Prevention of Neonatal Extravasation Injuries: The Experience of a Neonatal Unit in Hong Kong

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Neonatal Care
Kowloon East Cluster
Extravasation Injuries

An Iatrogenic Complication
Neonatal Extravasation Injuries
The Consequence
The Clinical Practice Guideline

Prevention of PIV Extravasation Flow Diagram

Peripheral Intravenous (PIV) Line (hourly assessment):
- Secure with transparent dressing?
  - Yes
  - Splintage?
    - No
    - Secure PIV with transparent dressing
      - Splintage
    - Yes
    - Continuous infusion?
      - No
      - High risk medication?
        - Yes
        - Flush PIV device with Saline before drug administration: PIV device patent?
          - Yes
          - Remove PIV device
            - Notify physician for setting new PIV device
          - No
          - Remove PIV device
            - Notify physician for setting new PIV device
          - Monitor PIV site: every 10 minutes
            - Yes
            - Extravasation?
              - Yes
              - Remove PIV device when therapy discontinue
            - No
            - Remove PIV device
              - Notify physician for setting new PIV device
          - No
          - Remove PIV device
            - Notify physician for setting new PIV device
    - Yes
    - Intermittent drug administration?
      - No
      - Remove PIV device
        - Notify physician for setting new PIV device
      - Yes
      - Hourly assess PIV site
        - Yes
        - Extravasation?
          - Yes
          - Remove PIV device when therapy discontinue
          - No
          - Remove PIV device
            - Notify physician for setting new PIV device
        - No
        - Remove PIV device
          - Notify physician for setting new PIV device

High risk medications
- For PIV administration
  1. Acyclovir
  2. Amphotericin B
  3. Caffeine Citrate
  4. Phenytoin
  5. Sodium Bicarbonate
- For CVC administration
  1. Calcium (all salt form)
  2. Dextrose > 12.5%
  3. Potassium > 60meq/L
  4. Sodium Chloride ≥ 3%
  5. TPN
  6. Vasopressors and inotropes
Key Changes

1. Assessment
   - Look, Touch, Compare
   - Size of contralateral extremity

2. Identification of high-risk medication
   a. Determine method of administration
      - Central venous Vs Peripheral intravenous
   b. Determine frequency of assessment
      - Hourly assessment Vs every 10 minutes
Infiltration Scale

**Grade 0**
No symptoms
Flushes with ease

**Grade 1**
Localized swelling (1% to 10%)
Flushes with difficulty
Pain at site

**Grade 2**
Slight swelling at site:
(10% to 25% of the extremity above or below site)
Presence of redness
Pain at site

**Grade 3**
Moderate swelling at site:
(25% to 50% of the extremity above or below site)
Pain at site
Skin cool to touch
Blanching
Diminished pulse below site

**Grade 4**
Severe swelling at site (> 50% of the extremity above or below site)
Infiltration of blood products, irritants, and/or vesicants (any amount of swelling)
Skin cool to touch
Blanching
Skin breakdown / necrosis
Blistering
Diminished or absent pulse
Pain at site
Capillary refill > 4 seconds

*Pop (2012)*
Management of Neonatal PIV Extravasation Flow Diagram

Neonatal PIV Extravasation
1. Stop infusion
2. Remove cannula
3. Determine grade of extravasation

Extravasation: Grade 1 & 2
1. Elevate affected limb
2. Observe circulation Q1H
3. Document for progress

Extravasation: Grade 3 & 4
1. Notify attending physician
2. Extravasation not caused by vasopressor: subcutaneous Hyaluronidase injection by physician
3. Extravasation caused by vasopressor: administer Phentolamine by physician
4. Elevate affected limb
5. Observe circulation Q1H
6. Pain management
7. Determine if skin is intact

Intact Skin
1. Observe extravasated site Q1H for 12 hour
2. Document for progress
3. Consult wound nurse if skin breakdown
4. Report & update progress to family
5. Incident reporting

Skin: Not Intact
1. Consult wound nurse for wound management if necessary
2. Document for progress
3. Consult plastic surgeon if necessary
4. Report & update progress to family
5. Incident reporting

Infiltration Scale
Grade 0
No symptoms
Flushes with ease

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Localized swelling (1% to 10%)
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Pain at site

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Slight swelling at site:
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Skin cool to touch
Blanching
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Pain at site
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Pop (2012)
Implementation

- Didactic training
- Video
- Cue cards
  - High-risk medication
  - Pediatric PIV infiltration scale
  - Flow diagram of clinical practice guideline
- Daily nursing round
Evaluation

