Preventing medical device-related skin damage

Hannah Liversedge

Abstract
While medical technology is continuing to improve healthcare outcomes and quality of life for patients, the number of people affected by medical device-related skin damage is increasing. In many cases, life-preserving medical devices used in interventions such as nasal continuous positive airway pressure or oxygen therapy can cause significant skin damage, with negative consequences including pain, infection and delayed hospital discharge. This article outlines methods that nurses can use to minimise the risk of skin damage, focusing primarily on the prevention of pressure ulcers. It also examines how nurses can work collaboratively with patients, manufacturers and regulatory bodies to reduce the risk of medical device-related skin damage in the future.

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Advances in medical technology over the past 20 years have enabled many people with serious health conditions to experience significant improvements in quality of life, regain their mobility and independence, and gain control over their health. In some cases, these improvements in medical technology have been life-saving. For example, insulin pump therapy has been associated with reduced cardiovascular mortality among people with type 1 diabetes compared with the use of multiple daily insulin injections (Steineck et al 2015). However, these improvements can also lead to new challenges such as medical device-related skin damage, which can be caused by a range of devices including tubing, face masks and adhesive dressings. For example, in one retrospective analysis of hospital and hospice patients in the US and Canada, more than 8% of pressure ulcers were caused by medical devices (Kayser et al 2018).

As with any other type of iatrogenic skin damage (relating to medical treatment), medical device-related skin damage can cause pain and increased risk of infection (Reunes et al 2011, McGinnis et al 2014). Other consequences include delayed discharge from hospital and the increased financial burden incurred by treatment costs (Dealley et al 2012). Damage from medical devices can cause long-term scarring, which is a particular issue for children who can experience lifelong consequences (Manning et al 2015). In some cases, it may be necessary to substantially alter a patient’s care plan if medical device-related skin damage occurs. For example, in neonatal intensive care units (ICUs), some patients may need to be reintubated as a result of skin damage from nasal continuous positive airway pressure (CPAP) (Newnham et al 2013), increasing the risk of other types of iatrogenic damage. Skin damage from CPAP can involve any interface between the skin and the CPAP equipment, including the tubing, mask and straps. Similarly, a case has been reported of a child requiring a tracheostomy because of complications from non-invasive respiratory support, including pressure ulcer development (Tan et al 2016). In rare cases, surgery has been required to treat medical device-related skin damage that cannot be resolved with conservative treatment (Sleilati et al 2008).

Some cases of medical device-related skin damage may be unavoidable because the device is essential to preserve life, for example endotracheal tubes; however, there are steps that
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Medical device-related skin damage can cause pain and increased risk of infection (Reunes et al 2011, McGinnis et al 2014). Other consequences include delayed discharge from hospital and the increased financial burden incurred by treatment costs (Dealey et al 2012).

While there are some medical devices that are frequently associated with skin damage, such as those used in nasal continuous positive airway pressure, issues have been reported with a multitude of products, in a wide range of healthcare settings, and across all ages.

Wherever possible, nurses should ensure that the skin underneath a medical device is assessed regularly, because medical device-related pressure ulcers can develop more quickly than pressure ulcers caused by other factors such as immobility (Kayser et al 2018).

Any decisions about which medical device to use must be individualised to a patient’s specific needs. It is also important to take into account the risk of medical device-related skin damage when making decisions in relation to their care and treatment. However, it is often challenging to find a medical device that fits the patient well, particularly in neonates, children.

Key points

- Medical device-related skin damage can cause pain and increased risk of infection (Reunes et al 2011, McGinnis et al 2014).
- While there are some medical devices that are frequently associated with skin damage, such as those used in nasal continuous positive airway pressure, issues have been reported with a multitude of products, in a wide range of healthcare settings, and across all ages.
- Wherever possible, nurses should ensure that the skin underneath a medical device is assessed regularly, because medical device-related pressure ulcers can develop more quickly than pressure ulcers caused by other factors such as immobility (Kayser et al 2018).

