>

<sup>1</sup> RN. Nurse Specialist in Critical Care. Hospital Sírio Libanês, São Paulo, SP – Brazil.  
<sup>2</sup> RN. PhD in Nursing. Adjunct Professor. Federal University of Minas Gerais – UFMG, School of Nursing – EE, Department of Basic Nursing. Belo Horizonte, MG – Brazil.  
<sup>3</sup> RN. PhD in Nursing. Adjunct Professor. UFMG/EE, Department of Maternal-Child Nursing. Belo Horizonte, MG – Brazil.

Corresponding author: Allana dos Reis Corrêa. E-mail: allanareiscorrea@gmail.com  
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### ABSTRACT

**Objective:** to identify the available evidence regarding strategies to reduce door-to-balloon time in patients with acute myocardial infarction (AMI) requiring inter-hospital transport to cardiac lab services. **Method:** an integrative review of the literature using the LILACS and PubMed databases, inclusive of all articles published between January 2005 and March 2015. Of the 21 publications identified, nine were included in the sample. **Results:** strategies with the best results in reducing door-to-balloon time were: pre-hospital ECG (evidence level III) and early notification of and direct transfer to reference centers (evidence level IV). In studies using these measures, more than 50% of patients were reperfused within 90 minutes or within 60 minutes. **Conclusion:** Interventions to reduce door-to-balloon time were infrequently applied alone. Multiple coordinated and standardized strategies should be used in all phases for the care of AMI patients.

**Keywords:** Practice Guidelines as Topic; Health Planning Guidelines; Transportation of Patients; Myocardial Reperfusion; Myocardial Infarction; Acute Coronary Syndrome.

### RESUMO

**Objetivo:** identificar as evidências disponíveis quanto às estratégias para reduzir o tempo porta-balão nos pacientes com infarto agudo do miocárdio (IAM) que necessitam de transporte inter-hospitalar para serviços de hemodinâmica. **Método:** trata-se de uma revisão integrativa da literatura nas bases de dados LILACS e Medline via PubMed no período de janeiro de 2004 a julho de 2014. Das 21 publicações identificadas, nove foram incluídas na amostra. **Resultados:** as estratégias com melhores resultados na redução do tempo porta-balão foram: eletrocardiograma pré-hospitalar com nível de evidência III, ativação precoce e transferência direta para os centros de hemodinâmica, com nível de evidência IV. Nos estudos que utilizaram essas intervenções, mais de 50% dos pacientes foram reperfundidos em menos de 90 minutos ou com tempo de até 60 minutos. **Conclusão:** intervenções para reduzir o tempo porta-balão foram pouco aplicadas isoladamente, sendo evidente a necessidade de estratégias conjuntas e padronizadas em todas as etapas do atendimento ao paciente com IAM.

**Palavras-chave:** Guias de Prática Clínica como Assunto; Diretrizes para o Planejamento em Saúde; Transporte de Pacientes; Reperusão Miocárdica; Infarto do Miocárdio; Síndrome Coronariana Aguda.

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## RESUMEN

*El objetivo del presente estudio fue identificar las evidencias disponibles sobre las estrategias para reducir el tiempo puerta-balón en pacientes con infarto agudo de miocardio (IAM) que requieren transporte interhospitalario para los servicios de hemodinámica. Se trata de una revisión integradora de la literatura en las bases de datos LILACS y PubMed entre enero de 2004 y julio de 2014. De las 21 publicaciones identificadas, nueve fueron incluidos en la muestra. Las estrategias con mejores resultados en la reducción de la puerta-balón fueron el ECG pre hospitalario con nivel de evidencia III, la activación temprana y la transferencia directa a los centros de hemodinámica con nivel de evidencia IV. En los estudios que utilizaron estas intervenciones, más del 50% de los pacientes fueron reperfundidos en menos de 90 minutos o con un tiempo de hasta 60 minutos. Las intervenciones para reducir el tiempo puerta-balón se aplicaron poco en forma aislada, siendo evidente la necesidad de estrategias conjuntas y estandarizadas en todas las etapas de la atención al paciente con IAM.*

**Palabra clave:** Guías de Práctica Clínica como Asunto; Directrices para la Planificación en Salud; Transporte de Pacientes; Reperusión Miocárdica; Infarto del Miocardio; Síndrome Coronario Agudo.

