INTRODUCTION

Bed sores are called pressure sores or pressure ulcers. Bed sores are areas of damaged skin and tissues caused by sustained pressure that reduces blood flow to vulnerable areas of the body. Dead skin leaves an open ulcer. People in a bed or wheelchair for a prolonged period get these pressure sores.

Examples -

- Older people who are immobile.
- Patients with fractures or head injuries following road traffic accidents.
- following cerebral vascular accidents.
- Patients with malignancies with metastasis.

Credit; https://images.google.com/

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Identification of pressure ulcers.

- Discoloured patches of skin that do not change colour when pressed.
- Red patches on white skin.
- Purple or blue patches on black or brown skin.
- Patches of skin feel warm, spongy, or painful or itchy.

Credit; https://images.google.com/

So, preventing bedsores and giving speedy recovery for bedsores patients will give them great relaxation and recovery.

PURPOSE

The main purposes of this project are to...

1. Prevention of bed sores.
2. Making a speedy recovery.
3. Minimizing the caregiver's engagement time with the patients.

The main duties of the caregiver are...

- Controlling Pressure

The caregiver has to change the patient's lying position per every 2 hours.

- Contr olling Temperature

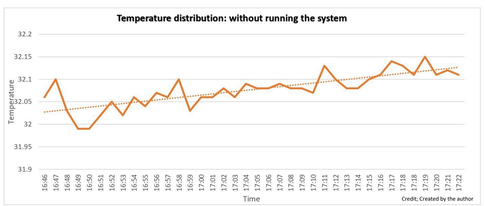
- Controlling Sweat.

When the skin temperature increases by 1°C, the risk of bed sores increases approximately 14 times. So, The skin temperature in the range of 29.4°C to 37.1°C is correlated with the tissue damage score. Therefore, The guardians have to maintain the be d surface temperature below 33°C.

According to the medical recommendation, ~~the room~~ temperature should be maintained between 24°C - 30°C. Due to the climate changes, maintaining the patient's skin without sweat is a big task for the caregiver.

ENGINEERING GOAL

For controlling the bed sores' causes, There are three main aims to fulfil....



Generally, normal mattress surface temperature is gradually increased

1.Controlling the temperature of the bed surface.

a)Maintaining the temperature of the bed surface below 33°C.
b)Cooling for the specially identified areas.

2. Reducing the continuous pressure on the skin and treating the identified areas.

3. Controlling Sweat via the room temperature and humidity.

a) Identifying and maintaining the room temperature.

4. Correlating all the units together to maintain the best condition on the bed for the patient.

BACKGROUND RESEARCH

A survey was held To find present bed sore prevention methods and the problems with bedsores

Survey category	Skin pressure	Skin temperature	Moisture			Shearing
			Sweat	Urine	Faeces	
Doctors and medical staff	Changing position in every 4 hours before bed sores and changing position in every 2 hours after bed sores. Using air beds (Not effective)	Using water beds before and after infecting the bed sores. But as Shearing and other problems, practically water beds are not recommended.	There is No system for sweat controlling, but they recommend that keeping the patient's skin without sweat	Using urine catheter and diapers	Use diapers	Using cotton bed sheets and keep increasing the moisture level on the skin using moisturizing cream Keep clean bed surface
Guardians and the people who engage with the bed sores patients	Mostly no specific time but change position with the patients' responses. Mostly use normal foam mattress before bed sores and after infecting use air beds	Commonly can see they have no idea about the skin temperature and some patients use waterbeds	Mostly no caring about that Maintaining room temperature according to the patient's responses	Most of the patients use urine catheter and diapers	A lot of patients use diapers.	No more considering about the shearing and no good knowledge about the good bed surface maintaining

- Mostly, no idea about sweat. They treat their patient if they notice the patient is sweaty.
- Most of the people are not well educated in this regard.

Conclusion

- There is a huge gap between theoretical prevention methods and how those methods are pract ically used.
- Bed sores are preventable.

