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Stick to Skin: A New Way for Medical Wearables

Medical Materials & Technologies

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Introduction

Wearables are wonders — they have the power to enhance human health simply by connecting technology to skin. Medical wearables play a key role in enablement of positive care outcomes and help simplify care management – changing patient quality of life for the better. But when it comes to designing an effective wearable device, numerous considerations must be taken into account. In this paper, we will go "under the skin" to examine the factors that impact performance, including the science of skin and adhesion and how to make devices stick. As the body's largest organ, our skin is a powerful place to get answers — and uncover more about the health happening underneath. Yet, the design process can be challenging and finding the right adhesive for your application can be sticky. Let's start at the surface, then dive deeper.

Why Wearables Matter

As technology advances, the demand for devices that attach to our skin increases – from wound care dressings to wearable sensors. Wearables give us greater insight into our health by tracking, listening, monitoring and more. Wearables are often defined as technology that connects to the internet and attaches to the body via clothing (i.e. wrist straps, chest straps) or glasses – that definition is changing as innovation occurs. Medical adhesives are specially formulated to stick wearables to skin for intended applications. Plus, the added convenience and flexibility of stick-to-skin adhesives empower design engineers to develop more complex and longer-duration wear time devices.

Curious to learn more about the science of adhering to skin?

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Why Skin is a "Sticky" Deal

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. 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, age, and underlying conditions and diseases.[1] A main challenge in designing adhesive-based wearables, then, comes from knowing our skin surface is always in flux. Skin changes shape, moisture content and elasticity and constantly sheds dead keratinocytes from its surface. Human skin is demographically variable — from infants to the elderly. Skin regeneration takes approximately 28 days.[2] As skin ages, collagen in the sub-dermal layers changes. Demographics and design should work hand in hand, especially when you think of it this way: the needs of fragile elderly skin may differ greatly from the needs of infant skin.

Make It Stick, Ask Key Questions

Scientists and engineers must answer complex questions when choosing the right adhesive system for 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? Will the skin require additional preparation? Other factors may influence adhesive choice and how well the adhesive performs on skin.

Factors that Influence Adhesion:

Contaminated surface: Oils, lotions, creams, make up may interfere with adhesion by making it harder for adhesive properties to stick to skin.

Epidermal function: Moisture management and protection may impact adhesion — as exposure to moisture can lead to skin breakdown, irritation and other conditions.

Cell renewal cycle: Our skin constantly changes and presents a new surface; it gets rid of irritants, heals itself and pushes old cells out of the way to make room for new ones.

Elastic surface: The Medical Tape must be conformable for it to stick effectively to the surface of the skin — it must be move, stretch and bend with the skin.

Low surface energy: Low surface energy is generally great for most things skin is expected to do, such as easy removal of contaminants with simple soap and water. But the challenge lies in creating an adequate balance between adhesion levels – right in the middle – or else the adhesive will stick too little or too much, rendering it ineffective or causing trauma.

Rough texture: An uneven or non-smooth surface interferes with adhesion, because it makes it hard for the tape to fully stick.

Key Questions

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

1. How long is the device intended to stick to skin?
2. What is the demographic of the intended user? Infant, Adult or Elderly?
3. Where on the body should the device be worn?
4. What are the activity levels of the user during use? Active or sedentary?

A Complex Situation

As evidenced above, many factors impact successful adhesive selection. The chart below illuminates the complexity — plotting dry or oily skin (surface type) against young or elderly skin (age) for a short or long duration (wear time).

Bring Your Ideas to Life

3M Medical Materials and Technologies can help your ideas materialize — from lab to life. Our team of global experts can help you select the right materials for your application, mitigate risks, reduce costs and, ultimately, transform lives with wearable devices. Our portfolio of adhesives and films offers a range of solutions for your applications.

Find My Adhesive

Ready to design a device that stays on skin long enough to capture key information and data? Explore our web-based tool to identify 3M products that could be a good fit your application.

FindMyAdhesive.com

References:

[1]3M Critical and Chronic Care Solutions Division (2008). State of skin: Elevating the science of skin management [PDF file]. Retrieved from https://multimedia.3m.com/mws/media/1560208O/state-of-skin-elevating-the-science-of-skin-management.pdf

[2]Cartier M., Smith G. Evaluation of Wear Time for Various Tapes on Human Volunteers: 21-day Study (2016). [PDF file]. Retrieved from https://multimedia.3m.com/mws/media/1376131O/70-2011-6757-7-white-paper-summary.pdf

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