



Science.  
Applied to Life.™

# State of skin:


Elevating the science  
of skin management



# Contents

<b>Introduction.....</b>	<b>3</b>
<b>Why skin matters.....</b>	<b>10</b>
Structure of skin.....	12
Genetics and lifestyle.....	14
Environmental factors.....	14
How skin changes over your lifetime.....	15
Underlying conditions and diseases.....	17
<b>A comprehensive framework for skin management.....</b>	<b>18</b>
Maintaining the integrity of skin.....	20
Safe securement to skin.....	20
Repairing injured skin.....	21
Help prevent infection.....	21
<b>What happens when skin is not considered or managed?.....</b>	<b>22</b>
Medical Adhesive-Related Skin Injury (MARSI).....	24
Moisture-Associated Skin Damage (MASD).....	26
Pressure Ulcer/Injury (PU/I).....	27
Bloodstream Infection (BSI).....	28
Unplanned Extubation (UE).....	30
Chronic Wounds (Venous Leg Ulcer (VLU)/Foot Ulcer).....	31
Surgical Site Infection (SSI).....	33
<b>A holistic approach to skin health.....</b>	<b>34</b>
People.....	36
Practice.....	38
Products.....	39
<b>The science of skin advancements.....</b>	<b>40</b>
<b>Putting skin at the front line of health.....</b>	<b>45</b>
<b>References.....</b>	<b>50</b>






“We focus on the heart. We focus on the lungs. But we don’t focus on the skin, and the skin is the gateway to the entire body.”

– former NICU nurse  
discussing nursing education






“Skin can be an entry  
for germs. We have  
to be diligent in  
making sure her skin  
is clean because  
those germs could  
be devastating to her.”

– *mom of a daughter with a  
primary immunodeficiency disorder*






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“He’s got a 7-inch  
scar on his head with  
80 staples and I am  
asking myself, how  
can I care for this  
wound on his skin?”

*– wife providing care to her  
husband with brain cancer*



A close-up photograph of human skin, showing a vertical surgical scar. The skin is a warm, brownish-tan color. The scar is a lighter, pinkish-purple hue, with some raised, irregular tissue along its length. The lighting is soft, highlighting the texture of the skin and the details of the scar.

“The emotional connection with your skin is something you don’t realize until it’s compromised.”

– *woman managing skin issues resulting from a surgically related medical error*



A close-up photograph of human skin. The skin is light-colored with visible pores and fine hairs. There is a prominent, irregularly shaped area of redness and irritation, likely a sunburn, located in the lower-left quadrant of the image. The redness is more intense in some areas, appearing almost purple-red, and fades into the surrounding normal skin color in others. The texture of the skin appears slightly rougher in the affected area.

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“Skin is  
non-refundable.”

*– perspective from a 57-year-old adult who burned off her epidermis from prolonged sun exposure*



## Five different experiences. One thing in common. **Skin.**

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It's an ever-present, always visible entity that we see but don't really look at closely until something is wrong. Skin is a window to who we are as people. For these five people, skin means something more than smile lines and human touch. It means pain. It means heartbreak. It means sadness. It means livelihood. It means life-changing experiences.



**Imagine watching your spouse dying of brain cancer,** and as you're processing losing the love of your life, you are thrust into the role of caregiver, where conversations center around good days versus bad days. Now imagine those good and bad days are all connected to the pain of your spouse's skin. Not his chemo treatments. Not his cancer. But instead, how badly the dressings hurt his already fragile skin.

**Imagine a grandmother living in fear when playing with her grandkids** because an accidental scratch or bump can turn into an hours-long bleed followed by a severe scar and possibly massive infection. Imagine if skin wasn't just an organ, but it was a constant reminder of how you need to operate in daily life. That's because everything from putting on a shirt to going to work can mean the difference between severe pain or no pain.

**Imagine going in for surgery to better your life and stop your constant, chronic pain.** Now imagine that surgery resulting in scarring and continued pain, creating a new connection to your body – a connection where driving a car, hugging your children and dancing with your spouse have all changed because of your compromised skin.

## **Skin matters. Skin is personal. Skin is human.**

What would happen if we thought differently about skin?

What would happen if we elevated its importance when delivering care?

How would it better a person's health care experience when they're sick and when they're well?

How could thinking skin first change someone's life?



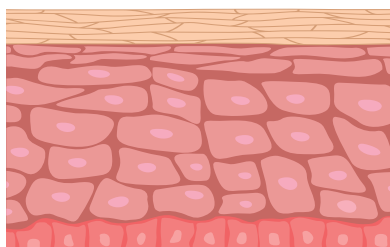
A close-up photograph of aged, wrinkled skin, showing deep creases and a rich, warm brown color. The texture is highly detailed, with many small ridges and valleys. A solid red horizontal line is positioned below the text.

# Why skin matters



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The skin is a dynamic organ, reflecting who we are in the presence or absence of a health condition or disease. As the largest organ in the body, skin is critical to the maintenance of our bodies and our health. When skin is damaged, it can negatively impact our psychological and physical health.<sup>1,2</sup> The skin's ability to act as a barrier against damage and infection depends on a variety of factors, including:



**Structure of skin**



**Genetics and lifestyle**



**Environmental factors**



**How skin changes over your lifetime**



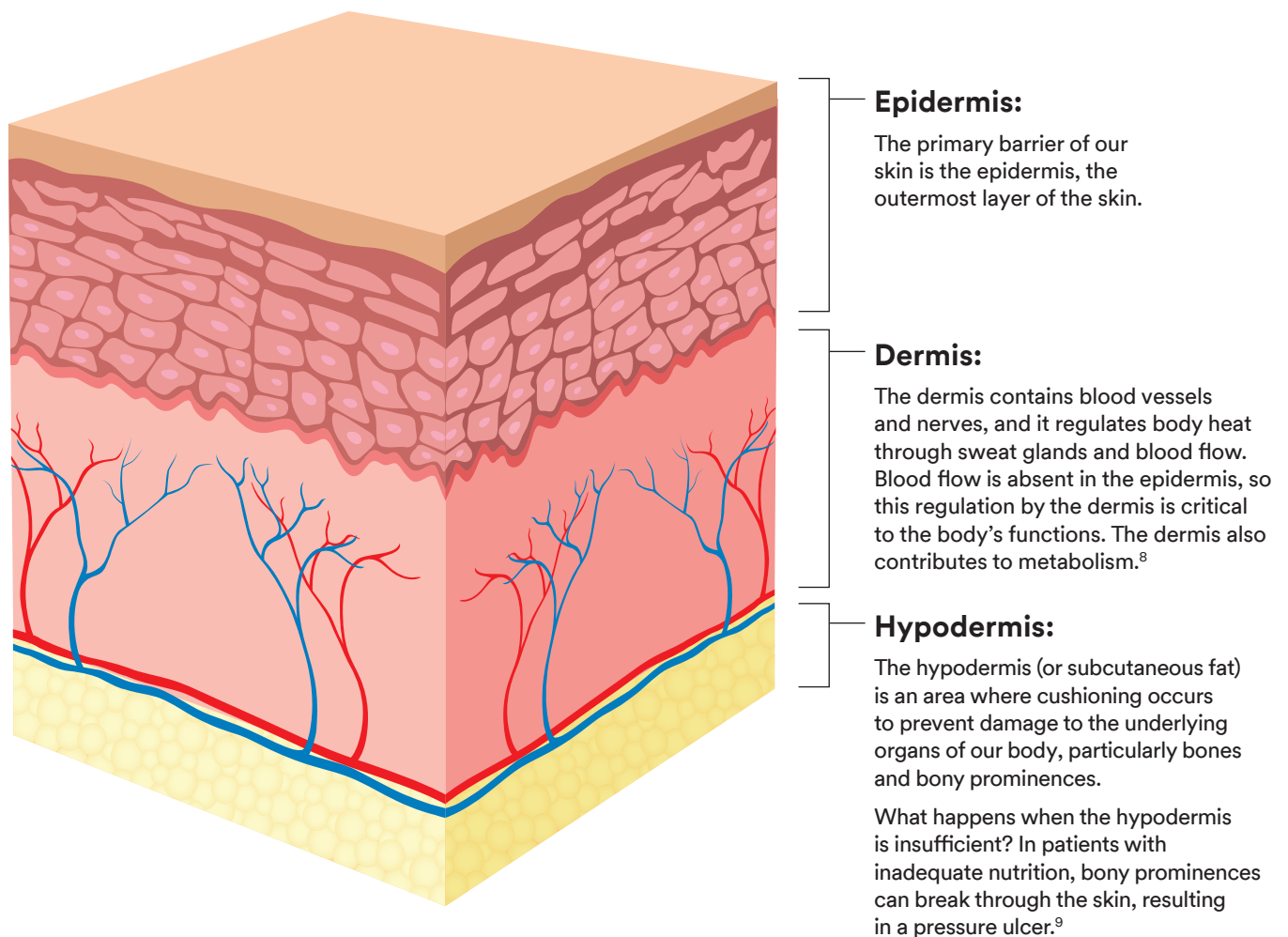
**Underlying conditions and diseases**



# Structure of skin

The barrier function of the skin is both dynamic and complex.<sup>3</sup> Researchers and scientists have learned that we live, for the most part, in harmony with a large number of bacteria in the environment.<sup>4</sup> Based on current estimates, it's believed that we have more bacteria on the parts of our bodies exposed to the environment than we have cells in our bodies.<sup>5</sup> Bacteria form communities that exist in a delicate balance, and these bacterial communities are required for normal skin function. Collectively, this grouping of bacteria is known as a microbiome or microbiota.<sup>6</sup>

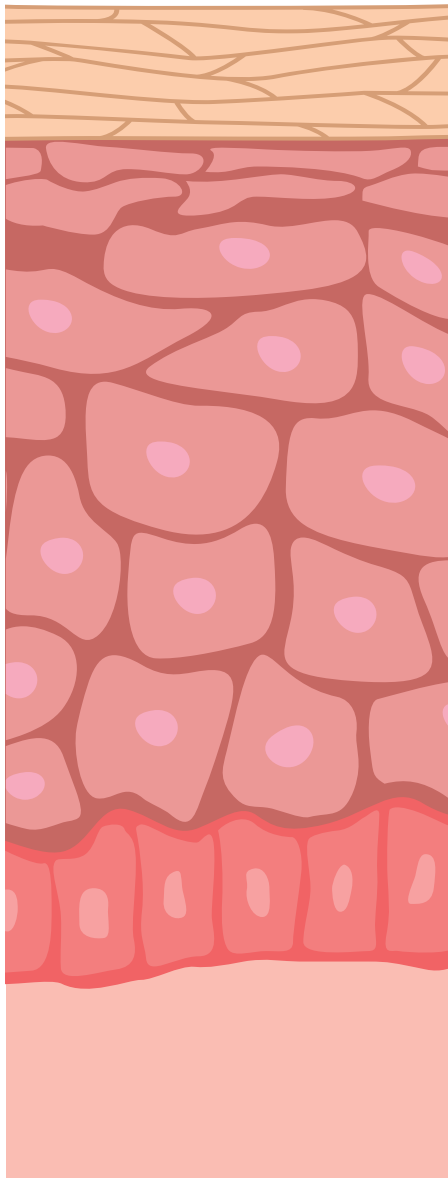
**The skin is composed of multiple layers: hypodermis (or subcutaneous fat), dermis and epidermis.<sup>7</sup>**





# Structure of skin

The epidermis consists of multiple layers.



## Stratum corneum:

The layers between the basal layer and the outermost layer (the stratum corneum) have viable cells. Like the dermis, these cells perform metabolic functions, particularly related to vitamin D metabolism, but the cells also produce sufficient acid to reduce the pH of the skin's surface to approximately 5.0. This mild acidity forms the acid mantle that acts as the first line of defense against disease-causing bacteria.

The stratum corneum is thin – no thicker than a sheet of paper – and is composed exclusively of dead cells. These cells are refreshed by the migration of living epidermal cells from the basal layer to the surface.

While the cells of the stratum corneum may be dead, their function remains and their biochemistry is critical to maintaining normal fluid levels in the skin.

The stratum corneum is covered with the bacteria of the skin's microbiome.

A protein called filaggrin determines normal fluidity of the epidermis.

## Basal layer:

The basal layer produces cells that migrate toward the skin's surface and subsequently die.



## Genetics and lifestyle



Genetics and lifestyle help to determine the health of our skin. Today, researchers and scientists are more familiar with genetics and genetic makeup than ever before. It's now possible to learn about your genetic makeup by providing saliva or blood samples to genetic testing companies.<sup>10</sup> The skin reflects

genetic changes through both function and disease. These changes can be subtle or dramatic and complex, often taking years before they are clinically expressed and become apparent both to patients and caregivers.

Changes in skin function can be observed over a matter of minutes, hours, days, weeks or even years. The ability to understand the interconnectedness of our genetic makeup and the dynamic responses of our skin constitutes the science of skin. The understanding of the science of skin is critical to allow for the successful development of technologies that can interact with living skin.

## Environmental factors



Certain actions can result in negative effects on our health, often without our knowledge. When we experience stress, our skin responds. A hormone called cortisol rises within our bodies. The skin has chemical systems that also produce and modify cortisol levels. For example, when you

become sunburned, your cortisol levels rise and your psychological response can change. Our skin and our mind are connected in complex ways.

Even when the environmental stress from sunlight doesn't result in a burn, it may result in detrimental changes to skin that can take years to manifest. Damaged skin will be less resilient because of an accelerated loss of the protein elastin. We lose elastin naturally, so even through the best prevention efforts, skin changes occur over time that present-day science and technology cannot prevent.



# How skin changes over your lifetime



Aging over a period of decades results in a series of well-documented, yet often not well-understood, changes to the skin.

## Fluid management

The epidermis has a natural wave-like structure that flattens over the years. As discussed earlier, the dermis lies beneath the epidermis, and this layer is critically involved in heat loss and gain. Temperature management in the skin is handled by blood vessels and sweat glands. When fluid is lost due to sweat, it is released on the epidermis. There, the stratum corneum serves its most critical function: fluid management. If a device or material is attached to intact skin, fluid accumulation can occur to varying degrees depending on individual physiology.<sup>11</sup> Excess fluid can result in Moisture-Associated Skin Damage (MASD). The design of materials that adhere to the skin must reflect an understanding of this part of the science of skin.

