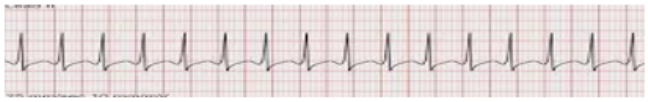
UC DAVIS HEALTH | CHILDREN'S HOSPITAL

Neonatal Transport Clinical Guidelines
Zoll X Series-- Cardioversion, Defibrillation & External Pacing

Synchronized Cardioversion

- Utilize nonpharmacologic and pharmacologic agents first (if indicated or able)
- Identify appropriate rhythm for cardioversion: unstable SVT, A-Flutter, A-Fib and monomorphic V-TACH with a pulse (see images)
- Provide sedation as able/needed
- Apply ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest
- Press ECG print button (for pre and post cardioversion strip)
- Monitor should be in ECG mode (lead I, II or III)
  - A. Press **SYNC** Key: Monitor must be in SYNC mode before delivering shock
    - Sync markers should be tracking R waves
    - If Sync markers do not appear, select a different lead (I,II or III) and/or increase ECG size
  - B. Press **ENERGY SELECT:** enter desired energy level
    - 1st cardioversion: begin with 0.5- 1 J/kg
    - If needed, repeat cardioversion with 2 J/kg
  - C. Press **CHARGE**, announce "all staff clear", then press **SHOCK**
- Press shock button until energy is delivered
- The monitor will exit Sync mode after every delivered shock
- Repeat steps A thru C if additional cardioversion needed
- To cancel cardioversion, press DISARM key

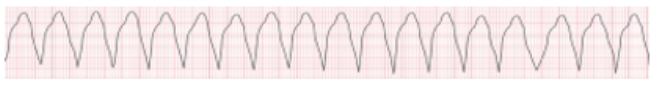
SVT



Atrial Flutter

Atrial Fibrillation

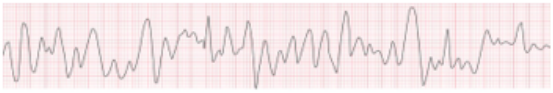
Monomorphic V-Tachycardia Note: If R waves are unable to be analyzed (due to ECG complex morphology), abort cardioversion and proceed to defibrillation



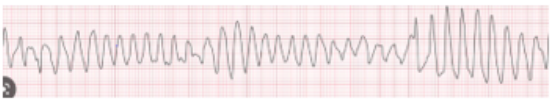
Defibrillation

- Identify shockable PULSELESS rhythm for defibrillation: Polymorphic V-TACH w/out a pulse and V-FIB (see images)
- Apply ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest
- Press ECG print button (for pre and post defib strip)
- Monitor should be in ECG mode (lead I, II or III)
  - A. Press **ENERGY SELECT:** enter desired energy level
    - 1st shock: begin with 2 J/kg
    - 2nd shock: 4 J/kg (if 1st shock is not effective)
    - Subsequent shocks ≥ 4 J/kg, up to 10 J/kg max
  - B. Press **CHARGE**, announce "all staff clear", then press **SHOCK**
    - Press shock button until energy is delivered
    - If the shock button is not pressed within 60 seconds of reaching selected energy level, the unit will automatically disarm
    - Repeat steps A and B if additional defibrillation needed with increased joules
    - To cancel defibrillation, press DISARM key

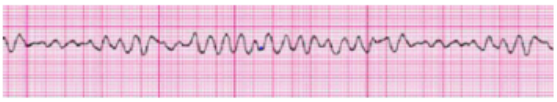
Polymorphic Ventricular Tachycardia



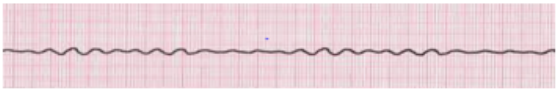
Torsades de Pointes: a form of polymorphic V-tach



