Clinical Guidance

Extrasystoles in the neonatal period

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**Extrasystoles** (also known as ectopic beats) are a common phenomenon in the newborn period. They often cause uncertainty as to whether they are benign or whether they require further investigation and referral.

The majority of ectopic beats are benign premature atrial contractions (PACs) and self-resolve within a few days to weeks after birth. The minority may be indicative of pathology that needs further investigation.

The following guideline informs the clinician of 1) an algorithm of management, and 2) an explanation of ectopic beats with how to differentiate Atrial from Ventricular extrasystoles, as the management may be different.

Also included are investigations we have available and where they can be found.

If at any point there is diagnostic uncertainty or ECG interpretation is needed, discuss the case (together with a copy of the 12 lead ECG) with the attending consultant. Further support can be sought from our local paediatric consultants with expertise in Cardiology (PEC) – Dr Otunla or Dr Groves. If needed discussion with the Paediatric Cardiology Registrar at the Royal Brompton Hospital may be needed, however this decision should be after discussing with the attending NICU consultant.

If unable to get necessary investigations before discharge home and there is clinical uncertainty about sending the baby home safely, then keep the baby as an inpatient and arrange investigations at the earliest opportunity.
Algorithm for management

For both PACs and PVCs – are there any exacerbating factors?
- Inotropes
- Electrolyte abnormalities
- Hypothermia
- Stimulants eg: Caffeine
- Vascular lines lying inside the heart
- Recent cardiac surgery

Order 12 lead ECG

Atrial ectopics
- Normal examination
- Heart rate in normal range
- ECG normal including QTc
- <15 PACS per minute on auscultation
- Well baby
- No antenatal fetal cardiac concerns
- No Family history of CHD or arrhythmia
- No exacerbating factors (see above)

YES:
- Reassure & discharge. No follow up needed

NO:
- If >15 PACS per minute but all other criteria normal, order 24 hr tape to screen for SVT as in-patient. If tape negative for SVT, allow baby home & teach parents how to count the pulse (use brachial) and signs of baby being unwell. Explain that if HR>200bp (sign of SVT) or sustained <80bpm in term or preterm <100bpm (sign of heart block) to seek medical help.
- Follow up at 1 month of life with ECG +/- repeat Holter if PACS still frequent
- If PACS persist at 1 month of life and >15/hr discuss with our PEC

Ventricular ectopics
- Monomorphic single or couplet PVCs, normal QTc, no VT

Order 24 hour tape & Echo as in-patient
- Echo normal and PVCs monomorphic, < 60/hr and no VT

YES
- Allow baby home. Teach parents how to count the pulse (use brachial) and signs of baby being unwell. Explain that if HR>200bp (sign of SVT) or sustained <80bpm in term or preterm <100bpm (sign of heart block) to seek medical help.
- Follow up at 3 months of life and re-Holter. Re-echo to check function if PVCs persisting
- Discharge if resolution of PVCs
- If persisting and/or >60/hr, or polymorphic or VT – discuss with PEC or if not available then Royal Brompton Paediatric Cardiology Registrar on Call

Natural history is that PVCs resolve by 7 months of life in most infants

All babies:
- Is the baby well?
- Examine baby: full CVS examination including pre-/post ductal sats
- Check heart rate in normal range
- Any antenatal fetal cardiac concerns?
- Family history of CHD or arrhythmia?

Admit to NICU for cardiac monitoring.
Order 24 hour tape; Echo to check function & structure.
Discuss case attending NICU consultant. Consider liaison with local PEC or if not available then Royal Brompton Paediatric Cardiology Registrar on Call

Abbreviations:
PAC – premature atrial contraction
PVC – premature ventricular contraction
PEC – paediatrician with expertise in cardiology
CHD – congenital heart disease
VT – ventricular tachycardia
SVT – supraventricular tachycardia
Ordering a 12 lead ECG
During weekday office hours:
- Request on Patient Centre and then call the ECG department to confirm. If the baby is term and well in a cot they can go to the ECG department with mother. Otherwise request for a portable one to be done on the NICU
Out of hours:
- Our team will need to perform it. ECG machines are available on Joan Booker Ward and King Fisher. Ensure you clean the leads with a Sani-Cloth. The ECG stickers are placed in the same positions as one would with an adult; with a very small baby you may have to cut the stickers in half in order to accommodate all of the leads on the chest (see below).

Ensure the ECG is calibrated to 10 mV (10 small squares) and the speed is set to 25mm/second.
Ordering a Holter monitor
- Order through Patient Centre & follow up with a phone call to cardiology investigations department to perform
- Ensure named consultant is on the request form as the report will be sent to them
- Holter monitoring cannot be requested over the weekend

Premature atrial contractions

Premature atrial contractions (PACs) are early depolarisations of atrial tissue distinct from the sinus node. The beat comes prematurely before the next normal beat is due. As the impulse originates from an area different to the sinus node, the P wave often has a different morphology than the P wave that originates from the sinus node:

- The atrial impulse is conducted (usually) to the ventricles down the normal pathway ie: AV node and His bundle to the ventricular bundle branches. Therefore the QRS morphology is usually NARROW complex
- Sometimes the PAC is conducted through an aberrant pathway, producing a broad QRS complex. The QRS complex should be preceded by a P-wave if it is a PAC
- Occasionally the P wave will be buried in the T wave of the preceding beat, making it difficult to be certain whether the ectopy is of atrial or nodal (ie: from or near the AV node) in origin
- Sometimes a PAC is not conducted to the ventricle as the bundle of His is in refractory state. This produces a long pause between 2 R waves

Nonconducted/blocked PACs

Non-conducted PACs can produce an irregular rhythm which is slow. Therefore careful ECG interpretation is needed to differentiate non-conducted PACs from AV block.
To differentiate from 2nd degree AV block: the non-conducted PAC has a shorter P to premature p (p’) interval than the normal P to P interval, whereas in 2nd degree AV block the P to P interval is unaltered - see below

A. 2nd degree heart block with unaltered P to P interval between conducted and no conducted atrial beats
B. Non-conducted PAC with a shorter P to p’ interval compared to the normal P to P interval

A.

