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# Design of a Nursing Bed for Patient Transfer Scenarios

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**ABSTRACT**
Existing transfer beds offer functions like turning over and sitting up, each with unique features and advantages, but they fail to meet the demand for automated transfer in long-distance patient transportation scenarios. Therefore, the design of nursing beds based on patient transfer scenarios is of profound significance for improving the comfort and safety of patients during transportation. Through structural optimization design and functional module design, it can effectively reduce jolts and discomfort during transfer, lower the risk of secondary injuries, free patients' families and medical staff from manual labor, and save human resources through automated transfer. This study focuses on the design of nursing beds for non-emergency patient transfer scenarios, optimizing the problems of traditional nursing beds such as functional disconnection, low transfer efficiency, and insufficient comfort and safety in inter-hospital referral, cross-regional transfer, and community-home transfer scenarios. The design effectively enhances cross-scenario adaptability, operational efficiency, and patient experience, realizing safe and humanized transfer of non-emergency patients.

**KEYWORDS**
Non-emergency transfer scenarios; Nursing bed; Modular design; Scenario adaptation

## 1 Introduction

With the intensification of population aging and the increase in the number of patients with chronic diseases, many patients need to be transferred between hospitals, rehabilitation institutions, families, and other locations to meet different needs, such as discharge transfer, inter-hospital referral, rehabilitation or long-term care, and cross-regional transfer. Such transfer not only requires attention to the patient's physical condition but also consideration of their comfort and safety. As the frequency of this demand continues to rise, the market scale of non-emergency transfer has also expanded. Due to the significant differences in nursing bed requirements between emergency and non-emergency transfers, this design focuses more on meeting the needs of nursing beds for patient transfer in non-emergency scenarios.

## 2 Analysis of Design Requirements

There are nursing beds of different standards for different scenarios, and there is a disconnect between functions and adaptation to various scenarios in the current design: In inter-hospital referral scenarios, the conversion of multiple scenarios corresponds to the connection of multiple nursing beds. The cumbersome bed-transfer process consumes a lot of time and manpower, and the design of a transfer nursing bed that can adapt to multiple scenarios can alleviate this process; In cross-regional transfer scenarios, there is a lack of anti-jolting and integrated monitoring design, requiring frequent observation of the patient's status, equipped with appropriate monitoring instruments and professional medical staff; In community-home scenarios, it is limited by the balance between portability and safety. At the patient experience level, existing products have significant shortcomings in comfort, safety, and psychological recognition. Future designs should focus on scenarios, integrate dynamic processes, intelligent monitoring, and humanized interaction in a targeted manner, and truly achieve "safe transfer" and "psychological maintenance".

## 3 System Architecture of the Nursing Bed for Patient Transfer Scenarios

### 3.1 Preliminary Definition of the Nursing Bed Product

The functional positioning of the nursing bed focuses on non-emergency transfer scenarios, and achieves cross-scenario adaptation through a modular design concept. The main body of the product consists of a basic nursing module, an intelligent control module, and a scenario adaptation module, aiming to meet the needs of three typical scenarios: inter-hospital referral, cross-regional transfer, and indoor space handling. The basic nursing module adopts a lightweight carbon fiber frame and a memory foam mattress to balance strength and comfort; The intelligent control module integrates an Internet of Things (IoT) communication unit and an edge computing chip to support real-time vital sign monitoring and dynamic posture adjustment; The scenario adaptation module realizes functional expansion through detachable transfer plates, infusion poles, and folding mechanisms. The product design emphasizes "safety-efficiency-experience", reduces the intensity of manual handling through automatic bed transfer and rapid docking with ambulances, and optimizes the operational experience of medical staff and the usage experience of patients.

### 3.2 Service System Architecture of the Nursing Bed for Patient Transfer Scenarios

The relationships between economic, information, product and other elements among various stakeholders of the nursing bed product are sorted out by means of a service system architecture diagram. It clearly presents the mutual relationships among various stakeholders in the service system, and then completes the closed loop of the product in the entire process. In the architecture of this system, the stakeholders include professional medical staff, the product itself, APP software, patients, family members, ambulances, service companies, medical institutions, service organizations, product manufacturers, etc. The closed-loop connection between them ensures the construction of the product system.

