Preventing IntraVenous Extravasation Injuries

Cincinnati Children’s Vascular Access Team

- Neil Johnson, MD
- Barb Tofani, RN, MSN
- Sylvia Rineair, RN, MSHA, VA-BC
- Mary Haygood, RN, BSN
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“No-one Has All The Answers”

CHA Webinar February 2013
Objectives

• Describe Cincinnati’s 4 Year I/V Extravasation Harm Reduction Initiative

• Describe Our 3 Phase Strategy
  – Reliable Hourly Bedside I/V Checks
  – Evidence Based 3 Tier Med Tissue Risk Stratification
  – “No Grade” 2 Component Assessment / Documentation Tool

• Discussion and Sharing
Outline

• The Cincinnati Children’s Safety Environment
• Definitions
• Mechanisms of Extravasation Injury
• Reliable Hourly I/V Checks (Volume / Swelling)
• Medication Risk Stratification (Tissue Toxicity)
• 2 Component Extravasation Assessment Tool
• Goodbye Grading: Why We Divorced “Grading”
Outline cont’d

- Treatment, Feedback and Accountability
- Other Extravasation Assessment Systems
- Results
- Questions and Discussion
CCHMC Safety Culture

Patient Safety First

At Cincinnati Children’s, we believe that keeping our patients and employees safe is a precondition for everything we do. Safety is central to delivering the best-in-class outcomes we are committed to and is a fundamental right of the parents who bring their children to us for care. It is the reason we ask patients and families to sit on our boards, participate in our improvement work and help us design care delivery. We hope they will push us out of our comfort zone and eradicate a common belief in healthcare – that harm is an eventuality that comes with taking care of very sick kids. Stephen Muething, MD, vice president of safety, leads our efforts.

Manager's Safety Toolbox

- 2012 Culture Survey Results
- 2011 Culture Survey Results
- Think Safety, Talk Safety
- Aparent Cause Analysis (ACA)
- Dr. Steve's Journal
- Submit a Safety Story
- Manager SSE Post Event
- Patient Safety Video Toolkit

Patient Safety Program Information

- Daily Safety Brief (secured)
- ASSERT Project Overview
- Patient Safety Training
- ELM-Login

National Patient Safety Goals

- 2011 National Patient Safety Goals

Safety Videos

- Be a Soaper Hero. Clean Your Hands
  "How you too can be a Soaper Hero!"
- Patient Safety Video
- Safety in Three Words Video
- Daily Safety Brief
- Reducing Serious Safety Events
  "Learn what CCHMC plans to do!"

Safety News

- Tenets of Surgical Safety
- Surgical Safety Mission Statement
- Commitment to Patient Safety
  "What does that look like?"
- Count Policy
- AHA Pals Information
- PIV Extravasation Grading Scale
- Peripheral Venous Infusion Risk

Codes/MRT/CPR Committee

- CPR/MRT Communications
- Monitor Oversight
  Under Development

Behavioral Observation Tool

- e-BOT link
- e-BOT Tutorial
- Paper BOT

Resources and Tools

- ISMP Medication Safety Alert Newsletter
- ISMP Nurse Advise-ERR Newsletter
Serious Safety Events

A serious safety event (SSE) is a variation from expected practice followed by death, severe permanent harm, moderate permanent harm, or significant temporary harm.

Why This Measure Is Important
Our goal is to eliminate all serious harm to our patients.

How We Measure
To measure SSEs, we use a standard definition that has been adopted by the Ohio Children’s Hospitals' Solutions for Patient Safety (SPS) collaborative. For a given period, the total number of SSEs identified is divided by the sum of the adjusted patient days (inpatient days plus “equivalent” outpatient days) and multiplied by 10,000. A rolling 12-month average of SSEs per 10,000 adjusted days is calculated monthly. The chart below displays a moving average of the quarterly rate to reflect the historical downward trend of the serious safety event rate.
CCHMC Safety

• CCHMC Board Takes Active Ownership
• Major Focus of Hospital
• Anderson Center
  – Academic and Operational Safety Center
• Serious Safety Events
  – Executive Cabinet Investigations
  – Prevention Plan
  – Multiple Issues Raised
The Vascular Access Team at CCHMC

“Integrated” Executive Management

Patient Services | Pediatrics | Anesthesia | Radiology | Surgery

Barb Tofani R.N.  
Senior V.P.  
Peri-Operative Services

Neil Johnson M.D.  
Medical Director  
Vascular Access

Mary Haygood RN  
Clinical Manager,  
Vascular Access

Sylvia Rineair RN  
Clinical Director,  
Vascular Access

Interventional Radiologists

Peripheral I/V Group  
Central Vascular Catheter Group  
PICC Group
CCHMC infusion and Vascular Access Governance (iVAG)

Cabinet Sponsors
• Medical Members of Cabinet
• Bob Carpenter J.D.

Leadership Group
• Barb Tofani R.N.
• Neil Johnson M.D.
• Sylvia Rineair R.N
• Mary Haygood R.N.
• Tracey Blackwelder
• Darcy Doellman R.N.
• Derek Wheeler M.D.
• Denise Adams M.D.
• Vicki DeCastro, RN
• John Hingl RPH
• Ranjit Chima M.D.
• Steve Muething M.D.
• Rich Falcone M.D.
• Sam Kocoshis M.D.
• Lauren Solan M.D.

Permanent Working Groups

ADHOC Working Groups
Example:
PIV Infusion Working Group
R/Y/G List

Devices
Operations and Safety
Blood Stream Infections
Process Improvement and Monitoring
Training Education Public Relations
Research

Leadership Group
Sylvia Rineair R.N
Mary Haygood R.N.
Tracey Blackwelder
Darcy Doellman R.N.

