Evaluation of Strategies to Reduce Reperfusion Times in ST-Segment Elevation Acute Myocardial Infarction. Mobile Health Experience (mHealth)

Evaluación de estrategias para reducir los tiempos de reperfusión en el infarto agudo de miocardio con elevación del segmento ST. Experiencia en salud móvil (mHealth)

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ABSTRACT

Background: Mobile phone transmission of electrocardiogram photos would reduce time to reperfusion in ST-segment elevation acute myocardial infarction.
Objective: The aim of this study was to evaluate the efficacy of mobile phone technology as a strategy to shorten times to reperfusion.
Methods: A quasi-experimental, multicenter study, including patients from the Greater San Miguel de Tucumán, was carried out from August 2017 to April 2018. The strategy consisted in the transmission of electrocardiogram photos by WhatsApp, for the early activation of the infarction protocol. Delay times and impact on the quality of care were assessed.
Results: A total of 105 patients were analyzed. A significant reduction of the time to diagnosis was observed in the mobile health group [30 min (10-90) vs. 10 min (5-15); <p=0.0001] and in the door-to-balloon time [166 min (135-210) vs. 132 min (80-150); p=0.019].
Conclusions: The mobile health strategy improved the diagnosis and the door-to-balloon times, though they are still suboptimal.

Key words: ST-segment elevation acute myocardial infarction - Myocardial Reperfusion – Telemedicine

RESUMEN

Introducción: La transmisión de la foto del electrocardiograma vía teléfono móvil, reduciría los tiempos de reperfusión en el infarto agudo de miocardio con elevación del segmento ST.
Objetivo: Evaluar la eficacia de la tecnología celular como estrategia para acortar los tiempos de reperfusión.
Métodos: Estudio cuasi experimental, multicéntrico, que incluyó pacientes del Gran San Miguel de Tucumán, desde agosto de 2017 a abril de 2018. La estrategia consistió en la transmisión de fotos del electrocardiograma vía WhatsApp, para la activación temprana del protocolo de infarto. Se midió tiempos de demora e impacto en la calidad de atención.
Resultados: Se analizaron 105 pacientes. Se observó reducción significativa del tiempo diagnóstico, 30 (10-90) vs. 10 (5-15) minutos en el grupo salud móvil < p = 0,0001; y en el tiempo puerta balón, 166 (135-210) vs. 132 (80-150) minutos p = 0,019.
Conclusiones: La estrategia salud móvil mejoró los tiempos al diagnóstico y puerta balón, aunque, siguen siendo subóptimos.

Palabras clave: Infarto de miocardio con elevación del ST - Reperfusión miocárdica - Telemedicina

Abbreviations

ECG	Electrocardiogram	**PPCI**	Primary percutaneous coronary intervention
FMC	First medical contact	**SIPROSA**	Sistema Provincial de Salud de Tucumán (Provincial
EMS	Emergency medical system		Health System of Tucumán)
mHealth	Mobile health	**STEMI**	ST-segment elevation acute myocardial infarction
PHCC	Primary healthcare center		

INTRODUCTION

Time that elapses between the onset of symptoms and the reperfusion of the involved vessel is critical to reduce the morbidity and mortality of patients with ST-segment elevation acute myocardial infarction (STEMI). (1)

Delays in treatment are a quality of care index that should be recorded and reviewed regularly. (2)

There are several components in the delay of care in STEMI and various ways of recording and disclosing them. (3)

Registries around the world show suboptimal times compared with those established by clinical practice guidelines for the management of STEMI. (4, 5)

Guidelines recommend that each region follows its own reperfusion strategy based on establishing a local situation diagnosis and working in networks to activate the infarction code in order to enhance medical care and help to reduce delays and improve clinical outcomes. (6)

The use of telemedicine improves prehospital diagnosis and shortens the delay times for coronary reperfusion. (7)

In 2005, Terkelsen et al. demonstrated the benefit of prehospital diagnosis for STEMI patients. In his study, the door-to-balloon time with prehospital diagnosis was significantly reduced compared with that in patients with in-hospital diagnosis (34 min vs. 97 min, p <0.001). (8)

At present, these results have been reproduced in many countries despite the geographical context and healthcare resources. (9-11)

A public network program for telemedicine-aided reperfusion of myocardial infarction performed at Hospital de Alta Complejidad en Red El Cruce) (El Cruce High-Complexity Network Hospital) in Argentina evidenced a significant reduction of the times to implement reperfusion. (12)

Currently, Mobile Health (mHealth) technology expands the specialized medical service application using the cell phone network for the transmission of mobile data as a tool to increase coverage and strategy, in order to improve the efficiency of health services and optimize the use of resources. (13)

In the Public Health Network of the Province of Tucumán, there was lack of coordination between the different scenarios, causing delays in reperfusion times. This problem prompted the hypothesis that the use of mobile phones (mHealth) as a tool to be applied in the early diagnosis of infarction would reduce reperfusion times and improve quality of care.

