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| Question | |
| **NLS 5200 - Heart rate assessment methods in delivery room- diagnostic characteristics** | |
| **Population:** | Newly born infants in the delivery room |
| **Intervention:** | Use of auscultation, palpation, pulse oximetry, Doppler device, digital stethoscope, photoplethysmography, video plethysmography, dry electrode technology or any other newer modalities |
| **Comparison:** | 1. ECG; 2. Between intervention comparisons |
| **Main outcomes:** | Time for first heart rate assessment from the device placement  Time for first heart rate assessment from birth  Accuracy of heart rate assessment |
| **Setting:** | Delivery Room |
| **Perspective:** | Population perspective |
| **Background:** | This question was last assessed in 2015, where it was found that ECG provided a faster and more accurate heart rate assessment when compared to auscultation with or without pulse oximetry {Wyckoff 2015 S546}. This systematic review identified newer methodologies for heart rate assessment for comparisons. |
| **Conflict of interests:** | None |

# Assessment

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| Problem Is the problem a priority? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know | Annually 140 million neonates are born worldwide and up to 5% of term neonates will not initiate adequate respiratory effort after stimulation by drying and warming. More than 7 million newborn infants will require positive pressure ventilation (PPV) every year for heart rate (HR) below 100 beats per minute (bpm) or gasping or apnea. Rising HR is the most important indicator of effective PPV in initially bradycardic newborns {Wyckoff 2020 S185}. HR is critical to decision-making in the delivery room (DR); therefore, accurate assessment of HR is a priority.  Although there have been multiple studies investigating latency and accuracy of various modalities for HR determination in the DR, there is limited evidence to date as to which is the best method for HR assessment in terms of rapidity and accuracy {Dawson 2013 957; Henry 2020 3; Iglesias 2018 F236; Kamlin 2008 758; van Vonderen 2015 51}. | Fast, accurate and continuous HR estimation is desirable during neonatal resuscitation as it allows the team to make decisions and determine effectiveness of the resuscitation efforts.  Underestimating HR can lead to interventions when not indicated, such as PPV, intubation, chest compressions and epinephrine administration. This may lead to harm. On the other hand, overestimation of HR may result in a delay of necessary critical interventions, such as PPV, intubations, chest compressions and potentially result in adverse outcomes {Phillipos 2016 130}.  Recommendations for HR assessment vary among resuscitation councils. |
| Desirable Effects How substantial are the desirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial ○ Small ●Moderate ○ Large ○ Varies ○ Don't know | The certainty of evidence for all comparisons remains low. **Comparison 1: Pulse oximeter (PO) with electrocardiogram (ECG)** PO is slower and more imprecise for newborn HR assessment in the DR compared to ECG {Abbey 2021 1; Bjorland 2020 1; Bobillo-Perez 2021 785; Bush 2021 F551; Dawson 2013 955; Henry 2021 72; Iglesias 2016 274; Iglesias 2018 F233; Kamlin 2008 756; Katheria 2012 e1180; Mizumoto 2012 205; Murphy 2019 F548; Murphy 2021 F438; van Vonderen 2015 49}.