Ventricular Fibrillation



Ventricular Fibrillation



References

1. Zoll X Series Operators Guide. https://www.zoll.com//media/publicsite/products/x-series/9650-002355/9650-002355-01-sf_d.ashx. 2018. REF: 9650-002355-01 Rev. D.
2. AHA Guidelines for CPR and ECC. Pediatric Advanced Life Support. https://cpr.heart.org/-/media/cpr-files/cpr-guidelines-files/highlights/hghlghts_2020_ecc_guidelines_english.pdf. 2020.
3. Clinical Guidelines developed by Y Gonzalez Neonatal Transport ERN, and approved in collaboration with Dr. Daniel Cortez, MD, PhD, Director of Pediatric Electrophysiology and Dr. Catherine Rottkamp, MD, PhD, Neonatal Transport Program Medical Director, UC Davis Medical Center Children's Hospital. 04.18.23 (V1)

Updated: YG 04.18.23

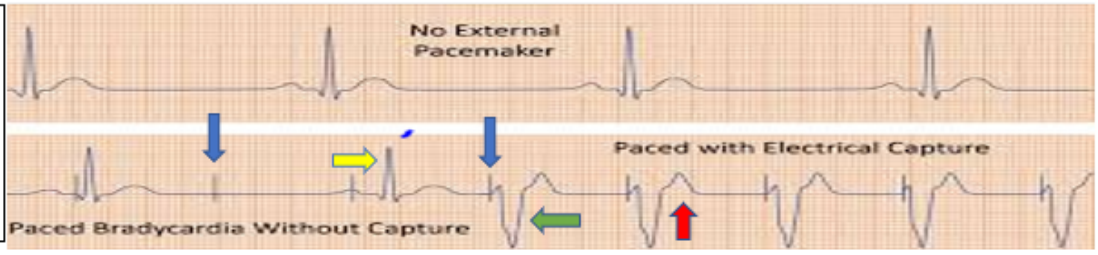
External Pacing FIXED MODE

– Identify appropriate rhythm for pacing: symptomatic bradycardia and heart block
– Pt condition qualifier for fixed mode: Unstable patient that will not tolerate missed capture due to artifact
– In FIXED MODE, the patients' intrinsic heart rate is not sensed (asynchronous)
– FIXED MODE works best in non-static settings where artifact noise is a risk
– Provide sedation as able/needed per standard
– Apply ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest

A. Press **PACER**
   – Verify R waves are being detected, confirm QRS tones occur with each R wave (settings-ECG-tone-ON), and that displayed monitor heart rate accurately reflects patient's pulse rate (assess pulse and pleth waveform)
B. Select Mode: **FIXED**
C. Select **HEART RATE**: **enter rate 20 beats per minute above intrinsic heart rate**
   – Increase heart rate slowly if needed based on patient condition
D. Select **OUTPUT mA**
   – Start at 20 mA and assess for capture (lowest mA option on the Zoll is 10 mA)
   – Typical range for capture is 40-80 mA (Note: preterm newborns may require lower mA for capture)
   – **Once capture noted, increase mA by 20**
   – Determination of capture must be assessed electrically and mechanically (palpation of pulses)
   – 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 (see rhythm strip below for example of confirmation of electronic capture)
   – Mechanical capture is confirmed by presence of palpable pulses
   – If needed, change ECG lead (I, II or III) and/or increase ECG size to help determine electrical capture
E. Press **START PACING** to begin pacing
F. Press **STOP PACING** to discontinue pacing

– **DURING FIXED MODE PACING EVERY SINGLE BEAT MUST BE CAPTURED**
– Continually assess for pacing capture and hemodynamic stability to ensure appropriate pacer settings (perfusion, blood pressure, Sp02, etc). If able, obtain blood gas and lactic acid to assess for trends in metabolic status

a. ↓ = Pacer Spike
b. → = Intrinsic rythm
c. ← = Widened QRS complex
d. ↑ = T waves opposite direction of QRS



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

References
1. Zoll X Series Operators Guide. https://www.zoll.com//media/publicsite/products/x-series/9650-002355/9650-002355-01-sf_d.ashx. 2018. REF: 9650-002355-01 Rev. D.
2. AHA Guidelines for CPR and ECC. Pediatric Advanced Life Support. https://cpr.heart.org/-/media/cpr-files/cpr-guidelines-files/highlights/hghlghts_2020_ecc_guidelines_english.pdf. 2020.
3. Clinical Guidelines developed by Y Gonzalez Neonatal Transport ERN, and approved in collaboration with Dr. Daniel Cortez, MD, PhD, Director of Pediatric Electrophysiology and Dr. Catherine Bottkamp, MD, PhD, Neonatal Transport Program Medical Director, UC Davis Medical Center Children's Hospital.

