Towards the Development of an Alternating Pressure Overlay for the Treatment of Pressure Ulcers Using Miniaturized Air Cells

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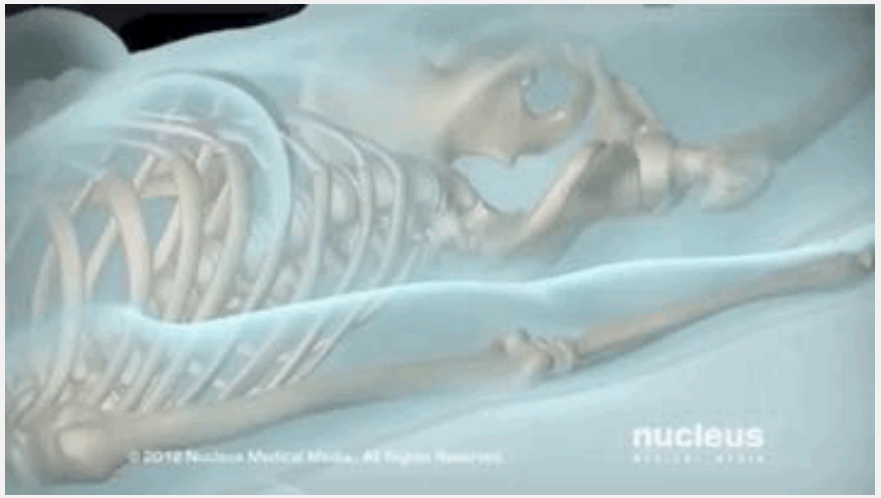
PRESSURE ULCERS?



- Skin Deformity
- Application of **prolonged pressure** on the **skin** which **compresses** the **blood vessels** that supply oxygen and vital nutrients to the **skin**.
- More prominent in **bony areas**

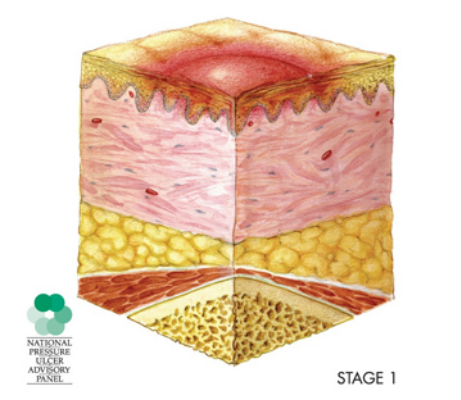
GLOBAL IMPACT

- **Annual** total **treatment cost** of pressure ulcers
  - UK is **£1.4–2.1 billion** (which is around 4% of total NHS expenditure)
  - US is **$18.5 billion** to the health system
- **Death** of **60,000 persons** in the **US (2019)**

- Gerry Bennett, Carol Dealey, John Posnet, "The cost of pressure ulcers in the UK," British Geriatrics Society 2004, vol. 33, no. 03, 2004, doi: 10.1093/ageing/afh086.

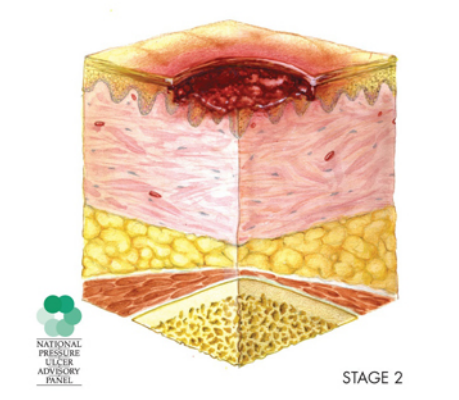
IF NOT TREATED PROPERLY....

STAGE 1



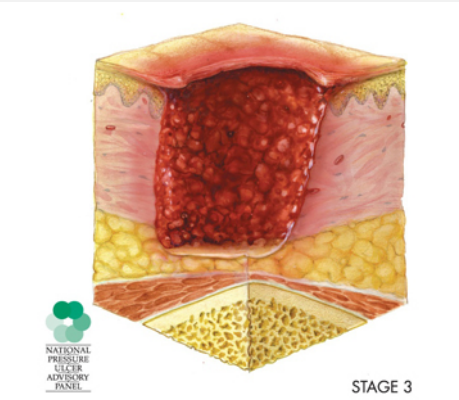
- Skin discoloration
  - Red
  - Blue
  - Purple
  - Black

STAGE 2



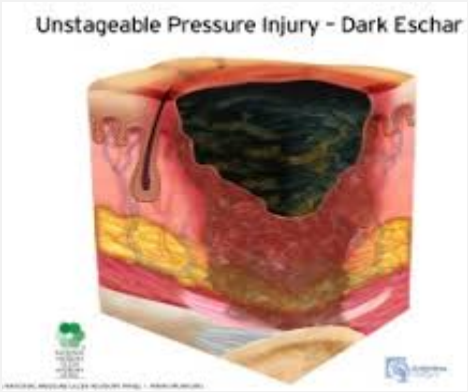
- Some **skin loss** or **damage** involving the **top-most skin layers**