Bi-Monthly

Leadership Group
Derek Wheeler M.D.
Denise Adams M.D.
Vicki DeCastro, RN
John Hingl RPH
Ranjit Chima M.D.
Steve Muething M.D.
Rich Falcone M.D.
Sam Kocoshis M.D.
Lauren Solan M.D.

January 25, 2011
Outline

- The Cincinnati Children’s Safety Environment
- Definitions
  - Mechanisms of Extravasation Injury
  - Reliable Hourly I/V Checks (Volume / Swelling)
  - Medication Risk Stratification (Tissue Toxicity)
  - 2 Component Extravasation Assessment Tool
  - Goodbye Grading: Why We Divorced “Grading”
Definition

- **HARM**
  - Institute for Healthcare Improvement (IHI)
    - “Unintended physical injury resulting from medical care…”
  - Canadian Disclosure Guidelines (JAMA 2012 Vol307 #20)
    - “an outcome that negatively affects a patient’s health / quality of life…”
CCHMC I/V Extravasation HARM

**MILD HARM**  
Any of the Following:
- Discoloration at or near PIV Site
- Swelling < 60% (X/Y)
- Redness
- GREEN List Medication
- YELLOW List Medication

**MODERATE HARM**  
Any of the Following:
- Any number of Blisters
- Swelling > 60%
- Impaired Limb Function < 48 Hours
- RED List Medication

**SEVERE HARM**  
Any of the Following:
- Distal Arterial Compromise (No palpable distal pulse, Cap Return > 8 seconds, Skin Ischemia)
- Fasciectomy
- Skin Graft or Tissue Transfer at any time after Extravasation Event
- Impaired Limb Function > 48 Hours

Note: This harm assessment applies to harm caused:
- Up to 72 hours after PIV Extravasation for Mild – Moderate Category findings
- At ANY time after PIV Extravasation for SEVERE Harm Category findings.
Definition

- SAFETY

Institute of Medicine (2000): 
“….no commonly accepted definition of the safety net exists…..”

Institute of Medicine, 2000 America’s Health Care Safety Net: Intact but Endangered. National Academy Press p3-4
Definition

• **SAFETY:**
  CCHMC Vascular Access Team (VAT)
  – The Processes, Policies, People and Systems which seek to:
    • **AVOID** Unnecessary Risk
    • **MINIMIZE** Necessary Risk

“NOTHING in Life or Medical Practice is Risk Free”
The ONLY way to achieve Zero Risk is to close the Hospital
Definition

• **EXTRAVASATION** Vs Infiltration
  
  – We Only Use The Word “**EXTRAVASATION**”
  
  • EXTRA = “Out Of or Outside”
  
  • VASCULAR = Vessel

  • **EXTRAVASATION** = “Out of the Vessel”

“Infiltration” better used to refer to purposeful injection of fluids

Example:
“The skin was infiltrated with Xylocaine solution before incision”
Definition

- **VESICANT**
  - An agent that causes **Blistering**
  - Originally a Chemical Warfare Term
    • e.g. Mustard Gas

Serious PIV Harm May **NOT** Involve **BLISTERING**

Therefore: The Word “VESICANT” not used at CCHMC
Outline

- The Cincinnati Children’s Safety Environment
- Definitions

**Mechanisms of Extravasation Injury**
- Reliable Hourly I/V Checks (Volume / Swelling)
- Medication Risk Stratification (Tissue Toxicity)
- 2 Component Extravasation Assessment Tool
- Goodbye Grading: Why We Divorced “Grading”

- **TOXICITY** (Local Tissue)
  - Osmolality
  - pH (Acid – Base)
  - Biological Activity

- **VOLUME** (Pressure)
Mechanisms of Extravasation Injury

- **OSMOLALITY**
  - Non-Isotonic Solutions Destroy Cells / Tissue

  ![Diagram showing the effects of hypertonic, isotonic, and hypotonic solutions on a cell.](https://via.placeholder.com/150)

  **EXAMPLES:** TPN, 8.4% Na Bicarbonate, 20% Dextrose

- **TOXICITY** (Local Tissue)
  - Osmolality
  - pH (Acid – Base)
  - Biological Activity

- **VOLUME** (Pressure)
Mechanisms of Extravasation Injury

• **pH** (Acid – Base)
  – Blood pH = 7.4
  – High or Low pH
  • Damages Proteins and Kills Cells

  – $\text{pH} = - \log_{10} [H^+]$
  • pH = 5 is 10 times more acidic than pH=6

• **TOXICITY** (Local Tissue)
  – Osmolality
  – pH (Acid – Base)
  – Biological Activity
• **VOLUME** (Pressure)
Mechanisms of Extravasation Injury

- **BIOLOGICAL ACTIVITY**
  - Vasopressors (Epinephrine / Dopamine)
    - CONSTRICT vessels
  - Chemotherapy Drugs
    - KILL Cells (!)
  - Other

- **TOXICITY** (Local Tissue)
  - Osmolality
  - pH (Acid – Base)
  - Biological Activity

- **VOLUME** (Pressure)
Mechanisms of Extravasation Injury

• **VOLUME**
  - Massive Amounts of I/V Fluid in Tissues
  - Compartment Syndrome
    • Fluid Pressure Occludes Veins
    • Venous Occlusion → More Swelling
    • Progressive Swelling → Arterial Compromise
    • Dead Limb

Our WORST Extravasation Injury was caused by Normal Saline
Outline

- The Cincinnati Children’s Safety Environment
- Definitions
- Mechanisms of Extravasation Injury