## Thinning skin barrier

The thinned layer of the dermis and epidermis that occurs with aging means that there is an increased risk of harm when a device with an adhesive is attached to the skin – whether it's a sensor, a wound dressing, a cover over the exit site of a vascular catheter, the material used to secure an endotracheal tube, a dressing applied to a chronic ulcer or the material used to fix a catheter in place. Damage such as Medical Adhesive-Related Skin Injury (MARSI), tension blisters, skin stripping and skin tears can occur due to removal of a device when the strength of the adhesive is greater than the strength of the bond between skin cells.<sup>12</sup> That's why it's important to maintain a balance between performance of the adhesive and the maintenance of the skin's integrity.



# How skin changes over your lifetime

## Underdeveloped skin barrier

Aging and the increased risk of damage due to adhesives represents one end of the age spectrum. At the opposite end are infants, newborns and premature infants. While infants born at the typical gestational age of 40 weeks rapidly develop nearly adult-like skin characteristics, premature infants are at an increased risk for MARS because their skin is not completely developed. In the most vulnerable patients, wounds resulting from MARS can require surgical repair. Infection can also occur as the result of an imbalance between the skin and the bacteria of the skin's microbiome.

Recognizing the changes in skin that occur over a person's lifespan is a key consideration of the science of skin that results in various technological solutions for a changing environment.

### **The science of adhering to skin.**

Skin is the body's first line of defense, but for a scientist or design engineer, it can be a complex barrier to designing adhesives, dressings and devices for both healthy and compromised skin. As a living, breathing organ, skin sweats, stretches and grows hair. It can behave differently based on age, race, diet or medical condition. As technology advances, the demand for adhesives and devices that attach to our skin increases – from wound care dressings to drug delivery solutions and wearable sensors. Scientists and engineers must answer complex questions when choosing the right adhesive system for these devices, such as: How long will the adhesive or device remain on the patient? Where will the adhesive or sensor be placed on the body? What skin types or conditions will be encountered?

It's critical that scientists and engineers understand the true functional characteristics of the skin when it comes to designing adhesives and wearable devices. Our skin is constantly changing, always presenting a new surface. It's getting rid of irritants, healing itself and pushing old cells out of the way to make room for new ones.



## Underlying conditions and diseases



Genetics, age and environment are critical factors that we all share in the journey that our skin takes through life. Additional considerations result from a variety of underlying conditions and diseases that are reflected by the skin's condition.<sup>13,14</sup> Let's take a look at a couple of these underlying diseases and their impact on skin.

### Diabetes mellitus

Diabetes mellitus is a disease that continues to rise worldwide. The disease is chronic but it's now technically feasible for patients to monitor glucose levels directly and continuously. However, current technologies require a break in the skin's integrity for this to occur. As a consequence of having an elevated glucose blood level, automated or patient-controlled pumps can provide insulin to maintain a nearly normal glucose blood level.<sup>15</sup> These devices require adhesion to skin, which can result in skin damage if the adhesive selected is stronger than the bond between skin cells.

### Leukemia and atopic dermatitis

Acquired diseases can leave us with an increased risk of infection. For example, surgery on a patient receiving steroid therapy for another disease can raise the risk of infection and result in a Surgical Site Infection (SSI). Patients with leukemia require intravascular injections of chemotherapy. These drugs can dramatically reduce the patient's capacity to fight infection, putting them at risk for a bloodstream infection due to the presence of the catheter. Some diseases, such as atopic dermatitis, express on the skin but can also carry risks of increased infection of the skin.<sup>16</sup>

Now that we've looked at several factors that can affect the ability to maintain skin integrity, we'll explore a comprehensive framework for skin management.



A close-up photograph of human skin, showing the intricate texture of the epidermis with fine ridges and valleys, and several dark, fine hairs. The lighting is soft, highlighting the natural sheen and color variations of the skin.

# **A comprehensive framework for skin management**

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Meeting the challenges of managing skin in care settings requires a comprehensive, integrated framework to protect the skin, prevent injuries and treat wounds. This approach explores maintaining the integrity of the skin, ensuring adhesives, dressings and devices are safely secured to the skin, repairing injured skin and preventing infection.

Properly assessing the risks to skin, establishing standardized protocols, developing better processes through multidisciplinary skin teams and choosing the right technology for the right patient at the right time can help prevent health care-acquired skin injury and infection. Using this comprehensive approach to skin management, we will examine the prevalence of related skin injuries or infections, costs, best practices and latest scientific advances.



## Maintaining the integrity of skin



Exposure over time to factors such as irritants, moisture, friction, shear and adhesives can lead to skin breakdown and conditions. Not only can these conditions affect patient health and healing, they can also influence care costs and facility resources. And because they have shared risk factors, it's not uncommon for multiple conditions to present simultaneously, further amplifying their impact.

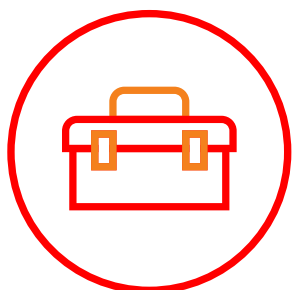
## Safe securement to skin



The constant regeneration of skin poses a challenge in formulating adhesives that can stick to skin. The medical adhesives you select, as well as how you apply and remove them, can have a serious impact on clinical outcomes, cost targets and patient care. In addition to covering wounds and cuts, people wear monitors, infusion sets, medication patches and more. Adhesive materials hold breathing tubes in place, secure intravenous lines, and help people manage post-operative drains, ports and other devices. If not safely secured, these devices may become dislodged or pose the risk of infection.



## Repairing injured skin



Our aging population, prone to obesity and comorbidities<sup>17</sup>, has become increasingly affected by chronic wounds that can take weeks or months to heal<sup>18</sup>. Meanwhile, as surgeries continue to rise, related infections have become an increasingly significant problem.<sup>19</sup> These wounds and infections present a significant burden on patient health as well as health care costs.

## Help prevent infection



Despite hard work to reduce incidents, Healthcare-Associated Infections (HAIs) continue to be a serious problem. HAIs are one of the top 10 leading causes of death each year in the United States.<sup>20</sup> Eliminating HAIs such as Bloodstream Infections (BSIs) or Surgical Site Infections (SSIs) cannot be achieved with a single initiative, process or technology. Even when strictly following best practices for hygiene, aseptic technique and catheter insertion practices, there still remains a risk for BSIs. Post-operative SSIs disrupt the healing processes of surgical patients, drain monetary resources and demand more from hospital staff.



**What happens when  
skin is not considered  
or managed?**

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Skin injuries and conditions that can occur when integrity, safe securement, repair and infection are not considered or managed properly include:



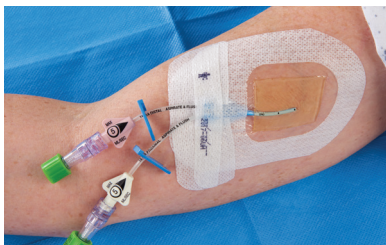
**Medical Adhesive-Related Skin Injury (MARS)**



**Moisture-Associated Skin Damage (MASD)**



**Pressure Ulcer/Injury (PU/I)**



**Bloodstream Infection (BSI)**



**Unplanned Extubation (UE)**



**Chronic Wounds (Venous Leg Ulcer (VLU)/Foot Ulcer)**



**Surgical Site Infection (SSI)**

We'll discuss each condition and its impact, as well as how to prevent or treat them through the latest best practices recommendations and scientific advancements.

