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Nursing Bed with Integrated Toilet

Abhinandan Kondekar[1*], Shraddha Abhang[2], Sakshi Fatangare[3], Aaman Jain[4], Aditya Jamdhade[5]

[1,2,3,4]Student, Department of Mechatronics Engineering Sanjivani College of Engineering, Kopargaon, Maharashtra, India
Corresponding Mail id: kondekarabhinandan@gmail.com

Abstract— The nursing bed with integrated toilet is an new innovation in the healthcare sector .Our idea focuses on the patients who are unable to walk and are bedridden due to the some illness or injuries .There have been made many attempts to develop a better toileting aid for bedridden patients to replace conventional incontinence products such as absorbent products, indwelling urinary catheters, and bedpans, although without much success .Automatic urine and feces disposal systems. Have been developed in Japan and South Korea. But still there is not much success in it and not properly received by the patients .We have come with an approach we have developed an Nursing Bed for patients. The toilet basin was joint onto the pelvis plate of the bed, and the fluid waste is collected by an inlet of toilet collected the liquid waste in the toilet basin into a plastic bag through a curved waste storage tube attached to the toilet basin. The mechanism consists of the screws , motors ,pumps , pipes, Etc. This medical bed with an embedded toilet could be a promising solution for excretion care of bedridden patients.

Keywords— "Nursing Bed Innovation, Integrated Toilet System, Bedridden Patient Care, Automated Waste Disposal, Healthcare Assistive Devices, Toileting Aid Technology, Smart Medical Bed, Excretion Management System, Elderly and Disabled Care, Hospital Bed Sanitation System."

I. INTRODUCTION

As of May 2021, India's population stood at approximately 1.39 billion, with nearly 64 million individuals aged 65 and above. A significant number of these elderly citizens, along with others affected by conditions such as paralysis, spinal injuries, issues, and severe accidents, are confined to their beds—dependent on constant care and attention. With the traditional joint family structure steadily disappearing, families are often left struggling to provide the round-the-clock assistance these patients need. This growing challenge sparked a personal and professional journey. After more than twenty years hospital furniture industry—closely collaborating with doctors, nurses, and caregivers we began to notice a recurring need: practical, compassionate solutions that truly ease the burden The caregiving. This need hit home of Deeply personal level when a loved one in our family suffered a spinal injury after an accident. Caring for them through the long and often painful recovery made us acutely aware of the emotional or physical toll such situations take—not just on patients, but also on those who care for that. That experience became a turning point, reinforcing our belief that it's times to reimagine patient comfort and hygiene with real empathy or innovation.

1. Diversity of Patients Considered

Our survey encompassed diverse group the bedridden individuals, each struggling in their own way carry out even most basic bodily needs due to limited mobility or challenging health conditions. Among them were elderly individuals whose strength had faded the age, now relying entirely on others for movement and care. We spoke accident survivors—some with fractured limbs, others with spinal injuries—whose once-active lives were suddenly paused, forcing them into a world of dependency, whether temporarily or for the long haul.

There were also post-operative patients, gently urged by their doctors to stay still so their bodies could mend in time. We met neurological patients—stroke survivors, or those living with paralysis—bravely coping with the loss of control over their limbs and routines. Some battled chronic ailments like advanced arthritis or heart disease, which drained their energy and made even sitting up the struggle. Others had conditions that demanded complete bed rest—spinal disc issues, difficult pregnancies, or serious gastrointestinal disorders—that confined them to bed and stripped away that comfort the independence.

Patients with incontinence issues, for whom bathroom access becomes a major challenge and hygienic handling is crucial.

These individuals often cannot perform basic movements such as turning in bed, sitting up, or even repositioning themselves—making daily routines like urination and defecation difficult and distressing, not just for the patient but also for their caregivers.

2. Involvement of Key Stakeholders

To gain a comprehensive understanding of the caregiving ecosystem, we ensured that our survey reached all the relevant stakeholders involved in patient management. This included:

Family members who provide care at home and are often emotionally and physically burdened.

Doctors and specialists, especially orthopedics, neurologists, and geriatricians, who guide patient rehabilitation.

