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Electronically Recorded Heart Sounds In The Pre-Hospital Diagnosis Of Heart Failure - The Collier County Experience

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INTRODUCTION

Paramedics are faced with the challenge of deciphering a variety of complaints relating to dyspnea, chest pain, weakness, unexplained diaphoresis or nausea, as well as outright syncope. Yet, despite having limited information to work with, they are under great pressure to come up with the correct diagnosis and treatment decisions every single time. Obviously, this often does not occur because there is so much overlap of symptoms and disease, exacerbated by the limited availability of diagnostic tools for pre-hospital use.

At Collier County EMS, we have spent the last year using a new technology that can help to more effectively assess and treat both Congestive Heart Failure and Acute Ischemia in the pre-hospital environment. Known as AUDICOR, this device replaces the standard 12-lead ECG on our existing defibrillator/monitors to help the medic identify subtle heart sounds that, in the proper clinical context, are highly correlated with acute decompensated heart failure (ADHF). By coupling AUDICOR technology with appropriate therapy, we believe we can significantly improve the diagnosis and treatment of patients with ADHF.

BACKGROUND

Nearly 5 million Americans have heart failure and about 550,000 additional cases are diagnosed each

year. A study of 222 adult patients with dyspnea noted a pre-hospital error rate of 23% in diagnosing heart failure. Importantly, in those patients who had comorbidities, e.g. chronic obstructive pulmonary disease (COPD), heart failure was missed in 46%.¹ Less than 10% of eligible patients with ADHF receive vasoactive therapy at all and, of the 10% who do, most of them receive it up to eight hours or more after the diagnosis has been made.

This is important, since accurate and early diagnosis leads to more effective treatment of heart failure. Earlier diagnosis and treatment has been shown to result both in better clinical outcomes and lower cost of care.^{2,3} Not only does accurate pre-hospital diagnosis and treatment improve patient outcomes, but administering heart failure drugs to patients with non-cardiac dyspnea increases patients' mortality (13.6% improper treatment vs. 3.8% proper treatment).^{1,3} In a study of 146 pre-hospital patients, Jaronik et al found that paramedic treatment with Furosemide was considered appropriate in 58%, inappropriate in 48%, and potentially harmful in 17%.⁴ Beginning appropriate treatment early also significantly reduces the duration and cost of hospitalization for heart failure.¹⁻³

In the presence of dyspnea, the third heart sound (S3) is a reliable marker of the hemodynamic abnormalities associated with heart failure.⁵ Drazner et al showed in a study of 2,569 patients the S3 was 99% specific for heart failure, but could be detected by auscultation in only 21% of the patients with heart failure. This study also showed that patients who had an S3 had worse clinical outcomes than those without this finding.⁶ This emphasizes both the diagnostic and the prognostic value of the S3. It also shows that auscultation can detect the S3 in only about 1/5 of the patients with heart failure.

ELECTRONIC DETECTION OF HEART SOUNDS

AUDICOR uses the same approach as a standard 12-lead ECG, but substitutes a pair of special sensors in the V3 and the V4 positions that record both sound and ECG information. This information is used to



Figure 1. The AUDICOR® Dual sensors

produce a recording of heart sounds concurrently with the 12-lead ECG. Specialized signal processing and analysis is used to detect third and fourth heart sounds (S3, S4) much more reliably than is possible by auscultation. In a multi-center emergency department study, the prevalence of an AUDICOR S3 in heart failure patients prior to receiving treatment exceeded 50% with high specificity.⁷ AUDICOR also offers a greatly enhanced 12-lead ECG algorithm to more accurately diagnose Acute MI, Acute Coronary Syndromes (ACS), and Left Ventricular Hypertrophy.

USE OF AUDICOR AT COLLIER COUNTY

Thanks to these advances, our paramedics can much more accurately distinguish acute decompensated heart failure from many other causes of acute dyspnea leading to earlier treatment. It also enables them to make a much more informed decision about myocardial ischemia when the ECG changes are not classic. This information is used to determine who is at greatest risk for immediate problems with acute coronary syndromes and should be transported directly to a cardiac cath lab. While further investigation is needed, we anticipate that recorded heart sounds hold

great promise for the management of patients with acute ischemic heart disease. For example, the S3 could indicate the presence of heart failure associated with an acute myocardial infarction or an episode of unstable angina.

Here is a good example of a dyspneic patient who presented with subtle signs and symptoms of heart failure. This diagnostic information led to appropriate treatment at the receiving facility. Based on our early experience with cases such as this, our medics would now treat with Nitrates and Lasix in the field.

CASE STUDY

An 86 year-old woman called an ambulance because of worsening shortness of breath over the past few weeks. She had a history of chronic heart failure, COPD, chronic renal insufficiency, hypertension, and adult onset diabetes mellitus.

Physical Examination was unrevealing

Neck - no jugular venous distension

Extremities - no edema

Normal Breath Sounds

Differential Diagnosis

1. Acute heart failure
2. Pneumonia
3. COPD exacerbation

AUDICOR® Findings

1. S3 heart sound
2. Left ventricular hypertrophy
3. ST-T abnormalities

EMS Actions Based on AUDICOR® Findings

The AUDICOR® findings suggested underlying heart disease: S3 heart sound, left ventricular hypertrophy, and ST-T abnormalities. Paramedics administered oxygen and IV with normal saline during transport to the hospital.

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