

Original Research Article

# Integration of Customized Wheelchair Tracking and Durable Medical Equipment's Solutions for Hospitals: A Continuous Quality Improvement Project

## Abstract

**Aim:** The purpose of the project is to design a model that will reduce the number of missing wheelchairs in the National Institutes of Health (NIH) Clinical Center; this will be achieved by designing a process to improve the tracking of wheelchairs at the clinical center.

**Study design:** Qualitative.

**Place and Duration of Study:** National Institutes of Health (NIH) Clinical Center between 2017 and 2018.

**Methodology:** A process flow chat was designed to study the current process and identify areas of opportunities. All stakeholders were interviewed to do a root-cause-analysis. A fishbone diagram was constructed to ascertain the flow and direction of the problem being investigated.

**Results:** The study found that it was a good management decision to invest in Stryker TC wheelchairs that reduced the rate of missing wheelchairs from an average of 50% to an average of 20% monthly. However, the study further opined that it will be better to reduce this number to zero because the operational expenses associated with replacing missing wheelchairs is huge. In 2017, 100 new wheelchairs were purchased at \$5,000 each. This transport equipment is quite expensive, and it will be saving the hospital about \$200,000 dollars annually if they don't have to replace missing wheelchairs.

**Conclusion:** The study concluded that investing in Stryker TC wheelchairs was the best decision to have been made by NIH considering the fact that that singular decision reduced the incidences of missing wheelchairs from 50% to 20% monthly, saving the hospital \$200,000 annually in operational expenses associated with replacing them, despite the high cost of transport equipment. The study further recommended, among many other recommendations, the purchase of more Stryker wheelchairs in future by the NIH because the Stryker chairs are more durable, less prone to damages and easy to clean.

**Keywords: Wheelchairs, Missing, Tracking, Durable Medical Equipment**

## **1. INTRODUCTION**

This project is borne out of the need to proffer solution to the incessant missing wheelchairs at the National Institutes of Health (NIH) Clinical Center. The purpose of the project is to design a model that will reduce the number of missing wheelchairs in the institution; which is meant to be achieved by designing a process to improve the tracking of wheelchairs at the clinical center.

### **1.1 Background**

The wheelchair (WC) stands as a fundamental example of mobility-assistive equipment (MAE)<sup>1</sup>, especially for sick patients. Every hospital has wheelchairs as regular equipment. They affect almost every aspect of the hospital's functioning. Wheelchairs can be a hassle, from the expenses involved to the delays that may result from their unavailability. Wheelchairs help some people recover more quickly, but many cannot be carried safely without one's assistance. It is crucial for these individuals to be able to access wheelchairs easily when needed. It could be crucial in some situations. The time a staff member spends looking for an open wheelchair detracts from the quality of care provided to patients. The patient's health may suffer as a result of this. This then brings to the fore, the need to proffer solution to incessant missing wheelchairs in hospitals and clinical centers.

According to Z & Z Medicals, Inc., most hospital facilities estimate a 10 percent annual loss in their fleet of wheelchairs; this percentage can occasionally rise to 25 percent<sup>2</sup>, and the staff wastes up to 20 minutes of their working time every day searching for a wheelchair<sup>3</sup>. As a matter of fact, when a wheelchair is not readily available, people other than patients are kept waiting. Getting patients where they need to go fast and effectively is essential to the entire workflow of healthcare. Insufficient wheelchair availability or inadequate wheelchair tracking will lead to lines and delays that affect hospital operations and reduce efficiency<sup>4</sup>.

According to an article in The Strait Times, hospitals basement parking lots, specialized clinics, wards, and other common areas, are usually the custodians for wheelchairs that were not in use<sup>5</sup>. To fully understand the relevance of this project, it is important to evaluate a system where wheelchair tracking is not fully functional and its effect on the healthcare

center. In 2017, the NIH recorded about 40 – 60% of their wheelchairs was missing monthly as shown in the table below:

**Table 1: Percentage of missing wheelchairs at NIH Clinical Center**

| Month          | Percentage of missing wheelchairs |
|----------------|-----------------------------------|
| January 2017   | 45.30%                            |
| February 2017  | 55.39%                            |
| March 2017     | 55.39%                            |
| April 2017     | 61.15%                            |
| May 2017       | 51.08%                            |
| June 2017      | 51.08%                            |
| July 17        | 54.67%                            |
| August 2017    | 45.32%                            |
| September 2017 | 45.32%                            |
| October 2017   | 59.71%                            |
| November 2017  | 49.64%                            |

This of course poses a serious challenge because operational inefficiencies sequel to missing wheelchair and other Durable Medical Equipment (DME) could lead to bad patient experience, time delay in work flow and increases the cost of business operations for healthcare centers. The introduction of effective tracking system will improve workflow, patient experience, support time and promote accountability.

