Scientific Research Publishing

Surgical Science, 2016, 7, 427-432
http://www.scirp.org/journal/ss
ISSN Online: 2157-9415
ISSN Print: 2157-9407

Management of Extravasation Injuries in Preterm Infants

Ana De Leo, Billy Ching Leung*, Henk Giele, Lucy Cogswell

Department of Plastic Surgery, John Radcliffe Hospital, Oxford University Hospital NHS Trust, Oxford, UK
Email: *billychingleung@gmail.com

How to cite this paper: De Leo, A., Leung, B.C., Giele, H. and Cogswell, L. (2016) Management of Extravasation Injuries in Preterm Infants. *Surgical Science*, **7**, 427-432.
http://dx.doi.org/10.4236/ss.2016.79058

Received: August 18, 2016
Accepted: September 19, 2016
Published: September 26, 2016

Abstract

Extravasation injuries occur in up to 70% of neonates in intensive care, majority being preterm infants. Their fragile and premature anatomy makes prevention and management of extravasation extra difficult compared to those of full-term. With increasing advances of intensive care for preterm infants, the use of intravenous medication and nutrition will increase, thus lead to further potential risk of extravasation injuries, which has serious complications, such as full-thickness skin loss, tissue necrosis and acute limb compartment syndrome, with long-term functional and cosmetic sequelae. There is a current lack of evidence in the literature on the most appropriate therapeutic strategy for this vulnerable patient group. This review aims to highlight our trust regime on the management of extravasation injuries (non-chemotherapeutic) for preterm infants, including injury classification and assessment, and implementation of initial interventions.

Keywords

Extravasation, Non-Chemotherapeutic, Preterm, Infants, Treatment

1. Introduction

The use of intravenous access for medication and nutrition is essential in neonatal intensive care. Neonatal veins are small and fragile. The physiology of extravasation is not yet fully understood but there are two main theories as to its aetiology: Displacement of the catheter or increased vascular permeability. While many minor injuries resolve spontaneously and do not cause tissue necrosis, some cases result in serious complications. These may include full-thickness skin loss, necrosis of muscle and tendon requiring reconstructive surgery or even amputation. Pathogenesis involves a combination of local inflammatory reactions caused by the irritant drug properties, and com-

pression of surrounding tissues by a large volume of infiltrate, known as acute limb compartment syndrome (ALCS) [1].

Extravasation injuries are known to happen at some point in up to 70% of neonates undergoing intensive care [2] [3]. In 2004, Wilkins and Emmerson conducted a study on neonatal intensive care unit admissions in the UK and reported an incidence of 38/1000 patients experiencing extravasation injuries severe enough to cause skin necrosis [3]. 70% of these injuries occurred in infants of 26 weeks gestation or less. The same study showed that approximately 4% of infants leaving intensive care units have functionally or cosmetically significant scars produced by extravasation injuries.

Parenteral nutrition is the most common cause of infant extravasation injuries. Other substances implicated include dextrose and calcium, blood, sodium bicarbonate, Tham solution (tromethamine), dextrose and flucloxacillin, insulin and aminophylline, dextrose and magnesium, and platelets. All of these are known to irritate the venous endothelium and raise the risk of venous rupture [4].

In terms of age, most extravasations (93%) happen in babies between 26 and 28 weeks' gestation when immature skin, small blood vessels and poor venous integrity increase the risk of such injuries. The immune system is poorly regulated in neonates compared to adults, and this dysregulation is further magnified with a younger gestational age. The rule of oxidative stress in premature infants is a concern; it has been linked to a number of infant morbidities including necrotising enterocolitis, retinopathy of prematurity and chronic lung disease.

A PubMed search in the English and German literature using the keywords "extravasation" and "treatment" for the period between January 1965 to the present time shows that there is no agreement on the best practice to reduce tissue damage and its consequent complications. In practice, a number of treatments are used. In this article, we review the management of preterm patients with non-chemotherapeutic extravasation injury at Oxford University Hospitals NHS Trust.

2. Initial Management

With preterm infants, the immaturity of the skin and subcutaneous tissues together with the environment of the incubator, makes compliant to the normal paediatric management guidelines difficult [5]. Our initial management regimes include prompt intervention and assessment, as highlighted below.

1) If extravasation is suspected, promptly stop the infusion and disconnect it from the drip set.
2) Take digital photographs to monitor the injury.
3) Begin analgesia if not already prescribed.
4) Aspiration of the extravasate: Often the vein is very small and collapses immediately so to aspiration may not be feasible.
5) Elevate the affected limb: This may be difficult to achieve for a preterm infant in incubator.
6) Marking the extravasation area: Determining the extravasation area is challenging as

the normal immature skin is patchily marbled; it may have prominent subcutaneous veins and often appears hyperpigmented. When marking out the area involved, a maker pen may be too sharp for the delicate preterm skin.

7) Estimate the volume, concentration and duration of exposure to the extravasated drug: this is often not clear for drugs delivered at a continuous, very low rate infusion in the preterm infant.

