

Zoll Safety Considerations

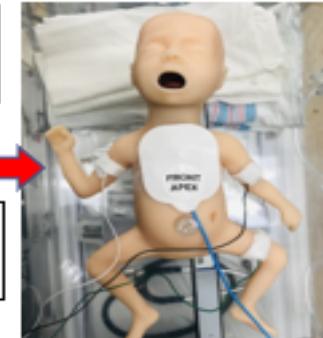
- Before attempting synchronized cardioversion, ensure optimal Zoll monitor ECG signal quality to minimize the risk of synchronizing on artifact
- Take precautions to avoid electrical arcing during cardioversion or defibrillation:
 - Ensure adhesive gel on the multifunction pads is in good condition
 - Ensure that electrodes and pads fully adhere to the patient, including all outer edges, and are flat against the skin
 - Poor adherence and/or air under the multifunction pads can cause arcing and skin burns
 - Do not touch the patient, or any equipment connected to the patient during defibrillation or cardioversion
 - Do not allow the patient's body to come into contact with metal objects, bed frame, etc: unwanted pathways of electrical current may result
- External Pacing: Patient can be touched/physically assessed by providers to assess pulses while being externally paced
 - Ensure adhesive gel on the multifunction pads is in good condition (if indicated, consider changing pads as recommended)
 - In consultation with MCP, consider changing MINI PadPro pads after 4 hours of external pacing
 - In consultation with MCP, consider changing Zoll Pediatric pads after 1 hour of external pacing
- Take precautions to reduce oxygen near the multifunction pads with use of cardioversion and defibrillation
 - Use the minimum concentration or flow rate of oxygen that is clinically necessary, if able
 - Utilize oxygen concentrations of < 30% to reduce fire hazard, if able

Application of Multifunction Pads and ECG 3 Lead For Zoll Monitor

- < 3kg: use MINI Infant PadPro pads
- > 3kg: use Zoll Pediatric pads
- Maintain at least 1 inch separation between ECG leads and multifunction pads (see images)



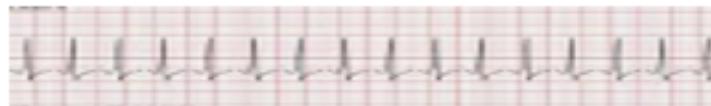
Patients > 3kg: Apply Zoll pediatric multifunction pads on front chest and back with neonatal ECG leads on chest/abdomen (see image w/blue arrow)



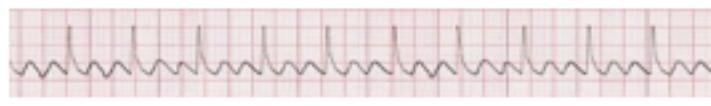
Patients < 3kg: Apply MINI PadPro multifunction pads on front chest and back with cloth limb leads for ECG (see image w/red arrow)

SYNCHRONIZED CARDIOVERSION	DEFIBRILLATION
<ul style="list-style-type: none"> — Utilize nonpharmacologic and pharmacologic agents first: if indicated — Identify appropriate unstable rhythm for cardioversion: SVT, A-Flutter, A-Fib and monomorphic V-TACH with a pulse (see images) — Attach multifunction pads to cable, place pads on front and back of chest. Apply 3 lead ECG electrodes and <u>attach</u> to Zoll ECG cable — Monitor in PADS mode (preferred), or lead I, II or III — Press ECG print button to obtain pre and post cardioversion strip — Provide sedation as able/needed <p>A. Press SYNC Key: <u>Must be</u> in SYNC mode before delivering shock</p> <ul style="list-style-type: none"> • Sync markers should be tracking R waves on monitor • If Sync markers do not appear: adjust pads, select a different lead <u>III</u> or <u>III</u> or adjust ECG size <p>B. Press ENERGY SELECT button: enter desired energy level</p> <ul style="list-style-type: none"> — 1st cardioversion: begin with 0.5–1 J/kg — If need, repeat cardioversion with 2 J/kg <p>C. Press CHARGE button, announce "all staff clear", then press and hold illuminated SHOCK button until energy delivered</p> <ul style="list-style-type: none"> • The unit will discharge with the next detected R wave • The monitor will exit SYNC mode after every delivered shock <p>D. Repeat steps A thru C if additional cardioversion <u>needed</u></p> <ul style="list-style-type: none"> • To cancel cardioversion, press DISARM key 	<ul style="list-style-type: none"> — Identify shockable pulseless rhythm for defibrillation: Polymorphic V-TACH w/out a pulse and V-FIB (see images) — Attach multifunction pads to cable, place pads on front and back of chest. Apply 3 lead ECG electrodes — Press ECG print button to obtain pre and post defibrillation strip — Monitor in PADS mode (preferred), or lead I, II or III <p>A. Press ENERGY SELECT button: enter desired energy level</p> <ul style="list-style-type: none"> — 1st shock: begin with 2 J/kg — 2nd shock: 4 J/kg (if 1st shock is not effective) — Subsequent shocks \geq 4 J/kg, up to 10 J/kg max <p>B. Press CHARGE button, announce "all staff clear", then press SHOCK button until energy delivered</p> <ul style="list-style-type: none"> • If the shock button is not pressed within 60 seconds of reaching selected energy level, the unit will automatically disarm • To cancel defibrillation, press DISARM key <p>C. Repeat steps A and B if additional defibrillation needed with increased joules</p>

