ORIGINAL ARTICLE

Optimization of Door-to-Balloon Time Implementing a Process Improvement Program. Results after 5 Years

Optimización del tiempo puerta-balón mediante la implementación de un programa de mejora de procesos. Resultados a 5 años de funcionamiento

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ABSTRACT

Background: If available, primary transluminal coronary angioplasty (PTCA), performed timely and in experienced sites, is the best reperfusion strategy for ST elevation myocardial infarction (STEMI). The door-to-balloon (DTB) time expresses operational efficiency of the site in charge of the PTCA, with an impact on patient's progress. The aim of this study was to analyze the long-term results of a continuous improvement program for the DTB time process.
Methods: Patients diagnosed with STEMI who had undergone PTCA from January 2015 to May 2022 were prospectively and consecutively enrolled. The population was divided in two periods: an immediate implementation period and a long-term follow-up period.
Results: 671 patients were prospectively and consecutively enrolled. During the implementation period (P1) 91 patients were enrolled, and 580 during the program follow-up (P2) . The median (interquartile range, IQR) DTB time was 46 min (29-59) for P1 vs 42 min(25-52) for P2, p=0.055). The second period showed a reduction in pre-activations (P1 54,1% vs P2 30 %, p=0.02) and on-hour procedures (42% for P1 versus 30% for P2, p=0.029).
Conclusion: The registry showed long-term maintenance of good results, despite reduced reactivations and on-hour procedures.

Key words: Myocardial Infarction - Angioplasty - Time-to-Treatment

RESUMEN

Introducción: De estar disponible, la angioplastia primaria (ATCp), en tiempos adecuados y en centros con experiencia, es la mejor estrategia de reperfusión para el infarto agudo de miocardio con supradesnivel del segmento ST (IAMCEST). El tiempo puerta-balón (TPB) es una expresión de eficiencia operativa de la institución que realiza la ATCp, con impacto en la evolución del paciente. El objetivo de este trabajo fue analizar los resultados a largo plazo de un programa de mejora continua del proceso TPB.
Material y métodos: Se incluyeron en forma prospectiva y consecutiva pacientes con diagnóstico de IAMCEST sometidos a ATCp desde enero de 2015 a mayo de 2022. La población se dividió en dos períodos: período de implementación inmediata y período de seguimiento a largo plazo.
Resultados: Se ingresaron 671 pacientes en forma prospectiva y consecutiva. En el primer período de implementación, (P1), se incluyeron 91 pacientes, y en el segundo período, de seguimiento del programa, (P2), 580 pacientes. La mediana (rango intercuartilo, RIC) de TPB fue de 46 min (29-59) en P1 vs 42 min(25-42) en el P2, p=0,055). En el segundo período se evidenció una reducción de las preactivaciones (P1 54,1% vs P2 30%, p=0,02) y los procedimientos on hours (42% en P1 vs 30% en P2, p=0,029).
Conclusión: El registro mostró el mantenimiento de los buenos resultados a largo plazo a pesar de una reducción de las preactivaciones y los procedimientos on hours.

Palabras clave: Infarto del miocardio - Angioplastia - Tiempo de tratamiento

INTRODUCTION

Primary angioplasty (primary transluminal coronary angioplasty, PTCA) has shown to be the best therapy for the management of ST elevation myocardial infarction (STEMI), when performed timely and in experienced sites. (1–4) Total myocardial ischemia time, from the onset of symptoms to reperfusion, is a major predictor factor in these patients. (5) The time elapsed from the arrival of the patient to the healthcare center to the opening of the artery, door-to-bal-

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loon (DTB) time , is considered one of the main hospital care quality indicators. (6–8) Some tools have proven to be of benefit to reduce such time, and therefore, our site developed a protocol in January 2015 to reduce DTB time. The initial results of the program were published in 2016 on this journal, so the aim of this study is to analyze the long-term results of such program. (9)

METHODS

Study design

The program began in January 2015, and our previous article analyzed the results of the "working" phase, from October 2015 to May 2016. In order to evaluate long-term results, we have compared the immediate implementation period of the program (P1), from October 2015 to May 2016, against long-term follow-up of the program (P2), from June 2016 to May 2022.

As specified in the cited publication, the institution's door-to-balloon program is developed by a multidisciplinary team with representatives from different areas: admission (administrative and security staff), external emergency room (doctors and nurses), staff in charge of patient transfer (stretcher-bearers and assistants), hemodynamics (doctors, nurses, and technicians). (9)

DTB time is defined as the time elapsed from patient's admission to catheter guidewire insertion through coronary obstruction, as recommended by international clinical guidelines. The time of catheter guidewire passage is recorded in the angiography machine, providing the possibility of subsequent audits.

DTB time data are monthly reported by the Patient Safety team in our site, with staff outside the DTB program.

Working hours, when the service was available upon admission of a STEMI patient, were from Monday to Friday, from 7 am to 8 pm (on-hour). Beyond this time, service activation was considered as non-working hours (off-hour).

The initial program included a set of strategies with evidence of DTB time reduction. These tools were maintained until the time of writing this paper.