Common causes of medical device-related skin damage

While there are some medical devices that are frequently associated with skin damage, such as those used in CPAP, issues have been reported with a multitude of products, in a wide range of healthcare settings, and across all ages. Case studies reported in the literature include skin indentation from cervical collars (Ham et al 2016), pressure ulcers from orthopaedic braces (Su and Nan 2014), and rectal trauma from faecal management systems (Sparks et al 2010). Medical devices are a common cause of pressure ulcers in children and neonates, and in high-acuity environments such as ICUs there are frequent challenges involving medical device-related skin damage (Black et al 2010, Schlüer et al 2014). Devices that are used widely, such as pulse oximeters, may also be associated with serious complications such as full-thickness burns (Bunker et al 2014). Medical devices such as male urinary sheath catheters, peripherally inserted central catheters (PICCs), and the tubing used in percutaneous endoscopic gastrostomy (PEG) feeding, have been associated with skin damage in the hospital setting (Shah and Shahidullah 2018, Sinha et al 2018, Zhao et al 2018). It is reasonable to assume that these and other devices also pose a risk of skin damage in the community setting, although evidence is limited. Anecdotally, issues have been reported in the community setting with devices such as home oxygen nasal cannulae.

Products that are intended to preserve skin health may also cause skin damage in some patients. For example, acrylic-containing dressings may cause sensitisation and allergic contact dermatitis in patients following regular or prolonged use (Mestach et al 2018). Epidermal stripping through the use of medical adhesives has also been reported in neonates, particularly preterm neonates (Fox 2011, August et al 2014). The adhesive dressings used to secure PICCs may be associated with several types of skin damage, including mechanical trauma and contact dermatitis (Zhao et al 2018). However, the full extent of skin damage caused by medical adhesives in acute and community settings is not clear, and further research in this area is required.

Medical devices may also have a role in the development of pressure ulcers. However, the risk factors associated with the development of medical device-related pressure ulcers have not yet been fully explored (Black et al 2010). Most pressure ulcer risk assessment tools used in acute settings do not consider the risks posed by medical devices; however, an exception is the Glamorgan paediatric pressure ulcer risk assessment scale (Willock et al 2009), which is designed for use in children and young people.

Little research has been undertaken into the factors that increase a person’s risk of developing medical device-related pressure ulcers, other than the presence of a device itself. Therefore, when attempting to assess an individual’s risk of developing skin damage resulting from the use of a medical device, it is important to consider factors that have been shown to contribute to pressure ulcers related to immobility, such as suboptimal nutrition (Iizaka et al 2010).

Fit of medical devices

Nurses should consider the fit of any medical device when attempting to minimise the risk of skin damage. Medical devices such as respiratory masks that are too large may rub against the patient’s skin, increasing the risk of friction and shearing forces, or causing skin irritation. Medical devices that are too small or tight increase the risk of pressure ulcers. In addition, healthcare staff may tighten devices such as respiratory masks used in CPAP to achieve the optimal airtight seal (Visscher et al 2015), further increasing the risk of pressure damage to the patient’s skin and soft tissues (Worsley et al 2016).

Total face masks are associated with a reduced risk of skin damage compared with oral or nasal respiratory masks (Yamaguti et al 2014). Trials in healthy volunteers have indicated that total face masks are also associated with a reduction in pain experienced on the bridge of the nose, suggesting that their use may reduce pressure to this high-risk area (Holanda et al 2009).

Any decisions about which medical device to use must be individualised to a patient’s specific needs. It is also important to take into account the risk of medical device-related skin damage when making decisions in relation to their care and treatment. However, it is often challenging to find a medical device that fits the patient well, particularly in neonates, children.
and people with atypical anatomy such as craniofacial abnormalities (Cielo and Marcus 2015, Tan et al 2016). The advent of 3D printing has provided a possible solution that involves the creation of bespoke masks based on scans of patients’ faces, and has been used in the context of radiotherapy and burns treatments (Briggs et al 2016, Wei et al 2017). Although mathematical models have also been proposed for the custom design of respiratory masks, there is little research into their application in a clinical context (Chu et al 2013). Additionally, following a successful trial in healthy volunteers, Brill et al (2018) suggested that taking objective pressure measurements using pressure-sensing scanning technology at the interface between the mask and the skin may be useful when fitting non-invasive ventilation masks. Both healthcare professionals who were trained in mask fitting and those who were untrained were able to reduce pressure on the nasal bridge when fitting a mask using this system of pressure measurement (Brill et al 2017). While this technology is not used widely in clinical settings, similar to 3D printing, it is emerging as an intervention that may prove effective in the future.

