



# Wheelchair Maintenance Training Program

Version 1.3

---

Wheelchair Maintenance Training program

(WMTP)

Clinician's Reference Manual

---

## ACKNOWLEDGEMENTS

This training material was supported by the U.S. Department of Health and Human Services, National Institute on Disability Independent Living and Rehabilitation Research (H133A120004). The contents of this manual are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. Department Health and Human Services.

This training material has resulted from the work of a group of people, including Dr. Michael Boninger, Dr. R Lee Kirby, Michelle Oyster, Dr. Jonathan Pearlman, Dr. Rory A Cooper, Emily Krobot, Dr. Lynn Worobey, Michael Lain, Rosemarie Cooper, Annmarie Kelleher, Chad Evans, Samuel Bucior, Chika Eke, Maria Toro, and volunteers that helped to pilot the training. Materials have been based on the Wheelchair Service Training Package from the World Health Organization<sup>1</sup>.

This work is protected by the Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND) license. For more information, see <http://creativecommons.org/licenses/by-nc-nd/3.0/>

---

<sup>1</sup> Khasnabis, C. and K. Mines, *Wheelchair Service Training Package Basic Level*. 2012, WHO.

**TABLE OF CONTENTS**

Acknowledgements .....2

1. Introduction to the WMTP .....4

2. General background on wheelchair maintenance .....4

3. Getting started .....8

4. Preparing to deliver the wheelchair maintenance training program .....8

    4.1 Items to consider before training wheelchair users .....8

    4.2 Items needed for training .....9

    4.3 Items to consider during training .....12

    4.4 Good practice training tips .....13

5. Detailed presentation plans .....14

    5.1 Manual wheelchair maintenance .....14

    5.2 Power wheelchair maintenance .....60

appendix 1: Bolt board instructions .....106

appendix 2: Manual wheelchair nomenclature .....114

appendix 3: Schedule for manual wheelchair maintenance .....115

appendix 4: Changing manual wheelchair tire inner tubes .....116

appendix 5: Power wheelchair nomenclature .....119

appendix 6: Schedule for Power wheelchair maintenance tasks .....120

appendix 7: Reminders .....122

appendix 8: Manual wheelchair maintenance hands-on activity checklist .....123

appendix 9: Power wheelchair maintenance hands-on activity checklist .....124

Reference List .....126

## 1. INTRODUCTION TO THE WMTP

### Disclaimers

The University of Pittsburgh and the members of the team who developed this program are not responsible for any injuries or deaths arising from the use of the materials. Users of these materials assume full responsibility for their actions.

### Purpose

Wheelchair service personnel have a responsibility to inform wheelchair users how to care for their wheelchair and cushion at home. The Wheelchair Maintenance Training Program is designed to develop the skills and knowledge of wheelchair users and caregivers (when applicable), to perform basic wheelchair maintenance. By the end of this training, participants will be able to demonstrate to wheelchair users how to care for their wheelchair at home, to identify common technical problems with a wheelchair and explain how these problems can be solved within the local community.

This training program includes both manual and power wheelchairs and attempts to incorporate the latest evidence on wheelchair breakdowns, repairs and maintenance.

---

## 2. GENERAL BACKGROUND ON WHEELCHAIR MAINTENANCE

The following information summarizes current research evidence and United States (US) policy related to wheelchair maintenance.

- ▶ The number of wheelchair breakdowns and wheelchair-related injuries is on the rise – the number of wheelchair related injuries reported from medical institutions alone has doubled between 1991 and 2003 [1].
- ▶ Poor wheelchair maintenance has been linked to an increased risk of breakdowns, injuries and increased costs of care.
- ▶ A lack of wheelchair maintenance has been cited as a factor which contributes to wheelchair related injuries and death [1-5].
- ▶ The majority of commercial wheelchairs available in the US are not compliant to the minimum durability standards [6-8].

- ▶ Between 5% to 18% of wheelchair users in the community experience wheelchair related injuries each year [1-5, 9-13].
- ▶ Between 44% and 57% of individuals with spinal cord injury who have participated in a survey have reported at least one wheelchair breakdown in the past 6 months [14-16].
  - ▶ Out of those individuals who experienced a wheelchair breakdown, between 20% to 30% stated that it resulted in an adverse event, which included missing work and appointments, being stranded at home or away from home, and/or being injured [14-16].
- ▶ Power wheelchairs have been reported to have more frequent breakdowns than manual wheelchairs.
  - ▶ Users of power wheelchairs with seat functions such as tilt, recline, and elevating leg rests reported being injured in greater numbers than those who did not have seat functions [15].
- ▶ Unpublished data suggests that wheelchair repairs and replacement costs account for over 30% of the direct wheelchair expenditures paid annually by large-scale providers for wheelchairs (such as the VA or Medicare).
- ▶ In a study conducted by Hansen et al in Sweden, it was found that 99% of wheelchairs had active maintenance issues that required attention. Participants were then randomized into either a control or an intervention group. The intervention group received wheelchair maintenance based upon therapist recommendations, while the control group received no assistance. The study reported that those in the intervention group experienced a decrease in the number of wheelchair accidents by 100%. There was no decrease in the number of accidents for the control group [17].
- ▶ If an individual does not have regular wheelchair maintenance, he/she is over ten times more likely to have had a wheelchair-related accident in the past 3 years, demonstrating that with appropriate training, wheelchair-related injuries can be reduced [13].
- ▶ Basic wheelchair maintenance can be done at home.
- ▶ A maintained wheelchair will be more comfortable and easier to use.
- ▶ A maintained cushion will provide continued pressure relief and support.

### **Wheelchair repairs, maintenance, and replacement policy in the US<sup>2</sup>**

---

<sup>2</sup> For detailed information visit:

In the US, many health insurance policies follow coverage policies from the Centers for Medicare and Medicaid Services (CMS). This document includes a brief description of CMS's policies related to repair, maintenance, and equipment of wheelchairs. This may or may not apply to all of your client's health insurance policies.

Under CMS's policy, payment may be made for the repair, maintenance, and replacement of medically required durable medical equipment (DME), in this case wheelchairs, including equipment which had been in use before the user enrolled in Part B of the program.

### Repairs

- ▶ A repair is defined under CMS as the “means to fix or mend and to put the equipment back in good condition after damage or wear”.
- ▶ Payments for repairs and maintenance may not include payment for parts and labor covered under a manufacturer's or supplier's warranty.
- ▶ Repairs to equipment which a beneficiary owns are covered when necessary to make the equipment serviceable. However, Medicare does not pay for the repair of previously denied equipment or equipment in need of frequent and substantial servicing.
- ▶ If the expense for repairs exceeds the estimated expense of purchasing or renting another item of equipment for the remaining period of medical need, no payment can be made for the amount of the excess.
- ▶ A new Certificate of Medical Necessity (CMN) and/or physician's order is not needed for repairs.

### Maintenance

- ▶ Routine periodic servicing, such as testing, cleaning, regulating, and checking of the beneficiary's equipment is not covered.
- ▶ CMS considers it reasonable to expect that beneficiaries will perform the maintenance. Normally, purchasers of DME, such as wheelchairs, are given operating manuals which describe the type of servicing an owner may perform to properly maintain the equipment.

- ▶ The owner is expected to perform such routine maintenance rather than a retailer or some other person who charges the beneficiary. Thus, hiring a third party to do such work is for the convenience of the beneficiary and is not covered.
- ▶ There is no comprehensive training to perform this maintenance, which is the purpose of this training.
- ▶ More extensive maintenance defined by CMS, which based on the manufacturers' recommendations is to be performed by authorized technicians, is covered as repairs for medically necessary equipment which a beneficiary owns.
- ▶ A new CMN and/or physician's order is not needed for covered maintenance.

### Replacement

- ▶ Replacement refers to the provision of an identical or nearly identical item.
  - ▶ Irreparable wear refers to deterioration sustained from day-to-day usage over time and a specific event cannot be identified. Replacement of equipment due to irreparable wear takes into consideration the reasonable useful lifetime of the equipment. If the item has been in continuous use by the user on either a rental or purchase basis for the equipment's useful lifetime, the beneficiary may elect to obtain a new piece of equipment.
  - ▶ A replacement may be reimbursed when a new physician order and/or new CMN, when required, is needed to reaffirm the medical necessity of the item.
  - ▶ The reasonable useful lifetime of durable medical equipment is determined through program instructions. In the absence of program instructions, carriers may determine the reasonable useful lifetime of equipment, but in no case can it be less than 5 years.
  - ▶ Computation of the useful lifetime is based on when the equipment is delivered to the beneficiary, not the age of the equipment. Replacement due to wear is not covered during the reasonable useful lifetime of the equipment. During the reasonable useful lifetime, Medicare does cover repair up to the cost of replacement (but not actual replacement) for medically necessary equipment owned by the beneficiary.
-

### 3. GETTING STARTED

It is recommended that you copy the power point presentations and videos to the hard drive of the computer you will use during the training. You should also read this reference manual to prepare for the training.

---

## 4. PREPARING TO DELIVER THE WHEELCHAIR MAINTENANCE TRAINING PROGRAM

### 4.1 ITEMS TO CONSIDER BEFORE TRAINING WHEELCHAIR USERS

- ▶ The suggested trainer to participant maximum ratio is 1:3-4 or 2:6-8 trainers per wheelchair users. This is particularly important for the hands-on activities, so that the trainer can provide the appropriate assistance and feedback.
- ▶ Be prepared to accommodate impaired hand function among wheelchair users.
  - Have large foam grips available for wheelchair users to use.
- ▶ The trainer must be aware of local maintenance resources, such as:
  - Local places where wheelchairs can be maintained
  - Specific maintenance needs for locally available wheelchairs
  - Wheelchair maintenance services and costs provided by local wheelchair vendors or any local vendors, such as bicycle shops.
- ▶ The following can help you answer some of the items above and to compile a comprehensive list of local resources:
  1. Please identify the local resources that you would recommend to your client for expert technical assistance if he or she were in need of a wheelchair or an expert maintenance intervention. Please list the name, telephone number, address, and website (if available):



Name	Telephone	Address	Services provided	Website

- ▶ Share this list with your participants.

