Moisture-associated skin damage in an intensive care unit setting

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In an Intensive care unit (ICU) the focus is mainly on keeping people alive. That is the most important perspective. At the same time, some patients stay in ICU for a long time and other nursing-related problems must be solved during their stay. Moisture-associated skin damage (MASD) is a group of skin problems that may also occur while the patient is in ICU. Some MASD-related problems are very common in ICU and should be handled professionally by the staff. This article identifies how MASD-related problems are discovered and how they are treated according to the latest knowledge and standards within an international context.

Moisture-related skin issues have always been a nursing problem. But for the past three decades we have categorised these as different kinds of problems. Diaper dermatitis (now called incontinence-associated dermatitis, or IAD) was the first group of moisture-related conditions to be investigated more scientifically (Langøen et al, 1993). In 2011, the term 'moisture-associated skin damage' (MASD) was used in a series of articles (Black et al, 2011; Colwell et al, 2011; Gray et al, 2011). MASD was defined as "inflammation and erosion of the skin caused by prolonged exposure to various sources of moisture, including urine or stool, perspiration, wound exudate, mucus, or saliva" (Gray et al, 2011). MASD now includes four different conditions that cause skin damage due to moisture (Woo et al, 2017). These are:

- Incontinence-associated dermatitis (IAD)
- Intertriginous dermatitis (ITD)
- Periwound skin damage
- Peristomal MASD.

In their article, Valls-Matarín and colleagues added two more conditions to the list (Valls-Matarín et al, 2017):

- Exudate-associated cutaneous dermatitis (EACD)
- Dermatitis due to saliva or mucus.

But these two conditions are rarely included in the list for MASD. All these conditions have some pathophysiological similarities. The moisture causes keratinocytes and intraepidermal lipids to dissolve, causing damage to the skin barrier function. Although these four conditions have some pathophysiological differences, their similarities mean that many of the preventive and therapeutic considerations are applicable to all four conditions.

Moisture associated skin damage (MASD) in the intensive care unit (ICU)

An ICU differs from other clinical departments in many ways. The patients are sicker, and the clinical focus is very much on respiration and circulation. But these units are normally well equipped and have skilled personnel. Another difference is that most of the patients have an indwelling urine catheter, reducing the risk of IAD caused by urine. Therefore, in an ICU setting, IAD is mostly caused by faecal incontinence.

Several authors have investigated the prevalence and incidence of MASD and related conditions in an ICU setting (Valls-Matarín et

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al, 2017; Werth and Justice, 2019; Johansen et al, 2020), while others have investigated the prevalence of IAD only (Bliss et al, 2011; Campbell et al, 2016; Wang et al, 2018).

The findings from this research are that IAD is the most common MASD problem. The prevalence of IAD in an ICU setting varies greatly. In an article by Johansen et al (2020), the prevalence was 5%, while in the USA they found prevalence of 36% (Bliss et al, 2011). Others have found prevalence of 26.2% (Valls-Matarín et al, 2017) and 23.9% (Wang et al, 2018). IAD is obviously a big problem in ICUs. IAD in an ICU setting differs from that in other clinical settings since patients in an ICU have an indwelling catheter (Johansen et al, 2020). This means that urine is rarely causing the skin problems.

The second-most common MASD condition in the ICU is ITD. Valls-Matarin et al (2017) report that 15.9% of the patients in an ICU had ITD. Periwound skin damage and peristomal MASD is rare in an ICU setting.

Identifying the true prevalence of MASD is complicated by the occurrence of pressure ulcers, particularly categories 1 and 2, which appear mostly in the same body areas as IAD, but are caused by pressure and shearing forces. Moisture damage increases the risk of pressure ulcers (Beeckman et al, 2014; 2015), but they are not the same and are not necessarily always linked. Pressure ulcers are often misdiagnosed as IAD, or IAD is misdiagnosed as a pressure ulcer. In a Spanish study, as many as 40% of nurses misdiagnosed lesions in the intergluteal cleft (Valls-Matarín et al, 2017).

Pathophysiology in the development of MASD

The four conditions included in MASD have two things in common (Gray et al, 2011; Woo et al, 2017):

1. They are all related to prolonged exposure to various sources of moisture
2. The skin barrier function is impaired, and different kinds of skin irritants can cause inflammation.

The impaired skin barrier function is important, and many of the preventive and treatment activities we carry out are to restore the skin barrier function. The skin barrier function can be categorised according to three different functions (Langøen and Bianchi, 2013):

- Physical barrier
- Chemical barrier
- Immunological barrier.