Nursing staff and hospital attendants, who are on the front lines of daily patient care and understand the nuances of patient handling.

Medical product vendors and physiotherapists, who deal with the limitations of current solutions and understand the demand for practical innovations.

3. *Method of Data Collection*

We developed a structured questionnaire aimed at collecting both quantitative and qualitative data. The questionnaire was carefully designed to gather insights on:

Challenges during patient hygiene management (especially defecation and urination).

The physical strain and number of caregivers needed to manage a single patient.

Preferences regarding bed adjustability, mobility, and hygiene systems.

Feedback on existing hospital beds and what improvements are desired.

Opinions on cost-effectiveness and willingness to adopt new solutions.

The survey was personally distributed and discussed with 52 individuals, who represented a mix of patients, family members, and healthcare professionals. Their valuable feedback was then analyzed to guide our design choices.

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1. LITERATURE REVIEW

2. Rao, S., in his study **"Smart Assistive Beds for Dependent Patients"**, discusses the growing need for multifunctional nursing beds in long-term care settings. The research highlights the role of **integrated toilet systems** in enhancing patient autonomy and reducing manual intervention during toileting. Rao emphasizes that such innovations significantly lower the risk of caregiver injuries and patient discomfort, especially in bedridden individuals. [1]
3. In **"Design Considerations for Toilet-Attached Medical Beds"**, Gupta, N., and Sharma, R. analyze the mechanical challenges involved in aligning bed platforms with integrated toilet mechanisms. Their study explores the use of **hydraulic and gear-driven elevation systems**, which enable the patient to transition over a built-in toilet unit seamlessly. The authors underline that alignment accuracy and hygiene sealing are key technical factors in successful designs. [2]
4. Patel, K., and Roy, M., in **"Evaluation of Commode Beds in Home Healthcare"**, focus on the effectiveness of manual and semi-automatic commode beds used in domestic settings. The paper finds that **foldable toilet units and waterproof bedding materials** offer practical solutions for patients in resource-limited environments. The study also discusses caregiver feedback, which reflects improvements in task efficiency and sanitation. [3]
5. In **"Integrated Toilet Beds for Critical Care Units"**, Iyer, A., presents a prototype nursing bed that includes an **automated waste collection and cleaning mechanism**. The system uses **sensor-triggered operations** to deploy the toilet opening and simultaneously activates a sanitizing flush cycle. Iyer notes that this setup reduces odor issues and supports infection control protocols in clinical settings. [4]
6. **"Mechanical Design of Toilet Beds for Paraplegic Patients"** by Jadhav, V., explores the unique mechanical configurations needed to support non-ambulatory users. The study proposes a **dual-motor lifting mechanism** that assists users into a toileting position while minimizing spine pressure. Jadhav's design prioritizes **low-cost manufacturing** and highlights its viability in rural healthcare centers. [5]
7. Meena, T., in her paper **"Patient-Centric Designs for Elderly Toileting Beds"**, emphasizes ergonomics and patient com-

fort. The research discusses features like **backrest inclination, lateral turning, and water-resistant mattresses** to accommodate elderly users who have limited motion control. The author recommends combining these with a **simple push-button toilet deploy system** for optimal usability. [6]

8. Lastly, in **"Multi-Function Nursing Beds: A Holistic Approach"**, Verma, R., and Banerjee, S. explore **smart beds** that integrate not only toileting systems but also vitals monitoring, posture control, and emergency alert modules. Their research shows how such integrated systems can drastically **reduce caregiver dependency** and promote patient dignity in both hospital and home settings. [7, 8]

2. SYSTEM DESIGN

The **Nursing Bed with Integrated Toilet** is designed to enhance the care and comfort of bedridden or semi-mobile patients. By incorporating a retractable toilet system within the bed, patients can use the toilet without being moved, reducing caregiver strain and improving patient dignity.

The bed is constructed from **mild steel** for durability and corrosion resistance, with an adjustable backrest and safety side rails to prevent falls. A **cut-out area** in the bed aligns with the integrated toilet system, made from stainless steel or plastic, which is covered by a **movable padded cover** when not in use.