## INTRODUCTION

Cardiovascular diseases are the leading cause of mortality and in-hospital complications in Brazil and the United States of America (USA).<sup>1,2</sup> In Brazil alone, more than 1 million deaths from cardiovascular diseases were recorded between 2001 and 2010. Of these, 40.5% (603,932 deaths) were from acute myocardial infarction (AMI).<sup>3</sup> In the USA, which has an average of 800,000 deaths per year, mortality from AMI represents 27% of all annual deaths.<sup>2</sup> Although this a high percentage of overall deaths, currently only 6-7% of AMI patients die.<sup>2</sup> This is significantly lower than that what was seen in the 1970s, when approximately 30% of AMI patients died.

One of the most common ischemic heart diseases is acute coronary syndromes (ACS), which comprises unstable angina (UA) and acute myocardial infarction with or without ST-segment elevation (STEMI or NSTEMI).<sup>4</sup> Generally, acute coronary disorders are caused by the obstruction of the lumen of the coronary artery due to the formation of atherosclerotic plaque. This reduces or stops blood flow to the myocardium and, thus, oxygen supply.<sup>4</sup> Therefore, reperfusion therapy is the most effective therapy for AMI, as it helps to ease the discomfort caused by myocardial ischemia and its complications, which can result in death due to ventricular fibrillation even before the patient receives specialized care.<sup>1,4-6</sup> Reperfusion success, be it through fibrinolytic therapy or primary angioplasty, is time-dependent. Therefore, the time between onset of symptoms and reperfusion therapy should be as short as possible.<sup>5-13</sup> A study conducted in North Carolina, USA, assessed the impact of delayed treatment of AMI and showed that the faster myocardial reperfusion is achieved, the better the cardiac function after the procedure and the lower the chances of reinfarction.<sup>7</sup> In contrast, patients who waited longer to receive reperfusion therapy had higher death rates after 30 days, although the outcome is not always directly associated with risk factors.<sup>7,14</sup>

Chemical fibrinolysis and primary angioplasty are the most common reperfusion strategies used in the treatment of AMI. The former involves three time intervals: between onset

of symptoms and patient conveyance to the emergency receiving facility; between activation of the emergency medical services and arrival at the primary hospital (transport time); and between the arrival at the primary hospital and thrombolytic (door-to-needle) time. Access to primary angioplasty, on the other hand, involves five intervals that can lead to delays in patient care: between onset of symptoms and the search for expert help; between the call for help and the arrival to the primary hospital (transport time); between the arrival to and the departure from the primary hospital (primary hospital delay); inter-hospital transfer time to a hospital with cardiac lab services; and door-to-balloon time, which corresponds to the time interval between arrival at a hospital with cardiac lab services and performance of primary angioplasty.<sup>4-6,10,12,15</sup>

Studies have shown that time between onset of symptoms and the search for help is one of the main causes of delayed care and leads to a longer ischemic time (time from onset of symptoms until reperfusion), which is critical to the success of myocardial reperfusion.<sup>1-2,4-7,16</sup> In the treatment of STEMI there is a pattern of better outcomes when the patient seeks care within 12 hours of onset of symptoms and can be treated with door-to-ECG time of up to 30 minutes, a door-to-balloon time of less than 90 minutes, with a maximum delay of 120 minutes; or door-to-needle time less than 30 minutes.<sup>17</sup>

Although thrombolysis is a treatment option more readily available than primary angioplasty, several studies have shown that the latter is more advantageous than the former, because it results in better short- and long-term outcomes for patients. Moreover, due to the risk of brain bleeding, the performance of thrombolysis is associated with the application of more rigorous criteria.<sup>5-7,13,17-19</sup> Conversely, in Brazil and in other countries, there are only a few hospitals with cardiac laboratories where angioplasty can be performed and these are usually located far away from regional and rural hospitals.<sup>7,8,18,20</sup> For this reason, many sites find it difficult to achieve the door-to-balloon time of 90 minutes or less, as recommended in the Brazilian as well as in international guidelines.<sup>4-6</sup>

In 2011, the Ministry of Health published Ordinance GM Number 1600, of June 7th, 2011, which reformulated the National Policy for Emergency Healthcare and instituted the Emergency Care Network in the context of the Unified Health System (SUS). This Ordinance gives priority to cerebrovascular, cardiovascular and trauma care. In cardiovascular care settings, the provision of care to patients with AMI is considered to be a priority and aims at coordinating and integrating all health facilities to expand and qualify users' access to humane and comprehensive care in a quick and timely manner. Consequently, it was expected that patients with AMI would receive treatment within the time recommended in the guidelines, but this is still not a reality.<sup>21</sup>

Thus, considering the morbidity and mortality of cardiovascular diseases as well as the aforementioned issues, we ask the following question: what are the available strategies to reduce door-to-balloon time in patients with AMI requiring inter-hospital transport to cardiac lab services? Knowledge of these strategies can contribute to the organization of care for AMI patients who are admitted to health facilities lacking immediate cardiac lab services.