SVT



Atrial Flutter



Atrial Fibrillation



Monomorphic V-Tachycardia Note: If R waves are unable to be analyzed due to ECG morphology, consider aborting cardioversion and proceed to defibrillation



Note: Electrical transfer to a patient via the Zoll for cardioversion or external pacing can cause an inadvertent non-sustainable rhythm (ventricular fibrillation or polymorphic V-Tach). Be prepared to defibrillate as needed by following defibrillation guidelines.

Clinical Guidelines developed by UCDAVIS Neonatal Transport ERM, and approved in collaboration with Dr. Daniel Carter, MD, PhD, Director of Pediatric Electrophysiology and Dr. Emily Stieren, MD, PhD, Medical Director Neonatal Transport Program and Neonatal Intensive Care Unit, UC Davis Medical Center Children's Hospital.

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Neonatal External Pacing: DEMAND MODE

General Information

- Identify appropriate rhythm for external pacing: symptomatic bradycardia or heart block
- Patient condition qualifier for DEMAND MODE: can tolerate missed capture if artifact pacing inhibition occurs
- Note:** DEMAND MODE is the device default and the preferred safest mode in a static setting
- In DEMAND MODE, the patient's intrinsic heart rate is sensed: DEMAND mode is a synchronous mode
- If artifact is sensed in DEMAND mode, it can cause pacing inhibition with loss of pacing capture
- Patient can be touched/physically assessed by providers to assess pulses while being externally paced: See Zoll Safety Considerations
- Provide sedation as needed per OCT Neonatal Standing Orders
- During external pacing, ECG monitoring analysis occurs from the 3 lead ECG electrodes

To Initiate DEMAND External Pacing Follow Steps 1 thru 6

- Apply 3 lead ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest
- Turn Zoll Monitor on and press PACER button**
 - During external pacing, ECG analysis from the Zoll monitor must be done in lead I, II or III. Ensure R waves detected, turn QRS volume on (settings-ECG-tone-ON), confirm QRS tones occur with each R wave, and that displayed monitored heart rate accurately reflects patient's pulse rate: assess brachial pulse and ~~color~~ waveform
- Select Pacing Mode: DEMAND**
 - Demand is the Zoll default setting for external pacing
- Set desired HEART RATE: enter rate 10 beats above intrinsic patient heart rate**
 - Increase pulse per minute (PPM) rate slowly if needed based on patient condition
- Select OUTPUT mA**
 - Start at 20 mA and assess for pacing capture (lowest mA output on the Zoll X Series is 10)
 - Typical range for capture is 40-80 mA
 - Note: preterm newborns may require lower mA for capture
 - Once pacing capture is noted, increase mA setting by 10
 - Determination of pacing capture must be assessed electrically and mechanically
 - Mechanical capture is confirmed by the presence of palpable pulses: ensures systemic circulatory support
 - Electronic capture is confirmed by: 1) the presence of a pacer spike, 2) followed by a widened QRS complex, 3) appearance of T-waves in the opposite direction of QRS complex, and 4) loss of intrinsic rhythm
 - If needed, change monitored ECG LEAD from I, II or III and/or adjust ECG SIZE to evaluate electrical capture
 - See rhythm strip example that displays confirmation of electronic pacing capture
- To begin pacing: Press START PACING button**
- To discontinue pacing: Press STOP PACING button**