The bed is thoughtfully designed with patient's dignity and caregiver's convenience at heart. It is the adjustable backrest—operated either manually and via electric controls—allows patients sit up the comfortably, especially during toileting, which can be one of the most sensitive aspects of care. Waste is discreetly collected in removable container beneath the seat, while more advanced versions come equipped with a automatic flushing mechanism, ensuring better hygiene with minimal effort.

To promote cleanliness, a nearby wash basin is integrated into and setup, complete with atheuser-friendly water inlet for effortless handwashing (Fig 1).

Fig:1

The waste disposal system a designed with the both cleanliness and dignity in mind. An removable container positioned beneath the seat allows for quick and hygienic waste removal, making daily care routines less stressful for both patients and caregivers. In more advanced models, an automatic flushing feature takes it a step further—handling sanitation seamlessly without the need for manual effort.

For added convenience, the setup includes a nearby wash basin that patients can easily access for handwashing or other personal hygiene tasks. The basin connects to a flexible water inlet hose, ensuring that clean water is always within reach without requiring complicated plumbing.

When it comes to safety and comfort, the bed's thoughtful design truly stands out. Rounded edges and smooth finishes help prevent accidental scrapes or bruises, while the bed height has been the carefully adjusted to reduce strain for caregivers and make patients feel more secure. Protective side rails provide extra layer safety, especially important during rest or toileting activities (Fig 2).

Fig:2

The nursing bed we have propose represents a significant step forward in patient car blending functionality, comfort, or safety in ways that current designs simply do not. This innovative model integrates several key features, including a built-in commode, side-turning capabilities, and a seamless transformation from a lying position to a seated one, much like a chair. truly sets it apart is the specialized screw-driven mechanism that allows the commode glide smoothly into place or retract, all without requiring patient to be moved—preserving both their comfort and dignity.

In contrast, earlier designs—such as the one developed by Yeom et al.—used a fixed pelvic plate to support the toilet basin. While functional, setup required caregivers to manually shift the patient to open or access the commode, increasing the risk of strain or injury for both parties. Our approach eliminates that challenge by introducing an smart separation of the bed's surface, both widthwise and lengthwise. This allows for gentle repositioning of the patient with minimal effort and no need for lifting—making caregiving safer, simpler, and far more respectful.

Previous beds like those the Shinde and Rajhans, and Soonthornkiti and Jearanaisilawong, focused on pressure relief or lateral turning mechanisms but lacked features like a commode or the ability to convert to an chair position. The new bed integrates these features while also improving patient comfort or reducing caregiver strain.

Simulation and load testing confirmed the new bed's mechanical performance, which meets expectations. Two recently granted patents validate the uniqueness of design and its functionality.

3. MANUFACTURING CHALLENGES

1. **Middle Section Threading:** The internal and external threading posed a challenge, which was resolved by using two separate pieces, welded together and machined to create the required middle section.
2. **Commode Design:** Crafting the small commode pot with a flushing jet and other complex features required custom bending, welding, and assembly. MIG welding ensured leakage prevention.
3. **Thrust Bearing:** A roller contact thrust bearing was used to reduce manufacturing complexity (Fig 3).

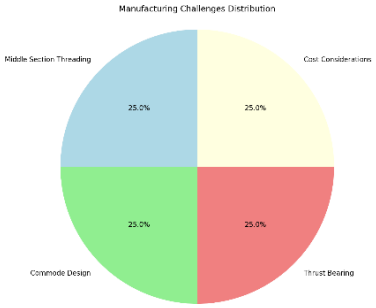

Fig :3

4. FUNCTIONALITY

Toilet Basin Integration: The toilet basin is seamlessly integrated into the bed structure. It is securely attached to pelvis plate of bed, ensuring that the patient can use the toilet comfortably without needing to be moved. The basin is positioned in a way that allows it to collect both urine and feces in a hygienic and efficient manner.

1. Collection Waste System: Waste the collected via and inlet tube that the transports liquid waste into an curved waste storage tube, which is attached to the toilet basin. This is tube directs a waste into an disposable plastic bag. The bag is easily replaceable, ensuring convenience for caregivers while maintaining hygiene.