#### 4.2 ITEMS NEEDED FOR TRAINING

The following are needed for training manual wheelchair users and power wheelchair users:

- ▶ Lecture area of an estimated size of at least 300 sqft for 8 wheelchair user without attendant.
  - ▶ As an example, a conference room where tables can be moved around has been used successfully in the past.
- ▶ Accessible tables or desks for participants to take notes.
- ▶ Room must include enough space to allow for group activities (including room to complete wheelchair maintenance activities)
  - ▶ Consider that participants may come with their caregivers
- ▶ All areas, including bathrooms, must be wheelchair accessible
- ▶ Projector/projector screen

- ▶ Ability to play a DVD
- ▶ Name tags for participants, caregivers (if applicable), and trainer
- ▶ “How to Care for a Wheelchair at Home” DVD (manual or power wheelchair)
- ▶ Wheelchair Maintenance Training PowerPoint slides
- ▶ Wheelchair maintenance cards (one set per participant)
- ▶ Tools
  - ▶ Home maintenance toolkit (one per participant)
  - ▶ At least one pump or compressor
  - ▶ Extra patch kit to teach patching a tire (one per every 2 participants)
  - ▶ Foam grip to accommodate grip weaknesses
- ▶ Cleaning supplies
  - ▶ One rag per participant
  - ▶ One bucket with water and mild soap for every two participants
- ▶ Cushions:
  - ▶ Foam: ideally with signs of wear such as cracks or foam chipping.
  - ▶ Air: ideally with a leak in valve and/or underinflated
  - ▶ Gel: ideally with hard gel or leaking gel
  - ▶ Protector cushion (e.g jay protector cushion)

The following are needed for manual wheelchair users training only:

- ▶ One rigid frame manual wheelchair
  1. Rigid back support with loose hardware
  2. Foldable backrest
  3. Rigid seat base (if possible)
- ▶ One folding frame manual wheelchair
  4. Loose swing away foot support
  5. Stretched upholstery

*The following features could be on either of the above manual wheelchairs:*

6. Loose clothing guard
7. Worn out tires
8. Flat tire
9. Wheels with loose spokes
10. Loose wheel lock
11. Caster float
12. Caster with damaged bearing
13. Anti-tippers
14. Worn out armrest, examples:
  - a. Loose
  - b. Padding wore out
15. Quick release wheels
16. Casters with hair/lint
17. Wheel with loose spokes
18. Wheel with loose handrim

The following are needed for power wheelchair users training only:

- ▶ Power wheelchair with:
  1. At least one power seat function
  2. Loose or worn out head support
  3. Loose or worn out arm support
  4. Loose or worn out foot support
  5. Damaged back support, examples:
    - a. Worn out fabric
    - b. Crack in the back support
    - c. Loose back posts
    - d. Loose hardware
  6. At least one of these postural supports:
    - a. Pomel

- b. Thigh guide
  - c. Hip guide
  - d. Trunk/lateral support
7. Loose/misplaced plastic shrouds
  8. Worn out seat belt, examples:
    - a. Fraying fabric
    - b. Non-functional latch
  9. Worn out tire or a wore out tire by itself
  10. Pneumatic tire (if possible)
  11. Caster flutter
  12. Anti-tippers

▶ Additional tools:

1. Gallon plastic bag
2. 1 bag Zip ties
3. 1 erasable marker per every two participants.

#### 4.3 ITEMS TO CONSIDER DURING TRAINING

- ▶ Wheelchair Maintenance Training PowerPoint slides:
  - ▶ Note that the key points are written on the slides.
  - ▶ Trainers should provide the information given next to each slide in this Reference Manual to make sure that every point is covered.
- ▶ Observe closely the progress of each participant. The best opportunity is during the hands-on sessions.
- ▶ Monitor the individuals or groups according to the activity. Answer any questions and assist with maintenance identification and performance as needed. Some individuals will be better at this than others, depending on their technical experience.

#### 4.4 GOOD PRACTICE TRAINING TIPS

- ▶ Read each session plan carefully before training starts.
- ▶ Use the notes in the power point or have this manual while presenting to cue you to highlight the important points.
- ▶ Make sure you are confident with the material you are delivering.
- ▶ Gather training resources and prepare the training room.
- ▶ Speak clearly and calmly.
- ▶ Prepare examples that involve different types of wheelchairs.
- ▶ Ask questions to check that you have been understood.
- ▶ Repeat important points to reinforce them.
- ▶ Observe hands-on activities closely and give help if needed.
- ▶ Ensure that you circulate between the small groups and check the progress of each.
- ▶ Encourage everyone to speak; do not let one participant dominate.
- ▶ Praise good work from participants and give positive feedback.
- ▶ Let participants know they can ask questions any time.
- ▶ Think about the needs of any participants with visual or hearing difficulties. Some activities and teaching approaches may need to be adapted accordingly.

## 5. DETAILED PRESENTATION PLANS

Choose the appropriate power point presentation and video depending on your audience. If your participants are manual wheelchair users, use the file "Manual Wheelchair User Maintenance Training.pptx" and "manualwheelmaintenance.wmv". If your participants are power wheelchair users, use the file "Power Wheelchair User Maintenance Training.pptx" and "powerwheelchairmaintenance.wmv".

Words in **bold** are actions for the trainers (for example: **ask**, **demonstrate**, **explain**, **show DVD**).

Do not forget to fill in the second slide with the appropriate times that are applicable to the training session.

### 5.1 MANUAL WHEELCHAIR MAINTENANCE

#### 1. Introduction (5 minutes)

- ▶ **Welcome** the wheelchair users and thank them for participating in this training program.
- ▶ **Introduce** yourself and your co-trainer if you have one.
- ▶ **Ask** participants to introduce themselves.

### Manual Wheelchair Maintenance Training



Version 2014-07-23

This training material was supported by the U.S. Department of Health and Human Services, National Institute on Disability Independent Living and Rehabilitation Research (H133A120004). The contents of this manual are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. Department Health and Human Services.

- ▶ **Fill** in the slide with the appropriate times that are applicable to the training session.

**Explain:**

- ▶ This is an interactive learning approach to training.
- ▶ Today, we will watch a video, have a presentation and show examples of how to do maintenance.
- ▶ In the next session we will do hands-on practice either on your wheelchair or on a demo wheelchair.

**Wheelchair maintenance training agenda for the next two days.**

Day	Duration (minutes)	Time	Activity
1	5		Introduction
	15		Objectives and relevance
	5		How to take care of a wheelchair at home DVD
	60		Caring for a wheelchair at home
	5		Summary
2	90		Hands-on wheelchair maintenance activity
	20		Summary and discussion
	5		Adjournment

- ▶ **Remind the participants of the date and time for the next session’s class.**
- ▶ **Emphasize that participants are free to ask questions at any time.**

- ▶ Before starting **read** the slide.

We will teach you how to identify problems and how to do basic maintenance.

These two sessions are **not** intended to be a wheelchair repair clinic.

**Gather:**

- ▶ Maintenance cards.
- ▶ Toolkit.

**Emphasize:**

- ▶ We are going to use research evidence to provide motivation as to why people should perform more regular maintenance.

**Explain while demonstrating:**

**Interactive wheelchair maintenance training experience with take home resources and reminders.**

- ▶ At the end of the second training session you can take home both the maintenance cards for future reference and the toolkit.

**Explain:**

- ▶ You will also receive reminders during the next year to perform maintenance.
- ▶ We will talk about the reminders in detail later today.

**2. Objectives and relevance (15 minutes)**

- ▶ **Read the learning objectives**
- ▶ **Click to highlight the first two objectives.**
- ▶ **Explain: our goal is to accomplish the first two objectives today and the last two objectives in the second session.**

**Learning objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks
- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

**Learning objectives**

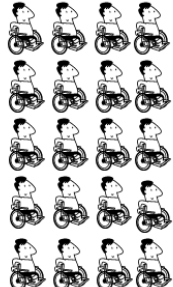
- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks

- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

**Explain:**

- ▶ Between 5 and 18% of wheelchair users in the community experience wheelchair-related injuries each year.

**Injuries occur more frequently when wheelchairs are not maintained or repaired.**

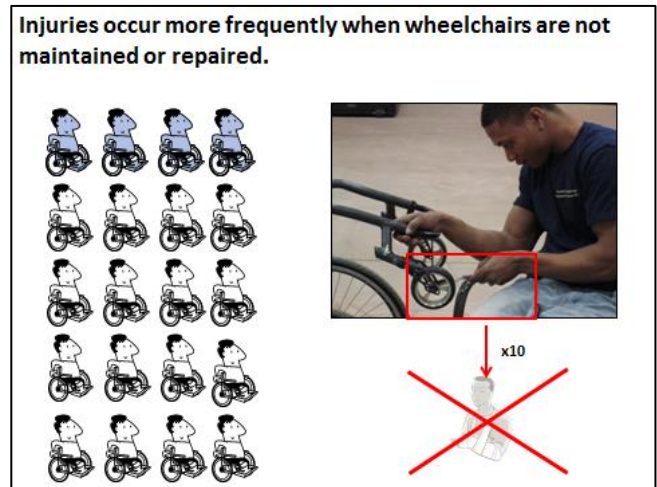




**Click so 4 images are highlighted**

**Explain:**

- ▶ This means, of every 20 wheelchair users, between one to four wheelchair users will experience a wheelchair-related injury.
- ▶ Causes of wheelchair-related injuries include tipping over and wheelchair malfunction among others.
- ▶ In fact, wheelchairs that are poorly maintained increase the risk of their users being injured due to a wheelchair breakdown.
- ▶ Wheelchair users who maintain their wheelchair are 10 times less likely to sustain an injury than those who do not maintain it.



