TECHNIQUE

Remote Monitoring for the Intra-Aortic Balloon Pump

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Abstract

A system was developed for the transtelephonic transmission of an ECG and arterial blood pressure waveforms from an intra-aortic balloon pump to a remote location. This system extends the capabilities of the balloon pump supervisory personnel and supplements patient care by improving communications. It has been demonstrated that ECG and arterial blood pressure waveforms can be easily transmitted by telephone, and that these signals are reproduced with such fidelity that trouble shooting and advice can be communicated from a site other than the patient's bedside. This technique was successfully employed in ten patients to date.

Introduction

Telephone transmission of the ECG for permanent pacemaker follow-up and arrhythmia monitoring is a common clinical procedure.[1] The most common and least expensive systems use an acoustical coupling technique in which an analog signal, ECG, is converted to a frequency modulated sound that is transmitted using a standard telephone. The receiver device, through another telephone, converts the variable audio tones back into an analog signal that can be easily identified as an ECG nearly identical to the original.[2] Recipients of permanent pacemakers use a relatively inexpensive ECG transmitter device which is simple to use, yet supplies potentially vital cardiographic information to medical personnel from a remote location.[3]

Intra-aortic balloon (IAB) counterpulsation is common to most cardiovascular and surgical services. The IAB pump can usually be managed by well trained nurses, familiar with critical care equipment and procedures. Problem solving for complex counterpulsation situations, electronic or mechanical failures, however, can be difficult and may require the attention of supervisory personnel. In many situations, these individuals may not be readily called to the patient's bedside. To extend the capabilities of the supervisory personnel, and to improve the care of patients being maintained on IAB pumps, a system was developed that allows the bedside nurse to transmit an ECG and arterial blood pressure tracing to a remote location. From this location, evaluation and instruction can be communicated. A transtelephonic telemetry system commonly used for remote pacemaker analysis was adapted for this use. The details of this system are presented.

Methods and Materials

The Datascope System 82 Intra-aortic Balloon Pump[a] was fitted with an acoustical Life Signs 12 Lead Transmitter[b] that was obtained from the manufacturer with a slight modification in its output band pass filter (Figures 1 & 2). The modification consists of a 0 to 120 Hz

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a Datascope Corp., Paramus, NJ 07652
b Instromedix, Beaverton, OR 97005

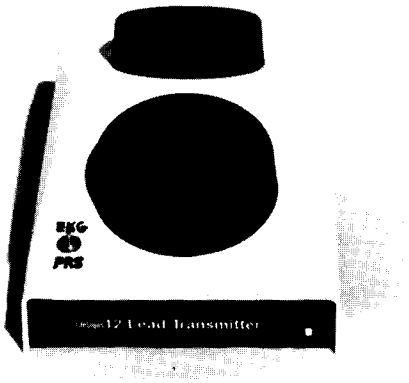

Figure 1: The Life Signs 12 Lead Transmitter with switch for selection of either ECG or arterial blood pressure traces to be transmitted.

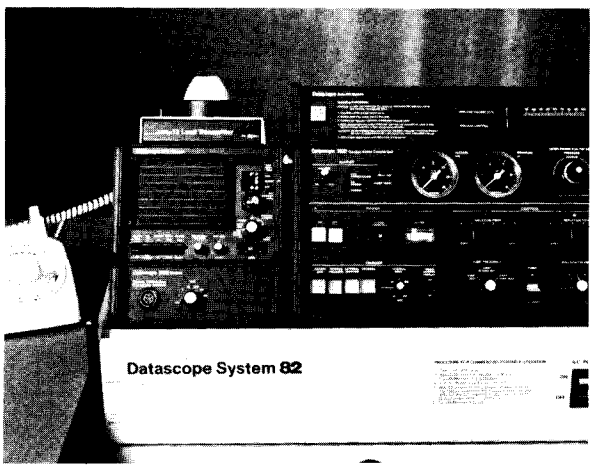

Figure 2: The Datascope System 82 Intra-Aortic Balloon Pump with the Life Signs 12 Lead Transmitter mounted on top of the Datascope 870 monitor.

output band pass instead of the normal .04 to 120 Hz range for only ECG transmission. A lower band pass level was necessary for fidelity of reproduction of the arterial blood pressure waveform. A switch was installed in the transmitter to allow for the selection and transmission of either ECG or arterial blood pressure traces as received from the IAB pump (Figure 3). These input signals come directly from the IAB pump and do not interfere with its normal operation. Transmission of these signals to a remote location was accomplished, using a standard telephone, by calling the desired number from the bedside and placing the receiver onto the transmitter.

