ORIGINAL ARTICLE

Development of a virtual tool for monitoring quality of care in acute myocardial infarction via the internet ☆

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Abstract
Background: Measurement of quality indicators contributes to monitoring the performance of initial treatment of ST-elevated myocardial infarction (STEMI).
Objective: To develop a virtual tool to calculate performance indicators of initial treatment of STEMI online via the internet.
Methods: We identified critical elements of the therapeutic process and formulated indicators in a retrospective pilot study, and developed a virtual tool for prospective data collection on initial treatment of STEMI. Rio de Janeiro hospitals with emergency care units were selected and invited to participate in the project. Online reports were developed to be accessed at www.qualiiam.icict.fiocruz.br/indicadores.php and analyzed.
Results: Five hospitals agreed to participate in the project and monitored treatment of different numbers of patients with a diagnosis of STEMI (A = 7, B = 14, C = 16, D = 44 and E = 43). Aspirin was administered in 94.6% of cases, angiotensin-converting enzyme inhibitors or angiotensin receptor blockers in 76.1% and beta-blockers in 82.5%; 68.4% of patients with no contraindication received fibrinolysis. In no case was door-to-needle time less than 30 min, and mean time was 122 min. All patients admitted to hospitals with catheterization facilities underwent primary angioplasty; mean door-to-balloon time in these patients was 161 min; in only 28% was it less than 90 min.
Conclusion: The system can be used as a tool to monitor the performance of initial treatment of patients with STEMI. Analysis of these indicators in the future may help to evaluate the contribution of online reporting to the development of better treatment practices.
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Desenvolvimento de um sistema para monitoramento da qualidade do atendimento ao infarto agudo do miocárdio via WEB

Resumo

Fundamento: A mensuração de indicadores de qualidade contribui para monitoramento do desempenho do tratamento do Infarto Agudo do Miocárdio com Supradesnivelamento do Segmento ST (IAMCSST).

Objetivo: Desenvolver uma ferramenta virtual para calcular indicadores de desempenho através de informações enviadas via WEB.

Métodos: Identificação de pontos críticos no processo terapêutico e formulação de indicadores avaliados em retrospetivo estudo piloto. Desenvolvimento de ferramenta virtual para coleta prospetiva dos dados relacionados com o atendimento inicial ao IAMCSST. Seleção e convocação dos hospitais para cadastro no sistema e exposição do projeto. Utilização do sítio www.qualiiam.cict.fiocruz.br/indicadores.php para acesso aos relatórios dos indicadores em tempo real.

Resultados: Houve variação no número de pacientes cadastrados por cada hospital (A = 7; B = 14; C = 16; D = 44; E = 43). AAS foi administrado em 94,6% dos casos. A administração do IECA/BRA ocorreu em 76,1% dos pacientes. A administração de betabloqueadores ocorreu em 82,5%. 68,4% dos pacientes sem contra-indicação a fibrinolítico recebeu o fármaco. Em nenhum caso o tempo porta agulha foi inferior a 30 min. A média obtida foi 122 min. Todos os pacientes admitidos nos hospitais com hemodinâmica foram submetidos à angioplastia primária. A média obtida para tempo porta-balão foi 161 min. Em apenas 28% destes pacientes o tempo porta balão foi menor do que 90 min.

Conclusão: O sistema pode ser usado como ferramenta de gestão para monitoramento dos indicadores de *performance* no atendimento inicial ao IAM. Análises futuras destes indicadores poderão contribuir para avaliar o impacto destes relatórios sobre a incorporação de melhores práticas assistenciais.

Introduction

Measurement of quality indicators is now used to monitor performance at various stages of hospital care.

For ST-elevation myocardial infarction (STEMI), which accounts for 30–47% of cases of myocardial infarction (MI),[1] reperfusion should be initiated within 12 hours of symptom onset, and has a greater impact on mortality reduction if performed within 3 hours.[2]

Various countries assess performance measures in the treatment of STEMI,[3–6] based on indicators published in the guidelines.[7,8]

The Myocardial Ischaemia National Audit Project is a database of quality indicators of treatment of MI in England and Wales. Four-monthly reports are published for the purpose of assessing outcomes and quality of care. Sustained improvements in fibrinolysis and secondary prevention have been observed since its implementation.[9]