# Medical Adhesive-Related Skin Injury (MARSI)

## The impact of MARSI

MARSI is a complication that occurs across all care settings affecting the healthy, or the acutely or critically ill, often during removal of medical tapes and other medical devices adhered to the skin. This occurs when the bond between the adhesive and skin is stronger than the bond between the superficial layers of the skin. Patients most vulnerable to MARSI include those with delicate skin, such as newborns or the elderly<sup>21</sup>; orthopedic patients<sup>21</sup> with compression bandages; oncology patients undergoing radiation; immunocompromised patients; or patients who are undergoing frequent dressing changes such as those with long-term use of vascular access devices. MARSI can cause pain, increase the risk of infection, delay healing and reduce a patient's quality of life.<sup>22</sup>

MARSI affects about one in seven patients (a 13 percent median rate) in the acute care setting.<sup>23</sup> The average adhesive-induced skin injury costs \$88.50 to treat, which is 125 times greater than the average cost of one roll of plastic tape.<sup>24</sup> MARSI can affect patient satisfaction ratings, which can affect reputation and reimbursement at health care facilities.

► [Learn more about MARSI.](#)



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The average tape-induced skin injury costs \$88.50 to treat, which is 125x greater than the average cost of one roll of plastic tape.<sup>24</sup>

### Medical Adhesives and Patient Safety: State of the Science

Download the full report at [www.aadva.org](#)

## Best practices & guidelines from recognized experts

In 2012, a consensus panel of 23 recognized key opinion leaders convened to establish best practices for the assessment, prevention and treatment of MARSI. The document describes how to assess the patient's skin condition, keeping in mind potential risk factors such as age, comorbidities, medications, and allergies or sensitivities.

The consensus statement also advises how to select the right adhesives for the right situation, given the many choices available for adhesives that are flexible, breathable, for short-term or for long-term use, for moist skin or for dry skin, and so on.

[Purchase Medical Adhesives and Patient Safety: State of the Science.](#)



# Medical Adhesive-Related Skin Injury (MARSI)

## The impact of MARSI on wearable device selection

When designing stick-to-skin medical devices, skin can be a fierce adversary. Any wearable that adheres to the skin is likely to require a medical-grade pressure-sensitive adhesive.

The activity, age and health of the patient, as well as skin allergens, are just a few of the considerations for selecting the right adhesive material. Additionally, patients with fragile skin, such as newborns and the elderly, can be vulnerable to MARSI. Constant contact with moisture can also make skin vulnerable to injury. An improperly selected or applied adhesive can even cause hair follicles to become inflamed, which is a condition called folliculitis.

Designers must take care to select quality materials during the concept stage of wearable device production. In addition to being of high quality, the materials must take into consideration common skin allergens and irritants and meet Food and Drug Administration (FDA) safety testing standards. The choice of one material can also affect other materials of construction. For example, certain polymers can interact with adhesives after assembly, causing them to fail.

Biological factors that can make sticking to skin difficult include age, moisture and hair. Just as wearable devices must be tested to ensure the safety of the user, so should the adhesion be tested on human skin and pass biocompatibility tests.

► [Learn more about wearable devices.](#)



## Best practices & guidelines on medical device wear time

Based on studies of wear time for various tapes and adhesives on human volunteers, here are some best practices for choosing adhesive systems for a new wearable device:<sup>25</sup>

- ✓ Use an extended tape edge or skirt that holds the device to the skin.
- ✓ Carefully consider the chemistry of the adhesive – not all types of tape systems perform equally.
- ✓ The key to appropriate adhesive selection is to identify the needs of the population, including considerations such as gentle removal, repeat use and longer wear times.
  - If a gentle-to-skin solution is required, use a silicone adhesive with a duration of up to 8 days.<sup>26</sup>
  - For longer duration, acrylate adhesive can last up to 14 days, depending on the use.
- ✓ Always explore a range of adhesives and backings when choosing materials.

[Download Evaluation on How Tape Construction Affects Wear Time: 15-Day Study.](#)

# Moisture-Associated Skin Damage (MASD)

## The impact of MASD

MASD can occur when the skin softens, swells and becomes wrinkled when exposed to excessive moisture (such as urine, stool, sweat, wound drainage, saliva or mucus), making it vulnerable to inflammation, skin erosion or damage from friction.<sup>27</sup> MASD includes periwound skin damage, peristomal skin damage and intertriginous dermatitis. One of the most challenging types of MASD is Incontinence-Associated Dermatitis (IAD), a painful inflammatory skin condition that can interfere with recovery or quality of life and may increase the risk of complications, such as secondary infections and pressure ulcers.<sup>28,29</sup>

IAD represents a significant global health concern affecting up to 41 percent of nursing home residents and 35 percent of all patients in acute care settings.<sup>30,31</sup> The cost of treating skin conditions associated with incontinence among U.S. patients has been estimated at more than \$136 million.<sup>32</sup>

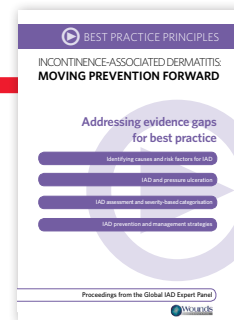
► [Learn more about MASD.](#)

 **41%**  
of residents

IAD affects up to 41 percent of nursing home residents.<sup>30</sup>

 **\$136M+**  
for IAD treatment

The cost of treating skin conditions associated with incontinence among U.S. patients has been estimated at more than \$136 million.<sup>32</sup>



## Best practices & guidelines from recognized experts

In 2014, a group of 20 international experts gathered to review knowledge gaps related to IAD and to advance best practice principles that address these gaps.<sup>29</sup>

For clinicians delivering hands-on patient care, these best practice principles provide practical guidance on how to assess, manage and even prevent IAD. The experts determined that poor or inappropriate management of incontinence, such as infrequent cleaning, plastic-backed containment devices or aggressive cleaning techniques contributes to IAD.<sup>29</sup> For facility leaders, there is a step-by-step guide for IAD prevention, plus suggestions for developing a structured IAD prevention program in their care settings.

