

# **Research Developments of Transfer Device for Rehabilitation Patient**

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#### Abstract

Transfer device is very important for patient rehabilitation in the lifting of the patients who needed to transfer from one place to another. By now the developments status of native and foreign transfer device was studied according to the rehabilitation population requirement of both inside and outside China. Through the existed patents and literatures studies the patient transfer device shortcoming and future research direction have been discussed. Along with the age of aging all over the world the transfer device needs to get improved in family, portability, intelligence and low prices in the future of China due to its broad marker. All of this provides help for the design process of these equipments and the rehabilitation patients who need the device.

## **Keywords**

Rehabilitation, Patient Transfer Device, Development, Research

# **1. Introduction**

According to the sixth national census of China's total population in 2010 and the second national sample survey of disabled persons in China in 2015 it can be calculated that the total number of disabled persons in China will reach 90 million by the end of 2016. There will be about 25 million people with severe disabilities by that time including physical disabilities and mental disability. Besides the physical disabilities number is about 24,720,000 by then. Most of those persons do not have the ability to move conveniently themselves so they need to be taken care of by family member of some others. This not only increase social burden, but also cause the labor costs increasing. Along with our country entering the aging society there are more and more patients with lower limb movement disorder. Coupled with the improvement of people's living standard human beings' average weight is getting heavier. The work intensity of nursing, medical staff and family member has been challenged. Therefore the research of rehabilitation patient transfer device is imperative.

This not only reduces the work intensity of care and medical staff but also reduces the cost of social labors. So that more and more people will benefit from it especially the disabilities and their family numbers. The structure of this article is as shown in figure 1.



Figure 1. Whole article structure.

## 2. Background

As our country entering into the aging time the number of people who need surgery will also increase. Thus the bedridden patients and people with lower limb disabilities increase too. Coupled with the frequent occurrence of traffic accidents and disasters in recent years in China, the demand for medical and health equipment has been increased. The care for inconvenience of mobility and paralyzed patients has become a challenge for hospitals and families. The traditional nursing mode is depended on artificial. Not only the nursing staffs feel tired but also the patient will feel uncomfortable. This will be more serious for obese patients. The emergence of patient transfer device allows more and more people liberated from manual labor. Then the society resources can be reduced.

#### 3. Research Status

In 1975, Cicero C. Brown designed a lift and transmission device for human lifting. It not only reduced the workload of nursing staff but also it played an important role in patient rehabilitation. This is the first patient transfer device in the world according to the public existed literatures records [1]. In 1979 Hill-home's Liko focused on the rehabilitation of patient transfer machine. Then it had made considerable progress till now. In 1996 Guido Capaldi had improved a crane into a patient transfer device and installed it on the roof. The device has been welded by overall framework. The device can transfer the patients convenient indoor which enhanced the safety and comfort of them [2]. In 2000 William H. Simon designed a portable patient lift device used for lifting and transferring patients. It has been used in clinical applications and was helpful for doctors and nurses to take care for or inspect patients with lower limb paralysis [3]. In 2001 Reza Hakamiun had designed a type of electric transfer machine which can measure body weight. It is portable for raising or lowering a human being by a hanging pocket [4]. In 2003 Anthony Louis Moffa had designed a patient lifting device which can achieve linear scaling and angle conversion through supporting leg. It has the function of preventing the patient lift device from shifting in the process of promoting [5]. In 2009 Richard A. Patterson had designed a type of patient transfer device with wheels which can be transferred from the bed to the diagnosis bed or the operating table. This has reduced the pain of patients [6]. In 2014 Willis E. Martin had designed a patient lift device that considering the patient's feelings and was stable and safe. It is easy to manipulate and operate and then it has been applied to other fields either [7]. As in China according to the existed literatures the earliest research on this field was in 2002. The development of the device started late and the technology is not mature therefore a lot of drawbacks of these equipments existed. There is a huge space for the research of rehabilitation patient transfer device in future. In 2002 Gao Jingin had designed an electric displacement shift machine with a simple connecting rod [8]. This made the elderly or

patients' body to lean forward in the cushion raising process of the patient transfer device and prevent the user from dumping backwards. Besides the manual has been instead by electric power which greatly reduced the labor intensity of nursing and the patient's family member. Until now most of the existing transfer device in the market has solved the problem of moving patients from one place to another. However the problem of how to transfer the patient from the bed to the patient transfer device or the operating table has not been solved perfect now. In 2006 Ma Yulong had designed a patient transfer device which can conveniently be used for the patients who lie on bed or the persons with lower limbs paralysis to move from wheelchair to the stool or other facilities in a horizontal or a sitting mode. This prevented the patient from cracking or disease aggravating during the transfer process [9]. In 2009 Liu Shan, Li Jiamin had designed a transfer device for serious patient. A sling hanging up device has been used with universal wheel so 1 or 2 persons could easily transfer the patient to the destination [10]. Fan Jincheng had designed a patient's mobile equipment by using a sling to assist the handling of them. Beside it has made some innovations in the technology of human armrest [11]. In 2011 Ma Jiang has designed a transfer device consisted of an elastic core plate. Besides the elastic plate can be replaced by outer coat conveniently which can avoid the cross infection in hospital in certain extent. The elastic core plate is installed at both ends of the handle facilitate. The transfer device has the advantages of cleanness, sanitation, structure simple, low cost and so on [12]. In 2012 Wang Yinghui had designed an electric patient transfer device for disabled people. A plate seat and shoulder Z shaped structure was fitted on it while the driven system is electricity motor. The lifting mechanism is used through the vertical frame and the upper part of the chute riser [13]. Liu Chunfang had designed a special transfer structure for patients with spinal fractures. It was composed of canvas, cotton cloth, hard board, sponge, zipper and handle. The transfer device can be made into different models according to the height and weight of different persons. This ensured that the patient's spine didn't deform and reduced the patient's pain [14]. In 2013 Zhou Yuliang had made a turbine bar transfer device which could increase security and comfort of patients. The height of the whole frame can be changed and it is provided with a universal wheel. It also has the advantages of convenient disassembly [15]. Wang Yilong has designed a transfer turning equipment for patients with stroke, vegetative or bedridden. The inventor had effectively avoided the occurrence of bedsore. The turnover driving device composed of speed reduce motor, rotating axis and two turnover rod. It increases the safety and the comfort of the patients by using this production [16]. In 2014 Zhang Qiuzi and Li Tengjiong had designed a type of trauma patient weight measure machine. The device connected with the transmission belt and the hanger rack on top which combined weighing and transfer together. It has the advantages of high efficiency, safety, simple operation and convenient transfer [17]. Pan Guoxin had designed a holding type electric patient

