Technological innovations for the diagnosis of Acute Myocardial Infarction (AMI): A medical perception

https://doi.org/10.56238/sevened2024.012-040

Thais Cristine Rodrigues Leonel Lamounier[1], Samia Mercado Alvarenga[2], Natali Morgana Cassola[3] and Kelmara Mendes Vieira[4]

ABSTRACT

As it is a consolidated market, technological innovations in the diagnostic medicine sector must aim not only to meet the expectations of stakeholders but also to bring an improvement in access to health and a better patient experience. A German company set out to develop a Point-Of-Care capable of detecting serum levels of high-sensitivity troponin (hs-cTNI) at very low values, in order to reduce the time to diagnosis of acute myocardial infarction. International guidelines recommend that the hs-cTNI result be available within one hour of patient sample collection, but few hospitals achieve this goal, leading to delay in clinical decision-making and consequent harm to the patient. To understand how the medical profession of cardiology understands and evaluates the importance of a technological innovation in this sector, a survey was conducted at the World Congress of Cardiology. About 32% of the interviewees do not use hs-cTNI in their service and almost half do not comply with the application of the 0h-1h protocol for diagnosis. The interviewees reported that the use of this technology would be beneficial and necessary, and added that patients with non-ischemic pathologies would also benefit from the diagnosis of myocarditis and pulmonary thromboembolism. Finally, it is concluded that, according to the perspective of the medical profession, innovation in the cardiovascular medicine sector for the diagnosis of AMI allows faster and more assertive clinical decisions, promoting a better patient experience and improving the flow within emergency services.

Keywords: AMI, Technological innovations, Diagnostic medicine, High-sensitivity troponin, Point-of-care, OCD, Hs-cTnI, Acute myocardial infarction, Emergency department.

[1] Specialist in Business Management. Luiz de Queiroz College of Agriculture of the University of São Paulo.
[2] Master's Degree in Economics. Federal University of Sergipe.
[3] Graduated in Economic Sciences. Universidade Federal de Santa Maria (UFSM).
[4] Doctor in Business Administration. Federal University of Santa Maria (UFSM).

INTRODUCTION

The medical technology (medtech) industry is a dynamic and innovative sector that works to save and improve lives. With more than 500,000 products and services on the market, companies in this sector are improving patient outcomes and helping to make health systems more sustainable and accessible (ESTATÍSTICA, 2010). According to Davila, Epstein and Shelton (2007), innovation is one of the most important factors to ensure the future of any company and to remain in the market in the face of competition.

However, innovation efforts often fall short of their intended goals, often by not starting from an advantageous position, paralyzing new businesses in bureaucracy, and by misaligning new businesses with the company's core businesses. One of the important points that market research demonstrated was that building a new business is challenging, but the key to long-term growth is the creation of value throughout the stages of the customer experience (Oliveira et al., 2020).

Porter and Teisberg (2004) emphasize that innovation in this sector can reduce costs, improve the quality of life of the population and increase the population's accessibility to health services. For this to be possible, it is necessary for medical technology companies to make an effort to strategically seek innovations that increase value for the patient along the service delivery chain and with a holistic view of the market.

In the market of medical technology companies, there are diagnostic medicine companies. Specifically in relation to the diagnosis of cardiovascular diseases, the need for innovation becomes even more imperative, since cardiovascular diseases are one of the main causes of mortality in the world, with Acute Myocardial Infarction (AMI) being the most prominent, along with Stroke (SBC, 2015). In Brazil, the Department of Informatics of the Unified Health System (DATASUS) counted 1,066,194 cases of hospitalizations due to AMI between 2010 and 2021 (BRASIL, 2021).

The high mortality rate in the Brazilian public health system can be attributed, among other causes, to the difficulties in accessing patients with suspected AMI to intensive care treatment, reperfusion methods, and therapeutic measures established for AMI. In addition, early diagnosis until appropriate and timely treatment is one of the pillars for reducing this rate (Marcolino et al., 2013).

According to the studies by Konder (2013) and Silva (2012), most urgent and emergency centers in Brazil are overcrowded with cases of low complexity or care for chronic diseases. Such a situation tends to increase the risk of mortality due to the delay in care and, consequently, in the clinical decision-making of patients in a severe situation (Rocha and Fernandes, 2014; Marcelo, Di João and Fernandes, 2021).

AMI is a medical emergency that occurs when there is an interruption of blood flow to a part of the heart, resulting in injury to the heart muscle. Early and accurate diagnosis is essential for proper treatment and reduction of damage to the heart. For patients with unstable angina and

suspected non-ST-elevation AMI, international guidelines (American Heart Association, 2021) recommend that it be performed based on clinical symptoms, together with electrocardiogram (ECG), biomarker analysis, echocardiography, and one of the diagnostic scales (TIME OR GRACE). The most widely used biomarker of cardiac necrosis is high-sensitivity troponin (hs-cTnT/I). This marker has the ability to triage patients complaining of chest pain and refer them to the correct clinical management based on the 0h/1h algorithm.

International guidelines recommend the use of this algorithm to minimize the time from the patient's arrival at the emergency department to the final diagnosis, however, to date, the successful clinical implementation of these rapid algorithms is restricted to hospitals that work with well-defined flows and a robust central laboratory structure, as current hs-cTnT/I assays require proof that they are high sensitivity tests. that is, that allow the detection of serum troponin levels even in very small amounts. However, this characteristic has only been proven in the literature to date in large diagnostic platforms in a central laboratory (Clinical Chemistry, 2019).

Based on this context, a Point Of Care (POC) hs-cTnT/I test can be of great value to perform hs-cTnT/I measurements in the exclusion and inclusion protocol for AMI. This is because they are portable, practical equipment that can be used at emergency triage stations, in the doctor's office or wherever it is convenient (Bhatnagar et al., 2016). However, the POC tests currently available on the market for troponin dosing are not able to meet the criteria necessary to be considered high sensitivity, and therefore, are not used for this purpose, according to (Regan et al., 2019).

