Computer Life (CPL) ISSN: 1819-4818
DELIVERING QUALITY SCIENCE TO THE WORLD

Mechanism design and motion analysis of transport machine for critically ill patients

Jiannan Zhang [1, a], Yongxiang Jiang [1,2, b, *], Shengcheng Zhang [1, 2, c], Siwei Luo [2, d] and Chengkun Wang [2 ,e]

[1] Tianjin University of Technology and Education, Tianjin 300300, China;

[2]Tianjin Key Laboratory of Intelligent robot technology and application ,Tianjin 300300,China；

[a]1763839414@qq.com, [b]jiangyongxiang@tute.edu.cn, [c]10501436@qq.com, [d]409573531@qq.com, [e]676259975@qq.com

---

Abstract: Patients need to be transferred between stretcher and hospital bed, hospital bed and operating table, which has been plagued by medical staff in China. The traditional handling method is not only complex and increases the workload of medical staff, but also causes secondary injury to patients. It is of great significance to design an automatic transport mechanism without changing the patient's horizontal posture in the process of transport. The mechanism is divided into three parts: handling device, lifting walking device and driving device. The handling device has the function of semi-automatic translation and transfer; the lifting walking device is an improved lathe, which realizes the height adjustment of the bed plate and supports the object handling function; the driving device uses synchronous belt pulley to work circularly.
Keywords: critical patient transporter, handling; lifting, patient.

---

1. INTRODUCTION

As an important link in the process of rescue, it is necessary not to change the patient's posture. The transfer between beds is a complex process, and the requirements for manual lifting are very strict. For patients with spinal injury, when they are transported from the operating table to the hospital bed or from the hospital bed to other beds, they are required to keep the head, neck and body level without distortion. If mistakes are made in this process, the patients will be injured again, or even may be injured There are some unforeseen consequences, so it is necessary to realize the translation of patients between the bed and the bed, and the research on the critical patient transporter has important application value.

2. OVERALL DESIGN OF MECHANICAL STRUCTURE OF CRITICAL PATIENT TRANSPORTER

2.1 Mechanical structure of critical patient transport machine

The transport machine for critically ill patients consists of three parts, i.e. handling device, lifting walking device and driving system, As shown in Figure 1.

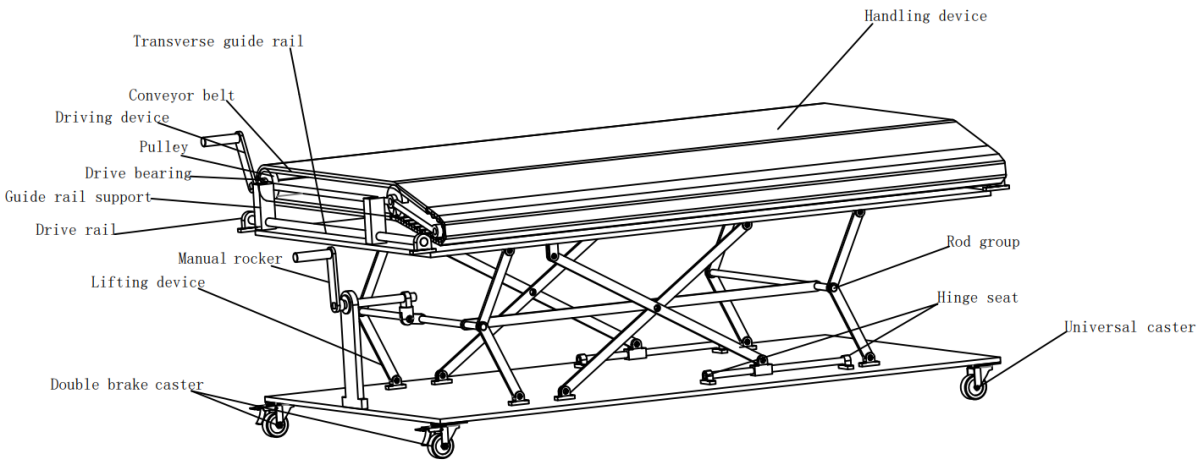

Figure 1.Integral frame of mechanical structure of critical patient transporter

2.1.1Mechanical structure design of handling device

The mechanical structure of handling device includes conveyor belt, handling device, driving system, transmission bearing and transmission slide rail. The bottom of the conveyor belt is designed as a rough surface, which can be connected with the handling equipment; the handling equipment as a whole is a metal structure, which is divided into upper and lower devices, the lower device is a free slide rail, which is connected with the upper transport device, which can provide free lateral translation for the upper device, and the end of the upper device is equipped with a mechanical drive system to provide power feed for the transmission bearing and the conveyor belt, so as to realize the final treatment of patients The horizontal transport of the goods.

