¹ ENCORE Hospital, Aparecida de Goiânia,
GO, Brazil.

Results of an infarction care telemedicine program

Resultados de um programa de atendimento ao infarto por telemedicina

Victor Eduardo de Almeida e França^{1ID}, Pedro Arthur Ferreira Borges¹,
Leonardo Veloso do Amaral¹, Max Weyler Nery¹, Debora Rodrigues¹,
Fernanda Leão Martins¹, Fernando Henrique Fernandes¹,
Adriano Gonçalves de Araújo¹, Flavio Passos Barbosa¹,
Álvaro de Moraes Júnior¹, Maurício Lopes Prudente¹, Giuliano Gardenghi¹

DOI: 10.31160/JOTCI202028A20190028

ABSTRACT – Background: In Brazil, myocardial infarction affects approximately 300 thousand individuals per year, with mortality rate of 30%, and 80% of deaths occur in the first 24 hours. The telemedicine systems, such as Latin America Telemedicine Infarct Network, aim to optimize the stages from triage to treatment. Communication among the emergency care units and tertiary care services is known to be difficult, and the system aims to interconnect triage, physician and transport, facilitating transfer of patients to the cath lab. Therefore, implementing a telemedicine system for myocardial infarction and assessment of cardiovascular outcomes is justified. The objective of this study was to analyze the implementation of a telemedicine program, the characteristics of the population and the time intervals for treatment and transfer, in addition to in-hospital mortality.

Methods: A cohort study with 110 individuals diagnosed as ST-segment elevation myocardial infarction in five emergency care units in the city of Aparecida de Goiânia, from November 2015 to August 2018. **Results:** In the period described, 110 patients were treated, mean age of 58±11 years, 72.2% were male, 53.6% hypertensive, 23.6% diabetic, 27.3% active smokers and 6.4% had a history of previous infarction. Of the patients admitted, 90.9% were submitted to primary percutaneous coronary intervention, and 8.2% of total number of patients died within the first 30 days. **Conclusion:** Implementing a telemedicine system resulted in reduced mortality as compared to the public health system. Despite better care, we observed longer transfer time, which justifies the need to implement fibrinolytic therapy in secondary care units.

Keywords: Myocardial infarction; Telemedicine; Angioplasty

How to cite this article:

França VEA, Borges PA, Amaral LV, Nery MW, Rodrigues D, Martins FL, et al. Results of an infarction care telemedicine program. J Transcat Interv. 2020;28:eA20190028. <https://doi.org/10.31160/JOTCI202028A20190028>

Corresponding author:

Giuliano Gardenghi
Rua Gurupi, Quadra 25, Lote 6 a 8 –
Vila Brasília
Zip code: 74905-350 – Aparecida de Goiânia,
GO, Brazil
E-mail: ggardenghi@encore.com.br

Received on:

Dec 4, 2020

Accepted on:

Mar 13, 2020

This content is licensed under a Creative
Commons Attribution 4.0 International License.

RESUMO – Introdução: No Brasil, o infarto agudo do miocárdio acomete aproximadamente 300 mil pessoas ao ano, com mortalidade de 30%, sendo 80% destas nas primeiras 24 horas. Os sistemas de telemedicina, a exemplo do *Latin America Telemedicine Infarct Network*, objetivam otimizar as etapas, desde a triagem ao tratamento. Sabendo da dificuldade de comunicação entre unidades de pronto atendimento e serviço terciário, o sistema busca interligar triagem, médico e transporte, facilitando a transferência do paciente à hemodinâmica. Desse modo, justifica-se a implementação de sistema de telemedicina voltado ao infarto agudo do miocárdio e à avaliação de desfechos cardiovasculares. O objetivo do presente trabalho foi analisar a implementação de um programa de telemedicina, bem como as características da população e os tempos envolvidos no tratamento e na transferência, além da mortalidade hospitalar. **Métodos:** Estudo de coorte com 110 indivíduos diagnosticados com infarto agudo do miocárdio com supradesnívelamento do segmento ST em cinco unidades de pronto atendimento do município de Aparecida de Goiânia, no período entre novembro de 2015 e agosto de 2018. **Resultados:** No período descrito, foram tratados 110 pacientes, com média de idade de 58±11 anos, sendo 72,2% do sexo masculino, 53,6% hipertensos, 23,6% diabéticos, 27,3% tabagistas ativos e 6,4% com história de infarto prévio. Dos pacientes admitidos, 90,9% foram submetidos à intervenção coronária percutânea primária e, do total, 8,2% foram a óbito nos primeiros 30 dias. **Conclusão:** A implementação do sistema de telemedicina resultou em redução da mortalidade comparativamente ao sistema público de saúde. Apesar da melhora da assistência, observamos tempos elevados de transferência, o que justifica a necessidade de implementação de terapia fibrinolítica nas unidades secundárias.

