UCDAVIS HEALTH | CHILDREN'S HOSPITAL

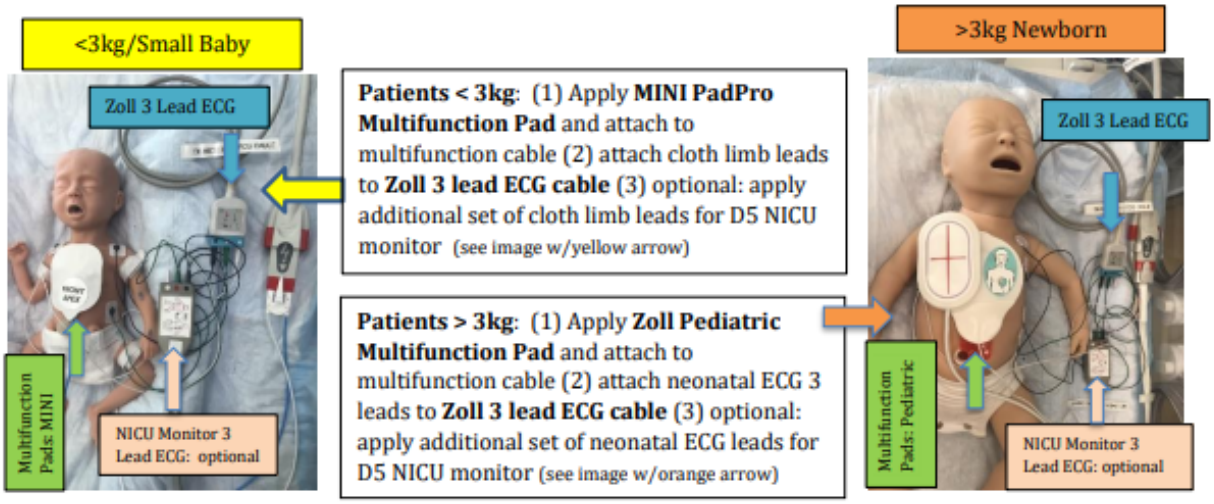
Neonatal Cardioversion, Defibrillation & External Pacing

D5 Neonatal Units Clinical Guidelines: Zoll R Series

Application of Multifunction Pads and ECG 3 Lead For Zoll Monitor

- For < 3kg: use MINI Infant PadPro pads -- apply multifunction pads on back first, then front chest (see image)
- For > 3kg: use Zoll Pediatric pads --apply multifunction pads on back first, then front chest (see image)
- Recommended Pad Change: Consult with provider 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

- Apply multifunction pads and connect to multifunction cable, then apply 3 lead ECG and connect to Zoll ECG cable: **maintain at least 1 inch separation between ECG 3 leads and multifunction pads** (see images)
  - To ensure correct and safe use of the Zoll for defibrillation, cardioversion and/or external pacing, ECG analysis must be done on the Zoll monitor via multifunction pads, and/or lead I, II or III
  - Note: Maintaining unit monitor 3 lead ECG is optional in urgent situations (allows for EMR data transfer); If additional ECG monitoring from unit monitor is requested, apply additional set of ECG leads (see image)



Zoll Safety Considerations:

- Take precautions to reduce oxygen near the defibrillation multifunction pads with use of cardioversion/defibrillation
  - As able, use the minimum concentration or flow rate of oxygen that is clinically necessary
  - If able, utilize oxygen concentrations of < 30% to reduce fire hazard
- 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/defibrillation:
  - Ensure adhesive gel on the multifunction pads is in good condition (if able, consider changing pads as recommended)
    - Consider changing MINI PadPro pads after 4 hours of external pacing
    - Consider changing Zoll Pediatric pads after 1 hour of external pacing
  - Ensure that electrodes 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 bed, 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, crib, bed frame, ect (unwanted pathways of electrical current may result)

SYNCHRONIZED CARDIOVERSION

– Utilize nonpharmacologic and/or pharmacologic agents first: if 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
– Attach multifunction pads to cable and place pads on front and back of chest. Attach ECG 3 leads to Zoll 3 lead ECG cable
– Press RECORDER button to print ECG strip (as needed)

