

2025年臺灣國際科學展覽會 優勝作品專輯

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作品名稱	Mattress Ventilation System
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Mattress Ventilation System

Project Report

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Introduction

One of the worldwide hidden problems with lack of attention is **Bedsore**s. Simply, These are ulcers, that happen on the **areas of the skin that are under pressure while lying on the bed for a prolonged time**. This can be infected to anyone in the world. The common group who face these bed sores are.....

- Elderly patients,
- Spinal cord injury patients,
- Stroke patients,
- Coma patients,
- People who have faced accidents

Bed sores develop when the **blood supply is cut off for more than 2-3 hours to the skin**, (Position changing time depends on the patient's condition) The **continuous pressure is the cause for that** and also the temperature **generated between the skin and the bed surface increases the metabolism of the tissues**. **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**. Not only that **shearing and moisture** are the other considerable factors for this problem.

This infection has 4 stages. Sometimes in the 4th stage of the **bed sores can cause death**.

Background Research

According to the current situation of the world, preventing bed sore is not a little game.

The easiest way of controlling something is “controlling the causes of the problem”. So I did a survey with the aid of doctors, medical offices, patients and guardians.

Mainly Questionnaire based on the things that have been done before and after inflecting on bedsores.

1. Patients based questionnaire
2. Doctors, nursing officers and bed sores-related person-based questionnaire

Survey of Bed sores patients

patient information

- Date of Survey , Age, Illnesses and conditions
- How long did it take to start bed sores after the main illness?
- stage of the bedsores
- Infected areas of the body

Bed behaviors

Before Infecting Bedsores (BIB)

- Used beds
- Followed intractions for priventing bedsores
- Used extarnal crems and any Coated things
- Excretion of feces and urine
- Other things what did

After Infecting Bedsores(AIB)

- Used beds
- Followed intractions for priventing bedsores
- Used extarnal crems and any Coated things
- Excretion of feces and urine
- Other things what did

Difficulties

1. Comfatability on the bed -about using bed sheets , cleaning
 2. Effect on the good sleep
- Breaf discription about the deficulties

Survey of Bed sores patients' external community

- Date
- Roll of the resourcer
- noticed bed sores causes additional to the theoretical causes
- curenet prosider to prevent bed sores for the unmobile patients

Before inflecting bedsores

- possition changing time
- any other pressure reducing methods
- temparture contoling on the bed surface
- bed surface maintain
- room temprature and humidity
- external creams and medicins
- procedures of Excreting feces and urine

After inflecting bedsores

- possition changing time
- any other pressure reducing methods
- temparture contoling on the bed surface
- bed surface maintain
- room temprature and humidity
- external creams and medicins
- procedures of Excreting feces and urine

facing difficulties with the bedsores

- problems with preventing bedsores
- problems with recovering bedsores patients

Summary of the survey result

Survey category	Skin pressure	Skin temperature	Moisture			Shearing
			Sweat	Urine	Faec	
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 a Moisture rising 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

Discussion of the survey

According to the above results, Maintaining the good condition of the bed is not Easy. In case, the caregiver of the immobile patient couldn't do the main procedure for At least 6 hours, which may cause for making new bed sores (the time depends on the patient's condition). So, the immobile Patient has to be under the caregiver for more than 16 hours. Even if the continuous pressure on the skin 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, They have a big complaint that makes a lot of uncomfortable for patients and risks to make new injuries to the skin. When questioned, most of the patients had no good idea about sweating. They treat their patient if they notice the patient is sweaty. Some patients used air conditioners due to their economic stability. Most of the people are not well-educated on this regard. As a result of no good knowledge about bed sores, they don't follow the recommended instructions to prevent bed sores, and they have no time and no monetary possibility to treat bed sores patients. Furthermore, another noticed thing is receiving the best treatments, 24 hours under a caregiver treatment, and not completely immobile patients have a huge probability of being protected from bed sores.

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

Expected Outcomes

The main expected outcomes of this project are to...

1. Preventing bed sores.

This is the main expected outcome of this project. At the end of the project, immobile patients will use this bed cover to protect from bedsores. This project should be more reasonable and affordable for anyone in the world

2. Making a speedy recovery and giving good bedtime for bed sores patients.

Immobile patients, except elderly patients, are mostly suffering from another primary disease. But the considerable part is they have a big probability of inflecting bed sores. That causes them to increase their primary disease. If we can prevent making new bed sores we will be able to give a speedy recovery for them

3. Minimizing the caregiver's engagement time with the patients.

According to the current bed sores-prevention methods, there should be a guardian near the patient. So, this project is expected to reduce the below duties of the patient

- Controlling Pressure

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

- Controlling Temperature

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 bed surface temperature below 33°C.