Descritores: Infarto do miocárdio; Telemedicina; Angioplastia

INTRODUCTION

The ST-segment elevation myocardial infarction (STEMI) is a clinical syndrome characterized by chest pain associated with ST-segment elevation on the electrocardiogram (ECG) and elevated myocardial necrosis markers.¹ According to the fourth update of the universal definition, it is characterized by the elevation of myocardial necrosis biomarkers (troponins) associated with electrocardiographic and/or typical clinical manifestation.²

Infarction stands out due to its elevated mortality, especially in the acute phase, in which up to 65% of deaths occur in the first hour, and up to 80% in the first 24 hours, and most deaths occur outside the hospital environment.^{3,4} North American evidence shows that patients take about 1 hour and 30 minutes to 2 hours to seek medical assistance, while less than 20% get to the service within this period in Brazil.^{1,3}

With broader knowledge about the pathophysiology and treatments of the disease, the precise diagnosis and reduced time to conduct and read the ECG led to a significant reduction in mortality, as well as the administration of timely treatment, resulting in well-established current goals.³ We have the objective of performing coronary cineangiography and primary percutaneous coronary intervention (PCI) in up to 90 minutes after patient admission to the emergency department, whereas in transfers from a hospital to a qualified center, the goal is in up to 120 minutes. Another feasible option would be the performance of thrombolysis within 30 minutes of admission in those medical facilities where PCI is not available, or if the patient's transfer is estimated at longer than 120 minutes.^{1,3,5,6}

Despite progression of diagnostic methods, access of patients to tertiary care services with the capacity for PCI (hubs) is very scarce, especially in public facilities. Considering this reality, new strategies for the diagnosis and interconnection between primary and secondary care services (spokes) to the hubs is needed in order to reduce these times, with the impact of precocity of revascularization, costs, and hospital mortality.⁷⁻⁹ In this way, it is possible to reduce the inability of these individuals that generally are at a productive age.

In the public health system, hospital mortality due to STEMI is still high. In the year 2000, it corresponded to 16.2%, in 2005 to 16.1%, and in 2010, to 15.3%.¹⁰⁻¹² However, we are still very distant from the North American reality, where mortality varied between 5% and 6% in 2009.¹

Based on the rationale we describe, the Latin America Telemedicine Infarct Network (LATIN) program was implemented in the city of Aparecida de Goiânia, in the metropolitan region of Goiânia, located in the state of Goiás, which has only one cath lab service.

The objective of the current study was to analyze the implementation of the program, as well as the characteristics of the population and the time involved in treatment and transfer, besides hospital mortality.

METHODS

This is a cohort study carried out in the city of Aparecida de Goiânia, in which data collection was done at the Hospital Encore, by means of the LATIN platform (<https://latin.telemedicina.com/index.php/login>). The electronic medical records of patients received by means of the LATIN system from November 2015 to August 2018 were analyzed. Patients seen by the platform came from five of the emergency care units (ECU), the spokes.

Data relative to the times of admission and transfer were recorded electronically by LATIN and Tasy (medical record system of the hub). The time of the original ECG determined the first care given, and at hospital reception or at the cath lab, hospital admission would be determined. The moment of the PCI was defined by means of the time recorded in the procedure media, containing an inflated balloon in the culprit lesion, aiming to minimize registration biases in the records. This study was approved by the Research Ethics Committee of the *Hospital de Urgência de Goiânia* – linked to *Plataforma Brasil* (CAAE: 94882318.7.0000.0033).