A. **Turn on MONITOR**: turn selector knob to monitor setting. Monitor in PADS MODE or lead I, II or III. Press **LEAD** button to change monitor mode. Press **SIZE** button to adjust ECG size
B. Turn selector knob to red **DEFIB** setting
C. Press **SYNC ON** button: **Monitor must display and be in SYNC mode before delivering cardioversion shock**
   - Sync markers should be tracking R waves on the monitor
   - If Sync markers do not appear: select a different monitor mode--Pads, or ECG lead I,II or III and/or increase ECG size by pressing SIZE button
D. Press **ENERGY SELECT up or down arrow button:** enter desired energy level per Emergency Drug Sheet
   – 1st cardioversion: begin with 0.5- 1 J/kg
   – If needed, repeat cardioversion with 2 J/kg
E. Press **CHARGE button** and announce "all clear"
F. **Press and hold the illuminated SHOCK button until energy is delivered to the patient**
   - The unit will discharge with the next detected R wave
   - **The monitor will exit SYNC mode after every delivered shock**
G. Repeat steps B thru F if additional cardioversion needed

DEFIBRILLATION

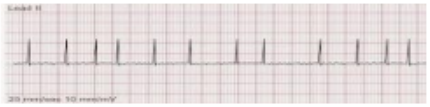
– Identify shockable PULSELESS rhythm for defibrillation: Polymorphic V-TACH w/out a pulse and V-FIB (see images)
– Attach multifunction pads to cable and place pads on front and back of chest. Attach ECG 3 leads to Zoll 3 lead ECG cable
– Press RECORDER button to print ECG strip (as needed)

A. **Turn on MONITOR**: turn selector knob to monitor setting. Monitor in PADS MODE or lead I, II or III. Press **LEAD** button to change monitor mode. Press **SIZE** button to adjust ECG size
B. Turn selector knob to red **DEFIB** setting
   - Ensure DEFIB is displayed on monitor
C. Press **ENERGY SELECT up or down arrow button:** enter desired energy level per Emergency Drug Sheet
   – 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
D. Press **CHARGE button** and announce "all clear"
E. Once illuminated, press **SHOCK BUTTON**
   - If the shock button is not pressed within 60 seconds the unit will automatically disarm
   - Note: Changing ENERGY SELECT once charge button is pressed will disarm defib
F. Repeat steps B thru E if additional defibrillation needed with increased joules

SVT

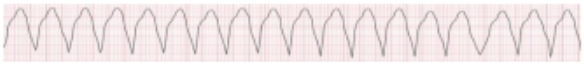
Atrial Flutter

Atrial Fibrillation

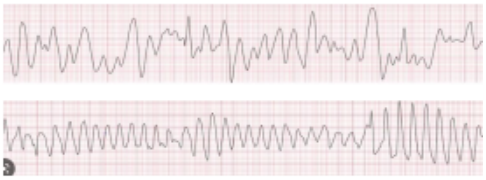


Monomorphic V-Tachycardia

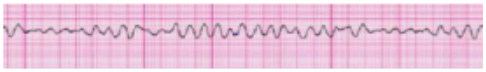
Note: If R waves are unable to be analyzed (due to ECG complex morphology), abort cardioversion and proceed to defibrillation



Polymorphic Ventricular Tachycardia



Ventricular Fibrillation



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

Neonatal External Pacing: PACE MODE (SYNCHRONOUS = SYNC)

General Information

- Identify appropriate rhythm for pacing: symptomatic bradycardia or heart block
- Patient condition qualifier for PACE sync mode: can tolerate missed capture IF artifact pacing inhibition occurs
- **Note: PACE SYNCHRONIZED MODE is the device default and the preferred safest mode in a static setting**
- If artifact is sensed in PACE mode, it can cause pacing inhibition with loss of pacing capture
- In SYNC PACE MODE, the patient's intrinsic heart rate is sensed (PACE = synchronous mode)
- Patient can be touched/physically assessed by providers to assess pulses while being externally paced
- Provide sedation as able/needed per order

To Initiate Synchronous External Pacing Follow Steps 1 thru 5

1. Apply 3 lead ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest
2. **To turn Zoll device on for pacing**: Turn large black selector knob to green **PACER** setting
   - 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 (press OPTIONS soft key), confirm QRS tones occur with each R wave, and that displayed monitored heart rate accurately reflects patient's pulse rate (assess pulse and pleth waveform)
3. Select Pacing Mode: **PACE**
   - PACE/Synchronous is the default setting for external pacing
   - Soft button key on bottom of monitor "Async Pacing On/Off" activates PACE or ASYNC mode
4. Set desired **PACE RATE:** turn small black/green RATE knob to **enter PPM rate 10 beats above intrinsic heart rate**
   - Increase pulse per minute (PPM) rate slowly if needed based on patient condition
   - PPM rate setting is displayed on monitor: Lowest PPM set rate is 30
5. **To begin pacing**: Set desired **OUTPUT mA to obtain pacing capture**
   - Turn small black/green OUTPUT mA knob: mA setting is displayed on monitor (lowest mA output is 8)
   - Start at 20 mA and assess for pacing capture
     - 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
   - 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
     - Press soft keys to change ECG LEAD I, II or III and/or adjust ECG SIZE to evaluate electrical capture
     - See rhythm strip example (page 5) showing confirmation of electronic pacing capture
   - Mechanical capture is confirmed by presence of palpable pulses: ensures systemic circulatory support for the patient

