Monitoring with the ZM-540PA NTX Transmitter

Purpose
The self-study packet is designed to introduce the procedures for monitoring ECG/Respiration/SpO2 and non-invasive blood pressure (NIBP) using the ZM-540PA NTX™ (NTX) transmitters. References for this article are available upon request.

Learning Objectives
By completing this packet, you will be able to:
1. Describe the monitoring capabilities of the NTX transmitters.
2. Describe proper patient preparation and attachment procedures.
3. Discuss the maintenance and cleaning procedures for the transmitters.

Introduction
The NTX is a small wireless transmitter that is used to send the ECG heart rate (HR) and rhythm, respiratory rate (RR), pulse oximetry (SpO2) and non-invasive blood pressure (NIBP) readings to a central monitoring computer that will analyze and trend the data, and notify the clinician when certain changes are detected. To accomplish this, the patient is attached to the NTX using three or six ECG electrodes, a finger probe and a blood pressure cuff.

Prior to placing the NTX transmitter on the patient, he/she must be “admitted” to the monitoring computer. The responsibility for completing this procedure is determined by the hospital policies and the steps for doing so are delineated in the online product training course and in the accompanying training and reference materials.

As the vital signs are collected, they are displayed on the NTX transmitter, and then sent to the central monitoring computer where they are displayed and analyzed. This packet discusses the procedures for connecting the patient to the NTX transmitter, and those for operating and maintaining it for optimal performance as a part of the monitoring system.
The NTX Transmitter - ZM-540PA

The first step is to place three AA batteries correctly into the NTX, paying attention to the direction of the + in the battery compartment. The Check Electrodes screen is displayed.

The diagram, table and images explain the basic operations on the transmitter.

1. Display

6. NIBP Interval key – used to set automatic blood pressures. Press repeatedly to select the desired interval. Press NIBP Start/Stop key to activate.

2. Infrared receiver – used for upgrading the software

7. Lead/Scroll keys – used to scroll through leads on main display and lines of waveform in review screen. Used together they lock the keys on the NTX (hold for 3 seconds to lock/unlock keys)

3. Screen key – used to change screens (below)

8. Battery compartment – uses 3 AA batteries

4. Function Key – Suspend Alarms proactively)

Battery indicator is in upper right corner of display

5. NIBP Start/Stop

Warning – Battery door must be in place during operation to prevent possible electrical interference with waveform and shock to user.

The holster allows for any size or style of cuff to be used with the NTX. When using the arm cuff holder, the neck strap secures the transmitter/arm cuff to the correct position on the patients’ arm.
The Monitoring Screens are changed by pressing the SCREEN key on the front of the transmitter. Press this key to display the main screen - the Numeric and Waveform Screen. We’ll discuss the other functions of the transmitter as we get to them in this packet.

The Electrode

Next, you will place three or six electrodes onto your patient’s chest to capture the respiration rate and pattern as well as the heart rate and tracing for the monitoring system to analyze. The number of electrodes that you will use depends on the policies for your unit.

The ECG signal (electrocardiogram) is the electrical activity that is generated by the heart, and the primary monitoring goal is to capture a “clean” signal for the monitor to analyze. The key component to accomplish this is the monitoring electrode itself.

There are many brands of electrodes, and any one that you use captures the tiny electrical signal from the patient and then conducts it to the system for analysis. If the electrodes become dry or do not adhere to the patient, the signal becomes skewed and the system may misinterpret it as a change in the patient. Therefore, it is important to open the package right before you apply the electrode to the patient, and to prepare the patients’ skin before placing the electrodes in strategic positions on the patient’s chest. And, it is most important to change these electrodes at regular intervals to provide the monitor with the best signal that you can, usually every 24 to 48 hours.
Electrode Placement

In order to capture this electrical signal from within the patient, you will place these conductive electrodes on strategic positions on the chest. The exact placement is crucial to accurate interpretation.

You will place the electrodes onto the upper chest at the right and left mid-clavicular lines and onto the left lower rib at the left anterior axillary line to assure accurate detection. Each lead wire is labeled and/or color-coded for the anatomical position: white-right arm (RA), black-left arm (LA), red-right leg (LL). If you are using the six electrode system, three more lead wires are added: green-right leg, brown-Va and brown-Vb. The brown lead wires are for two chest leads and the placement for both types are delineated below.

