

## Executive Summary – Guideline on Telecardiology in the Care of Patients with Acute Coronary Syndrome and Other Cardiac Diseases

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Cardiology is a very promising field in telemedicine. The transmission of electrocardiograms (ECG) from remote health services or ambulances to a central for analysis is already routine in the approach to acute coronary syndromes (ACS). This approach allows the obtention of expert guidance and referral to appropriate health units, with the potential of saving lives. This impact may be seen in acute myocardial infarction (MI), in which telemedicine has reduced intra-hospital mortality rates from 12.3% to 7.1%<sup>1-4</sup>.

### Basic concepts

In a health system geographically distributed like the Brazilian system, in which Basic Health Units (*Unidades Básicas de Saúde*, UBSs), Emergency Care Units (*Unidades de Pronto Atendimento*, UPAs), secondary hospitals, and ambulances are scattered throughout the country (often in remote locations), and specialized centers are located in advanced care units in large cities (such as tertiary hospitals), telemedicine offers the opportunity to improve the treatment of emergencies. The clinical ability of specialists in tertiary hospitals may be used to improve the care in Remote Care Units (*Unidades Remotas de Atendimento*, URAs), offering support for early diagnosis and therapy guidance for non-specialist medical practitioners providing medical care to patients in URAs<sup>5,6</sup>.

Communication channels in telemedicine include telephone lines for voice communication and connection to the internet, and for transmission of test results, ECG tracings, and images. Optionally, a video link may be used for visualization of the patient.

### Telemedicine in the approach to ACS<sup>7,8</sup>

**Situation A:** A patient goes by himself to the nearest URA, or calls the prehospital care service and is taken to the URA in a standard ambulance without an electrocardiograph.

### Keywords

Heart Failure / mortality; Myocardial Infarction / mortality; Telemedicine / utilization; Electrocardiography; Mobile Health Units.

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The professionals at the URA take the clinical history, examine, and obtain serial ECGs from the patient. The ECG tracings are transmitted along with the clinical history to the telecardiology hub where they are interpreted by cardiologists who quickly prepare and send a report, and guide the professionals at the URA on the appropriate therapy.

**Situation B:** A patient connects with the prehospital care service and an ambulance with an electrocardiograph and without a physician answers the call. Based on the patient's history and interpretation of the ECG, if the cardiologist at the telecardiology hub diagnoses the patient as having an ST-segment elevation MI (STEMI), he guides the medical team to administer the standard therapy (for example, aspirin and other medications) and transport the patient to a hospital that offers percutaneous coronary intervention (PCI) or to administer fibrinolytic treatment. Even if the diagnosis of STEMI is excluded, the ambulance team is oriented to follow the cardiologist's instructions about the path to be followed for that patient.

**Situation C:** A patient calls the prehospital care service, an ambulance with a physician and an electrocardiograph answers the call, and the team obtains an ECG that is transmitted to the telecardiology hub. Based on the clinical history and interpretation of the ECG, if the cardiologist at the telecardiology hub determines that the patient has STEMI, he guides the physician to administer treatment for STEMI, such as antiplatelet and anticoagulant agents, and to follow one of these options:

- If the STEMI patient can be transported to a hospital with PCI capability and the PCI can be performed within 120 minutes, or if the patient has contraindication to fibrinolytic treatment, the patient must be transported to the hospital with PCI. The ambulance physician also alerts the hospital to prepare the catheterization laboratory to treat a STEMI patient with primary PCI.
- If the PCI cannot be performed within 120 minutes, the ambulance physician is instructed to first administer fibrinolytic agents, preferably within 30 minutes, and then transport the patient to the nearest hospital equipped with a catheterization laboratory to continue the therapy.
- If the cardiologist in the telecardiology hub confirms that STEMI is not the diagnosis and the ambulance physician determines that the patient has ACS, after receiving the initial therapy the patient should be transferred preferably to a hospital equipped with a catheterization laboratory. If that is not possible, the patient should be transferred to the nearest hospital equipped with an intensive cardiac care unit. If the cardiologist determines

that the chest pain protocol should be initiated for the patient, he or she may direct the ambulance team to transport the patient to the nearest hospital, even if the hospital is not equipped with a catheterization laboratory, for monitoring of clinical parameters, ECG, and markers of myocardial necrosis (Figure 1).

To ensure that the transmitted information has good quality and the interaction is valuable, the patient with chest pain should receive a systematic approach, which can be achieved with several methodologies. One of these methodologies takes into account the "4D" for systematization of the diagnosis of ACS (Figure 2)<sup>9</sup>:

- First "D": classify the chest pain (*discomfort*) into types A (definitely anginal), B (probably anginal), C (probably not anginal), or D (definitely not anginal).
- Second "D": define whether an ST-segment elevation is present or not in the ECG.

