By the Numbers

Making the case for clinical use of Pressure Measurement Mat Technology to prevent the development of pressure ulcers.

By Nigel Shapcott, MS, ATP and Barbara Levy, PT, ATP

Accuracy costs money. In the field of pressure mapping technology, accuracy is particularly expensive.

While there are a number of Pressure Measurement Mat Technologies available on the market, they are all relatively costly, creating a significant deterrent to increased use of such systems.

This article examines the use of PMMTs as part of a selection protocol for wheelchairs and wheelchair cushions and addresses the barriers to the widespread implementation of PMMTs from a clinical perspective.

Cost has been a large barrier to the widespread use of this technology — typically $10,000 to $15,000 including a computer system.

The current generation of PMMTs was designed for research purposes, or at least the specifications for the PMMTs were driven by manufacturers' responding to requests from researchers for accurate systems providing numerical and graphical information.

These requirements have led to the development of sophisticated hardware and software with calibration jigs, all of which cost a great deal more than is available in a cash-strapped occupational or physical therapy department, nursing home or home care nursing budget.

In order to increase the use of PMMTs to levels that will significantly reduce the problem of pressure ulcers, two options are available:

- Educate more people about the benefits of PMMTs so that more are purchased, thus driving the price down.
- Redesign the technology to reduce the cost.

Costly Results

Pressure ulcers are a major problem for individuals who use wheelchairs or spend long periods of time in bed as a result of a long-term illness or disability.

Various estimates put the annual cost of pressure ulcers at around $1.3 billion,[1] and individual pressure sore costs per incident have been quoted as costing $24,600.[2] The study of pressure ulcers and their causes have been the life's work of many eminent researchers throughout the world for the past four decades.

Pressure ulcers, as well as being expensive to treat, can be debilitating. The threat or occurrence of pressure ulcers may prevent prolonged sitting in a wheelchair, which then prevents participation in educational, work and/or recreational activities.

What Causes Pressure Ulcers?

It is important to understand that pressure ulcers may have multiple causes and that simple static pressure may be just one of the factors in pressure sore formation.

For the sake of this discussion, we have described those issues related to the formation of these pressure ulcers as the three major factors outlined below:

- Excessive forces—These cause ischemia or other injury when applied to the body. The forces can be direct sustained pressure or transitory high pressure, or sustained shear or transitory high shear forces.[3,4,5,6,7,8,9,10]
- Skin condition—This is a factor that relates to numerous physiological characteristics of an individual and may include these: nutritional status; local blood flow and pressure; local tissue thickness and mechanical characteristics; general whole body health; cognitive and psychological status; movement; and innervation status.[11,3,12]
- Microenvironment—This factor may include the following subfactors: local temperature, local humidity and presence of contamination.[3,13]

The pressure threshold for damage to skin varies.[14] In other words, the skin of some individuals can resist sus-

tained levels of pressure much higher than that of other individuals, and pressure alone is not a reliable indicator of risk.

The Technology

PMMTs are a class of measurement device that consists of multiple pressure sensors in an array, normally about 18 inches square. Various types of sensors (pneumatic, resistive, capacitive) come in various numbers (200- 1,000 approximately) that make up the mat.

The mat is placed over the cushion or other support surface, allowing the client to sit or lie on it. A computer outputs a graphic display of the pressures. The graphics can be printed, along with notes and other client information.

Some hardware and software programs are dynamic, which enables a constant display of changing pressures to be observed, while others are static and take a "snapshot."