**Dressings and securing medical devices**

When balancing the benefits of preserving skin health with providing optimal care, it is important for nurses to consider the method that has been used to secure any medical device to the skin. Since some adhesive tapes used in healthcare settings may contain allergens or cause epidermal stripping, nurses should consider asking patients about their skin sensitivities as part of any holistic nursing assessment. It is also important to ensure that any medical device is applied using a method that distributes pressure as evenly as possible (Worsley et al 2018). In addition, following the manufacturer’s instructions for application should minimise the risk of harm, so nurses should ensure they are familiar with the correct process for applying any devices (National Pressure Ulcer Advisory Panel (NPUAP) et al 2014).

In some clinical settings such as paediatric ICUs (Murray et al 2013), prophylactic foam dressings that can provide pressure redistribution and absorb excess moisture are recommended for use underneath medical devices to preserve skin integrity. Prophylactic foam dressings may be beneficial in minimising the risk of pressure ulcers from medical devices (NPUAP et al 2014), although there is little evidence to suggest that any type of dressing is more effective than others in the prevention of medical device-related pressure ulcers (Clark et al 2014). Furthermore, prophylactic foam dressings should be used with caution, because they may increase the overall pressure on the skin and soft tissues (NPUAP et al 2014). It is important for nurses to remember that the application of prophylactic foam dressings under a medical device does not negate the need to reposition the device and assess the skin underneath regularly (Black et al 2015). Therefore, if the application of a prophylactic foam dressing obscures the skin in such a way as to make regular assessment impossible, it may be appropriate to omit the dressing and instead increase the frequency of skin assessment or repositioning of the medical device. The risk of damage to the skin on dressing removal should also be considered when deciding whether prophylactic foam dressings are appropriate (Matsumura et al 2014), and a specialist dressing removal product should be used if necessary.

**Skin assessment**

Wherever possible, nurses should ensure that the skin underneath a medical device is assessed regularly, because medical device-related pressure ulcers can develop more quickly than pressure ulcers caused by other factors such as immobility (Kayser et al 2018). This means that proactive assessment of the skin underneath a device is an essential aspect of the prevention and management of pressure ulcers. As part of the assessment, the nurse should observe the skin for signs of blanchable erythema and indentation, which are an indication that the skin and soft tissues underneath the medical device are becoming compromised. If possible, these areas of pressure should be relieved or alleviated, for example in most cases pulse oximeters can be rotated regularly between digits, although the manufacturer’s guidance must be consulted. Another example is for the nurse to alternate between using a nasal prong and a nasal mask when administering neonatal CPAP to reduce the risk of medical device-related skin damage (Newnam et al 2015).

The patient’s skin should also be assessed for signs of moisture. Perspiration often pools underneath medical devices and the skin may become damp from condensation where a patient is receiving humidified oxygen. In addition, some medical devices such as stoma flanges or respiration masks are likely to come into contact with other bodily fluids, such as urine, gastric juices or respiratory secretions. Excessive moisture weakens the outer layer of the skin (the stratum corneum) and decreases the skin’s resistance to friction, particularly in women (Gerhardt et al 2008, Schwartz et al 2018). Skin that is constantly wet is also at risk of maceration (the softening and breaking down of skin resulting from prolonged exposure to moisture) (Whitehead et al 2017). Therefore, ensuring that the skin underneath a medical device remains dry is an essential step towards maintaining its integrity.

It is also important to regularly assess the necessity of implementing the medical device, to ensure its continued use is appropriate. One literature review of the use of peripheral intravenous catheters in emergency departments suggested that around 32% were inserted as a ‘just-in-case’ measure (Gledstone-Brown and McHugh 2018). Similarly, the inappropriate use of urinary catheters is an issue in hospital settings (Tiwari et al 2012). As well as the risk of infection, both of these types of catheter have been associated with skin damage (Schlüer et al 2014, Kayser et al 2018). Ensuring that devices are not used unnecessarily, and are removed as soon as is clinically appropriate, is
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an essential component of preventing medical device-related skin damage.

**Patient education**

Patient education is recognised as an essential aspect of providing safe and effective healthcare, and campaigns such as Stop the Pressure (nhs.stopthepressure.co.uk) in the UK include targeted information for patients and carers about how to prevent pressure ulcers (Guy et al 2013). In one study undertaken in Australian nursing homes, education of the residents was viewed as essential to the success of a care bundle associated with a reduction in pressure ulcers (Price et al 2017).