**Reliable Hourly I/V Checks (Volume)**
- Medication Risk Stratification (Tissue Toxicity)
- 2 Component Extravasation Assessment Tool
- Goodbye Grading: Why We Divorced “Grading”

**MINIMIZE** Necessary Risk

**AVOID** Unnecessary Risk

- **TOXICITY** (Local Tissue)
  - Osmolality
  - pH (Acid – Base)
  - Biological Activity
- **VOLUME** (Pressure)
Quality Improvement Project to Reduce Infiltration and Extravasation Events in a Pediatric Hospital

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Key words: Peripheral venous infusion injury; Infiltration; Extravasation; Quality improvement; Safety

A safety event response team at Cincinnati Children's Hospital Medical Center developed and tested improvement strategies to reduce peripheral intravenous (PIV) infiltration and extravasation injuries. Improvement activities included development of the touch–look–compare method for hourly PIV site assessment, staff education and mandatory demonstration of PIV site assessment, and performance monitoring and sharing of compliance results. We observed a significant reduction in the injury rate immediately following implementation of the interventions that corresponded with monitoring compliance in performing hourly assessments on patients with a PIV, but this was not sustained. The team is currently examining other strategies to reduce PIV injuries.

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Strategies

• Peripheral I/V (PIV) Policy Revision
• Nursing Staff Education
  – Significant Institution-Wide Effort
  – TLC Methodology for Hourly Checks
• Nursing Unit Manual Hourly Checks AUDIT
  – >90% Compliance (after 3 months) → STOP Manual Audit
  – <90% Compliance → Continue Audit until >90% Achieved
• PROBLEMS:
  – Manual Data Collection
  – Variable Documentation
  – Two Electronic Data capture Systems

• TOXICITY (Local Tissue)
  – Osmolarity
  – pH (Acid – Base)
  – Biological Activity

• VOLUME (Pressure) Reliable Hourly Checks
Result: Good But Not Sustained

- TOXICITY (Local Tissue)
  - Osmolality
  - pH (Acid – Base)
  - Biological Activity

- VOLUME (Pressure) Reliable Hourly Checks
New Efforts: Reliable Hourly Checks

- **EPIC** EMR Implemented
  - All I/V Documentation now in ONE place
  - 18 month VAT – IT Project
- >60% Extravasation = 1 Month Manual **Audit**
  - Unpopular!
- Immediate **Feedback** System
- “Personal **Interview**” (>60%)

- **TOXICITY** (Local Tissue)
  - Osmolarity
  - pH (Acid – Base)
  - Biological Activity

- **VOLUME** (Pressure) Reliable Hourly Checks
New Efforts: Immediate Feedback System

- Supports Reliable Hourly Checks (Volume)
- Supports “R” Medication Injury Prevention (Toxicity)

• Automated (EPIC) Digital Messaging to VAT leadership and PIV team
  – Extravasations >30%
  – Any Amount of “R” drugs

• VAT Nurse (24/7) Visits Unit
  – Immediate FEEDBACK TO THE PERSON(S) RESPONSIBLE
  – Early Treatment (If Appropriate)
  – Educational Opportunity
  – Intelligence Gathering for Analysis by VAT Improvement Team

Extravasation Alert: X / Y Ratio 65%
Room: B4103
Unit: B4N

- TOXICITY (Local Tissue)
  – Osmolality
  – pH (Acid – Base)
  – Biological Activity
- VOLUME (Pressure)
“Instant” Pager Notification
New Efforts: Personal Interview

• ALL VOLUME Extravasations >60%
  – Detailed Report Required from Unit Manager
  – **Personal Interview** (Tofani-Johnson-Rineair)
    • Bedside Nurse(s) Involved
    • Unit Manager

• **TREND:**
  – Marked Decrease in >60% Fluid Extravasations
  – Most now “justifiable” or exceptional
  – Still Not Acceptable (O.R. Under Drapes etc.)

*TOXICITY* (Local Tissue)
- Osmolality
- pH (Acid – Base)
- Biological Activity

*VOLUME* (Pressure) Reliable Hourly Checks
Compare Is SO Important

Pager Feedback Strategy Identified “Compare” Not Done Reliably
“Compare” Not Done Reliably

- Recent Change: Evidence Based

→ So.... TLC Poster Revised

TLC

Touch • Look • Compare to prevent harm

TOXICITY (Local Tissue)
- Osmolality
- pH (Acid – Base)
- Biological Activity

VOLUME (Pressure)
Reliable Hourly Checks

• TOUCH (TOQUE)
  Touch every 60 Minutes
  IV should feel:
  Soft
  Warm
  Dry
  Pain Free

• LOOK (MIRE)
  Look every 60 Minutes
  IV site should be:
  Uncovered
  Dry
  Without Redness

• COMPARE (COMPARE)
  Compare every 60 Minutes
  IV Checks must happen even when asleep
  Los controles deben hacerse mientras duerme

Call your nurse if you notice anything wrong or if you have questions or concerns.
Llame a la enfermera si ve que algo no está bien o si tiene dudas o inquietudes
Outline

- Cincinnati Children’s Safety Environment
- Definitions
- Mechanisms of Extravasation Injury
- Reliable Hourly I/V Checks (Volume)

- 3 Tier Medication Risk (Local Toxicity)
- 2 Component Extravasation Assessment Tool
- Why No Grading??

“AVOID Unnecessary Risk”
MINIMIZE necessary risk
• Medication Risk Stratification
  – 18 Month Project
  – Multi-Disciplinary
  • Pharmacy
  • Nursing (VAT)
  • Physicians
  • Evidence Based Expert
  • Nutrition Service
  • NICU

Venous Infusion Extravasation Risk

This is an estimated risk for patients or health care encountered in extravasation from any antivascular infusion device. Risk derived from available evidence, COCHC data and COCHC expert opinion, subject to review and change as further evidence becomes available. Refer to COCHC Policy PTE 8-112 for information.

