

## *FACTORS INFLUENCING SKIN NECROSIS RESULTING FROM EXTRAVASATION INJURIES AND THE THERAPEUTIC APPROACHES IN THE PEDIATRIC INPATIENT WARD (JANUARY-DECEMBER 2019)*

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### ABSTRACT

**Introduction:** Extravasation injury, a common complication of intravenous therapy in children, Interestingly, the complications arising from extravasation injuries could be more severe than the underlying medical conditions, sometimes even requiring amputation. The study aimed to identify the factors influencing the occurrence of skin necrosis due to extravasation injuries and to categorize the treatment approaches employed at Dr. Soetomo General Academic Hospital's pediatric facility in Surabaya from January to September 2019.

**Methods:** This research takes a descriptive-analytic approach with a cross-sectional method. It involves examining data obtained from medical records. Specifically, the study focuses on the medical records of 44 pediatric patients who received treatment at Dr. Soetomo Hospital in Surabaya for skin necrosis resulting from extravasation injuries from January to December 2019. The analysis includes a retrospective review of patient information, looking at their characteristics, risk factors, the modalities used for wound care therapy, and the outcomes of their cases.

**Results:** There were 44 cases of skin necrotic injury due to extravasation injury, with the largest percentage of neonates group (34%), male gender (66%), hypertonic fluids/drugs (73%), most regions of dorsum and wrist dextra (17%) and the most used therapeutic modality was autolytic debridement (45%).

**Conclusions:** We found that the incidence of skin necrosis due to extravasation injury is influenced by factors such as the patient's age, the type of fluid or drug administered, and the location of the peripheral venous line. However, gender was not found to be a significant factor in the incidence of these injuries. Interestingly, the initial treatment approach that is still commonly employed is autolytic debridement.

### Highlights:

1. Skin necrotic injuries from extravasation were associated with age, the type of fluid/drug administered, and the location of the peripheral venous line, but not with gender.
2. Autolytic debridement remains a prevalent and commonly used initial treatment approach for these injuries.

## INTRODUCTION

Extravasation injury is one of the most common complications of intravenous

therapy. About 80% of pediatric patients receive infusion therapy in the hospital<sup>1</sup>. This therapy aims to provide fluids nutrition, electrolyte

correction, blood product transfusion, and drug administration<sup>2,3,4</sup>. Extravasation injury is the discharge of intravenous fluids or drugs given through intravenous therapy from vein into the surrounding tissue. The characteristics of an extravasation injury are pain, swelling, stiffness, a cold feeling, reddish skin color to black, and the flow of infusion slows or stops<sup>5</sup>. Local complications of intravenous therapy include phlebitis, infiltration, and extravasation injury, while systemic complications include embolism, fluid overload, allergic reactions, and sepsis<sup>5</sup>.

The incidence of skin necrotic due to extravasation injury at the Pediatric Inpatient Hospital Dr. Soetomo General Academic Hospital Surabaya in 2019, there were 44 patients. This figure is quite high and affects the assessment of the quality of service at Dr. Soetomo General Academic Hospital Surabaya. Children are risky group who get complications during infusion, 20-80% of children experience complications from infusion and 11-58% of children are at risk of extravasation injury. The incidence of extravasation injury in children who are hospitalized and receive parenteral fluid therapy is around 11-70%<sup>6</sup>. Based on a study conducted at the NICU (Neonatal Intensive Care Unit) unit in the UK, it was found that extravasation injury caused skin necrotic 38/1000 neonates, with 70% of the incidence occurring in preterm neonates (26 weeks gestation or less).

Extravasation injuries create areas of tissue ischemia due to endothelial damage and blood vessel thrombosis, which can be accompanied by the appearance of ulcers with surrounding red, swollen skin, and superficial skin damage in the extravasated area, followed by progressive damage and development of necrotic ulcers that will slough off the tissue and looks like dry black eschar<sup>7</sup>. Extravasation causes a loss of 0.24% of the epidermal layer of the skin in children<sup>5</sup>. Extravasation injuries can result in

damage to the entire thickness of the skin (full thickness) in areas of the body with thin of subcutis tissue, such as the back of the hand and the cubital fossa. Extravasation injury and its sequels can be a more serious morbidity than the main disease that makes the patient hospitalized, resulting in amputation of the patient's body parts<sup>8</sup>.