- Third "D": if the ECG does not show signs of ischemia, assess the probability of the patient having coronary artery disease (CAD) based on the presence of risk factors: age (above 45 years in men and 55 years in women), smoking, diabetes, hypertension, and family history of early CAD (below the age of 55 years in men and 65 years in women).
- Fourth "D": the diagnosis of ACS must be confirmed or excluded, or the chest pain protocol should be initiated.

Requirements in telemedicine for adequate diagnosis and treatment of ACS and other acute cardiac diseases (Figure 3)<sup>10</sup>.

Financial requirements, procedures, and clinical and team protocols for deployment of telemedicine for adequate diagnosis and treatment of ACS and other acute cardiac diseases (Figure 4)<sup>10</sup>.

Medical equipment, information technology, and services (Figures 5 and 6)<sup>10</sup>.

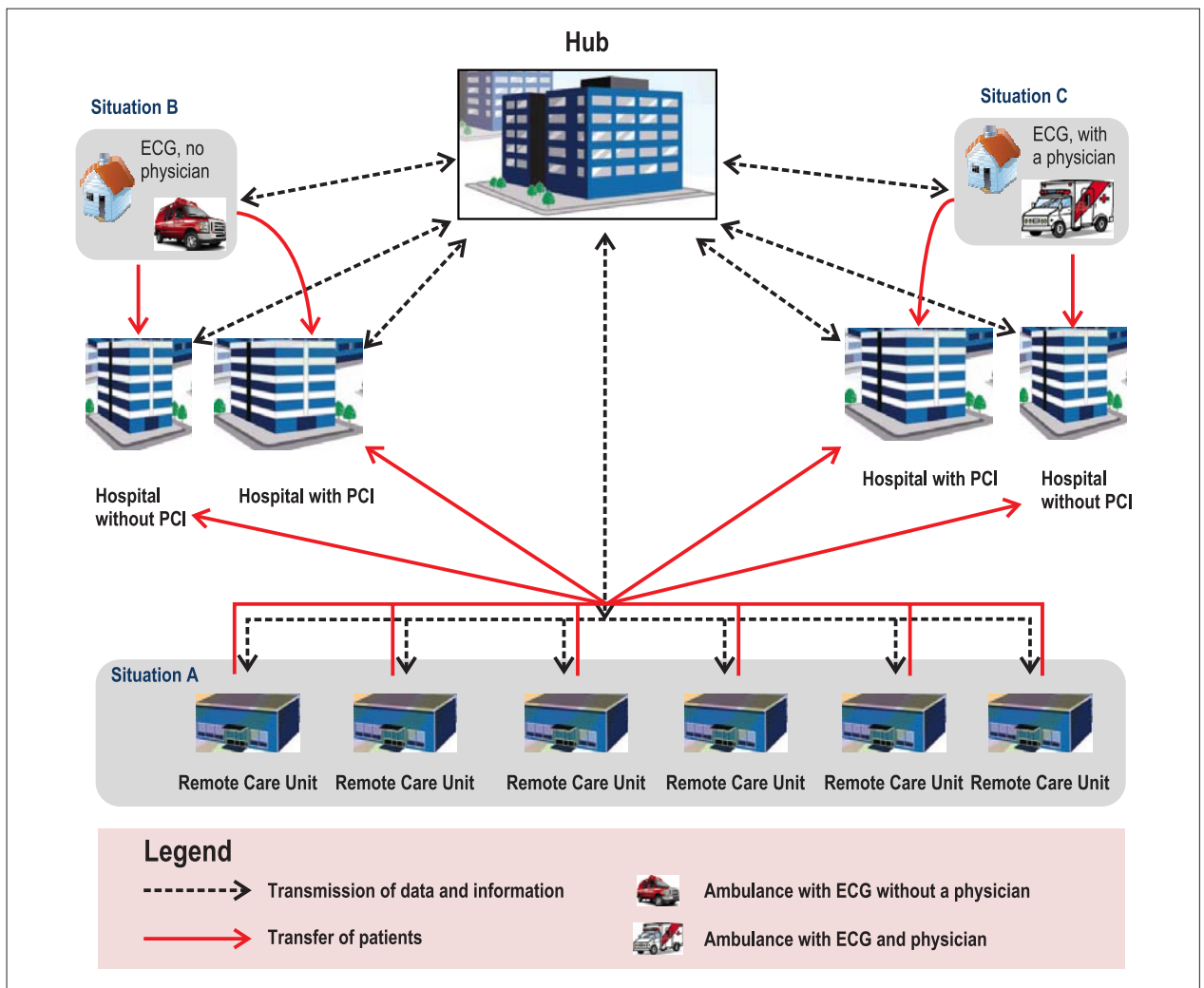


Figure 1 – Schematic representation of telemedicine for acute emergency therapy. Treatment strategies using telemedicine are shown for acute coronary syndrome (ACS). ECG: surface electrocardiogram.