2.1.2 Mechanical structure design of lifting walking device

The utility model relates to a mechanical structure of a lifting walking device, which comprises a lifting device and a walking device. The lifting device is supported and connected by a plurality of rod groups, and is connected by a screw thread, and the lifting of the mechanism is controlled by a manual rocker. The slide rail of the bed surface device is connected with the conveying device. Four universal wheels with self-locking performance are installed at the bottom of the walking device, which can realize the displacement between the critical patient transfer machine and the hospital bed.

2.1.3Driving device

The mechanical structure of the driving device is shown in Figure 1. The driving device is connected by synchronous belt pulley and controlled by manual rocker. The driving device is mechanically driven. The manual rocker is used as the power source to drive the pulley. During the operation, the movement and power are transmitted through the mutual meshing between the conveyor belt and the pulley, and finally the circular work is realized.

When carrying patients, the force required is mainly affected by gravity (patient's weight) and friction force (friction between patient and bed). The heavier the patient is, the greater the friction force is, and the greater the thrust of nursing staff is needed when the patient is transferred from the bed to the transfer machine. The transfer machine reduces the friction between the patient and the bed, mainly through the friction between the conveyor belt and the patient to realize the transfer between the bed and the mechanism.

Suppose that the weight of the patient is 61kg, the distance that the patient is lifted is h = 0.1M, the friction coefficient is 0.6, the carrying device is 50kg, the transfer speed is v = 0.02m/s, the distance that the patient is transported from the bed to the critical care machine is s = 0.84M.

The friction force between the transfer machine and the bed for critical patients was as follows:

$$f=\mu N=\mu(m_1g+m_2g)=670.32\ N \tag{1}$$

The time taken by the critical patient transport machine to successfully transport the patient to the correct position of the mechanism is as follows:

$$t=\frac{s}{v}=42s \tag{2}$$

According to the running speed of the mechanism and the calculation results of the above formula, the total power to be provided by the transfer mechanism during operation is:

$$P=fv=13.41W \tag{3}$$

In the process of transport, the work of the critical patient transport machine to overcome the patient's gravity is as follows:

$$W_1=m_1gh=59.78J \tag{4}$$

In the process of transport, the work of the critical patient transport machine to overcome the patient's gravity is as follows:

$$W_2=\mu m_1gs=316.10J \tag{5}$$

The average power in the process :

$$p_n=\frac{W_1+W_2}{t}=8.95W \tag{6}$$

Because there is no need to overcome human gravity to do work under the conveyor belt, only the friction resistance between the conveyor and the sickbed needs to be overcome

$$N_1=\mu mg=\mu(m_1g+m_2g)=670.32\ N \tag{7}$$

3. OVERALL PLAN OF CRTITCAL PATIENT TRANSPORTER

Through the cooperation of carrying device, lifting walking device and driving device, the critical patient transfer machine can realize the transfer of critical patients through the bed without changing the body position.

First of all, the height of the transport device of the critical patient transport machine is raised and lowered to the same height as that of the hospital bed, the critical patient transport machine is close to the hospital bed, and the side of the transport device with wedge angle conveyor belt is inserted under the side of the patient through the slide rail. The medical staff support the shoulder and hip of the patient with both hands respectively, and gently turn the patient to his body direction for about 30 degrees, so as to make the conveyor belt stable When the patient is safely inserted into 1 / 3 or 1 / 2

of the lower side of the patient, two people are required to cooperate. One drives the conveyor belt to transport the patient to the mechanism smoothly and safely, and the other cooperates to support the patient from the side to ensure the safe transfer of the patient to the transfer machine. Next, push the transfer machine to the operating table, lift it to the same height as the operating table, and drive the synchronous belt to transport the patient to the operating table smoothly and safely.