The risk factors that have a high potential for extravasation injury include age, small vein size, position of infusion, infusion dressing, bolus injection, type of intravenous fluid or drug given, the number of drugs more than one given in close proximity, size and intravenous catheter type, general vascular disease (peripheral vascular disease, diabetes, hypertension), and lack of paramedical knowledge. The types of intravenous fluids that cause extravasation in children most often are antibiotics, bicarbonate solution, and potassium chloride<sup>9</sup>. There are 3 types of drugs that cause extravasation, namely vesic drugs (blisters, blisters and cause tissue damage), irritant drugs (anti-pain drugs) and nonvesikan drugs (drugs that rarely produce acute reactions and tissue necrosis). Choosing the right wound care therapy modality will accelerate wound healing, reduce the treatment period, and reduce the risk of disability in patients that can appear in the future.

The general objective of this study was to find the relationship between variables, namely between age, gender, type of fluid/ drug administered through the peripheral venous line, and the location of the peripheral venous line installation, with the incidence of skin necrotic due to extravasation injury and the types of initial treatment modalities of skin wound care. necrotic due to extravasation injury in the pediatric hospital Dr. Soetomo General Academic Hospital Surabaya period January - September 2019.

## METHODS

This research is descriptive analytic with cross sectional approach. Medical record data of

all pediatric patients aged 1-18 years who are hospitalized in the pediatric inpatient ward of Dr. Soetomo General Academic Hospital Surabaya in the January - December 2019 period was given peripheral vein therapy and experienced skin necrotic complications due to extravasation injury and was consulted for Reconstructive and Aesthetic Plastic Surgery at Dr. Soetomo General Academic Hospital Surabaya was included in the research inclusion criteria. The exclusion criteria in the study were the medical records of pediatric patients aged 1-18 years who were hospitalized in the pediatric inpatient ward of Dr. Soetomo General Academic Hospital Surabaya who was given incomplete peripheral venous therapy mentioned the data regarding the type of fluid/ drug given and the location of the infusion. The independent variables in this study were age, sex, type of fluid/ drug administered through the peripheral vein, and the location of the peripheral venous line. The dependent variable in this study was skin necrotic injury due to extravasation. The sample in this study were all research subjects using a total sampling technique of 44 cases. Data verification is carried out by means of checking the completeness and suitability of the data with the operational limits that have been set. After all the data is collected, the data is grouped according to its type. Data is presented in tabular form accompanied by an analytical descriptive explanation. Data on age group, gender, and risk factors are presented in the form of a frequency distribution table. The researcher gave a code number to each research subject. The information obtained is kept confidential.

## RESULTS

A total of 4,793 pediatric patients were treated in the Pediatric inpatient ward of Dr. Soetomo Surabaya and received peripheral vein therapy in the period January -

December 2019, there were 44 skin necrotic cases due to extravasation injuries that were submitted to the Reconstructive and Aesthetic Plastic Surgery RSUD Dr. Soetomo Surabaya. The most age group that experienced skin necrotic incidence due to extravasation injury was the neonate age group (0-28 days), which was 15 patients (34%) Table 1.

We found that male sex group experienced more skin necrotic incidents due to extravasation injury, namely as many as 29 patients (66%) than 15 patients (34%) Table 2.

Table 1. Age Distribution of Patients with Skin Necrotic due to Extravasation Injury

Age	Numbers	Percentages
Neonates (0-28 days)	15	34%
Infant (1-12 months)	9	20.5%
Todler (1-5 years)	9	20.5%
School age child (5-12 years)	6	14%
Juvenile (12-18 years)	5	11%
<b>Total</b>	<b>44</b>	<b>100%</b>

Table 2. Gender Distribution of Patients with Necrotic Skin due to Extravasation Injury

Age	Numbers	Percentages
Male	29	66%
Female	15	34%
<b>Total</b>	<b>44</b>	<b>100%</b>

Most of the fluids/ drugs that caused skin necrotic injury due to extravasation injury were hypertonic, as many as 32 patients (73%) whereas for liquid/ drug which is isotonic or chemotherapy drug each resulted in the incidence of 6 patients (13.5%) Table 3.

The most frequently site for insertion of peripheral veins in skin necrotic events due to extravasation injury were the dorsum region of the right manus and wrist, which were found in 8 patients each (17%). The next most frequent location was the dorsum pedis right region, which was 6 patients (13%), followed by the left cruris region in 5 patients (11%). For the left wrist and left ankle regions were found in 4 patients (9%), respectively, the right ankle region was found in 3 patients (6%), and the

dorsum manus left and right antebrachii were found in 2 patients (4%). Meanwhile, the location most rarely found in skin necrotic events due to extravasation injury was the left cruris in 1 patient (2%) Table 4.

