

# Biomechanical Comparison of an Alternating Air Pressure (AAP) Support Mattress to a Dynamic Air Pressure Redistribution (DAPR) [low air loss] Mattress using CAT Scans and PET Scans.

Susan Scott-Williams, MSN, RN, CWOCN, Memphis, Tennessee Phyllis Murphy, MD Board Certified in Dermatology, Tampa, Florida

## ABSTRACT

**BACKGROUND:** Unrelieved pressure can cause occlusion of capillary blood flow causing a subcutaneous infarct and resulting pressure ulcer. Support surface technology should be able to redistribute pressure without causing tissue distortion, and occlusion of blood, lymph drainage and/or interstitial fluid flow.

**OBJECTIVE:** This independent study was conducted to evaluate the immediate biomechanical, metabolic and hemodynamic measurements of two commonly used support surface modalities on healthy subjects.

**DESIGN:** Twenty-five subjects were placed on an (AAP) mattress and alternatively on a (DAPR) mattress.

**MEASUREMENTS:** Microcirculatory blood flow measurements (laser doppler), transcutaneous oxygen (TcPO2), random radiographic studies consisting of computer aided tomography (CAT) scans and positron emission tomography (PET) with radioisotope tagging of glucose standard uptake values, scans were utilized. Measurements used determined the extent of soft tissue distortion (tensile stress), absence or presence of hypoxic tissue and accelerated metabolic activity associated with soft tissue inflammation.

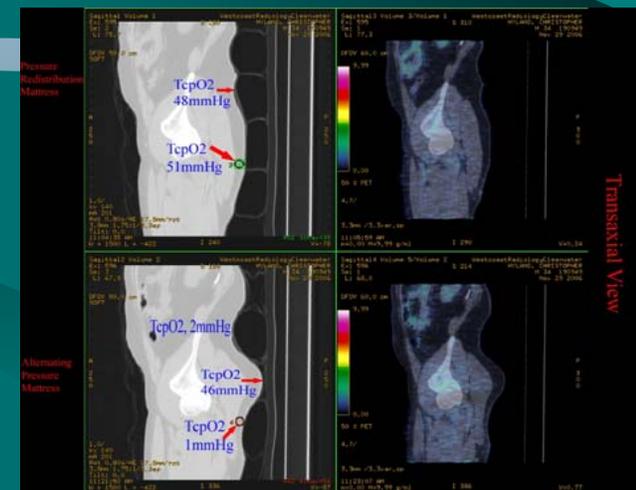
**RESULTS:** Preliminary results of nine subjects demonstrated decrease in TcPO2 measurement nearing occlusion, hyper increased cell metabolic activity on PET scan, and gross soft tissue distortion on the (APP) mattress. Subjects on the (DAPR) mattress experienced normal measured parameters.

**CONCLUSION:** Standardized measurements of microcirculatory blood flow may be helpful in determining efficacy of support surfaces in providing adequate pressure redistribution for pressure ulcer prevention.

## MATERIALS AND METHODS

- Four measurement parameters were used in the study.
- Positron emission tomography, also called PET imaging or a PET scan, is a diagnostic examination that involves the acquisition of physiologic images based on the detection of radiation from the emission of positrons.<sup>2,3</sup> By injecting a glucose isotope the cell metabolic active is measured by volume uptake. Specific measurements include soft tissue inflammation secondary to mechanical trauma, ischemia, reperfusion injuries. The more glucose that is absorbed by the cell the higher the metabolic activity. The higher the metabolic activity the more stress the cell is experiencing causing a greater demand for O2 and waste elimination
- Transcutaneous O2 (TcPO2) measurements determine the relative change in capillary oxygen tension at the skin support surface interface. This measurement is correlated with the Laser Doppler measurements
- Laser Doppler measures dynamic blood flow in the microcirculation. The measurement technique visualizes a change in the laser wavelength based on the movement (velocity) of blood cells. (Doppler shift effect). This will give an exact indication of dynamic blood flow in (PU) perfusion units and will be used to correlate with the static TcPO2 readings. Basically tells us when the circulation is occluded.
- CT Scan also known as Computer Aided Tomography (CAT imaging uses special x-ray equipment to produce multiple images or pictures of the inside of the body and a computer to join them together in cross-sectional views of the area being studied. The CT scan demonstrates three dimensionally the extent of soft tissue distortion and compression again bony prominence.