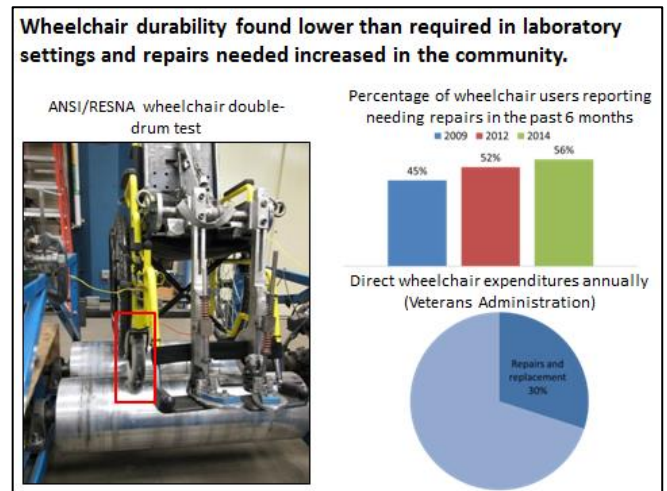
**Explain:**

- ▶ It is concerning that the majority of wheelchairs available in the US have been found non-compliant to minimum ANSI/RESA Wheelchair durability standards.
- ▶ This means that many wheelchairs are of lower quality than the expected standards.
- ▶ The image on the left shows an example of durability testing in a laboratory setting. The wheelchair is located on a double-drum device that simulates rolling, much like how cars are tested. The wheelchair is expected to last at least 200,000 cycles which are equivalent to 3-5 years of wheelchair use.
- ▶ The wheelchair right caster wheel is broken and shows an example of wheelchair breakdown.



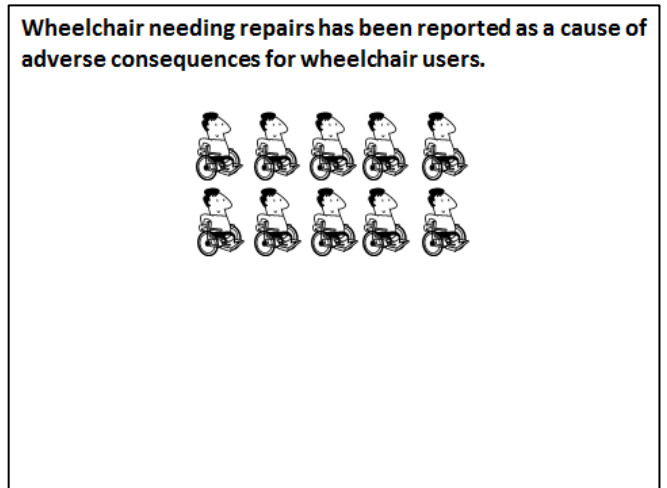
**Click to appear the bar chart and pie chart and explain:**

- ▶ Research has shown that the number of wheelchair breakdowns reported by wheelchair users in the US has been increasing over time.
- ▶ From 45% of wheelchair users in 2009 to 56% in 2014.
- ▶ These is concerning because breakdowns increase the cost to the health care system. In fact, repairs and replacement costs account for 30% of the direct wheelchair expenditures annually (VA National Prosthetics Patient Database).



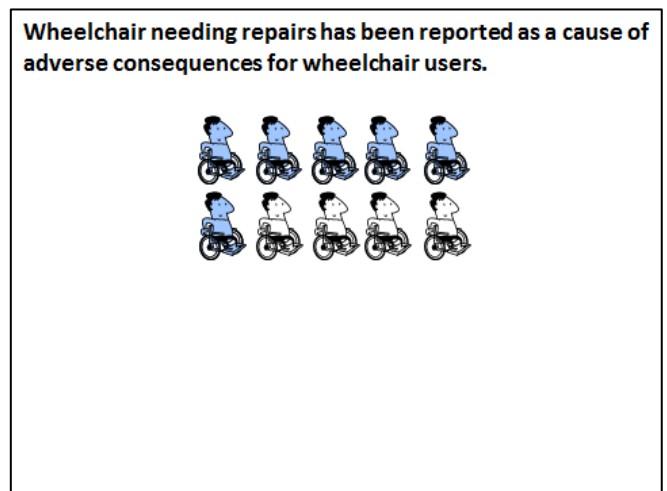
**Explain:**

- ▶ Research has shown that approximately 60% of wheelchair users have reported a needing a wheelchair repair in the previous 6 months.



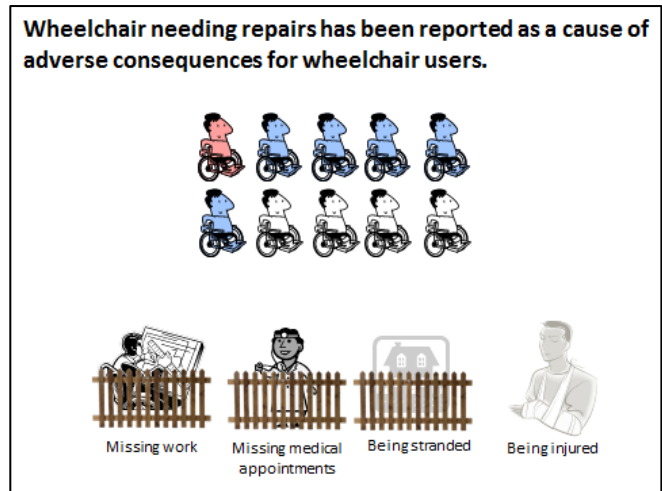
**Click to highlight this proportion and explain:**

- ▶ This means 6 out of every 10 wheelchair users.



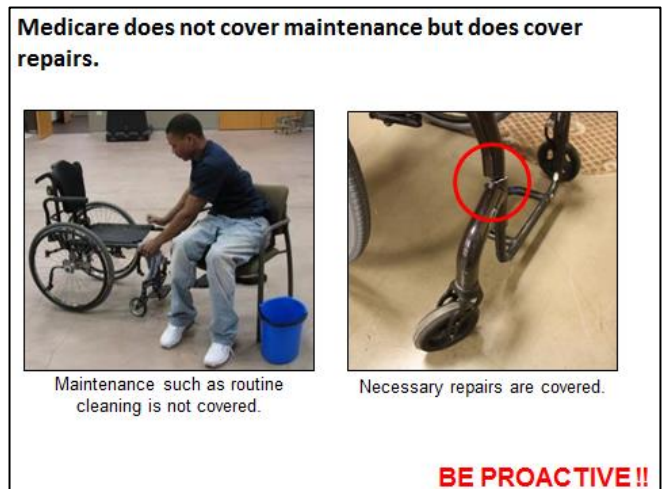
**Click to appear next images on the slide and explain:**

- ▶ In addition, one of these 6 wheelchair users that needed repairs, which represents approximately 23% of the 6 wheelchair users will have suffered an adverse consequence such as missing a medical appointment, missing work or school, or being stranded or injured, due to the need for a wheelchair repair.



**Explain:**

- ▶ Because most of the wheelchairs in the US are provided through health insurance, it is important to understand how health insurance relates to wheelchair maintenance and repairs.
- ▶ In the US, many health insurance policies follow Medicare's coverage.
- ▶ Routine periodic servicing, such as testing, cleaning, regulating, and checking of the beneficiary's equipment, is not covered.
- ▶ Therefore, unless a specific maintenance task is specified by the manufacturer as required to be done by a technician, maintenance is not covered and considered the user's responsibility.
- ▶ But, repairs are covered when necessary to make the equipment usable.
- ▶ Remember, maintenance issues lead to injuries and can be avoided.
- ▶ Currently insurance coverage does not address them until they become a repairable item (which may be after injury!).
- ▶ Thus, this maintenance training should help avoid these injuries.



**Ask participants:**

- ▶ Raise your hand if you know how to contact a wheelchair maintenance expert.

**Acknowledge the number of people who raised their hand.**

**Explain:**

- ▶ A wheelchair maintenance expert can include the wheelchair vendor, a wheelchair clinic, a wheelchair technician or a wheelchair supplier.
- ▶ It is important to be proactive! Call your wheelchair maintenance expert right away when you identify problems.
- ▶ If the wheelchair maintenance expert is not compliant, contact your local wheelchair clinic.
- ▶ They can advocate for you or help you get assessed for a more functional wheelchair.
- ▶ We strongly encourage you to learn from the wheelchair maintenance expert when they repair your wheelchair. This may teach you further repair skills than what is taught in this basic maintenance course.

**Explain:**

- ▶ All wheelchairs require periodic maintenance to operate properly. Examples include cleaning the caster axles.
- ▶ Some wheelchair parts require periodic repair and replacement.
- ▶ Repair and replacement of components can extend the life of the wheelchair and make using it much easier. Examples include patching a flat tire.
- ▶ Much like a car, if a wheelchair is not properly maintained, it can become more difficult to operate, and it will not perform as well as when it was new.

**Emphasize:**

- ▶ Active wheelchair check-ups are likely to reduce adverse events related to wheelchair breakdowns.