STAGE 3



- Necrosis (**death**) or **damage** to the **skin**
- Limited to the skin layers

STAGE 4



- The **necrosis** of the skin goes down **towards** the **deep layers** which might even **lead up to the bone** through the tendon and joints
- Lead to amputations(42%) and then even to death

European Pressure Ulcer Advisory Panel

CURRENT TREATMENT METHODS

❑ SUPPORT SURFACES –

- Functions -

  Reducing or Redistribution of Pressure

  Reduce friction and shear forces

- Factors selecting a support surface –

  Stage of the pressure ulcer

  Cost of the device ($100 - $40,000)

  Patient's Comfort

  Durability

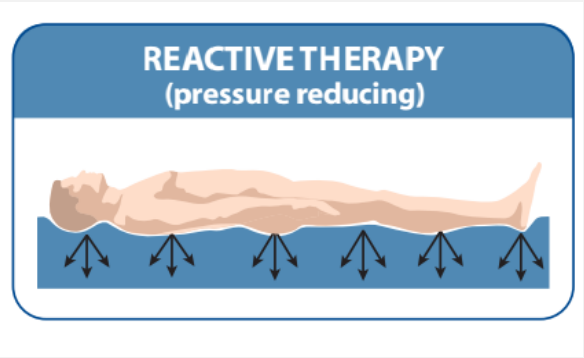
❑ NUTRITION

❑ DRESSINGS(ALGENATE AND HYDROCOLLOID) AND TOPICAL AGENTS

❑ CARE GIVING

- D. Stannard, "Support Surfaces for Pressure Ulcer Prevention," *J. Perianesthesia Nurs.*, vol. 27, no. 5, pp. 341–342, 2012, doi: 10.1016/j.jopan.2012.07.007.
- J. S. Mervis and T. J. Phillips, "Pressure ulcers: Prevention and management," *J. Am. Acad. Dermatol.*, vol. 81, no. 4, pp. 893–902, 2019, doi: 10.1016/j.jaad.2018.12.068.

SUPPORT SURFACES

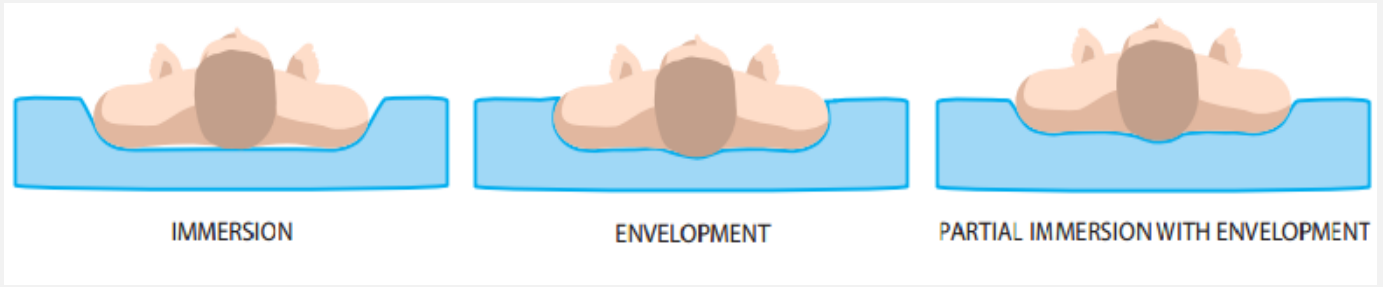


❑ REACTIVE SUPPORT SURFACES

- **Reduction** of pressure
- Foam mattress, Water mattress, Gel mattress
- Immersion or Envelopment of the body –

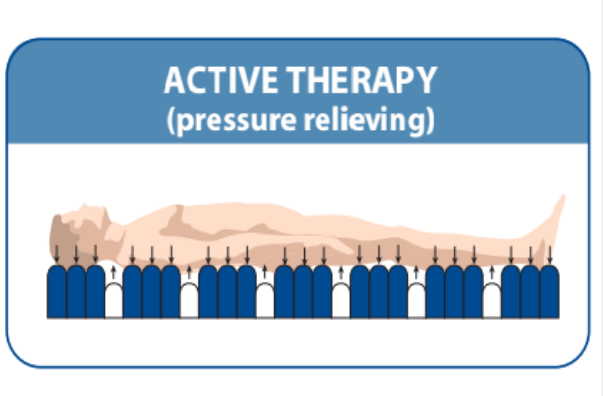
  Body weight distributed over a larger surface area
- Reduction of pressure –

  Not sufficient to stop the blockage of blood circulation



T. H. Care, "The Role of Support Surfaces in Pressure Ulcer Prevention and Treatment A Clinical Resource," *Talley*, pp. 1–27, 2017.