- Controlling Sweat.

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 Goals

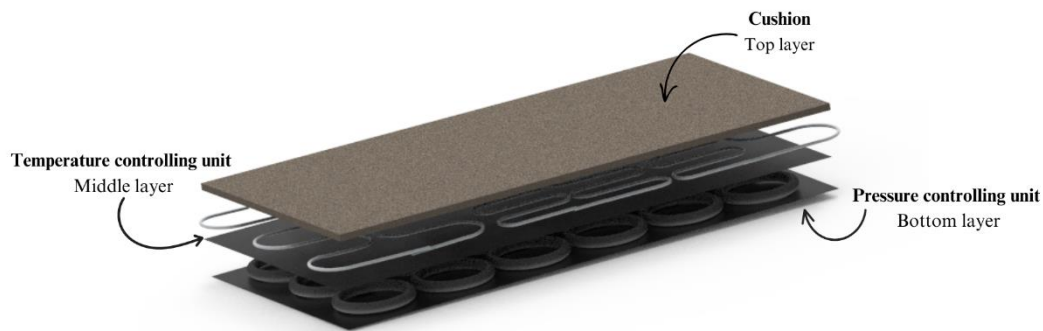
The best method of achieving the expected outcomes make a mattress cover to control causes of the bed sores. To achieve the expected outcomes, we have to do these things in bed cover.

1. Controlling the temperature of the bed surface.
 - a) Measuring the whole bed temperature data.
 - b) Maintaining the temperature of the bed surface below 33°C.
 - c) 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 patients

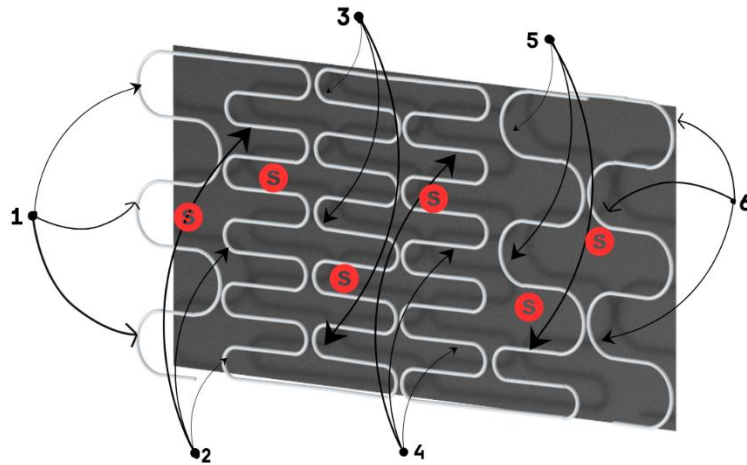
Procedure

Mainly, the bed cover has to be divided into 3 layers which are a Temperature-controlling unit for controlling the bed surface temperature, a pressure-controlling unit for controlling continuous pressure on the skin and a cushion layer for making the comfortable bed surface for the patient. And also the main controlling unit for collating the units and controlling the whole system. furthermore, The main compressor and airflow heat extractor also is required for this bed cover. Sweat-controlling system also has to be added to the main controlling unit