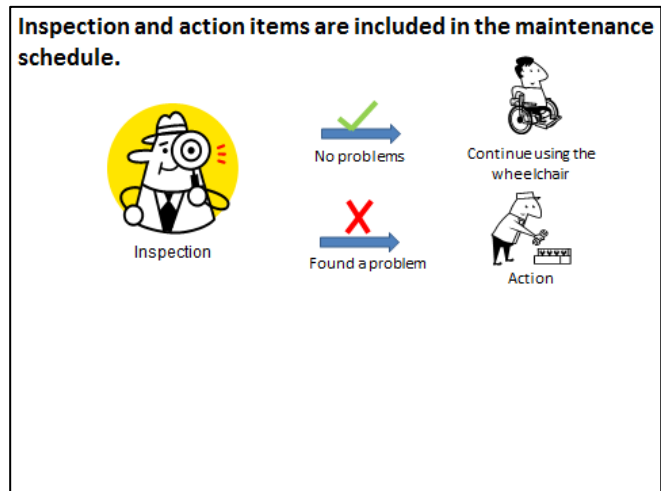


**Gather:**

- ▶ Wheelchair and damp rag.

**Explain:**

- ▶ Today we are going to go in detail over the proposed maintenance schedule. The schedule includes inspection and action items.
- ▶ You will inspect the wheelchair components to check their integrity and proper function. When problems are identified during the inspection they are followed by an action item.



**Demonstrate on the wheelchair while explaining:**

- ▶ An example of an inspection item is to check that the weld points on the frame are intact.

**Click to appear next images on the slide and explain:**

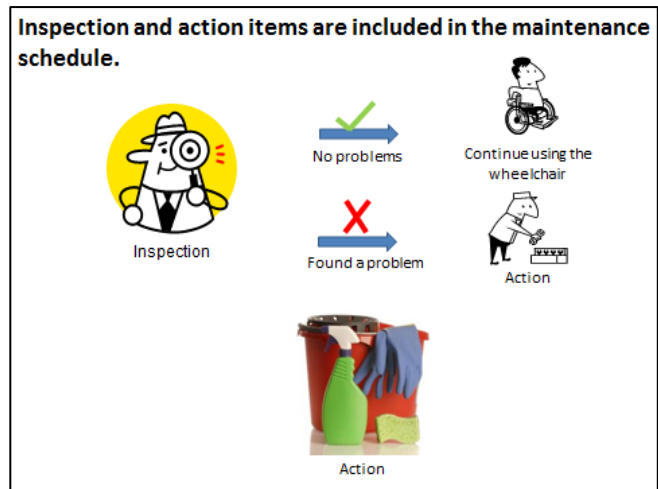
- ▶ In addition, action items are activities that are performed on the wheelchair.

**Demonstrate on the wheelchair while explaining:**

- ▶ An example of an action item is to wipe down the wheelchair frame.

**Explain:**

- ▶ Another way of understanding the difference between inspection and action is an inspection is looking for a problem and an action is trying to fix the problem. For example, an inspection item for your car is to check the gas level and an action item is to fill it up with gas if the level is close to empty.



**Gather:**

- ▶ Toolkit and bolt board (detailed board information on .

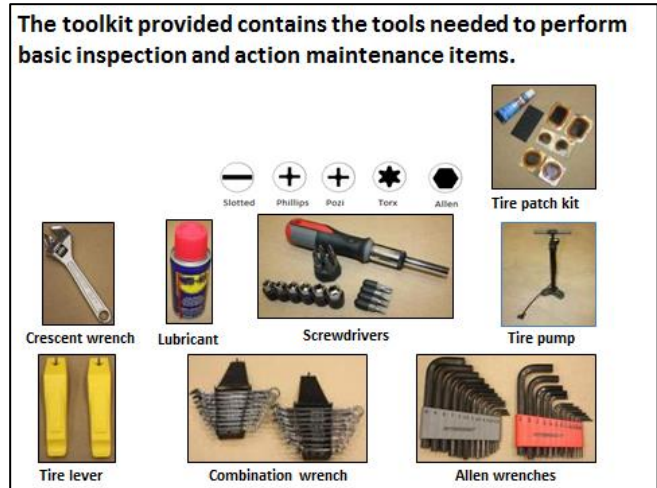
**Explain:**

- ▶ As mentioned at the beginning, each one of you is receiving a toolkit that has basic tools for maintenance.

- ▶ The toolkit has the following tools:

Invite participants to open the toolkit and identify the tools that you are naming.

Show each tool from one of the toolkits as you explain them and demonstrate on the bolt board while you explain each tool:



- ▶ Screwdriver: is a tool for turning screws. Always use a screwdriver tip that properly fits the slot of the screw. Your toolkit has a multi bit screwdriver with different tips that will fit the slots of the screws that we see on the slide.
- ▶ Allen wrench: is a tool for turning screws that have a hexagonal socket in the head (point to image on slide). Always use the correct size needed for the job, as using an Allen wrench on a socket that is too large may result in rounding the socket. Which means that the Allen wrench in the future would not be able to grab a hold of the socket. You have in your toolkit both standard and metric Allen wrenches.
- ▶ Open-end box-end wrench combination tool or Crescent wrench: are tools to turn nuts and bolts or keep them from turning while tightening them. Be sure to use the proper size wrench, and only use adjustable wrenches when you do not have the proper size. An adjustable wrench may cause bolts or nuts to round off if not used correctly.
- ▶ Plastic tire lever: Use to remove a pneumatic tire. We will see how to use this later in this session.
- ▶ Tire patch kit: used to patch a flat inner tube. It contains a scratching tool, glue, and patches. We will see later how to use it.

- ▶ Tire pump and gauge: A foot pump, compressor or high pressure hand pump is necessary to inflate tires over 50psi. Tires can also be filled using gas station airlines, but a valve adaptor may need to be used. Emphasize: the pump is not provided with this toolkit.
- ▶ WD40: lubricates and protects against corrosion. It also removes grease, gum, dirt, & scuff marks.

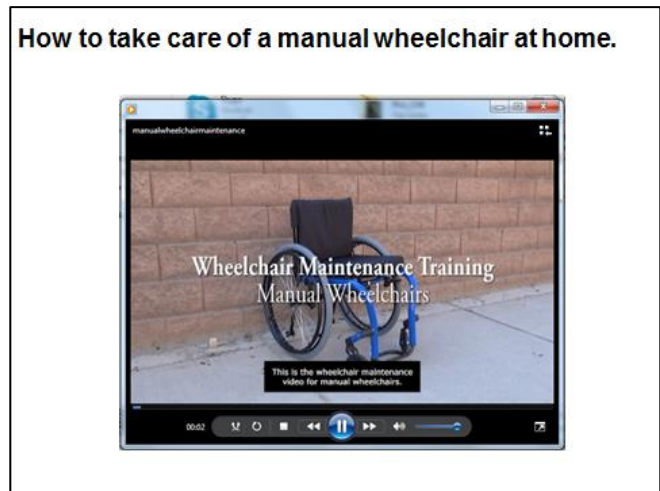
**Show the maintenance cards and you explain:**

- ▶ In addition, in the tool case, you will have a set of maintenance cards that you can use to remind you of the maintenance tasks and how often to perform them. We encourage you to store the maintenance cards with the toolkit.

**3. How to take care of a wheelchair at home DVD (5 minutes)**

**Explain:**

- ▶ We are going to watch a video that summarizes all the inspection and action items that we are going to learn today and practicing in the next session.
- ▶ **Play the file**  
**manualwheelchairmaintenance.wmv**



**4. Caring for a wheelchair at home (60 minutes)**

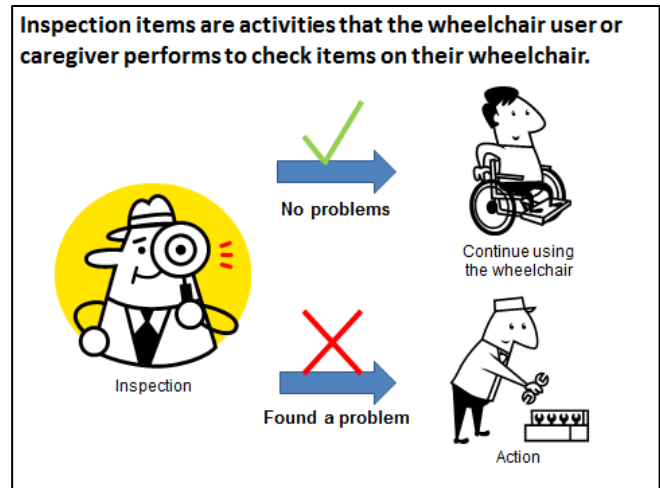
**Explain:**

- ▶ Before starting, remember, when transferring out of the wheelchair to do maintenance, always sit on a stable and protected surface.
- ▶ In the example image in the slide, the person is sitting on his own cushion on a stable chair while pumping a tire.



**Explain:**

- ▶ Now we are going to go over in detail each maintenance activity.
- ▶ We will start with the inspection items.
- ▶ You will inspect the wheelchair components to check their integrity and proper function.
- ▶ When problems are identified during the inspection they are followed by an action item.



**Read the summary of the inspection items and explain:**

- ▶ We will go over in detail on how to complete each inspection item and what to do if problems are identified.
- ▶ Orange highlights the inspections that are done weekly.
- ▶ The rest are done monthly.