2. The Electric Bed Mechanism: bed is equipped with an electric motors that provide easy adjustments for comfort or convenience. Patients can the control the positioning of the bed, including raising and lowering backrest or leg rest, to facilitate toileting. This is electric adjustment ensures that patient can be positioned correctly without additional assistance.

3. Bedridden Patients Independence: One of that standout features of this design is its ability that allow 84-year-old bedridden patient both male and female to use the toilet independently. The design eliminates need for constant caregiver intervention, enabling patients to urinate or defecate at their convenience without assistance.

4. Comfort and Ease of Use: The integrated toilet system is easy for patients to use and allows them to maintain dignity during toileting routines. The design focuses on comfort and minimizes the discomfort typically associated with conventional toileting aids.

5. RESULTS AND OBSERVATIONS

Based on the survey conducted, there was a clear and urgent need to design new type of bed specifically tailored for bedridden patients in healthcare settings. The proposed solution is a single, multifunctional bed unit that includes an integrated commode along with essential features such as a backrest, basin, overbed table, or rack. That key requirement identified this product were as follows: the bed must feature an opening within its structure and mattress to accommodate a commode. This opening is to be covered with a matching segment of the mattress, which can be lowered smoothly to prevent friction against the patient's body. The mechanism that operate this matter segment must be able to move in it downward beneath the bed levels, clearing the opening to allow that commode to rise. That commode itself should lightweight to minimize power consumption or must be capable of lifting through the bed's opening to provide support beneath the patient's pelvis.
Additionally, the bed should allow patient to assume sitting position by raising the backrest and a chair-like position by lowering the leg sections. These adjustments can be operated manually via a handle or automatically through an electric motor, or a combination of both. For hygiene, the design includes a flushing cistern and a water jet within the commode, both operated through a valve connected to reliable water supply. To ensure comfort and sanitation, commode is fitted with anti-odor water traps to prevent foul smell. These traps are adjustable, allowing for flexible sewer line connections via pipes based on installation requirements. All control mechanisms should be within easy reach of the patient or adjustable to suit individual comfort or accessibility.

5. CHALLENGES FACED

The nursing bed with a built-in toilet is a major step forward in caring for patients who are bedridden due to illness or injury. These individuals often struggle with using traditional toilets, which can lead to discomfort, embarrassment, and a heavy burden on caregivers. While some countries like Japan and South Korea have developed high-tech toilet systems for such cases, many of them are too complex, uncomfortable, or inconvenient to use regularly.
To solve these problems, we created a bed that has a toilet directly built into it. This allows patients to use the toilet without needing to be moved or helped by others. While developing this design, we faced several challenges:

1. **Fitting Toilet Basin Properly**: One of the toughest parts was figuring out how to attach the toilet basin near the patient's pelvis in a way that allowed waste to be collected easily, without causing discomfort. It also had to move in and out smoothly without disturbing the patient.

2. **Waste Collection** : We needed a clean and simple way to collect waste. So, we designed a curved tube that carries waste from the basin to a sealed plastic bag. This keeps things leak-proof, quiet, and easy to clean—without using complicated automatic systems that might break or confuse users.
3. **The Mechanical Setup**: The bed uses motors, pumps, screws, and pipes to operate. Getting all these parts to work together without making noise or using too much power was a big challenge. We wanted to keep everything simple and reliable.
4. **Hygiene or Smell Control**: Keeping everything clean and fresh was a top priority. We added a water system for flushing and cleaning, along with odor-control traps. It was tricky to design these parts so they worked well without needing professional plumbing.
5. **Comfort or Ease of Use**: We made sure all controls were within the patient's reach and easy to use, either by hand or electrically.