• Reduction of neonatal extravasation injuries
• Compare rate of neonatal extravasation injuries:
  – Pre-intervention Vs Post-intervention
    • Pre-intervention: collected over a period of 143 days
    • Post intervention: collected over a period of 143 days
  – Recruit neonate participants:
    • By convenience sampling
# Pre-intervention: Rate of Extravasation Injuries

## Characteristics of Neonates (Control Group)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Special care baby unit (SCBU)</th>
<th>Neonatal intensive care unit (NICU)</th>
<th>Frequency (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of care</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Special care baby unit (SCBU)</td>
<td>62 (59.6%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neonatal intensive care unit (NICU)</td>
<td>42 (40.4%)</td>
<td></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td>Male</td>
<td>59 (56.7%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>45 (43.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td>Full term</td>
<td>64 (61.5%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre term</td>
<td>40 (38.5%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Mean ± Standard Deviation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAPPE 2 score</td>
</tr>
<tr>
<td>APGAR score: 1 minute</td>
</tr>
<tr>
<td>APGAR score: 5 minute</td>
</tr>
<tr>
<td>Gestational age (week)</td>
</tr>
<tr>
<td>Birth weight (gram)</td>
</tr>
</tbody>
</table>

Total number of participants in ‘Control Group’: 104 neonates
Pre-intervention: Rate of Extravasation Injuries

1. Peripheral intravenousous catheter
   a) Number in-situ: 300
   b) PIV days: 855
   c) Number of extravasation: 12
   d) Rate of extravasation injuries per 1,000 PIV catheter days:
      \[
      \frac{12}{855} \times 1,000 = 14.035 \text{ per 1,000 catheter day}
      \]
### Post-intervention: Rate of Extravasation Injuries

#### Characteristics of Neonates (Intervention Group)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequency (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of care</strong></td>
<td></td>
</tr>
<tr>
<td>Special care baby unit (SCBU)</td>
<td>65 (59.6%)</td>
</tr>
<tr>
<td>Neonatal intensive care unit (NICU)</td>
<td>44 (40.4%)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>56 (51.4%)</td>
</tr>
<tr>
<td>Female</td>
<td>53 (48.6%)</td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td></td>
</tr>
<tr>
<td>Full term</td>
<td>65 (59.6%)</td>
</tr>
<tr>
<td>Pre term</td>
<td>44 (40.4%)</td>
</tr>
</tbody>
</table>

#### Mean ± Standard Deviation

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAPPE 2 score</td>
<td>21.93 ± 17.71</td>
</tr>
<tr>
<td>APGAR score: 1 minute</td>
<td>8.6 ± 1.81</td>
</tr>
<tr>
<td>APGAR score: 5 minute</td>
<td>8.96 ± 1.12</td>
</tr>
<tr>
<td>Gestational age (week)</td>
<td>36.47 ± 4.65</td>
</tr>
<tr>
<td>Birth weight (gram)</td>
<td>2528.11 ± 918.1</td>
</tr>
</tbody>
</table>

**Total number of participants in ‘Intervention Group’: 109 neonates**
Post-intervention: Rate of Extravasation Injuries

1. Peripheral intravenous catheter
   a) Number in-situ: 312
   b) PIV days: 1033
   c) Number of extravasation: 3
   d) Rate of extravasation injuries per 1,000 PIV catheter days:

   \[
   \frac{3}{1033} \times 1,000 = 2.9 \text{ per 1,000 catheter day}
   \]
## Homogeneity of Study Groups