This study is warranted by the reality of the delays in starting the most suitable definitive treatment for people with AMI, as well as by the lack of studies on the topic. This study aimed to identify the available evidence regarding strategies to reduce door-to-balloon time in patients with acute myocardial infarction (AMI) requiring inter-hospital transport to cardiac lab services.

## METHODS

This is an integrative review of the literature. It provides a synthesis of the knowledge available and makes possible the incorporation of significant results in clinical practice. Integrative reviews are a broad type of research that allow the inclusion of experimental and non-experimental research.<sup>20</sup> Furthermore, this method aims to reduce uncertainties in clinical practice, providing improvements and greater certainty for the decision-making process, whose main objective is to improve patient care.<sup>22</sup>

This review was designed to be conducted in six steps: drafting of the guiding question; literature search; data collection; categorization of studies; assessment of studies; interpretation of results; and presentation of the integrative review.<sup>20,22,23</sup> The guiding question was designed based on the PICO strategy. PICO is an acronym that stands for P=Patient or Problem, I=Intervention, C=Comparison or control, O=Outcomes.<sup>24</sup> P were human patients with AMI; I was to reduce door-to-balloon time; C was not applicable, since this is a comparative study; and O was coronary reperfusion. Thus, the guiding question was phrased as follows: "What is the available evidence regarding strategies to reduce door-to-balloon time in patients

with acute myocardial infarction (AMI) requiring immediate coronary reperfusion"?

Studies were selected from databases including Medline (accessed through PubMed - *National Library of Medicine*), Latin American and Caribbean Center on Health Sciences Information (LILACS) and Cochrane. We used the following controlled descriptors (structured phrases used for indexation in the databases): Practice guidelines as topic, Technical standards, Transportation of patients, Acute myocardial infarction and Acute coronary syndrome.<sup>25</sup>

The literature search was performed from March 2 to 30, 2015. We searched PubMed using the following terms and search strategies: "practice guidelines as topic"[MeSH Terms] OR "health planning guidelines" [All Fields] AND ("transportation of patients" [MeSH Terms] (Acute myocardial infarction" [All Fields]) e practice guidelines as topic" [MeSH Terms] OR "health planning guidelines"[All Fields] AND ("transportation of patients" [MeSH Terms] AND (Acute myocardial infarction" [All Fields] OR ("Acute coronary syndrome" [All Fields])). The LILACS and Cochrane databases were searched using the terms "transportation of patients" AND "acute myocardial infarction" AND "myocardial reperfusion".

The inclusion criteria were primary articles about strategies for reducing treatment time of patients with AMI, published in English, Spanish or Portuguese between January 2005 and March 2015. Articles in Portuguese were included in order to bring the Brazilian reality to this study. Exclusion criteria were articles that did not address the proposed topic and studies that were duplicated in the databases searched.

Table 1 illustrates the process of identification and selection of the articles that were included in this study.

Table 1 - Search strategy of the electronic databases

Database	Articles retrieved	Articles excluded	Sample
	N	N	N
Medline	22	13	09
LILACS	02	02	0
Cochrane	03	03	0
Total	27	18	09

Twenty-seven studies were retrieved and their full-text versions were read. Of these, 18 were excluded for the following reasons: the article addressed the treatment of patients with AMI, but did not had as its objective the proposal of new strategies to reduce treatment time (3); the article only addressed AMI risk factors and their relationship with disease severity (2); the article addressed the obstacles faced by patients in the health care system before receiving care (1); the article reported testing

an apparatus for extracorporeal circulation to be used during transportation of critically ill patients (1); the article addressed AMI in very specific and unusual situations (2); the article could not be found (1); the article dealt with education of cardiac patients (2); the article focused on prehospital treatment in cardiac and trauma emergencies (5); and researchers excluded from the sample all patients who required inter-hospital transfer (1).