6. FUTURE SCOPE

i. The is significant scope for the future improvement in design or functionality of the nursing bed with an integrated toilet. Firstly, enhancing commode unit is essential. the lightweight commode with a smooth, hygienic surface would improve comfort or usability. To support large-scale production, specially designed dies and tools can be developed. The odor control system can be upgraded by incorporating a more efficient water-sealed trap to eliminate leakage and unpleasant smells. Additionally, the materials used for flexible piping should be carefully chosen to balance strength and flexibility, ensuring reliability during regular use. If the water pressure is low, increasing the intensity of the washing jet would also enhance cleaning efficiency.

ii. Further improvements can be made to the bed's operating mechanisms. Introducing a safer 24-volt motorized drive system would increase safety while maintaining the option for manual operation through a handle during power outages or motor failures. A detachable commode pot mounted on a steel frame could also be developed, allowing for manual removal from below without disturbing the patient—especially useful when flushing is not required.

iii. To improve durability, replacing rust-prone hardware and connectors with stainless steel components is recommended. While this may slightly increase the cost, it will significantly enhance the product's lifespan. Finally, the current handle-operated screw mechanism takes time to change bed positions. This can be optimized by incorporating electrical actuators and integrating multiple actuators into a single control pendant, allowing quicker, smoother transitions with the press of a button.

7. CONCLUSIONS

The development of a multifunctional bed for incapacitated patients marks a significant advancement in patient care, particularly for individuals requiring long-term support due to illness, injury, or immobility. This bed was designed with the primary goal of improving patient comfort while minimizing the physical demands on caregivers. By integrating key features such as an adjustable backrest for achieving a comfortable sitting posture, an inbuilt commode with a flush and cleaning jet, and a seamless drainage system, the bed eliminates the need for physically shifting the patient during toileting activities.

To further enhance usability, a movable platform automatically covers the commode opening when not in use, ensuring both hygiene and safety. A specially engineered puller mechanism allows smooth raising and lowering of the commode unit using a simple handle operation, making the system accessible even in the absence of electrical power.

REFERENCES

[1] Tan, L., Lu, S., & Zhang, W. (2009). A Robotic Nursing Bed Design and Its Control System. *Proceedings of the 2009 IEEE International Conference on Robotics and Biomimetics*, December 19–23, Guilin, China.

[2] Peng, S.-W., & Lian, F.-L. (2010). Mechanism Design and Mechatronic Control of a Multifunctional Test Bed for Bedridden Healthcare. *IEEE/ASME Transactions on Mechatronics*, 15(2), 234–241.

[3] Mascaro, S., Spano, J., & Asada, H. H. (1997). A Reconfigurable Holonomic Omnidirectional Mobile Bed with Unified Seating (RHOMBUS) for Bedridden Patients. *Proceedings of the 1997 IEEE International Conference on Robotics & Automation*, April, Albuquerque, New Mexico, 1277–1282.

[4] Wei, C.-H., Tung, T.-C., Hsiao, S.-C., Chen, W.-C., Chiu, Y.-M., Tu, K.-T., Yeh, C.-W., & Chen, K.-Y. (2007). Hospital Bed with Auxiliary Functions of Lateral Positioning and Transferring for Immobilized Patients. *The 33rd Annual Conference of the IEEE Industrial Electronics Society (IECON)*, November 5–8, Taipei, Taiwan, 2991–2995.

[5] Basmajian, A., Blanco, E., & Asada, H. (2002). The Marionette Bed: Automated Rolling and Repositioning of Bedridden Patients. *Proceedings of the 2002 IEEE International Conference on Robotics & Automation*, May, Washington, DC, 1422–1427.

[6] Roy, B., Basmajian, A., & Asada, H. H. (2003). Manoeuvring a Bed Sheet for Repositioning a Bedridden Patient. *Proceedings of the 2003 IEEE International Conference on Robotics & Automation*, September 14–19, Taipei, Taiwan, 2224–2229.

[7] Roy, B., Basmajian, A., & Asada, H. H. (2005). Repositioning of a Rigid Body With a Flexible Sheet and Its Application to an Automated Rehabilitation Bed. *IEEE Transactions on Automation Science and Engineering*, 2(3), 300–307.

[8] Fiedler, G., Papaioannou, G., Mitrogiannis, C., Nianios, G., & Kyprianou, T. (2009). Development of a New Bed System with Improved Decubitus Prophylaxis for Bed-Ridden Patients. *Proceedings of the 9th International Conference on Information Technology and Applications in Biomedicine (ITAB)*, November 5–7, Larnaca, Cyprus.