The epidermis is the uppermost layer of the skin and is mostly responsible for the physical barrier function of the skin. The epidermis is then categorised into five strata. The uppermost stratum, the stratum corneum (SC), is essential to the barrier function. In the SC there are keratinocytes that are lubricated by intra-epidermal lipids, consisting mainly of ceramides (50%), cholesterol (25%) and free fatty acids (15%) (Fluhr and Darlenski, 2009). Damage to the keratin envelope and/or the intra-epidermal lipids in the SC will result in impaired barrier function (Langøen and Bianchi, 2013). Different MASD conditions impair the skin and epidermis in different ways.

Incontinence-associated dermatitis

In IAD, urine incontinence is a vital factor. Skin can handle moisture if the barrier function is intact. When bacteria and urine are mixed, the bacteria on the skin break down urine into ammonia. Ammonia causes an increase in the pH of the skin (Langøen and Bianchi, 2013). The increased pH enhances the enzymatic activity caused by proteases and lipases that we find on the skin (Black et al, 2011). When the patient also has faecal incontinence, the amount of protease and lipase increases dramatically, especially if the faeces are loose or liquid. The enzymes break down the SC by dissolving both the protein (keratin) and the lipid envelope of the keratinocytes. The mechanical barrier is damaged and bacteria, ammonia, bile salts and other irritating substances can penetrate the SC barrier and cause inflammation in the skin (Black et al, 2011; Langøen and Bianchi, 2013; Beeckman et al, 2015). Also, frequent use of soap and water, friction from diapers and occlusion can contribute to the breakdown of the barrier function (Langøen and Bianchi, 2013).

Intertriginous dermatitis

Intertriginous dermatitis (ITD) normally appears in areas of the body where we have skin folds (intertriginous areas). Sweat, water and soap from cleansing procedures and urine become trapped in the skin fold and cannot evaporate (Black et al, 2011). Gradually, the same mechanism as in IAD develops (Lumbers, 2018). The keratin and lipid envelope around the keratinocyte and intra-epidermal lipids are degraded and dissolved. The pH of the skin rises due to humidity, the breakdown of sweat and urine into ammonia and the soap residue left on the skin after rinsing. The moisture, together with raised pH, increases the risk of fungal infection (Farage et al, 2010). We see a clinical

picture where the skin in intertriginous areas is gradually dissolved and turns white, very often with a pink centre.

Periwound skin damage

Periwound skin problems are a complex condition with different mechanisms due to the type of wound. Stasis eczema in venous leg ulcers and hyperaemia due to shearing forces and pressure in pressure ulcers, cause skin damage to the periwound skin. But these conditions are not necessarily moisture-dependent and are therefore not regarded as MASD (Colwell et al, 2011). On the other hand, wound exudate, especially from non-healing wounds, breaks down the skin barrier function (Langøen and Lawton, 2009). Exudate from non-healing wounds has a high amount of matrix metallo protease (MMP) (Colwell et al, 2011). The high content of MMP is one of the main reasons for the wounds' non-healing condition. The pH in non-healing wounds is very often high (Percival et al, 2014), between 7.5 and 8.6. Pathogenic bacteria such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* contribute to the production of an alkaline environment, and this is also preferrable for these bacterias (Percival et al, 2014). The alkaline pH increases the effect that MMP has on keratin. The pH is reduced when a wound becomes a healing wound (Power et al, 2017). High skin pH, a high level of MMP and moisture trapped under a bandage all contribute to the development of periwound skin problems.

Peristomal MASD

Peristomal moisture-associated dermatitis is defined as "inflammation and erosion of skin related to moisture that begins at the stoma/skin junction and can extend outward in a 4-inch radius" (Colwell et al, 2011).

The frequency of peristomal MASD varies in different research reports due to research method and quality of the hospital's follow-up system. A Swedish prospective study followed 180 patients for two years after surgery. They found that most complications occurred within the two weeks after discharge. The most common complication was skin problems around the stoma. In end-ileostomy, 60% of patients experienced MASD-related problems, while 73% of patients with loop-ileostomy had MASD problems. In colostomy, the frequency was much lower at 20% (Persson et al, 2010)

There are different types of stomas, but this article is primarily focused on stomas in the GI tract and uro-genital system. In these stomas the mechanism is very similar to IAD (Colwell et al, 2011).

