Determination of Optimal Technique to Monitor Bed Occupancy and Body Position

Daniel Smith, Philip Tharp*, Charity Pires*, Maureen Linden, MSBME*; Kim Davis MSPT†*

**Center for Assistive Technology and Environmental Access, Georgia Institute of Technology*

†Crawford Research Institute, Shepherd Center

Introduction

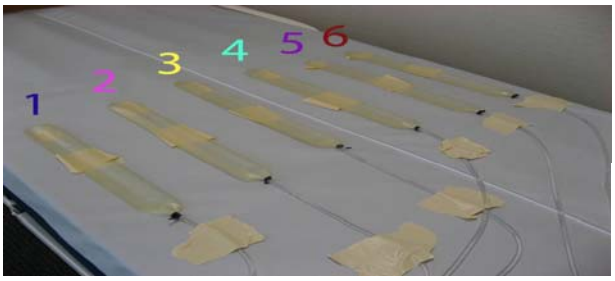
- Risk of pressure ulcer development is related to not only the *amount,* but also the *duration* of pressure.[1]
- Current assessment tools to aid in determining position in bed include:
  - Interface Pressure Mapping Array (eg. FSA) – can give the pressure distribution profile, but must be used between the body and mattress, so is not plausible for long term monitoring. Further, IPM systems are expensive.
  - Position monitors - these use accelerometers to determine the orientation of a body part with respect to gravity. The device must be worn and would be intrusive to ADL's.
- The aim of the overall study is to develop a non-invasive, low-cost system for determining and logging a patient's position in a bed to monitor which at-risk sites are loaded and for how long. This addresses the time risk factor for pressure ulcer development.
- The goal of this pilot study was to determine the optimal test equipment and placement to differentiate between supine and sidelying.

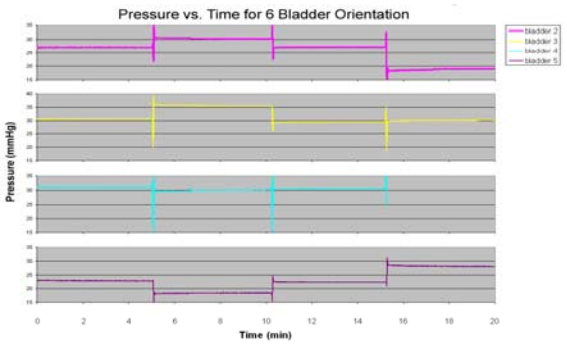
Methodology

- Fluid filled bladders of various shapes and sizes were placed under the mattress at locations corresponding to bony prominences, selected to distinguish supine from sidelying (occiput, scapula, sacrum, greater trochanter, femoral condyles, calcaneous).
- Standard methods for patient positioning, using pillows for offloading, were utilized.
- 4 Able-bodied subjects participated in multiple trials.
- Pressure from the bladders was measured with integrated circuit pressure sensors (Phidget) and logged on the data logger (Sparkfun).
- The bladders were connected to pressure sensors, which were in turn relayed to the Sparkfun data logger through a pressure sensor circuit board. Data from the logger was transferred to be analyzed on the computer.
- The test subject was positioned in the supine position for 5 minutes, independently repositioned into left-sidelying for 5 minutes, returned to the supine position for 5 minutes, repositioned to right-sidelying position for a final 5 minutes. This process constituted one trial.
- A total of 3 trials were conducted per subject, per specific bladder array.
- In both supine and sidelying, subjects were centered on the mattress to mimic typical positioning.

Results

- Initial testing showed that the mattress' pressure dispersion resulted in little pressure differentiation between positions anywhere other than the pelvis.
- Body position could possibly be determined by location of high pressure areas as loads transitioned between the sacrum (supine) and trochanter (sidelying).
- Optimal size, shape and placement of bladders was determined to be: oblong bladders lined up side-by-side under the pelvic region of the mattress. Each of the bladders was filled with 80ml of water.





Graph 1 (above): Displays the pressure values for bladders 2-4 over time. The distinct change in values indicate the subject's change in position. Bladders 1 and 6 are not shown due to insignificant change.

Figure 1 (above): Layout of the bladders under the mattress.

Table 1 (below): Pressure in each bladder per position (in mmHg).

	Supine 1			Left Sidelying		
	Average	Stand. Dev.	Coeff. Of Variance	Average	Stand. Dev.	Coeff. Of Variance
Bladder 1	7.81	0.24	0.030	8.01	0.11	0.014
Bladder 2	27.18	0.06	0.002	30.32	0.15	0.005
Bladder 3	28.87	0.06	0.002	35.56	0.08	0.002
Bladder 4	30.96	0.06	0.002	30.02	0.20	0.007
Bladder 5	22.89	0.06	0.002	18.41	0.08	0.005
Bladder 6	6.40	0.06	0.009	6.31	0.06	0.010
	Supine 2			Right Sidelying		
	Average	Stand. Dev.	Coeff. Of Variance	Average	Stand. Dev.	Coeff. Of Variance
Bladder 1	7.84	0.05	0.007	6.75	0.16	0.023
Bladder 2	27.25	0.05	0.002	18.82	0.21	0.011
Bladder 3	29.44	0.06	0.002	30.02	0.08	0.003
Bladder 4	30.46	0.05	0.002	37.39	0.24	0.006
Bladder 5	22.36	0.07	0.003	28.23	0.13	0.004
Bladder 6	6.29	0.06	0.009	6.23	0.08	0.013

- Bladders 2 and 5 detected the subject's position changes in all trials. Rolling to sidelying towards bladder 2 caused a marked increase in bladder 2's pressure reading and a similarly sized decrease in bladder 5's pressure readings.
- Bladders 3 and 4 behaved similar to bladders 2 and 5, respectively, but less consistently.
- Bladders 1 and 6 did not detect position changes.

Conclusions

- The new water-bladder method was successful in identifying the subject's position through investigation of location of areas of high pressure.
- Mattresses tested dispersed pressure to the extent that positions of the occiput, scapula, femoral condyles, and calcaneous could not be distinguished.
- The positions of the oblong bladders were tested only on two mattresses. (Pressure Guard Renew, Span America; DermaTech™ Sunrise Medical) Future recommendations include testing different mattresses to assure that the chose bladder size and orientation is effective yields similar results to the mattresses tested.
- Pressure mapping systems (e.g. FSA or Tekscan) could be used to deduce the pressure profile and aid in the positioning of bladders on different mattresses.

Literature Cited

1. Reswick, J and Rodgers J, Experience at Rancho Los Amigos Hospital with devices and techniques to prevent pressure sores, in Bedsore Biomechanics, C.a.S. Kennedy, Editor. 1976, University Park Press: Baltimore. p. 301-310.

SHEPHERD CENTER
A Catastrophic Care Hospital

mobilityRERC

catea Center for Assistive Technology & Environmental Access Georgia Tech