The Medicare Quality Monitoring System, run by the US government, provides information on hospital performance including data on legislation, costs, and morbidity and mortality rates, which is then analyzed and used in the Hospital Compare initiative. This provides performance indicators for the treatment of particular conditions (for example mortality from pneumonia, door-to-balloon times, and aspirin prescription rates in MI).[10]

The US National Registry of Myocardial Infarction, including over two million cases of MI since 1990, demonstrated that at least one in five patients did not receive all the recommended therapies. A 37% reduction in annual mortality in these patients between 1990 and 2006 has been attributed to improved adherence to guidelines.[11]

Despite the growing number of studies on quality of health care in Brazil, most hospitals do not routinely measure such variables, although some, such as Hospital Albert Einstein in São Paulo and Hospital Pró-Cardíaco in Rio de Janeiro, provide up-to-date information on their indicators that can be freely consulted on the internet.[12,13]

Methods

In the first stage of the project critical elements in the treatment of STEMI were identified and indicators were formulated following analysis of the US and Brazilian clinical protocols and based on the available evidence. A panel of specialists was formed to discuss controversial points in the guidelines on the in-hospital treatment of STEMI and to standardize indications and contraindications for therapeutic strategies.

In the second stage, a pilot study was performed aimed at exploring the possibility of obtaining these indicators retrospectively from information in the medical records of patients admitted with a diagnosis of STEMI in a teaching hospital. Analysis of the pilot study showed significant gaps in the recording of contraindications to recommended therapies.

In the latest phase, a virtual tool was developed for the prospective collection of data in real time, using a

client/server platform so that various hospitals could access the Fiocruz server, where the data are processed and the indicators are automatically generated.

Hospitals that according to the national health institutions register provided emergency cardiological treatment were selected to participate in the project; these included institutions with the necessary catheterization facilities to perform primary angioplasty, as well as those using solely fibrinolytics as reperfusion therapy.

Ten hospitals in the municipality of Rio de Janeiro that met the required conditions were invited to a meeting at which the aims of the project were presented. Information on the institutions and the physicians responsible for entering data into the system were recorded via the site www.qualiiam.cict.fiocruz.br, which generates passwords for participants.

Each hospital developed its own method of collecting data from medical records, which were then entered on an electronic form without patients being identified. All patients were aged 18 or over. The criteria used for a diagnosis of STEMI were characteristic elevation and gradual decline of troponin or more rapid increase and fall in creatine kinase MB (CK-MB), together with at least one of the following criteria: (a) ischemic symptoms; (b) electrocardiographic alterations indicative of ischemia (ST-segment elevation or depression or new-onset left bundle branch block); (c) pathological Q waves on the electrocardiogram; or (d) evidence on imaging studies of loss of myocardial viability or of wall motion abnormalities.[4,14,15]

The electronic form developed to enter data into the system consists of fields defined on the basis of clinical protocols for the first 24 hours of STEMI treatment. The first section is for recording data related to hospital admission, including date and time of admission, gender, age, and time of symptom onset, funding source, hospital department that made the diagnosis of STEMI and information on treatment and previous medication. This is followed by four sections on administration of recommended drugs in the first 24 hours: (i) aspirin/clopidogrel; (ii) beta-blockers; (iii) angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blockers (ARBs); and (iv) fibrinolytics. Data on percutaneous coronary intervention (PCI) are recorded in the final section.

In the sections on medical therapy, the following information is required: date, time and dosage of the prescription and administration of each drug, and all contraindications as stipulated in the clinical protocols. In the section on PCI, the date and time of balloon inflation are recorded. Justification must be provided in cases where no reperfusion method was employed.

In order to ensure uniformity in the definition of variables, a glossary of terms has been developed that can be accessed via an icon in the data collection form.

All fields on the electronic form must be completed. The system detects inconsistencies in the date and time of admission and in the administration of medical therapy, which are essential elements for the calculation of indicators.

Following the pilot study, in which the lack of data on contraindications made it difficult to identify the justification for non-use of recommended therapies, further options were added to all relevant fields: ''NH'' (when the drug was not available), ''A'' (absence of information in the medical record) and ''Other'' (free text field to record any other problems encountered).

Once completed, the electronic form is sent via the internet to the server, where the indicators are calculated in real time.