The five spokes were all located in the city of Aparecida de Goiânia and varied from 2.7 to 21.3km distance to the tertiary care service (cath lab). According to what was evaluated in ideal conditions by the Google Maps electronic tool, the transfer time could vary from 8 to 37 minutes, using an automotive vehicle (Table 1).

Table 1. Spokes, estimated transfer time and distance

Medical Centers (spokes)	Transfer under normal conditions (minutes)	Distance (kilometers)
Cais Colina Azul	23	12.1
Cais Nova Era	7	2.7
ECU Flamboyant	37	21.3
ECU Buriti Sereno	22	11.8
ECU Brasicon	26	13.8
Mean and standard deviation	23.0±10.7	12.3±6.6

Spoke: origin; ECU: emergency care unit.

None of the spokes had a cardiology service, so that ECG results were reported by cardiologists who were part of the International Telemedical Systems (ITMS), a component of the LATIN system. Thus, the electrocardiographic diagnosis of the STEMI was established and the spoke was informed; right away, an e-mail and a direct call were sent to the cardiologist on call at the hub for the case to be described, a vacancy verified, and immediate transport provided. Patients with an evolution greater than 12 hours were excluded from the protocol.

The Emergency Medical Services (SAMU, acronym in Portuguese) was triggered by the spoke team after release of a vacancy in an intensive therapy unit (ICU) at the hub, as well as the confirmation of infarction by the cardiology team. The SAMU provided feedback on the time of departure from the point of origin, so the cath lab team could get prepared.

At the time of diagnosis and after the release of the vacancy, the hub's hemodynamic service was contacted regarding the transfer. At hospital admission, invariably the patient was admitted to the cath lab service without going through the emergency department, to proceed with the coronary angiography.

Considering the presentation of the data in the results, the categorical variables were expressed as absolute numbers and percentage. The continuous variables were expressed as mean±standard deviation. For tabulating the data, Microsoft Excel 365®, version 2016 was used.

RESULTS

The program was implemented at the end of 2015 and had its first STEMI case on November 30, 2015. During the entire program, until mid August 2018, 55,827 ECGs were generated. During the period described, 465 (0.8% of total) patients were diagnosed with STEMI, and 119 (25%) were characterized as progressed (more than 12 hours), 12 (2.5%) died at the spoke, 44 (9.4%) were not admitted due to insufficient beds, 176 (37.8%) were reclassified as another diagnosis, and 110 (23.6%) were admitted to the hub. The characteristics of the treated group are displayed on table 2.

Table 2. Clinical characteristics of the participants

Analyzed variables	
Age, years	58±11
Male	80 (72.7)
BMI	27.1±5.6
Smoking	30 (27.3)
Former smoker	13 (11.8)
Hypertension	59 (53.6)
Chagas disease	3 (2.7)
Previous infarction	7 (6.4)
Diabetes mellitus	26 (23.6)

Results expressed as mean±standard deviation or n (%).
n=110 individuals studied in the hub.
BMI: body mass index.

After admission, six patients (5.5%) were reclassified as evolved infarction, and the early invasive strategy was chosen for two of them (within 24 hours). On table 3, the characteristics of admission to cath lab, times of treatment, and pre- and post-PCI complications were described.

Table 3. Characteristics upon hospital admission

Analyzed variables	
Killip	
I	82 (75.2)
II	18 (16.5)
III	2 (1.8)
IV	7 (6.4)
Cardiac arrest before admission	5 (4.6)
Transfer time, min	126.3±75.5
M2B, min	183.9±87.2
D2B, min	54.3±37.7
Creatinine, mg/dL	1.2±0.9
CKD-EPI	86.1±27.4

Results expressed as mean±standard deviation or n (%).
n=110 individuals studied in the hub.
M2B: first medical contact to balloon-time; D2B: door-to-balloon time; CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration.

