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MICROCLIMATE:
A Best Practices Guide

by Erica Thibault, MS, RN, CNS, APN, CWON

Pressure ulcers continue to be a significant health care issue in the United States. Incidence rates vary across clinical settings, but may be as high as 38% in some clinical settings and as low as 0.4 % in other clinical settings.[1] An estimated 2.5 million pressure ulcers are treated every year in the United States at an estimated cost of $11 billion.[1] The costs to treat one individual full-thickness ulcer may be as high as $70,000.[1] According to the National Pressure Ulcer Advisory Panel (NPUAP), there are several factors that contribute to the formation of pressure ulcers, and one of these is the level of moisture at the skin level—the microclimate. It is within this context that the management of the microclimate is important to the prevention and treatment of pressure ulcers.

WHAT IS MICROCLIMATE?

Much of the current discussion related to the treatment and prevention of pressure ulcers revolves around the ability to control or manage what has been termed *microclimate*. This term is not new; it has been used to describe the smaller, more precise climate areas of the earth, such as the Banana Belt or the Snowbelt. In the treatment of pressure ulcers, the term *microclimate* is used to describe "the local tissue temperature and moisture (relative humidity) at the body/support surface interface."[2]

Elevated body and skin temperatures, as well as an increase in humidity experienced by the acutely ill patient, are some of the contributing factors that affect the protection and healing properties of the skin. Many patients in the hospital experience increased moisture at the skin level. Excessive moisture can result from an increase in perspiration and repeated exposure to urine and stool. It is this increase in moisture at the skin level that directly influences the microclimate.

THE LOW AIR LOSS FUNCTION OF A SUPPORT SURFACE "PROVIDES A FLOW OF AIR TO ASSIST IN MANAGING THE HEAT AND HUMIDITY (MICROCLIMATE) OF THE SKIN."[2] THE AIR VOLUME IN THE LOW AIR LOSS FEATURE OF THE MATTRESS SHOULD BE SUFFICIENT ENOUGH TO REMOVE EXCESSIVE MOISTURE AT THE SKIN LEVEL.

HOW DO WE INFLUENCE THE MICROCLIMATE?

One of the ways to manage the microclimate is to control or manage humidity and moisture at the skin level. This can be accomplished through the use of briefs that wick away moisture and the use of specialized moisture barrier products, lotions, and creams to hydrate and condition the skin. Patient briefs should be changed as soon as they are soiled and a mild cleanser should be used. Moisture barrier products and creams should be applied according to the manufacturer's directions. The patient's care plan should include adequate hydration and nutrition. Cardiac and respiratory function should also be monitored to prevent dehydration and fluid overload.

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IS MICROCLIMATE THE MISSING PIECE OF THE PRESSURE ULCER PUZZLE?

by Diane L. Krasner, PhD, RN, CWCN, CWS, MAPWCA, FAAN

BACKGROUND

Pressure ulcer researchers and clinicians are struggling with the fact that despite improved support surfaces, national and international clinical practice guidelines, educational initiatives, and our best efforts, pressure ulcer prevalence and incidence has remained about the same in US acute care facilities at approximately 15.3% and 7.6% from 1999 to 2004, respectively.[1] A 2003 study of hospital inpatients found that the rate of pressure ulcer-related hospitalizations increased 63% from 280,000 cases in 1993 to 455,000 cases in 2003 in the US.[2] These and other data have prompted pressure ulcer researchers to revisit our understandings of pressure ulcer causation. The focus of pressure ulcer research for the past 40 years has been on pressure, interface pressures, friction, and shear. Is "microclimate" the missing piece of the pressure ulcer puzzle?

WHAT EXACTLY IS MICROCLIMATE?

The term *microclimate* was first used in a pressure ulcer context in 1976 by Roaf in the UK to refer to the environment in which pressure ulcers occur.[3] It is different from the term *microenvironment*, which is usually used in the context of wound research to describe the wound at a cellular level (wound fluid, proteolytic nature, growth factor profile, etc.). These terms have sometimes been used interchangeably in recent literature. Roaf conceptualized microclimate to include skin temperature, humidity, and air movement.[3]

In 2007, Reger and Ranganathan published an analysis of the literature from 1975 through 2006 entitled "Support Surface Interface Pressure, Microenvironment, and the Prevalence of Pressure Ulcers: Analysis of the Literature." The researchers reviewed articles that addressed the interface pressures of pressure-relieving support surfaces or pressure ulcer prevalence in the general population and spinal cord-injured patients.[6] Despite a limited number of studies (some with acknowledged shortcomings), Reger and Ranganathan concluded that "no direct or positive relationship exists between interface pressure and the distribution of pressure ulcers at various anatomic locations. This observation suggests that other factors, such as support surface microenvironment, influence ulcer formation at these anatomic sites."[6] Reger and Ranganathan conceptualized microenvironment to include temperature, moisture, duration of the applied load, atrophy, and posture. "These factors influence tissue quality by reducing the strength and the rigidity of soft tissues and increase the friction coefficient of the skin."[6]

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PRODUCTS USED IN THE MANAGEMENT OF THE MICROCLIMATE.