Ready Catheterization lab: The possibility of having the catheterization lab in good conditions to perform the procedure off-hours. This allows the patient to be admitted and prepared for the intervention before the arrival of the hemodynamics team.

Bypassing the ER: Direct access to the catheterization lab for patients admitted through the emergency room (ER) after diagnosis, to avoid delays.

ER pre-activation: Hemodynamics team activation after the request for referral to the site of the patient diagnosed with STEMI, from his home or from an institution. The interventionist's activation occurs upon a single call from admission, both to the ER and the interventional team, after receiving the referral call from the domicile or from a referring site.

Single activation call: One single phone call by the on-duty clerk to the member of the Hemodynamics team in charge that day, reduces the number of communication exchanges from the ER.

Informing of program activation through loudspeakers: Activation process is informed in this way, so that each member involved performs the corresponding tasks, and individual calls are avoided.

Statistical analysis

For quantitative data description, the mean and standard deviation (SD) or median and interquartile range (IQR) were used as applicable. Categorical variables were described using absolute numbers and percentages. For variables comparisons, Chi-square test, t-test or Mann-Whitney test were used as applicable. A two-tailed p value of <0.05 was considered to be statistically significant. The Kruskal-Wallis test was performed for multiple group median comparisons. The SPSS statistical package was used (version 22.0 SPSS Inc., Chicago, IL).

Ethical considerations

Informed consent was required to take part in the study. Approval by the Ethics and Training Committee was obtained, and the principles of the Declaration of Helsinki were followed.

RESULTS

A total of 671 patients were prospectively and consecutively enrolled over 2 periods. During the implementation period (P1) 91 patients were enrolled, and 580 during the program follow-up (P2) (Table 1).

Baseline characteristics showed no differences as regards mean age and sex of patients. The percentage of patients undergoing the procedure as PTCA was slightly higher in P2 (89.7% vs 86.8%), with no differences in the rate of radial artery access or the hemodynamic condition upon admission.

During P1, 71% of patients were admitted through ER versus 48% in P2 ($p=0.001$), which was associated with a higher rate of ER pre-activation (54% vs 30%, $p=0.02$) and bypassing ER. The rate of on-hour procedures was reduced from 42% in P1 to 30% in P2 ($p=0.029$).

The DTB time was similar in both periods: 46 min (IQR 29-59) in P1 vs 42 (IQR 25-52) in P2, with a 97% of patients below target time of 90 minutes in P2. (Figures 1 and 2).

DISCUSSION

Our experience shows that it is possible to maintain a DTB time optimization process in a site over time. We have hierarchically ordered these five findings.

First, the program showed the capacity to maintain a proper DTB time, with more than 97% of patients below 90 minutes, and 80% below 60 minutes. These results are comparable to those reported by other institutions worldwide. (1,10) Maintaining such a process throughout 5 years, with staff changes and institutional development, requires a coordinated effort for the task to become natural and be passed from one person to the other in all groups taking part. Long-term success of this type of processes depends on having a defined list of objectives and the ability to obtain performance metrics; therefore, programs also need the capacity to measure performance indicators. These are specific to the context affecting each site and country. The working group should meet regularly to analyze performance and discuss any required

Table 1. Comparison of the 2 periods

Variable	Period 1 91 patients	Period 2 580 patients	p
Age, years-median (IQR)	60.1 (53.1-70.7)	62 (54-73)	0.221
Men – n (%)	69 (76)	469 (81)	0.585
Radial artery access – n (%)	182 (92.9)	83 (96.5)	0.083
Primary angioplasty – n (%)	170 (86.8)	78 (89.7)	0.014
Killip & Kimball A-B -n (%)	80 (88)	516 (89)	0.839
Times			
Direct consultation – n (%)	27 (29)	300 (52)	0.001
Emergency system - n (%)	64 (71)	280 (48)	0.001
Pre-activation - n (%)	49 (54.1)	174 (30)	0.021
Bypassing ER – n (%)	45 (46)	160 (27.5)	0.001
On-hour – n (%)	38 (42)	174 (30)	0.029
DTB time, min-median (IQR)	46 (29-59)	42 (25-52)	0.119
DTB time lower than 90 min – n (%)	84 (92)	562 (97)	0.055

DTB: door-to-balloon. ER: emergency room. IQR: interquartile range.