Table 3. Distribution of Types of Fluids / Drugs Given by Peripheral Vein Pathways

Types of Fluids/ Drugs Given by Peripheral Vein Pathways	Numbers	Percentages
<b>Hypertonic</b>	<b>32</b>	<b>73%</b>
Total Parenteral Nutrition (900- 1.100 mOsm/L)	22	50%
Natrium Bicarbonat (2.200 mOsm/L)	2	4.6%
Kalium Chlorida (4.024 mOsm/L)	6	14%
Phenytoin (6.175-9.740 mOsm/L)	2	4.6%
<b>Isotonic</b>	<b>6</b>	<b>13,5%</b>
CalciumGluconas (276 mOsm/L)	3	7%
Packed Red Cell (304 mOsm/L)	2	4,6%
Thrombocyte Concentrate (275-295 mOsm/L)	1	2%
<b>Chemotherapy</b>	<b>6</b>	<b>13,5%</b>
Daunorubicin (Vesikan)	5	11%
Cyclophosphamide (Netral)	1	2%
<b>Total</b>	<b>44</b>	<b>100%</b>

Figure 4. Distribution of Location of Peripheral Vein Pathways in Patients with Necrotic Skin Due to Extravasation Injury

Location of Peripheral Vein Therapy	Frequencies	Percentages
<b>Dorsum Manus</b>	<b>10</b>	<b>21%</b>
Dorsum Manus Dextra	8	17%
Dorsum Manus Sinistra	2	4%
<b>Wrist</b>	<b>12</b>	<b>26%</b>
Wrist Dextra	8	17%
Wrist Sinistra	4	9%
Antrebrachii Dextra	2	4%
<b>Cruris</b>	<b>6</b>	<b>13%</b>
Cruris Dextra	1	2%
Cruris Sinistra	5	11%
<b>Ankle</b>	<b>7</b>	<b>15%</b>
Ankle Dextra	3	6%
Ankle Sinistra	4	9%
<b>Dorsum Pedis</b>	<b>10</b>	<b>21%</b>
Dorsum Pedis Dextra	6	13%
Dorsum Pedis Sinistra	4	8%
<b>Total</b>	<b>47</b>	<b>100%</b>

Based on the choice of treatment modality for initial wound care in skin necrotic incidents due to extravasation injury, the modality most often chosen to treat the initial case was autolytic debridement, which was used in 20 patients (45%), followed by surgical debridement + moist dressing used in 19 patients (43%) Table 5.

Table 5. Distribution of Therapeutic Modalities Used for Necrotic Skin Due to Extravasation Injury

Therapeutic Modality	Frequencies	Percentages
<i>Surgical Debridement + Moist Dressing</i>	19	43%
<i>Surgical Debridement + Absorbant Dresing</i>	2	5%
<i>Autolytic Debridement</i>	20	45%
<i>Enzymatic Debridement</i>	3	7%
<b>Total</b>	<b>44</b>	<b>100%</b>

## DISCUSSION

Peripheral venous therapy is needed to provide fluid, nutrition, and drug therapy. One of the complications of providing peripheral venous access is skin necrotic injury due to extravasation. Several risk factors have been identified as the cause of extravasation, namely the risk factors for the patient's age, the sex of the patient, the type of fluid/drug given through the peripheral venous line, and the location of the peripheral venous line. The incidence rate of skin necrotic due to extravasation injury in pediatric patients who were admitted to the Dr. Soetomo General Academic Hospital Surabaya in January-December 2019, amounting to 0.9% of all pediatric patients who received peripheral venous therapy. This figure is consistent with previous studies by Cassagnol & McBride (2009) who found that the incidence of extravasation was 0.1-7% of all patients receiving peripheral venous therapy<sup>10</sup>. The incidence of skin necrotic injury due to extravasation injury in the age group under 1 year (neonates and infants age group), was 24 patients (55%) of the total incidence of skin necrotic injury due to extravasation injury. From the data above, it can be seen that the incidence of skin necrotic injury due to extravasation injury in the group of children will be higher at the age of the patient who is getting younger, influenced by the size and strength of the veins in neonates and infants, the skin is still immature and thin, the thinner fat subdermal, as well as a known delay in extravasation events.