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Median Pooled difference** | **95% CI** | | **Time for first HR from device placement (RCTs)** | 136  (2 RCTs)12,13 | ⨁◯◯◯  Very low a,b,c | 12 s slower | 13 s faster to  38 s slower  p>0.05 | | **Time for first HR from device placement**  **(Observational studies)** | 323  (6 Observational studies)2,4,7,8,10,14 | ⨁⨁◯◯ Low a,c | 57 s slower | 13 s slower to  101 s slower  p<0.05 | | **Time for first HR from birth**  **(RCTs)** | 87  (2 RCTs)1,13 | ⨁⨁◯◯ Low a,c | 6 s  slower | 10 s faster to 23 s slower, p>0.05 | | **Time for first HR from birth**  **(Observational studies)** | 334  (6 Observational studies)2, 3, 5, 9, 11, 14 | ⨁⨁◯◯ Low a,c | 52 s  slower | 9 s slower  to 94 s slower, p<0.05 | | **Accuracy of HR assessment** | 216 neonates 28,211 observations 1, 5, 6, 9, 14 | ⨁⨁⨁◯ Moderatea | **Mean bias** | **LoA\***  **95% CI** | | HRPO – HRECG:  -1.2 bpm | LoA: - 17.9 to 15.5 bpm(95% CI -32.8, 30.4) | | **Accuracy of HR assessment (sensitivity and specificity of PO for HR<100 bpm)** | 124  (3 studies)1, 7, 9  124 newborns  8,342 observations | ⨁◯◯◯  Very low a,b,c | Sensitivity 0.83 ( 95% CI 0.76;0.88)  Specificity 0.97 (95% CI 0.93; 0.94)  No similar data for severe neonatal bradycardia (ECG HR <60 bpm) | |   \*Limit of agreement: LoA with lower and upper LoA  1{Abbey 2021 1}, 2{Bjorland 2020 1}, 3{Bobillo-Perez 2021 785}, 4{Bush 2021 F551}, 5{Dawson 2013 955}, 6{Henry 2021 72}, 7{Iglesias 2016 274}, 8{Iglesias 2018 F233}, 9{Kamlin 2008 756}, 10{Katheria 2012 e1180}, 11{Mizumoto 2012 205}, 12{Murphy 2019 F548}, 13{Murphy 2021 F438}, 14{van Vonderen 2015 49}   1. Risk of bias 2. Inconsistency 3. Imprecision   **Comparison 2: Auscultation compared to ECG**  Auscultation may be faster than ECG for HR assessment at birth. Auscultation may be accurate but imprecise for HR estimation at birth {Bobillo-Perez 2021 785; Cavallin 2020 90; Kamlin 2006 320; Murphy 2018 F490-1; Treston 2019 F227}.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Median Pooled difference** | **95% CI** | | **Time for first HR from device placement**  **(Observational Studies)** | 105  (3 Observational studies)1,4,5 | ⨁⨁⨁◯ Moderatea | 4 s faster | 10 s faster to 2 s slower  p>0.05 | | **Time for first HR from birth**  **(Observational Studies)** | 70  (2 Observational studies)1,5 | ⨁⨁◯◯ Lowa,b | 24 s faster | 45 s faster to 2 s faster  p<0.05 | | **Accuracy of HR assessment** | 71  (2 Observational studies)3,4 | ⨁⨁◯◯ Lowa,b | **Mean bias** | **LoA\***  **95% CI** | | HRAUS – HRECG  - 9.9 bpm | LoA -32 to 12 bpm  (95% CI -217, 198) | | **Accuracy of heart rate assessment at 90 s** | 80  (2 Observational studies)1,2 | ⨁⨁◯◯ Lowa,b | -9.6 bpm | LoA -52 to 33 bpm  (95% CI -307, 203) | | **Accuracy of heart rate assessment at 120 s** | 80  (2 Observational studies) 1,2 | ⨁⨁⨁◯ Moderatea | -0.4 bpm | LoA -34 to 35 bpm (95% CI -594, 189) |   \*Limit of agreement: LoA with lower and upper LoA  1{Bobillo-Perez 2021 785}, 2{Cavallin 2020 90}, 3{Kamlin 2006 320}, 4{Murphy 2018 F490-1}, 5{Treston 2019 F227}   1. Risk of bias 2. Imprecision   **Comparison 3: Palpation compared to ECG**  Palpation is inaccurate and imprecise for HR estimation at birth{Cavallin 2020 90; Kamlin 2006 320}.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Mean (SD)** | **Mean difference (SEM)** | | **Accuracy of HR assessment** | 21  (1 Observational study)2 | ⨁◯◯◯ Very lowa,b,c | Palpation vs. ECG: 147 bpm (19) vs.  168 (22) bpm p<0.001 | -21 (21) bpm | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Mean Pooled difference** | **LoA** | | **Accuracy of HR assessment at 60 s** | 60  (1 Observational study)1 | ⨁◯◯◯ Very lowa,b | -20 bpm | -80 to 40 bpm | | **Accuracy of HR assessment at 90 s** | 60  (1 Observational study)1 | ⨁◯◯◯ Very lowa,b | -25 bpm | -73 to 22 bpm | | **Accuracy of HR assessment at 120 s** | 60  (1 Observational study)1 | ⨁◯◯◯ Very lowa,b | -23 bpm | -6 to 20 bpm | | **Accuracy of HR assessment at 300 s** | 60  (1 Observational study)1 | ⨁◯◯◯ Very lowa,b | -31 bpm | -96 to 34 bpm |   \*Limit of agreement: LoA with lower and upper LoA  1{Cavallin 2020 90}, 2{Kamlin 2006 320}   1. risk of bias 2. applicability concerns 3. imprecision   **Comparison 4: Palpation compared to auscultation**  Auscultation provides more accurate HR over time than palpation{Cavallin 2020 90; Owen 2004 215}.