External Pacing DEMAND MODE

– Identify appropriate rhythm for pacing: symptomatic bradycardia and heart block
– Patient condition qualifier for demand mode: Stable(ish) patient that can tolerate missed capture due to artifact
– In DEMAND MODE, the patient's intrinsic heart rate is sensed (this is a synchronous mode)
– If pacing in DEMAND MODE, artifact can inhibit pacing = loss of capture
– Provide sedation as able/needed per standard
– Apply ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest

A. Press **PACER**
   – Verify R waves are being detected, confirm QRS tones occur with each R wave (settings-ECG-tone-ON), and that displayed monitor heart rate accurately reflects patient's pulse rate (assess pulse and pleth waveform)
B. Select Mode: **DEMAND**
C. Select **HEART RATE**: **enter rate 10 beats per minute above intrinsic heart rate**
   –Increase heart rate slowly if needed based on patient condition
D. Select **OUTPUT mA**
   –Start at 20 mA and assess for capture (lowest mA option on the Zoll is 10 mA)
   –Typical range for capture is 40-80 mA (Note: preterm newborns may require lower mA for capture)
   –**Once capture noted, increase mA by 10**
   –Determination of capture must be assessed electrically and mechanically (palpation of pulses)
   –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 (see rhythm strip below for example of confirmation of electronic capture)
   –Mechanical capture is confirmed by presence of palpable pulses
   –If needed, change ECG lead (I, II or III) and/or increase ECG size to help determine electrical capture
E. Press **START PACING** to begin pacing
F. Press **STOP PACING** to discontinue pacing

– Continually assess for pacing capture and hemodynamic stability to ensure appropriate pacer settings (perfusion, blood pressure, Sp02, etc). If able, follow blood gases and lactic acid to assess for trends in metabolic status
– DEMAND MODE is the preferred pacing mode and works best in static settings
– If artifact is sensed in demand mode, it can cause pacing inhibition = loss of capture
– Switch to FIXED MODE if loss of capture due to artifact is affecting patient stability: follow FIXED MODE guidelines if needed
– In DEMAND MODE, a back-up heart rate can be set as needed (for concerns of heart rate slowing during transport)
   –Set back-up heart rate to the lowest heart rate desired/acceptable. If DEMAND pacing initiated due to slowing heart rate reaching set rate (back-up rate), ensure capture---follow step D

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

References
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Medications To Consider For Atrial Arrythmias

- Adenosine
- Procainamide
- Esmolol: Follow blood glucose closely with initiation, and changes in dose (within 15 minutes)

Medications to Consider For Ventricular Arrythmias

- Lidocaine
- Magnesium Sulfate: May cause hypotension
- Procainamide
- Esmolol: Follow blood glucose closely with initiation, and changes in dose (within 15 minutes)

Medication To Consider For Complete Heart Block

- Isoproterenol infusion (not stocked in transport medications—must obtain prior to leaving UCD or @ OSH)

*Note: follow orders per MCP medical direction, refer to administration information listed on the Neonatal Emergency Drug Sheet and instructions listed by pharmacy in the NICU transport medication/drip bags.

Application of ECG Leads and Multifunction Pads

- < 3kg: use MINI Infant PadPro pads
- > 3kg: use Zoll Pediatric pads
- Maintain at least 1 inch separation between ECG leads and pads (see images)
- Consult with MCP and cardiology to discuss changing pads based on patient clinical status:
  - Consider changing MINI PadPro pads after 4 hours of external pacing
  - Consider changing Zoll Pediatric pads after 1 hour of external pacing

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)

References

1. Zoll X Series Operators Guide. https://www.zoll.com//media/publicsite/products/x-series/9650-002355/9650-002355-01-sf_d.ashx. 2018. REF: 9650-002355-01 Rev. D.
2. PadPro Instructions For Use Mini Infant 2602. Conmed Corporation. 12/2021.
3. AHA Guidelines for CPR and ECC. Pediatric Advanced Life Support. https://cpr.heart.org/-/media/cpr-files/cpr-guidelines-files/highlights/hghlghts_2020_ecc_guidelines_english.pdf. 2020.
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