B.

Conducted Ps

Blocked PACs

P to P interval

P to p’ interval (shorter than P to P interval)

If every other beat is a PAC, then this is referred to as atrial “bigeminy” or atrial “couplets.” Atrial bigeminy is generally benign and makes no difference in the individual’s prognosis when compared with isolated PACs.

NB: Rarely, PACs in a bigeminal pattern will block (i.e. every other beat is a non-conducted PAC), thus resulting in bradycardia. It is important to evaluate the ECG in patients with bradycardia since atrial bigeminy usually has a benign prognosis.

Atrial ectopics - clinical significance
Premature atrial contractions are frequently seen in healthy newborns and are usually of no significance.
They do not need treatment.
In most newborns, PACs will resolve in the first few weeks to months of life.

PACs do not need further investigation in the context of:
- Convinced of atrial nature of ectopics
- Frequency less than 15 PACS per minute\(^1\) (greater than this may initiate paroxysmal SVT)\(^2\)
- Otherwise normal ECG
- No antenatal concerns for congenital heart disease
- Well baby with a normal cardiovascular examination including 4 limb pulses and normal oxygen saturations
- Heart rate in normal range

NB:
For both PACs and PVCs – are there any exacerbating factors?
- Inotropes
- Electrolyte abnormalities
- Hypothermia
- Vascular lines lying inside the heart
- Recent cardiac surgery

Premature ventricular contractions

A premature ventricular contraction (PVC) is a spontaneous depolarization of the ventricular myocardium resulting in an early ventricular contraction. They are relatively common in the neonatal and early infancy period with up to 18% of those >30days manifesting PVCs on 24 hour Holter.

- PVCs may arise in any region of the ventricles
- Manifest on ECG as widened, bizarre QRS complexes that are NOT preceded by a premature P-wave

Wide complex ventricular ectopic beat not preceded by a premature P-wave

- When all PVCs have identical morphology, the focus is likely from a common site and are termed MONOMORPHIC (or unifocal) – see below

Variation in PVC morphology are POLYMORPHIC (or multiform) and suggest origin from more than 1 ventricular site – see below

POLYMORPHIC (or multifocal) PVCs:

Frequent PVCs may exhibit a definite rhythm
- Alternating with a normal beat – Bigeminy:
Occurring after 2 ventricular beats – Trigeminy. Ventricular trigeminy is rare but has a favourable prognosis and usually resolves in the first 7 months of life.

2 PVCs in a row (Couplets):

Beware of R on T phenomenon – premature depolarization occurs on the T-wave of the preceding beat, predisposing to VT

R on T: the R wave occurs on the T wave of the preceding beat:
Clinical significance of PVCs

Usually unifocal (monomorphic) PVCs are benign and disappear at a mean age of 2 months. One can be reassured if there are:

1. Lack of symptoms and the baby is well
2. Monomorphic QRS complexes
3. No more than 2 consecutive PVCs occurring at one time i.e: couplets
4. Normal QTc interval
5. Normal electrolytes
6. Structurally normal heart and normal cardiac function by echocardiogram
7. Disappearance of PVCs at higher heart rates
8. Negative family history for sudden death in the young (<40 years) or inherited arrhythmia disorder

When to be concerned:

a. 3 or more PVCs in a row
b. Polymorphic QRS complexes
c. R on T phenomenon
d. Suspected or known underlying heart disease – structural, myopathic, previous cardiac surgery
e. Prolonged QTc
f. Unwell baby

Evaluation

Further investigation for PVCs is warranted (compared to PACs) to screen for ventricular arrhythmias i.e: Ventricular Tachycardia, and exclude structural, myopathic and inflammatory disorders of the heart which can be associated with ventricular ectopy.

Assessment by a Paediatrician competent in ECG interpretation is crucial

- An echocardiogram is required to evaluate for structural heart disease and assess function
- a 24-hour Holter monitor is necessary to quantify the ventricular ectopy burden and to evaluate for ventricular tachycardia (three or more PVCs in a row). A frequency >60/h of PVCs would be considered “frequent.”
- Exacerbating factors for PVCs (table 1) should also be ruled out though these factors are often absent in an otherwise healthy newborn

Table 1

<table>
<thead>
<tr>
<th>Exacerbating factors for premature ventricular ectopics</th>
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<tbody>
<tr>
<td>Inotropes</td>
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<td>Electrolyte abnormalities</td>
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<tr>
<td>Hypothermia</td>
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<tr>
<td>Vascular lines inside the heart</td>
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<tr>
<td>Recent cardiac surgery</td>
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4 G De Rosa et al. Outcome of newborns with asymptomatic monomorphic ventricular arrhythmia. Arch Dis Child Fetal Neonatal Ed 2006;91:F419-F422
Management
The vast majority of well infants and neonates with isolated PVCs and a normal family history require no form of therapy and the PVCs self resolve on average in the first 7 months of life. Follow the algorithm above.

References
1. How to Read Pediatric ECGs, 4e by Myung K. Par
5. G De Rosa et al. Outcome of newborns with asymptomatic monomorphic ventricular arrhythmia. Arch Dis Child Fetal Neonatal Ed 2006;91:F419-F422
7. Killen S, Fish F. Fetal and neonatal arrhythmias. DOI: 10.1542/neo.9-6-e242. NeoReviews 2008;9;e242-e252 DOI: 10.1542/neo.9-6-e242