The analysis of time of treatment as per the guidelines showed adequate balloon-door time (D2B) in 93 (89.4%) patients, and adequate time of the first medical contact to balloon (M2B) in 21 (19.8%) of them. Of the total number of patients, 100 (90.9%) were submitted to primary PCI, with a mean of 1.2±0.4 stents implanted, in which the radial access was the preferred in 105 cases (96.3%). The other characteristics are described on table 4.

Table 4. Characteristics of procedures and clinical outcomes

Analyzed variables	
Adequate M2B	21 (19.8)
Adequate D2B	93 (89.4)
Cardiac arrest after balloon	10 (9.1)
Arterial access	
Radial	105 (96.3)
Femoral	3 (2.8)
Brachial	1 (0.9)
Treated artery	
LAD	51 (46.3)
RCA	50 (45.4)
LCx	8 (7.2)
SF-Ao-LAD	1 (0.9)
Primary PCI	100 (90.9)
Number of stents	1.2±0.4
LVEF after intervention	50.1±10.6
Days at ICU	3.8±2.6
Days at inpatient unit	2.2±2.2
Length of hospital stay	6.0±4.0
Mortality	9 (8.3)

Results expressed as mean±standard deviation or n (%).
n=110 individuals studied in the hub.
M2B: first medical contact to balloon-time; D2B: door-to-balloon time; LAD: left anterior descending artery; RCA: right coronary artery; LCx: left circumflex artery; SF-Ao: saphenous vein graft; PCI: percutaneous coronary intervention; LVEF: left ventricle ejection fraction; ICU: intensive care unit.

During the procedure, three patients (2.7%) presented with total atrioventricular block, and two required a temporary pacemaker (1.8%). During hospitalization, 91 patients (82.7%) were evaluated with echocardiography, which demonstrated the left ventricle ejection fraction (LVEF) >50% in 47 (51.6%), between 40% and 49% in 30 (33%), and <40% in 14 (15.4%).

Of all patients treated, in only 52 (47.7%) no supplementary treatment was proposed from the coronary point of view, such as additional PCI or coronary artery bypass grafting.

DISCUSSION

The implementation of telemedicine, within the framework of the myocardial infarction, affords a quick diagnosis, based on the documentation of a 12-lead ECG and the interconnection with a reporting center, favoring rapid contact with tertiary care services and the possible referral of the patient to more effective treatment, or the performance of fibrinolytic therapy at the point of origin.^{1,3,8,11,13}

The LATIN program is the first with such characteristics in the state of Goiás, seeking, as main therapy, the performance of a primary PCI and the consequent reduction of times for diagnosis and transfer to the hub. Nevertheless, within our reality, we observe a great difficulty in obtaining these internationally established goals due to the large delay in transfers (mean 126.3 ± 75.5 minutes). It is believed that the use of exclusive ambulances would lead to an advance in this statistics, since other measures implemented were not capable of improving this parameter, despite the tendency to improve the time of transfer between 2015 and 2018 ($p=0.09$). In comparison with similar studies, we noted lower M2B times relative to our study – 1 hour on average –, reinforcing the need for improving agility of the transport systems. Nonetheless, it is important to point out that the said service only had one large spoke facilitating allocation to the transport service.¹⁰

The mean door-balloon time at the hub was 54.3 ± 37.7 minutes, with a median of 46 minutes; however, not considering the reclassified patients as evolved infarction, it was 51 ± 31.3 minutes with a median of 44 minutes. Such values are closed to the means of a similar study,¹⁰ but based on literature,⁹ there is still space for improvements, especially in the communication between transport teams and hubs teams, optimizing the cath labs, avoiding idleness, and making access of infarcted patients easier.

Mortality due to STEMI in the in-hospital period was 8.3%, characterizing a significant reduction when compared to the mortality rates in the public service, which reached 26.1%¹¹ and 15.3%,¹⁰ in 2009 and 2010, respectively. In the region studied the rate is estimated to be even higher, because of difficult access to thrombolysis – a fundamental approach which should be guaranteed.^{5,11} One should also consider that before the current program presented in this article, there was no access to primary PCI by the public health service in the said city.