To discontinue pacing: turn small OUTPUT mA knob to 0 and turn large black knob to grey MONITOR setting or OFF

Assessment of the patient undergoing external pacing and clinical considerations

- 4:1 button is used to determine underlying ECG rhythm: While depressed, this button causes pacing stimuli to be delivered at ¼ of the set pacing pulse per minute rate. When the button is released, normal pacing resumes
- Continually assess for pacing capture and hemodynamic stability to ensure appropriate pacer settings: Assess pulses, perfusion parameters, blood pressure, Sp02, metabolic status, blood gases and lactic acid for trends
- If loss of capture due to artifact is affecting patient stability: consider switching to ASYNC PACE MODE
  - If ASYNC PACE MODE needed, follow Neonatal Asynchronous Pacing Guidelines
- In PACE (SYNC) MODE, a back-up heart rate can be set as needed (for concerns of trends in slowing heart rate)
- Set back-up heart rate to the lowest heart rate desired/acceptable. If SYNC PACE initiated due to slowing heart rate reaching set rate (back-up rate), ensure adequate rate and capture---follow steps 3 thru 5

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

Neonatal External Pacing: ASYNCHRONOUS MODE (ASYNC)

General Information

- Identify appropriate rhythm for pacing: symptomatic bradycardia or heart block
- Patient condition qualifier for ASYNC mode: Unstable patient that will not tolerate missed pacing capture due to artifact
- In ASYNC PACE mode, the patients' intrinsic heart rate is not sensed (ASYNC mode is asynchronous)
- **ASYNC PACE mode works best in non-static settings where artifact noise is a risk** (artifact can cause pacing inhibition)
- **Note: PACE SYNCHRONIZED MODE is the device default and the preferred safest mode in a static setting**
- Patient can be touched/physically assessed by providers to assess pulses while being externally paced
- Provide sedation as able/needed per order

To Initiate Asynchronous External Pacing Follow Steps 1 thru 5

1. Apply 3 lead ECG electrodes, plug multifunction pads into cable, and place pads on front and back of patient chest
2. **To turn Zoll device on for pacing**: Turn large black selector knob to green **PACER** setting
   - 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 (press OPTIONS soft key), confirm QRS tones occur with each R wave, and that displayed monitored heart rate accurately reflects patient's pulse rate (assess pulse and pleth waveform)
3. Select Pacing Mode: **ASYNC PACING**
   - Press soft button key on bottom of monitor "Async Pacing On/Off" to activate ASYNC or PACE mode
4. Set desired **ASYNC PACE RATE:** turn black/green RATE knob to **enter PPM rate 20 beats above intrinsic HR**
   - Increase pulse per minute (PPM) rate slowly if needed based on patient condition
   - PPM rate setting is displayed on monitor: Lowest PPM set rate is 30
5. **To begin pacing**: Set desired **OUTPUT mA to obtain pacing capture**
   - Turn small black/green OUTPUT mA knob: mA setting is displayed on monitor (lowest mA output is 8)
   - Start at 20 mA and assess for capture
     - Typical range for capture is 40-80 mA Note: preterm newborns may require lower mA for capture
   - **Once capture noted, increase mA setting by 20**
   - **DURING ASYNC MODE, EVERY SINGLE BEAT MUST HAVE PACING ELECTRICAL CAPTURE**
   - Determination of pacing capture must be assessed electrically and mechanically
   - 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, press soft keys to change 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
   - Mechanical capture is confirmed by presence of palpable pulses: ensures systemic circulatory support for the patient

To discontinue pacing: turn small OUTPUT mA knob to 0 and turn large black knob to grey MONITOR setting or OFF

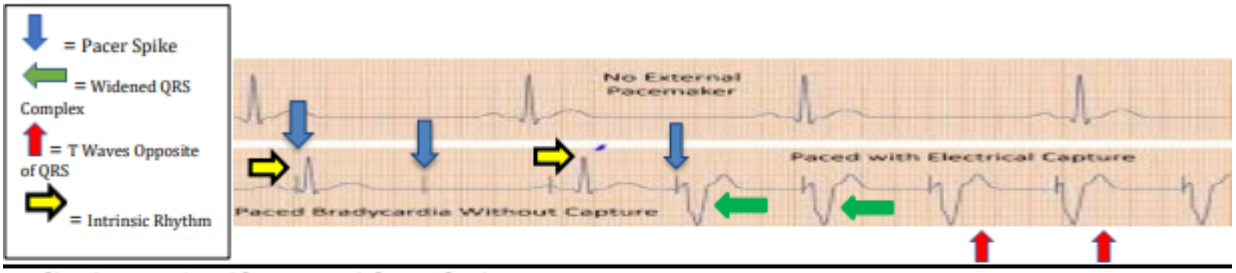
Assessment of the patient undergoing external pacing and clinical considerations