This is the expected main layer arrangement in the bed cover

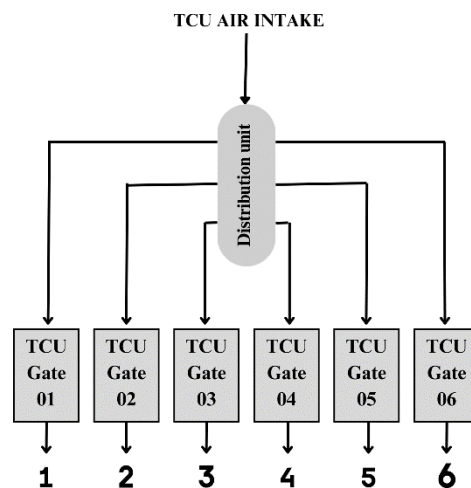


Temperature controlling unit



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

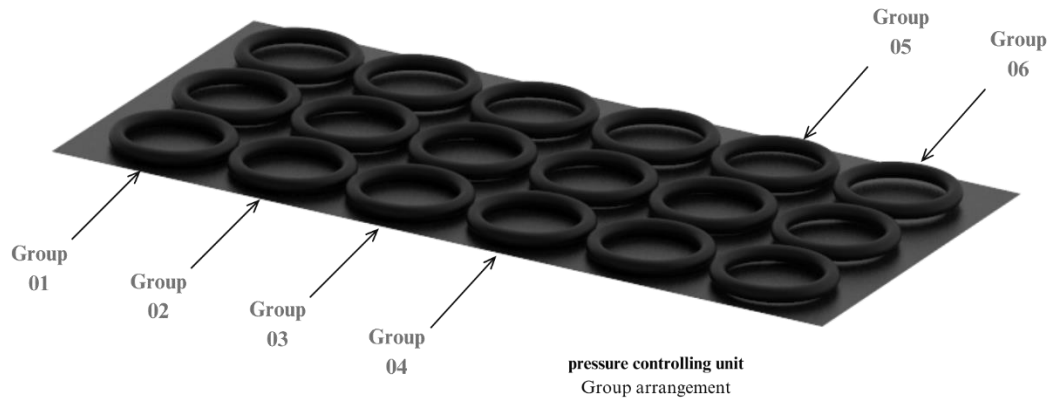
- Air-distributing Perforated clear PVC tubes are placed in a special pattern for distributing air equally to the head-to-toe of the patient.
- The unit has been divided into 6 groups.
- 3 Air intakes have supplied air to each group to maintain constant air pressure in the tube.(1,2,3,4,5,6)
- Sensors (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.



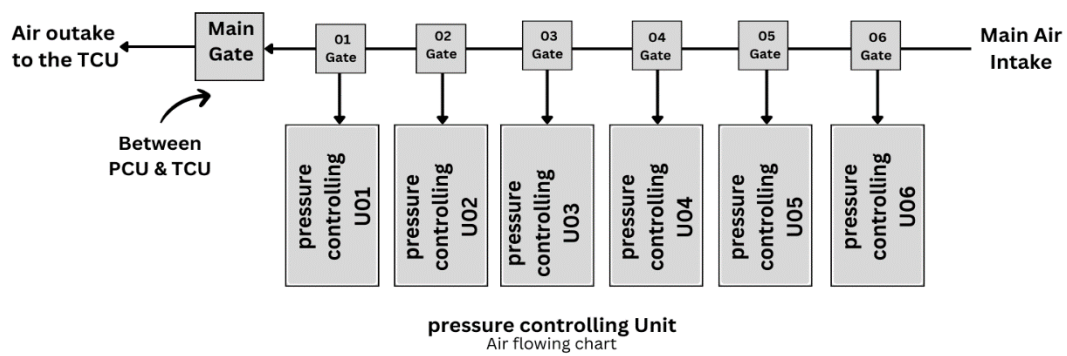
Temperature controlling unit
Air flowing chart

- Sensors and the airflow controllers are correlated

Pressure controlling unit.



- 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.

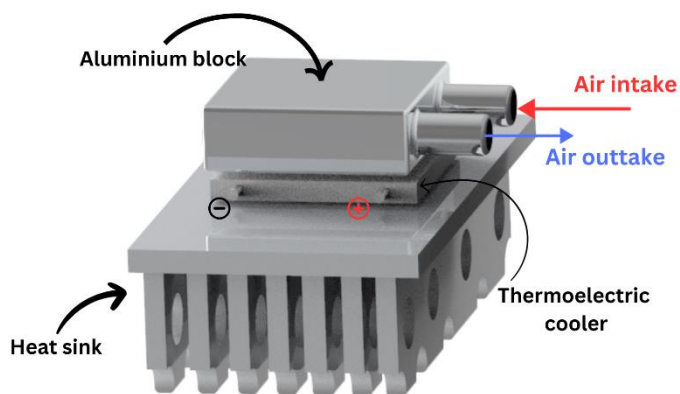
- The DHT11 Sensor has been connected to the microcontroller and there is a port to plug the cooler which connects externally to control the temperature in the room.

Air intake system

The main compressor

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

The Air thermal extractor.



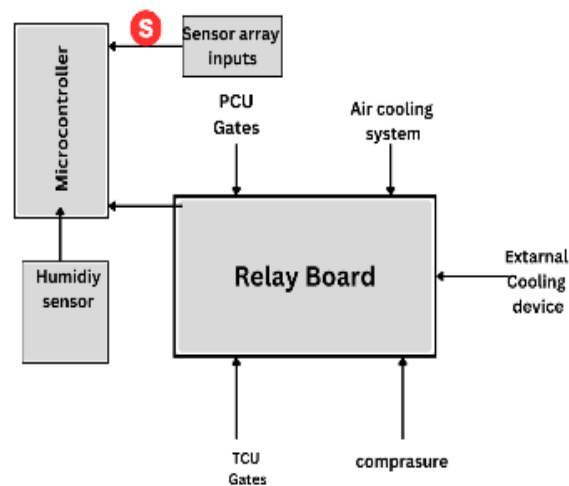
Connections

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

- The condenser has been attached to the air intake

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.