❑ACTIVE (ALTERNATING PRESSURE) SUPPORT SURFACES



- Pressure **Redistribution** –

  Areas of the body experience zero pressure in different cycle times

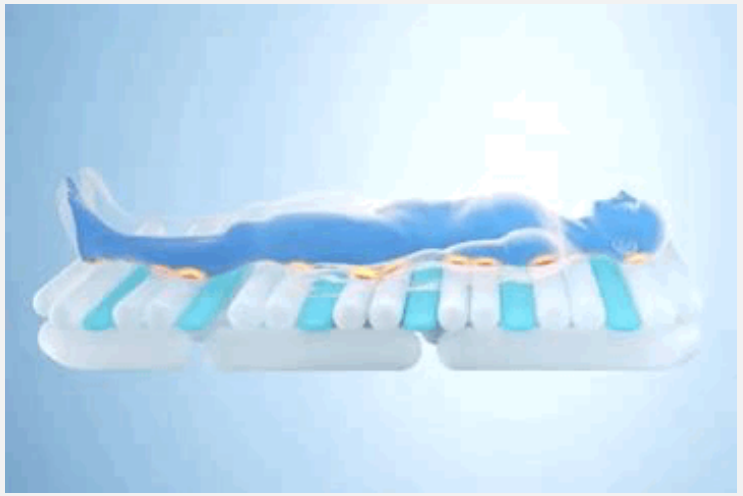
- Usually cycle time – 4 to 6 times an hour

- Added advantages –

  Tissue perfusion and removal of toxic metabolites

  Increased Lymphatic Drainage

  Prevention of the patient being slipped down



- **European Pressure Ulcer Advisory Panel**

  Recommend to patients who cannot reposition regularly

- According **WHO**

  Reduce risk of pressure ulcers specially of high risk patients

- **Better pay back** in comparison with standard hospital beds

- T. H. Care, "The Role of Support Surfaces in Pressure Ulcer Prevention and Treatment A Clinical Resource," *Talley*, pp. 1–27, 2017.
- The Prevention and Management of Pressure Ulcers in Primary and Secondary Care. Apr. 2014, NICE Clinical Guidelines, No. 179. National Clinical Guideline Centre(UK)
- National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel. Prevention and treatment of pressure ulcers: a clinical practice guideline. 2009. NPUAP Washington DC

AIM AND OBJECTIVES

- AIM

  To develop a control system to achieve high resolution, self-controlling, mobile support surface for the treatment of pressure ulcers

- Objectives

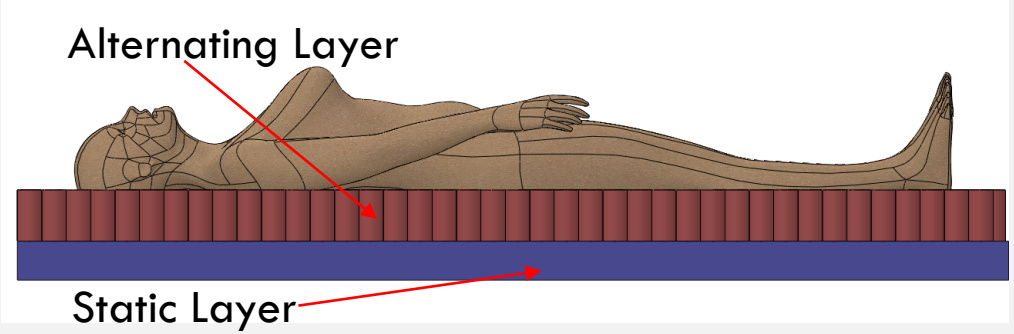
  ✓ To develop the effective alternating pressure formulation method for pressure ulcer treatment

