Unplanned extubation in neonates – SSBC Neonatal Network wide audit

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Introduction

Invasive mechanical ventilation via endotracheal tube is a common treatment modality in neonatal units. It has contributed to improved survival of sick neonates. Mechanically ventilated neonates are prone to many adverse events such as Unplanned Extubation (UE). It has the potential to cause cardiorespiratory deterioration, airway trauma such as subglottic stenosis due to repeated reintubations and ventilator induced pneumonia.

Studies show variation in rate of UE from 1.14 to 5.3 per 100 ventilated days. Compared with data from PICUs, unplanned extubations in neonatal patients occur 2 to 3 times more frequently.

Potential reasons for this increased incidence include longer duration of intubation, shorter length of the trachea in neonates compared with older children, the use of uncuffed endotracheal tubes in neonates, and less routine use of sedation and muscle relaxation, as well as time spent out of bed while being held by parents. There are many factors that contribute to UE such as method of fixation of endotracheal tubes, procedures such as weighing and suctioning and agitation of the patient, resulting in rapid movement of the head.

Greater emphasis has been placed in recent years on improving quality and patient safety. Given the frequency and importance of this potentially serious adverse event in the neonates, Unplanned Extubation rate should be monitored and considered as a quality metric.

The SSBCNN provides care for about 4,400 babies / year. It provides about 5,500 - 6,000 intensive care days every year across the network. All the 5 neonatal units provide neonatal care for a variety of neonatal conditions. The network has two neonatal intensive care units providing neonatal care for babies of all gestation from 23 weeks and three local neonatal units providing neonatal care for babies above 27 weeks gestation as per the established network pathways. A network wide audit to assess the incidence of UE across the network, its risk factors, rate of re-intubation following UE and outcomes following UE was conducted with a view to develop a quality improvement programme to reduce the incidence of UE.

The goal is to achieve 1 UE per 100 patient-intubated days. This rate has been identified as the benchmark for PICUs.

Methods

The audit programme was approved by the Quality Improvement group from SSBCNN and all the 5 neonatal units within SSBC neonatal network agreed to participate in the audit process. The audit was prospective in nature and was conducted over a period of 6 months from October 2016 till March 2017.

Initial data was collected regarding the unit characteristics. They included designation of the unit,
number of deliveries in 2015, number of ventilation days in 2015, type of ET tube used and method of fixation and whether the unit had systems in place to capture incidences of UE in their unit.

The proforma was designed to collect the details of individual episodes of UE and efforts were made to ensure that patient were limited to badgernet id so that patient details were identifiable to the individual units for review, if required.

The following information was collected on individual episodes of unplanned extubation.

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**Audit on Unplanned Extubation (UE) in newborn babies**

**Proforma**

**Unit details**

- Unit designation:
  - NICU □
  - LNU □
  - SCBU □

**Patient demographics**

- Patient id (Badger id):
  - Sex: Male □ Female □
- Birth Weight (grams):
  - GA at birth (weeks + days):

**Episode of unplanned extubation**

<table>
<thead>
<tr>
<th>Location</th>
<th>ITU □ Labour ward □ Other □ Details:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of the day when the event occurred</td>
<td>AM □ PM □</td>
</tr>
<tr>
<td>Recent working weight of the baby</td>
<td>grams</td>
</tr>
<tr>
<td>Corrected GA of the baby on the day of the event</td>
<td>weeks + days</td>
</tr>
<tr>
<td>Was the ET position documented on the ITU chart</td>
<td>Yes □ No □</td>
</tr>
<tr>
<td>What was the position of ET on the X ray prior to unplanned extubation</td>
<td>(mention the vertebral level)</td>
</tr>
<tr>
<td>How long was the baby ventilated on the present ET tube prior to unplanned extubation</td>
<td>Days Hours</td>
</tr>
<tr>
<td>Mode ventilation at the time of unplanned extubation</td>
<td>CMV □ SIMV □ PTV / AC □</td>
</tr>
<tr>
<td>Was the baby receiving paralysing agents Eg. Atracurium, Vecuronium etc...</td>
<td>Yes □ No □</td>
</tr>
<tr>
<td>Wes the baby on Morphine / Midazolam</td>
<td>Yes □ No □</td>
</tr>
<tr>
<td>Was the extubation planned in the next 24 hours</td>
<td>Yes □ No □</td>
</tr>
</tbody>
</table>
# Audit on Unplanned Extubation (UE) in newborn babies