When considering the use of a medical device, nurses should ensure that they provide advice to patients about skin care and the prevention of skin damage. If patients are aware of the risks of skin damage and how to prevent it, this will enable them to be actively involved in this process (Price et al 2017). In addition to preventing skin damage from developing in the first instance, patient education is likely to prevent any skin damage from deteriorating, particularly because the patient – as the person receiving the treatment – is most likely to notice if the medical device begins to affect their skin. If a patient or their relatives are alerted to the potential for a medical device to cause skin damage, they may be increasingly likely to report any signs of deterioration such as erythema, indentation and discomfort, rather than viewing these as inevitable side effects of treatment. By encouraging patients to self-report any signs of deterioration, nurses increase the likelihood that the development of skin damage such as pressure ulcers will be identified early and prevented from progressing further (Garber et al 1996).

Nurses in acute settings should consider the health of patients’ skin in any discharge planning, particularly in patients with complex health needs who may require treatment that involves the use of medical devices for an extended period, such as home oxygen therapy or PEG feeding. Patients will often be maintaining and/or operating a medical device themselves, or receiving assistance from a parent, partner or other informal carer. Therefore, information about skin care and the risk of medical device-related skin damage should be included in any patient education provided on discharge. It may also be appropriate for the nurse to contact other services to ensure that any medical devices are appropriate. For example, an occupational therapist may be able to advise on the management of medical devices prescribed for long-term use in the community (Rose and Mackenzie 2010).

**Collaboration with manufacturers**

In some cases, it is not possible to prevent medical device-related skin damage. Some devices that are frequently associated with skin damage, such as endotracheal tubes or arterial catheters, are essential to preserve life and cannot be resited or repositioned (Black et al 2010). Similarly, in some cases it may not be possible to identify a medical device that fits the patient perfectly. In these situations, the healthcare professional could consider collaborating with device manufacturers to develop a bespoke method of preventing harm. For example, healthcare professionals on a long-term ventilation unit in the US observed there was a high rate of children developing tracheostomy-related pressure ulcers in the unit (Boesch et al 2012). Alongside staff education and increased skin assessments, the healthcare professionals worked with a manufacturer to develop a tracheostomy tube that did not rub on the child’s chest or neck, resulting in a significant decrease in the prevalence of pressure ulcers (Boesch et al 2012).

**Reporting medical device-related skin damage**

Any form of harm resulting from the use of a medical device, including skin damage, should be reported to the relevant regulatory body such as the UK Medicines and Healthcare products Regulatory Agency (MHRA). Anyone can report an incident involving a medical device to the MHRA through its Yellow Card Scheme (MHRA 2019a).

The scheme has been successful in identifying previously unknown adverse effects of various medicines and devices. For example, following reports of skin damage from the use of medicated corn removal plasters containing salicylic acid, the manufacturer included a warning about potential skin irritation in the product information (MHRA 2019b). Yellow Card incident reports should be completed in addition to any incident report submitted within their local healthcare organisation, although some healthcare computer systems enable this to be undertaken simultaneously.

An essential aspect of the nurse’s role is to report patient safety issues and escalate these where necessary, and this includes sharing information to identify and minimise any risks associated with care (Nursing and Midwifery Council 2018). Thus, issues that may not have been considered when the medical device was first developed can be addressed by the manufacturers to ensure future safety.

**Conclusion**

Medical device-related skin damage, including pressure ulcers, is a significant issue in a range of clinical settings. Various medical devices can cause skin damage, including some that are essential to preserve life. Although medical device-related skin damage is particularly apparent in high-acuity environments such as ICUs, any patient whose treatment involves the use of a medical device may be at risk. However, there are steps that nurses can take to minimise the risk of skin damage, including regular skin assessments, pressure relief where possible, and the removal of medical devices when they are no longer necessary.

By working collaboratively with patients and their family members, other healthcare professionals, and manufacturers, nurses can reduce the risk of medical device-related skin damage. In cases where it cannot be prevented, nurses can have a crucial role in minimising the risk of medical device-related skin damage in the future, through effective collaboration with manufacturers and reporting cases to the relevant regulatory body.