The product service system is divided into four stages: pre-experience and purchase stage, assembly service stage, product use service stage, and maintenance and replacement service stage. In the on-site assembly service stage, the product manufacturer displays the product, processes, APP, services, trials, etc., to arouse the company's interest and purchase intention; In the assembly service stage, the standardized docking between the bed body and the ambulance stretcher interface, the data intercommunication setting between the APP and the hospital information system, and the operation training for medical staff are carried out; In the product use service stage, after the nursing bed is officially put into the transfer scenario, medical staff can realize one-key lifting, posture adjustment, and synchronous vital sign data through the intelligent control module. Patient family members can obtain transfer progress, nursing records, and abnormal early warning information through the APP. The service company provides cloud technical support and regularly updates software functions; In the maintenance and replacement service stage, the service company establishes a periodic maintenance mechanism, such as checking motor life and battery performance, provides spare parts replacement or module upgrade services, and continuously improves the scenario adaptability and service extensibility of the nursing bed.

### 3.3 APP Architecture

Based on different goals and the functional division of the product system, this study divides the information structure of the APP into an interface for medical staff and an interface for family members. The medical staff interface includes:

(1) Equipment Management Module: Integrates nursing bed posture adjustment (one-key lifting, backboard angle adjustment) and equipment status display functions. Medical staff can quickly complete operations through touch or voice commands, and receive equipment operation abnormal warnings (such as low battery).

(2) Patient Data Module: The data is connected to the hospital information system, enabling viewing of patient medical records, one-key generation of transfer reports, and uploading to electronic medical records.

The family member interface includes:

(1) Status Check Module: Provides real-time patient posture diagrams (such as supine, semi-sitting position) and medical staff operation records. Family members can check the transfer status and specific location to relieve anxiety.

(2) Notification and Reminder Module: Pushes notifications of key transfer nodes (such as departure, arrival, completion of bed transfer).

The functional structure of the APP is divided into a medical staff terminal and a family member terminal. The first-level interfaces of the medical staff terminal include: platform management, equipment management, and patient information. The platform has one second-level interface for information; The equipment management has three second-level interfaces: backboard lifting, height lifting, and equipment status; The patient information has one second-level interface for basic information. The first-level interfaces of the family member terminal include: platform management and information viewing. The platform management has one second-level interface for querying information and one third-level interface for information filling; The information query has three second-level interfaces: status, route, and location.

## 4 Product Design Architecture of the Nursing Bed for Patient Transfer Scenarios

### 4.1 Product Structure Division

The product structure is shown in Figure 1 above. According to the product function definition, the operation of the

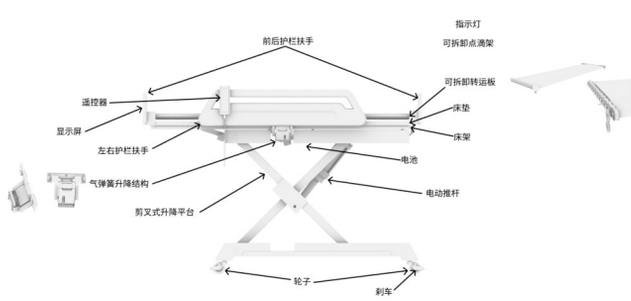


Figure 1 Product Structure Division

product is sorted out and drawn as follows:

(1) The transfer bed is moved out of the ambulance through the track, and then transferred to the ground using electric lifting.

(2) Remove the transfer plate, install a disposable sterile bed sheet on the transfer plate, and then assemble the transfer plate in place.

(3) Arrange the patient's clothes, bed sheets, etc.

(4) Place the cart close to the hospital bed and perform close docking.

(5) Adjust the height of the transfer bed to be higher than the hospital bed.

(6) Extend the transfer plate, and at the same time lower the height of the transfer bed until the transfer plate is close to the hospital bed.

(7) Continue to extend the transfer plate to half the length behind the patient.

(8) Rotate the transfer plate to move the patient to the center of the transfer plate, and at the same time move the transfer plate back to the bed frame.

(9) The transfer plate moves and rotates simultaneously to transfer the patient to the comfortable sponge plate on the second layer of the transfer cart.

(10) Store the transfer plate, and adjust and fix the patient's posture.

(11) Dock the guide wheels of the transfer bed with the ambulance track, retract the bracket by electric lifting, and then position it.

(12) After arriving at the destination, move the bed out as in step 1.

(13) After docking and installing the transfer plate on the transfer bed, move it to half the length behind the patient and rotate it into place.