As demonstrated at other services, the timely pharmacological strategy proves to be as important as the primary PCI, according to studies that demonstrate reduction in mortality of up to 18.8%, in services with prevalence varying from 34% to 81% of individuals treated initially with pharmacological treatment, followed or not by a pharmacological-invasive or rescue strategy.^{4,11}

Implementation of the pharmacologic therapy at the spokes is paramount to treat the population described, with proven reduction in mortality.^{1,3,4,11} We reiterate that the guaranteed access to thrombolytics, by means of the Ministry of Health ordinance number 2,994, of December 13, 2011, that “approves the line of care of the myocardial infarction and the acute coronary syndromes protocol,” which guarantees the supply of alteplase and tenecteplase.¹⁴

Lastly, we should highlight the need for actions in health education, considering that the impact of delay in seeking medical care in infarction cases is high. In the sample observed, we point out the group with approximately 25% of individuals who entered the spoke more than 12 hours from the beginning of symptoms, a fact similar to other studies in which the incidence varied from 22% to 43%.^{4,15}

The present study has a limitation, which should be pointed out. Since it is an observational study, our survey was based only on the collection of data present in medical records, which even when filled out carefully, make their information subject to completion biases by the absence of adequate methodological control in the day-to-day welfare routines. Despite the limitation, we believe it is possible, based on the data found, to compare the reality demonstrated in similar investigations, providing evidence of how to carry out treatment of individuals affected by STEMI in Brazil.

CONCLUSION

The implementation of the telemedicine service in a city in the Midwestern Region, in Brazil, resulted in systematization and integration between the public and private services, enabling agility to make diagnosis and the possibility of adequate percutaneous coronary intervention for the treatment of infarction. In addition to the improving and expediting diagnosis, comparatively with the reality of public services in Brazil, we can infer a significant improvement in the mortality rate related to infarction. However, we also note the need for improvement in the transport system, and the implementation and training of the teams at the emergency care units to perform fibrinolytic therapy.

FINANCING SOURCE

None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: VEAF, GG, FHF, AGA, FPB, AMJ and MLP; data collection: VEAF, PAB, LVA and FLM; data interpretation: VEAF, MWN, DR, FLM and MLP; writing of the text: VEAF, PAB e LVA; approval of the final version to be published: VEAF, PAB, LVA, MWN, DR, FLM, FHF, AGA, FPB, AMJ, MLP and GG.