Even though there had been a number of studies with respect to tracking of wheelchair and other DME within the hospital, it is no doubt that an effective tracking system can help hospital personnel locate wheelchairs and other DME within the hospital, thereby saving money and time. Tracking of DME including wheelchairs improves operations timeframe, workflow and overall promotes patient experience. Proper accountability is necessary for cost savings and reduction in redundancy. Over the years, there has been significant advance improvement in technology for an effective tracking mechanism. Some innovative

technologies available for tracking wheelchairs and other Durable Medical Equipment within the hospital include:

- **RFID:** The utilization of Radio Frequency Identification (RFID) is rapidly gaining traction due to its numerous extended applications. However, there aren't many instances where such a technology is actually used in the healthcare industry because of the investment concern<sup>6</sup>. Radio frequency identification (RFID) technology uses electromagnetic fields in the radio frequency range to wirelessly capture and read the data store in a tag for identifying and tracking purposes. RFID was discovered to be practical and helpful in the healthcare industry by several early adopters in areas like patient identification and asset tracking. Adoption however, is hampered in large part by technology limits, privacy concerns, interference issues, expensive pricing, and a lack of international standards. To improve RFID use in healthcare, more affordable, well-designed systems are required, along with privacy concerns being addressed<sup>7</sup>. RFID technology can also be used to help medical professionals diagnose and treat patients more quickly and accurately. It can also be used to facilitate the automatic streamlining of the patient identification process in health centers<sup>8</sup>.
- **IR:** Infrared location tags simply transmit codes with light. They require ceiling mounted readers and extensive infrastructure. Because they use light instead of radio waves, the solution cannot pass through the wall. Hence, there is less possibility of false positive, radio-based systems can pick up other readers through walls.
- **GPS:** Global Positioning System (GPS) is based on a system of satellites communicating with receivers. It tells exact location and works with Wi-Fi. The satellites broadcast signals that contains information about their location and time. However, the tracking devices are quite big.
- **Barcode technology** requires proximity. The scanners or lasers used to read the barcodes measures the light reflected from the linear barcode. Hence it is not efficient when an object is not in sight.

However, since RFID waves do not need line of sight to operate and come in varying read/tracking ranges, RFID technology is far superior and more practical compared to barcodes. RFID tags are used to tag objects and come with their own unique serial number. A computerized system allows for quick and easy tracking of these objects. Some of these innovative technologies can also be used in combination. Some examples are:

- **IR/RFID**

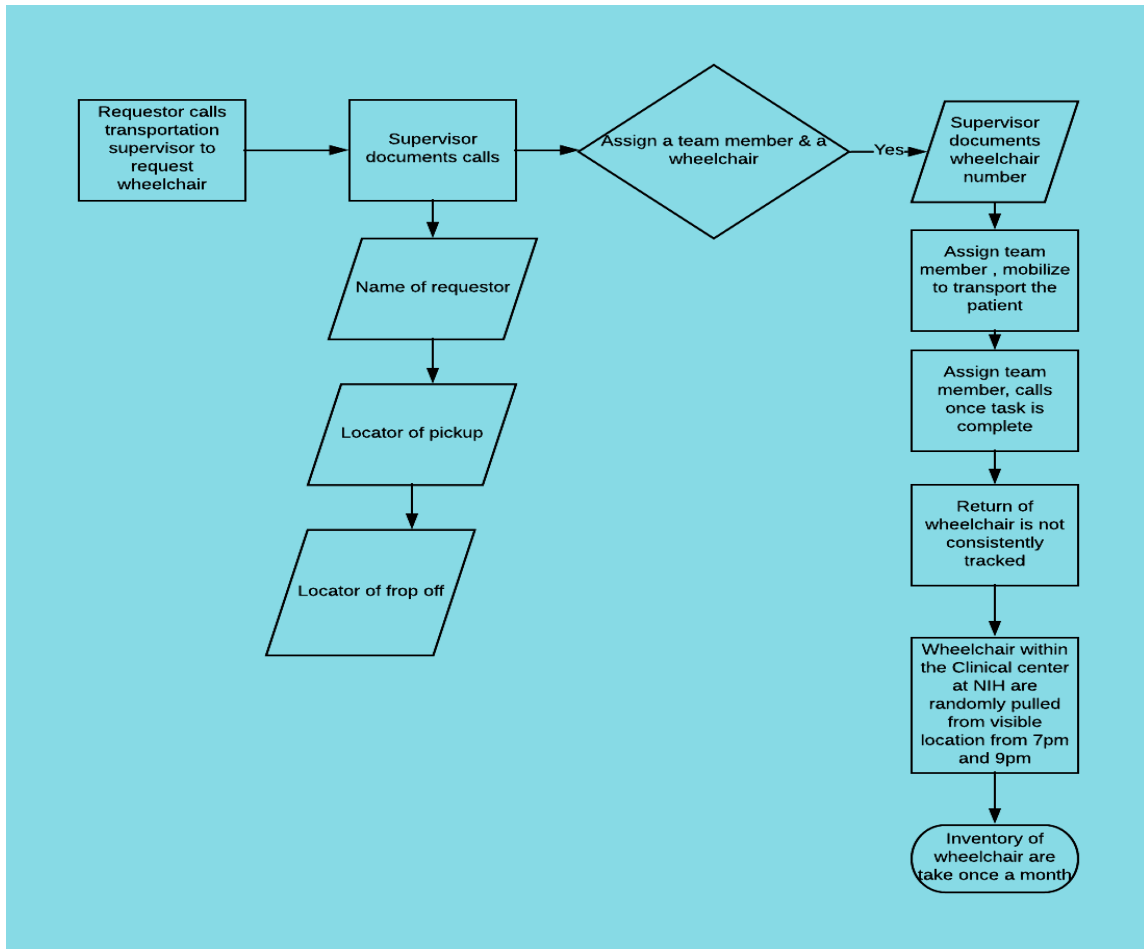
- RFID + Barcode
- RFID + Barcode + GPS

In 2012, the Johns Hopkins Hospital adopted the Real Time Locating System (RTLS), Infrared (IR) technology by Midmark for asset tracking and management. In 2016, the hospital improved surgical on-time cases by 25% with the installation of Venus RTLS in all 33 Operating Rooms. It was observed that most surgical delays were caused by missing equipment particularly Intravenous (IV) pumps. Prior to the installation of the RTLS, typical 8 hours shift was dedicated to finding and stocking 30 service carts, after the installation of the RTLS tags, the number of carts stocking during an 8 hours shift rose from 30 to 60 carts. In all, it is obvious that tracking of DME and Wheelchairs within the hospital will improve operation efficiencies, reduce staff frustration, improve patient experience and save time and money. Simple low-cost techniques can enable efficient tracking of wheelchairs within the hospital. Interventions do not always have to be complex or sophisticated.