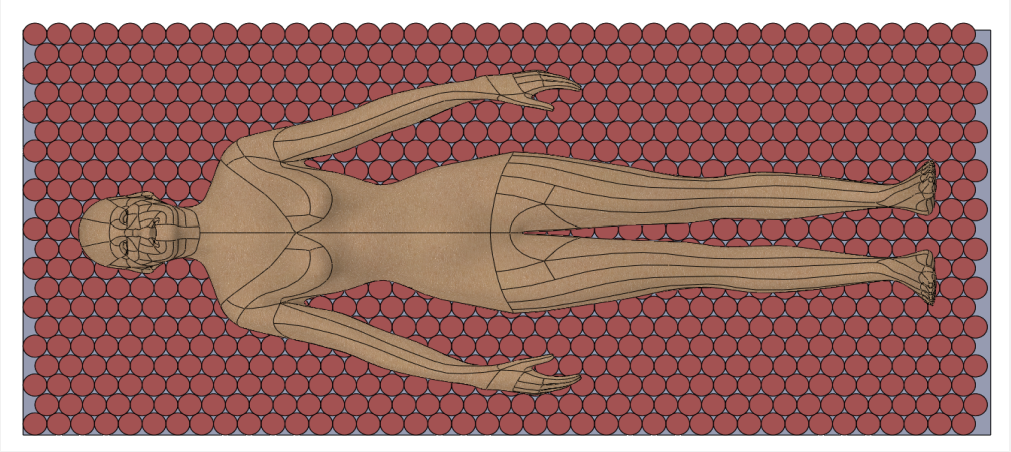
  ✓ To design a control system for regulating the pressure of the support surface, providing self-controllability

METHOD

- Proposed system consist with two parts

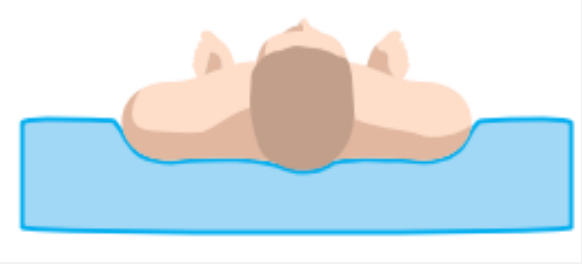
Alternating pressure overlay





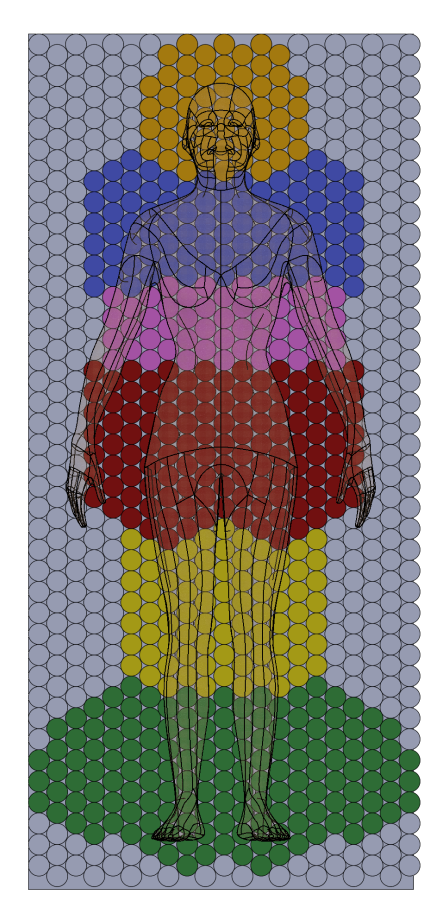
Control system of the pressure alternation