The first step for medical management is to assess the child:

1) Week of gestation (at <25 weeks all organ systems are immature).
2) Weight (is important to calculate injured area).
3) Other medications, particularly those infused via the same site (some drugs could further compromise peripheral blood supply; antibiotics and analgesia).
4) Ventilation and lung function (the pO2 level is important in evaluating skin colour, and is a factor in wound healing).
5) Cardiovascular anomalies (limb swelling may be related to other anomalies).
6) Skin colour (which could predict healing properties, such as hypertrophic scarring or pigmentation of scars).
7) Define the total body surface area involved in extravasation.

3. Examination of the Extravasation

Accurate estimation of the size of the extravasation is important to choose appropriate treatment. There are several methods for assessing the extravasation size, the different methods may be used in combination. The "rule of nines" is a convenient and rapid method of estimating the extent of total body surface area (TBSA) burned and is commonly used to evaluate extravasation injuries. It is fairly accurate in adults and small extravasation injuries, but it is not accurate in cases of patchy extravasation necrosis, and in paediatric lesions. The more accurate method of measuring the extent of TBSA involved is the Lund and Browder chart, which subdivides body areas into segments and assigns a proportion of the body surface to each body region based on patient age. It compensates for the variation in body shape with age, and can therefore give an accurate assessment of extravasation area in children. However, it is less accurate when used for preterm 500g patients.

The authors prefer to use "palm of hand 1%" rule, in which the patient's hand is used to estimate the percentage TBSA involved in extravasation, traditionally considered as 1% of TBSA. Exactly what constitutes "the palm of the hand" and how large an area it is depends on whether you follow advanced trauma life support (ATLS) teaching, UK teaching or use a "Lund and Browder" chart. ATLS teaches that the area of the palm (hand minus digits) is equal to 1% of TBSA [6]. In the UK, it is generally thought that the area from the distal wrist crease to the tips of the fingers (Palm Plus digits) is equivalent to 1% TBSA [7].

Neurovascular compromise and compartment syndrome of the affected limb are rare in these delicate patients, but pulses should be evaluated and if the limb is too swollen to assess the pulse manually, ultrasound is vital to confirm viability of the limb. Check

the involved area of skin for signs of reduced capillary refill, erythema, blistering and tissue which will help determine the stage of the lesion. Frequently in these tiny patients, ischemia-related lesions are confused with extravasation injuries. Equally, extravasation of vasoactive substances can complicate the clinical scenario. Ultrasound to assess skin blood flow is useful in these cases and when it comes to treatment, nitroglycerine adhesive dressings may be considered [8].

4. Classification of Injuries

Classifications do not always correspond directly with the clinical scenario, but are helpful when comparing clinical and experimental data, and aid reproducibility of treatment results.

Many classifications have been proposed. The authors use the McCullen classification:

1) Stage 1: painful intravenous site, no erythema and swelling, flushes with difficulty.
2) Stage 2: painful intravenous site, slight swelling, redness, no blanching, brisk capillary refill below infiltration site, good pulse volume below infiltration site.
3) Stage 3: painful intravenous site, marked swelling, blanching, cool to touch, brisk capillary refill below infiltration site, good pulse volume below infiltration site.
4) Stage 4: painful intravenous site, very marked swelling, blanching, cool to touch, capillary refill more than four seconds, decreased or absent pulse, skin breakdown or necrosis.

5. Treatment

Hyaluronidase (150 U/ml solution) is not indicated for babies of less than 28 weeks as the skin is considered too immature. The British National Formulary also recommends caution when using hyaluronidase in infants [9]. Furthermore, the most recent Cochrane protocol based on current available evidence, was also unable to recommend hyaluronidase or any particular intervention for the management of serious extravasation injury in neonates [10].

All injuries, with or without skin breakdown should be covered with an occlusive dressing to reduce risk of infection and friction. Dressings have the advantage of keeping the wound moist, which aids healing. However, jelonet or other non-adherent dressings are dangerous in the incubator due to risk of burns. Hydrogel dressings had shown evidence to be safe for preterm infants of all gestational ages. They consist of 80–90% water, can be applied directly to the skin, and keep the wound moist which facilitates sloughing of necrotic tissue and enhances the rate of autolysis. Hydrogel can be secured to the wound with a transparent dressing, thus avoiding frequent dressing changes. This is important for patient comfort, to reduce trauma to the healing tissues, and to protect the wound from infection. Saline irrigation and flush out must be considered if a large-volume extravasation is suspected. A 27 gauge needle often is used with a 5 ml syringe of saline; no more than 5 ml is usually injected (**Figure 1** and **Figure 2**).

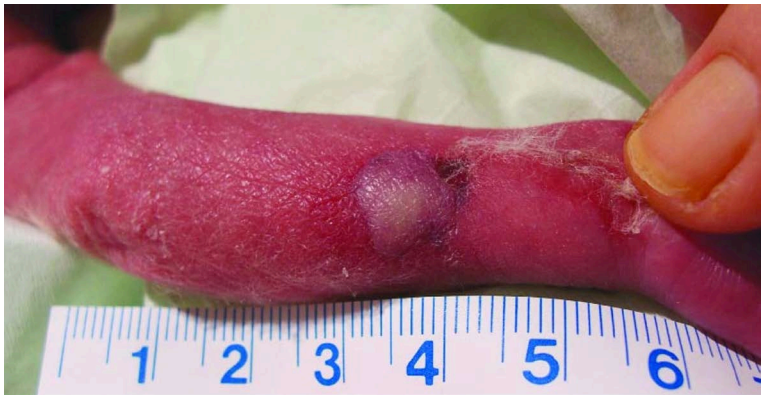

Figure 1. Skin necrosis from total parenteral nutrition extravasation [11].