Red – Higher Risk
- Acyclovir
- Amiodarone
- Caffeine Citrate
- Calcium (Oxalate)
- Dextrose >12.5%
- Doxycycline
- Esmolol
- Mannitol 20% & 28%
- Promethazine
- Potassium >60 mEq/L
- Sodium bicarbonate
- Sodium chloride ≥ 3%
- TPN > 950 mL/24 hr

Yellow – Intermediate Risk
- Acetazolamide
- Alopurinol
- Amikacin
- Amphotericin B (conventional)
- Arginine
- Ciprofloxacin
- Dextrose 10% ≤ 12.5%
- Dextrose
- Erythromycin
- Ganciclovir
- Lonazepam
- Midazolam
- Morphine
- Ondansetron
- Nafcillin
- Non-Ionic Radiology Contrast
- Phenobarbital
- Phenytoin
- Potassium ≤ 60 mEq/L
- TPN ≤ 500 mL/24 hr

Green – Lower Risk
- Amoxicillin/Clavulanate
- Ampicillin
- Ampicillin/ Sulbactam
- Cefixime
- Ceftriaxone
- Cefotetan
- Cefotaxime
- Cefuroxime
- Cloxacillin
- Chlorhexidine
- DILR
- Dextrose < 10%
- Fentanyl
- Piroxicam
- Famotidine
- Ondansetron
- Herpan
- Sugammadex
- TPN
- Lactated Ringer’s
- Lidocaine
- Magnesium Sulfate
- Mesna
- Methotrexate
- Methylprednisolone
- Normal saline
- Pentazocine
- Piperacillin
- Piperacillin/Tazobactam
- Tobramycin

Chemotherapy Drugs
- Extravasation treatment: Refer to policy PTE 8-113

Cabinet Sponsors
- Medical Members of Cabinet
- Mike Carpenter J.D.

Leadership Group
- Rakesh Desai M.D.
- Alley Hegard R.N.
- Tracy Beedle, RN
- Larry Oehrtman, M.D.
- John Harrison Ph.D.
- Peter Righetti, M.D.

Permanant Working Groups
- Admission/ Discharge
- Infection
- Inpatient/ Outpatient
- Equipment
- Process Improvement
- Nursing
- Research

Cincinnati Children’s Hospital Medical Center
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change the outcome
Medication Risk Stratification

- Literature Evidence Search
- **MEASUREMENT**
  - pH
  - Osmolarity
- Measurements of COMMON Pediatric Formulations
- Blood Products Excluded
  - Blood = Bruise
  - Not Tissue Toxic

### TOXICITY (Local Tissue)
- Osmolarity
- pH (Acid – Base)
- Biological Activity

### VOLUME (Pressure)

---

**Venous Infusion Extravasation Risk**

- **Red**
  - Higher Risk
    - Acrizolamine
    - Amikacin
    - Caffeine Citrate
    - Calcium (All Salts Form)
    - Dextrose > 25%
    - Doxycline
    - Exmolol
    - Mannitol 20% & 25%
    - Premethazine
    - Potassium > 60 mEq/L
    - Sodium Bicarbonate
    - Sodium Chloride > 3%
    - TPN > 500 mL/24h
    - Vasopressors such as Dopamine
  - CHEMOTHERAPY DRUGS
    - Refer to policy P&I 20-612

- **Yellow**
  - Intermediate Risk
    - Acetaminophen
    - Amikacin
    - Anadren
    - Anaphylaxis B (Conventional)
    - Arginine
    - Captopril
    - Dextrose 10% to 33.3%
    - Dexamethasone
    - Ergonovine
    - Ganciclovir
    - Lorazepam
    - Methylprednisolone
    - Morphine
    - Chlorpromazine
    - Naloxone
    - Non-Ionic Radiology Contrast
    - Phenobarbital
    - Phenylbutazone
    - Potassium > 60 mEq/L
    - TPN > 500 mL/24h
    - Vancomycin

- **Green**
  - Lower Risk
    - Amikacin:
    - Amphenol
    - Ampicillin
    - Anadren
    - Arginine
    - Captopril
    - Cefazolin
    - Ceftriaxone
    - Cefuroxime
    - Chloramphenicol
    - Cloxacillin
    - Dexamethasone
    - Doxycycline
    - Durexan
    - Erythromycin
    - Fluconazole
    - Gatifloxacin
    - Gentamicin
    - Isoniazid
    - IVIG
    - Lassaspine
    - Lopinavir
    - Loprin
    - Magnesium suflate (Intra)
    - Melphalan
    - Methotrexate
    - Methylenetetrahydrofolate
    - Neomycin
    - Norfloxacin
    - Penicillin
    - Phenytoin
    - Piperacillin
    - Piperacillin-Tazobactam
    - Pravastatin
    - Proton pump inhibitors
    - Methotrexate
    - Thalidomide

**RED Criteria**
- pH < 5 or > 9
- Strong Published Evidence
- >950 Mili Osmoles
Reducing Risk of Harm From Extravasation

A 3-Tiered Evidence-Based List of Pediatric Peripheral Intravenous Infusates

**Abstract**

Extravasation of medications during peripheral intravenous (PIV) therapy can result in harm to pediatric patients. These medications have physical and/or biologic factors that cause tissue damage. To assist in clinical decisions when using these infusates, an evidence-based table of medications stratified by their relative risk of causing harm if extravasated was developed. Local data and experience, a systematic review of the pediatric literature, and measured pH and osmolality of common pediatric preparations of PIV infusates were used to create a 3-tiered table of PIV infusates categorized by relative risk of causing harm if extravasated.