**Some inspections should be done weekly, though most should be done monthly.**

Nuts and bolts	Rear wheels	Tire
		Bearings
	Casters	Spokes
		Alignment
		Quick-release mechanism
		Locks
		Handrim
	Cushion	Bearings
		Anti-tip
	Supports	Cover
		Arm
		Foot
		Back
		Upholstery
	Frame	Clothing guard
		Welds
		Cross-brace
		Suspension

Legend: ■ Weekly inspections

**Read the slide.**



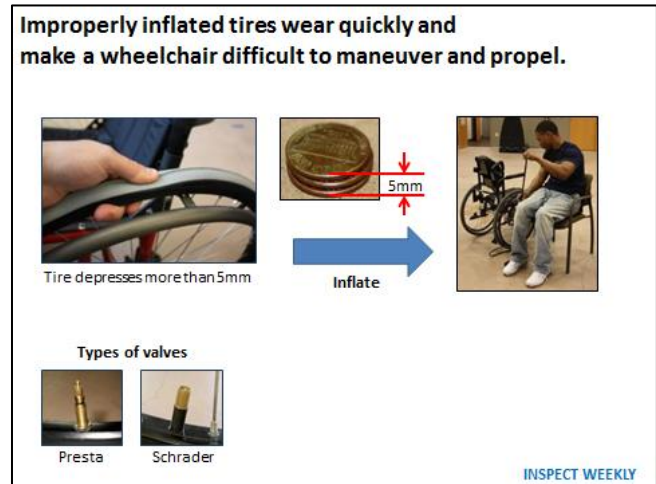


**Gather:**

- ▶ Wheelchair with flat tire and a tire pump.
- ▶ You can have adaptor valves for participants to try.

**Explain:**

- ▶ If you have pneumatic tires, properly inflated tires are important for wheelchair propulsion.
- ▶ If the tire lacks sufficient pressure, the wheelchair will be difficult to maneuver, propulsion will take more energy and it will stress the shoulders more.
- ▶ The tire and wheel will also wear much more quickly when the tire is not properly inflated.

**Demonstrate propelling with a flat/underinflated tire.****Demonstrate how to inspect while explaining:**

- ▶ Check the pressure by pressing down firmly on the tire with your thumb.
- ▶ If the tire presses down more than 5mm (roughly the thickness of three pennies stacked together), the tire needs to be inflated.
- ▶ Add air to the tire using a bike pump, compressor, or CO<sub>2</sub> cartridge.
- ▶ We recommend checking the tire pneumatic pressure weekly and to check it more often during winter.

**Emphasize:**

- ▶ **Do not use a gas station air hose. Wheelchair tires have very small volume and it is very easy to explode a tire.**
- ▶ **Point out the type of valve that the demonstration wheelchair has while explaining: There are two types of valves used for pneumatic tires on wheelchairs: *presta valves* and *schrader valves*. Make sure your air pump has the correct type of valve for your wheelchair.**

**Ask:**

- ▶ How much should you inflate the tire?

**Acknowledge answers**

Click to show the next pictures on the slide and explain:

- ▶ It is recommended to inflate to pressure indicated on tire. **Demonstrate pumping the tire, mention the suggested pressure on the tire and inflate.**



**Discuss:**

- ▶ People's answers may be variable depending on type of tire (e.g. "road" vs "mountain" and size) and ride preference ("comfort" at low pressure, "performance" at higher pressure).

**Ask:**

- ▶ How often should you check the tire pressure?

**Acknowledge answers**

Click to appear the recommended frequency and explain: We recommend checking the tire pneumatic pressure weekly and to check it more often during winter.

**Gather:**

- ▶ Different type of cushions, e.g. foam, gel, air, etc.

**Explain:**

- ▶ Cushions are a very important component of the wheelchair and do not last as long as the frame.
- ▶ The interaction between the cushion and the body determines the user's comfort, function, and clinical safety.



- ▶ Deterioration in the cushion can increase the risk of developing a pressure ulcer.

**Explain while demonstrating:**

- ▶ Remove the cover so you can inspect both cushion and cover.
- ▶ That means that you must be out of the wheelchair.
- ▶ Look for tears or holes in the cover or zipper malfunction, which might expose the cushion surface or create a wrinkled sitting surface.
- ▶ The cushion cover on the top right of the slide has a hole.
- ▶ If the cover contains a foam liner, look for tears or flaking in the foam.
- ▶ The cushion on the bottom right has flaking in the foam liner of the cover.
- ▶ The bottom of most covers has a Velcro or a nonskid surface.
- ▶ Inspect this surface for worn or torn Velcro or breakdown of the nonskid material.
- ▶ The cover is designed to protect the cushion, so it should be replaced if damaged.
- ▶ After inspecting the cover inspect the cushion for shape and contour.

**Explain:**

- ▶ There are many types of cushions.
- ▶ Depending of the type there are signs you should look for.
- ▶ We are going to discuss some examples.

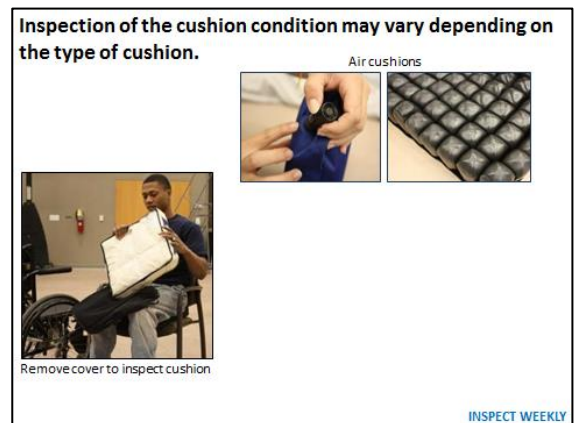
**Explain while demonstration (if you have that type of cushion available):**

- ▶ Keep air cushions properly inflated.
- ▶ Inspect that the valve is in good condition and does not leak.
- ▶ If you suspect that there is a leak, remove the cover and submerge the cushion in water and look for bubbles.
- ▶ A rubber air cushion (e.g. ROHO) can be patched using the same procedure we saw for patching a tire.

**Ask:**

- ▶ Those of you who are using ROHO’S, do you have the patching kits that came with the cushion?

**Acknowledge answers.**



**Emphasize:**

- ▶ When you travel by air pay special attention to the cushion because the pressure will change.
- ▶ Always travel with a patch kit.

**Click to appear the next images on the slide and explain:**

- ▶ If you have a gel cushion, knead the gel daily from the outer perimeter to the middle of the cushion.
- ▶ Inspect that the gel is not hard and that there are no leaks.
- ▶ An example of a worn out cushion can be seen on the left with the blue gel that is leaking.

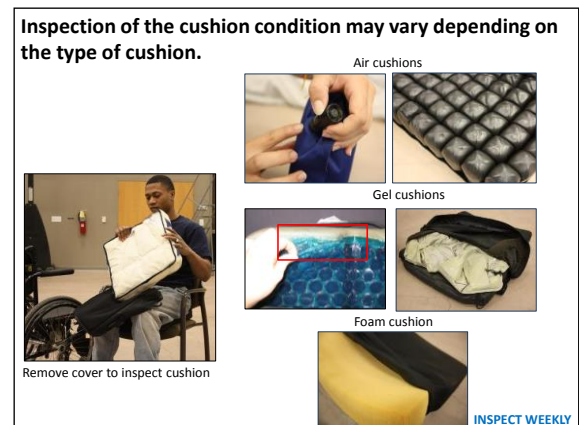


**Click to appear the next image on the slide and explain:**

- ▶ If you have a foam cushion, inspect that the foam is intact and not deteriorated and chipping.
- ▶ When you press it, it should bounce back.

**Explain:**

- ▶ If the cushion has a solid seat insert, check that it is not broken.



**Emphasize and show on the cushion you are holding:**

- ▶ Be aware of the direction of the cushion.
- ▶ After inspecting, place the cushion properly back on the wheelchair.

**Explain:**

- ▶ This task should be performed **weekly** and if problems are identified a wheelchair maintenance expert must be contacted immediately to get the cushion replaced. If a cushion is not replaced it may lead to unwanted consequences such as pressure sores.

Read the slide.

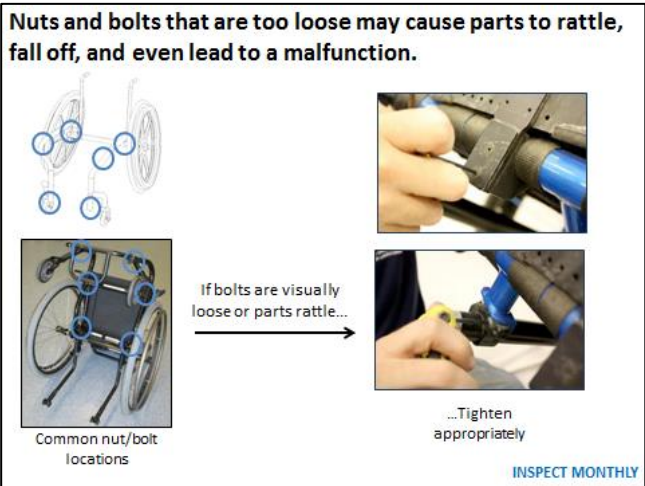


Gather:

- ▶ Wheelchair with loose clothing guard.
- ▶ Show examples of bolts and tools to use to tighten.
- ▶ Show an example of a lock nut.

Explain:

- ▶ Most maintenance consists of ensuring that nuts and bolts are properly adjusted.
- ▶ Inspecting nuts and bolts should be done while you inspect different parts as we will see throughout the presentation.



- ▶ Nuts and bolts that are too loose will loosen further or not hold the part properly.