## **2. METHODOLOGY**

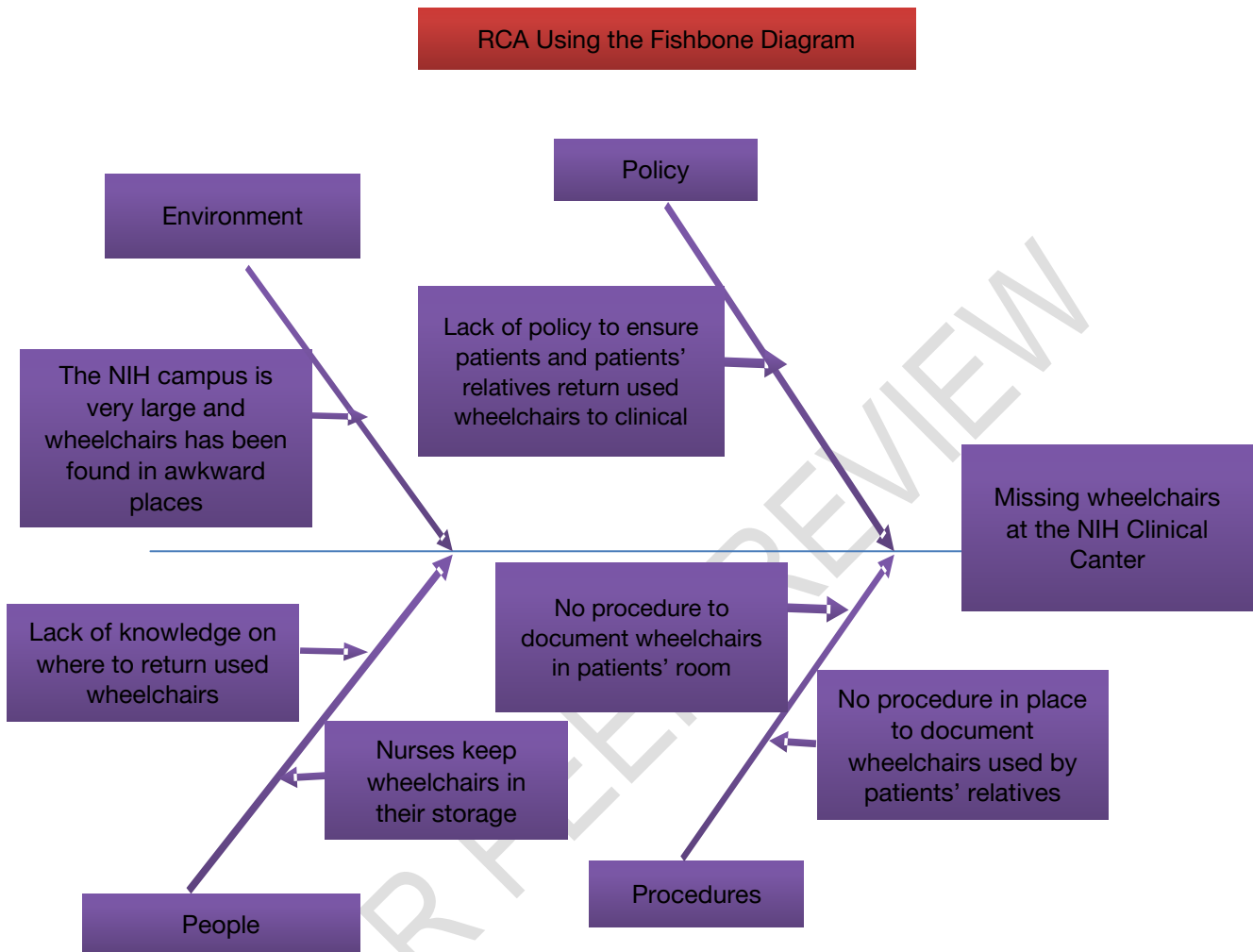
The Capstone project was conducted at the National Institutes of Health (NIH) Clinical Center. The NIH is the largest Biomedical Research Center in the world<sup>9</sup>. The clinical center is a hospital devoted to clinical research; it has over 1,600 clinical research studies in progress. In 2017, the hospital saw 9,700 new patients, had 92,000 outpatients' visits, 4,500 inpatient admissions, with 46,388 inpatient days and an average length of stay of 8.8 days<sup>9,10</sup>. First, a process flow chat was designed to study the current process and identify areas of opportunities as shown in Figure 1.

All of the stakeholders were interviewed to do a root-cause-analysis. In December of 2011, NIH purchased 100 new Stryker Wheelchairs. The Stryker Prime TC Transport Chairs has a rigid frame that helps prevent theft. Since the arrival of these chairs, the number of missing wheelchairs has decreased by about 50%. Cleaning is key to preventing infection and Hospital acquired infections. The Stryker TC are power-washable and makes cleaning easier. They feature a smoother design with obvious touch points, so there are fewer nooks and crannies for bacteria and viruses to get trapped in, and wiping the product down is simple and efficient. The use of color palette in the design makes it easier to see missed spots



**Fig. 1. The Current Process for accessing Wheelchairs**

Then, a fishbone diagram was constructed, Figure 2. A fishbone diagram, sometimes referred to as an Ishikawa diagram or a cause and effect diagram, is a type of visual aid used in business to pinpoint and look into multiple potential reasons of a given problem, event, or result. It is organized like the skeleton of a fish, with the causes running to the left like the fish's bones and the problem statement at the head of the animal. With the use of the diagram, difficult issues can be reduced to manageable parts, facilitating productive brainstorming and causal relationship analysis among teams. Fishbone diagrams are useful for root cause analysis because they offer a methodical framework for investigating all possible sources of an issue, not just the most apparent one<sup>11</sup>.