**Key words**: adverse effects, children, extravasation, infants, intravenous infusions, peripheral catheterization

**Table 4 Continued**

<table>
<thead>
<tr>
<th>Medication*</th>
<th>Harm</th>
<th>pH</th>
<th>OSM</th>
<th>CONC</th>
<th>DIL</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium (unknown concentration)</td>
<td>C</td>
<td>5</td>
<td>763</td>
<td>0.3 mEq/mL (900 mEq/L)</td>
<td>NS</td>
<td>11,16</td>
</tr>
<tr>
<td>Promethazine</td>
<td>F</td>
<td>4.8</td>
<td>213</td>
<td>25 mg/mL</td>
<td>D5W</td>
<td>39</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>C</td>
<td>7.8</td>
<td>932</td>
<td>0.5 mEq/mL</td>
<td>SW</td>
<td>1,10,12,20,28</td>
</tr>
<tr>
<td>Sodium chloride ≥3%</td>
<td>C</td>
<td>6.8</td>
<td>998</td>
<td>3%</td>
<td>SW</td>
<td>Concentrations not specified in the references</td>
</tr>
<tr>
<td>TPN ≥500 mOsm/L</td>
<td>F, C</td>
<td>Varies</td>
<td>≥150</td>
<td>NA</td>
<td>NA</td>
<td>*(≥500 mOsm/L in references (C, harm) [4,5])</td>
</tr>
<tr>
<td>Vasopressors such as dopamine (vasoactive)</td>
<td>F, C</td>
<td>2.9</td>
<td>997</td>
<td>80 mg/mL</td>
<td>D5W</td>
<td>Dobutamine in references [21,41]</td>
</tr>
<tr>
<td>Chemotherapy agents (cytotoxic)</td>
<td>F, C</td>
<td>Varies</td>
<td></td>
<td></td>
<td>Various</td>
<td>Various</td>
</tr>
</tbody>
</table>

**Intermediate risk**

- Acetazolamide
- Allopurinol
- Anaknac
- Amphotericin B (conventional)
- Arginine
- Ciprofloxacin
- Dextrose 10% to &le;12.5%
- Diazepam
- Erythromycin
- Fenofibrate
- Lorazepam
- Midazolam
- Morphine
- Neflin
- Nontonic radiographic contrast
- Ondansetron
- Phenobarbital

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Venous Infusion Extravasation Risk

This is an estimate of risk for phlebitis or local tissue injury due to extravasation from any intravenous infusion device. Risk derived from available evidence, CCHMC data and CCHMC expert opinion, subject to review and change as further evidence becomes available.

For Treatment of Extravasation, Refer to CCHMC Policy P&TII-112

This does not apply in situations of emergency medical treatment...

If a medication is not on this list, please refer to the CCHMC formulary or contact pharmacy (6-4291) for information.

Red
Higher Risk

- Acyclovir
- Amiodarone
- Caffeine Citrate
- Calcium (all salts forms)
- Dextrose > 12.5%
- Doxycycline
- Esmolol
- Mannitol 20% & 25%
- Promethazine
- Potassium > 60 mEq/L
- Sodium bicarbonate
- Sodium chloride > 3%
- TPN > 950 mOsm/L
- Vasopressors such as Dopamine

Yellow
Intermediate Risk

- Acetazolamide
- Allopurinol
- Analgin
- Amphotericin B (conventional)
- Arginine
- Ciprofloxacin
- Dextrose 10% to ≤12.5%
- Diazepam
- Erythromycin
- Ganciclovir
- Lorazepam
- Midazolam
- Morphine
- Ondansetron
- Nafcillin
- Non-Ionic Radiology Contrast
- Phenobarbital
- Phenytoin
- Potassium ≤ 60 mEq/L
- TPN ≤ 950 mOsm/L
- Vancomycin

Green
Lower Risk

- Aminophylline
- Amphotericin B Liposomal
- Ampicillin
- Ampicillin Sulbactam
- Cefazolin
- Cefoxime
- Cefotaxime
- Ceftazidime
- Ceftriaxone
- Clindamycin
- CSLR
- Dextrose < 10%
- Fentanyl
- Fosphenytoin
- Furosemide
- Gentamicin
- Heparin
- Imipenem
- IVIG
- Lactated Ringers
- Lipid
- Magnesium sulfate (soaks)
- Meropenem
- Methyleneblue
- Normal saline
- Pentamidine
- Piperacillin
- Tobramycin
- Piperacillin/tazobactam
- Ticarcillin
- Ticarcillin-clavulanate
- Tobramycin

*NOTE:
No intravenous infusion is "safe".
Gross extravasation, even of normal saline, may result in serious harm including compartment syndrome, causing ischemia and loss of tissue or permanent loss of limb function.

Peripheral Venous Access is defined as any Venous Access Device whose tip lies outside the Right Atrium, Superior / Inferior Vena Cava, or the Brachiocephalic Veins.

December 5, 2012
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Unexpected Positives

• Universal Availability R/Y/G
  – Every Computer Workstation
  – Every Pyxis etc.
  – Hard To Avoid

• Nurses Strongly Influence Doctor Behavior (!)
  – Trend → Central Access for Red Drugs
  – Increased Awareness of IV Risks of Red Drugs
  – “Pseudo Policies” are Sometimes a Positive Phenomenon
Outline

• The Cincinnati Children’s Safety Environment
• Definitions
• Mechanisms of Extravasation Injury
• Reliable Hourly I/V Checks (Volume / Swelling)
• Medication Risk Stratification (Tissue Toxicity)

• Goodbye Grading: Why We Divorced “Grading”
• 2 Component Extravasation Assessment Tool
Medical Grading Systems: Fractures

- Usually Based on
  - Severity
  - Treatment Pathways
  - Outcomes

- Type 1: Minor Injury
- Type 2: Almost Always Heals
- Type 3: Involves joint
- Type 4: High Risk
- Type 5: Disaster
Medical Grading Systems: Neuroblastoma

International Neuroblastoma Staging System (INSS)

1.  
2a.  
2b.  
3.  
4.  
4S.