In order to improve the service provided in the early detection of people with chest pain and contribute to overcoming challenges in the Brazilian health system, a German medical technology company proposed to develop a POC equipment that allows the detection of troponin meeting the high sensitivity criteria by the year 2023 (Apple, 2021). However, it is necessary to investigate how the medical community uses the technologies already available on the market and how it evaluates the clinical relevance that an innovative technology in the cardiology sector can contribute to improving the patient experience throughout their journey from the suspicion of AMI to the final diagnosis.

Thus, the objective of the present study was to analyze the data provided by the medical profession during the cardiology congress, allowing a better understanding of the market and the clinical relevance according to the answers given.

MATERIALS AND METHODS

This research is applied and exploratory in nature, as it seeks to provide greater familiarity with the theme in order to make it more explicit or to formulate hypotheses (Piovesan; Temporini, 1995, p. 321). In addition, it has a descriptive aspect, describing the characteristics of a specific

phenomenon, such as the implementation of an innovative technology in the cardiology sector in the Brazilian health system. As for the technical procedure, it is a survey that involves the direct questioning of people, of a qualitative nature, with the objective of understanding the behavior and perception of the interviewees (Yin, 2015).

For data collection, a research instrument consisting of 6 questions is used, to be answered objectively by the interviewees. The questionnaire was developed by experts together with members of the present study team. The target audience of the study was composed of health professionals and the questionnaire was made available at the technology company's stand to a sample of attendees participating in the 77th Edition of the World Congress of Cardiology, which took place on October 13, 14, 15 and 16, 2022. All respondents were asked voluntarily and in an informed manner to contribute with the following form:

1- Does the institution you work for use troponin as a marker for AMI? If not, which marker is used?

a) Yes

b) No

2- What type of troponin is used?

a) Conventional Troponin T

b) Conventional Troponin I

c) High-sensitivity troponin I

d) High-sensitivity troponin T

e) I don't know how to inform

3- Does the institution you work for use Point of Care as a rapid test for troponin dosage? If not, what platform do you use?

a) Yes

b) No

4- Does the institution you work for use the 0-1hrs infarction algorithm? If not, which one is used?

a) Yes

b) No

5- Do you believe that having a high-sensitivity troponin Point Of Care as a rapid test will be beneficial for patients with suspected MI without supra?

a) Yes

b) No

6-What other pathological situations could benefit the rapid medical management of the use of high-sensitivity troponin by Point Of Care as a rapid test?

The questionnaire was prepared by the Medical Affairs team of the medical equipment company together with the Marketing and Communication team. The Marketing and Communication sector were responsible for the processes of dissemination, formatting of the art and adequacy of the research with the LGPD law. On the other hand, the Medical Affairs team ensured the clinical relevance of the research, adequacy to new terminologies and contextualization with medical demands. With this questionnaire, the company aimed to understand how the medical team understands the innovation process in the cardiovascular medicine sector for the best positioning of its product and its importance to improve patients' clinical outcomes.

RESULTS AND DISCUSSION

BIOMARKERS FOR AMI DIAGNOSIS

The evolution of biomarkers

Biomarkers have evolved over the years so that they have the highest sensitivity and specificity possible (SBC, 2015). A good marker of myocardial necrosis should be in large quantities in the cell, especially in the cytosol. This is necessary so that the macromolecule can be detected quickly, and that it remains in the bloodstream for a sufficient time so that the health professional can monitor the patient's prognosis throughout the days of hospitalization. In addition, it should not be detectable in healthy patients or patients without heart disease, that is, it should be present only in the myocardium and not in other organs and tissues (Ladenson, 2012).

The evolution of the biomarkers has gone through: Aspartate aminotransferase (AST) found mainly in the liver and heart muscle, Creatine kinase (CK) which consists of a dimer composed of two subunits (B and M) that are separated into three different molecular forms (isoenzymes): CK-BB or CK-1 found mainly in the brain; CK-MB or CK-2, hybrid form, mainly in the myocardium and CK-MM or CK-3 mainly in skeletal muscle. In addition to Lactate dehydrogenase (LDH), also found mainly in the myocardium; Troponin T and Troponin I (TnT and TnI) and Myoglobin found in both skeletal and cardiac muscle (KUMAR et al., 2010).

The AST enzyme is present in the mitochondria of cardiac cells and, around 6 to 8 hours after myocardial infarction, its serum activity begins to increase, reaching its maximum peak (20 to 200 U/mL) between 18 and 24 hours. However, one of the main disadvantages of this enzyme for the diagnosis of AMI is that it is non-specific and false positives may occur, since it is elevated in cases of liver disorders (Motta et al., 2007).

Another enzyme used for the diagnosis of AMI is CK, especially its isoenzyme CK-MB. The myocardium contains significant amounts of CK-MB, while in other tissues, CK-MB is found in small contents. This enzyme rises in 4 to 8 hours from chest pain, reaching its maximum in 12 to 24 hours, returning to normal, in uncomplicated cases, in 48 to 72 hours. However, as with AST,

elevation of this enzyme may occur in clinical conditions other than AMI, such as muscle trauma, myopathies, hyper and hypothermia, myocarditis, defibrillation, chronic renal failure, pregnancy, ectopic production (cervical tumor). In addition, CK and its MB fraction (CK-MB) do not show serum elevation until the 4th hour after the onset of chest pain and, therefore, do not show good sensitivity in the initial stage of AMI (Cavalcanti et al., 1998).

Like the CK-MB enzyme, lactate dehydrogenase (LDH) has its activity increased between 8 to 12 h from chest pain and reaches its maximum peak in 24 to 48 h. The increase in this enzyme also does not refer only to AMI, but is one of the markers that define this possibility. However, it remains high in the bloodstream for 7 to 14 days. Another form of diagnosis is the determination of myoglobin, which is not an enzyme, but is found in the blood about 1 hour after the onset of symptoms, being a good early marker of AMI. However, like the previous enzymes, it is not specific for infarction (Motta et al., 2007).