[Download Incontinence-Associated Dermatitis: Moving Prevention Forward Best Practice Principles.](#)



# Pressure Ulcer/Injury (PU/I)

## The impact of PU/I

PU/I occurs when the skin, and frequently underlying tissues, is damaged by pressure, friction and/or shear. The skin that covers bony prominences, such as the heel or sacrum, is especially vulnerable to PU/I. It also can be related to a medical device.<sup>33,34</sup> Risk factors include moisture, friction and shear, advanced age and malnutrition.<sup>35</sup> PU/I can lead to longer hospital stays and higher rates of readmission, and it can contribute to greater patient pain and suffering – and in some cases, premature mortality.<sup>36</sup>

Although significant progress has been made in recent years to prevent PU/I, facility-acquired PU/I is a growing health care problem, with a prevalence rate of 3.1 percent.<sup>38</sup> PU/I affects about 670,000 admitted patients each year, significantly increasing their mortality rate (9.1 percent versus 1.8 percent).<sup>35</sup> About \$11 billion is spent each year on PU/I care – up to \$70,000 per individual PU/I.<sup>34</sup>

► [Learn more about PU/I.](#)



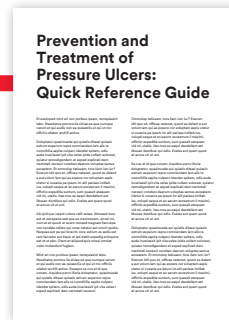
**\$11B**  
on pressure  
ulcer care

About \$11 billion is spent each year on pressure ulcer care – up to \$70,000 per individual pressure ulcer.<sup>34</sup>



**670K**  
admitted  
patients

PU/I affects about 670,000 admitted patients each year, significantly increasing their mortality rate.<sup>35</sup>



## Best practices & guidelines from recognized experts

In recent years, there have been advances in how to diagnose and treat PU/I. The National Pressure Ulcer Advisory Panel (NPUAP) has identified the following risk factors for PU/I: limited mobility, poor perfusion and oxygenation, poor nutrition, increased skin moisture, higher body temperature, advanced age, poor sensory perception, hematological measures and poor general health.<sup>34</sup>

In addition to recommending a change in terminology from pressure ulcer to pressure injury, the panel also recently updated its staging system. The staging system ranges from Stage 1: non-blanchable erythema of intact skin to Stage 4: full-thickness skin and tissue loss, as well as Unstageable Tissue Pressure Injury: obscured full-thickness skin and tissue loss and Deep Tissue Pressure Injury: persistent non-blanchable deep red, maroon, or purple discoloration. The Centers for Medicare and Medicaid Services (CMS) now consider Stage 3 and 4 pressure ulcers acquired during hospitalization to be preventable and will no longer reimburse for them. Additionally, the panel added definitions for medical device-related pressure injuries that result from the use of devices designed and applied for diagnostic or therapeutic purposes, and mucosal membrane pressure injury found on mucous membranes with a history of a medical device in use at the location of the injury.

[View Prevention and Treatment of Pressure Ulcers: Quick Reference Guide.](#)

# Bloodstream Infection (BSI)

Every IV site presents the potential for infection, dislodgement, skin damage and other complications. These complications can potentially cause patient discomfort and pain, extended hospital stays, additional therapy and surgical intervention – even increased patient mortality.

## The impact of bloodstream infections

### Catheter-Related Bloodstream Infection (CRBSI)

CRBSI, a blood infection associated with an intravenous catheter, is a costly and potentially lethal complication. The majority of CRBSIs are associated with central venous catheterization (central line); CRBSI is up to 64 times more likely to occur in a central line than in peripheral venous catheters.<sup>39</sup> However, more than 300 million peripheral intravenous catheters are inserted each year in the United States alone.<sup>40</sup> It is important to consider the risk of CRBSI with any vascular access device.

The incidence of CRBSI in the U.S. is 1.27 cases per 1,000 device days.<sup>41</sup> CRBSI is associated with 1.57 times higher risk of mortality in critically ill adults<sup>42</sup>, and 12 or more days of hospitalization are required to treat CRBSI<sup>43</sup>.

► [Learn more about CRBSI.](#)



CRBSI is up to 64 times more likely to occur in a central line than in peripheral venous catheters.<sup>39</sup>



About 41,000 bloodstream infections strike hospital patients with central lines each year.<sup>46</sup>

### Central Line-Associated Bloodstream Infection (CLABSI)

CLABSIs result in thousands of deaths each year and add more than \$2.3 billion in costs to the U.S. health care system, yet these infections are preventable.<sup>44,45</sup> About 41,000 bloodstream infections strike hospital patients with central lines each year; one in four infected patients will die.<sup>46</sup> The average cost of a CLABSI is about \$45,000 per patient<sup>43</sup>, although one estimate puts that cost at more than \$70,000<sup>47</sup>.

► [Learn more about CLABSI.](#)

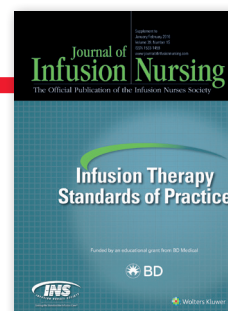


# Bloodstream Infection (BSI)

## Phlebitis

Securement of a vascular catheter is not only critical to its function, but is equally critical to prevent adverse events. The risk of infection of a central venous catheter increases with failed securement. In the case of peripheral vascular catheters, the incidence of blood vessel irritation (phlebitis) as a result of improper securement raises the risks of failed catheter function, increases pain and increases the risk of infection.<sup>48</sup>

Securement failure can be expressed not only as loosening leading to phlebitis, but can also result in complete dislodgement and loss of the catheter. Loss of the catheter requires replacement with associated risks. Proper securement ensures continued proper function of vascular catheters – no matter which blood vessel they are placed into. It protects against phlebitis and loss of the catheters required for the patient's therapy.<sup>48</sup>



## Best practices & guidelines from recognized experts

In 2016, the Infusion Nurses Society (INS) issued a revised Infusion Therapy Standards of Practice, incorporating five years' worth of new data to establish the most current, evidence-based best practices in vascular access.

The standards provide key takeaways for clinicians around gauge size selection, limiting access attempts, proper securement, using chlorhexidine gluconate (CHG)-impregnated dressings over central venous access devices (CVADs) and consideration of passive disinfecting caps.<sup>48</sup>

**[Purchase a copy of Infusion Therapy Standards of Practice.](#)**


# Unplanned Extubation (UE)

Critical tube management involves inserting, maintaining and removing tubes necessary to save and sustain patients' lives. Extubation is the removal of a previously inserted tube; sometimes an extubation is unplanned or unintended by the health care provider.

## The impact of Unplanned Extubations (UEs)

UEs may result from improper use of medical tapes and other tube securement devices and may lead to additional respiratory complications, life-threatening hemorrhage and prolonged hospitalization. Patient care procedures (suctioning, repositioning, weighing and re-taping), patient movement and loosening of medical adhesives represent 70 to 80 percent of the causes of UEs.<sup>49</sup>

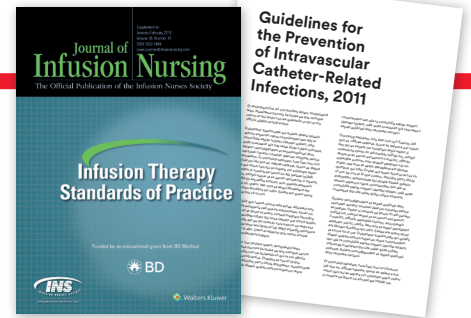
UEs are the fourth most common safety event in North American Neonatal Intensive Care Units (NICUs)<sup>50</sup> and affect up to 4 percent of critically ill children<sup>51,52</sup>. They increase the hospital stay by 6.5 days per pediatric patient, increasing hospital costs by \$36,692 per patient.<sup>53</sup> In adult Intensive Care Units (ICUs), the rate of UEs is between 7 and 18 percent<sup>54</sup>, and can lead to a median increased length of stay of 5.5 days for ICU patients<sup>53</sup>.