OBJECTIVES

The aim of this study was to assess the efficacy of cell phone technology (mHealth) as a strategy to shorten the times to reperfusion in patients with STEMI in the public health network of the city of San Miguel de Tucumán and also to evaluate the percentage of patients treated according to the type of reperfusion therapy.

METHODS

Description of the study area

The Sistema Provincial de Salud (SIPROSA) (Provincial Health System) of Tucumán consists of a network of primary healthcare centers (PHCC), second level hospitals, an ambulance network, and a referral hospital (Hospital Centro de Salud Zenón Santillán)) with 24-hour hemodynamics availability.

Type of study and design

A quasi-experimental, multicenter study, including patients diagnosed with STEMI admitted to the Coronary Care Unit of Hospital Centro de Salud Zenón Santillán was carried out in the period between August 2017 and April 10, 2018.

The intervention consisted in equipping the PHCC and ambulances with electrocardiograph and cell phone with internet for the transmission of the electrocardiogram (ECG) photo via WhatsApp to the coordinating cardiologist.

The post-intervention results (mHealth group) were compared with the historical control group without intervention (pre-mHealth group), from August 2016 to April 10, 2017.

Patients referred to private centers, those who were recruited outside the geographical work area and those whose ECG image was not transmitted via WhatsApp were excluded from the study.

Procedures

A working protocol was developed for the transmission of the ECG photo via WhatsApp from the first medical contact (FMC) in PHCC and the emergency medical system (EMS), which is received by the coordinating cardiologist who confirms the diagnosis and activates the infarction protocol, as shown in Figure 1.

The emergency room staff of the PHCC and EMS were trained on the working protocol and the use of the electrocardiograph. During the month of August a pilot test was carried out; subsequently, the data obtained was collected until April 10, 2018.

Study variables

Population characteristics were analyzed: age, gender, cardiovascular risk factors, cardiovascular history, and electrical location of the infarction.

Time to diagnosis: time elapsed from the FMC until first ECG, measured in minutes. Source: clinical history.

Time to EMS: time elapsed from diagnosis to reference hospital admission, measured in minutes. Source: clinical history.

Reperfusion time: time elapsed from FMC to initiation of reperfusion therapy (balloon inflation or initiation of thrombolytic therapy), measured in minutes. Patients were divided based on whether the FMC was in a PHCC or EMS, or if the FMC was in a referral center. Source: clinical history.

Total time: time elapsed between symptom onset until initiation of reperfusion treatment (primary angioplasty or thrombolytic therapy), measured in minutes. Source: clinical history.

Statistical analysis

An Excel database was used for the statistical analysis. A descriptive and associative analysis of the variables of interest was performed. Continuous variables were expressed as median and interquartile range according to their distribution. Categorical variables were expressed as numbers and percentages. Student´s t-test and the chi-square test were used with a significance level of 5%.

STATA 11.0 was used for statistical analysis.

Ethical considerations

Since it was a study based on an intervention in the system, and not on the individual patient, an informed consent was not requested.

The working protocol was evaluated and approved by the Health Research Directorate of SIPROSA, the Teaching and Research Committee of Hospital Centro de Salud Zenón J. Santillán, and the SIPROSA Teaching and Research Committee of the Health Emergencies Directorate.

RESULTS

A total of 62 patients was analyzed in the group without strategy, and 43 patients in the group with strategy. They were also subdivided into groups according to whether the patient had the FMC in a PHCC or EMS, or if the FMC was in a referral center.

There were no significant differences in the characteristics of the groups studied, in terms of cardiovascular risk factors, cardiovascular history and electrical location of the infarction. Mean age was 53.8±10.7 years and 86.5% were men.

Reperfusion therapy

The percentage of patients treated and of primary percutaneous coronary intervention (PPCI) increased by 5%, and 8.8%, respectively. There were no significant differences between both groups (Figures 2A and 2B).

Table 1 shows a significantly lower time to diagnosis and door-to-balloon time in the intervention group.

Table 2 indicates that the benefit of the mobile strategy results in a significant shorter time to diag-

nosis in the prehospital setting of the mHealth group with FMC in the PHHC or EMS (30 min vs. 15 min)

DISCUSSION

In the group without strategy, most PHCC and EMS did not perform an ECG in the FMC. In the strategy group, an improvement was observed with a significant reduction in the time to diagnosis and the door-to-balloon time, due to the more effective coordination in the network with the use of mobile devices. It was observed that no patient referred from another center received thrombolytics in the FMC, with very long median times, close to 100 minutes. This time is reduced to more than half in patients with FMC in the reference centers. A hypothesis, which will be the reason for a subsequent substudy, is that the "social coverage factor" would influence the choice of the type of reperfusion therapy but not the "time factor". Regarding the transfer time, no significant differences were observed between the groups. Training and awareness of the EMS staff could optimize times.

