

# ST-segment monitoring

## Benefits, barriers, and pathways to acceptance

### Literature review

#### INTRODUCTION

In recent years, a number of peer-reviewed papers (listed below) have presented evidence that the traditional 12-lead ECG is not by itself sufficient for monitoring certain patients at risk for heart attack. These papers describe how the additional technique of continuous ST-segment review provides a proactive way to detect cardiac events in patients in the emergency department or ICU whose ECGs appear normal and who do not necessarily complain of symptoms. They also mention other patient populations in which the technique has proven useful, including some patients who have undergone percutaneous coronary intervention<sup>1</sup> and patients being weaned from mechanical ventilation.<sup>2</sup>

Taken together, these peer-reviewed papers have presented evidence that ST-segment monitoring can help clinicians detect potentially life-threatening conditions, investigate the causes, and start treatment sooner. In addition, the papers cite research that links ST-segment monitoring to improved patient outcomes.<sup>3</sup> Still, the adoption of ST-segment monitoring is far from universal. Observers have identified a number of barriers to its wider use and have also cited specific ways to overcome those barriers, including:

- Better education of nurses and physicians
- Greater interdisciplinary cooperation
- Hospitals' adoption of written ST-review practice standards and protocols
- ST-segment monitoring technology that is easy to use and understand for caregivers at all levels

#### ST-SEGMENT MONITORING DETECTS CLINICALLY SILENT EPISODES

The traditional 12-lead ECG, given once or intermittently, provides essentially a 10-second "snapshot" of heart function and does not record dynamic changes in the heart over time. Yet research shows that 80 to 90 percent of ischemic episodes are clinically silent and are likely to be missed by a conventional 12-lead ECG.<sup>4</sup>

On the other hand, "Research demonstrates that monitoring for ST segment changes in multiple leads, preferably 12 leads, substantially improves the chance of detecting ischemic events."<sup>5</sup> The ST segment is measured at 0.6 seconds after the J point on the ECG. It is recorded in millimeters of depression below or elevation above the isoelectric baseline. Depression or elevation of 1 mm to 2 mm, lasting for at least one minute, can be clinically significant and warrants further assessment of the patient.<sup>6</sup>

#### CLINICAL EVIDENCE SUPPORTS ST-SEGMENT MONITORING

One reason some clinicians have been slow to adopt continuous ST-segment monitoring may be a perceived lack of conclusive proof that it is effective. So far, no controlled, randomized clinical trials have shown beyond a doubt that patients who are monitored have better outcomes than patients who are not. On the other hand, a number of studies strongly indicate that ST-segment review is beneficial. Among the findings:

- T. Jernberg, P. Abrahamsson, B. Lindahl, P. Johanson, I. Wallentin and M. Delborg found that use of multi-lead ST-segment monitoring in patients with ACS allowed prospective identification of those who had the best response to longer treatment with low-molecular-weight heparin, resulting in lower rates of mortality, myocardial infarction, and revascularization<sup>8</sup>
- A.C.P. Maas, C.M. Wyatt and C.L. Green found that age, heart rate and late ST-segment elevation were independent risk factors for adverse clinical outcomes, and that ST-segment monitoring helped in assessing response to therapy, especially in high-risk patients more than 70 years old<sup>9</sup>
- A Canadian study found that after adjustment for risk scores, the presence of ST-segment shifts on continuous ECGs was a stronger independent predictor of mortality than were the findings of on-admission 12-lead ECGs<sup>10</sup>

- K.M. Akkerhuis, P. Klootwijk and W. Lindeboom found that the number of ischemic events in 24 hours, as identified by ST-segment monitoring, was directly proportional to the probability of cardiac events at five and 30 days. Specifically, each transient ischemic event was predictive of a 25 percent increase in the risk of death or myocardial infarction at five and 30 days<sup>11</sup>
- Several investigations found that continuous ST-segment monitoring helped predict patients' severity of disease during hospitalization, after discharge, and in long-term follow-up<sup>12</sup>

#### **ST-SEGMENT MONITORING CAN HELP SEVERAL PATIENT GROUPS**

A variety of patient groups can benefit from continuous ST-segment monitoring. In relatively recent years, clinical guidelines have been published for optimum use of ST-segment monitoring and for identifying patients on which to use it.

In 1999, the ST-Segment Monitoring Practice Guidelines International Monitoring Group recommended that the monitoring be included for at least 24 to 48 hours:

- In patients experiencing acute myocardial infarction or Acute Coronary Syndrome
- In patients after coronary artery intervention to detect patency after thrombolytic therapy or primary angioplasty<sup>13</sup>

In 2004, the American Heart Association (AHA) published a scientific statement<sup>14</sup> of practice for ECG monitoring in hospitals that included guidelines for ST-segment monitoring in certain patients.

The American Association of Critical Care Nurses (AACN) and the International Society of Computerized Electrocardiology endorsed those guidelines.<sup>15</sup>

Also in 2004, the AACN published a Practice Alert (revised in 2008) recommending that standard practice include continuous ST-segment monitoring:

- In patients in the early phases of ACS who arrive in the emergency room with chest pain or anginal-equivalent syndromes
- In patients who have undergone a percutaneous coronary intervention but have not achieved optimum perfusion as shown by an angiogram
- In patients who may have a variant angina (for example, caused by vasospasm rather than by occlusion)<sup>16</sup>

The practice alert provides short, specific guidelines for ST-segment monitoring.