According to the joint guidelines of the American College of Cardiology (ACC) and the European Society of Cardiology (ESC), and updated in 2021 and 2020 respectively, the recommendation biomarker I Class-A of myocardial necrosis is Troponin.

TROPONIN AS A MARKER OF MYOCARDIAL NECROSIS

The contraction of both skeletal and cardiac muscle is dependent on a contractile complex called sarcomere, troponin being one of the proteins that make up this complex. There are three types: troponin I (Tn I), actin-inhibiting subunit, troponin C (Tn C), a calcium-linked and contraction-regulating subunit, and troponin T (Tn T), a tropomyosin-linked subunit (Motta et al., 2007).

Tn C is genetically the same in both skeletal and cardiac muscle, but the genes encoding troponins I and T, cardiac and skeletal, are different, which allowed the development of antibodies with low cross-reactivity for the diagnosis of AMI. Both markers are equivalent for the determination of serum troponin, but the most commercialized is Tn I (Lewandrowski, 2014).

Most troponins are attached to thin filaments as part of the sacarere structural group and a small portion is free in the cytoplasm. When the membranes of cardiac cells are damaged, troponin is detected in the bloodstream, especially in the complex form of TnI-TnC and the free form of TnT. However, it is possible to find the TnT-TnI-TnC complex and the free form TnI in the circulation (Lewandrowski, 2014).

According to Ravel (1997), IT is more sensitive than CK-MB during the first hours after AMI, with sensitivity equal to 33% from 0 to 2 hours, 50% from 2 to 4 hours, 75% from 4 to 8 hours, and approaches 100% 8 hours after the first symptoms of the disease. In addition, it is known that

troponin rises in plasma 4-6 h after AMI attack, reaching peak concentrations between 12 and 18 h after infarction, and may remain elevated for 7 to 10 days after the acute episode (SBC, 2009).

Panteghini et al (2008) proposed that the molecular structure of Tn I favors its specificity, since its N-terminal chain has a singular sequence. Therefore, the antibodies are specific against the epitopes of the TnI region. In addition, unlike other cardiac markers, Tn I is highly specific for myocardial tissue, is not significantly detectable in the blood of healthy people, and shows an increase well above the threshold values in cases of AMI (PANTEGHINI, 2008).

According to the joint guidelines of the American College of Cardiology (ACC) and the European Society of Cardiology (ESC), and updated in 2021 and 2020 respectively, the recommendation biomarker I Class-A of myocardial necrosis is Troponin.

HIGH-SENSITIVITY TROPONIN

In the 2000s, laboratory assays were introduced to the market that were able to detect very low levels of troponin even in healthy patients. These biomarkers have been termed "high-sensitivity troponin." By definition, High Sensitivity Troponin (hs-cTnT/I) is understood as laboratory assays that have the ability to detect this protein in small concentrations in plasma and serum, with greater precision, even in individuals apparently free of cardiovascular disease (Thygesen et al, 2010).

The following can be highlighted as characteristics of a high-sensitivity assay: the total inaccuracy, coefficient of variation (CV), of the assay should be ≤ 10% at the 99th percentile for the healthy reference population and the limit of quantification (LoQ) should be such as to allow plasma concentrations to be measurable and quantifiable for at least 50% (ideally > 95%) of healthy subjects. In addition, it is necessary that the test presents reference values with stratification by sex. (Thygesen et al, 2012).

Compared to conventional troponin assays, they have been shown to be more sensitive for the diagnosis of AMI. Even in patients who did not have their concentration elevated above the 99th percentile or undetectable with the first-generation tests, the new methods were able to better discriminate patients with a higher risk of long-term mortality (Keller et al, 2009).

APPLICATION OF 0H-1H ALGORITHMS

The diagnosis of AMI is based on three pillars: the first is the patient's clinical condition, characterized by chest pain, anxiety, sweating, signs of shock, hypotension, decreased pulse amplitude, left ventricular failure, arrhythmias, and vomiting. Parallel to these symptoms, there are electrocardiographic (ECG) alterations and an increase in biochemical markers of necrosis (PESARO et al., 2004).

The ECG is an integral part of the diagnostic work-up of patients with suspected AMI and should be acquired and interpreted promptly (within 10 minutes) of clinical presentation. An example of a clinically important finding on the ECG is the presence of ST-segment elevation (STEMI). With this electrocardiographic alteration, it is possible to easily refer the patient to the appropriate therapy.

However, the great challenge for the medical profession is to exclude patients for ST-segment non-ST AMI (STEMI) detected on the ECG. To this end, biomarkers are essential (Thygesen et al, 2012).

According to the National Institute for Health Research (NIHR), in 2021, only about 20% of emergency room complaints for chest pain are actually a myocardial infarction and there are many other possible causes of chest pain, for example: gastroesophageal disorders, muscle pain, anxiety, or ischemic heart disease. Thus, it is important to have an algorithm that is able to direct not only those who are in the process of infarction, but also those who are not and lead them to the best therapy.

As described above, STEMI patients are easily included in the AMI protocol and directed to treatment. However, the challenge lies in the process of excluding IMSST patients. In 2020, the European Society of Cardiology (ESC) published guidelines that propose algorithms with exclusion rule and inclusion of acute myocardial infarction (AMI) in patients admitted in the stroke setting and for the management of myocardial infarction.

Before hs-cTnT/I, this process took 6 to 9 hours to occur, which resulted in longer patient time in emergency rooms, delayed diagnosis of AMI, and increased costs with incorrect management. Currently, serial measurements have been performed with hs-cTnT/I tests to accurately measure changes in cTn concentrations, allowing the discrimination of acute from chronic elevations and proposing acceptable exclusion rules within 1 to 3 hours.

Among the hs-cTnT/I-based rapid screening algorithms, the 0/1-h algorithms have been extensively validated and appear to provide the best balance of safety and efficacy. Thus, they are used as a Class I recommendation in current clinical practice guidelines (Reichlin et al., 2012).