Based on gender factors, it was found that



male sex experienced more skin necrotic due to extravasation injury than women, which was 66%. Female blood vessels have a risk of complications of intravenous insertion, this incident is influenced anatomically that female blood vessels are smaller due to a lot of fat deposits and vice versa in male blood vessels there is less incidence of extravasation due to less fat deposits due to high activity so that not too risky in the incidence of complications of intravenous insertion<sup>11</sup>. However, in a study conducted by Safiudin (2013), it was stated that there was no relationship between gender and extravasation complications, where in the study 35 respondents were found, with the distribution of male sex as many as 16 people (45.7%) and as many as women. 19 people (54.3%), with p value = 0.243. Most fluids that cause skin necrotic injury due to extravasation are hypertonic<sup>12</sup>. Hypertonic fluids are fluids that have a higher total osmolality than extracellular fluids and can draw fluid and electrolytes from tissues and cells into blood vessels<sup>13</sup>. Hypertonic fluids have heat properties that can cause damage to blood vessels so that in use they must be mixed with isotonic solutions so as not to cause extravasation of the infusion attached<sup>14</sup>.

Besides hypertonic fluids, isotonic fluids can also cause extravasation if given too quickly or bolus. Chemotherapy fluids that are inflammatory, irritant, or vesic can also damage the endothelial walls of blood vessels, causing leakage of blood vessels<sup>14</sup>. Most chemotherapy agents are vesic in nature and can induce extravasation necrosis. Included in this group is Daunorubicin. Sodium bicarbonate is so alkaline that it can cause skin necrosis. Phenytoin will precipitate if they enter the interstitial network without being dissolved, and local damage can occur<sup>15</sup>. Previous research conducted by Murphy (2019) stated that the majority of extravasation

cases were found at the location of the peripheral venous access in the superior extremities, as many as 70%<sup>16</sup>. The regions of the dorsum manus and pedis and fossa cubiti are areas with a thin thickness of subcutaneous fat, thereby increasing the risk of extravasation complications until necrosis of the entire thickness of the skin over the subcutis area<sup>17</sup>. Installation on the right side will also increase the risk of extravasation injury because the right side is the side that is actively moved. Continuous movement will cause the intravenous cannula to rub, bend, and damage the blood vessel walls so that extravascular fluid/ drug leakage can occur (mechanical factors)<sup>18</sup>. Based on the choice of initial wound care therapy modality in skin necrotic events due to extravasation injury, it must be adjusted to the existing wound problems, namely necrotic problems, exudate problems, or infection problems. Autolytic debridement is the body's own ability to lyse or break down necrotic tissue in the wound area by using the body's natural defense system, namely enzymes and macrophages and the activity of white blood cells<sup>19,20</sup>. This autolysis can be obtained through bandages that can retain moisture. This moist wound surface supports rehydration of dead tissue and wound fluid which consists of white blood cells and this enzyme will break down necrotic tissue<sup>21</sup>.

Nurse knowledge and skills data were not discussed in this study. The knowledge and ability of nurses in placing intravenous access and how to enter fluids/ drugs intravenously as well as recognizing early signs and early treatment of extravasation greatly affect the incidence and prognosis of extravasation injury<sup>22</sup>.

A limitation in this study is the magnitude of the bias between extravasation events that occur, because it is possible that not all extravasation events that occur are referred to in Reconstructive and Aesthetic Plastic Surgery. It is possible that the true prevalence rate could be higher than that obtained in this study.

In addition, the researcher also

acknowledged that there were other deficiencies in this study, namely the absence of detailed data for comparison in the form of pediatric patients who were treated at the inpatient of Dr. Soetomo General Academic Hospital for the period January-December 2019 who received peripheral vein therapy but did not experience extravasation injuries so he could not describe the risk of skin necrotic events due to extravasation injury in a population.

### CONCLUSION

There was a relationship between the incidence of skin necrotic injury due to extravasation injury with age, types of fluid/drug given, and the location of the peripheral venous line, whereas the incidence was not related to gender. The initial treatment modality that is still frequently used today is autolytic debridement.

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### CONFLICT OF INTEREST

The authors have no conflicts of interest in this study.

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None.

### AUTHORS CONTRIBUTION

DAN wrote and revised the manuscript. AGS and IDS are intellectual contributions, methodology, and research data, All authors approved the final manuscript.

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