The data were extracted using a tool adapted from other review study.<sup>25</sup> Next, the manuscripts were analytically read to sort the information available and obtain responses to the study question. Then the studies were interpretatively read to understand the material and develop the theory for analysis. Next, the studies were classified according to seven levels of evidence, as shown in Table 2.

Table 2 - Classification according to level of scientific evidence<sup>26</sup>

Level of Evidence	Study design
I	Evidence that is generated from systematic reviews or meta-analyses of all relevant randomized controlled trials (RCT) or evidence-based clinical practice guidelines based on systematic reviews of RCT.
II	Evidence derived from at least one properly designed RCT.
III	Evidence from well-designed trials without randomization.
IV	Evidence from well-designed case-control or cohort studies.
V	Evidence from systematic reviews of qualitative and descriptive studies.
VI	Evidence from a single descriptive or qualitative study.
VII	Evidence from the opinion of authorities and/or reports of expert committees

Studies rated level I or II are considered strong evidence; those rated level III or IV are considered moderate evidence; and studies rated V to VII are considered weak evidence. This classification is based on the study design and on its ability to show cause and effect.<sup>26-28</sup>

## RESULTS

All nine studies were retrieved from Medline and published in English. Only one study had a nurse as one of its authors. The author was a nurse from the Oregon Health and Science University School of Nursing, in the USA. All other studies have been written by physicians, especially cardiologists. Studies 2, 4 and 9 have been conducted in countries other than the USA, namely: Australia, the Netherlands and Taiwan. Only study number 2 had level of evidence III, all the other studies had level of evidence IV, which shows that they all provided a moderate level of evidence.

Table 3 summarizes the main results found in the studies selected for this review.

The strategies identified to reduce door-to-balloon time were as follows: electrocardiogram (ECG); early pre-hospital notification of the catheterization laboratory; direct transfer of STEMI patients to the catheterization laboratory, considering the association with previous strategies and the difficulties related to inter-hospital transport; communication between professionals involved in the percutaneous intervention process and expansion of regional systems for treatment of STEMI patient, considering the development of regional protocols to standardize patient triage, care and transfer.

## DISCUSSION

One of the highlights of this review was the lack of articles in Portuguese and conducted in Brazil, which evidences a gap in research on the topic in the country.

With regard to the level of evidence, the fact that half of the studies included in this review had level of evidence IV is probably due to the difficulty of conducting randomized trials on this topic, as it would be ethically incorrect to compromise patients' health status by deliberately exposing them to ineffective treatments.

As for the strategies for reducing door-to-balloon time, we found that usually more than one strategy was used for this purpose and that greater importance was given to the performance of joint actions to achieve better results. We identified four strategies that were efficient in reducing door-to-balloon time. They are presented next.

### PREHOSPITAL ECG WITH EARLY NOTIFICATION OF THE CATHETERIZATION LABORATORY

Prehospital ECG was used as a strategy in seven studies. Even when it was not used as the main strategy, it always reported to be successful. This shows the wide use of the method, not only in the USA but also in other countries of the world, such as the Netherlands and Taiwan.<sup>10,12,15,18,27,30</sup>

Study number 2 – classified as having level of evidence III – addresses prehospital ECG as the main strategy for reducing door-to-balloon time, together with early notification of the catheterization laboratory. The strategy was considered to be effective in reducing treatment time of patients with AMI, with reperfusion time within guideline recommendations. 93% of patients were reperfused in less than 90 minutes. In order to be used as a strategy for the early diagnosis of STEMI, ECG was performed by paramedics in the ambulance and interpreted by them or a computer program, or else transmitted to the care center where diagnosis was confirmed by a physician.<sup>30</sup>

Table 3 - Information regarding the studies included in this review and their classification in levels of evidence