<table>
<thead>
<tr>
<th>Lead wire</th>
<th>Position</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (-)</td>
<td>Right chest under the clavicle</td>
<td>Right chest under the middle of clavicle</td>
</tr>
<tr>
<td>Black (N)</td>
<td>Left chest under the clavicle</td>
<td>Left chest under the middle of clavicle</td>
</tr>
<tr>
<td>Red (+)</td>
<td>Left anterior-axillary line at edge of the lower rib.</td>
<td>Left anterior-axillary line at edge of lower rib. Position higher and more anterior for RESP monitoring.</td>
</tr>
<tr>
<td>Green (ground)</td>
<td></td>
<td>Right anterior-axillary line, edge of lower rib</td>
</tr>
<tr>
<td>V1*</td>
<td>4th Intercostal Space to the right of the sternum – best lead for arrhythmia monitoring</td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>4th Intercostal Space to the left of the sternum</td>
<td></td>
</tr>
<tr>
<td>V3*</td>
<td>Halfway between V2 and V4 – ST monitoring</td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td>5th Intercostal Space, left mid-clavicular line</td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td>Anterior axillary line at same level as V4</td>
<td></td>
</tr>
<tr>
<td>V6</td>
<td>Mid-axillary line at same level</td>
<td></td>
</tr>
</tbody>
</table>

*Recommended default V-leads
The following Skin Preparation/Electrode Management procedure is recommended by the American Association of Critical Care Nurses (AACN) for continuous ECG monitoring:

1. Select electrode site according to appropriate placement diagram.
2. Shave or trim excess hair to insure that electrode makes contact with skin.
3. Gently abrade skin with dry gauze to remove dead skin cells.
4. **IF SKIN IS OILY**, clean site with alcohol and friction and allow to dry completely.
5. Attach lead wire to electrode.
6. Attach electrode to patient, pressing circumference of electrode to secure adhesive.
7. Place transmitter in pouch or pocket to minimize movement on lead wires.
8. Use stress loops as necessary to minimize excessive artifact on ECG tracing due to movement of individual lead wires.
9. Change electrodes as needed or at least every 24-48 hours to insure fresh conduction gel and adhesive.

**Numerics and Waveform Screen**

Once the lead wires are attached to the electrodes on the patient, the heart rate, respiration rate and ECG tracing are displayed on the main Numeric and Waveform screen on the NTX and on the central monitoring computer. When you attach the SpO2 finger probe, the pulse oximetry value (SpO2) is displayed in a percentage, along with the pulse indicator. Once you take a blood pressure, it will appear on this screen as well.
Respiration Monitoring

The NTX transmitter uses the right arm (RA) and left leg (LL) electrodes to detect respiration. By placing the LL electrode on the lower rib at the anterior axillary line, the lungs inflate and deflate between the RA and the LL electrodes and the system detects a good respiration signal.

As the patient breathes, the monitor detects a change in the electrical current and it displays a waveform on the screen. A respiratory rate per-minute is displayed on the NTX and it is stored in the monitoring computer trends as well. To improve the detection of respiration, use fresh electrodes and, if necessary, you can move the LL electrode up to the 5th intercostal space.

Pulse Oximetry – Oxygen Saturation (SpO2)

The NTX transmitter monitors pulse oximetry continuously using an infrared finger sensor that attaches from the transmitter to the patient’s finger. The SpO2 value, the pulse rate and a pulse indicator are displayed on the transmitter display and the SpO2 values and a waveform are displayed on the monitoring computer screen. These values are trended in the monitor’s memory, along with the other vital signs.

When the probe is removed from the finger, an alarm is generated at the monitoring computer. It is important to instruct the patient to keep the probe in place or to replace it promptly when it is removed. When the probe is attached to the NTX and is not on the patient, SpO2 monitoring is not occurring. If SpO2 monitoring is not required, remove the probe from the NTX in order to stop the monitoring at the central computer.

It is also important to change the location of the probe every 4 to 8 hours and to inspect the site for changes in circulation due to the pressure of the probe. These probes may be reusable or disposable.
Non-Invasive Blood Pressure (NIBP)

The NTX uses the occlusive-oscillometric method to measure systolic, diastolic and mean non-invasive blood pressure. The Nihon Kohden NIBP algorithm measures changes in the amplitude pattern of pulsatile oscillations (vibrations) in the artery as it is reduced from above systolic to below diastolic pressure. The systolic pressure is the pressure at which the pulsatile oscillation suddenly increases (pulse returns), and the diastolic pressure is the pressure at which the pulsatile oscillation suddenly decreases (pulse stabilizes). The mean blood pressure is the point where maximum pulsatile oscillation occurs.

Cuff selection should be based on the size of the extremity. To obtain accurate readings, select a cuff that is wide enough to wrap the upper arm and keep the cuff reference markers within the range that is indicated on the inside of the cuff.

Inappropriate cuff size will result in inaccurate NIBP readings. Cuffs that are too large produce false low readings, and cuffs that are too small produce false high readings.