Survival (%)

- Low MYCN (n = 30)
- High MYCN (n = 30)

P = 0.001

Months after diagnosis
The INS Grading System (Briefly)

- Grades 1-4
  - Mostly Descriptive
  - “Skin Blanched” is feature of ALL Grades
  - “Cool to Touch” is feature of THREE Grades

- Adult Based
  - Fixed Edema Measurements regardless of Ped. Patient Size

- Poor Outcome (Harm) Correlation for “Grades”
  - All Bad Outcomes are Grade 4 (Sensitive)
  - BUT….VERY Few Grade 4’s have Bad Outcome (NOT Specific)
    - (eg Small Amounts Vancomycin)

- Bundles TWO Separate Harm Components Into One “Grade”
  - Extravasated Fluid VOLUME (“Edema”)
  - MEDICATION (Local Tissue) TOXICITY (“Vesicant or Blood”)
The INS Grading System (Briefly)

- “Vesicant” Extravasation = Grade 4
  - 1ml or 100 ml
  - Same Grade, Very Different Outcomes
- No “Official” Vesicant List
  - “We Know It When We See It....”
Blood Products Dangerous = Grade 4?
Blood Products = Grade 4
The INS Grade 4 Problem

Assumption: Highest Grade = Highest Harm

- CCHMC Safety Leaders Assumed “GRADE 4” = “Serious Harm”
  - “It’s the HIGHEST Grade.. Why not??”
- Grade 4 PIV “Harm” was >40% of “Total Hospital Harm”
- Pressure on VAT to “Reduce Serious Harm” was Substantial

Extremely HIGH Sensitivity
Every Serious Harm = Grade 4

Very LOW Specificity
Very Few Grade 4 = Serious Harm
The INS Grading System

• No Longer Recommended by....... INS
• Grades Are Problematic for
  – Treatment Decisions
  – Institutional Harm Reduction Programs
• Grades Only Loosely Associated with OUTCOMES

See Excellent Discussion in:
Rodica Pop, PhD, RN
J. Infusion Nursing, Vol. 35, Number 4, July/August 2012
Children’s Medical Center, Dallas
Outline

- The Cincinnati Children’s Safety Environment
- Definitions
- Mechanisms of Extravasation Injury
- Reliable Hourly I/V Checks (Volume / Swelling)
- Medication Risk Stratification (Tissue Toxicity)
- Goodbye Grading: Why We Divorced “Grading”

- CCHMC
  - 2 Component
  - Extravasation Assessment / Coding Tool
CCHMC Extravasation Coding System

- Step 1 - VOLUME Measurement
- Step 2 - MEDICATION (If Any)
- Step 3 - DOCUMENTATION
Step 1: VOLUME

STEP 1: Volume

STEP 1a: Measure Swelling

Notes:
- Define edges of swelling by palpation/visual observation.
- Measure longest dimension.

STEP 1b: Measure ARM Length

Notes:
- Y = Axilla to tip of longest finger
- For Y measure arm length regardless of site of extravasation.
- NEVER measure leg or other body part.

STEP 1c: Calculate

\[
\left( \frac{X}{Y} \right) \cdot 100 = \square \%
\]
Step 1a:

- Measure Max Dimension
- Includes ANY Extravasation
  - PIV
  - PICC
  - CVC
  - PORT
  - Scalp / Chest
Step 1b:

- Measure **ARM Length**
  - Surrogate for Body Size

- “**Y**” is ARM length
  - Surrogate for Patient Body Size
  - Easy To Measure
  - Used for **ALL** Extravasations
  - Allows Consistent Quantification
    - Even If Extravasation is Scalp or Chest

If Patient has NO Arms:
Refer to CCHMC Policy #1
Step 1c: Calculate

\[
\left(\frac{X}{Y}\right) \cdot 100 = \% 
\]

Nurses USE Mobile Phone or…
CCHMC Online Calculator (In EPIC)
Step 2: MEDICATION

**EXTRAVASATION MEDICATION CODING**

- R = medication on RED list
- Y = medication on YELLOW list
- G = medication on GREEN list
- F = Fluids only (no medications or potassium)
- U = medication Unlisted
- N = medication not listed but causing harm similar to a RED drug (this category will rarely be needed)

**Notes:**

- "Extravasated Medication" means medication administered through the IV/CVC during the previous 2 hours, or since the last normal IV/CVC site check, whichever is longer.
- Refer to current Red/Yellow/Green listing (each new version has a different color border, consult latest version)
Step 3: DOCUMENT

- CCHMC Uses EPIC

STEP 3: Document immediately in EPIC

Notify Vascular Access Team as soon as possible if:

Volume $\geq$ 30%

and/or RED list Medication

Vascular Access Team Pager:

736-0337
Step 3: DOCUMENT

• Other Institutions

For outside hospitals, use this space to attach your local Documentation requirements.
Implementation

• BIG Education Effort
  – Julie Stalf, RN
  – Sylvia Rineair, RN
  – Mary Haygood, RN
  – Barb Tofani, RN

• CCHMC Education Team
Initial Validity Testing

• Validity and Repeatability
  – 100 patients coded using 2 Vascular Access Team (VAT) RNs assessing PIV site separately
  – Next phase 100 patients coded using 2 RNs assessing PIV site separately (one VAT and one unit RN)
Correlation: Bedside RN Versus VAT Team RN
First 50 Patients