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Mean difference** | **95% CI** | | **Accuracy of HR assessment** | 60  (1 RCT)2 |  | No pooled summary available |  | | **Accuracy of HR assessment** | 60  (1 observational)  {Cavallin 2020 88} | ⨁◯◯◯ Very lowa,c | -4 bpm for each minute after birth | -6 to -1 bpm p=0.007 |   \*Limit of agreement: LoA with lower and upper LoA⨁◯◯◯ Very lowa,b  1{Cavallin 2020 90}, 2{Owen 2004 215}   1. risk of bias 2. imprecision 3. applicability concerns   **Comparison 5: Digital stethoscope (DS) compared to ECG** Digital stethoscope may be accurate but imprecise for HR estimation at birth {Gaetner 2017 F370}.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Mean difference** | **95% CI** | | **Accuracy of HR assessment (crying periods included)** | 23  (1 Observational study)1 | ⨁◯◯◯ Very lowa,c | HRDS –HRECG: 0.2 bpm | −17.6 to 18 bpm\* | | **Accuracy of HR assessment (crying periods excluded)** | 23  (1 Observational study) 1 | ⨁◯◯◯ Very lowa,c | HRDS –HRECG: 1 bpm | −10.5 to 12.6 bpm\* |   \*Limit of agreement: LoA with lower and upper LoA  1{Gaetner 2017 F370}   1. risk of bias 2. imprecision 3. applicability concerns   **Comparison 6: Doppler ultrasound (DU) compared to ECG** Doppler US may be accurate and precise for HR assessment but certainty of evidence is very low {Agrawal 2019 2056; Shimabukuro 2017 1070}.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Median Time**  **(IQR)** | | | **Time for first HR from birth**  **(Observational Study)** | 131  (1 Observational study)1 | ⨁◯◯◯ Very lowa,b | DU: 76 s (IQR 51 s to 91 s) vs  ECG: 96.5 s (IQR 74.2 s to 118 s)  p<0.05 | | | **Accuracy of heart rate assessment** | 164  (2 Observational studies)1,2 | ⨁⨁◯◯ Lowa,c | **Summary Mean bias** | **LoA\***  **95% CI** | | HRDU – HRECG - 0.2 bpm | -5 to 6  (95% CI -222, 223) |   \*Limit of agreement: LoA with lower and upper LoA  1{Agrawal 2019 2056}, 2{Shimabukuro 2017 1070}   1. risk of bias 2. applicability concerns 3. imprecision   **Comparison 7: Dry electrodes incorporated in a belt (DEB) compared to (conventional 3 lead) ECG**  Dry electrodes incorporated in a belt may be faster than conventional 3 lead ECG for HR estimation at birth. DEB may be accurate and precise for HR estimation at birth when compared to conventional 3 lead ECG{Bush 2021 F551; Rettedal 2021 5; van Twist 2022 1139}. .  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Outcome** | **Number**  **of observations** | **Certainty of the evidence (GRADE)** | **Median Time**  **(IQR)** | | | **Time for first HR assessment from device placement**  **(Observational study)** | 48  (1 Observational study)2 | ⨁◯◯◯ Very lowa,b | HRDEB at 22 s (IQR CI 13 s to 45s) vs  HRECG 171 s (IQR 129 s to 239 s) | | | **Time for first HR from birth**  **(Observational study)** | 28  (1 Observational)1 | ⨁◯◯◯ Very lowa,b | HRDEB 13 s (IQR CI 10 s to 18 s) vs HRECG 42 s (IQR 31 s to 63 s) | | | **Accuracy of HR assessment** | 66  (2 Observational studies)2,3 | ⨁⨁◯◯ Lowa,c | **Summary Mean bias** | **LoA\***  **95% CI** | | HRDEE – HRECG – 1.4 bpm | -2.5 to 5.2  (95% CI -30,33) |   1{Bush 2021 F551}; 2{Rettedal 2021 5}; 3{van Twist 2022 1139}   1. risk of bias 2. imprecision 3. applicability concerns | ECG allows for continuous HR assessment compared to auscultation, which offers intermittent HR assessment.  