PRODUCT	PURPOSE
MOISTURE BARRIER PRODUCTS	TO REDUCE THE RISK OF MOISTURE AND MACERATION TO THE SKIN
SKIN EMOLLIENTS	TO HYDRATE DRY SKIN IN ORDER TO REDUCE RISK OF SKIN DAMAGE
BRIEFS	USED TO CONTAIN EFFLUENT AND "WICK AWAY" FLUID FROM THE SKIN
LOW AIR LOSS MATTRESSES	PROVIDES A FLOW OF AIR TO ASSIST IN MANAGING THE HEAT AND HUMIDITY OF THE SKIN[3]

The microclimate can also be controlled or managed in combination with the use of a support surface such as those integrated with low air loss technology. According to the NPUAP, a support surface is defined as "a specialized device for pressure distribution designed for management of tissue loads, microclimate, and/or other therapeutic functions." [2]

The low air loss function of a support surface "provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin." [2] The air volume in the low air loss feature of the mattress should be sufficient enough to remove excessive moisture at the skin level. Too much moisture from incontinence and perspiration reduces the overall strength of the skin and its ability to adapt to changes in the microclimate; this excess moisture can also leave the skin vulnerable to the effects of increased friction.[2]

CONCLUSION

All of these interventions can be used to alter the microclimate in an effort to support the care of the patient and his or her skin; such interventions can prevent breakdown and/or support healing. The microclimate and its management continue to be important in the prevention and treatment of pressure ulcers.

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Today, NPUAP & EPUAP propose using the term *microclimate* to refer to:

- Skin surface or tissue temperature, and
- Humidity or skin surface moisture at the body-support surface interface [7]

Q & A WITH CRAIG MILLER JR.

PRESIDENT OF AMERICAN NATIONAL MANUFACTURING, CORONA, CALIFORNIA

Getting Down to Basics: A Manufacturing Perspective on Microclimate

In an effort to drill down to a basic understanding of how certain support surfaces aid in the management of microclimate, we went straight to the source—the designers and manufacturers. The result: A question-and-answer session focused on the very support surfaces we all use on a daily basis in the care of our patients. This feature will give us a better understanding not just of how support surfaces are designed, but how they work and how we can better use them.

Q. WHAT IS THE DEFINITION OF LOW AIR LOSS?

A. Low air loss is a feature of a support surface that provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin. The problem with this definition is that it does not state the volume of air flow—liters per minute (lpm) that is required to achieve the proper flow to manage heat and moisture. (See below for more on this.)

Q. HOW IS FLOW OF AIR EXPRESSED QUANTITATIVELY, AND HOW DO LOW AIR LOSS AND FLOW OF AIR RELATE TO DIFFERENT TYPES OF SUPPORT SURFACES?

A. There are different types of support surfaces – those that sometimes utilize low air loss are the following: static, zoned, alternating pressure, lateral rotation, and pulsation. These can be in low profile form or in full mattress replacement form. The air flow rates for these types of support surfaces range from 8 liters per minute to 1,740 liters per minute—flow of air is expressed quantitatively in liters per minute as tested by a calibrated anemometer. As there is much variation in 8 liters per minute to 1,740 liters per minute, consider this: the air flow on a compressor commonly referred to as a "fish pump" or aquarium pump typically delivers 4 to 8 liters per minute, while large output compressors for support surfaces deliver up to 50 liters per minute. By comparison, a dual stage blower used on a true low air loss mattress delivers 1,740 liters per minute.

To put the air flow rates into real world examples, an 8-liter per minute pump would take approximately one hour to inflate a queen size camping mattress, while a 1,740-liter per minute blower would take less than one minute.

It is important to understand that the air supply means that, whether it be a compressor (fish pump) or a blower, its first obligation is to supply the air chambers with the proper pressurization. Compressors with small liter flows can only provide minute air flow—if any—for low air loss. One characteristic of an active support surface is that the air source (compressor or blower) must provide cyclic changes in loading and unloading (i.e. filling up the air cell and deflating the air cell on a timed basis). A compressor-based system cannot allow a large amount of air to escape because the primary purpose is to provide pressure redistribution through the loading and unloading of the air cells, which leaves a minimal amount of air flow to address microclimate via low air loss.

Several manufacturers use inexpensive imported compressors and bend or stretch the terminology in order to market the product as a higher end product; therefore, one must use caution and be knowledgeable in selecting a support surface.

The takeaway point is this: the high air volume support surface is superior. What we consider true low air loss is a support surface that is blower-driven (at least 1,100 liters per minute) to allow for quick cyclic changes (loading and unloading) and also allow for a large amount of air to escape below the patient to manage the heat and humidity (microclimate) of the skin.

Q. HOW DOES A SUPPORT SURFACE USE AIR MOVEMENT TO INFLUENCE TEMPERATURE AND MOISTURE AT POINT OF SKIN/SUPPORT SURFACE CONTACT?