Demonstrate while describing:

- ▶ Visually identify loose bolts.
- ▶ Move parts and check that they do not rattle.
- ▶ Tighten all loose nuts and bolts until snug.
- ▶ Depending on the bolt, you can use a screwdriver, wrench or Allen wrench.
- ▶ Tighten to the point where the parts that the nuts and bolts are holding do not move at all.
- ▶ Do not over tighten!
  - Clamps are meant to be very tight. Tighten as much as reasonably possible with the appropriate tool.

- Moving parts, such as the wheel lock mechanism, should be snug but not particularly tight. These often use locknuts.

- ▶ Over tightening a loose nut or bolt could damage the part and/or bolt.
- ▶ Bolts are graded for strength and hardness.
- ▶ The specific grade is selected by the manufacturer for the part where the bolt is to be used. Bolts used on wheelchairs must be replaced with the proper size and type bolt.

**Emphasize:**

- ▶ If nuts or bolts are missing, stripped or broken, contact a wheelchair maintenance expert to get the bolts/nuts replaced.
- ▶ All nuts and bolts should be inspected monthly.

**Gather:**

- ▶ A wheelchair with worn out tires.

**Explain:**

- ▶ The wheels have a significant effect on the performance of the wheelchair.
- ▶ Worn out tires can make the wheelchair harder to propel.

**Explain while indicating what type of tire you have in your sample wheelchair:**

- ▶ Rear tires can be pneumatic tires or solid.
- ▶ You can determine what type of tire you have by looking at the rim where the air valve sticks out. If there is no valve your tire is solid. If there is a valve you have a pneumatic tire.

**Demonstrate while explaining:**

- ▶ Visually inspect the rear tires for wear, cracks, bulges, looseness, damage, and flat spots. Note in the lower right picture the green arrow points to intact thread and the red arrow points to worn out threads.
- ▶ Contact a wheelchair maintenance expert to replace tires when the tread becomes worn, cracked, loose or when the side walls begin to bulge out when pumped with air.



- ▶ Emphasize: In solid tires, it can be hard to see a flat spot on the tire. Usually, you will feel it when rolling on a flat and smooth surface.

**Ask:**

- ▶ How often show this inspection be performed?

**Acknowledge participants answers.**

**Answer:**

- ▶ This task should be performed at least monthly.

**Ask: From your experience, how often do you usually get your tires replaced?**

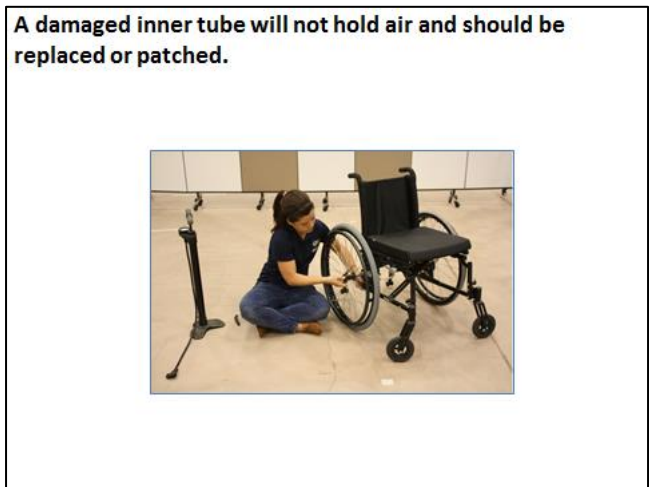
**Acknowledge answers**

**Gather:**

- ▶ A wheelchair with a flat tire.

**Explain:**

- ▶ If you pump your tire and it goes flat right away you may have a hole in the tube.
- ▶ Show participants the levers and patches from one of the toolkits and explain:
  - You can patch it with the patch kit in your toolkit or replace the inner tube for a new one.
  - You will need two plastic tire levers to remove the tube.



**Click to appear the animated image and explain while animation runs:**

1. Release the air left in the tube
2. Release the wheel and place on a flat, level surface.
3. Pry off the tire with the plastic tire lever by bending back slightly the edge of the tire where it meets the rim
4. Use the second tire lever to loosen the tire from the rim
5. Pull out the inner tube, starting with the section opposite the valves and ending with carefully removing the valve last.

6. You will either patch or replace the tube.
7. Take the tube and place the inner side into the rim trench of the wheel, starting by carefully placing the valve through the hole on the rim.
  - Tip: Inflating the tube a little makes it easier to put on.
8. Stretch the tube around the rim.
  - Tip: A little liquid dish soap can make it easier to put a tire on.
9. Let all the air out before fully inflating to help remove the kinks.
10. Pump the tube to the required pressure.

**Explain:**

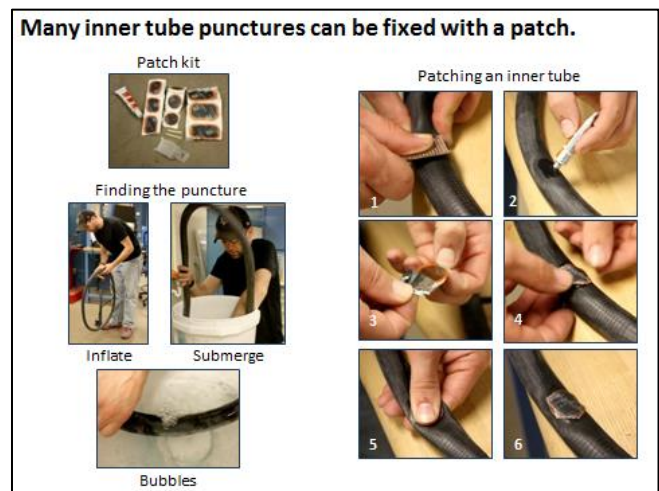
- ▶ Next session during the hands-on activity we will practice.

**Gather:**

- ▶ Flat inner tube, patch kit, pump, permanent marker bucket with water.
- ▶ **Show the materials as you explain:** To patch the tube you will need a bucket partially full of water and the tire patch kit.

**Demonstrate as you describe the steps:**

1. After removing the inner tube, to identify where you have the puncture by pumping up the tube until full and submerge the tube underwater.
2. The part of the tube that bubbles is where the hole is located.
3. Mark the position of the hole with a pen or marker.
4. Dry off the tube and gently scratch the area around the hole with the scratching tool.
5. Apply the glue all around the area of the hole
6. Affix the patch.
7. Press down on the patch firmly for about a minute to make sure it stays on.
8. Put the tube back into the tire.



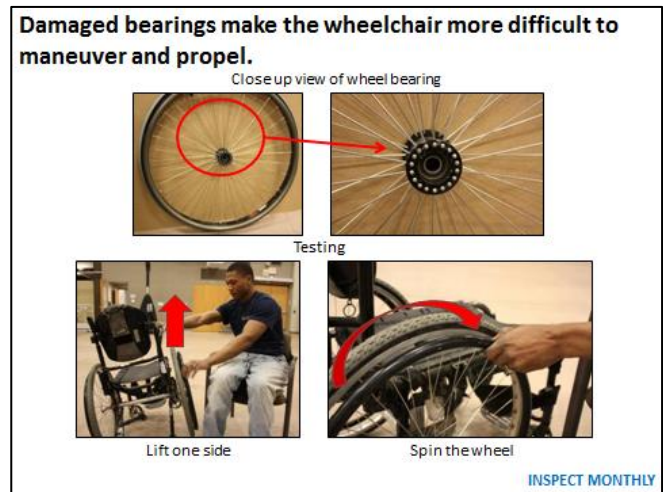


**Gather:**

- ▶ Damage bearing or caster with a damaged bearing.

**Explain:**

- ▶ The wheel bearings allow for free rotation of the wheel around the wheel axis.
- ▶ Therefore, damaged bearings can increase rolling resistance which will make you spend more energy and stress your shoulders more while propelling.
- ▶ Bearings will wear out on a wheelchair during normal use.
- ▶ Noise is the first thing that will alert you about a wheel bearing that is failing.
- ▶ Most prominently, a knocking noise, and on some occasions, a squeaky squealing moan is what would be the first indicator of such a problem.
- ▶ Initially, the sound would be heard only at certain speeds, but will become fairly regular and prominent as the condition of the bearings worsen.



**Pass around the broken bearing example.**

**Demonstrate while describing:**

- ▶ Inspect that the bearings are working properly.
- ▶ Lift one side of the wheelchair off the ground, and spin the wheel, letting it rotate to a stop.
- ▶ If the wheel slows and stops quickly when spun, the nut and bolt holding the bearing could be too tight.
- ▶ If the wheel slows and rotates backwards slightly when spun, the bearing is not being compressed and it could be too loose.
- ▶ Repeat the same procedure with the other wheel.

**Emphasize:**

- ▶ If problems are identified, contact a wheelchair maintenance expert to get the bearings replaced.

**Recommend:**

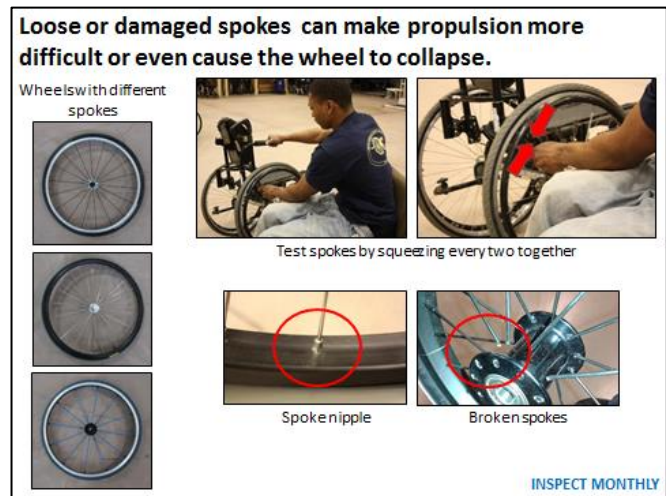
- ▶ This inspection should be performed monthly.

