Skin Deep

Imaging technologies may detect pressure ulcers and deep-tissue injuries that healthcare workers may miss, especially in dark-skinned people.

BY JANE M. SANDERS

For people with impaired mobility and reduced ability to sense injury, the risk is high for pressure ulcers that can develop when they sit or recline in one position too long or wear a poorly-fit prostheses for an extended period.

Healthcare professionals routinely check patients for early signs of erythema, or skin redness. But visual inspections sometimes fail to detect reddening of the skin and other indicators of tissue damage, especially in people with darkly pigmented skin. If undetected, these at-risk sites can develop pressure ulcers.

Beyond ulcers looms a more serious risk for these patients — that of pressure-induced, deep-tissue injury, which occurs below the skin and is often not diagnosed visually until it has reached a dangerous, advanced stage.

Healthcare practitioners may be able to reduce their patients’ risk of these complications by supplementing their visual inspections with a low-cost, handheld imaging device that could detect both early-stage pressure ulcers and the more serious deep-tissue injuries. Such a device is the ultimate goal of a Georgia Institute of Technology study now in field trials. The work is being funded by a grant from the National Institutes of Health (NIH) in collaboration with the National Institutes of Justice. A significant focus of the study is on detection of bruises and erythema in people with darkly pigmented skin.

“There’s a huge opportunity to intervene if we can see pressure ulcers at a very early stage,” says lead researcher Stephen Sprigle, director of the Georgia Tech College of Architecture’s Center for Assistive Technology and Environmental Access (CATEA). “Detecting them then drives the treatment. If you take the visual indicator away, it adversely impacts care, and for folks with darkly pigmented skin, that’s a problem.”

In addition to the human costs of pressure ulcers, there are monetary burdens, as well. The cost to heal a pressure ulcer is estimated to reach $40,000 for certain ulcers, Sprigle notes. In the United States alone, the costs associated with healing ulcers and worker productivity losses exceed $2 billion a year.
that works like the ultrasonic scanners used to visualize babies in the womb, except this scanner operates at a higher frequency to get more detailed images of the skin.

“Ultrasound is based on the concept of acoustic reflections, which are like shouting in a mountain range and hearing an echo in response,” explains Linghua Kong, a research engineer in CATEA. “Depending on the time it takes for an echo to come back, we can determine the distance of the obstacle.”

In their initial field test using high-frequency ultrasound, researchers noted that the thickness of the skin oscillates slightly. More controlled tests confirmed this finding, and analysis is under way to describe the new phenomena. “This is an exciting result because the frequency and the amplitude information can potentially be used to determine how old the bruise is,” Kong says.

**Forensic Evidence**

Determining when and how a bruise occurred is important to the National Institutes of Justice for forensic purposes. NJI funded the NIH grant because of its interest in the development of a low-cost imaging device to help officials identify elder neglect and abuse.

“One of the markers of neglect in the elderly is pressure ulcers, and bruises are a marker of abuse,” Sprigle explains. “Detecting these problems in the elderly shares some of the same problems we have in detecting erythema in people with dark skin.”

Currently, doctors examine bruises and, based on their experience and previous research, they guess the age of the bruises depending on their color.

“There’s a lot of error in this process, and it’s not admissible as evidence in court,” Caspall notes. “So we’re trying to come up with some guidelines to quantify bruises so doctors can backwards extrapolate to the onset of the bruise.”

Researchers are monitoring bruising over time and looking for consistent trends in spectral and acoustic components. If they can model bruise behaviors, such as oscillatory function, they can use them as parameters for aging bruises.

Acoustic imaging data also may provide clues as to whether a patient’s injury resulted from a fall or other type
of impact, Sprigle says. “By combining multi-spectral imaging of bruises, which have a visual indication, with acoustic imaging, which tells us the extent of injury under the skin, it’s possible we can start to form profiles of the types of mechanism of injury — blunt or sharp or a fall versus an impact,” Sprigle says.

**Testing the Technologies**

Clinical field studies began in January 2006 and will continue through the summer at an A.G. Rhodes nursing home in Atlanta and at the Shepherd Center. Because of immobility, patients at Shepherd and residents in the nursing home are at risk for pressure ulcers. Researchers hope to get data over weeks or months as healing occurs on about 25 to 30 patients, particularly those with dark skin.

Clinical data collection helps drive the researchers’ modeling and algorithm development. Though these studies don’t reveal the etiology and the time base on bruises, they will provide enough background information to do controlled animal studies later, Sprigle says.

The current phase of the project is funded through August 2006, and Sprigle plans to apply to NIH and NIH for continuation funding. Ultimately, the researchers plan to develop a prototype software program and/or hardware device. The researchers estimate the ultimate product - a handheld imaging device - will cost no more than $5,000 a unit. They want to license the technology to an optics and/or acoustics firm.

“There’s a need for this technology in every nursing unit in every hospital, group home, nursing home and rehabilitation facility,” Sprigle says. “Also, if we can detect bruising caused by abuse, it will be useful to social service agencies.”

Pressure ulcers are a common ailment among patients with impaired mobility, including those with spinal cord injury, multiple sclerosis, stroke, amputation and dementia.

“Given that in the United States we spend billions per year to treat pressure ulcers, prevention is always a better option…” Sprigle says. “This project aims to do that by getting clinicians and practitioners an inexpensive and accessible imaging device they can use at bedside, in the emergency room or at home. Both of these technologies we’re studying meet those requirements.”

Read more at: gbresearchnews.gatech.edu/reshor/rh-ss06/bruises.html

**ABOVE:** Georgia Tech engineers designed an enhanced multi-spectral imaging system for detecting bruising and erythema. The system consists of a laptop computer that imports images from a camera with a multi-spectral filter wheel. The camera’s filters measure narrow bands of visible light — about 10 nanometers in length.

**BELOW:** Clinical data collection helps drive the researchers’ modeling and algorithm development. Though these studies don’t reveal the etiology and the time base on bruises, they will provide enough background information to do controlled animal studies later, researchers say.