REFERENCES

- O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2013;29(61(4):e78-e140. <https://doi.org/10.1016/j.jacc.2012.11.019>
- Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, White HD; Executive Group on behalf of the Joint European Society of Cardiology (ESC)/American College of Cardiology (ACC)/American Heart Association (AHA)/World Heart Federation (WHF) Task Force for the Universal Definition of Myocardial Infarction. Fourth Universal Definition of Myocardial Infarction (2018). *Circulation*. 2018;138(20):e618-51. <https://doi.org/https://doi.org/10.1161/CIR.0000000000000617>
- Piegas LS, Timerman A, Feitosa GS, Nicolau JC, Mattos LA, Andrade MD, et al. V Diretriz da Sociedade Brasileira de Cardiologia sobre tratamento do infarto agudo do miocárdio com supradesnível do segmento ST. *Arq Bras Cardiol*. 2015;105(2):1-121.
- Solla DJ, Paiva Filho IM, Delisle JE, Braga AA, Moura JB, Moraes X Jr, et al. Integrated regional networks for ST-segment-elevation myocardial infarction care in developing countries: the experience of Salvador, Bahia, Brazil. *Circ Cardiovasc Qual Outcomes*. 2013;6(1):9-17. <https://doi.org/10.1161/CIRCOUTCOMES.112.967505>
- Clemmensen P, Schoos MM, Lindholm MG, Rasmussen LS, Steinmetz J, Hesselfeldt R, et al. Pre-hospital diagnosis and transfer of patients with acute myocardial infarction—a decade long experience from one of Europe's largest STEMI networks. *J Electrocardiol*. 2013;46(6):546-52. <https://doi.org/10.1016/j.jelectrocard.2013.07.004>
- Le May MR, Wells GA, So DY, Glover CA, Froeschl M, Maloney J, et al. Reduction in mortality as a result of direct transport from the field to a receiving center for primary percutaneous coronary intervention. *J Am Coll Cardiol*. 2012;60(14):1223-30. <https://doi.org/10.1016/j.jacc.2012.07.008>
- Cade J, Pereira MA, Janella B, Mehta S, Botelho R, Neto DC, et al. TCT-438 Telemedicine Increases the Access to Primary Percutaneous Coronary Intervention Saving Costs and Lives in ST-Elevation Myocardial Infarction (STEMI). Three-year Analysis of the Latin America Telemedicine Network (LATIN) Program in Sao Paulo East Zone. *J Am Coll Cardiol*. 2018;72(13):B176. <https://doi.org/10.1016/j.jacc.2018.08.1604>
- Mehta S, Botelho R, Fernandez F, Cade J, Prudente M, Cavalcanti R, et al. Time to telemedicine diagnosis (TTD): an important new metric for AMI strategies. *J Am Coll Cardiol*. 2019;73(9):3024. [https://doi.org/10.1016/S0735-1097\(19\)33630-7](https://doi.org/10.1016/S0735-1097(19)33630-7)
- Mehta S, Botelho R, Rodriguez D, Fernández FJ, Ossa MM, Zhang T, et al. A tale of two cities: STEMI interventions in developed and developing countries and the potential of telemedicine to reduce disparities in care. *J Interv Cardiol*. 2014;27(2):155-66. <https://doi.org/10.1111/joic.12117>
- Matsuda CN, Cade JR, Janella BL, Pazolini VA, Cintra GF, Bourget M, et al. Implementação da telemedicina no atendimento inicial do infarto agudo do miocárdio com supradesnívelamento do segmento ST. *J Transcat Intervent*. 2018;26(1):eA0014. [https://doi.org/10.31160/JOTCI2018;26\(1\)A0014](https://doi.org/10.31160/JOTCI2018;26(1)A0014)
- Caluza AC, Barbosa AH, Gonçalves I, Oliveira CA, Matos LN, Zeefried C, et al. Rede de infarto com supradesnívelamento de ST: sistematização em 205 casos diminui eventos clínicos na rede pública. *Arq Bras Cardiol*. 2012 ;99(5):1040-8. <http://www.scielo.br/pdf/abc/2012nahead/aop09512.pdf>
- Lotufo PA. The pace of reduction of cardiovascular mortality in Brazil (1990 to 2017) is slowing down. *Sao Paulo Med J*. 2019;137(1):3-5. <https://doi.org/10.1590/1516-3180.2018.1371090219>
- Botelho RV, Meetha S, Ladeira JC, Fernandez F, Sanchés M, Souza DF, et al. The role of telemedicine in STEMI interventions. In: Meetha S. *Manual of STEMI interventions*. United Kingdom: Wiley-Blackwell; 2017. p. 371-8. <https://doi.org/10.1002/9781119095446.ch25>
- Brasil. Ministério da Saúde. Portaria nº 2.994 de 13 de dezembro de 2011. Aprova a linha de cuidado do infarto agudo do miocárdio e o protocolo de síndromes coronarianas agudas, cria e altera procedimentos na tabela de procedimentos, medicamentos, órteses, próteses e materiais especiais do SUS [Internet]. Brasília (DF): Ministério da Saúde; 2011 [citado Jan 23]. Disponível em: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt2994_15_12_2011.html
- Ribeiro DG, de Andrade PJ, Paes Junior JN, Saraiva LR. Acute myocardial infarction: predictors of mortality at a public hospital in the city of Fortaleza, Ceará state. *Arq Bras Cardiol*. 2003;80(6):614-20. <https://doi.org/10.1590/S0066-782X2003000600004>