Computerized Detection Of Third Heart Sounds Improves Sensitivity For The Emergency Department Diagnosis Of Heart Failure

Alan B. Storrow, MD*; Sean P. Collins, MD*; Christopher J. Lindsell, PhD*¶; W. Frank Peacock, MD#

University of Cincinnati, *Department of Emergency Medicine; ¶Institute for Health Policy and Health Services Research; #Cleveland Clinic Foundation, Department of Emergency Medicine

OBJECTIVE

We determined the diagnostic test characteristics of physician auscultation versus computerized detection of a third heart sound (S3) in emergency department patients with possible heart failure.

We hypothesized that computerized S3 detection would be more sensitive and specific than physician auscultation for a primary discharge diagnosis of heart failure.

BACKGROUND

The third heart sound (S3) occurs about 0.14 seconds after the second heart sound in early diastole. Of the many proposed theories, the most likely explanation is that excessive rapid filling of a stiff ventricle is suddenly halted, causing vibrations that are audible. S3 detection is often considered normal in adolescents and young adults, while its detection after the age of 40 is usually considered abnormal and indicative of left ventricular dysfunction.

METHODS

Patients were enrolled at two large tertiary care emergency departments if they presented with symptoms of heart failure, including dyspnea. Diagnostic test characteristics of an S3 were described for two methods, both performed shortly after emergency department arrival and before treatment:

1) A validated algorithm from an acoustic heart sound recording (AUDICOR™, Inovise Medical, Inc., Figures 1 and 2)
2) Physician auscultation and notation of findings on a structured case report form.

A primary diagnosis of heart failure was based on the final hospital discharge summary. Data are reported with 95% confidence intervals.

RESULTS

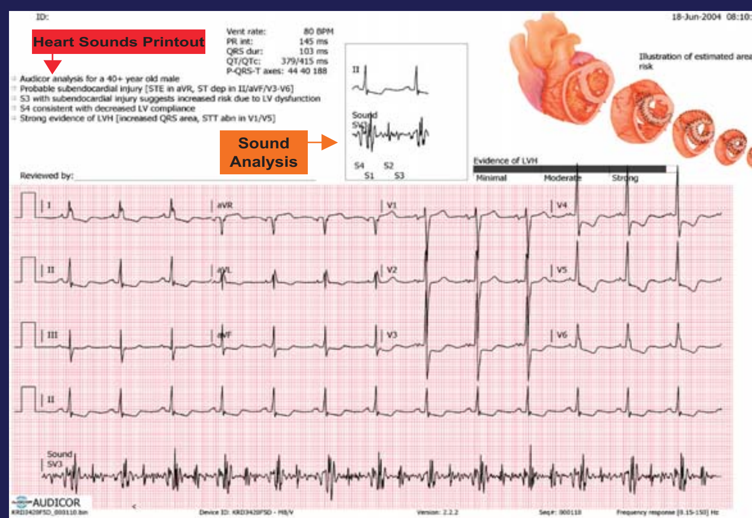

Figure 1 The AUDICOR add-on device (white) attached to an existing ECG.

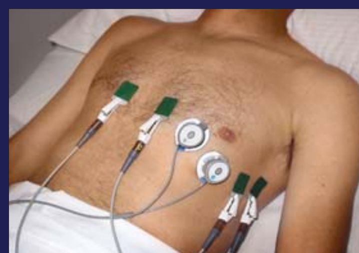

Figure 2 Placement of the AUDICOR sensors

Of 439 patients enrolled, 226 had either no heart failure or a primary diagnosis of heart failure, were evaluated prior to receiving treatment, and had usable sound data. 54 had a primary diagnosis of heart failure and 172 had no heart failure. African-Americans comprised 48.2% and males 47.3% of the sample. Median age was 60. Seventy patients were less than 55 years old, 12 were older than 85.

For a primary diagnosis of heart failure, sensitivity of S3 by physician auscultation was 22.2%, while for the AUDICOR algorithm it was 38.9%. Specificity was 87.1% and 92.4%, respectively. Physician auscultation of an S3 had a positive predictive value of 28.6%. For the AUDICOR algorithm, it was 61.8%. Negative predictive value was 82.8% for both methods.

Results are presented with 95% confidence intervals in Table 1.

Table 1 Physician auscultation versus computerized detection for third heart sounds.

	Physician Auscultation			Computerized Detection		
	Heart failure	No heart failure		Heart failure	No heart failure	
S3	8	20	S3	21	13	
No S3	28	135	No S3	33	159	

	Physician Auscultation			Computerized Detection		
Accuracy	63.3	56.6	69.5	79.6	73.7	84.4
Sensitivity	22.2	10.7	39.6	38.9	26.2	53.1
Specificity	87.1	80.5	91.8	92.4	87.2	95.7
PPV	28.6	14.0	48.9	61.8	43.6	76.1
NPV	82.8	76.0	88.1	82.8	76.6	87.7
FPR	12.9	8.2	19.5	7.6	4.3	12.9
FNR	77.8	60.4	89.3	61.1	46.9	73.0

CONCLUSION

This pilot study suggests that the S3 detected by the AUDICOR algorithm is more sensitive and specific for heart failure than physician auscultation. Such data, along with further refinements in this new technology, may prove valuable in the emergency department evaluation of patients with possible heart failure.