Neonatal extravasation injury: Case report

This case report describes an incident of extravasation injury in a preterm neonate. The current literature on the identification and management of such injuries is then reviewed and recommendations made for further study.

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Key points

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1. Extravasation injuries from peripheral cannulae are the commonest iatrogenic injury within the neonatal intensive care unit (NICU).
2. There is still no consensus on management of such injuries.
3. The wide varieties of treatment modalities all lack evidence to support them.
4. Further research is required.

CASE REPORT

A liveborn female was delivered by emergency caesarean section for transverse lie, following spontaneous onset of labour at 29^{+4} weeks' gestation. She required minimal resuscitation with Apgar scores of 9^{1} and 9^{5}. She was transferred to the neonatal intensive care unit and commenced on intravenous (IV) benzylpenicillin, gentamicin, and total parenteral nutrition (TPN) – this was a 10% dextrose base with 6mmol sodium and 3mmol calcium per 300mL bag. The TPN infusion was initiated at 90mL/kg/day, via a peripheral IV cannula placed without difficulty in the dorsum of her left hand. She received respiratory support in the form of pressure-assist nasal continuous positive airways pressure in view of her prematurity, with a positive end expiratory pressure (PEEP) of 5-6cm H_2O. Chest radiograph and cranial ultrasound were normal. At 18 hours of life, respiratory incidents and oxygen requirement had worsened and she was electively intubated, receiving surfactant therapy. For this procedure she received fentanyl and suxamethonium through this IV cannula. She was commenced on morphine sulphate (in 10% dextrose) at 5 micrograms/kg/hour via a new peripheral IV cannula in the dorsum of the right hand and intralipid at 1g/kg/day through the left hand cannula along with the TPN.

At 40 hours after delivery, her left hand was noted to be swollen and erythematous. TPN and lipid were discontinued, the cannula removed and the hand elevated. Further IV access was extremely difficult and a double lumen umbilical venous catheter was placed, through which the TPN was then infused.

No damage to the overlying skin was evident, so the decision was made to treat the injury conservatively. Irrigation was not carried out, and the hand was simply elevated. Twelve hours-post injury the hand was of normal appearance. Follow-up two weeks later showed no residual scarring.

Discussion

Management of the preterm neonate will invariably involve the placement of indwelling vascular catheters. In the extremely preterm or sick term infant, this is often initially central access via umbilical arterial and venous routes. These are associated with significant complications, and placement should always be confirmed radiographically[1]. In the more stable neonate, or those requiring multiple infusions, peripheral IV cannulae are essential. Placement of a peripheral IV cannula is one of the most common procedures carried out in NICU so, as expected, iatrogenic injury is most likely to be a result of peripheral IV cannulae. A recent survey of tertiary UK units suggested an incidence of 38 per 1000 infants for injuries leading to overlying skin necrosis[2] (**FIGURE 1**). However, an overall prevalence of up to 70% of neonates having at least one extravasation injury has been suggested[3]. An earlier consecutive review of NICU survivors from a single unit had a prevalence of scarring from peripheral IV cannulae in 61%, with 4% having functional or cosmetic importance[4] (**FIGURE 2**).

Extravasation is defined as the unintentional infusion of fluid into an extravascular space with the potential to cause damage. It occurs when the tip of a cannula no longer lies within a free-flowing intravascular space. This may be due to misplacement at initial cannulation, though confirmation of placement with a small amount of 0.9% saline should always be routine practice. Cannulae are not infrequently dislodged during taping and securing of the line. It is also possible for the cannula to be displaced at a later date. Finally, 'tissuing' of the cannula with the formation of thrombosis around the cannula tip leads to an increase in pressure

within the vein. This may lead to backflow of infused fluid leaving the vein at the point of entry of the cannula, or until the venous wall is ruptured – again causing extravasation[5].

Tissue may be chemically injured through direct toxicity or high osmolality of the infusate. Calcium-containing infusates often lead to significant injury, as can TPN and lipid-formulations as these are all directly toxic to tissues. There may also be pressure effects from a high volume of fluid within a relatively inextensible tissue. This may be exacerbated by other sources of pressure e.g. an IV splint or a non-invasive blood pressure cuff. Extravasation injury can be highly variable in the extent of injury and damage done to overlying and underlying tissues. Damage is dependent upon the volume of fluid infused into the extravascular tissue, the type of fluid, location of the cannula, and the length of time before the extravasation is noticed. TPN is the commonest fluid implicated in extravasation injuries[2,6].

Preterm skin vulnerability to damage increases with decreasing gestation. The epidermis has fewer layers in the extreme preterm infant, and the dermis has less cohesion and strength[7]. The difficulty in placing IV cannulae within such small patients contributes to the damage. Veins themselves are more fragile and so more readily ruptured by any increase in pressure. The supporting connective tissue is less thick so movement of the cannula outside the vein may be more likely to occur. Neonates cannot localise pain and generalised signs of discomfort may not alert staff to the problem. In the ventilated sedated infant, so common in NICU, the only indication of injury may be a rising tachycardia.