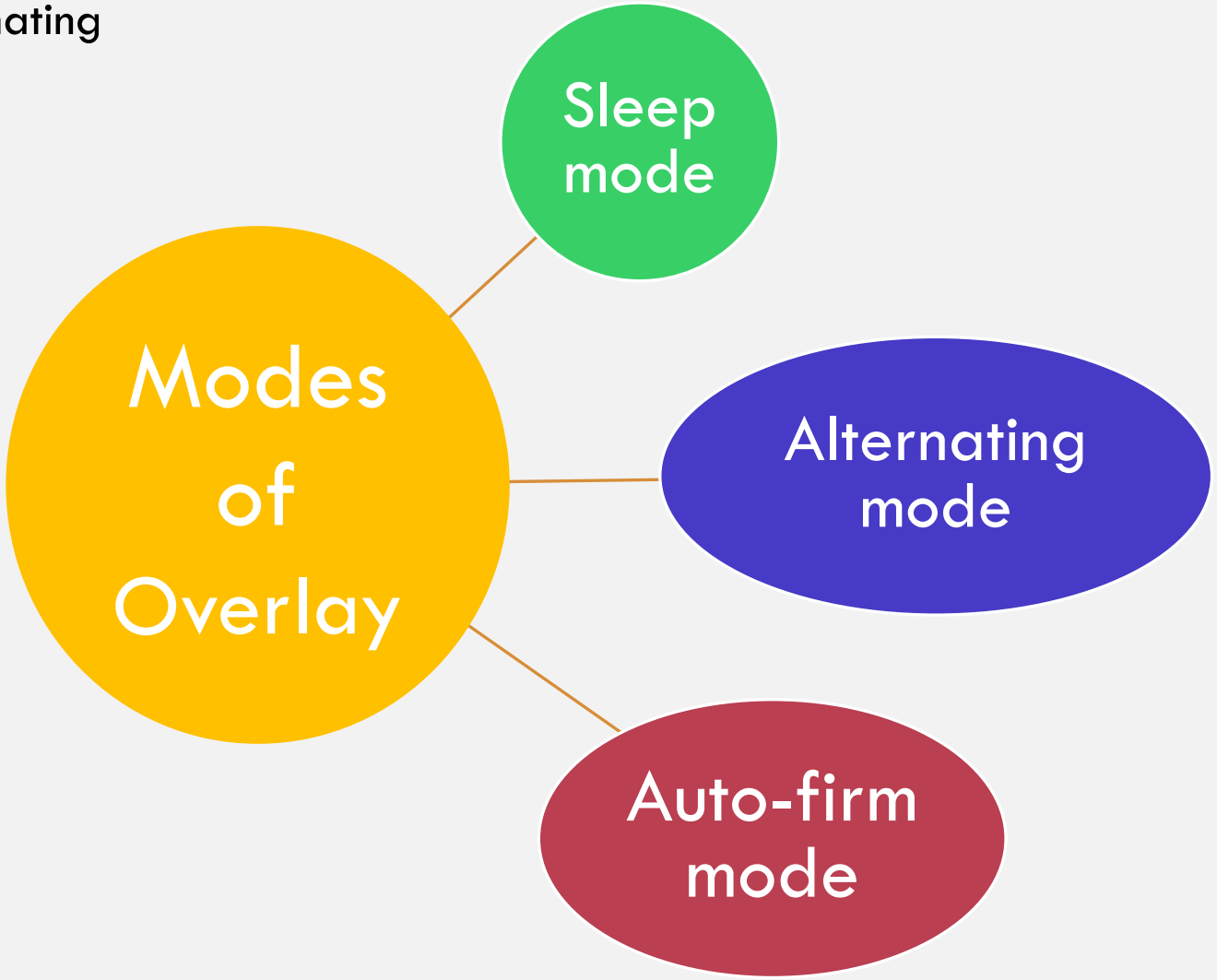
- Control the stifness of the overlay
- Identify the localized high pressure zones
- Initiate alternating pressure patterns



METHOD

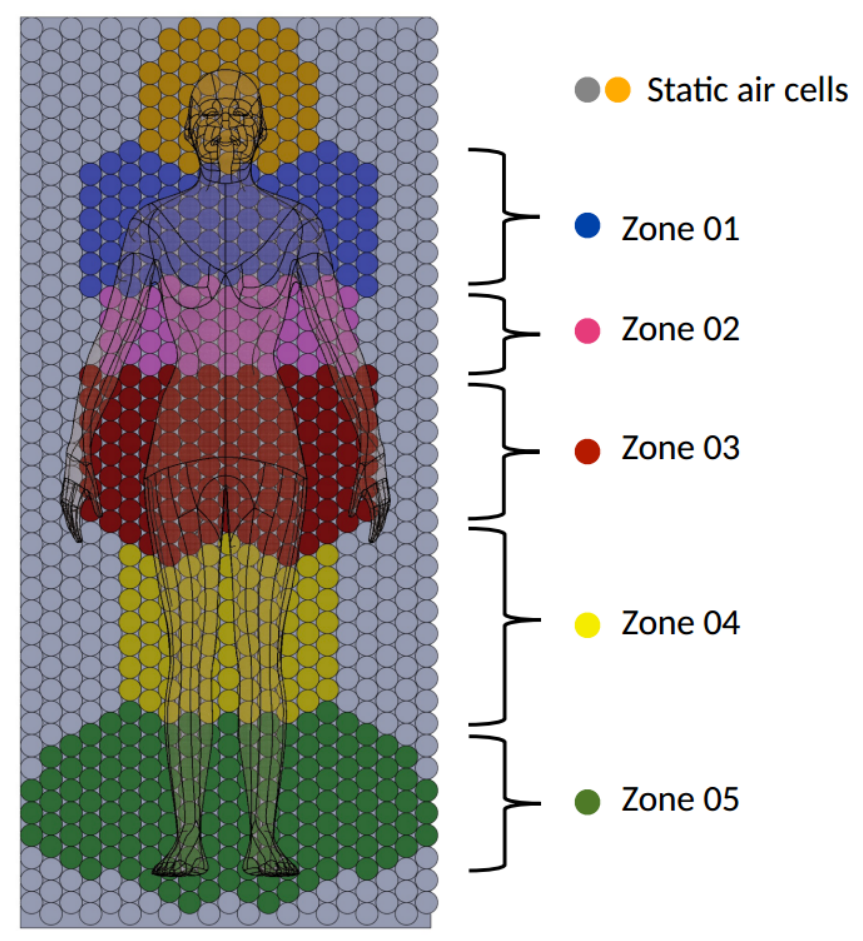
- Basic Functions of The Pressure Alternating