Fig. 1. Median door-to-balloon time (min) over time

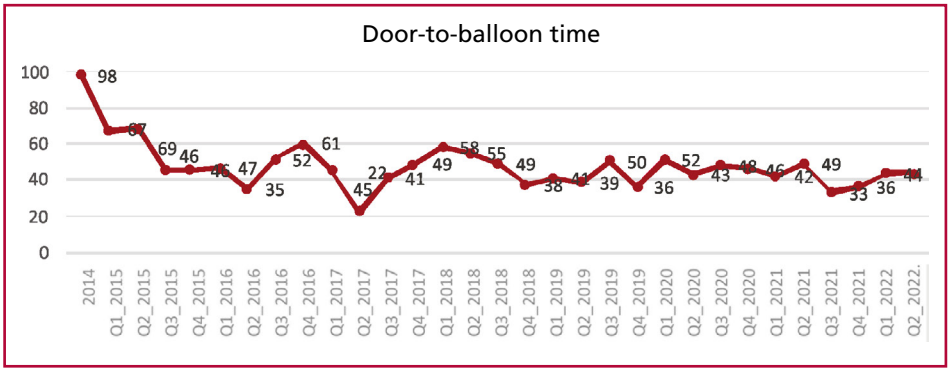

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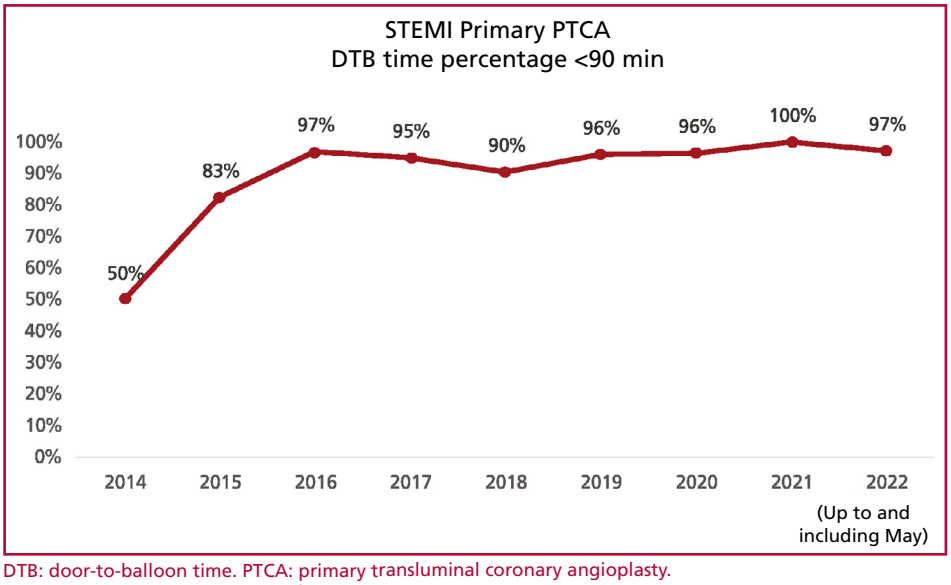
Fig. 2. PTCA in less than 90 minutes over time



DTB: door-to-balloon time. PTCA: primary transluminal coronary angioplasty. STEMI: ST elevation myocardial infarction

adjustment. Please note that the process continued even throughout the pandemics. (11)

Second, a key process to reduce DTB time is pre-activation, which enables the site to be prepared, so that everything is ready for prompt reperfusion as soon as the patient arrives. The pre-hospital ECG allows for early identification and pre-hospital management of STEMI patients and affects both clinical decision-making and choice of target hospital. Prior notice to the receiving hospital shortens reperfusion therapy times and allows actions to be taken there. (6) When comparing both periods, there seems to be a reduction in this phenomenon, which might be explained by a reduced communication flow between the site and the ambulance systems, the inclusion of the pandemics in the analysis, and the fragmentation of the outpatient medical emergency system in the city of Buenos Aires. It is worth pointing out that, despite this reduction, the DTB time remained low, although it definitely represents an opportunity for improvement.

Third, bypassing ER has also shown to reduce in-hospital ischemia times. Studies have shown that long emergency service times contribute to a substantial proportion of general delays between identified patients and pre-hospital STEMI activation. (8,12–14) The protocols used to bypass ER and take patients with suspected infarction directly to the Cath lab have been associated with improved results. Reduced use of this strategy in P2 seems to be directly linked to reduced pre-activations. However, this may happen not necessarily with a pre-activation, but just by evaluating patients with chest pain and an electrocardiogram, upon arrival of the ambulance. Fortunately, for the past few years, many emergency systems have had an ECG machine inside the ambulance when chest pain is the activation diagnosis. It is still necessary to continue to interpret and disclose the benefits of pre-activation.

Fourth, please note that these strategies are applicable to other healthcare systems, provided they are part of institutional programs and performed after analysis of the barriers at the site. The latter is of major importance, as different systems and sites pose different barriers. The management process for patients with STEMI requires the action of different players at the receiving site and joint efforts to optimize the delay. (15,16)

Fifth, we are aware that optimal STEMI treatment should be based on using networks of hospitals with different levels of healthcare connected by an efficient ambulance service. (17) This type of network reduces delayed treatment and increases the proportion of patients receiving reperfusion. Much work is pending in this sense in the city of Buenos Aires. Work teams from scientific associations involved in initiatives such as Stent-Save a Life! Argentina have the mission to improve STEMI patients access to quality reperfusion treatments in order to reduce morbidity and mortality. (18,19) However, to achieve these goals, it is essential to begin with the internal organization of our sites in order to be incorporated in these networks though efficient work.

LIMITATIONS

This is a retrospective analysis of a prospective database. This ensures consecutive patients, but limits process data for analysis.

CONCLUSIONS

The study shows that door-to-balloon program effectiveness could be maintained, despite reduced pre-activations and inclusion of the pandemics in the process.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web/Additional material.)

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