USE OF POINT-OF-CARE

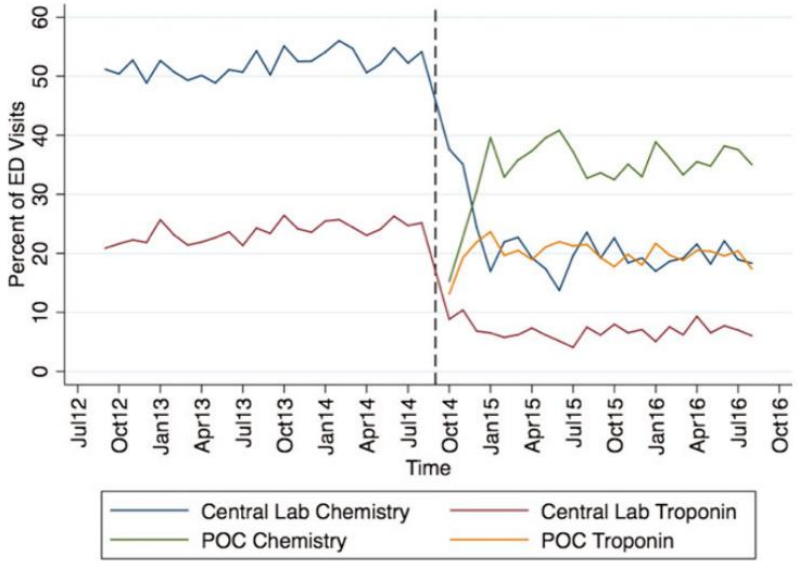
More recent studies have shown a positive impact when POC equipment is used for care in urgent and emergency departments. According to Yang Z and Min Zhou D, 2016, there was a reduction in the length of stay in emergency departments, a reduction in the time to detect critical illness (acute myocardial infarction or sepsis), and a reduction in the time for specific interventions.

In addition, Pines et al, 2018, demonstrated in a follow-up study in an emergency care unit in Washington, in the United States, that there was a 20 to 30-minute reduction in the release time of the cardiac troponin result after the implementation of the POC. At the same time, 64% of the

interviewees in the study stated that there was an improvement in the quality of care and there was a 44% reduction in the time to release the results of the other tests from the central laboratory.

In addition, the number of troponin samples for the central laboratory decreased significantly (Figure 1) and consequently it was not used in 52% of visits in the pre-implementation period of the POC to 21% after implementation. Troponins from the central laboratory decreased from 24% to 7% after implementation. This allowed the central laboratory to concentrate its efforts on the care for the other laboratory tests and to quickly lead the patient to their correct treatment.

Figure 1 - Use of the central laboratory and POCT, September 2012–August 2016. The dotted line represents the implementation of POCT. POCT = point of care test.



Fonte: Integrating Point-of-care Testing Into a Community Emergency Department: A Mixed-methods Evaluation, ACADEMIC EMERGENCY MEDICINE 2018; 25:1146–1156

Correct patient targeting is particularly important in the context of emergency department crowding around the world, with clear links between delays in care and higher mortality rates. From an economic point of view, the use of a point-of-care test in primary care units significantly reduces costs with referrals for hospitalization, invasive treatments, and the number of beds occupied (Mueller et al., 2017).

Despite the demonstrated benefits of the use of POC in the emergency department, commercially available POC tests for troponin quantification do not meet the high sensitivity criteria mentioned in the literature and, therefore, as also demonstrated in the research of the present study, it is not a reality in clinical practice.

An evidence-based systematic review of POC testing identified the need for integration of POC into clinical decision-making as a key requirement to demonstrate the benefit of this technology. These studies used cTn methods in POC compared to the methods present in the central laboratory to evaluate the response time for the final diagnosis, using the diagnosis based on the

reference values of that method or by the use of the 99th percentile. Although these studies support the use of the POC, the results were not satisfactory for the use of the methodology for the final diagnosis.

For all these reasons, there is a growing demand for tests with this capacity, as an increasing number of patients are presenting to emergency departments around the world with suspected myocardial infarction. Therefore, high-sensitivity troponin assays in POC may enable faster decision-making in this high-risk population and reduce the burden on the healthcare system (Sörensen, 2021).

According to the studies of Apple el al, 2021, the device of the German company has undergone laboratory tests that prove its use for the detection of high-sensitivity troponin. At the end of the tests, the equipment was proven to be suitable for high-sensitivity troponin measurement according to the criteria of the IFCC C-CB Committee on Clinical Applications of Cardiac Bio-Markers) and the AACC Academy Guidance.