**Gather:**

- ▶ Wheel with a loose spoke.

**Explain:**

- ▶ Through use, spokes can become loosened, damaged, or broken.
- ▶ The spokes should all have equal tension.
- ▶ One loose spoke will cause the others to carry more tension.
- ▶ Ultimately the wheel will go out of true (how much it wobbles from side to side).
- ▶ Spokes have domino effect; if there is only one loose, others will follow it very quickly.
- ▶ Loose spokes can make the wheelchair harder to propel and/or cause the wheel to collapse.
- ▶ If spoke tension is unequal, you may hear a faint, metallic, snapping sound as you move.



**Demonstrate while describing:**

- ▶ Inspect the spokes monthly by squeezing two together all the way around the wheel. **Show the loose spoke.**
- ▶ If a spoke “gives” when you squeeze gently, it may be too loose.
- ▶ Inspect that the spokes are not bent.
- ▶ Inspect that the nipples are tight, not bent or nicked.

**Ask:**

- ▶ What should you do if you find loose spokes?

**Answer:** If problems are identified, contact a wheelchair maintenance expert. It is recommended that you do not do this on your own because spokes must be tensioned to a specific torque range and a special stand is used to do this. Otherwise, spokes or their nipples could break and the wheel could go out of true. A bicycle store/shop is useful to get spokes tightened if you have pneumatic tires. If you have solid tires, you need to contact the wheelchair maintenance expert since a new wheel might be the best solution.

**Gather if possible:** Wheelchair misaligned.

**Explain:**

- ▶ Wheel alignment describes the degree to which the rear wheels are parallel to each other and parallel with the centerline of the wheelchair.
- ▶ Tracking is important as the user pushes on the handrims very frequent about once a second. If the wheelchair does not track well, it will drift from its course between pushes and forces the wheelchair user to push more often with one arm than the other to travel straight.
- ▶ This will increase strain on one arm, waste energy, and reduce control over the wheelchair.



**Demonstrate pushing a misaligned wheelchair while explaining:**

- ▶ Wheelchair users learn how the wheelchair “feels” so they can identify misalignment.
- ▶ The wheelchair should roll straight with no excess drag, pull or side motion.
- ▶ It should not be difficult to push and you should not hear wheel rubbing.
- ▶ When turning, there should be no squeaking, binding, or excessive side motion.

**Explain:**

- ▶ Tracking can be checked by rolling through a puddle of water and allowing the wheelchair to coast.
- ▶ The wheelchair should maintain its direction.
- ▶ If problems are identified, contact a wheelchair maintenance expert.
- ▶ This task should be performed monthly.

**Gather:**

- ▶ Wheelchair with quick release wheel and an example of a quad quick release lever if possible.

**Explain:**

- ▶ Wheel axles can be removable (commonly known as quick-release) or fixed.

**Demonstrate while explaining:**

- ▶ Hold the wheel from the hub and wiggle in all directions.
- ▶ If the wheel is fixed, it should not have play.
- ▶ If the wheel is quick-release some play is acceptable.
- ▶ Check that the quick-release mechanism functions properly.
- ▶ The axles should slide through the wheel housing smoothly and click and latch into place.

**Explain:**

- ▶ Wheels that do not latch securely can come off and lead to an accident.
- ▶ If the axle does not latch properly contact a wheelchair maintenance expert immediately.

**Ask:**

- ▶ How often do you remove the wheels? For example to transfer in/out a car?

**Acknowledge answers.**

**Emphasize:**

- ▶ If you remove the wheels often be aware every time you do so that it is functioning properly.
- ▶ If you do not remove the wheels often this inspection should be performed monthly.



**Gather:**

- ▶ Wheelchair with loose lock.

**Explain:**

- ▶ Wheel locks act as parking brakes and assist when transferring to other surfaces, or when rider wishes to remain in a particular spot.
- ▶ They allow the rider to be more stable when desired, such as when lifting or pushing things or even simply sitting still.
- ▶ There are many different types of wheel locks.



**Demonstrate while describing:**

- ▶ Inspect that the wheel lock is working properly.
  - First inspect that the wheel locks are secured tightly to the frame.
  - Apply the lock and check that it holds the tires firmly in place.
  - Note that they are easily activated and that the wheel locks do not interfere with the tire while rolling.
- ▶ Wheel locks that interfere with normal wheel rolling cause wear to the tire and brake.

**Emphasize:**

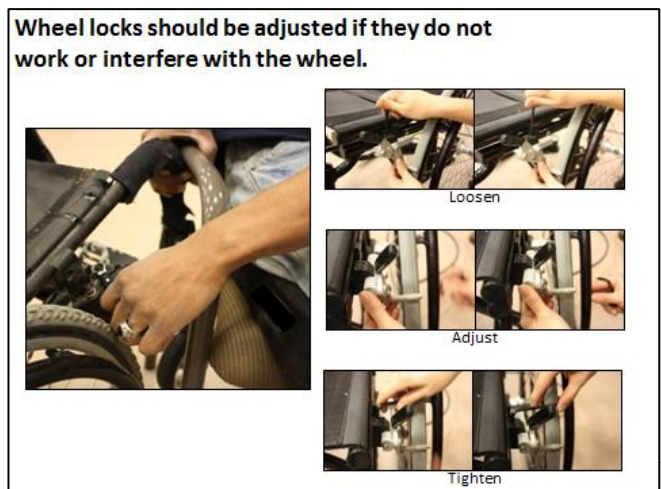
- ▶ If pneumatic, tires must be inflated properly for the brakes to work.
- ▶ This task should be performed monthly.

**Gather:**

- ▶ Allen wrench and open wrench.

**Demonstrate while explaining:**

- ▶ If you find any problem while inspecting the wheel locks:
- ▶ Adjust wheel locks if they are loose or not working properly.



- ▶ Use an open-box wrench and/or Allen wrench to adjust as necessary.
- ▶ If the locks still do not work properly, contact the wheelchair maintenance expert.

**Gather:**

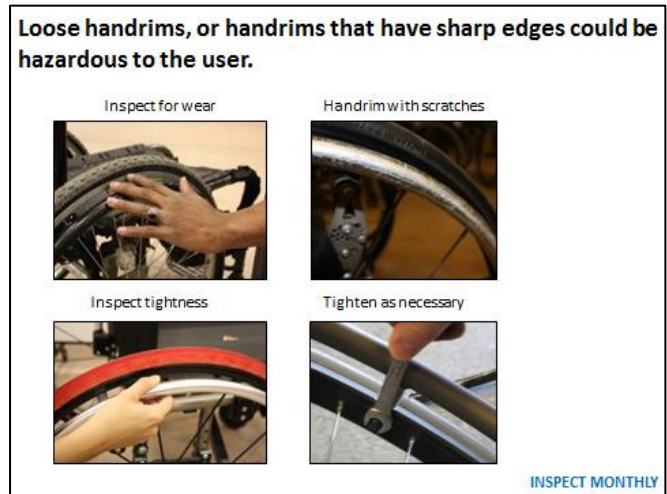
- ▶ Wheel with loose handrim

**Explain:**

- ▶ Handrims are metal or plastic rings that are attached to the rear wheels and used to propel a manual wheelchair.

**Demonstrate while explaining:**

- ▶ Inspect the handrims for wear, dents, or bends.
- ▶ Cracks can cut or harm the user.
- ▶ Contact a wheelchair maintenance expert to have the handrim replaced.



**Demonstrate while explaining:**

- ▶ Inspect if they are loose.
- ▶ You can feel that they are loose while you propel.
- ▶ A loose handrim can make it more difficult to grasp and may fall off.
- ▶ You can tighten the handrim using an open-end wrench or a screwdriver.
- ▶ If unable to do so contact the wheelchair maintenance expert.
- ▶ This inspection should be performed **monthly**.

**Gather:**

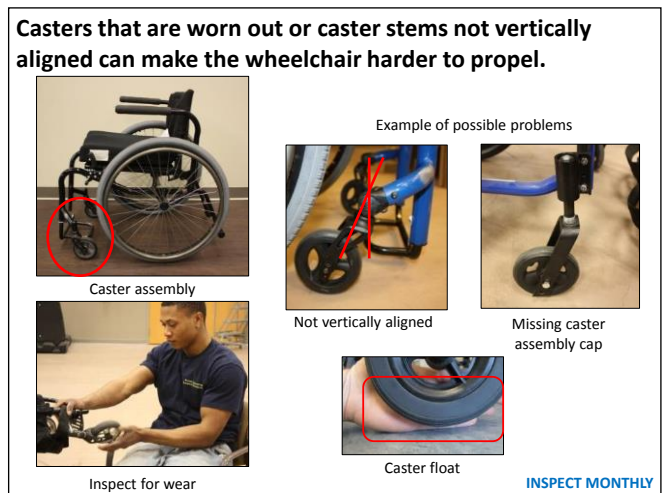
- ▶ Wheelchair with caster float if possible

**Explain:**

- ▶ The caster wheels have an important effect on the performance of the wheelchair.
- ▶ Worn out caster wheels can make the wheelchair harder to propel.

**Demonstrate while describing:**

- ▶ Inspect casters wheels for wear, cracks,



looseness, bulges, and tears.