Note: INACCURATE READINGS MAY OCCUR DURING MOVEMENT AS THE MUSCLE ACTION MAY BE INCORRECTLY DETECTED AS A PULSE. When readings are questioned, use a different method (not oscillometric technology) to validate the results.

To take a blood pressure reading, press the green Start/Stop key.

To set automatic blood pressure readings, press the NIBP Interval key to display the screen, and then press the same key to scroll through the choices. The white intervals are available, and the blue one is selected. Press the Green Start key to activate the chosen interval.

To turn off automatic readings, choose the MANUAL interval.
The NTX transmitter allows you to quickly review information on the device. We discussed how the Check Electrode screen appears when you add the batteries to turn on the transmitter. You can return to this screen at any time to review a single tracing, or if you should use 6 electrodes rather than the basic 3, you can review 4 ECG leads at this screen. Press the SCREEN key repeatedly until this or any of the other screens is displayed.

To conserve power, the screen will go blank after a few seconds without user interaction. Press the SCREEN key to turn on a blank display.
The FUNCTION key can be used as a SUSPEND key to prevent alarms at the central computer while you are changing electrodes on your patient, or as a PAUSE function when the patient is disconnected from the NTX. To suspend the alarms, press the FUNCTION key, and then the right arrow key to confirm the request.

You may want to lock the keys on the NTX to prevent the patient from inadvertently changing a setting. To do so, hold both the arrow keys for 3 seconds. The Key Locked dialog displays for 1 minute after pressing to lock the keys.

The key control can be unlocked by pressing the SCREEN key and then both arrow keys again for 3 seconds.
Cleaning the Transmitters
Wipe the outside surface of the transmitter and electrode lead wires with a non-abrasive cloth moistened with disinfecting alcohol or neutral detergent (i.e. Ivory) diluted with water. Dry completely.

To clean the SpO2 probe, wipe the probe and cable with a soft cloth or cotton swab moistened with 70% alcohol solution. Dry thoroughly. Note: do not use cresol soap, sodium hypochlorite or benzalkonium chloride as they will damage the probe.

To clean the reusable NIBP cuff, remove the lock plate and carefully pull out the inflation bag from the cloth cover. Cloth cover: Wash with neutral detergent and water. Thoroughly dry it. When washing in a washing machine, put it in a net. Inflation bag: Wipe with a soft cloth or cotton moistened with disinfecting alcohol. Thoroughly dry it.

Disinfecting the Transmitters
Wipe the outside surface of the transmitter and electrode lead wires with a non-abrasive cloth moistened with any of the disinfectants listed below. Use the recommended concentrations to prevent transmitter damage and follow the manufacturer recommended contact times to achieve results.

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Concentration (%)</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProSpray wipes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disinfecting Alcohol</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Sporicidin® Disinfectant</td>
<td>Spray or wipes</td>
<td></td>
</tr>
<tr>
<td>Benzalkonium chloride</td>
<td>0.2</td>
<td>BZK wipes</td>
</tr>
<tr>
<td>Chlorhexidine gluconate solution</td>
<td>0.5</td>
<td>Hibistat®</td>
</tr>
<tr>
<td>Glutaraldehyde solution</td>
<td>2.0</td>
<td>Cidex</td>
</tr>
<tr>
<td>Hydrochloric alkyl diaminoethylglycine</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Benzethonium chloride solution</td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

To disinfect the SpO2 probe, soak the probe in either Glutaraldehyde solution 2% or hydrochloric alkyl diaminoethylglycine 0.5%. Wash the probe with running water after disinfection and push the rubber part of the probe to remove liquid inside that part of the probe. Dry thoroughly.

To disinfect the reusable NIBP cuff or holster, use glutaraldehyde solution. Use the recommended concentration. After disinfecting, clean as described above. Use of any other disinfectant solutions may cause damage to the transmitter that may not be covered under the product warranty.
Conclusion

The NTX transmitter, as a part of a monitoring system, continuously monitors the patient’s heart rate and rhythm, and respiratory status through impedance respiration and pulse oximetry. By offering noninvasive blood pressure capability, the clinician has another physiologic parameter to add to the clinical data set for the assessment.

The clinician’s responsibility with this system is to insure that this data is accurate and valid, which is accomplished by using the proper ECG monitoring procedures, alarm control procedures and prompt interventions when changes occur. It is imperative that caregivers pay particular attention to the preparation and maintenance procedures for this technology. This includes: 1) preparing the skin before placing electrodes onto it, 2) placing the electrodes in the recommended positions, 3) changing the electrodes on a regular basis, 4) changing the batteries on the transmitter in a timely manner, and 5) cleaning the transmitter between patients.

You will facilitate improved outcomes during your patient’s hospital stay by maintaining the monitoring system appropriately, by acquiring the best information that you can, and by responding when the system alerts you to changes as they occur.