transfer device with 2 methods of adjustment. The arm's opening was adjusted by manual. The support frame's opening and closing was adjusted by electric motor. Thus the lifting and fall of the supporting arm was carried out [18]. In 2015 Xie Xiaosheng had designed a patient transfer mechanism both with manual lifting and electric lifting working conditions. It solves the problem that the power supply sometimes was insufficient. The conversion of the two ways can be achieved through the assembly and disassembly of the movable shaft pin [19]. Xu Zhengwen had manufactured automatic transfer equipment in 2015. Patients with paralysis of lower limbs can operate it independently. In the frame the air bag is adopted to get the patients automatic fixed. The four axis linkage was adopted to maintain the balance of the gravity center. The patient can operate it by a handle switch or a remote control switch. This is the intelligent development beginning of the rehabilitation transfer device [20] in China. Zhen Huawei had designed a short, narrow, miniature, easy operating patient transfer device with a jack. It has the advantages of small volume, flexible motion and low cost which meet the low-paid class people's demand. This solves the problem that the indoor area is small [21]. Xu Zhengwen has designed a type of patient transfer device fixed with GPS positioning and navigation system also had the wheelchair function. It can be controlled by a nursing assistant or by himself or automatically controlled by a computer program [22]. Peng Qingfeng has designed a lower limb fracture transfer device. It helps the patients stop bleeding as well as avoiding the distortion of the lower limb. And it has simple structure and greatly alleviated the patient's pain when they were moved [23]. Tan Yinglian had designed a wall mounted patient transfer device. By two stretching devices the transverse and longitudinal motion can be executed. The transfer problem from bath to bed or toilet of patients especially the lower limb paralysis has been solved either [24]. Other scholars such as Shi Yonghui, Jia Zhoujun, Tong Li, Liu Wenyu, Zhu Naiyi, Chen Xuanhang also has made contribution to the design, analysis and application of rehabilitation patient transfer device [25-30].

## 4. Research Weakness

At present there is a certain progress in the research of the patient transfer device in China especially the foreign technology has been more and more mature. The technological innovation has not been greatly improved in recent years. To some extent we should consider the patient's feelings during the design and use stage of these devices. In general there is a common problem of the domestic and foreign rehabilitation patient transfer device. The low automation degree and relative single function can not meet the demands of persons now. The high automation transfer device can not be accepted by many patients because of the expensive price. If a person need one more services he need to buy more than one devices. This not only increases the burden on the family but also takes up the social resources. This is also a factor that why in the market the patient transfer device can not be more widely promoted now. Most of the patient transfer device is only to achieve the motion of patients from bath to bed or toilet. And the use of it in hospitals and nursing homes is not yet popular till now. The overall weight of most patient transfer device is too high which to some extent affect the widespread use of it. So there is a long way of patient transfer device to go in China as in figure 2.

In order to achieve the goal of family spread it is necessary to improve the patient transfer device operability and reduce the difficulty for most of the operator. Next if the products meet the requirement of portability for everyone it must be minimized the whole size and made into a foldable type. In addition some automatic control or voice control functions need to be added on the device In order to make the products intelligent. Finally the products structure optimization and advanced manufacturing technology are needed to cut down the cost. So the approaches above must be considered in the future research.



Figure 2. Development trend of rehabilitation patient transfer device.

## **5. Research Prospect**

Through the above review of home and abroad we can draw the conclusion that the rehabilitation patients transfer device has the following development direction: family, portable, intelligent and low cost. In China now there are not many families using this transfer equipment for this or that reason. Next the total weight of the device should be reduced without carrying capacity reducing. In the future if it is portable the use markets can be expanded much. We are in an intelligent era now and the transfer machine is no exception too. So we should make an effort to the intelligent process of it. Perhaps in the next few years the patients can use the transfer device themselves by voice or wireless control which will greatly reduce the family and social burden. Finally the direction of these equipment should be focus on is cost. There are still a lot of low-income people in China and other countries. If the device is too expensive many persons who really need it will refuse to use due to they can't afford the cost. Thus there is still much work to be done in the development of rehabilitation patient transfer device.

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