Study	Title	Author	Journal / Country/Year	Objective/Methods	Results	Conclusion	Level of Evidence
01	An Approach to Shorten Time to Infarct Artery PAtency in Patients With ST-Segment Elevation Myocardial Infarction <sup>27</sup>	Gross <i>et al.</i>	American Journal of Cardiology/ EUA/2007	Protocols were created for paramedics to identify and directly triage all patients with STEMI to a single PCI center. / Cohort study	223 patients were assessed. Paramedic diagnosis of STEMI was associated with shorter door-to-balloon time. Ninety-minute initial hospital door-to-patient infarct artery was achieved in 58.3% of paramedic-diagnosed patients, with 0% mortality.	Regionalized and collaborative strategies may help significantly reduce door-to-balloon time and mortality.	IV
02	Prehospital 12-lead ECG to triage ST-elevation myocardial infarction and emergency department activation of the infarct team significantly improves door-to-balloon times: ambulance Victoria and monashHEART acute myocardial infarction (MonAMI) 12-lead ECG project <sup>29</sup>	Hutchison <i>et al.</i>	Circulation Cardiovascular Interventions/ AUS/2009/	To determine the impact of a multidisciplinary approach to STEMI management with the implementation of paramedic performed 12-lead ECG-based triage of STEMI and ED activation of the infarct team on door-to-balloon time. / Trial without randomization.	93% of patients in the protocol group achieved a D2BT of ≤90 minutes. The median D2BT of all patients was 56 minutes.	Prehospital ECG triage is an effective strategy to reduce door-to-balloon time in patients with AMI.	III
03	Pre-hospital triage for primary angioplasty direct referral to the intervention center versus interhospital transport <sup>15</sup>	Dieker <i>et al.</i>	JACC: cardiovascular interventions/ HOU/2010	To study the impact of direct referral to an intervention center after pre-hospital diagnosis of STEMI on treatment intervals and outcome. / Cohort study	Only 23% of patients referred through a nonintervention center were treated within 90 minutes, whereas 82% of patients directly transported were treated within this time window.	Prehospital diagnosis of STEMI, direct transport to an intervention center with pre-hospital notification of the catheterization laboratory proved to be an effective treatment strategy.	IV
04	Impact of the prehospital ECG on door-to-balloon time in ST elevation myocardial infarction <sup>10</sup>	Rao <i>et al.</i>	Catheterization and cardiovascular interventions/ EUA/2010	To see if a more aggressive approach utilizing prehospital ECGs and transporting patients from the field directly to the cardiac catheterization laboratory could improve reperfusion times. / Cohort study	The mean D2B for patients with initial ECG in hospital was 90.5 minutes, compared to 60.2 minutes in patients with prehospital ECG.	Utilizing the prehospital ECG as a tool to bypass ER triage significantly decreases D2B times in patients with STEMI.	IV
05	Primary percutaneous coronary intervention for patients presenting with ST-elevation myocardial infarction: process improvements in rural prehospital care delivered by emergency medical services <sup>18</sup>	Rezaee <i>et al.</i>	Progress in Cardiovascular Diseases/ EUA/2010	To evaluate EMS processes of care before and after a period of continuous quality improvement to improve first-medical-contact-to-balloon times/ Cohort study	The time assessed was reduced in 30 minutes after quality improvement.	It is possible to reduce first-medical-care-to-balloon times in patients with STEMI through the implementation of improvements and having limited resources.	IV
06	Primary percutaneous coronary intervention for patients presenting with ST-segment elevation myocardial infarction: process improvement in a rural ST-segment myocardial infarction receiving center <sup>11</sup>	Nielse <i>et al.</i>	Progress in Cardiovascular Diseases/ EUA/2010	Implementation of strategies focusing on improving the process of acute STEMI patient care in a rural setting/Cohort study	77% of patients achieved a D2BT of ≤90 minutes. The shorter the door-to-ECG time, the shorter the door-to-balloon time.	The study showed the effectiveness of strategies for improving the process of care for patients with STEMI.	IV

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Table 3 - Information regarding the studies included in this review and their classification in levels of evidence