Bedside RN vs Vascular Access RN: Edema Measurements

Difference in Edema Measurement vs Individual Patients
<table>
<thead>
<tr>
<th>% Swelling and Infusate Component</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Extravasation ( \geq 30% ) AND **Red list infusate</td>
<td><strong>TREAT</strong> unless very good reason not to</td>
</tr>
<tr>
<td>**Extravasation (&lt; 30% ) AND **Red list infusate</td>
<td>Clinical evaluation of the extravasation site by attending physician and Vascular Access Team or VAT Medical Director (or designee) to determine if <strong>Hyaluronidase</strong> is clinically indicated. Decision criteria include imminent skin loss, and / or peripheral circulation impairment (compartment syndrome).</td>
</tr>
<tr>
<td>**Extravasation ( \geq 30% ) AND **Yellow or **Green list infusate</td>
<td>Clinical evaluation of the extravasation site by attending physician and Vascular Access Team, Medical Director or designee to determine if <strong>Hyaluronidase</strong> is clinically indicated, but <strong>Hyaluronidase</strong> treatment usually <strong>NOT</strong> indicated.</td>
</tr>
<tr>
<td>**Extravasation (&lt; 30% ) AND **Yellow or **Green list infusate</td>
<td>No treatment indicated.</td>
</tr>
<tr>
<td><strong>Extravasation of any % of a Red list Vasoactive medication</strong> (Dopamine, epinephrine and related medications)</td>
<td><strong>Consult and TREAT:</strong> Rx Phentolamine PICU / NICU Attending Or Dr. Johnson</td>
</tr>
</tbody>
</table>

**In Plain English**

**TREAT** unless very good reason not to

Probably **TREAT** unless good reason not to

Probably **NOT** Treat unless good reason to do so

**NO Treatment**
Result: Hyaluronidase Rx

- $350
- 4-5 Needle Sticks
- Previously Widely Recommended
  - E.R. Small Saline Extravasation Event

- 75% DECREASED Use (Last 12 months)
  - No Serious Harm Events
CCHMC I/V Extravasation HARM

MILD HARM
Any of the Following:
- Discoloration at or near PIV Site
- Swelling < 60% (X/Y)
- Redness
- GREEN List Medication
- YELLOW List Medication

MODERATE HARM
Any of the Following:
- Any number of Blisters
- Swelling > 60%
- Impaired Limb Function < 48 Hours
- RED List Medication

SEVERE HARM
Any of the Following:
- Distal Arterial Compromise (No palpable distal pulse, Cap Return > 8 seconds, Skin Ischemia)
- Fasciotomy
- Skin Graft or Tissue Transfer at any time after Extravasation Event
- Impaired Limb Function > 48 Hours

Note: This harm assessment applies to harm caused:
- Up to 72 hours after PIV Extravasation for Mild – Moderate Category findings
- At ANY time after PIV Extravasation for SEVERE Harm Category findings.

OUTCOME or TREATMENT Based
Outline

- Other Extravasation Assessment Systems
  - Treatment, Feedback and Accountability
  - Results
  - Questions and Discussion
Other “Grading” Systems

A New Approach to Management of Intravenous Infiltration in Pediatric Patients
Ibrahim Amjad M.D. et.al.
J. Infusion Nursing Vol 34 #4 July / August 2011

<table>
<thead>
<tr>
<th></th>
<th>Millam</th>
<th>Infusion Nurses Society</th>
<th>Thigpen</th>
<th>Proposed Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage II</td>
<td>Grade 1</td>
<td>Stage 2</td>
<td>1st Degree</td>
</tr>
<tr>
<td></td>
<td>Stage III</td>
<td>Grade 2</td>
<td>Stage 3</td>
<td>2nd Degree</td>
</tr>
<tr>
<td></td>
<td>Stage IV</td>
<td>Grade 4</td>
<td>Stage 4</td>
<td>3rd Degree</td>
</tr>
</tbody>
</table>

- Focused on (Plastic Surgery) Treatment Decisions
- Determines TREATMENT Algorithm not PREVENTION
CMC Dallas System

- Sensible Pediatric Modification of INS
- Introduces “% SWELLING” Concept
- Uses MEASUREMENT

**Pediatric PIV Infiltration Scale**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No symptoms</td>
</tr>
<tr>
<td></td>
<td>Flushes with ease</td>
</tr>
<tr>
<td>1</td>
<td>Localized swelling (1%–40%)</td>
</tr>
<tr>
<td></td>
<td>Flushes with difficulty</td>
</tr>
<tr>
<td></td>
<td>Pain at site</td>
</tr>
<tr>
<td>2</td>
<td>Slight swelling at site (up to 1/4 of the extremity above or below site), or 10%–20% of the extremity above or below site</td>
</tr>
<tr>
<td></td>
<td>Presence of redness</td>
</tr>
<tr>
<td></td>
<td>Pain at the site</td>
</tr>
<tr>
<td>3</td>
<td>Moderate swelling at site (1/4 to 1/2 of the extremity above or below site), or 20%–50% of the extremity above or below site</td>
</tr>
<tr>
<td></td>
<td>Pain at site</td>
</tr>
<tr>
<td></td>
<td>Skin cool to touch</td>
</tr>
<tr>
<td></td>
<td>Blanche</td>
</tr>
<tr>
<td></td>
<td>Diminished pulse below site</td>
</tr>
<tr>
<td>4</td>
<td>Severe swelling at site (more than 1/2 of extremity above or below site), or more than 50% of the extremity above or below site</td>
</tr>
<tr>
<td></td>
<td>Infiltration of blood products, leukotrienes, and/or vasoactive substances (any amount of swelling)</td>
</tr>
<tr>
<td></td>
<td>Skin cool to touch</td>
</tr>
<tr>
<td></td>
<td>Blanche</td>
</tr>
<tr>
<td></td>
<td>Skin breakdown or necrosis</td>
</tr>
<tr>
<td></td>
<td>Diminished or absent pulse</td>
</tr>
<tr>
<td></td>
<td>Pain at site</td>
</tr>
<tr>
<td></td>
<td>Capillary refill &gt; 4 seconds</td>
</tr>
</tbody>
</table>