## RESULTS AND DISCUSSION



- CT scans: Transaxial Views:** Pressure redistribution (LAL) We see uniform distribution of pressure with minimal soft tissue distortion and consistent normal TcPO2 values with no occlusion of microcirculation.
- CT scans: Transaxial Views:** Alternating Air Pressure (AAP): Gross distortion of soft tissue with compression against bony prominence, Lower average TcPO2 values, Occluded circulation above inflated zones.

## CONCLUSIONS

- Preliminary results found no evidence of increased blood flow, increases in oxygen tension, or cyclic reactive hyperemia on those individuals supported by an alternating air pressure (APP) surface.
- The average Transcutaneous oxygen tension noted was below that which was observed on a pressure redistribution surface with total occlusion of blood flow over 50% of the surface at any given time.
- High vertical shear forces with gross distortion of subcutaneous tissue and muscle strain were visualized under CAT scans on individuals supported by an APP surface.
- Increased cell metabolic activity demonstrated by PET Scan may be indicative of a minimum mechanical stress of soft tissue or an inflammatory response to hypoxia.

## BIBLIOGRAPHY

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- Positron Emission Tomography (PET) Radiology Info retrieved April 15<sup>th</sup>, from <http://www.radiologyinfo.com/diag/im27/pet2.htm>
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## BACKGROUND

- Interface pressure measurements reflects only surface pressure, does not measure the tissue pressure at the bone/muscle level and ignores vertical shear.
- Reliance on manufacturer's claims of clinical efficacy of any particular support surface modality must be closely scrutinized.
- Specific operational characteristics of one support surface may conflict with another, i.e. Alternating Pressure Surface Vs. Dynamic Pressure Redistribution Surface (Low Air Loss).
- Biomedical technology exists which will quantify with irrefutable accuracy the immediate Bio-Mechanical impact a support surface has on living tissue.

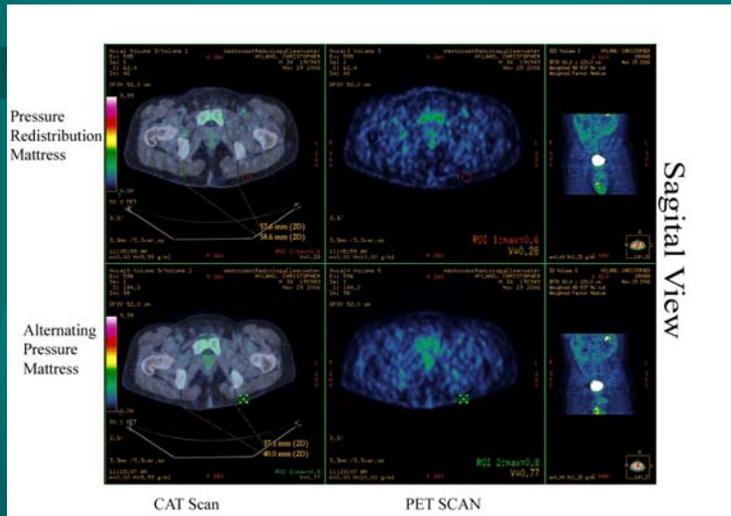
## PURPOSE AND HYPOTHESIS

- The purpose of this study was to determine the biomechanical differences between dynamic air redistribution surfaces (Low Air loss/LAL) and Alternating Air Pressure surfaces (AAP)
- Hypothesis: That a quantifiable difference in the Biomechanical response of living tissue to different support surface modalities exists.
- The clinical relevance of this study is to provide an alternative method of evaluating the clinical efficacy and potential adverse side effects of the two most commonly used support surface modalities.

## PET SCANS



## CAT SCANS



- PET Scans: Sagittal Views Pressure Redistribution (LAL):** Standard Uptake Volume of Glucose (SUV) = .28 gm/ml normal
- PET Scans: Sagittal Views: Alternating Pressure (APP):** Standard Uptake Volume of Glucose (SUV) = .77gm/ml 2 to 3 times accelerated metabolic activity over pressure redistribution (LAL).