Study	Title	Author	Journal / Country/Year	Objective/Methods	Results	Conclusion	Level of Evidence
07	Data feedback reduces door-to-balloon time in patients with ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention <sup>12</sup>	Lin <i>et al.</i>	Heart Vessels/ TAIWAN/2010	To assess the effect of data feedback on D2B time and its seven individual components in primary angioplasty. / Cohort study	The proportion of patients treated within 90 min increased from 26.8 to 55.0%. The most significant decrease occurred in median door-to-ECG, consult-to-cardiologist, and puncture-to-balloon time.	Data feedback to the emergency department and catheterization laboratory staff led to a reduction of 25 minutes in D2B time.	IV
08	Expansion of a regional ST-segment-elevation myocardial infarction system to an entire state <sup>13</sup>	Jollis <i>et al.</i>	Circulation/ EUA/ 2010	To determine whether expanding the STEMI system to all hospitals and EMS agencies statewide would improve the rate and speed of myocardial reperfusion / Cohort study	Door-to-balloon time fell for all patients. 50% of patients received reperfusion within 90 minutes. The median treatment time for hospital transfer patients was 113 minutes.	Reperfusion time can be reduced, but more emphasis should be given to patients requiring inter-hospital transfer.	IV
09	Transport time and care processes for patients transferred with ST-segment-elevation myocardial infarction <sup>28</sup>	Muñoz <i>et al.</i>	Circulation Cardiovascular Intervention/ EUA/ 2012	To systematize best practices and simultaneously search for new ways of improving and simplifying the current system for treatment of STEMI in a statewide hospital network/Cohort study	The longest reperfusion time of patients who needed to be transferred was achieved at the first hospital. Only 20% of patients received reperfusion within 90 minutes.	It is still necessary to investigate ways of reducing reperfusion time in transferred patients, especially during transfer between the first and the second hospital	IV

In Brazil, prehospital care teams are part of the Emergency Mobile Care Service (SAMU), which may be composed which can be composed by a team of nurse technicians or by a physician and a nurse. There are no paramedics in Brazil. Therefore, it is possible that the implementation of this strategy may be feasible in the Brazilian context, since part of the team is already trained to interpret ECG recordings. Nevertheless, it is important to first analyze the costs of such implementation.

Early notification of the catheterization laboratory was used as a strategy - even if not always as the main strategy - in seven of the nine studies included in this review.<sup>10-12,15,18,27,30</sup> Notification of the catheterization laboratory should be done through a maximum of two calls after prehospital ECG confirmation of STEMI, both for patients directly transported and for those transferred. The use of this method could generate "false" notifications, as other reperfusion strategies may be chosen after arrival at the tertiary hospital. Notwithstanding, the benefits of early notification outweigh the detriments, because they do not create losses to the staff nor to the patient.

### **DIRECT PATIENT TRANSFER FROM THE FIELD TO THE CATHETERIZATION LABORATORY**

Direct transfer of patients with STEMI to the catheterization laboratory was used in four studies, together with other strategies such as prehospital ECG and early notification of the catheterization laboratory.<sup>12,15,27,30</sup> This strategy resulted in a reduction of door-to-balloon times. Yet other studies suggest that the impossibility of direct transfer leads to the need of inter-hospital transport to provide access to resolute treatment. And that this transfer may result in longer myocardial ischemic times.

Study number nine used different modes of inter-hospital transportation: ground and air (helicopter). It was found that helicopter transport was associated with longer ischemic time - due to longer door-in door-out times - and could not be used as a strategy to reduce door-to-balloon time. This conclusion is controversial, as the authors themselves recognize, since air transfer has been found to be a successful strategy in other studies. This indicates the importance of an appropriate structure in regard to the positive development of air transport of patients, so that it can be truly effective and beneficial to patients.

Study number 8 assessed the expansion of the STEMI system to all hospitals statewide and found that it resulted in a reduction of door-to-balloon times, but did not affect transfer times.

Guideline recommendations suggest a maximum of 30 minutes for each stage of care provided to transferred patients (initial hospital, transfer and hospital with catheterization laboratory) so that a reperfusion time of less than 90 minutes can

be achieved. In addition, it is essential to find out the main reasons for delays in the treatment of these patients.<sup>4</sup>

A cohort study conducted in Dallas (USA) between 2003 and 2009 aimed at identifying reasons for delays in treatment and outcomes of patients with STEMI requiring inter-hospital transfer. The study included 2,034 patients transferred for primary angioplasty from hospitals located between 95 and 330 km. In spite of the distance between the sites, 30.4% of patients could receive reperfusion therapy within 90 minutes. Longer treatment delays occurred in the secondary hospital (64%), where they were associated with transport waiting time and delays in the emergency room, as well as with doubts regarding the diagnosis and non-conclusive initial ECG findings, and in the tertiary hospital (15.7%). With regard to transportation, longer delays were more associated with the distance than with the transport itself.<sup>9</sup>

Since inter-hospital transfers lead to longer ischemic times, an important strategy would be to avoid them.<sup>4</sup> However, Brazilian patients frequently require transfer to a catheterization laboratory to continue treatment and door-to-balloon time may be compromised by the vast territorial distances, the reduced number of cardiac beds and the small number of available air and ground transport vehicles.