Further research indicates that ST-segment monitoring may be beneficial in other types of patients. It has been recommended for four to eight hours after percutaneous coronary intervention for patients with no complications. Those patients may experience coronary "stretch" pain or gastrointestinal upset, and ST-segment monitoring can help rule out ischemia and relieve their anxiety. The monitoring is also useful after cardiac surgery to help differentiate cardiac pain from incisional pain.<sup>17</sup>

Another area under research is using ST-segment monitoring during weaning of patients from mechanical ventilation. Here, ST segment changes that suggest ischemia correlate with failure to wean. As such, monitoring could help caregivers predict weaning failure and determine how well patients will tolerate weaning trials.<sup>18</sup>

In addition, researchers who used continuous ST-segment monitoring during carotid endarterectomy concluded that the monitoring may help detect myocardial ischemia. Other research supported the value of 12-lead ST-segment monitoring during major vascular surgery. In fact, even critically ill patients who do not undergo surgery and have high myocardial oxygen demand may experience untoward cardiovascular events that could be detected by ST monitoring.<sup>19</sup>

#### **CONTINUOUS ST MONITORING FACES RESISTANCE AND LACK OF AWARENESS**

Even in the face of all this evidence, one survey of cardiologists found that continuous ST-segment monitoring is routine practice in only about half of critical care units in the United States, and just 45 percent of respondents were aware of the AHA consensus guidelines for ECG monitoring in hospitalized patients.<sup>20</sup> According to the survey, one often cited reason is lack of interest and lack of awareness of the technique among physicians. While ECG monitoring is mainly a nursing function, hospitals often rely on physicians to dictate which parameters should be monitored.

Another potential barrier is the absence of standard protocols for ST-segment monitoring at hospitals. The same survey of cardiologists found that among hospitals where the respondents admitted patients, 49 percent had a standard of practice for using continuous ST-segment monitoring.<sup>21</sup>

Other barriers arise at the level of clinical practice. One issue is that nurses in general lack the training they need to implement ST monitoring properly and interpret the results. Basic ECG training usually emphasizes monitoring for cardiac arrhythmias and gives less attention to the ST-segment changes that can accompany ACS.<sup>22</sup>

Finally, false alarms and false positives are a common concern. To be effective, monitoring equipment should have ST-segment analysis software and alarm capabilities, but alarms need to be customized carefully. Frequent false alarms irritate nurses and may desensitize them, possibly leading to missed alarms and potential harm to patients.

#### **BARRIERS TO ACCEPTANCE CAN BE BROKEN DOWN**

Clinical experience shows that barriers to the acceptance of ST-segment monitoring can be broken down. One positive contributor is hospital standards of practice. The cardiologist survey found that respondents practicing at hospitals with standards of practice for continuous ST-segment monitoring were significantly more likely to order the monitoring for appropriate patient populations.<sup>23</sup>

It is also essential for different disciplines to collaborate on decisions related to ECG monitoring so that all involved in care can support best practices. For example, at one Minnesota hospital, an interdisciplinary team developed a standard of practice to ensure acceptance by cardiologists, hospitalists, cardiac rehabilitation professionals, and nurses.<sup>24</sup>

The standard states in part that before notifying a physician about a ST alarm, the nurse must verify that the patient's ECG patches are placed correctly and that the alarm is not caused by an artifact. Next, for any 2 mm change in the ST segment sustained for 15 minutes, with or without signs or symptoms, the nurse obtains an as-needed 12-lead ECG to confirm that ST changes are present. Before the attending physician is called, the nurse pages the house officer to confirm findings in the 12-lead ECG that suggest ischemia. This process reduces telephone calls for alarms that turn out to be false.<sup>25</sup>

Appropriate monitoring technology is also important. Monitors with continuous 12-lead capability add value.<sup>26</sup> Bedside caregivers should not be required to configure the alarms manually – alarms should be set so that they are triggered by a 1 mm or 2 mm deviation from the patient's baseline, unless the nurse determines that the alarm should be modified or disabled in light of the specific patient's needs. Factors to consider in selecting equipment also include:

- The amount of technical, educational and training support available from the vendor
- The vendor's commitment to customer service
- The capacity for future device upgrades
- Whether the system can be used seamlessly across the care continuum, so that data can travel with the patient through levels of care<sup>27</sup>

The team that reviews and selects the monitors should include physicians, nurses, information technology personnel, and biomedical engineers.

#### OPTIMAL USE OF ST-SEGMENT MONITORING DEPENDS ON TRAINED STAFF

Effective training for nurses responsible for ECG monitoring is essential. Key issues to address include how to measure and interpret ST-segments; the significance of ST-segment changes; how to use monitoring equipment correctly; how to manage alarms; proper positioning, application, and maintenance of electrodes; and what to do when ST alarms occur. Specific monitoring practices to be covered include:

- Properly preparing the patient's skin before attaching the ECG electrodes
- Marking the electrode positions with indelible ink and keeping the electrodes in those locations throughout, so as to avoid false-positive readings
- Evaluating the ST-segment with the patient in a supine position, and upon an alarm sounding, checking whether the patient has moved. Ideally, initial staff education is followed by ongoing assessment of competency.

One effective education strategy is to present case studies that show how ST-segment monitoring affected patients who have been cared for in staff members' own care settings. Especially powerful are case studies that highlight nursing interventions that enabled early recognition and treatment of myocardial ischemia.<sup>28</sup>

#### ST-SEGMENT MONITORING PROVIDES A SOUND FOUNDATION FOR DECISION MAKING

Clinical experience shows that ST-segment monitoring unquestionably has a place in the care of cardiac patients.

Significant research supports the use of continuous ST-segment monitoring as part of the foundation for patient-care decisions. Nurse and physician experts alike have issued guidelines for such monitoring, and the evidence warrants evaluation of whether ST-segment monitoring is done in a given institution as those guidelines suggest.<sup>29</sup>

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This report draws on information from several medical journal articles, papers and practice guidelines that reflect some recent findings and clinical approaches related to ST segment monitoring. They include:

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