**A Pediatric Peripheral Intravenous Infiltration Assessment Tool**

**ABSTRACT**

Infiltration is a common complication of Intravenous (IV) therapy. The use of adequate tools for IV assessment can identify infiltration in its early stages, thus reducing the potential for more serious complications. Assessment of IV devices in children needs to be performed using age- and size-appropriate tools that take into account children’s smaller size and particular characteristics. It is also important to consider the site of an infiltration in relation to the affected venous system. This article discussed the development of a pediatric IV assessment tool as well as its psychometric properties.

**BACKGROUND**

In 1999, the Intravenous Nurses Society, pioneers of the concept of peripheral intravenous infiltration, published their guidelines. These guidelines focused on the prevention of infiltration, but did not address the management of infiltration once it occurs. The pediatric population is particularly at risk for infiltration, with studies showing a higher incidence in children than in adults. Additionally, children’s smaller size and anatomy make it more difficult to accurately assess infiltration. Therefore, the development of a pediatric IV assessment tool is crucial for the early identification and management of infiltration complications. 

**METHODS**

A qualitative study was conducted to assess the effectiveness of the pediatric IV assessment tool. The tool was administered to a group of pediatric patients with IV devices, and the results were compared to the actual occurrence of infiltration. The study found that the tool was able to accurately identify infiltration in 90% of cases. Additionally, the tool was able to predict infiltration in 80% of cases, allowing for early intervention and prevention of complications. 

**CONCLUSIONS**

The pediatric IV assessment tool has been shown to be effective in identifying and predicting infiltration in children. It is important for nurses to use this tool in order to reduce the potential for complications and improve patient outcomes.
CMC Dallas System

Similar Issues to INS Grading:
Mixes VOLUME and Medication local TOXICITY in one scale
No “Vesicant” List
Blood is NOT Dangerous Over and Above the Volume Issue
ANY Amount of “Vesicant” $\rightarrow$ Immediate GRADE 4
Makes it Difficult to Show IMPROVEMENT (e.g. Hourly Checks)
Discourages Improvement Project Participants
DISCUSSION:

It is equally important to develop vesicant lists and to assess a vesicant’s potential to cause harm when infiltration of these agents occurs.
DISCUSSION:

The development of interventions and treatment algorithms for PIV infiltration complications may be more important than assigning a grade. This discussion was particularly interesting in light of the new *Infusion Nursing Standards of Practice* published by INS.\(^{20}\) Grading is no longer recommended as part of the PIV assessment, perhaps suggesting that the assignment of a grade may be of less significance than previously believed.

A combination of assessment and intervention tools tailored to pediatric patients may reduce pain and suffering associated with PIV infiltration, improve patient satisfaction and outcomes, and also have financial benefits.

We Agree
Results: Calendar 2012

- **ZERO** Severe Harm
- **Moderate Harm** = 0.55/1000 Line Days
- **Red Drugs**
  - Most PIV Red Drugs Now Only Given PIV in Code Situations → ? Early Intraosseous Rx
  - **BUT:**
    - New EPIC Data System (3 months)
    - Complete data but not yet analyzed

“No one has all the answers. Severe Harm is only one slip up away”
Population: All patients admitted to an inpatient unit who had a PIV during their stay
Line day calculation: Each line is counted once for every day it is in place including the day of placement/admission and removal/discharge. A line counts as one line day regardless of the length of time the line is in place during that day
Infiltrate calculation: Every infiltrate is counted that occurs from the time a patient arrives on an inpatient unit until discharged from the hospital
Documents Available:

- http://cincinnatichildrens.org/vascularaccess
Summary

- **Primary CCHMC Institutional Safety Focus:**
  - Serious Harm **PREVENTION**
  - CCHMC Data Centric Standardized Institutional Improvement Requirement

- **INS 1-4 PIV Grading System Inhibited Improvement Success**

- We Separated **VOLUME** and **TOXICITY** Harm Components

- **New Assessment Tool Developed for ALL I/V Extravasations**
  - No “Grading” Continuous Numerical Scale (% Swelling - Volume)
  - Eliminates Vague Descriptive Components
  - Automatically Accounts for Pediatric Body Size (Ratio X/Y)
  - Evidence Based Three Tier Stratification of Med Toxicity Risk (RYG)

- **PRIMARY Focus is PREVENTION** of I/V Injuries
  - “No Treatment Required if Injuries PREVENTED or Minimized”

- **AVOID** Unnecessary Risk
- **MINIMIZE** Necessary Risk
Thanks

• iVAG (Our Governance Group)
• The Whole Extraordinary CCHMC VAT Team
• Dallas Children’s Vascular Access Team
• John Racadio MD
  – “Neil... Why Don’t You Just Abolish Grading ???”
• Glen Minano – Graphics
• Darcy Doellman RN – RYG list Initiative
• Marshall Ashby Quality Improvement Consultant
• Steve Muething MD
  – Vice President of Safety, CCHMC

Manuscript Submitted:
J. Infusion Nursing, January 2013
Questions?????