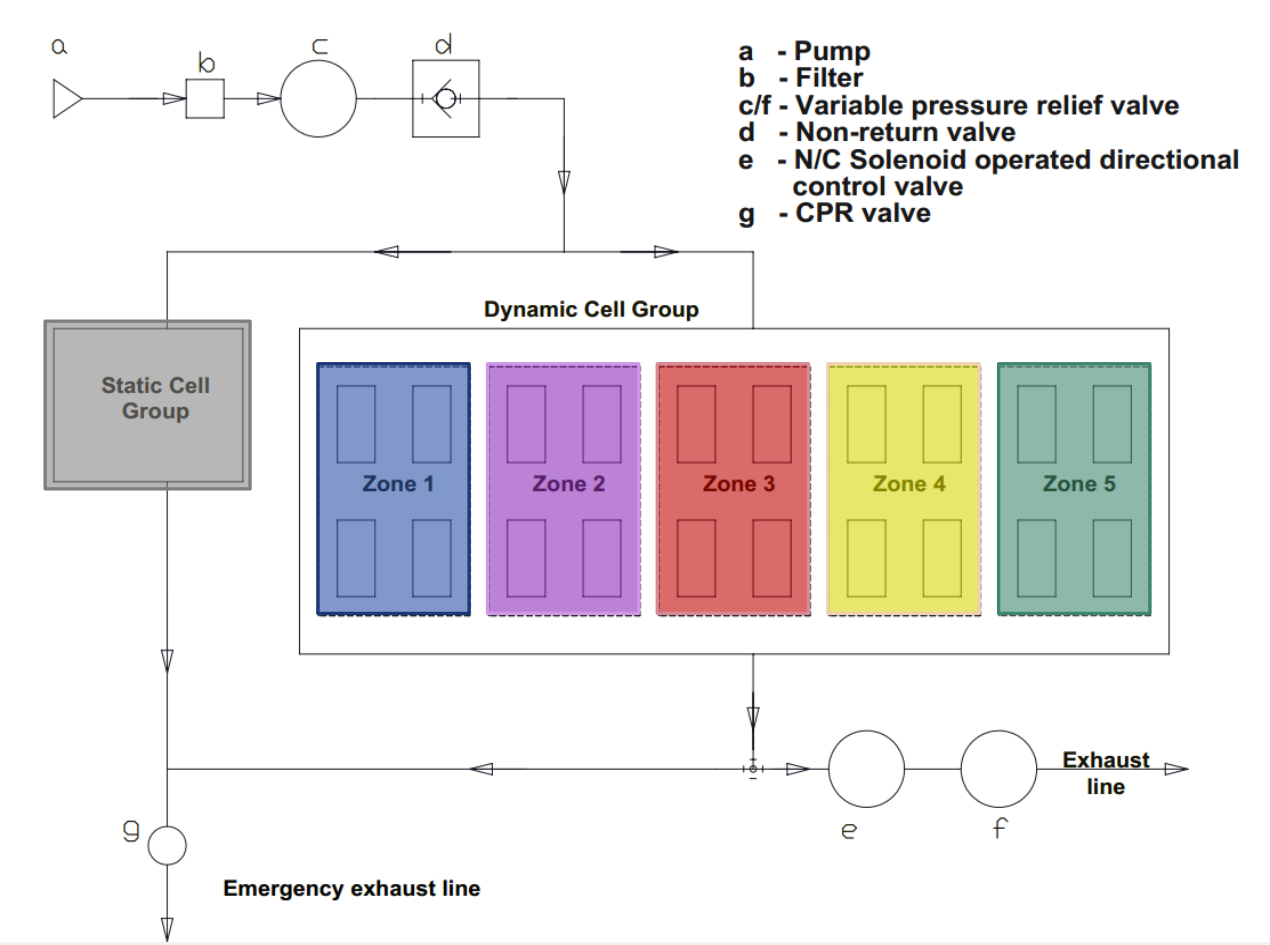




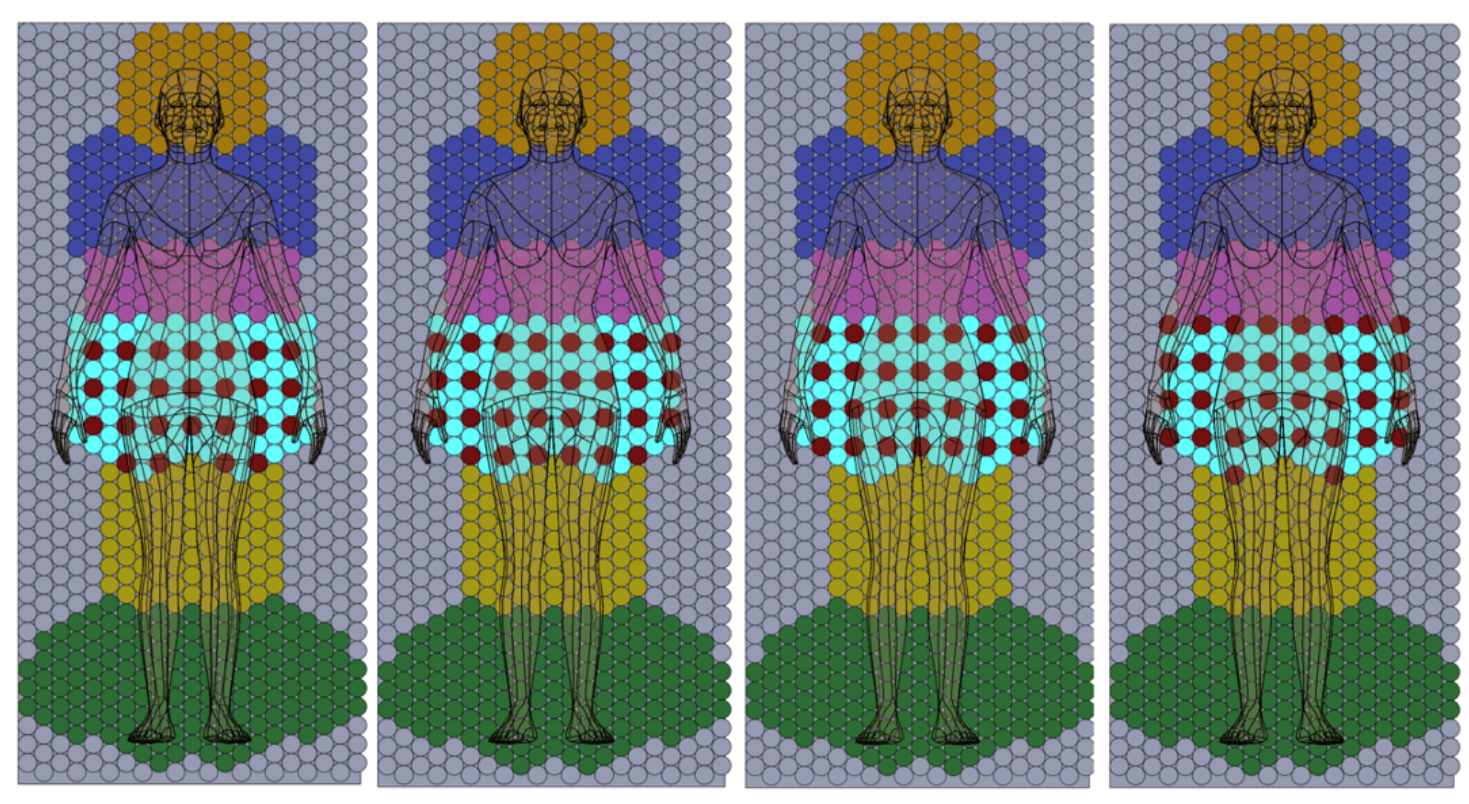
RESULTS AND DISCUSSION

Basic over view of the control system





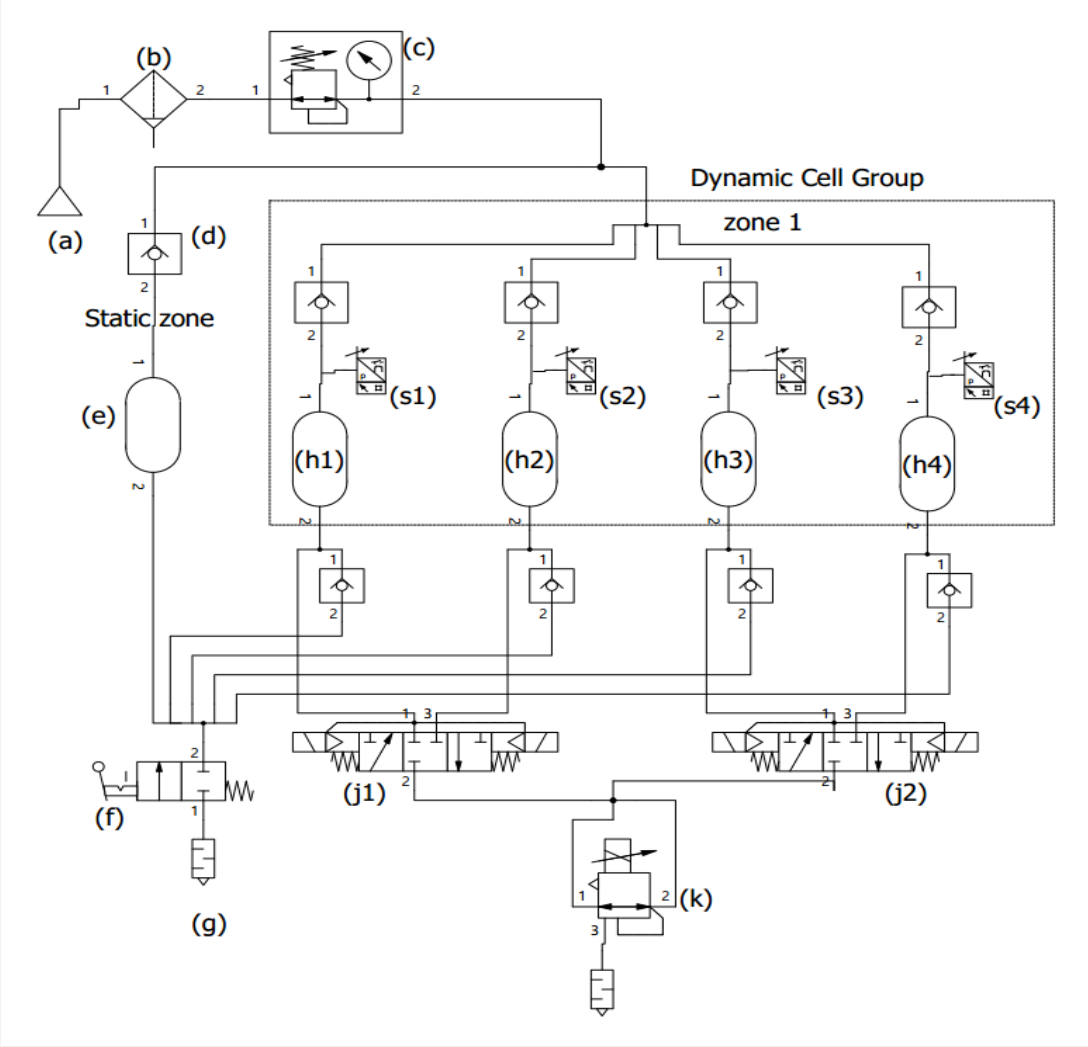
Pressure Pattern



Inflated air cells Deflated air cells

- Randomised air cell array
- Higher pressure localized zones will be actuated
- 1-in -4 cycle
- *75%* of patient's body to be comfortably support on inflated air cells
- Cycle time: 10, 15, 20 min

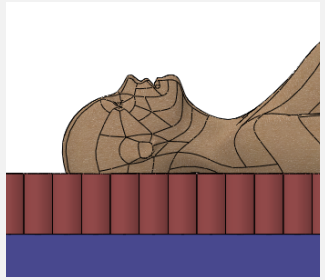
Pneumatic Diagram Of The Control System

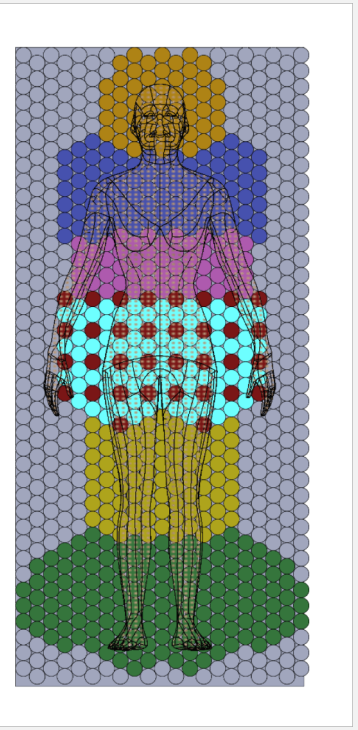


a. - Pump
b. - Air Filter
c. - Variable pressure control valve
d. - Non-return valve
e. - Static cell group
f. - CPR valve
g. - Exhaust-silencer
h_1-h_4.- Individual deflatable set of bladders in zone 1
j_1/j_2. - N/C Solenoid operated 3/3 valve
k. - Solenoid operated variable pressure relief valve
s_1-s_4.- Back pressure sensors

CONCLUSION

- Ongoing research of designing and development of a pressure alternating overlay
- Cell-on-cell deign to avoid bottoming out while providing a high-resolution pressure pattern
- Three modes of actuation: Sleep mode, Alternating mode, Auto-firm mode
- Flexibility to adapt the stiffness of the overlay with patient's body weight
- Real-time localized high pressure zone identification by monitoring back pressure
- 1-in-4 alternating cycle for comfortable weight distribution on inflated air cells





ACKNOWLEDGEMENTS

- The authors would like to thank the University of Moratuwa, Sri Lanka for the support given in completing this paper and providing facilities to conduct the research.

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THANK YOU