(14) Repeat steps 5 and 6.

(15) First rotate the transfer plate and retract it at the same time to make the patient lie on the hospital bed.

(16) Complete the transfer process.

## 4.2 Hardware-Level Appearance Design

### 4.2.1 Modeling and Exploration

The modeling is explored in two parts: armrest modeling and lifting modeling. The armrest adopts a streamlined curved surface and a split structure, while the exposed scissor structure of the lifting mechanism will bring a strong sense of machinery. Therefore, the industrial sense of the mechanical equipment will be weakened through the appropriate arc transition of the armrest, and a balance will be found between rigidity and roundness, toughness and transparency. The bed frame is mainly matte medical white, with fluorescent marks dotted on the armrests and interfaces to enhance the visibility of functional divisions. The scheme can have three color combinations: basic medical white, quiet blue, and emergency orange.

### 4.2.2 Sketch Deduction

Figure 2 Armrest Sketches

The armrest shape should avoid being too tough or too round. Due to the mechanical sense brought by the scissor structure, the overall effect should be considered, and the visual language should be more unified, so the armrest shape cannot be too soft.

The overall visual language has been unified, the proportion and color matching have been changed, and the shape of

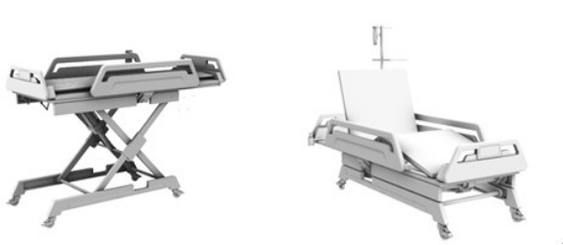

Figure 3 Second Round of Sketches

the cushion has been basically determined. However, some details have not been considered in place, but modeling has begun, and the details will be solved during the modeling process.

Figure 4 Third Round of Sketches

### 4.2.3 Modeling and Rendering

Figure 5 Renderings

Figure 6 Renderings

## 4.3 Software-Level APP Design

The interactive design interface will be divided into three sizes: tablet size for medical staff, nursing bed size, and mobile phone size for family members. The interface style focuses on the setting of key operations, omitting most redundant decorations and information, which is more in line with the feeling of medical facilities.

The functions of the tablet terminal include platform management, equipment management, and patient management, as shown in the following figure:

The functions of the nursing bed terminal include basic patient information and equipment management (transfer plate movement), as shown in the following figure:

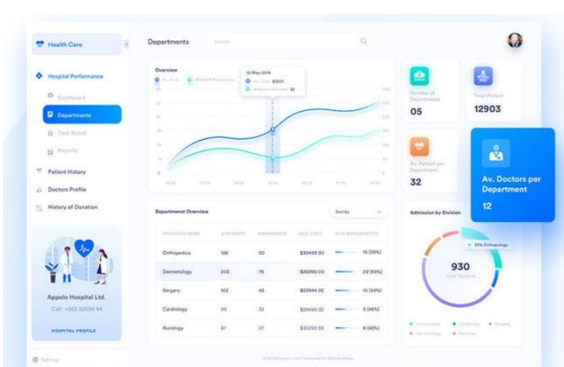


Figure 7 Rendering

Figure 8 Rendering

The functions of the family member terminal include patient platform management and information viewing, as shown in the following figure:

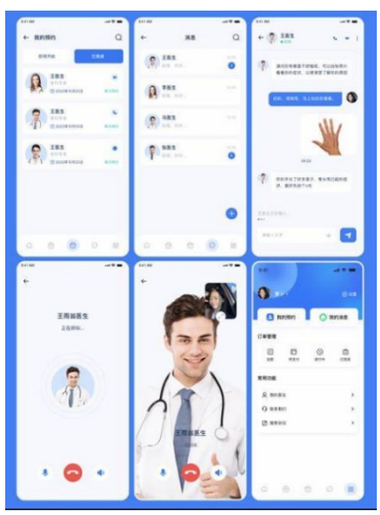

Figure 9 Rendering

## 5 Conclusion

This study conducts a systematic exploration around the design of nursing beds for non-emergency transfer scenarios, and proposes an innovative design scheme based on the modular concept. Through in-depth analysis of users' actual needs, it is proposed that modular design can effectively solve the shortcomings of traditional equipment in cross-scenario adaptability, operational efficiency, and patient comfort.

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