## Proforma

### Patient care activity at the time of the event

<table>
<thead>
<tr>
<th>Activity</th>
<th>During transfer of the baby:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suctioning</td>
<td>In and out of incubator</td>
</tr>
<tr>
<td>Weighing</td>
<td>Transfer from labour ward / PN ward / Others</td>
</tr>
<tr>
<td>Fixing / Refixing the ET tube</td>
<td>Any other activity:</td>
</tr>
<tr>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

### Unit activity at the time of the event

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of nurses available</td>
<td></td>
</tr>
<tr>
<td>Recommended number of nurses</td>
<td></td>
</tr>
<tr>
<td>Was the baby receiving 1:1 nursing care</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>

### Post Unplanned extubation event

<table>
<thead>
<tr>
<th>Event</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the baby get re-intubated</td>
<td></td>
</tr>
<tr>
<td>Did the baby required CPR following UE</td>
<td></td>
</tr>
<tr>
<td>Did the baby require higher FiO2 following UE and reintubation</td>
<td></td>
</tr>
<tr>
<td>Was there any worsening of blood gas following UE</td>
<td></td>
</tr>
<tr>
<td>Any other complications (Eg. Pulmonary Haemorrhage etc..)</td>
<td></td>
</tr>
</tbody>
</table>
Results

Information was not available from one of the 5 neonatal units. The total number of deliveries and ventilator days in 2015 were analysed to assess the general workload in the neonatal units. The total number of deliveries varied from 4160 to 6364 per year and the ventilator days varied from 147 (RHH) to 1030 per year. The ventilator days were higher in neonatal intensive care units as expected. All the units used one brand of ET tube which is slightly stiffer compared to another brand. One neonatal intensive care unit used a locally adopted method of securing the ET tube. Other 3 units used ‘Neofit’ bar to secure the ET tube. One local neonatal unit changed the method of securing from suturing to ‘Neofit’ during the audit period. However, this did not change the number of accidental extubations. Of the 4 units, 2 of them had system in place to capture unplanned extubation event either through Datix or daily safety briefing.

Ventilator days during audit period

The two neonatal intensive care units had similar number of ventilator days during the audit, whereas, the two local neonatal units had varying number of ventilator days.

One of the neonatal intensive care unit had increased use of HFOV compared to other units.

Unplanned extubation events

There were a total of 23 unplanned extubation events across all 4 neonatal units during the audit period. No details were available for 3 episodes from one neonatal unit. However, they were added to the total number to calculate the UE rate and other analysis where possible.

There were a total of 961 ventilator days across all 4 neonatal units during the audit period giving an overall Unplanned extubation rate of 2.3 per 100 ventilator days.
The number of UE events varied significantly between the neonatal units from 0.75 per 100 to 7.6 per 100 ventilator days.

No details were available for 3 unplanned extubations from unit 2.

12/20 were male and 8/20 were female babies.

40% (8/20) were born at term and 10% (2/20) were born less than 27 weeks. This was expected due to possible increased activity and better tone in babies born at higher gestation.
Similarly 40% (8/20) weighed more than 2.5 kg and 10% (2/20) weighed less than 1 Kg.

1/20 occurred during transfer from labour ward. But the rest of 19/20 UE events occurred in the intensive care room on the unit.

Position of the ET tip was documented in 19/20 cases. It was not documented in one case as it happened during transfer from labour ward.

ET position on X ray was recorded in 15/20 cases. It was not recorded in 5/20 cases either because UE occurred before or during X ray. Of the 15 cases, 13/15 cases had ET tip documented at T2 – T3. One case was noted to be at C7 and another case was noted to be at T4. Information was not collected as to whether ET tip position was adjusted in the two cases who had ET tip position in less than optimal position.

65% (13/20) babies were ventilated for less than 24 hours out of which 45% (9/20) were ventilated for less than 12 hours.

19/20 babies had conventional ventilation of different types such as SIMV, PTV/AC, PSV. 1/20 was on HFOV ventilation during the UE event.

None of the babies were on paralytic agents during the UE event. 35% (7/20) babies were on sedation during the UE event.

55% (11/20) babies were not planned for extubation over the next 24 hours.