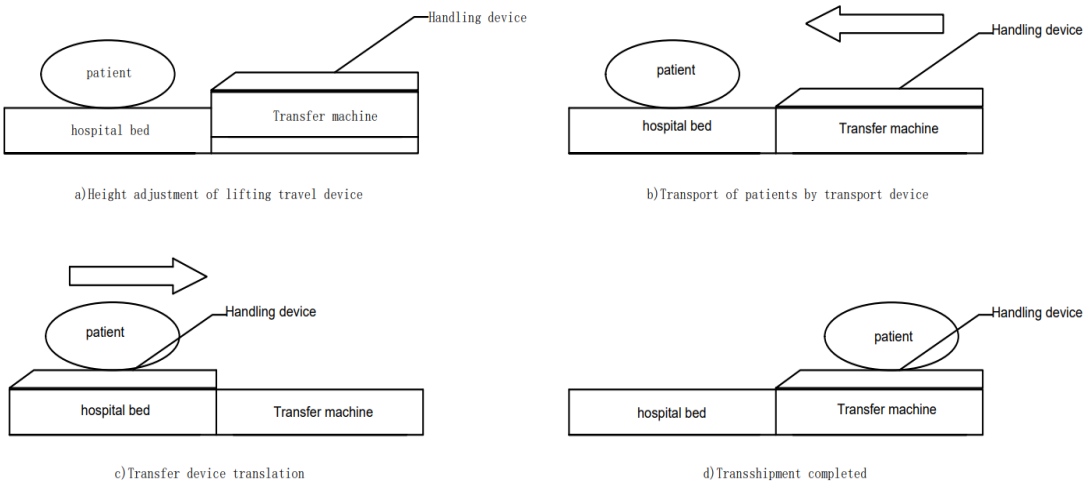

Figure 2 Schematic diagram of transfer process

4. CONCLUSION

For the particularity of critically ill patients, the traditional methods of axial turnover and "easy to cross the bed" are still used in the clinical transport and nursing of these patients. The traditional methods have the characteristics of long time to cross the bed, low patient satisfaction, high complications and high back discomfort of medical staff, which are criticized by medical staff and patients. Painless bed transport system can realize the level painless transport of critically ill patients without changing the bed position. The mechanism is novel in technology and low in cost, which brings great convenience for clinical work, simplifies the operation process of critically ill patients' bed transfer, saves the time and manpower of bed transfer, reduces the pain of patients and avoids secondary injury, increases the satisfaction of patients, and reduces the discomfort of medical staff's waist and back, so it has high clinical application value.

ACKNOWLEDGEMENTS

This study is funded by "Design of transport machine for critical patients" by College students' Innovation and Entrepreneurship training Program (202010066092); Hulunbeir Science and Technology support Project (2018127005)" Snow cleaning Robot based on panoramic Vision Technology "; Tianjin Vocational and Technical normal University (KJ2004)" Plant Protection six-rotor UAV key Technology Development and implementation "; Tianjin Vocational and Technical normal University (KJ2003)" Deep Song Mobile Robot key Technology Development and implementation "funding.

REFERENCES

[1] Lu Tao, Lu Guoping, Shi Yanjun, et al. Research and application of stretcher for critically ill patients [J]. Southeast national defense medicine, 2007,9 (5): 344-345

[2] Yi Yan, Liu Xueping, Zhang Benliang. The role of shovel stretcher in clinical nursing work [J]. Journal of North Sichuan Medical College, 2004,19 (3): 126-127 。
[3] Evanoff B, Wolf L, Aton E, et al. Reduction in Injury Rates in Nursing Personnel throughintroduction of Mechanical Lifts in The Workplace[J]. American Journal of Industrial Medicine,2003, 44 (5) : 451-457.
[4] Biering S F. Risk of Back Trouble in Individual Occupations in Denmark[J]. Ergonomics, 1985,28(1): 51-60.
[5] Hudson M A. Texas Passes First Law for Safe Patient Handling in America: LandmarkLegislation Protects Healthcare Workers and Patient from Injury Rrelated to Manual Patient Lifting[J]. Journal of Long-Term Effects of Medical Implants, 2005, 15(5): 559-556.
[6] Edilch R F, Hudson M A, Buschbacher R Metal. Devastating Injuries in Healthcare Workers: Description of The Crisis and Legislative Solution to The Epidemic of Back Injury from Patient Lifting [J].Journal of Long-Term Effects of Medical Implants,2005,15(2):225-241.
[7] Sherrow. Gurney[P]. United States Patent: 5022810, 1991-06-11.
[8] Patmore K, Schreiber A. Patient Transfer Device[P]. US: 8234727, 2012-8-7.
[9] Mcuulty C. Body Transfer System and Method[P]. US: 7748062, 2010-7-6.
[10] Guo Chi, LAN Tianbiao, Li Tao, et al. Design of ball foldable operation transfer bed plate [J]. China Medical equipment, 2014, 11 (11): 46.