**Fig. 2. The Fishbone Diagram for pinpointing the incidences of Missing Wheelchair**

To better understand the process:

- There is no process in place to track where patient relatives drop wheelchair after use
- There is no process in place to track the exact location of each wheelchair, though every wheelchair is assigned a number.

With this information, a process improvement plan was designed using the PDSA Cycle.

Using the PDSA Tool:



## 2.1. New Process

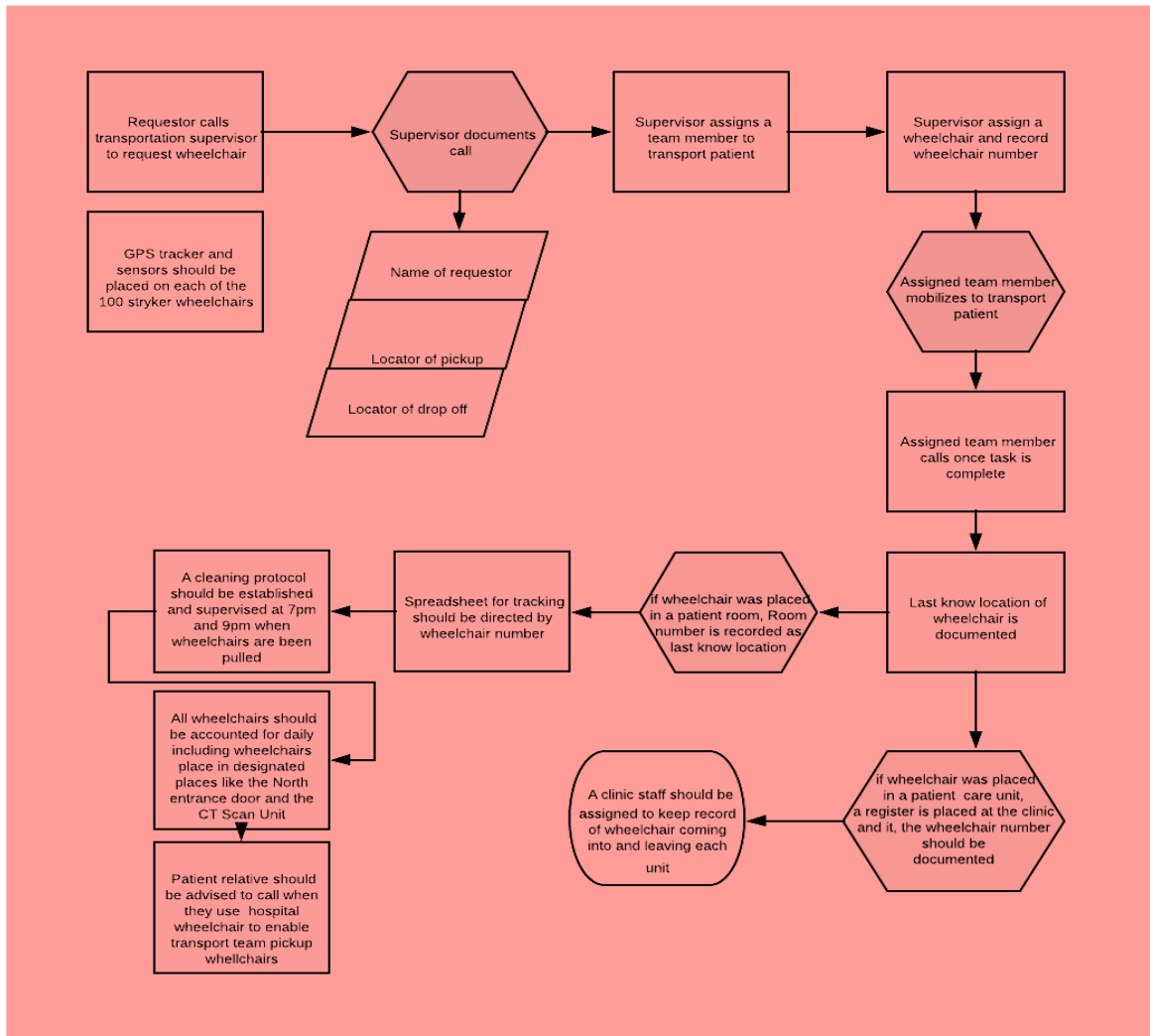


Fig. 3. The New Process for tracking Wheelchairs

Do – A test of the new proposed system was undertaken to see if the number of missing wheelchairs will be reduced. This process was tested at a single Patient Care Unit.

#### Study

Data from the new process was collected and analyzed and the results were recorded. The number of missing wheelchairs at the end of each month was recorded. The number of patients calling messengers services after the use of a wheelchair were analyzed to see if the policy is effective.

#### Act

If the percentage of missing wheelchairs is less than 10% at the end of each month, recommendations will be made to management to propose the expansion of the new process to the entire clinical center.

### 3. RESULTS AND DISCUSSION

#### 3.1. Project Results

The study found that it was a good management decision to invest in Stryker TC wheelchairs that reduced the rate of missing wheelchairs from an average of 50% to an average of 20% monthly. However, it will be better to reduce this number to zero Operational expenses associated with replacing missing wheelchairs is huge. In 2017, 100 new wheelchairs were purchased at \$5,000 each. This transport equipment is quite expensive, and it will be saving the hospital about \$200,000 dollars annually if they don't have to replace missing wheelchairs.

#### 3.2. Project Findings and Next Steps

Designing a solution for tracking of wheelchairs can ensure savings. The purchase of the new Stryker wheelchairs leads to a reduction in the percentage of missing wheelchairs.

**Table 3: Reduction in the percentage of New Stryker Wheelchairs**

| Month         | Percentage of missing wheelchairs |
|---------------|-----------------------------------|
| December 2017 | 0%                                |

|               |        |
|---------------|--------|
| January 2018  | 19.40% |
| February 2018 | 32.10% |
| March 2018    | 20.10% |
| April 2018    | 19.41% |
| May 2018      | 17.20% |