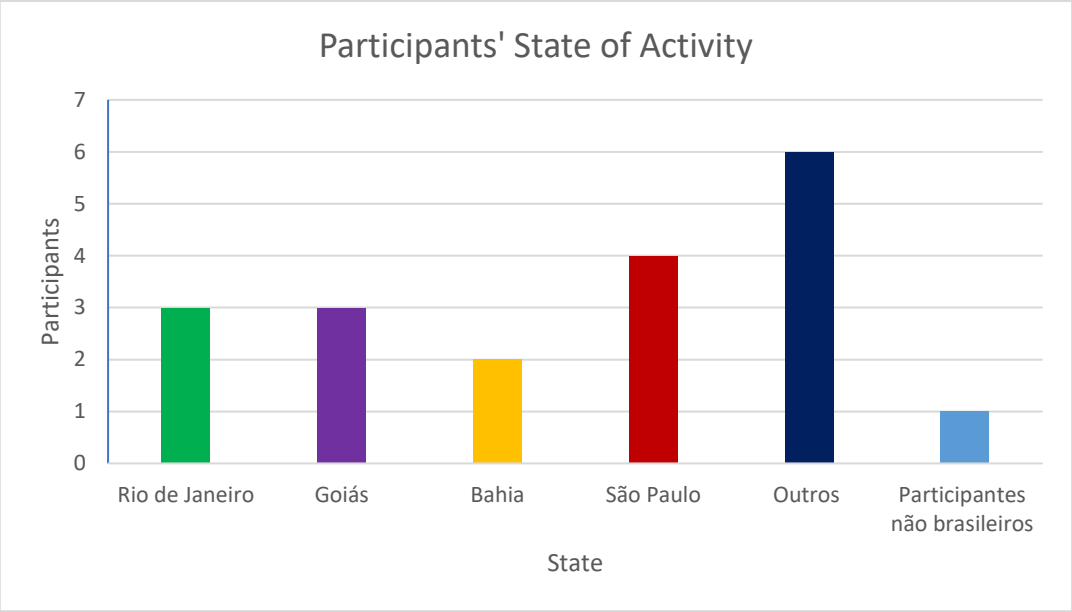
ANALYSIS OF RESPONDENTS' RESPONSES

DEMOGRAPHICS OF RESPONDENTS

For a better description of the results, it is necessary to present the profile of the interviewees. The survey was conducted at the company's stand during the World Congress of Cardiology, which took place on October 13, 14, 15 and 16, 2022. Twenty (20) participants were interviewed, including physicians and residents. The participants arrived at the company's stand voluntarily and each one of them was asked to participate, explaining the main objective of the questionnaire. There was no resistance on the part of the congressmen to grant the answers.

According to the data reported by the participants, about 20% (twenty percent) live in São Paulo, 15% (fifteen percent) in Goiás, 15% (fifteen percent) in Rio de Janeiro and 10% (ten percent) in Salvador. Three participants were of non-Brazilian nationality, two of them were from Ecuador and one from the United States, as shown in Graph 1.

Graph 1 – State of performance of the research participants.

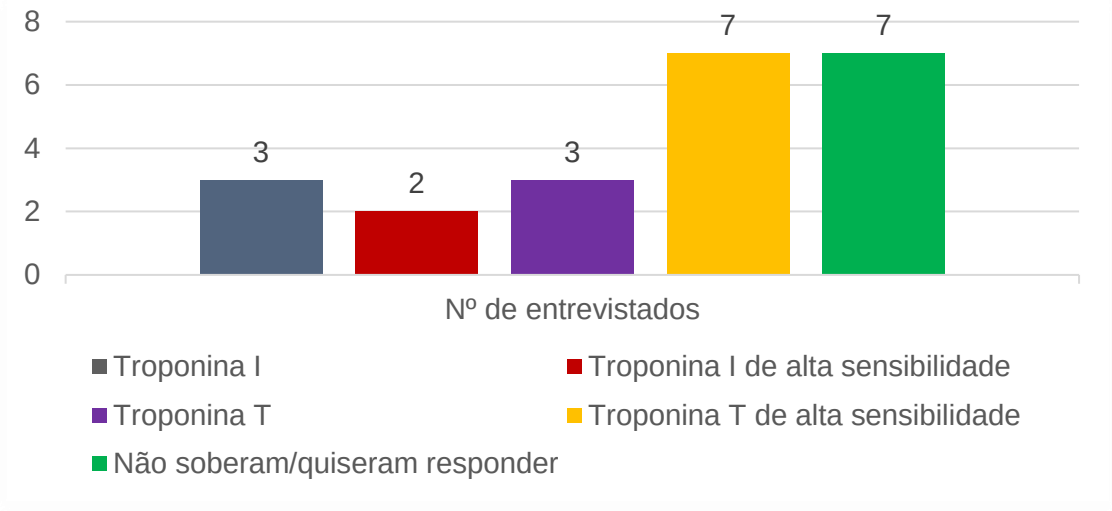


The proportion of men and women was equal to 50% (fifty percent) for both genders. The distribution of participants was generally homogeneous, with no predominance between one region or another, which makes the research more robust in relation to the results. In addition, there was no predominance of genders.

USE OF HIGH-SENSITIVITY TROPONIN IN THE OCCUPATIONAL HOSPITAL

The participants were asked about which biomarker the institution in which they work had for the diagnosis of AMI. Among the twenty (20) interviewees, only one person answered that they did not use troponin and could not inform which other marker was used. Nineteen (19) of those who answered that they use troponin were asked which type (T or I) the institution uses. 7 (seven) participants did not know how to answer, 3 (three) answered the option "Troponin I conventional", 2 (two) "Troponin I of high sensitivity", 3 (three) "Troponin T conventional" and finally 7 (seven) "Troponin T of high sensitivity", as shown in Graph 2.

Graph 2 - Type of troponin used in the interviewee's work institution.



The above data indicate that, for the most part, the work institutions of the physicians and residents interviewed use troponin as a biomarker for the diagnosis of infarction, since 74% have troponin in place. However, a large proportion still use conventional troponin, i.e., 32% still disagree with international guidelines for the use of high-sensitivity troponin. This data is extremely relevant when it comes to the evaluation of innovation in the health sector, since even after successive evolutions in the development of new biomarkers, some institutions do not have this resource.

It is worth noting that according to the latest guideline published in 2021 by the Brazilian Society of Cardiology (SBC, 2021), the greatest limitation of conventional troponins is their low sensitivity when the patient has a onset time of less than 6 hours. With the introduction of high-sensitivity troponins, it became possible to detect lower troponin levels in a shorter time after the onset of ischemic myocardial injury, which contributes to a faster and more effective diagnosis.

Also according to the SBC, in patients who arrive at the emergency department less than 3 hours after the onset of the condition, high-sensitivity troponins are significantly more sensitive than conventional troponins for diagnosing AMI, improving the diagnostic power at that time by 61% and by 100% if the collection is 6 hours after the onset of the condition.

With the increase in sensitivity and diagnostic accuracy for AMI detection using high-sensitivity troponin, accelerated diagnostic algorithms have been proposed. Thus, the time to diagnosis can be reduced, resulting in a shorter emergency room stay and lower cost. In addition, it is recommended that the troponin result be available within 60 min of collection. If the clinical analysis laboratory structure does not enable this goal, point-of-care technologies should be considered (SBC, 2021).