 **70-80%**  
of patient care  
procedures

Patient care procedures (suctioning, repositioning, weighing and re-taping), patient movement and loosening of medical adhesives represent 70 percent to 80 percent of the causes of UEs.<sup>49</sup>

 **6.5**  
days longer

UEs increase the hospital stay by 6.5 days per pediatric patient, increasing hospital costs by \$36,692 per patient.<sup>53</sup>



## Best practices & guidelines from recognized experts

Since the 1980s, central line securement had most often been accomplished with the use of sutures and a polyurethane dressing. That is despite evidence of significantly increased bloodstream infection rates with sutures in peripherally inserted central lines and recommendations from the Centers for Disease Control and Prevention (CDC) for suture-less securement of central lines.<sup>55</sup>

New alternatives for central line securement and dressings are available that may perform better than sutures and simple polyurethane dressings in reducing the risk of complications. One innovation is a suture-less securement device (SSD), with an adhesive base that offers additional anchor points into which the central line can be "clipped" for securement, with a specially designed and bordered polyurethane adhesive dressing to cover the device and the insertion site. The CDC and the Infusion Nurses Society (INS) now recommend the use of a SSD to reduce the risk of infection for intravascular catheters.<sup>56,48</sup>

**[Purchase a copy of Infusion Therapy Standards of Practice.](#)**

**[View CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections.](#)**



# Chronic Wounds

Chronic wounds pose a significant and often underappreciated burden to the individual, the health care system and our society as a whole.<sup>57</sup> The prevalence of chronic wounds is growing rapidly due to an aging population and a sharp rise in the incidence of diabetes and obesity worldwide.<sup>58</sup> Chronic wounds can cause pain, loss of function and mobility, depression, distress and anxiety, embarrassment and social isolation, financial burden, prolonged hospital stays, and chronic morbidity or even death.<sup>59</sup>

About 6.5 million people in the U.S. are treated every year for chronic wounds at a cost of approximately \$25 billion.<sup>58</sup> In the U.K., about 2.2 million patients are treated for chronic wounds at a cost of £5.3 billion.<sup>59,60</sup>

Chronic wounds include Pressure Ulcers/Injuries (PU/Is), Venous Leg Ulcers (VLUs), diabetic foot ulcers and arterial and mixed etiology ulcers.

 **6.5M**  
people are treated

About 6.5 million people in the U.S. are treated every year for chronic wounds.<sup>58</sup>

 **\$25B**  
in care costs

Approximately \$25 billion is the annual cost of treating chronic wounds in the U.S.<sup>58</sup>


# Chronic Wounds


## The impact of a Venous Leg Ulcer (VLU)

A VLU is a chronic wound that takes more than four to six weeks to heal, usually developing on the inside of the leg, just above the ankle.<sup>61,62</sup> VLUs pose significant challenges to patients and health care systems because they can persist for months, or even years, and are costly to manage. They can have a devastating impact on an individual's physical and emotional well-being.<sup>63</sup>

VLUs account for 85 percent of all lower-extremity ulcers, with treatment costs of \$3 billion and loss of 2 million workdays per year in the U.S. and U.K.<sup>64</sup>

► [Learn more about VLU.](#)

 **85%**  
of all lower-extremity ulcers  
Venous leg ulcers account for 85 percent of all lower-extremity ulcers.<sup>64</sup>

 **\$1.5B**  
in care costs  
The total annual cost of diabetic foot ulcers in the U.S. is estimated to be more than \$1.5 billion a year.<sup>66</sup>

## The impact of foot ulcers

Foot ulcers, which are especially common among patients with diabetes, affect about 15 percent of such patients during their lifetime.<sup>65</sup>

Health care costs related to diabetic foot ulcers have increased significantly over time even though the length of hospital stays has not gone up, nor have the relative number of emergency admissions. This may reflect the fact that the patient population is becoming progressively sicker and that there are an increasing number of attempts at limb salvage.<sup>66</sup>

The total annual cost of diabetic foot ulcers in the U.S. is estimated to be more than \$1.5 billion a year<sup>66</sup>; add in related complications, and that cost may go to more than \$13 billion<sup>67</sup>. As much as a quarter of the direct medical cost of diabetes may be attributed to diabetic foot ulcers.<sup>67</sup>



## Best practices & guidelines from recognized experts

An international group of experts in leg ulcers and venous disease met in December 2014 and published a consensus document that recommends a simple ABC treatment model for VLUs: "A" for assessment and diagnosis, "B" for best practice wound and skin management and "C" for compression therapy for leg ulcer management.<sup>68</sup>

The "C" – compression therapy – is widely recognized as the standard of care for VLU management, as it increases healing rates compared to no compression therapy<sup>69</sup>, and it helps reduce recurrence rates after wound closure<sup>70</sup>.

[Download Simplifying Venous Leg Ulcer Management: Consensus Recommendations.](#)



# Surgical Site Infection (SSI)

## The impact of SSIs

An SSI, often caused by bacteria from the patient's own skin<sup>71,72</sup>, can either be limited to the skin or involve tissues under the skin, organs or implanted material<sup>73</sup>. Patients who contract an SSI are more likely to spend time in the ICU<sup>74</sup>, be readmitted to a hospital<sup>75</sup> or die<sup>76,77</sup>.

SSIs affect 2 to 5 percent of surgical inpatients in the U.S.<sup>77,78</sup> SSIs can cost up to \$29,000 per incident with an additional seven to 11 hospital days added to each patient's stay.<sup>79</sup> More than 90,000 readmissions annually are attributed to SSIs, costing about \$700 million.<sup>80</sup> Since most SSIs are preventable, they have become a pay-for-performance metric and a target of quality improvement efforts.<sup>80</sup>

 **\$29K**  
per incident

SSIs can cost up to \$29,000 per incident with an additional seven to 11 hospital days added to each patient's stay.<sup>79</sup>

 **90K+**  
readmissions

More than 90,000 readmissions annually are attributed to SSIs, costing about \$700 million.<sup>80</sup>

### American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update

These guidelines are intended to provide a framework for the development of local policies and procedures. They are not intended to be used as a substitute for clinical judgment. The American College of Surgeons and the Surgical Infection Society are not responsible for any adverse consequences that may result from the use of these guidelines. The American College of Surgeons and the Surgical Infection Society are not responsible for any adverse consequences that may result from the use of these guidelines.

## Best practices & guidelines from recognized experts

A number of factors can increase the risk of surgical infection, according to the 2016 American College of Surgeons (ACS) guidelines.<sup>80</sup> Factors include how the surgery site is prepped, wound protectors, treating the wound site during the operation, closing the wound, dressing the wound and post-operative topical antibiotic therapy.

While not yet conclusive, ACS says evidence suggests antibiotic sutures, topical antibiotic therapy during the operation, and use of wound protectors and a preparation solution to scrub the surgical site all can reduce the risk of an infection.<sup>80</sup>

**[Purchase American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update.](#)**



A close-up, macro photograph of human skin, showing the intricate, wavy patterns of the epidermal ridges and valleys. The lighting is warm and directional, creating a sense of depth and highlighting the natural texture of the skin. The colors range from light tan to deep, rich brown.

# A holistic approach to skin health

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## How your practice can make a difference

One thing that all of the skin health conditions we've discussed in this report have in common is that steps can be taken to prevent them.