Carrying out data processing and calculation of indicators was the responsibility of the Health Information Laboratory of the Institute for Scientific and Technological Communication and Information of the Oswaldo Cruz Foundation (Fiocruz), where the server is located. The calculation of performance indicators for STEMI treatment took account of contraindications and indications for treatment in the first 24 hours of hospitalization. These items were considered mandatory for inclusion of patients in the study. In cases where precise data were not available, the information was flagged as incomplete.

In calculating the indicators, the numerator was taken as the number of cases without contraindication that received a particular drug and the denominator was taken as the number of cases without contraindication. Patients who had received a drug before hospital admission were excluded from the calculation for that drug. Thus, the number of patients considered in the indicators for different therapeutic procedures may vary.

When calculating the indicator for administration of ACE inhibitors or ARBs, the denominator takes account of both the absence of contraindications and the fact that these drugs are not indicated in all cases of STEMI. According to the review of guidelines by the panel of specialists, ACE inhibitors and ARBs have a higher level recommendation in patients with hypertension, diabetes or clinical or echocardiographic signs of left ventricular systolic dysfunction. Based on these characteristics, the indicator was calculated only in cases in which these drugs were indicated and there were no contraindications to their use.

At the same time, a tool was developed to access the results of the indicators via the internet, so that representatives of the participating hospitals could generate reports in real time that would include the number of patients considered in calculating each indicator, reference values recommended by the protocols, and the mean of the results obtained by all the hospitals in the system, while maintaining the confidentiality of each institution's data. Using passwords generated by the system, representatives can consult the site at www.qualiiam.cict.fiocruz.br/indicadores.php to access the results for the following indicators:

- percentage of patients without contraindication for aspirin who received the drug within 24 hours of hospital admission;
- percentage of patients without contraindication for beta-blockers who received the drugs within 24 hours of hospital admission;
- percentage of patients with left ventricular systolic dysfunction and without contraindications for ACE inhibitors or ARBs who received one of these drugs within 24 hours of hospital admission;

- percentage of patients without contraindication for fibrinolysis who received fibrinolytics within 24 hours of hospital admission;
- percentage of patients who received fibrinolytics within 30 min of hospital admission;
- percentage of patients who underwent angioplasty with balloon inflation within 90 min of hospital admission;
- mean time (min) between hospital admission and the administration of fibrinolytics (door-to-needle time);
- mean time (min) between hospital admission and angioplasty balloon inflation (door-to-balloon time).

Results

Of the 10 institutions invited to participate in the project, five (two public and three private) agreed. After 18 months 124 cases of STEMI had been entered into the system, the number of patients differing between hospitals (A = 7; B = 14; C = 16; D = 44; and E = 43). The mean age of those included was 63.6 years and 69.2% were male.

Table 1 shows the results for the indicators calculated for the five hospitals in the municipality of Rio de Janeiro between October 2008 and October 2010.

The best performance was seen in the administration of aspirin (94.6%). ACE inhibitors or ARBs were prescribed in 76% of patients with indication, excluding those who presented contraindications. Beta-blockers were used in 82.5% of the 80 patients without contraindication.

The percentage of patients without contraindication to fibrinolytics who received these agents was 68.4% (n = 29). In no case was door-to-needle time less than 30 min; the mean was 122 min and the longest door-to-needle time was 392 min after hospital admission.

In three of the 14 cases in which fibrinolysis was not performed the reason given was delay in in-hospital diagnosis of STEMI, the diagnosis only being confirmed over 12 hours after symptom onset. Four other patients arrived at the hospital more than 12 hours after symptom onset, and there was thus no indication for fibrinolysis.

All 74 patients admitted to hospitals with catheterization facilities underwent primary PCI. Mean door-to-balloon time was 161 min, ranging between 30 and 900 min. In only 28% of patients undergoing PCI was the door-to-balloon time less than 90 min as recommended.

Discussion

The development of a virtual tool for real-time calculation and analysis of the main quality indicators related to initial treatment of STEMI has provided valuable information on hospital performance, data that can be used to monitor and improve quality of care.

Most patients were male and in the seventh decade of life, as is found in the main registries of acute coronary events.[11,16]

The data on medical therapy (aspirin, ACE inhibitors/ARBs and beta-blockers) within 24 hours of admission showed better adherence to guidelines than in other studies.[13,16] This is probably due to the fact that in the present study patients with contraindications were not included when calculating the indicators, which appears

not to have been the case in other studies. In any event, there is room for improvement in the initial treatment of patients admitted with STEMI, in terms of both prompt diagnosis and drug therapy, since the guidelines recommend that the latter should be administered within 24 hours of admission in 100% of eligible patients.