Prevention

Avoiding extravasation injuries is obviously the optimal approach. Extreme care should always be taken in confirming the initial placement of an IV cannula. Whilst the old adage of 'If in doubt, take it out' may seem appropriate here, the often-perilous difficulties with IV access mean that cannulae may continue to be used until damage is obvious. Pressure monitoring within the lumen has been advocated to identify intravascular thrombosis and 'tissuing' of the cannula[8]. There are doubts that this is sufficiently sensitive at the low pressures used in the preterm infant[9]. Even so, infusions should always be driven via syringe drivers specifically manufactured for the small volumes used in neonates.

FIGURE 1 Example of an injury caused by total parenteral nutrition extravasation leading to overlying skin necrosis – expectant management with simple (nonimpregnated) dressing alone.

Peripheral IV cannulae are felt to be more prone to extravasation due to lack of stability and security when placed. Central venous catheters such as percutaneous indwelling vascular catheters ('long lines') are often recommended and it is suggested that the risk of extravasation is less. A recent Cochrane review[10] failed to find any evidence that adverse outcomes are reduced with central placement, including those studies where extravasation was a specific outcome. In the meta-analysis of included trials the relative risk of extravasation for percutaneous long lines was 0.36 but with a wide confidence interval (0.07-1.75) and so not sufficient to recommend either method. This is in contrast to a recent survey of UK neonatal unit experience that showed a significantly higher number of extravasation injuries with peripheral cannulae than central lines[2].

Unfortunately the overwhelming need for IV access and inherent problems with cannulating the extreme preterm mean that iatrogenic injury will still occur, despite multiple precautions.

Management of injury

Though extravasation injury has been acknowledged to cause significant morbidity in infants, extending into later life, there remains no consensus on the ideal treatment for injuries that occur. Management strategies fall into 3 categories – expectant, topical/skin care, and invasive.

Expectant

It is often difficult to predict the extent of injury from extravasation. Some authorities recommend observation alone of extravasation until the total area involved is well demarcated[11]. This may reduce the need for repeated treatment or further iatrogenic damage to skin that may otherwise heal healthily. This is the commonest form of management for cannulae that have 'tissued' without obvious damage to overlying skin. However in more serious injury, recent case reports have been in favour of some intervention, and that this should be as early post-injury as possible[12-14].

Topical/skin care

Wound care via the application of dressings and topical medicines is frequently used to manage extravasation injuries. These may be left exposed to dry, or covered with occlusive dressings. These dressings are often medicinally impregnated e.g. hydrocolloids. Several different medications have been tried on extravasation injuries with considerable geographical variation in use. Silver sulfadiazine with chlorhexidine, fibri-nolyin/deoxyribonuclease, nitroglycerin, and glyceryl trinitrate ointments have all been used with variably good outcomes[11,15-17]. A recent report from Korea used a combination of antibacterial and herbal ointments, though two of the five infants treated as such required further operative management[12]. There is no evidence to support the use of any single dressing modality or topical agent. No randomised trials have been performed. Despite the potential for these injuries to cause significant long term effects, involvement of wound care teams in the skin care is frequently absent or minimal[2,6].

Extravasant removal

In 1993, Gault described a method of removal of extravasant from the site of

FIGURE 2 Same site as in FIGURE 1 showing contracture of skin six weeks post-injury.

injury and demonstrated a reduction in the number of patients requiring surgical management[18]. The methods involved general anaesthesia, followed by infiltration with hyaluronidase and subsequent saline flushing. The site was then also aspirated via a liposuction microcannula to remove remaining extravasant. This was subsequently adopted and adapted by a variety of neonatal units[13,19,20]. The current 'adapted' method involves infiltration with local anaesthetic in the area of the injury. The skin is then punctured and irrigated with saline (typically at least 500mL). Some areas use hyaluronidase, an enzymatic debridement agent which breaks down the normal layers of skin, allowing the saline to irrigate all affected areas. There is also variation in the number of skin punctures carried out, from two (entry and exit) to multiple. The original Gault method required plastic surgical expertise but the adapted technique can be carried out by medical or nursing staff on a unit. It has the benefit of being performed in a timely manner, often within an hour of injury. However the procedure is invasive and the use of hyaluronidase carries a definite risk of causing further tissue damage. It is also potentially painful and does require training of staff to be familiar with the technique.

The results of irrigation techniques are generally positive with very few infants requiring additional surgical management[20]. There are good outcomes reported with the use of saline alone[18]. The rationale for hyaluronidase is to dissolve the various layers of skin and prevent 'pockets' of extravasant from forming and escaping irrigation. As mentioned earlier, preterm skin is at greater risk from injury due to the reduced number of layers. It is possible that hyaluronidase use confers no extra benefit particularly within the extreme preterm population.

Where irrigation is performed, case series have suggested that rapid intervention can reduce the extent of tissue damage by direct removal of the extravasant. Results are reportedly better if irrigation is done within six hours of injury[20], and animal models suggest that it should preferably be within one hour[14]. However it is important to note that there has been no randomised trial demonstrating any proven benefit of irrigation over either expectant or topical management.

Conclusion

Extravasation remains the commonest iatrogenic injury within neonatal care. The last fifteen years have seen a considerable shift in some units towards irrigation as a means of management. The physiological argument of removing the extravasant is powerful, but there remains no evidence base to show significant benefit of this treatment over topical or conservative management. The feasibility of carrying out irrigation and the training required also need to be considered. The argument for the use of hyaluronidase in the extreme preterm is less powerful, demonstrating even more clearly the need for further work in this common, yet all too neglected, area of neonatology.

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