**Chest pain (Discomfort):** screen the patient and classify the pain into types A, B, C, or D

**Define the ECG:** presence of ST-segment elevation or signs of ischemia

**CAD:** low, intermediate, or high probability

**Diagnosis:** confirm/exclude ACS or initiate the chest pain protocol

**Figure 2 –** Care systematization for the establishment of the diagnosis in patients with chest pain. ECG: electrocardiogram; CAD: coronary artery disease; ACS: acute coronary syndrome.

	Recommendation Grade	Level of Evidence
Investigation of the patient, including the type of pain and the likelihood of coronary artery disease, and acquisition of an electrocardiogram for detection of ST-segment elevation myocardial infarction and coronary syndrome without ST-segment elevation in patients with suspected acute coronary syndrome treated in mobile and fixed emergency units before the teleconsultation.	I	A
	Recommendation Grade	Level of Evidence
Distant specialized support for electrocardiogram interpretation for detection of ST-segment elevation myocardial infarction and coronary syndrome without ST-segment elevation in patients treated in mobile and fixed emergency units.	I	B
	Recommendation Grade	Level of Evidence
Distant specialized support for guidance on the management of patients with suspected acute coronary syndrome treated in mobile and fixed emergency units.	IIa	A
	Recommendation Grade	Level of Evidence
Acquisition of a prehospital electrocardiogram to refine the management and reduce the time to reperfusion in patients presenting with ST-segment elevation myocardial infarction.	I	B
	Recommendation Grade	Level of Evidence
Acquisition of a prehospital electrocardiogram for the diagnosis of ST-segment elevation myocardial infarction and acute coronary syndrome without ST-segment elevation to reduce mortality in these patients.	I	B

**Figure 3 –** Recommendation grades and levels of evidence of the procedures for management of patients with ACS.

### Telecardiology in remote routine diagnosis

One of the most common applications of telecardiology in remote areas is in the analysis of diagnostic tests, such as ECG, Holter, ambulatory monitoring of blood pressure (AMBIP), and echocardiography. Other applications include synchronous or asynchronous teleconsulting systems or second opinions, teleauscultation, remote monitoring of blood pressure, vital signs and implantable electronic devices, and educational activities. In addition, telecardiology

has important applications in the penitentiary system, in pediatrics, and in fetal cardiology.

### Cardiac arrhythmias and syncope<sup>11-13</sup>

Since several types of cardiac arrhythmia occur in short and unexpected episodes, its diagnosis depends on an ECG recorded during the paroxysmal episode. A standard 10-second surface ECG may not be able to detect the abnormality in the heart rhythm. In this case, long-term

	Recommendation Grade	Level of Evidence
Adequate support from financial resources to establish the infrastructure of the telecardiology hub and assembly of the organizational structure for operation of the telecardiology service.	I	C
	Recommendation Grade	Level of Evidence
In the telecardiology hub and in the Remote Care Unit, the clinical protocols for diagnosis and treatment must be written in easy language and have simple application. The processes and work pace for each step must be documented and communicated to the team.	I	C
	Recommendation Grade	Level of Evidence
The team of cardiologists at the telecardiology hub for emergency consultations, such as interpretation of electrocardiograms, conference calls, web conferences, videoconferences, or telephone calls, must be adequate to the number of calls and the number of units connected to the hub.	I	C
	Recommendation Grade	Level of Evidence
Technical support and management professionals must be part of the team, and everyone should be trained, including users of the system at the mobile and fixed Remote Care Units.	I	C

**Figure 4** – Recommendation grades and levels of evidence for the financial requirements, procedures, and clinical and team protocols in telemedicine for adequate diagnosis and treatment of ACS and other acute cardiac diseases.

monitoring is recommended, such as 24-hour Holter monitoring or event recording for 2 to 4 weeks. For selected, more difficult cases, an implantable monitoring device named loop recorder may be used to record the ECG patterns during occasional but significant symptoms like syncope.