Figure 2. Extensive tissue necrosis from extravasation of pack red blood cells [12].

6. Outcomes

The authors' experience is that the regenerative capacity of preterm infants is high. Injuries should be reassessed in a week to 10 days. If skin necrosis is present, a Hyalomatrix® (a hyaluronic acid-based matrix) dressing is useful in some cases [13], or surgical debridement may be necessary. Delay to surgical debridement often results in a healed wound in this age group.

7. Discussion

Preterm infant extravasation injuries are different from those in the full-term paediatric population. Their management represents a challenge due to difficulties with assessment and managing wounds in very immature skin. It is difficult to come up with an overarching protocol for treatment of such injuries in this diverse patient group. Each case should be assessed on its merits, and the treatment protocol adapted on a case-by-case basis.

For the future, in vitro fertilisation is increasing the number of tiny preterm patients born, who are particularly vulnerable to extravasation [14]. ITU advances have improved the survival rates for pre-term infants who require intravenous nutrition and

medication as part of their care. These children are at risk of extravasation, and there is a current lack of evidence in the literature on the most appropriate therapeutic strategy for this vulnerable patient group.

References

[1] Tiwari, A, Haq, A.I., Myint, F. and Hamilton, G. (2002) Acute Compartment Syndromes. *The British Journal of Surgery*, **89**, 397-412. http://dx.doi.org/10.1046/j.0007-1323.2002.02063.x

[2] Irving, V. (1999) Management of a Neonatal Wound on a Newborn Infant. *Journal of Wound Care*, **8**, 485-486. http://dx.doi.org/10.12968/jowc.1999.8.10.26211

[3] Wilkins, C.E. and Emmerson, A.J. (2004) Extravasation Injuries on Regional Neonatal Units. *Archives of Disease in Childhood*, *Fetal and Neonatal Edition*, **89**, F274-F275. http://dx.doi.org/10.1136/adc.2003.028241

[4] Doellman, D., Hadaway, L., Bowe-Geddes, L.A., *et al*. (2009) Infiltration and Extravasation: Update on Prevention and Management. *Journal of Infusion Nursing*: *The Official Publication of the Infusion Nurses Society*, **32**, 203-211.

[5] Goutos, I., Cogswell, L.K. and Giele, H. (2014) Extravasation Injuries: A Review. *The Journal of Hand Surgery*, *European Volume*, **39**, 808-818. http://dx.doi.org/10.1177/1753193413511921

[6] ACOS (1993) Trauma Life Support Manual for Physicians (American College of Surgeons, Committe on Advanced Trauma). American College of Surgeons, Chicago.

[7] Kirby, N.G. and Blackburn, G. (1981) Field Surgery Pocket Book. HMSO, London. Ministry of Defence, Great Britain.

[8] BMJ (2002) British National Formulary. BMJ Books, 44.

[9] Gopalakrishnan, P.N., Goel, N. and Banerjee, S. (2012) Saline Irrigation for the Management of Skin Extravasation Injury in Neonates. *The Cochrane Database of Systematic Reviews*, **2**, Article ID: CD008404. http://dx.doi.org/10.1002/14651858.cd008404.pub2

[10] Onesti, M.G., Carella, S., Maruccia, M., Ciotti, M. and Scuderi, N. (2012) The Use of Hyalomatrix PA in the Treatment of Extravasation Affecting Premature Neonates. *Plastic and Reconstructive Surgery*, **129**, 219e-21e. http://dx.doi.org/10.1097/PRS.0b013e3182365e16

[11] Reynolds, B.C. (2007) Neonatal Extravasation Injury: Case Report. *Infant*, **3**, 230-232.

[12] Cho, K.Y., Lee, S.J., Burm, J.S. and Park, E.A. (2007) Successful Combined Treatment with Total Parenteral Nutrition Fluid Extravasation Injuries in Preterm Infants. *Journal of KOREAN Medical Science*, **22**, 588-594. http://dx.doi.org/10.3346/jkms.2007.22.3.588

[13] Mosalli, R., Elbaz, M. and Paes, B. (2013) Topical Nitroglycerine for Neonatal Arterial Associated Peripheral Ischemia Following Cannulation: A Case Report and Comprehensive Literature Review. *Case Reports in Pediatrics*, **2013**, Article ID: 608516.

[14] Sunkara, S.K., La Marca, A., Seed, P.T. and Khalaf, Y. (2015) Increased Risk of Preterm Birth and Low Birthweight with Very High Number of Oocytes Following IVF: An Analysis of 65 868 Singleton Live Birth Outcomes. *Human Reproduction*, **30**, 1473-1480. http://dx.doi.org/10.1093/humrep/dev076