

# Recognizing Bi-Ventricular Pacing From The 12-Lead ECG

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**Introduction:** An increasing number of patients are now treated with cardiac pacemakers (170,000 in 2004 and 418,000 in 2006) and implantable cardioverter-defibrillators (114,000 in 2006) in the USA per AHA reports. Both treatments could incorporate cardiac resynchronization therapy, i.e. bi-ventricular (BiV) pacing, which has led to a requirement for more sophisticated reporting of pacemaker ECGs. This study develops QRS morphology rules and assesses the performance in reporting BiV pacing from 12-lead printouts after a paced beat is identified.

**Methods:** Paced ECGs were collected simultaneously from two hospitals in two formats: 12 leads at 500sps and at 32,000sps. Ventricular-paced ECGs from 140 patients ( $68 \pm 12$  years, 71% males) were used. The BiV and right-ventricular (RV) pacer pulses were annotated based on the 32,000-sps data plotted on an expanded scale. 12-lead paced ECGs recorded at 500sps were evaluated with a passband up to 150Hz. Paced QRS durations and axes were measured. QRS morphology in lead I and V1 was noted.

**Results:** From a training set of 37 ECGs (11 BiV and 26 RV) from hospital 1, we found that a monophasic negative or biphasic lead I (RS complex) was the best criterion for detecting BiV pacing Se: 100%; Sp: 92%. (Note that the RV paced ECGs were used to assess specificity of detecting BiV pacing). We then applied these rules to evaluate the accuracies for BiV pacing using a test database of 103 paced ECGs (39 BiV and 64 RV pacemakers) collected from the two hospitals. Se and Sp for detecting BiV pacing was 87% and 91% respectively. In passing, it should be noted that the reverse is true for RV pacing.

**Conclusions:** The criterion for detection of BiV pacing using only the QRS morphology of lead I is straightforward to use and acceptable for manual ECG reporting.