### **COMMUNICATION BETWEEN PROFESSIONALS INVOLVED IN THE PERCUTANEOUS INTERVENTION PROCESS**

Communication between professionals involved in the process of percutaneous intervention is a strategy that aims to prevent further delays when the patient arrives at the tertiary hospital.<sup>12</sup> Study number assessed the effects of this strategy and showed that it was effective in the intra-hospital context.

Although little addressed in the literature, communication is a key factor in hospital care and patients' routine care, especially when multidisciplinary teams are involved. Moreover, it is a low-cost resource that can be used in any location.

This strategy is very important because it may speed up bureaucratic processes and contribute to reduce ischemic times. If there is no search for improvements in this area, fast diagnosis and patient transfer would be a lost effort. This strategy is feasible and could be successful in Brazilian hospitals.

### **EXPANSION OF REGIONAL SYSTEMS FOR TREATMENT OF STEMI**

The expansion of regional systems for treatment of STEMI was assessed in four studies that designed protocols to standardize treatment of STEMI patients in several hospitals, with or without catheterization laboratory, and in conjunc-

tion with prehospital care teams to reduce reperfusion times. Moreover, prehospital ECG was used in all of the aforementioned studies as well as the attempt to provide direct transport to tertiary centers.<sup>11,13,18,27</sup>

These studies gathered several possibilities in one single initiative. In addition to combining the strategies previously mentioned, they also standardized treatment in order to make sure that all care units deliver the same level of treatment, always prizing communication and quick decision-making.<sup>11,13,18,27</sup> Nevertheless, they presuppose the existence of appropriate structures and quality manpower, which are not always available in Brazil.

Most strategies for reducing door-to-balloon time in the studies included in this review are in line with the recommendations of *the American Heart Association*, namely: system activation through a single call to the hospital receiving the STEMI patient; prevention of delays at the start of inter-hospital transport; requiring the cardiac catheterization team to be prepared to perform the procedure within 20 minutes of notification; promoting effective information exchange between all members of the team that are involved in the process.<sup>31-34</sup> It is highlighted that the use of non-uniform strategies results in longer ischemic times, complicating the entire process of treatment of patients with STEMI.<sup>32</sup>

Despite all the evidence regarding treatment by health care teams in extra- and intra-hospital settings, strategies to reduce time from the onset of symptoms to the search for help are little addressed, which results in longer myocardial ischemic times and a greater number of associated complications. Patients oftentimes wait more than 24 hours before looking for help, which may lead to great complications and worse outcomes. Studies claim that this is the most difficult factor to be changed, because this time period depends exclusively on the patient.<sup>1,5,16,34</sup>

Strategies targeting the general population are also very important, especially to encourage the use of emergency mobile services, as many studies have shown that STEMI patients arriving in an ambulance experienced shorter treatment times.<sup>15,27,29</sup>

## CONCLUSION

Despite the existence of numerous studies on strategies for reducing door-to-balloon time, identifying the best strategy to achieve this goal is difficult, because the general context needs to be analyzed. The studies that addressed intervention with prehospital ECG (level of evidence III) and those that addressed early notification of the catheterization laboratory and direct transfer to the catheterization laboratory (level of evidence IV) were found to present the best results in reducing ischemic times in AMI. In studies using these strategies, more than 50% of patients were reperfused within 90 minutes or the remarkable time of 60 minutes.

Interventions to reduce door-to-balloon time were infrequently applied alone. We see that there is a perception that several different interventions should be implemented together – prehospital ECG, direct transfer to the catheterization laboratory, organization of the transfer system, importance of information exchanges during the process, and early notification of the catheterization laboratory - in order to make it possible for them to be systematically reproduced in bigger contexts such as regional protocols.

This study revealed that this is an area where there is a great gap in the Brazilian literature, because we could not find any national studies on the topic. This reality translates into an obstacle to the implementation of such strategies in the Brazilian context.

It is of paramount importance to identify the regional needs related to structure, input, investments in training, as well as what can be done to improve the extra- and intra-hospital care system in order to provide efficient care in a timely manner and reduce negative outcomes for patients, such as the occurrence of cardiac arrest, tachyarrhythmias and heart failure. This could then help decrease AMI morbidity and mortality, hospital stay, and consequently, costs for the National Health System.

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