TEL | +886-2-2596-0701
FAX | +886-2-2596-0702
eMail | service@whaleteq.com

ECGs - 3 Lead tests

It is normal in ECG testing when confronted by large numbers of test permutations to simplify the approach on the assumption that one test is representative. For example, an input impedance test on V1 and V4 can reasonably be considered representative of tests on the other chest leads. And tests with the 10 lead cable is representative of tests with a 5 lead cable.

One easy mistake though is to extend this to patient monitors that have the option to attach a 3 Lead cable.

In systems with 4, 5 or 10 electrodes, one of the electrodes is used as the "right leg drive", which is used for noise cancellation, both for mains and dc offsets. This function helps the system cope with dc offsets, mains noise (CMRR) and input impedance.

In systems with 3 leads, there are two possible approaches: one is forget about noise cancellation and hope for the best. Another, more common is to use the displayed lead to decide which two leads are used for measurement and have the other lead switch to the noise cancellation function. For example, if the normal default Lead II is shown on the display, electrode LA is not used (Lead II = LL - RA), freeing up this lead for use as noise cancellation.

You can check for the difference between these approaches by applying a dc offset (e.g. 300mV) to one of the electrodes, and then switching between Lead I, II and III and observing the baseline. If baseline remains constant, it is likely the manufacturer has used the "hope for the best" approach. If the baseline shows a transient when switching the lead displayed (e.g. Lead I to Lead II), it means the hardware circuit is switching the lead with the noise cancellation, and the high pass filter needs time to settle down.

Either way, system with 3 lead options should be retested. The recommended test in IEC 60601-2-27 include:

- sensitivity
- input impedance
- noise
- channel crosstalk
- CMRR
- pacemaker pulse (spot check)

For the remaining tests, it seems reasonable that tests on 10 lead configurations is representative. Though it is really up to the designer to know (and inform) about which tests can be considered representative. This is one of the weak points in IEC 60601 series in that there is no clear point of analysis for representative accessories and options, something which is discussed in another MEDTEQ article on accessories.

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