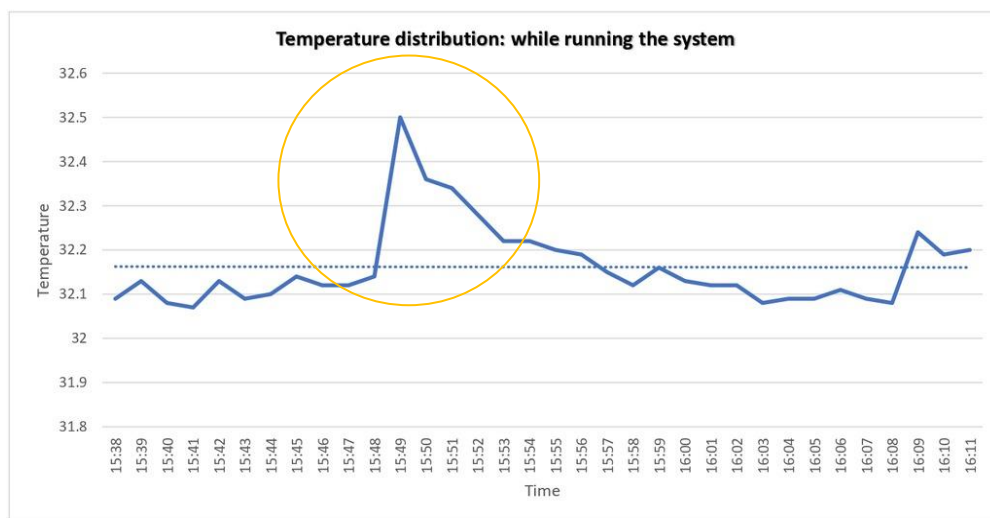
This is the main-expected procedure to achieve the goals and outcomes of the project

Results

- This mattress cover can **control at least 80% of the main causes of bedsores.**

Noticed things related to the temperature and pressure.

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



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.

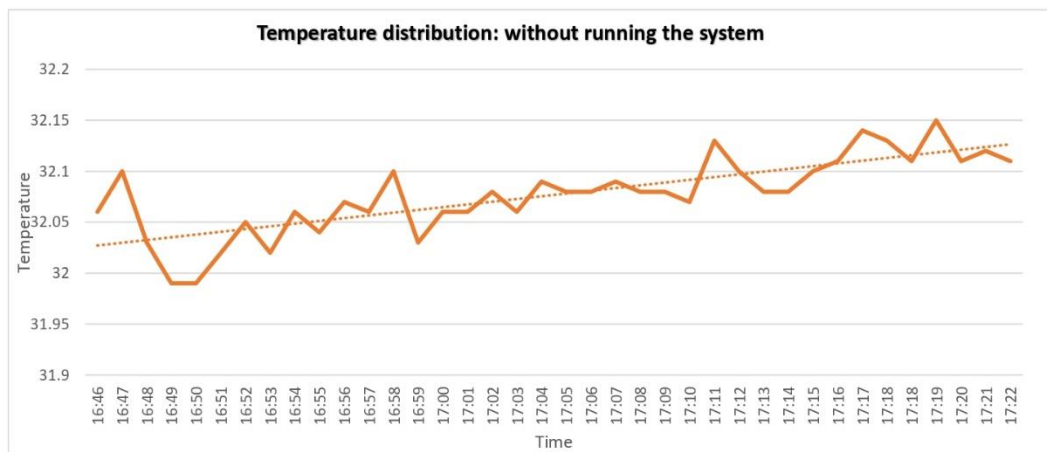
5. As a result of low humidity

low sweats

low shearing

- No bubbles and a rough feeling like air beds.
- This can reduce the pressure on the wounded areas that make a speedy recovery.

When a patient is on the bed, how the temperature changes happen with time is described by the below-graphed data recorded by the temperature-controlling unit without activating the cooling process of the bed cover.



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Microclimate and development of pressure ulcers and superficial skin changes,

Saldy Yusuf,^{1,3} Mayumi Okuwa,¹ Yoshie Shigeta,¹ Misako Dai,¹ Terumi Iuchi,¹ Sulaiman Rahman,² Awaluddin Usman,² Sukmawati Kasim,³ Junko Sugama,
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【評語】 100054

1. This research provides a thorough exploration of a novel mattress ventilation system aimed at preventing bedsores. The structured approach, clear objectives, and integration of engineering principles demonstrate a solid foundation for addressing a critical healthcare issue.
2. The engineering goals are practical and address the core issues of temperature control, pressure reduction, and sweat management. This multi-faceted approach is commendable.
3. The results section presents data that supports the effectiveness of the mattress cover in controlling temperature and pressure, which is crucial for validating the project's success.
4. Future work should focus on practical testing and iteration to ensure the system's effectiveness in diverse patient care environments.