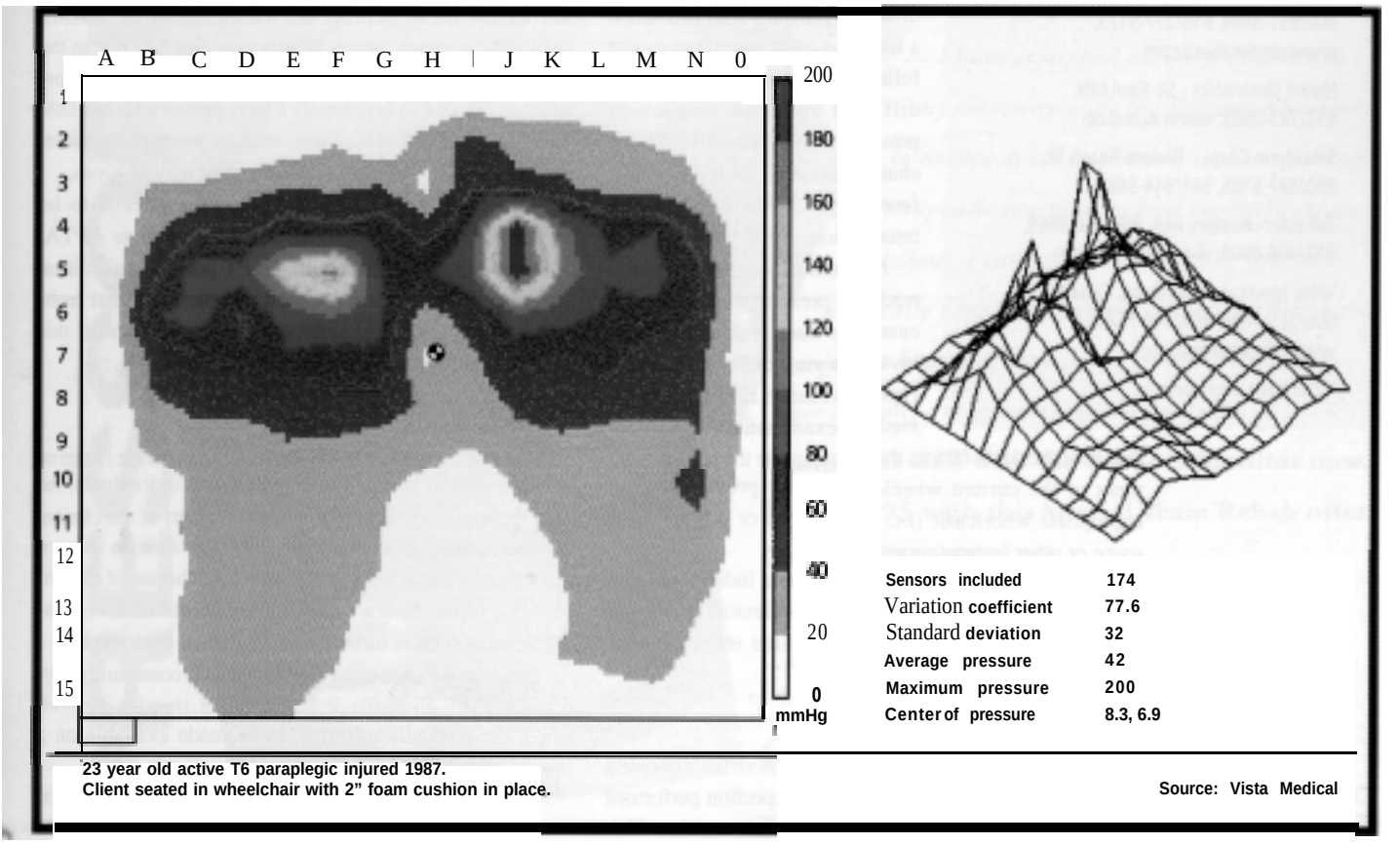
Why are Pressure Mats Used?

In a research setting, PMMTs have historically been used to investigate and understand various processes in pressure sore development. They are also used by manufacturers to design, develop and test new cushions.

In a clinical setting, PMMTs are typically used as part of the routine screening or evaluation procedure to determine whether individuals are at risk of developing pressure ulcers while using their existing equipment. Pressure mapping is often used for relative comparison between different types of cushions and wheelchair setups to assist in the selection of this equipment for particular individuals. They are also useful as biofeedback to the individual regarding weight shift and pressure relief abilities and strategies.