Limitations

The idiosyncrasy of the health staff reflected a high percentage of absence in the training stage and in the loss of cases during follow-up for not complying with the working protocol.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the website/Supplementary material).

Fig. 1. Flow chart of the patient with chest pain who enters the mobile Health network (mHealth) in the public health system.
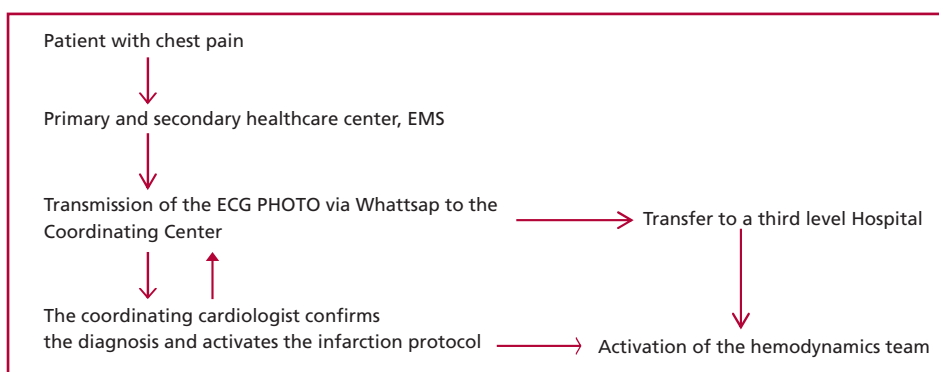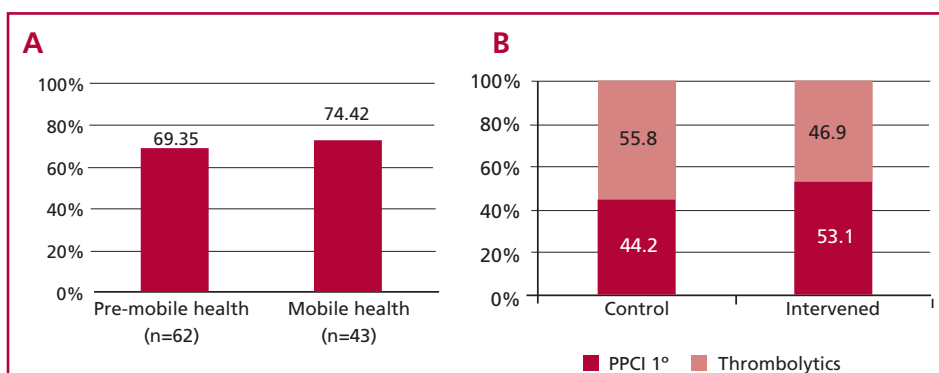

Fig. 2. A. Percentage of treated patients. **B.** Types of reperfusion therapy

Time	Pre-mHealth group n = 62	mHealth group n = 43	p-value
Time to FMC	107 (40-210)	120 (60-230)	0.78
Time to diagnosis	30 (10-90)	10 (5-15)	<0.0001
Time to EMS	79 (60-1.407)	71 (70-1439)	0.602
Door-to-balloon time	166 (135-210)	132 (80-150)	0.019
Door-to-needle time	87 (80-124)	95 (45-120)	0.648
Total time of reperfusion with PPCI	288 176-366)	236 (160-313)	0.229
Total time of thombolytic reperfusion therapy	158 (135-255)	210 (125-260)	0.310

Table 1. Analysis of times in minutes (median)

mHealth: Mobile Health. FMC: First medical contact. EMS: Emergency medical service. PPCI: Primary percutaneous coronary intervention.

Time	FMC in the referral center		
	Pre-mHealth group n = 18	mHealth group n = 21	p-value
Door-to-balloon time	166 (50-247)	127 (76-143)	0.515
Door-to-needle time	52 (29-85)	42 (35-95)	0.280
Time to diagnosis	10 (5-20)	8 (5-10)	0.152
Time	FMC in the referral center		
	Pre-mHealth group n = 44	mHealth group n = 22	p-value
FMC-balloon time	171 (140-208)	147 (80-172)	0.338
FMC-needle time	95 (82-129)	110 (90-135)	0.161
Time to diagnosis	30 (14-90)	15 (10-125)	< 0.0001

Table 2. Analysis of time in minutes (median) of patients with FMC in the reference center or referral center, according to the study group.

mHealth: Mobile Health. FMC: First medical contact. PHCC: Primary healthcare center. EMS: Emergency medical service.

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