APPLICATION OF THE 0H-1H PROTOCOLS FOR THE DIAGNOSIS OF AMI

The next question referred to the application of the 0h-1h protocol for the management of patients with chest pain in the institution where the physician or resident works. 9 (nine) of them do not apply the protocol to patients with suspected AMI, and 1 (one) of them does not know which protocol to use, 1 (one) uses the 1h-2h protocol and 6 (six) of them use the 6h-9hrs protocol. Still in relation to the group that answered that they do not use the 0h-1h protocol in the institution where they work, 5 (five) of them also did not know which type of troponin is used and 2 (two) of them use troponin T.

Table 1 - Application of the 0h-1h protocol by the institutions where the participants work

Apply the 0h-1h protocol for suspected AMI		
0h-1h		Total = 14
	Conventional Troponin I	2 (14%)
	High-sensitivity troponin I	2 (14%)
	Conventional Troponin T	2 (14%)
	High-sensitivity troponin T	6 (43%)
	They did not know how to inform	2 (14%)
They do not apply the 0h-1h protocol for suspected AMI		
0h-2h	High-sensitivity troponin T	*Total = 9* 1 (12,5%)
6 p.m.-9 p.m.	They did not know how to inform	5 (62,5%)
	Conventional Troponin T	1 (12,5%)
	Conventional Troponin I	2 (12,5%)

Most of the interviewees comply with the recommendation of the guidelines for the application of the 0h-1h protocol, since they have high-sensitivity troponin within the central laboratory of the service. However, a significant portion of the interviewees do not have the highly sensitive troponin available at their service by the central laboratory and, for this reason, do not comply with the 0h-1h protocol.

The study by Bittencourt and Hortale (2009) describes that there is evidence that the delay in care in hospital emergency services can lead to complications in the treatment of the following pathologies: pneumonia, appendicitis, sepsis and acute myocardial infarction, which makes it imperative to need a device capable of accelerating the process from the patient's arrival at the emergency department to the final diagnosis.

According to the information in the Clinical Chemistry study conducted by Apple, et al, 2019, unsuccessful implementation of the fast algorithms is due to the lack of hospital structure, a robust central laboratory structure, difficulties in transporting samples quickly, and internal management of the emergency department team. (Clinical Chemistry, 2019).

USE OF POC AS A PLATFORM FOR HIGH-SENSITIVITY TROPONIN QUANTIFICATION

The second question was about the use of the POC as a measurement platform for the biomarker troponin. Fifteen (15) people answered that they do not use the point-of-care and five (5) answered yes. For those who answered that they were not also asked what was the platform used, they all answered that they use the platform of the central laboratory for this dosage.

As described in the literature, the interview data show that cardiologists do not use the OCP to determine the final clinical diagnosis. This is due to the fact that the devices available on the market do not meet the high sensitivity criteria recommended by the IFCC and the AACC, causing this demand to be completely shifted to the central laboratory and often leading to delays in emergency services (Clinical Chemistry, 2019).

THE CLINICAL VALUE OF USING HIGH-SENSITIVITY TROPONIN AT POINT-OF-CARE

When asked if having a high-sensitivity troponin Point Of Care benefits for patients with suspected non-ST-elevation AMI, only one participant answered no and did not state the reason for the answer, all the others believe it is beneficial for the patient.

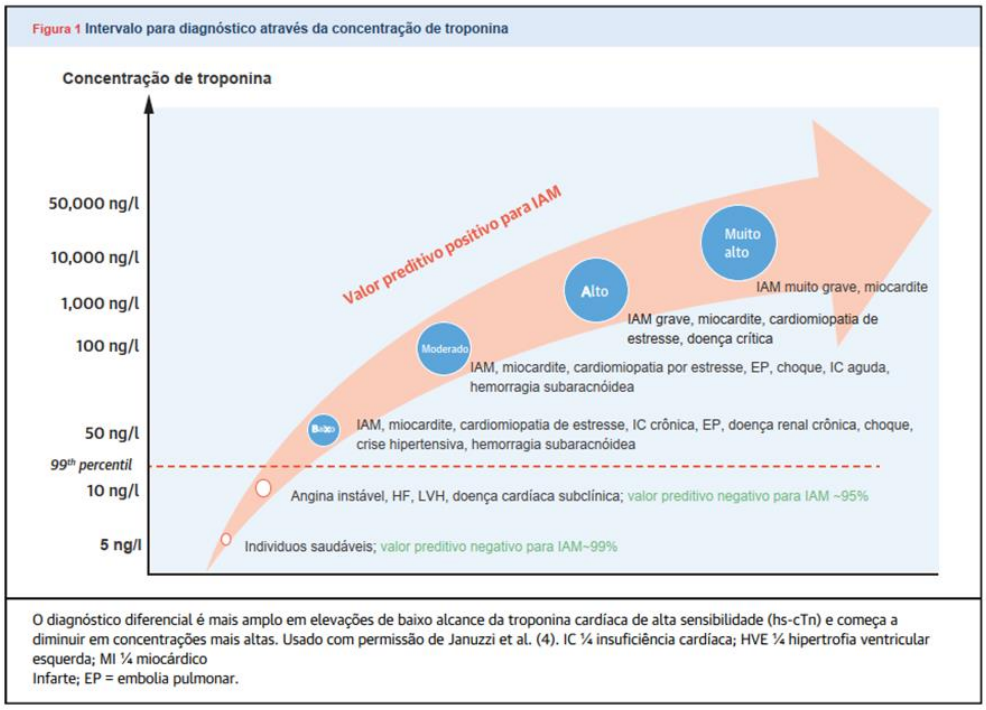
Sörensen, 2019, refutes the information of the interviewees, since in the study of derivation and validation of the cut-off value for the use of high-sensitivity troponin in POC, the author concludes that so far, the possible advantages of troponin POC assays compared to central laboratory assays are: reduction in response time to the result, There is no need to have a central laboratory on site and to transport samples. That's because POC equipment is portable, easy to handle, and can sit inside the ward room. All these factors contribute to the improvement of diagnostic capacity in patients with suspected AMI and, consequently, to a better short- and long-term prognosis.