The number of patients included in the denominator for calculating each indicator varied depending on the contraindications for each drug or procedure assessed. Aspirin had the lowest denominator, and besides contraindications such as bleeding events and allergy, the main reason for the lower number of patients eligible for this indicator was the fact that many were already medicated with aspirin on arrival, since early administration significantly reduces morbidity and mortality in cases of suspected MI. These patients were given aspirin in ambulances or in medical centers with no facilities for fibrinolysis, were routinely taking aspirin for pre-existing risk factors (for example, diabetes or peripheral arterial disease), or were self-medicated in view of symptoms suggestive of MI.

With regard to fibrinolysis in the present study, no institution achieved a door-to-needle time (the time elapsed between hospital admission and the start of intravenous infusion of fibrinolytics) of less than 30 min, as recommended in the guidelines. Hospitals with large volumes of patients may have longer waiting times before observation and performance of an ECG, resulting in delays in the diagnosis of STEMI. Current guidelines recommend an ECG within 10 min in cases of suspected MI.

As regards primary PCI, the guidelines recommended a maximum door-to-balloon time (the time elapsed between hospital admission and balloon inflation inside the infarct-related artery) of 90 min. This goal was achieved in less than 30% of patients undergoing PCI in our study, demonstrating that there is room for improvement in this process. Besides the factors mentioned above that may delay a diagnosis of STEMI, the availability of a catheterization laboratory and an interventional cardiology team can also affect door-to-balloon times.

Furthermore, over 30% of patients admitted to institutions without facilities for angioplasty received no reperfusion therapy at all, even when there were no relative or absolute contraindications. Overcoming this situation is a challenge for health systems around the world, particularly in developing countries.

In the US, the American College of Cardiology (ACC) has launched the D2B (door-to-balloon) program,[17] which focuses on strategies to reduce waiting times for patients with chest pain, streamline the process of diagnosing STEMI, and improve the timeliness of coronary reperfusion.[8]

The fact that no patients admitted to hospitals with facilities for PCI underwent fibrinolytic therapy may be due to the superiority of mechanical reperfusion, especially when performed within 90 min of hospital admission.[4]

Assessing outcomes of health care entails a series of steps, including definition of variables, development of appropriate methodology and processing of the data obtained. An advantage of the present project is the requirement to complete all the fields on the form, even when information is lacking from the medical record. This minimizes loss of data due to non-completion and enables identification of variables that are frequently

Table 1 Performance indicators for initial hospital treatment of ST-elevation myocardial infarction.

Indicators	%	n	Recommended
Percentage of patients without contraindication who received aspirin within 24 hours of admission	94.6%	93	100%
Percentage of patients without contraindication who received beta-blockers within 24 hours of admission	82.5%	80	100%
Percentage of patients with left ventricular systolic dysfunction and no contraindications who received ACE inhibitors or ARBs within 24 hours of admission	76.1%	67	100%
Percentage of patients without contraindication who received fibrinolytics within 24 hours of admission	67.4%	43	100%
Percentage of patients who received fibrinolytics within 30 min of admission	3.2%	29	100%
Percentage of patients who underwent angioplasty with balloon inflation within 90 min of admission	28%	74	100%

Indicators	Mean	SD	Min	Max	n	Recommended
Mean time (min) between admission and administration of fibrinolytic	122	88	30	392	29	<30 min
Mean time (min) between admission and balloon inflation in angioplasty	161	137.3	30	900	74	<90 min

ACE: angiotensin-converting enzyme; ARBs: angiotensin receptor blockers; SD: standard deviation.

missing from medical records, providing opportunities for improvement.

Conclusion

The system presented is a viable tool for monitoring performance in the treatment of STEMI, with updating of variables in real time.

The low level of adherence and of effective participation of institutions treating STEMI in terms of uploading and consulting information online in real time represents a challenge for implementation of the system.

The results obtained suggest that improvements are needed in the quality of care in MI, especially regarding the excessive delays in the use of reperfusion therapies. The tool was designed as a management aid to monitor the performance of individual hospitals and critical elements will vary between institutions. However, the small sample size limits any in-depth analysis.

Analysis of these indicators in the future in health services with different levels of complexity may help to assess the impact of online reporting on the development of better treatment practices.

Conflict of interest

The authors have no conflict of interest to declare.

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