PMMTs can be an extremely useful measurement technique as part of a holistic protocol to understand what may be the cause of the pressure sore problem or as an assessment of the risk of pressure sore development.

Also they can determine the comfort, fit or pressure relief of a contoured system in which the individual is unable to communicate-for example, in the population with severe developmental disabilities.



23 year old active T6 paraplegic injured 1987.
Client seated in wheelchair with 2" foam cushion in place.

Source: Vista Medical

In a well-organized clinical environment, PMMTs can be used quickly and effectively to gather information.

Clinical Technique and PMMTs

For the sake of brevity, we have summarized a typical clinical scenario when PMMTs are routinely used. In a clinical setting, a PMMT is used in addition to a traditional assessment to initially determine a baseline reading using the client's current wheelchair, associated cushion and other assistive technology.

If the pressures are low (less than 8O mmHg) with good pressure distribution and no active pressure sore problems, the person passes the initial screening, and no intervention is required.

If the pressures are higher (8O-12OmmHg) showing some peak pressures with uneven pressure distribution but with no active pressure sore problems, a different cushion may be tried, and pressure relief may be discussed as the intervention to prevent the development of a sore. In addition, the wheelchair footrests may be adjusted, or other frame modifications tried.

If the pressures are definitely high (120-200mmHg) witb significant peak pressures and poor pressure distribution, regardless of active pressure sore problems, a more detailed investigation will follow. This may involve trying different cushions, discussing pressure relief, alternative wheelchair positioning or trying a different type of wheelchair as the intervention.

No matter what the pressure readings, pressure ulcer problems ensure an intervention. This may involve trying different cushion types, pressure relief training, medical examination with attention to all possible factors that could cause the sore, adjustment of the current wheelchair and/or provision of an appropriate wheelchair (i.e. with manual or power tilt-in-space or other features as required).

PMMTs are a terrific tool for teaching individuals with impaired sensation the importance of pressure relief and for finding the most appropriate pressure relief methods for an individual.

The Test of Time

Perhaps the most widespread method for choosing cushions is trial and error, with skin inspection performed before and after a short- term use of each cushion. This involves wound examination both visually and by palpation. In some circumstances, a visual inspection of the wound is not possible, so a description of the wound is obtained from the individual and/or caretaker.

Unfortunately, in most situations where wheelchair cushions and wheelchairs are prescribed or otherwise obtained, there is no use of pressure measurement technology. The onus is put upon the user and/or caretaker to keep a check on skin conditions and to "build up tolerance" to a chosen cushion. In some circumstances, skin inspections are done on an approximately3O minute basis, (e.g. in a rehab setting where cushions are being tried out), but in the current clinical climate, the reality is that this occurs infrequently.

This situation may lead to conditions unfavorable for the prevention of pressure ulcers, particularly in individuals with impaired protective sensation.

Technology Usage

Given the $1.3 billion cost of pressure ulcers,there is a surprisingly minimal availability of pressure mats in clinical settings for the prevention of pressure ulcers, with approximately 2.50 to 300 currently in use in North America.ls This may be due to cost or a perceived complexity of time-consuming measurements.

Some facilities recognize the benefit of PMMTs and have purchased them to help prevent the occurrence of pressure ulcers. These facilities bill for the use of the PMMT and for the clinician's time. Whether we like it or not, in the current HMO-driven health care climate, the clinician (normally an OT or PT) is generally a busy person who has little time for additional procedures, such as pressure measurement, for which little to no reimbursement may be given.

Reimbursement for these procedures needs to be addressed by professional organizations such as APTA, which is currently working on thePT practice guidelines. Inclusion of the clinical pressure measurement mat technologies as a modality and evaluation procedure in this document should help increase reimbursement.