In addition, the participants were asked about what other types of pathologies could be used in the Point-of-care as a diagnosis and the answers were: Myocarditis and Pulmonary Thromboembolism (PTE). According to The American College of Cardiology (ACC), high-sensitivity troponin tests allow a wide range of diagnostic possibilities, that is, it was often said that it was a specific marker of AMI, but it is now known that it is an organ-specific marker and with these characteristics other diagnoses can be performed with just one measurement of a venous sample (Journal of the American College of Cardiology, 2021).

The data shown in Figure 2. Illustrating this scenario, from the moment AMI is ruled out, high-sensitivity troponin can be used for other cardiac pathologies. In addition, the study showed that in patients with high sensitivity troponin values, even below the 99th percentile have worse prognoses and a higher mortality rate compared to patients with undetectable troponins. As mentioned by the physicians in the interview of the present study, the literature shows the

possibilities of using this marker in other pathologies, such as heart failure, left ventricular hypertrophy, myocarditis, and pulmonary thromboembolism.

Figure 2 - Use of high-sensitivity troponin for differential diagnosis with other pathologies, such as heart failure, left ventricular hypertrophy, myocarditis, and pulmonary thromboembolism.



Fonte: Raber et al. jacc vol. 77, no.10, 2021 interpretation of high-sensitivity cardiac troponin assays in different clinical settings march 16, 2021:1357 – 671358.

The present study evaluated the responses of a small number of respondents. This can be justified by the fact that in order for the participant to have their answer counted, it was necessary to go to the company's stand, accept to participate in the survey, fill out the form and accept the consent forms. As such, some refused to give their opinion for the survey. In addition, the questions in the form were designed objectively and directed the participants' responses, which may have limited the amount of information provided. For all these reasons, new studies should be considered so that they have a larger sample size and so that participants can extrapolate the content of the answers previously selected to enter the questionnaire.

CONCLUSION

In an increasingly challenging economic scenario, diagnostic companies have been looking for ways to differentiate themselves competitively in order to maintain their current market and seek to open new markets. An innovation specifically in the field of cardiovascular medicine, for the diagnosis of acute myocardial infarction, can be challenging because it is a pathology in which every minute is essential in the final outcome of the patient. On the other hand, it can transform a reality if it is correctly positioned and if it is in accordance with the expectations of the stakeholders involved.

The data obtained in the present study demonstrated that the medical profession understands as positive the development of a technology capable of detecting and diagnosing people with suspected AMI early. In addition, the interviewees reported that other patients with non-ischemic pathologies could benefit from having access to a device such as the POC for the rapid detection of elevated high-sensitivity troponin values.

In addition, the survey also provided information on how health services can be improved by a new technology. Many of them do not comply with international recommendations for the diagnosis of AMI because they do not have access to a high-sensitivity troponin in a robust central laboratory structure, to a well-defined internal flow in the emergency department, and to a waiting time much longer than recommended by the guidelines.

Based on these data, it is possible to conclude that the main stakeholders and most likely users of high-sensitivity troponin in OCD consider this innovation not only beneficial, but also necessary for the current situation in urgent and emergency care services. In addition to being a potential market, this solution allows the diagnosis of heart attacks to be made faster and more accurately, promoting a reduction in harm to the patient in the short and medium term, a more assertive clinical decision, and cost reduction for hospitals with the number of hospitalizations and waiting time. In this way, not only the services would benefit, but also the patient throughout their entire care journey.

REFERENCES

1. Tendências da inovação na economia da saúde: um possível cenário para empreendedores. (2020-). Revista Coleta Científica: Coleta. ISSN 2763-6496.

2. How medtech companies can create value with new-business building. (2022-). [S. l.: s. n.].

3. IBGE – Instituto Brasileiro de Geografia e Estatística. (2013). Número de empresas que implementaram inovações de produto e/ou processo, 2017. Rio de Janeiro: IBGE.

4. Innovation in medical technologies: Reflection paper. (2020-). Europe: MedTech Europe. Disponível em: https://www.medtecheurope.org/. Acesso em: 10 jun. 2023.

5. Boeddinghaus, J., et al. (2020). Early diagnosis of myocardial infarction with point-of-care high-sensitivity cardiac troponin I. Journal of the American College of Cardiology, 75(10), 1-14. DOI: https://doi.org/10.1016/j.jacc.2019.12.065. Disponível em: https://www.jacc.org/toc/jacc/75/10. Acesso em: 10 jun. 2023.

6. Apple, F., et al. (2020). Implementation of high-sensitivity and point-of-care cardiac troponin assays into practice: Some different thoughts. American Association for Clinical Chemistry, 1-9. DOI: 10.1093/clinchem/hvaa264. Disponível em: https://pubmed.ncbi.nlm.nih.gov/33279984/. Acesso em: 10 jun. 2023.

7. Westwood, M. (2021). High-sensitivity troponin assays for early rule-out of acute myocardial infarction in people with acute chest pain: A systematic review and economic evaluation. Health Technology Assessment, 1-276. DOI: 10.3310/hta25330. Disponível em: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8200931/#. Acesso em: 10 maio 2023.

8. Collinson, P. (2020). Cardiac biomarker measurement by point of care testing - Development, rationale, current state and future developments. Clinica Chimica Acta, 1-230. DOI: 10.1016/j.cca.2020.05.018. Disponível em: https://pubmed.ncbi.nlm.nih.gov/32464138/. Acesso em: 10 maio 2023.

9. Apple, F. (2021). Determination of sex-specific 99th percentile upper reference limits for a point of care high sensitivity cardiac troponin I assay. Clinical Chemistry and Laboratory Medicine (CCLM), 1574-1578. DOI: 10.1515/cclm-2021-0262. Disponível em: https://pubmed.ncbi.nlm.nih.gov/34022125/. Acesso em: 10 maio 2023.