Preventing skin damage is the ultimate goal. Prevention starts with protecting against the vulnerabilities in your facility, in your practice, and most importantly, in your patients.

Let's take a look at three keys to effective skin management.



# People

## Develop highly trained and committed teams

The responsibility for skin care is often split up among a number of different care settings/providers with no common oversight. Providers acknowledge that there are too many separate initiatives and that an encompassing approach should be taken.<sup>81</sup> For instance, any given hospital may simultaneously run separate initiatives to fight CLABSI, peripheral IV infections and SSIs out of different committees.<sup>81</sup> Too often, health care providers are so focused on the condition they are treating that they ignore the health of the patient's skin.

Some facilities have responded to this problem by developing an umbrella approach, creating multidisciplinary “skin safety teams” specialized in tissue viability and led by clinical champions to ensure there is measurement, training and ongoing focus on prevention. The members of these quality teams are highly trained and committed to preventing or treating skin problems and people. To work effectively, these teams should have the backing of the top levels of the facility and report on evidence-based outcomes, including costs, to show accountability and build executive buy-in.<sup>81</sup> For instance, the University of Chicago Medicine's Nursing Skin Care Team used this approach to achieve an 83 percent reduction in hospital-acquired pressure ulcers over four years.<sup>82</sup>



**The University of Chicago Medicine's Nursing Skin Care Team used a skin safety team to achieve an 83 percent reduction in hospital-acquired pressure ulcers over four years.<sup>82</sup>**




# People

Additionally, assessing a patient's skin can be a daunting task given the complex factors that can cause skin damage. We have already seen that the intrinsic risk factors of age, mobility, comorbidities, skin allergies and nutrition, as well as extrinsic risk factors such as moisture, pressure, dryness, and friction and shear, can be caused or exacerbated by the adhesives or dressings selected for the patient. All too often, health care providers fail to adequately assess these patient factors.


Many providers may not be aware of or concerned about some of these patient risk factors. For instance, a University of Huddersfield survey found that only 31 percent of wound care clinicians had heard of MARS<sup>1</sup> as a collective way to describe forms of skin damage caused by medical adhesives, and only 37 percent expressed concern about the incidence of MARS<sup>1</sup> in their area of work.<sup>83</sup>

To better protect their patients' skin, providers need better education and training about risk factors and how to choose the most appropriate medical tapes, adhesives and dressings. Of the University of Huddersfield wound care clinicians surveyed, 80 percent acknowledged that training in the area of prevention and treatment of MARS<sup>1</sup> is either inadequate or unavailable.<sup>83</sup> To make sure they remain up-to-date, education and measurement of health care provider competencies in these areas should be done on a continuous basis.



 **31%**  
of wound care  
clinicians

Of those surveyed at the University of Huddersfield, only 31% had heard of MARS<sup>1</sup> as a collective way to describe forms of skin damage caused by medical adhesives.<sup>83</sup>

 **80%**  
of wound care  
clinicians

Of those surveyed at the University of Huddersfield, 80% acknowledged that training in the area of prevention and treatment of MARS<sup>1</sup> is either inadequate or unavailable.<sup>83</sup>


# Practice

## Implement evidence-based standards and processes facility-wide

The wide range of skin injury risks patients face presents a unique challenge for health care facilities. For instance, while surgery departments must work on reducing the rate of SSIs, pediatricians and gerontologists need to understand how to avoid the preventable causes of MARSIs given the delicate skin of newborns or the elderly. Health care providers recognize they need more education and training on how to assess patients for skin problems. In fact, 97 percent of the respondents to the University of Huddersfield survey said that prevention of MARSIs and the identification of patients at risk for MARSIs should be integral components of skin assessment.<sup>83</sup>

Health care settings – whether in the surgery department, NICU or nursing home – need to establish and follow standardized protocols for the protection of skin integrity, especially for patients with at-risk skin. The goal is to establish best practices and guidelines on preventing infection and protecting skin, which can be internal efforts or based on industry-wide initiatives, such as guidelines and consensus documents published by experts on PU/I, VLU, MARSIs, IAD and safe securement.



 **97%**  
of wound care  
clinicians

97% of respondents said that prevention of MARSIs and the identification of patients at risk for MARSIs should be integral components of skin assessment.<sup>83</sup>



# Products

## Choose proven technologies that improve patient outcomes

Nurses and other health care providers do the best with what they have, but sometimes lack the products they need. In one survey, 62 percent of clinicians indicated their current medical tapes do not meet the needs of fragile skin patients.<sup>84</sup> Sometimes they lack the knowledge of how to choose the right product for the right patient. We have seen that problems such as MARSI or unintended extubation may be due to the provider choosing an adhesive that is too strong or too weak for the patient's situation.

Facilities need to incorporate relevant, evidence-based and cost-effective technologies to reduce the risk of complications, optimize care and accelerate skin repair. Optimal products have been developed for every situation, whether it is to provide skin-safe securement, maintain skin integrity or repair damaged skin. How these products are selected, applied and removed can have a significant impact on patient outcomes.



 **62%**  
of clinicians

In one survey, 62 percent of clinicians indicated their current medical tapes do not meet the needs of fragile skin patients.<sup>84</sup>



A close-up photograph of human skin, showing a network of fine wrinkles and creases. The skin has a warm, orange-brown tone. The texture is highly detailed, with many small ridges and valleys. A prominent vertical crease runs down the center of the image. The lighting is soft, highlighting the contours of the wrinkles.

# The science of skin advancements

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## **Scientific advancements you can use to improve skin health.**

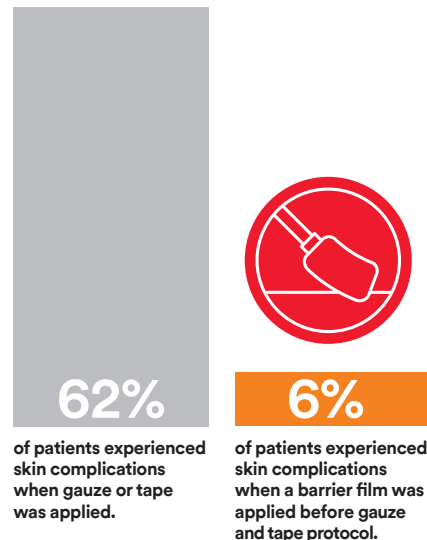
Fortunately, there have been significant advancements to protect, maintain and repair skin. In cooperation with clinicians, skin disease experts and medical manufacturers, scientists researching the structure of skin have developed innovative solutions that prevent skin damage and help heal chronic wounds; protect patients' surgical incisions; secure critical catheters, tubes and medical devices; and prevent dangerous bloodstream infections.