Do We Need Numbers?

The case can be made that because of the wide range of vulnerability to pressure ulcers between individuals, no need for absolute pressure to be used as a part of the clinical decision-making process exists. This is because on its own absolute pressure is not a good predictor. The use of clinical PMMTs, which have a capability to indicate relative sure comparisons, is sufficient in the clinical environment.

This may be unpopular in the research community, but it has a place clinically if it allows for simpler devices, which are clinically effective, to be made available on a more widespread basis.

For clinical use, PMMTs may not need to be designed

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Pressure Mapping Systems*

Manufacturers of **PMMT devices include the following:**

Crown Therapeutics - Belleville, IL 800/851-3444,618/277-9173; www.crownthera.com

Novel Electronics - St. Paul MN, 651/221-0505 **www.novel.de**

Seridyne Corp. - Riviera Beach FA 800/327-6185,561/844-3486

Tekscan - Boston, MA 800/248-3669, 617/464-4500 **www.tekscan.com**

Vista Medical - Winnipeg, Canada; 800/563-7676,204/949-7676; www.vistamedical.org

*This **is not a complete list.**

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and manufactured to the same specifications as PMMTs which are being used for research work. By eliminating the need for specific numbers, it will be possible to produce an effective, easier to use, less technologically sophisticated and less costly system for the reduction of incidence of pressure ulcers. Relative comparisons can still be made between cushions and other interventions to determine the best setup to eliminate peak pressures and obtain good pressure distribution.

Currently, manufacturers have relatively high manufacturing costs and, because of the system complexity, also have high training costs, both of which are passed on to the customer. Because of these high costs, the number of PMMTs sold is relatively low, and there is no opportunity to benefit from significant manufacturing cost reductions resulting from economies of scale. The situation is similar to that of the first VCRs, which were very expensive but now can be bought for much less because the high volume sold brought the cost of manufacturing down.

The benefits of simpler technology are reduced manufacturing costs, lower installation/training costs and the potential to benefit from economies of scale.

Proposed Specifications for Clinical PMMTs

• Best practice protocols - It is absolutely essential that any Clinical PMMT development be accompanied by the development of research-proven, clinically effective, best-practice protocols.

• Ease of use-Any new clinical PMMT device should be intuitive to set up and use with no special calibration required (automatically occurring).

• Reliable-Any new clinical PMMT device should be reliable. If maintenance is required, it should be available by replacement via overnight shipping.

• Clear indication of abnormal performance-It is absolutely vital that clinicians have trust in their equipment with automatic clear indication of abnormal performance.

• Comparative accuracy-All sensors must be approximately equal. For this discussion, we estimate that an accuracy range of between & 1OmmHg and k 25mmHg overall would be sufficient. This would, of necessity, need to beconfirmed by further research.

• Robust-Clinical environments have individuals of various body weights and transfer capabilities who will be sliding, pulling and generally subjecting clinical PMMTs to forces that are not seen routinely in a research environment. The mats must be durable to hold up to this type of use.

• Infection control-Protection against soiling is essential for the clinical PMMT. Covers should be washable with sufficient spare covers to allow for the normal hospital laundry process. Alternatively, disposable, low cost covers may be utilized.

• Portable-Current systems on the market are portable and usable with lap top computers. This capability should be retained.

• Low cost-Ideally the purchase price of a complete system should be approximately $1,000.

Conclusion

There is a need for the development of less costly pressure measurement mat technologies and protocols to help with the selection of the optimum cushion for individuals using wheelchairs in order to reduce the risk of pressure ulcers.

Additionally, educational packages must be developed for these technologies to teach clinicians the importance and correct use of the PMMT.

PMMTs should be available on a routine basis and at a reasonable cost. Reduction of the complexity of PMMTs both in operational and manufacturing spheres may enable costs to be reduced. The use of new technologies such as Handheld PC's(H/PC's) may also have an impact in reducing overall system costs.

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