| Characteristics of Neonatal participants | Control Group  \(N = 104\) Frequency (percent) | Intervention Group  \(N = 109\) Frequency (percent) | \(\chi^2\)  
\(P\) value |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>45 (43.3%)</td>
<td>53 (48.6%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>59 (56.7%)</td>
<td>56 (51.4%)</td>
<td>0.433</td>
</tr>
<tr>
<td>Level of care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCBU</td>
<td>62 (59.6%)</td>
<td>65 (59.6%)</td>
<td></td>
</tr>
<tr>
<td>NICU</td>
<td>42 (40.4%)</td>
<td>44 (40.4%)</td>
<td>0.998</td>
</tr>
<tr>
<td>Maturity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full term</td>
<td>64 (61.5%)</td>
<td>65 (59.6%)</td>
<td></td>
</tr>
<tr>
<td>Preterm</td>
<td>40 (38.5%)</td>
<td>44 (40.4%)</td>
<td>0.776</td>
</tr>
<tr>
<td>Mode of delivery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous vaginal</td>
<td>47 (45.2%)</td>
<td>40 (36.7%)</td>
<td></td>
</tr>
<tr>
<td>Cesarean section</td>
<td>40 (38.5%)</td>
<td>47 (43.1%)</td>
<td>0.618</td>
</tr>
<tr>
<td>Vacuum extraction</td>
<td>16 (15.4%)</td>
<td>20 (18.3%)</td>
<td></td>
</tr>
<tr>
<td>Assisted breech</td>
<td>1 (0.90%)</td>
<td>2 (1.90%)</td>
<td></td>
</tr>
<tr>
<td>Vesicant administration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>11 (10.6%)</td>
<td>17 (15.6%)</td>
<td>0.278</td>
</tr>
<tr>
<td>No</td>
<td>93 (89.4%)</td>
<td>92 (84.4%)</td>
<td></td>
</tr>
<tr>
<td>Types of IV line in situ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIV only</td>
<td>78 (75%)</td>
<td>78 (71.6%)</td>
<td>0.571</td>
</tr>
<tr>
<td>PIV and central line</td>
<td>26 (25%)</td>
<td>31 (28.4%)</td>
<td>15</td>
</tr>
</tbody>
</table>
## Homogeneity of Study Groups

<table>
<thead>
<tr>
<th>Characteristics of Neonatal participants</th>
<th>Control Group ((N = 104)) Mean ± Standard Deviation</th>
<th>Intervention Group ((N = 109)) Mean ± Standard Deviation</th>
<th>(P) value</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (gram)</td>
<td>2587.07 ± 950.58</td>
<td>2528.11 ± 918.1</td>
<td>0.646</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>Gestational age (week)</td>
<td>36.8 ± 4.31</td>
<td>36.47 ± 4.65</td>
<td>0.687</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>SNAPPE 2 score*</td>
<td>20.86 ± 22.76</td>
<td>21.93 ± 17.71</td>
<td>0.527</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>APGAR score (1 minute)</td>
<td>8.82 ± 1.82</td>
<td>8.6 ± 1.81</td>
<td>0.398</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>APGAR score (5 minute)</td>
<td>8.89 ± 1.43</td>
<td>8.96 ± 1.12</td>
<td>0.842</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>Number of PIV</td>
<td>2.88 ± 2.85</td>
<td>2.86 ± 2.96</td>
<td>0.854</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>PIV days</td>
<td>8.22 ± 8.761</td>
<td>9.48 ± 8.785</td>
<td>0.022</td>
<td>Independent (t)-test</td>
</tr>
<tr>
<td>Number of PIV extravasation</td>
<td>0.1304 ± 0.3443</td>
<td>0.0345 ± 0.1857</td>
<td>0.012</td>
<td>Mann-Whitney</td>
</tr>
</tbody>
</table>

* NICU patients only
### Homogeneity of Study Groups

<table>
<thead>
<tr>
<th>Characteristics of Neonatal participants</th>
<th>Pre-intervention ($N = 104$) Frequency (percent)</th>
<th>Post-intervention ($N = 109$) Frequency (percent)</th>
<th>$\chi^2$</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects with PIV extravasation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12 (11.5%)</td>
<td>3 (2.8%)</td>
<td></td>
<td><strong>0.012</strong></td>
</tr>
<tr>
<td>No</td>
<td>92 (88.5%)</td>
<td>106 (97.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity of PIV extravasation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0 or 1</td>
<td>92 (88.5%)</td>
<td>106 (97.2%)</td>
<td></td>
<td><strong>0.066</strong></td>
</tr>
<tr>
<td>Grade 2</td>
<td>6 (5.8%)</td>
<td>3 (2.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>4 (3.8%)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>2 (1.9%)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rate of Peripheral Intravenous Extravasation Injuries

• Pre-intervention:
  – 14.04 per 1,000 peripheral intravenous catheter days

• Post-intervention:
  – 2.904 per 1,000 peripheral intravenous catheter days

• Logistic regression:
  – Adjusted odds ratio in post-intervention period:
    – 0.2 (95% CI 0.05-0.74; \( p=0.016 \))

• Benchmark with international children’s hospital:
  – Rate ranged from 3.4 to 7.1 per 1,000 catheter days
    (Major & Huey, 2016; Tofani et al., 2012)
Conclusion

Compare to control group, there is a significant reduction of rate of neonatal extravasation injuries after implementation of the CPG

Rate of extravasation injuries: comparable with international children’s hospitals

Multidisciplinary collaboration: Key to mitigate the risk
Thank You