Assessment Of The Patient Undergoing External Pacing and Clinical Considerations

- Continually assess for pacing capture and hemodynamic stability to ensure appropriate external pacer settings:
 - Assess pulses, perfusion parameters, blood pressure, SpO₂, metabolic status, blood gases and lactic acid for trends
- If loss of capture due to artifact is affecting patient stability: consider switching to FIXED MODE
 - If FIXED PACE MODE is indicated, follow Neonatal External Pacing Fixed Mode Guidelines
- In DEMAND MODE, a back-up heart rate can be set if needed (for concerns of trends in slowing heart rate)
 - Set back-up heart rate to the lowest acceptable threshold rate (desired back-up rate). If DEMAND pacing initiated due to slowing heart rate reaching set back-up rate, ensure adequate rate and capture--follow steps 3-6
- ANALYZE button is used to determine underlying ECG rhythm: While depressed, this button causes pacing stimuli to continue being delivered at $\frac{1}{4}$ of the set pacing pulse rate per minute. When the button is released, normal pacing resumes

Note: Electrical transfer to a patient via the Zoll for cardioversion or external pacing can cause an inadvertent non-sustainable rhythm (ventricular fibrillation or polymorphic V-Tach). Be prepared to defibrillate as needed by following defibrillation guidelines.

Neonatal External Pacing: FIXED MODE

General Information

- Identify appropriate rhythm for pacing: symptomatic bradycardia or heart block
- Patient condition qualifier for FIXED mode: Unstable patient that will not tolerate missed pacing capture due to artifact
- In FIXED mode, the patients' intrinsic heart rate is not sensed: FIXED mode is asynchronous
- FIXED mode works best in non-static settings where artifact noise is a risk** (artifact can cause pacing inhibition)
- DURING FIXED MODE, EVERY SINGLE BEAT MUST HAVE PACING ELECTRICAL CAPTURE**: fixed mode pacing goal is to suppress intrinsic rhythm to minimize precipitating an inadvertent non-sustainable/nonperfusing rhythm
- Patient can be touched/physically assessed by providers to assess pulses while being externally paced
- Provide sedation as needed per OCT Neonatal Standing Orders
- With external pacing, ECG monitoring analysis occurs from the 3 lead ECG electrodes

To Initiate FIXED External Pacing Follow Steps 1 thru 6

- Apply 3 lead ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest
- Turn Zoll Monitor on and press PACER button**
 - During external pacing, ECG analysis from the Zoll monitor must be done in lead I, II or III. Ensure R waves detected, turn QRS volume on (settings-ECG-tone-ON), confirm QRS tones occur with each R wave, and that displayed monitored heart rate accurately reflects patient's pulse rate: assess brachial pulse and pleth waveform
- Select Pacing Mode: FIXED**
- Set desired HEART RATE: enter rate 20 beats above intrinsic patient heart rate**
 - Increase pulse per minute (PPM) rate slowly if needed based on patient condition
- Select OUTPUT mA**
 - Start at 20 mA and assess for capture** (lowest mA output on the Zoll X Series is 10)
 - Typical range for capture is 40-80 mA
 - Note: preterm newborns may require lower mA for capture
 - Once pacing capture is noted, increase mA setting by 20: to ensure every paced beat is captured, inhibiting intrinsic rhythm**
 - DURING FIXED MODE, EVERY SINGLE BEAT MUST HAVE PACING ELECTRICAL CAPTURE**
 - Determination of pacing capture must be assessed electrically and mechanically
 - Mechanical capture is confirmed by the presence of palpable pulses: ensures systemic circulatory support
 - Electronic capture is confirmed by: a) the presence of a pacer spike, b) followed by a widened QRS complex, c) appearance of T-waves in the opposite direction of QRS complex, and d) loss of intrinsic rhythm
 - If needed, change monitored ECG LEAD I, II or III and/or adjust ECG SIZE to evaluate electrical capture
 - See rhythm strip below for example of confirmation of electronic pacing capture
- To begin pacing: Press START PACING button**
- To discontinue pacing: Press STOP PACING button**