10. Pires, J., et al. (2018). Integrating point-of-care testing into a community emergency department: A mixed-methods evaluation. Academic Emergency Medicine, 1146-1156. DOI: https://doi.org/10.1111/acem.13450. Disponível em: https://onlinelibrary.wiley.com/doi/10.1111/acem.13450. Acesso em: 10 maio 2023.

11. Sörensen, N., et al. (2019). Diagnostic evaluation of a high-sensitivity troponin I point-of-care assay. Clinical Chemistry, 1592–1601. DOI: https://doi.org/10.1373/clinchem.2019.307405. Disponível em: https://academic.oup.com/clinchem/article/65/12/1592/5715864?login=true. Acesso em: 10 maio 2023.

12. Davila, T., Epstein, M. J., & Shelton, R. (2007). As regras da inovação - como gerenciar, como medir e como lucrar. Porto Alegre: Bookman.

13. Porter, M. E., & Teisberg, E. O. (2004). Redefining competition in health care. Harvard Business Review, 64-77.

14. Konder, M. T. (2013). Atenção às urgências: a integração das Unidades de Pronto Atendimento 24h (UPA 24h) com a rede assistencial do município do Rio de Janeiro.

15. Writing Committee Members, et al. (2022). 2021 ACC/AHA/SCAI guideline for coronary artery revascularization: A report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Journal of the American College of Cardiology, 79(2), e21-e129.

16. Bhatnagar, P., et al. (2016). Tendências na epidemiologia das doenças cardiovasculares no Reino Unido. Coração, 102(24), 1945-1952.

17. Lewandrowski, K. B. (2014). Cardiac markers, an issue of clinics in laboratory medicine. Elsevier Health Sciences.

18. Piovesan, A., & Temporini, E. R. (1995). Pesquisa exploratória: Procedimento metodológico para o estudo de fatores humanos no campo da saúde pública. Revista de Saúde Pública, 29, 318-325.

19. Yin, R. K. (2015). Estudo de caso: Planejamento e métodos. Bookman Editora.

20. Silva, G. S., et al. (2012). Redes de atenção às urgências e emergências: Pré-avaliação das Unidades de Pronto Atendimento (UPAs) em uma região metropolitana do Brasil. Revista Brasileira de Saúde Materno Infantil, 12, 445-458.

21. Oliveira, D., Gonçalves, M., & Sousa, B. (2020). A gestão de clientes e lealdade com recurso ao marketing experiencial: Uma perspetiva teórica. European Journal of Applied Business Management, 6(1).

22. Marcelo, T., Di João, J. G., & Fernandez, G. C. G. (2021). Superlotação das unidades de pronto atendimento: Um desafio da atenção básica: Uma revisão bibliográfica. Ensaios USF, 5(1).

23. Marcolino, M. S., et al. (2013). Implantação da linha de cuidado do infarto agudo do miocárdio no município de Belo Horizonte. Arquivos Brasileiros de Cardiologia, 100, 307-314.

24. Ladenson, J. H. (2012). Reflexões sobre a evolução dos biomarcadores cardíacos. Química Clínica, 58(1), 21-24.

25. Ravel, R. (1997). Aplicações clínicas de dados laboratoriais (6ª ed.). Rio de Janeiro: Guanabara Koogan.

26. Panteghini, M. (2008). Enzymatic assays for creatinine: Time for action. Scandinavian Journal of Clinical and Laboratory Investigation, 68(sup241), 84-88.

27. Thygesen, K., et al. (2012). Third universal definition of myocardial infarction. Circulation, 126(16), 2020-2035.

28. Thygesen, K., et al. (2010). Recommendations for the use of cardiac troponin measurement in acute cardiac care. European Heart Journal, 31(18), 2197-2204.

29. Keller, T., et al. (2009). Sensitive troponin I assay in early diagnosis of acute myocardial infarction. New England Journal of Medicine, 361(9), 868-877.

30. Pesaro, A. E. P., Serrano Jr, C. V., & Nicolau, J. C. (2004). Infarto agudo do miocárdio: Síndrome coronariana aguda com supradesnível do segmento ST. Revista da Associação Médica Brasileira, 50, 214-220.

31. Reichlin, T., et al. (2012). One-hour rule-out and rule-in of acute myocardial infarction using high-sensitivity cardiac troponin T. Archives of Internal Medicine, 172(16), 1211-1218.

32. Mueller, C., et al. (2017). Documento de posição da Sociedade Europeia de Cardiologia-Acute Cardiovascular Care Association sobre insuficiência cardíaca aguda: Um apelo para cuidados interdisciplinares. European Heart Journal: Acute Cardiovascular Care, 1, 81-86.

33. Rocha, R., & Fernandes, L. M. S. (2016). O impacto das Unidades de Pronto Atendimento (UPAs) 24h sobre indicadores de mortalidade: Evidências para o Rio de Janeiro.

34. Bittencourt, R., & Hortale, V. (2009). Intervenções para solucionar a superlotação nos serviços de emergência hospitalar: Uma revisão sistemática. Cadernos de Saúde Pública, 25(7), 1439-1454.

35. Regan, B., et al. (2019). Evaluation of molecularly imprinted polymers for point-of-care testing for cardiovascular disease. Sensors, 19(16), 3485.

36. Motta, M., et al. (2007). Cardio-cerebrovascular complications in elderly with diabetes. Archives of Gerontology and Geriatrics, 44(3), 261-269.

37. Cavalcanti, A. B., et al. (1998). Diagnóstico do infarto agudo do miocárdio. Valor da dosagem de mioglobina sérica comparada com a creatinofosfoquinase e sua fração MB. Arquivos Brasileiros de Cardiologia, 70, 75-80.

38. Kumar, V., et al. (2010). Robbins e Cotran - Patologia - Bases patológicas das doenças (8ª ed.). Rio de Janeiro: Elsevier.