The receiver unit, the RW-2 Receiver/Writer[c], contains a single channel thermal recorder and telephone coupling device (Figure 4). This unit also contains

c Wolff Industries, San Marino, CA 91108

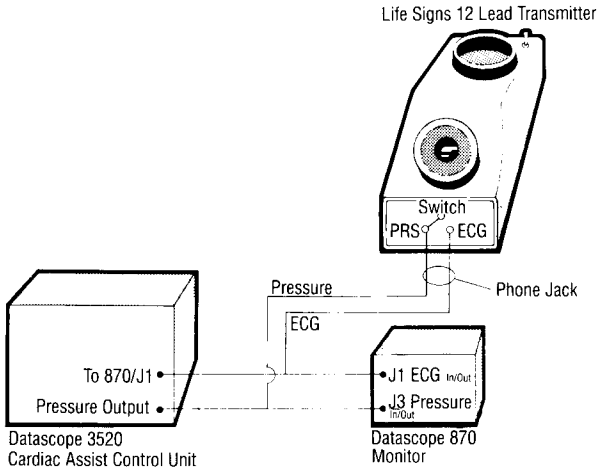

Figure 3: The basic wiring diagram of the Life Signs 12 Lead Transmitter as it is connected to the Datascope System 82 Intra-Aortic Balloon Pump.

modifications from the manufacturer. The output band pass was modified to 0 to 120 Hz instead of .04 to 120 Hz, and a continuous gain control was used to allow for matching pressure calibration signals from the IAB pump. The receiver is lightweight, AC powered, and can be easily carried to a remote location. The system was then available for periodic observation of the IAB pump timing or for urgent assistance as required by the critical care nurse at the bedside.

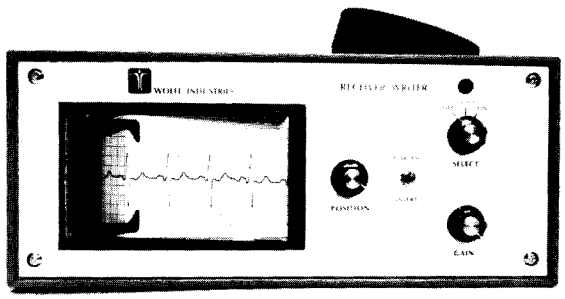

Figure 4: The RW-2 Receiver/Writer from Wolff Industries.

Results

The ECG and arterial blood pressure waveforms with IAB counterpulsation at 1:2 are presented in Figure 5 from two patients in our series. Simultaneous recordings of individual waveforms from both the central station in the Intensive Care Unit and the telephone receiver unit, as transmitted from the IAB pump, are shown. The fidelity of reproduction of all recordings

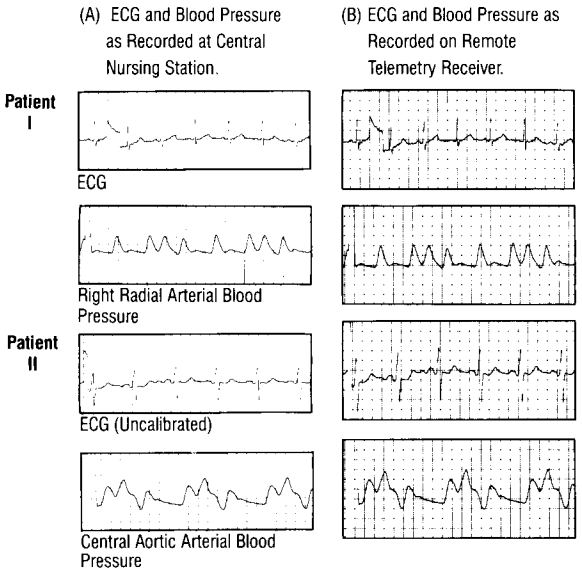

Figure 5: ECG and blood pressure waveforms recorded at the central nursing station in the Intensive Care Unit (A) as compared to the same waveforms simultaneously recorded on the remote transtelephonic receiver (B) for two different patients I and II. All pressures were recorded on a 0-200 mmHg scale at 25mm/sec.

was good. The blood pressure traces were easily calibrated by transmitting a 0 mmHg signal and then a 200 mmHg signal alternately until the receiver matched the transmitter. These pressure waveforms, however, did show some drift in calibration at the time of recording, but this was not critical in their analysis. The ECG was also calibrated for one of these recordings.

Conclusion

The technique described for telephone transmission of ECG and arterial blood pressure traces from the IAB pump to a remote location was found to be simple and reliable. These signals can be transmitted from a central nursing station, bedside monitor, or any other area where the ECG and blood pressure signals are available. The IAB pump was found to be the preferred point of origin for ease of communication and operation. The IAB pump, with telemetry capability, is easily moved from room to room and requires no additional electrical connections. This system was a useful addition to the IAB pumps used on the last ten patients requiring counterpulsation at this institution.

References

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