Mechanisms that contribute to peristomal MASD are:

- Prolonged exposure to moisture
- High content of urine (urostomy)
- High content of faecal enzymes, such as protease and lipase (ileostomy and colostomy)
- In Ileostomy the faecal content has a high pH, increasing the effect of protease and lipase (Beeckman, 2017)
- Frequent use of soap and water to remove faecal content from the skin.

There are some mechanisms, however, that are unique to peristomal MASD. The use of protective bandages, such as hydrocolloids, causes stripping when the bandage is removed. Leakage under the hydrocolloid leads to humidity and destruction of the skin (Colwell et al, 2011).

Prevention and treatment of MASD

Since these four types of skin damage are related to prolonged exposure to moisture and damage to the skin barrier function, prevention and treatment of MASD must address these two issues. Beeckman et al (2015) sum up the management of MASD with the acronym CPR, meaning cleanse, protect and restore the skin. Woo et al (2017) have a more detailed list of procedures to manage MASD.

1. Cleanse the skin with proper detergent. Use a synthetic detergent, either in liquid form or as a wipe. Avoid any form of alkaline soap with a high pH. There are two reasons for this. Alkaline soap damages the skin more than synthetic detergent, and alkaline pH on the skin contributes to the breakdown of the skin (Langøen and Bianchi, 2013)
2. Use absorbent dressings/diapers to collect moisture. Modern absorbent dressings and diapers remove moisture from the skin and trap it within the bandage. Some bandages and diapers use superabsorbent material to trap the moisture away from the skin. Many bandages use polyurethane foam or carboxymethyl cellulose (CMC) to trap moisture (Cowan, 2017). This is very important both to prevent and to treat both IAD and periwound skin damage
3. Use atraumatic tapes and adhesives. Some of the damage to the skin is caused by the stripping effect of tape on the SC. Using atraumatic tapes such as silicone tape

reduces the stripping effect (Lawton and Langøen, 2009)

4. Apply a barrier to vulnerable skin. We have access to a lot of new formulations that protect the skin, but the old mix of zinc oxide and white Vaseline (40/60), also called zinc paste, remains one of the best ways to protect the skin (Gray and Weir, 2007). The problem is that it is very difficult to remove and makes the use of adhesive dressings impossible. Besides zinc paste, the best alternatives are polymer film barrier preparations and barrier products containing cyanoacrylates (Woo et al, 2017)
5. Treat skin problems such as dermatitis and infections that lead to impaired barrier functions. This can be done either by protecting the damaged skin or by treating the infection. Very often, skin infections related to MASD are fungal infections, so antifungal treatment must always be an option (Langøen and Bianchi, 2013). Be aware that if you use polymer film barrier preparations or barrier products containing cyanoacrylates, the skin is so protected that an antifungal treatment will be useless for 72 hours. If the problem is more of a toxic or allergic dermatitis, then a cream or an emollient containing corticosteroids is the best option (Langøen and Lawton, 2009). Therefore, the diagnosis here is important. When treating fungal infection, a systemic treatment should also be considered, especially if it can be seen that the patient scratches the area, as the infection may then be transferred to other areas of the body (especially the eyes and mouth) under the nails
6. Regularly assess skin that is in danger of damage. Skin inspection is an important part of the work of the health professional. If this is done regularly, a healthcare professional will improve their ability to assess the skin. Since some of these conditions can be challenging to evaluate, regular education and training are the only option. As previously mentioned, 40% of the nurses in a Spanish ICU diagnosed a lesion in the intergluteal cleft as a pressure ulcer when it was IAD (Valls-Matarín et al, 2017)
7. Prevent skin damage and secure optimal skin health. Emollients can also be used for prevention. Ensure a strong SC with moisture content of 10% (Woo et al, 2017). Moisture content in the SC that is too high or too low increases the risk of impaired barrier function. Emollients containing natural moisturising factors (NMF), such as glycerine, lactic acid or urea, will contribute to a good moisture balance in the SC.

Conclusion

MASD is common in ICU settings. The personnel working in these units are very accomplished at handling respiratory and circulatory problems, but they do not necessarily have the same focus on skin problems, which arise from pressure and/or shearing forces or from prolonged exposure to moisture. Nevertheless, we all want these personnel to manage our respiratory and circulatory problems if we get sick. However, it is possible to inspect skin sites where we know moisture can cause skin problems. Good prevention is effective and should be performed as soon as signs of damage to the skin barrier are visible. Quality insurance projects are well suited for these types of improvement work. This way the personnel at ICU can expand their focus on the patient and secure a correct and knowledge-based treatment plan that can save a lot of energy for clinicians and a lot of suffering for patients. WINT

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