# Advancements to improve skin health

## Alcohol-free barrier films

Skin barrier products provide a protective interface between the skin and adhesives to reduce the risk of MARSI and protect the skin from body fluids. Alcohol-free barrier films should be used prior to adhesive product application, particularly on patients at high risk for skin injury.<sup>21</sup> Alcohol-free barrier films reduce the incidence of red, irritated skin (erythema) and skin stripping following medical adhesive removal in various patient populations, including newborns, and they also help protect skin around the wound.<sup>85,86,87,88</sup> Alcohol-free barrier films also greatly reduce the risk of peripherally inserted central catheter (PICC) line skin complications. In one study, 62 percent of patients in a control group had complications compared with 6 percent in the barrier film group.<sup>89</sup>

**Alcohol-free barrier films greatly reduce PICC line skin complications. In a study of patients with PICCs:<sup>89</sup>**



## Polymer chemistry

A novel cyanoacrylate polymer formulation has been proven to protect the skin by creating a highly durable, ultra-thin, transparent, breathable and flexible barrier. This elastomeric film protects the underlying tissue from fluids so it can heal and regenerate.<sup>90,91</sup> It protects patients under challenging conditions and is able to attach to wet, weepy, damaged skin surfaces.<sup>95</sup> This film allows easy, gentle cleansing, can be applied quickly, lasts up to seven days<sup>92</sup> and reduces the potential for cross-contamination with traditional products.



**This film allows easy, gentle cleansing, can be applied quickly, and lasts up to seven days.<sup>92</sup>**



# Advancements to improve skin health

## Silicone foam

Polyurethane foam dressings should be used to protect bony prominences from friction and shear as part of a comprehensive pressure ulcer/injury prevention strategy. Certain silicone foam dressings have shown significantly longer wear time<sup>93</sup> and gentle adhesion properties, which may help facilities save time and money by avoiding unscheduled dressing changes. A study showed that one silicone foam dressing removed significantly fewer skin cells than a standard acrylate adhesive, helping to reduce skin trauma.<sup>94</sup>



**Certain silicone foam dressings have shown significantly longer wear time.<sup>93</sup>**

## Chlorhexidine gluconate (CHG) and site visibility

Integrating antimicrobial protection, site visibility, catheter securement and breathability can reduce CRBSI by providing immediate and consistent antimicrobial activity and continuous site visibility. CHG-impregnated transparent gel pads not only reduce the risk of infection, but allow the care team to see the skin around the insertion site. They also ensure dressings are applied correctly and consistently, and stabilize the catheter with specially designed stabilization borders, keyhole notch and reinforcing tape strips to prevent dislodgement.

## Silicone adhesives

Silicone adhesives and tapes have been shown to be gentler to skin than other adhesive products and decrease the risk of MARSI. Silicone tape provides immediate adhesive strength and is soft and flexible enough to conform to uneven surfaces. Plus, it maintains constant strength for as long as it's left in place. In addition, the gentle adhesion of silicone pressure-sensitive adhesives (PSAs) do not cause skin trauma when properly removed and work well for repeat applications or repositioning a medical device.



**Gentle adhesion of silicone pressure sensitive adhesives (PSAs) does not cause skin trauma when removed.**

# Advancements to improve skin health

## Acrylate adhesives

Acrylates are customizable and demonstrate adhesion that increases over time as they warm against the body, flow into the nooks and crannies on the top layer of skin, and increase the surface area they bond with. They're also breathable and, overall, a better choice than synthetic rubber adhesives.

## Moist wound healing technology

Highly absorbent, multi-layer dressings, such as silicone foam dressings, can help in the treatment of chronic wounds, including pressure ulcers/injuries, by wicking moisture away from the wound and reducing the risk of skin maceration due to prolonged exposure.<sup>95</sup> New silicone foam dressings, using a specially designed film, adhesive and breathable dressing cover, demonstrate significantly longer wear times compared to conventional silicone foam dressings.<sup>96</sup> This new silicone foam technology helps moisture evaporate through its film backing, absorbs moisture to prevent prolonged exposure, minimizes disruption of healing tissue through improved flexibility and keeps the dressing in place without damaging the wound area.



**New silicone foam dressings demonstrate significantly longer wear times compared to conventional silicone foam dressings.<sup>96</sup>**

## Two-layer compression system

A two-layer compression system provides a comfortable, rigid sleeve that consistently delivers the right amount of compression to reduce swelling (edema). Clinically proven to reduce slippage<sup>97</sup>, the thin profile allows patients to return to activities of daily living in their own shoes and clothing. Since VLU healing times can be twice as long when patients are not compliant with compression, the system's comfort, low profile and sustained, therapeutic compression for up to seven days improves patient compliance and results in more effective treatment.<sup>98</sup>



**Therapeutic compression for up to seven days can reduce the need for dressing reapplication, improve patient compliance and result in more effective treatment.<sup>98</sup>**



**Putting skin at  
the front line of health**

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## **What you can do to implement change in your practice**

There are a myriad of ways skin can be injured or compromised. This can result in pain and infection, and may lead to a lower quality of life for patients, higher health care costs and serious, even life-threatening, complications.

But work is underway to advance clinical practice and to better understand the science of skin. Clinicians, skin injury and infection experts, industrial manufacturers and science companies have collaborated to develop better ways to assess each patient, improve practice standards, create better processes and team approaches, and invent better products and therapies to help protect the skin and heal skin injuries.



# Key skin health questions

## Clinicians

Putting a skin safety program into practice is critical to improving care and reducing costs. Take into consideration some key questions as you develop your facility's skin approach:

- Do your current protocols align with industry best practices?
- Are leaders assigned to maintain knowledge of industry advances and changes to standards?
- Does your facility's skin approach take into consideration the intrinsic and extrinsic factors that can influence a patient's risk for skin damage? For example:
  - **Intrinsic factors:** Extremes of age, dermatologic conditions, malnutrition, ethnicity, underlying medical conditions and dehydration.
  - **Extrinsic factors:** Drying of the skin (due to harsh skin cleansers, excessive bathing or low humidity), prolonged exposure to moisture, radiation therapy, certain medications (such as anti-inflammatory agents, anticoagulants, chemotherapeutic agents or long-term corticosteroids) and repeated tape/dressing/device removal.
- Is a facility-wide, multi-disciplinary leadership team in place to drive advances in care?
- How will your facility measure baseline results and improvements across all skin conditions?

## Medical Device Engineers

Skin should not be an afterthought. Instead, it should be a core consideration for the use of any medical device that interacts with or adheres to the skin. Consider these key questions before beginning product development:

- What type of securement is required? Have you considered the pros and cons of multiple types of adhesives, including how they stick to the skin, gentleness, and ability to adhere for different lengths of time?
- How will your product be tested and how will testing integrate skin safety?
- Does your team have experience in skin science and knowledge of best practices?

It covers us all, yet skin is easy to overlook. All too often, at the doctor's office, the hospital, the nursing home or when designing medical devices, it's simply a place to insert a needle, tape a tube or attach an adhesive – it's an afterthought.

Skin is a mirror of the body's function, or dysfunction. In care settings, every intervention presents the potential for skin damage, infection, dislodgement and other complications. Protecting and maintaining the integrity of skin is critically important. As conditions become more complex, it's ever-more challenging to do so.

By understanding why skin matters, what can happen when skin is not considered or maintained, how your practice can make a difference, what you can do to implement change in your practice, and how scientific advancements can play a role in improving skin health, you can make a different commitment to care. One that starts with skin and considers people from the outside in, not just the inside out.



A close-up photograph of human skin, showing a variety of moles and freckles. The skin has a natural, slightly textured appearance. The text is overlaid in the center-left area.

**Think skin first.  
Think skin deeper.**

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