ECG allows continuous visualization of HR while auscultation relies on a team member who needs to count audible heart beats over a period of time using a stethoscope.  Dry electrode technology may provide more accurate HR assessment during resuscitation when compared to ECG.  Accuracy of HR assessment was examined by pooled Bland-Altman (B-A) analysis. The B-A plot is a method to quantify agreement between two quantitative measurements. {Bland 1995 1085, Bland 1999 135, Bland 1986 307, Giavarina 2015 141, Montenij 2016 750} This analysis was used to quantify agreement between ECG (reference technique) and other HR monitoring methods (experimental techniques). Bland–Altman (B-A) analysis determines the bias, or mean difference between the experimental and reference technique, as a measure of accuracy. B-A plot also includes limits of agreement (LoA), as a measure of precision. These statistical limits are calculated by using the mean difference (Bias) and the standard deviation(s) of the differences between two measurements. The LoA indicates the interval within which 95% of the differences between the two methods fall. If more than 1 study reported B-A plot analysis, we pooled that data together to create a summary estimate of accuracy and precision. The B-A plot method only defines the intervals of agreements, it does not say whether those limits are clinically acceptable or not. For this systematic review, agreement within +/- 10 bpm was considered acceptable. The B-A plot can also uncover whether the bias and differences are same or differ across various levels of HR |
| Undesirable Effects How substantial are the undesirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Large ○ Moderate ○ Small ○ Trivial ○ Varies ● Don't know | * The current review found no studies that reported whether the use of ECG or other modalities to detect HR in the delivery room would cause clinical harm. | It remains unclear if the timing of cord clamping, especially in relation to the aeration of the lungs, impacts rate of bradycardia in newly born infants at birth. Immediate cord clamping may result in drop in left ventricular output and may result in bradycardia at the time of birth. Recognition of such bradycardia by tools that measure HR faster than auscultation with/without pulse oximeter may result in an increase in resuscitation interventions. It remains unclear if this assessment is beneficial or harmful.  There are limited data on use of ECG for delivery room resuscitation of VLBW infants. Application of leads to very/extremely premature skin may cause skin damage or may result in increased incidence of hypothermia if the plastic wrap used for thermoregulation is being repeatedly undone.  It remains unclear if the use of ECG will result in delay or non-recognition of pulseless electrical activity in a newly born infant.  It remains unclear if underestimation or overestimation of heart rate by pulse oximetry or auscultation will result in inappropriate interventions or delay in critical interventions such as positive pressure ventilation during neonatal resuscitation. |
| Certainty of evidence What is the overall certainty of the evidence of effects? | | |
| Judgement | Research evidence | Additional considerations |
| • Very low ○ Low ○ Moderate ○ High ○ No included studies | All evidence was of low certainty, downgraded for risk of bias and applicability concerns. |  |