Noticed Points

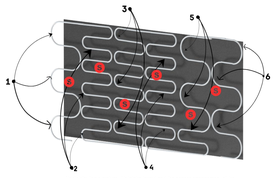
- Maintaining good condition on the bed is not Easy
- At least the patient has to be under the caregiver for more than 16 hours.
- Even if the pressure is controlled by changing the position every 2 hours, how can they control the temperature and sweat?
- Commonly, The caregivers have to change the patients from waterbeds to air beds and air beds to water beds. So, This may cause more damage to the skin of the patient.
- Financial problems.

METHODOLOGY

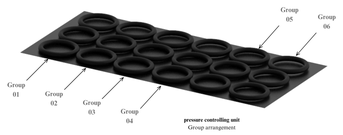
Temperature controlling unit(TCU)

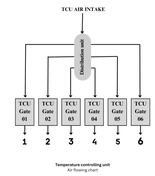
Structure

- Air-distributing PerforatedclearPVC tubes are placed in
- A special pattern for distributing air equally to the head-to-toe of the patient.
- The unit has been divided into 6 groups.
- 3 Air intakes have supplied air to each group to maintain constant air pressure in the tube
- (1,2,3,4,5,6) Sensors (Ds18b20) have been placed as an array on the air-distributing layer.
- From No 1 to No 6 have been placed airflow controllers.
- The distributing unit supplies the air for every airflow-controlling gate.



Air distributing structure, Air intake layout and the sensor arrangement of the Temperature-controlling unit



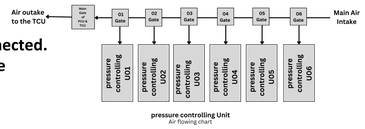


•Sensors and airflow controllers are correlated

Pressure controlling unit(PCU)

Structure

- All the groups have a pneumatic gate, and they are interconnected.
- The main gate between PCU & TCU is placed at the end of the pneumatic connecting tube.
- Every unit has a connection with the top group of TCU



Sweat controlling.

Structure

- The DHT11 Sensor has been connected to the microcontroller and there is a port to plug the cooler which connects externally to control the temperature in the room.

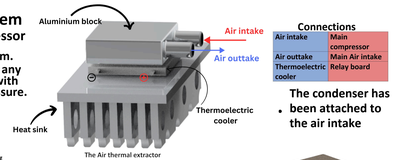
Main controlling unit.

- Heart of the bed cover.
- All the gates of the TCU, PCU and sensors have been connected.
- The relay board's responsibility is switching all the connected gates, air thermal extractor and compressor at the right time.

Air intake system

The main compressor

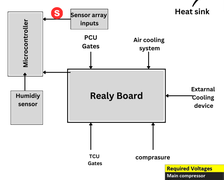
- Se parated system.
- It can be used in any air compressor with the right air pressure.



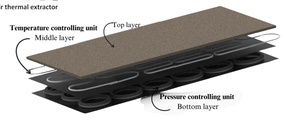
Connections

Air intake	Main compressor
Air outtake	Main Air intake
Thermoelectric cooler	Relay board

- The condenser has been attached to the air intake



Required Voltages	
Main compressor	Ac -230V
Air cooling system	Dc- 06V
Microcontroller	Dc- 12V
Sensors	Dc- 05V
Pneumatic valves	Dc- 12V
Airflow controlling	Dc- 12V
Fan	
Relay board	Dc- 12V



Main layer arrangement in the bed cover

PROCEDURE

1.Turn on the cooler, Open the main gate between PCU &TCU and open all the PCU gates.

2.Get the bed surface to the same level using the compressor without the high-temperature area.

3.Open the main gate between PCU & TCU

4.Turn on the gates of the identified high-temperature group in the TCU.

5.Runs the main compressor continuously on a pre-set time.