50% (10/20) babies did not have any care activity during the UE event. The remaining 10 babies had varied care activities during the event.
50% (10 / 20) did not receive 1:1 care during the UE event. 40% received 1:1 care and information was not available on 2 cases. There was no difference between NICU and LNU with regards receiving 1:1 care.

55% (11 / 20) of the time during UE, the units did not meet the recommended nursing numbers as per BAPM criteria. 30% (6 / 20) of the time, the units met the recommended criteria and no information was available on 3 cases. There was no difference between NICU and LNU with regards to meeting the recommended nursing numbers.

The average shortage of nursing numbers for the 11 cases was 21%. The shortage was less than < 20% in 6/11 cases, 20 – 30% in 4 / 11 cases and 30 – 40% in 2 / 11 cases.
40% (8/20) babies got reintubated following unplanned extubation. 25% (5/20) babies had increased oxygen requirement and worsening of gas following reintubation. One baby had pulmonary haemorrhage following UE. None of the babies required CPR following the event.

There was no difference between the day or night with regards to UE events. 50% (10/20) had UE events at night between 9 PM to 7 AM and 40% (8/20) had UE events during day between 9 AM to 7 PM. One each occurred between 7 – 9 in the morning and evening suggesting that nursing handover time did not have any impact on UE events.

**Conclusion**

Overall UE rate for the network was 2.3 per 100 intubation days. However, there was significant variation in the rates of UE in individual units. The two neonatal intensive care units had lower rates compared to Local neonatal units. One Neonatal intensive care unit had the lowest UE rates below the benchmarking used in PICU. The two local neonatal units had high rates of UE between 5.5 to 7.6. However it should be noted in one of the Local neonatal unit, although, the total number of UE in that unit were only 2, the lower ventilator days during the audit period (36 days) resulted in higher UE rate per 100 ventilator days.

60% (12/20) of the UE happened in babies above 32 weeks gestation. This could be due to the better tone, activity and shorter duration of illness requiring ventilator support in general. 4 of the 12 babies above 32 weeks gestation had to be reintubated and in 3 of those babies, there was either increase in oxygen requirement or worsening of gas following UE. This increases the risk associated with UE and subsequent problems.

Analysis of babies based on weight criteria correlated with gestational age with 60% (12/20) babies above 1.5kg having UE events.

Almost all of the events except one, occurred when the babies were being treated in the unit and not during transfer from the labour ward.

Half of the babies did not have any care activity recorded during these events, whilst the other half had varying activities with X ray being the most common in 3 babies.

It is also worth noting that time of the day did not make influence the UE event with no difference noted in the UE events during day, night or handover times.

Half of the babies did not receive 1:1 care during these episodes and BAPM criteria for nursing numbers were not met during similar number of episodes. The nursing shortage varied from 12 to 40% of the recommend numbers. The nursing shortage impacts on the ability to care for these babies and may have an impact on the UE rates. However it should be noted that the unit with relatively higher percentage of nursing shortage had the lowest rate of UE. This clearly indicates other factors are equally important in reducing the UE rate.
Recommendation

Unplanned extubations can be reduced by staff education and implementing standard care. The benchmark for UE should be 1 per 100 intubated days. A systematic approach is required to develop strategies and evaluate on a regular basis. The following strategies are recommended.

Ensuring that ET is in correct position

- Develop charts / guideline regarding the ideal length of insertion of ET tube for different GA/weight.
- Ensure that ET tip position on x ray and any adjustment made is documented in the notes.
- ET position should be documented in relation to upper lip
- ET position should be checked and documented with every change of nursing shift
- Routine use of carbon dioxide detectors in the event of suspected unplanned extubation before removing the ET tube
- Standard method of fixation of ET tube should be used in all babies

Ensuring the ET remains in correct position

- Two people should be involved in the care of ET tube and baby during the following procedures:
  - Securing and re-securing ET tube, weighing the baby, X ray, transferring baby from one incubator to another
- Use of mittens and socks in ventilated babies >32 weeks gestation

Increasing awareness and alertness amongst the staff

- Developing continuing education programmes for the staff about frequency and significance of UE
- Development of alert cards (Red and yellow) to identify at risk babies and be placed at the bedside to alert staff about the increased risk
- Centrally located display of the date of most recent UE and lessons from reviews and random audits

Evaluation, learning and implementation

- Random audit of the measures taken to prevent UE and display of information in a centrally located area
- Datix every UE event
- Root cause analysis of every case of UE using a structured questionnaire and meeting with teams involved