| Values Is there important uncertainty about or variability in how much people value the main outcomes? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Important uncertainty or variability ○ Possibly important uncertainty or variability ● Probably no important uncertainty or variability ○ No important uncertainty or variability | There is probably no important uncertainty or variability in how much people value time for first HR assessment from the device placement, time for first heart rate assessment from birth and accuracy of HR assessment as outcomes.  We included outcomes that were previously judged to be important by an expert panel and thus are likely to influence healthcare providers to use one method of HR monitoring over another in the DR. | Outcome ratings were adopted from the following publication: {Strand 2020 328} |
| Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● Don't know | The potential undesirable effects are unknown. One theoretical concern is the detection of pulseless electrical activity (PEA) with ECG monitoring, leading providers to inappropriately stop resuscitative efforts. The incidence of PEA within this population of newly born infants is not known, so the impact is unclear. If one assumes PEA is rare and newborns needing resuscitation is less rare, the balance of effects may favor the faster and more accurate HR assessment method of ECG. |  |
| Resources required How large are the resource requirements (costs)? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs ● Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ○ Don't know | Costs of ECG monitoring in the delivery room are context-dependent. Many centers are able to re-allocate monitors from existing resources; other providers will need to allocate resources to buy additional monitors. Beyond the ECG monitor, the cost of using disposable leads (gel electrodes) and costs associated with training should be considered. As such, it is deemed a moderate cost. | It is possible that the routine use of ECG for HR assessment in infants receiving positive pressure ventilation immediately after birth may reduce the need for further neonatal resuscitation interventions and long-term undesirable outcomes. Currently, there is insufficient evidence to determine whether routine use of ECG improves resuscitation efforts and clinical outcomes. |
| Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Very low ○ Low ○ Moderate ○ High ● No included studies | There is no evidence currently available to answer this question. |  |
| Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies | There is no evidence currently available to answer this question. |  |
| Equity What would be the impact on health equity? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced ○ Probably reduced ○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know | There are no data available to inform the answer to this question. | A preponderance of neonatal asphyxia occurs in resource-limited areas. We speculate that an affordable heart rate assessment tool that provides rapid and accurate data may positively impact outcomes in areas where neonatal asphyxia is more prevalent, potentially improving equity. |
| Acceptability Is the intervention acceptable to key stakeholders? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ○ Yes ● Varies ○ Don't know | Stakeholders have variable acceptance of ECG monitoring in the DR. We speculate this is predominantly due to the lack of evidence of impact on clinical outcomes and cost-effectiveness. |  |
| Feasibility Is the intervention feasible to implement? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know | Multiple studies have demonstrated the feasibility of using ECG in newly born infants in various settings {Perlman 2015 S207}. |  |