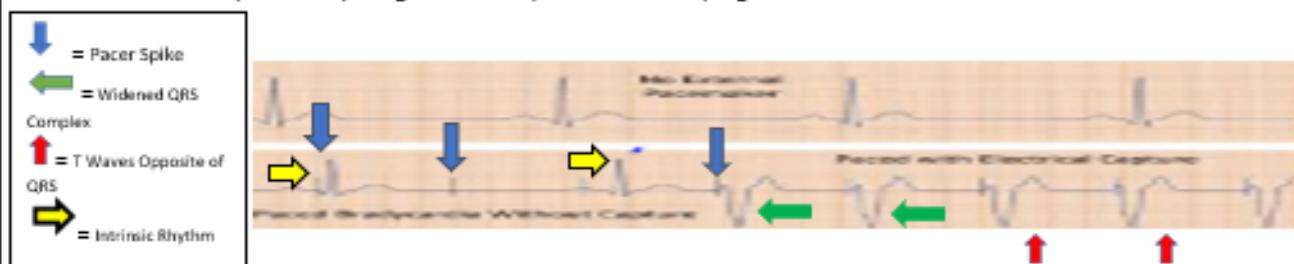
Assessment Of The Patient Undergoing External Pacing and Clinical Considerations

- Continually assess for pacing capture and hemodynamic stability to ensure appropriate pacer settings:
 - Assess pulses, perfusion parameters, blood pressure, SpO₂, metabolic status, blood gases and lactic acid for trends
- Consider switching to DEMAND MODE asap: follow Neonatal External Pacing Demand Mode Guidelines
 - Note: DEMAND MODE is the device default and the preferred safest mode in a static setting**
- ANALYZE button is used to determine underlying ECG rhythm: While depressed, this button causes pacing stimuli to continue being delivered at $\frac{1}{4}$ of the set pacing pulse rate per minute. When the button is released, normal pacing resumes

Note: Electrical transfer to a patient via the Zoll for cardioversion or external pacing can cause an inadvertent non-sustainable rhythm (ventricular fibrillation or polymorphic V-Tach). Be prepared to defibrillate as needed by following defibrillation guidelines.

Assessment of Effective Electrical Pacing Capture During External Pacing (DEMAND OR FIXED Mode)

1. The presence of a pacer spike
2. Followed by a widened QRS complex
3. Appearance of T-waves in the opposite direction of QRS complex
4. Loss of intrinsic rhythm with pacing electrical capture at desired/programmed rate



Medications To Consider For Atrial Arrhythmias

- Adenosine: start with 0.1mg/kg rapid IVP up to 0.3mg/kg via IV access closest to the myocardium
- Procainamide Infusion: starting dose 15mcg/kg/min and titrate up to 80mcg/kg/min maximum
 - Titrate by 5mcg/kg/min Q 15 min
- Esmolol Infusion: starting dose 50mcg/kg/min and titrate up to 300 mcg/kg/min
 - Follow blood glucose closely with initiation, and any changes in dose

Medications to Consider For Ventricular Arrhythmias

- Lidocaine Bolus 2%: 1mg/kg per dose IVP; repeat bolus dose if infusion initiated > 15 minutes after initial bolus
- Lidocaine Infusion: starting dose 20 – 50 mcg/kg/min
- Magnesium Sulfate: 25mg/kg IV bolus for pulseless V-tach; or over 10-20 minutes for V-tach with a pulse
 - Note: may cause hypotension
- Procainamide Infusion: starting dose 15mcg/kg/min and titrate up to 80mcg/kg/min maximum
 - Titrate by 5mcg/kg/min Q 15 min
- Esmolol Infusion: starting dose 50mcg/kg/min and titrate up to 300 mcg/kg/min
 - Follow blood glucose closely with initiation, and any changes in dose

Medications To Consider For Complete Heart Block (non-operative complete heart block)

- Atropine: 0.02mg/kg per dose IVP, may repeat after 5 minutes
- Isoproterenol Infusion: starting dose 0.02 mcg/kg/min

Note: Follow orders per MCP medical direction, ensure electrolytes are optimized, refer to administration information listed on the Neonatal Transport Medication Reference and instructions listed by pharmacy in the NICU Transport Medications and IV Infusions Bags

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