The system may be useful in several situations, among others:

- Detection of asymptomatic episodes of atrial fibrillation, which may require anticoagulation therapy to reduce the risk of stroke.
- Quick recognition of electrode lead failure, allowing fast intervention and avoiding inappropriate shocks.
- Reduction in the number of outpatient visits during long-term follow-up of patients with a pacemaker or implanted defibrillator.

#### Heart failure (HF)<sup>14,15</sup>

Distant monitoring, or telemonitoring, is a promising strategy to improve the outcomes of HF treatment, allowing remote monitoring of patients so physicians can intervene early when evidence of clinical deterioration is present. The approaches vary from computerized systems for decision support to programs managed by nurses or physicians. A dedicated hardware or a smartphone may be used to transmit the patient's data (for example, symptoms, weight, blood pressure, and heart rate). A structured phone support, which can better guide the

patient and offer specialized treatment to HF patients, has been shown to reduce the mortality and hospitalizations due to HF, improve quality of life, reduce the cost of treatment of prescriptions based on evidence, and improve the patients' knowledge and their knowledge about self-treatment.

#### Author contributions

Conception and design of the research, Acquisition of data, Writing of the manuscript and Critical revision of the manuscript for intellectual content: Oliveira Jr. MT, Paula LJC, Marcolino MS, Canesin MF; Analysis and interpretation of the data and Obtaining financing: Oliveira Jr. MT.

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#### Study Association

This study is not associated with any thesis or dissertation work.

	Recommendation Grade	Level of Evidence
In the Remote Care Unit, all patients with chest pain must have a 12-lead electrocardiogram performed, which should be interpreted in less than 10 minutes from the first medical contact (FMC).	I	A
	Recommendation Grade	Level of Evidence
Availability of a 12-lead electrocardiograph with a capability to transmit the tracing to the telecardiology hub, preferably with an option to print the tracing.	I	C
	Recommendation Grade	Level of Evidence
Use of photographic reproduction or low-quality scanning to transmit the electrocardiogram to the telecardiology hub for preparation of the report.	III	C
	Recommendation Grade	Level of Evidence
Use of software for electrocardiogram interpretation validated for emergency situations.	IIb	C
	Recommendation Grade	Level of Evidence
In remote locations in which the results of the markers are not available within 60 minutes, the local availability of point-of-care equipment should be evaluated.	I	A
	Recommendation Grade	Level of Evidence
Wait for the results of myocardial necrosis markers to start therapy in patients with a diagnosis of ST-segment elevation myocardial infarction.	III	A
	Recommendation Grade	Level of Evidence
Availability of cardiac markers assessment by a point-of-care methodology in remote fixed areas where a central laboratory is not available.	IIa	B

**Figure 5** – Recommendation grades and levels of evidence for the medical equipment in telemedicine for adequate diagnosis and treatment of ACS and other acute cardiac diseases.

	Recommendation Grade	Level of Evidence
Internet availability for wired or wireless transmission of patients' data, electrocardiogram, and other tests.	I	C
	Recommendation Grade	Level of Evidence
Presence of equipment for patient monitoring in the Remote Care Unit and in the mobile unit for all patients with suspected acute coronary syndrome.	I	A
	Recommendation Grade	Level of Evidence
Presence of telephone equipment for routine transmissions or to allow communication during network downtime, or failure in the equipment or transmission system.	I	C
	Recommendation Grade	Level of Evidence
Presence of internet connection with adequate bandwidth in the Remote Care Unit and in the telecardiology hub adapted for transmission of electrocardiograms and other additional resources, such as data and image.	I	C
	Recommendation Grade	Level of Evidence
Presence of wired or wireless <i>hardware</i> for work and communication, suitable for the demand of both the telecardiology hub and Remote Care Unit.	I	B
	Recommendation Grade	Level of Evidence
In services that choose to transmit videos, or still or dynamic images, the wired or wireless <i>hardware</i> for work and communication should be suitable for this purpose.	I	A
	Recommendation Grade	Level of Evidence
Presence of a protection system, security of local data and data to be transmitted, as well as an up-to-date anti-virus program in the telecardiology hub and Remote Care Unit.	I	C
	Recommendation Grade	Level of Evidence
Recording of all the communication involving orientation or exchange of information between the telecardiology hub and the Remote Care Unit.	I	C
	Recommendation Grade	Level of Evidence
Presence in the Remote Care Unit of electrocardiogram equipment compatible with the system used in the telecardiology hub and technical stock in sufficient amount to replace and maintain the system operative.	I	C

**Figure 6** – Recommendation grades and levels of evidence for the information technology equipment and services in telemedicine for adequate diagnosis and treatment of ACS and other acute cardiac diseases.

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