# Summary of judgements

|  | **Judgement** | | | | | | |
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| **Problem** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |
| **Desirable Effects** | Trivial | Small | **Moderate** | Large |  | Varies | Don't know |
| **Undesirable Effects** | Large | Moderate | Small | Trivial |  | Varies | **Don't know** |
| **Certainty of evidence** | **Very low** | **Low** | Moderate | High |  |  | No included studies |
| **Values** | Important uncertainty or variability | Possibly important uncertainty or variability | **Probably no important uncertainty or variability** | No important uncertainty or variability |  |  |  |
| **Balance of effects** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | Varies | **Don't know** |
| **Resources required** | Large costs | **Moderate costs** | Negligible costs and savings | Moderate savings | Large savings | Varies | Don't know |
| **Certainty of evidence of required resources** | Very low | Low | Moderate | High |  |  | **No included studies** |
| **Cost effectiveness** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | Varies | **No included studies** |
| **Equity** | Reduced | Probably reduced | Probably no impact | Probably increased | Increased | Varies | **Don't know** |
| **Acceptability** | No | Probably no | Probably yes | Yes |  | **Varies** | Don't know |
| **Feasibility** | No | Probably no | **Probably yes** | Yes |  | Varies | Don't know |

# Type of recommendation

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| Strong recommendation against the intervention | Conditional recommendation against the intervention | **Conditional recommendation for either the intervention or the comparison** | Conditional recommendation for the intervention | Strong recommendation for the intervention |
| ○ | ○ | **●** | ○ | ○ |

# Conclusions

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| Recommendation |
| * Where accurate HR estimation is needed at birth and resources permit, we suggest that the use of ECG for HR assessment of a newly born infant in the DR is reasonable (Conditional recommendation, low certainty of evidence). * PO and auscultation may be reasonable alternatives for HR assessment, but the limitations of these modalities should be kept in mind (Conditional recommendation, low certainty of evidence). * There is insufficient evidence to make a treatment recommendation regarding use of digital stethoscope, audible or visible Doppler ultrasound, dry electrode technology or any other newer modalities for HR assessment of a newborn in the DR. * Auscultation with or without PO should be used to confirm the HR when ECG is unavailable, not functioning or when pulseless electrical activity is suspected (Good practice point). |
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| Justification |
| * The available data suggest that ECG provides a more rapid and accurate assessment of HR in the DR when compared to any other newer modalities, but the certainty of evidence is very low. * Very few infants who had any of the following characteristics were included in these studies: those who were bradycardic, those requiring resuscitation as positive pressure ventilation, or extremely premature infants. * Evidence from ILCOR CoSTR 5201 showed that it is unclear if the level of speed and accuracy/precision of HR estimation at birth translates to clinically relevant differences in resuscitation interventions, resuscitation team performance or clinical outcomes for newborn infants. * Either auscultation or pulse oximetry or both have been commonly and routinely used for HR assessment in newborns at birth. In a resource limited setting, where ECG is not available, auscultation and/or pulse oximetry may serve as reasonable alternatives to ECG. HR estimation with these methods may be accurate but imprecise than ECG in the first few minutes after birth, especially in newborns who are bradycardic or are receiving resuscitation. * Palpation for heart rate assessment at birth is inaccurate but certainty of evidence is very low. * Dry electrode belt and Doppler US devices show good accuracy and speed for HR detection at birth. Larger studies which include extremely premature newborns and infants who are bradycardic and require resuscitation are needed. * The cost-effectiveness and effects on equity of routine use of various HR assessment methods remain unclear. Some devices are likely to be unaffordable in low resource settings. |

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| Subgroup considerations |
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| Implementation considerations |
| Acquiring ECG monitors in the delivery room: many centers might be able to re-allocate monitors from existing resources; other providers will need to allocate resources to buy additional monitors. Use of ECG for HR assessment for newly born infants will require training of resuscitation team personnel. |

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| Monitoring and evaluation |
| Continued monitoring and evaluation of resuscitation team performance and clinical outcomes, including resuscitation interventions is recommended. |

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| Research priorities |
| * Is there an impact of different heart rate assessment methods on resuscitation team performance, resuscitation interventions and neonatal clinical outcomes? * There were no studies identified that evaluated first heart rate assessment from device placement with newer modalities such as digital stethoscope, audible or visible Doppler ultrasound, reflectance-mode green light photoplethysmography or transcutaneous electromyography of the diaphragm in the delivery room. * There were no studies identified that evaluated time for first heart rate assessment from birth with newer modalities such as digital stethoscope, reflectance-mode green light photoplethysmography or transcutaneous electromyography of the diaphragm in the delivery room. * With a lack of evidence supporting an impact on clinical outcomes, cost effectiveness analysis of different modalities for HR assessment in the delivery room is challenging. * Should the heart rate assessment method in the delivery room be different for a vigorous vs non-vigorous newborn who does not respond to initial steps of resuscitation? * Should the heart rate assessment method in the delivery room be different for newly born infants of different gestational ages (<28+0 weeks, 28+0-33+6 weeks, ≥34+ 0 weeks)? * HR monitoring methods should be evaluated with larger studies especially in newborns who are receiving resuscitation or newborns with HR ECG < 100 bpm or HR ECG< 60 bpm. |
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