6. After that time, Open all the PCU gates to exhaust the air to the TCU

- This process runs till the temperature gets down more than 33°C by pre-set time by time.
- Unless start the process of PCU

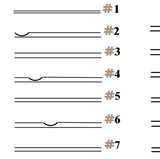
(TCU gates are normally open gates but PCU gates are normally closed gates including the gate between PCU & TCU)

➢ Pattern no 01

1.Open all the gates of the PCU to get the same bed level
2.Block the main gate between PCU& TCU then open the gate no 1, 3 and 5
3.The compressor works 4sce till the open groups are rising up.
4.TCU all the gates, PCU no2,4,6 and The main gate between PCU & TCU are opened simultaneously
5.Then, after a pre-settled period, the main gate between PCU & TCU is closed
6.Gates no 2,4 and 6 are opened.
7.After that, the compressor started to fill groups 2,4 and 6 in the PCU.
8.Then, after 4sec the compressor is automatically stopped.
9.At the same time, the main gate between the PCU & TCU is opened and gates 1,3 and 5 are opened to decrease the units' heights.

➢ Pattern no 02

1.hetotal air volume of the PCU is removed by opening all the gates of both the PCU & TCU
2.Switch out all the gates according to the below steps that make a wave on the bed.



Credit; Created by the author

- After that, the DHT11 humidity sensor starts to get the readings.
- If the sensor detects the room temperature is higher than 30°C, an external switch is turned on for another external cooler
- Unless the system starts to run from the beginning. According to the above steps, the system runs continuously

FUNCTIONALITY

➢ This is a fully automated system.
- Identifying the bed surface temperature area by area.
- If any area exceeds the temperature limit of 33°, The system automatically cools down that area. (the cooling process runs within the pre-set time).
- If the bed surface temperature is under 33°C, the pressure-controlling unit starts to run. Then, the pressure is released, according to the pre-set patterns.
- Then, room temperature and humidity are detected,
- If the room temperature is higher than 30°C, the connected temperature-reducing fans or AC are turned on

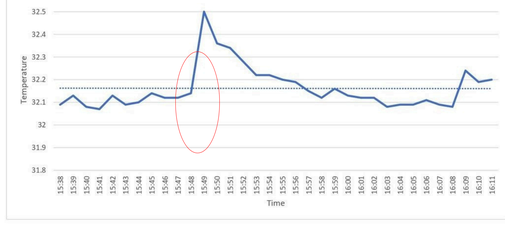
➢ This cycle runs continuously.

➢ While the system is running, this exhausts approximately 7.1 L of air to the bed surface every time of running this mechanism.

➢ Decreasing pressure and temperature in the specified areas

RESULTS

1. Maintaining the bed surface temperature below 33Celsius & temperature maintaining without turning on the cooling system (as a result of the PCU exhausts)...



5. As a result of low humidity → low sweats → low shearing

➢ No bubbles and a rough feeling like air beds. This can reduce the pressure on the woundedareasthatmakeaspeedyrecovery.

Increasing temperature: externally

After activating the mattress ventilation system, the external temperature reduced to the normal temperature by approximately 9 minutes

2. After activating the cooling system, the temperature decreased exponentially.
3. The room temperature controlling system supports the bed surface temperature controlling.
4. Releasing pressure on the identified high-temperature area makes this cooling process more efficient.

PRACTICAL USES

- Suitable for any type of bed as the flexibility(General foam mattresses to ICU beds)
- This can be used in mainly two formats. Those are....

a) General format.

- This defines the using of this bed cover in the home or small private rooms.
- Just only plug to start.
- According to the patient's condition and medical recommendations, adjust the below key settings
  - oTime duration of the pressure shifting patterns in the PCU.
  - oSet the bed surface and the room temperature on the suitable points.
- After recovering from bed sores, this can be used as a massage mattress and for comfortable sleep.

b) Interconnectedsystem format.

❖This format defines the use of this bed cover in hospital wards.

- The specialty of this format is all the beds can be interconnected.
- Only one compressor is needed to supply the air for each bed cover.
- This uses only one air thermal extractor.
- This saves a large amount of money at the industrial level.
- Affordable for anyone. (As the simplest of the technology that has been used to make this product)