### 3.3. Challenge

Meeting with all the relevant stakeholders at the same time was a challenge. Also, the compatibility and interoperability of new tracking and management systems with the hospital's current software infrastructure presented some technical difficulties. There were also concerns regarding security and privacy about tracking systems that gather and retain patient data.

### 3.4. Recommendation

1. There should be a policy in place to enforce return of wheelchairs used by patients or patient relatives to lobby or parking lot storage area.
2. The process for requesting wheelchairs should be automated – it may not be a big cost – it makes the process more accurate and easier. Last known location of a wheelchair can be confirmed from the system.
3. Purchase of more Stryker wheelchairs in future. The Stryker chairs are more durable, less prone to damages and easy to clean.
4. Tracking system should be upgraded to the use of RFID. It may be good management decision to spend more money to protect expensive assets. Spending about \$50,000 to protect assets worth \$500,000 may be a good investment decision. Spending \$50,000 may translate into not having to replace wheelchairs worth \$150,000 two years down the line that saves \$100,000 that will be available for operational use.

Other advantages of the RFID technology include:

- It does not require a direct line of sight to operate

- It can read at a much greater distance
- It can be designed to read multiple tags
- It has the ability to store relevant data on tag
- It contains high level of security: data can be encrypted, password protected
- The tags are available in various shapes
- It has varying read and track distances
- Much more labor efficient; once set up, an RFID system can be run with minimal human participation.

#### 4. CONCLUSION

The study concluded that investing in Stryker TC wheelchairs was the best decision to have been made by NIH considering the fact that that singular decision reduced the incidences of missing wheelchairs from 50% to 20% monthly, saving the hospital \$200,000 annually in operational expenses associated with replacing them, despite the high cost of transport equipment. The study further recommended, among many other recommendations, the purchase of more Stryker wheelchairs in future by the NIH because the Stryker chairs are more durable, less prone to damages and easy to clean.

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