- Continually assess for pacing capture and hemodynamic stability to ensure appropriate pacer settings: Assess pulses, perfusion parameters, blood pressure, Sp02, metabolic status, blood gases and lactic acid for trends
- Consider switching to PACE SYNCHRONIZED MODE asap: follow Pace Synchronized Guidelines

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

Assessment of Effective Electrical Pacing Capture During External Pacing (Sync or Async Mode)

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
d) Loss of intrinsic rhythm with pacing electrical capture at desired/programed PPM rate



Medications To Consider For Atrial Arrythmias

- Adenosine: start with 100mcg/kg rapid IVP up to 300mcg/kg via IV access closest to core/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
    - Per order, follow blood glucose closely with initiation, and any changes in dose

Medications to Consider For Ventricular Arrythmias

- Lidocaine 2%: 1mg/kg per dose IVP
- Magnesium Sulfate: 25mg/kg IV bolus; 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
    - Per order, 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: per standard, consult with pediatric cardiology, pediatric pharmacist, and refer to Neonatal Emergency Drug Sheet for reference and follow medication orders as entered in EMR

References

1. Zoll R 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. Accessed January 5th, 2024.
2. PadPro Instructions For Use Mini Infant 2602. Conmed Corporation. 12/2021.
3. Zoll One Step Pediatric Electrodes Instructions For Use. https://www.zoll.com/-/media/product-manuals/electrodes/english/ifu-8900-0218-40-onestep-pediatric-en.ashx#:~:text=Grasp%20the%20Apex%2FFront%20electrode,is%20more%20susceptible%20to%20burning. Accessed January 5th, 2024.
4. Pedipadz Soft Gel Multifunction Instructions For Use. https://www.zoll.com/-/media/product-manuals/electrodes/english/ifu-8900-3001-01-pedi-padz-solid-gel-en.ashx. Accessed January 5th, 2024.
5. 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. Accessed January 5th, 2024.
6. Pediatric Advanced Life Support Provider Manual. American Heart Association. 2020
7. ECRI Alert #H0594: External Defibrillators: Electrical Arcing in an Oxygen-Enriched Atmosphere ECRI Hazard Report. April 2020. https://www.ecri.org/about/. Accessed February 7th, 2024.

Medical Legal Disclaimer:

Welcome to the UC Davis Health, Department of Pediatrics, Clinical Practice Guidelines Website. All health and health-related information contained within the Site is intended chiefly for use as a resource by the Department's clinical staff and trainees in the course and scope of their approved functions/activities (although it may be accessible by others via the internet). This Site is not intended to be used as a substitute for the exercise of independent professional judgment. These clinical pathways are intended to be a guide for practitioners and may need to be adapted for each specific patient based on the practitioner's professional judgment, consideration of any unique circumstances, the needs of each patient and their family, and/or the availability of various resources at the health care institution where the patient is located. Efforts are made to ensure that the material within this Site is accurate and timely but is provided without warranty for quality or accuracy. The Regents of the University of California; University of California, Davis; University of California, Davis, Health nor any other contributing author is responsible for any errors or omissions in any information provided or the results obtained from the use of such information. Some pages within this Site, for the convenience of users, are linked to or may refer to websites not managed by UC Davis Health. UC Davis Health does not control or take responsibility for the content of these websites, and the views and opinions of the documents in this Site do not imply endorsement or credibility of the service, information or product offered through the linked sites by UC Davis Health. UC Davis Health provides limited personal permission to use the Site. This Site is limited in that you may not:

- Use, download or print material from this site for commercial use such as selling, creating course packets, or posting information on another website.
- Change or delete propriety notices from material downloaded or printed from it. · Post or transmit any unlawful, threatening, libelous, defamatory, obscene, scandalous, inflammatory, pornographic, or profane material, any propriety information belonging to others or any material that could be deemed as or encourage criminal activity, give rise to civil liability, or otherwise violate the law.
- Use the Site in a manner contrary to any applicable law.

You should assume that everything you see or read on this Site is copyrighted by University of California or others unless otherwise noted. You may download information from this Site as long as it is not used for commercial purposes, and you retain the proprietary notices. You may not use, modify, make multiple copies, or distribute or transmit the contents of this Site for public or commercial purposes without the express consent of UC Davis Health.