A. In order for a low air loss support surface to live up to its full potential, it must use both the correct materials and proper construction. The low air loss being emitted from the support cells needs to be delivered to the patient surface effectively. This is accomplished by delivering air below a breathable top cover with a high moisture vapor transmission rate (MVTR). Directly behind the breathable top sheet, there should be a crush resistant material that allows the air to be disbursed across the entire top cover surface and prevents the occlusion of air flow from the low air loss support cells. At the point of body contact, the fabric is designed to allow the air flow to permeate through the top membrane, which removes heat and moisture from the patient and wicks it towards the outer edge of the surface. It is easy to identify a properly constructed true low air loss mattress because the top cover will be billowing due to the high volume of air being disbursed under the top cover.

THE AIR FLOW ON A COMPRESSOR COMMONLY REFERRED TO AS A "FISH PUMP" OR AQUARIUM PUMP TYPICALLY DELIVERS 4 TO 8 LITERS PER MINUTE, WHILE LARGE OUTPUT COMPRESSORS FOR SUPPORT SURFACES DELIVER UP TO 50 LITERS PER MINUTE. BY COMPARISON, A DUAL STAGE BLOWER USED ON A TRUE LOW AIR LOSS MATTRESS DELIVERS 1,740 LITERS PER MINUTE.

Q. ARE THERE ANY MISCONCEPTIONS OR MISTAKES SURROUNDING USAGE OF SUPPORT SURFACES, IF ANY?

A. Yes, there are, and it's important to avoid them if you want to get the best and proper use out of your support surface to aid the patient. The first misconception that causes mistakes in usage is the material from which the support surface is made. Top covers for low air loss support surfaces must be anti-shear, low friction, vapor permeable, water resistant, antimicrobial and washable. Another mistake that can be made is inadvertent replacement of a component of the support surface with the wrong type of product. Replacement components that are to be purchased for support surfaces should meet or exceed the original

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MICROCLIMATE: WHAT'S THE EVIDENCE?

The reader is referred to the recently released consensus document entitled *Pressure Ulcer Prevention: Pressure, Shear, Friction and Microclimate in Context* (London: Wounds International, 2010) for a detailed review of the literature and outstanding discussion of the evidence-base for microclimate. While empirical evidence and clinical observation suggest that moisture control, skin temperature management, and maintenance of air flow are important variables, research has yet to demonstrate how this can be applied in clinical practice. How controlling these variables will impact pressure ulcer prevention and treatment has yet to be fully elucidated by clinical research. At this point in time, there are probably more questions than answers.

THE TERM *MICROCLIMATE* WAS FIRST USED IN A PRESSURE ULCER CONTEXT IN 1976 BY ROAF IN THE UK TO REFER TO THE ENVIRONMENT IN WHICH PRESSURE ULCERS OCCUR.[3] IT IS DIFFERENT FROM THE TERM *MICROENVIRONMENT*, WHICH IS USUALLY USED IN THE CONTEXT OF WOUND RESEARCH TO DESCRIBE THE WOUND AT A CELLULAR LEVEL (WOUND FLUID, PROTEOLYTIC NATURE, GROWTH FACTOR PROFILE, ETC.).

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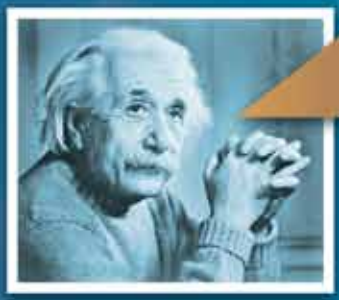
Some of the most important questions that remain to be answered include the following:

- What is normal skin temperature?
- Can skin temperature predict pressure ulcer development?
- What is the role of skin cooling in protecting against pressure ulcers?
- What is the role of support surfaces in managing the microclimate?
- How can support surface microclimate design decrease the rate of pressure ulcer development?
- Can support surface microclimate design improve the healing rates of pressure ulcers?
- Do we understand enough today about microclimate and support surfaces to direct support surface selection in day-to-day clinical practice?

These and other gaps in our understanding of microclimate will direct research efforts in the years to come.

CONCLUSION

There is "buzz" in the wound community about microclimate and "hype" in wound advertisements about various products and their effects on microclimate and microenvironment. Practitioners are encouraged to be critical thinkers and to review the current and emerging research on the issue. At this point, we probably have more questions than answers about microclimate and its relationship to pressure ulcer prevention and treatment.



The important thing is not to stop questioning. Curiosity has its own reason for existing. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery every day. Never lose a holy curiosity.
Albert Einstein
US (German-born) physicist (1879 - 1955)

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...equipment manufacturer specifications so that the integrity and performance of the surface are not compromised. Always refer to manufacturer recommendations when using replacement parts. Using sub-standard replacement parts may in fact harm the patient because a replacement cover may not allow sufficient air flow to the patient (i.e. billowing) to accommodate the blower. This can lead to poor management of the microclimate and poor patient outcomes.

Dehydration can be a concern for some patients on these types of surfaces. Again, it is important to monitor the patient for signs and symptoms of dehydration and adjust fluids according to physician orders.