- ▶ Inspect that the casters wheels are evenly touching the floor when on a flat surface.
- ▶ When one of the casters wheels does not touch the floor while on level ground, the wheelchair has caster float.
- ▶ This decreases the stability and performance of the wheelchair.
- ▶ Inspect that the caster stem housing is aligned vertically.
- ▶ If you find problems contact the wheelchair maintenance expert.
- ▶ Inspect the front caster caps; these caps protect the caster assembly from moisture and water.
- ▶ If they come off, contact the wheelchair maintenance expert.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with damaged caster bearing.

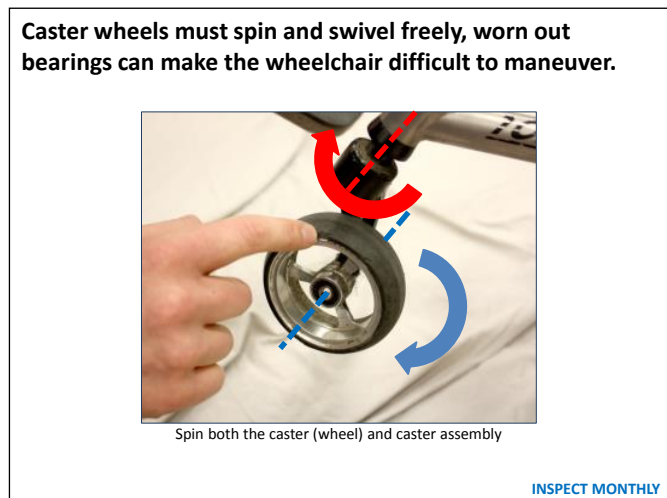
**Explain:**

- ▶ Like in the rear wheels, the caster bearings allow for free rotation of the wheel around the wheel axis.
- ▶ In addition, casters have another bearing that allows for shaft rotation.
- ▶ Bearings will wear out on a wheelchair during normal use.
- ▶ Wore out bearing can make the wheelchair difficult to maneuver.

**Demonstrate while describing:**

- ▶ Inspect the caster bearings by checking that they spin and that they are tight.
- ▶ Spin the caster and the caster assembly.
- ▶ To check caster bearings push the caster side to side.
- ▶ You should feel if there is any grinding.
- ▶ Inspect that there is no excessive play in the caster axle.

**Emphasize:**



- ▶ If problems are identified, contact a wheelchair maintenance expert to get the bearing replaced.
- ▶ Learning how to replace a bearing is out of the scope of this training program. However, we encourage you to learn from the wheelchair maintenance expert how to replace it.
- ▶ We recommend to inspect the bearing monthly.

**Gather:**

- ▶ Wheelchair with anti-tippers.

**Explain:**

- ▶ Anti-tip casters may be used on the front and rear of a wheelchair.
- ▶ When rear anti-tip casters are in use and properly adjusted, if the wheelchair begins to tip over the rear anti-tip casters resist the tipping.
- ▶ Therefore, they can help to prevent some tipping accidents.



**Demonstrate while describing:**

- ▶ Inspect that the pins work, that they can be put on and off, and that the rollers are not broken.
- ▶ If problems are identified, contact the wheelchair maintenance expert to have the anti-tip casters replaced.
- ▶ If anti-tippers are present, inspect them **monthly**.

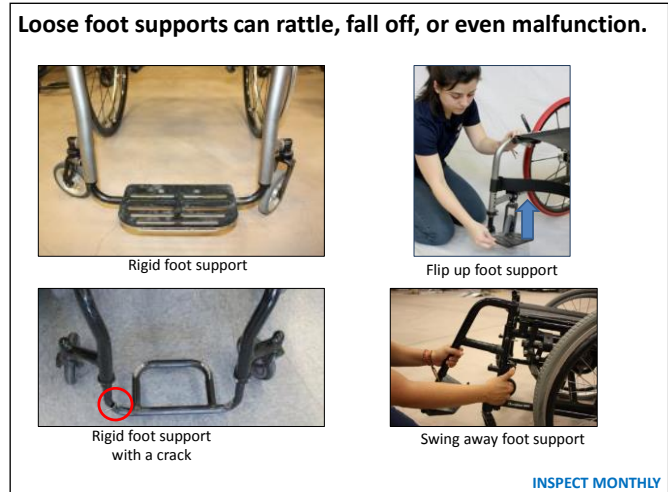


**Gather:**

- ▶ Wheelchair with rigid frame and rigid foot support as well as a wheelchair with loose swing-away foot support.

**Explain:**

- ▶ Foot supports are used to support the feet and legs.
- ▶ Often the foot supports are the first part of the wheelchair to come in contact with an obstacle.
- ▶ They are used to open doors, act as bumpers, and are often scraped along the ground when the wheelchair is loaded into a motor vehicle or during mobility techniques such as wheelies, curb cuts, and sharp inclination changes such as the end of ramps.
- ▶ Cross-brace-frame wheelchairs typically have foot supports that can flip up or down, swivel, are angle-adjustable, or can be removed, whereas rigid-frame wheelchairs have the foot support built into the frame.
- ▶ Rigid foot supports are normally are not removable, but the height often can be slightly adjusted to accommodate various leg lengths.
- ▶ Swing-away foot support are not as durable as rigid foot support.



**Point out the different foot supports in participants’ wheelchairs.**

**Demonstrate while describing:**

- ▶ Inspect that the foot supports are intact, tightened and can be released (if originally designed to do so), put back into place with ease and that they latch properly.
- ▶ Inspect the swing away foot support, look for wear in the pin, bolt and bushing in this mechanism.
- ▶ You can use a screwdriver, wrench or Allen wrench to tighten loose bolts.
- ▶ If problems are identified, contact the wheelchair maintenance expert.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with a damaged armrest, especially loose and/or worn out.

**Explain:**

- ▶ The primary purpose of the arm support is to provide good resting posture for the arms.
- ▶ In addition, arm supports provide a form of support and are convenient handles when the rider leans to one side or the other.
- ▶ They are also helpful when attempting to reach higher places, and they also assist some people with transfers.



**Explain while demonstration with the demo wheelchair and pointing at participants wheelchairs:**

- ▶ Arm supports can be fixed or adjustable.
- ▶ Most can be removed or flipped out of the way in order to provide clearance for transferring in and out of the wheelchair.
- ▶ Removable arm supports usually fit into one or two sockets.
- ▶ Commonly, if there are two attachment points, the front socket contains a latch to lock the armrest in place.
- ▶ Flip back arm supports are hinged at the back near the intersection of the seat and backrest.
- ▶ Some flip back supports use the latch in the front to help secure them in place.

**Demonstrate while describing:**

- ▶ Inspect that the arm supports are intact, tightened and can be released (if originally designed to do so), put back into place with ease, and latch easily.
- ▶ Inspect for sharp edges that could cause harm.
- ▶ Loose arm supports can make the user fall when using them for support during transfers.
- ▶ Tighten as necessary.
- ▶ If a problem is identified, contact the wheelchair maintenance expert.
- ▶ This inspection should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with stretched upholstery and/or wheelchair with rigid back support with loose hardware.

**Explain:**

- ▶ Back supports provide comfort and postural support while sitting.
- ▶ Back supports can be sling upholstery or rigid.



**Point out the different back supports in participants' wheelchairs.**

**Demonstrate while describing:**

- ▶ For upholstery back supports, inspect for wear, tears, stretched upholstery, or metal parts that may be sticking out.
- ▶ Inspect all upholstery rivets or screws and check that the upholstery is not tearing in those spots.
- ▶ Loose upholstery may provide less postural support and can lead to skeletal deformities.
- ▶ Contact a wheelchair maintenance expert to replace the upholstery when these problems are identified.

**Demonstrate while describing:**

- ▶ For rigid back supports inspect the surface is intact.
- ▶ Inspect that the back support hardware is properly attached to the back support posts and does not rattle.
- ▶ Tighten loose bolts with a screw driver, Allen wrench, or wrench.
- ▶ If the fabric is worn out and/or the foam is rigid, contact the wheelchair maintenance expert to get a replacement.

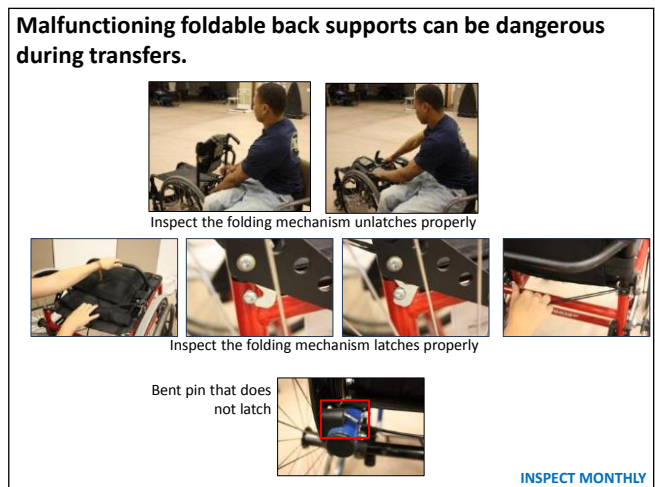
**Advise participants:**

- ▶ When the upholstery is replaced, it is best to replace the bolts or screws that hold it in place.
  - This will ensure that they are properly maintained as well.
  - Encourage your wheelchair maintenance expert to do so.

- ▶ The back support should be inspected **monthly**.

### Explain:

- ▶ Most rigid-frame wheelchairs have a foldable back support for transport and storage.
- ▶ If you have a folding back support, check that the mechanism lock is in place.
- ▶ Loose back supports can be dangerous during transfers because they could move or come out.
- ▶ Always make sure that the back support is locked before using it after unfolding the back.
- ▶ If problems are identified contact your wheelchair maintenance expert to get it fixed or replaced.



### Demonstrate while describing:

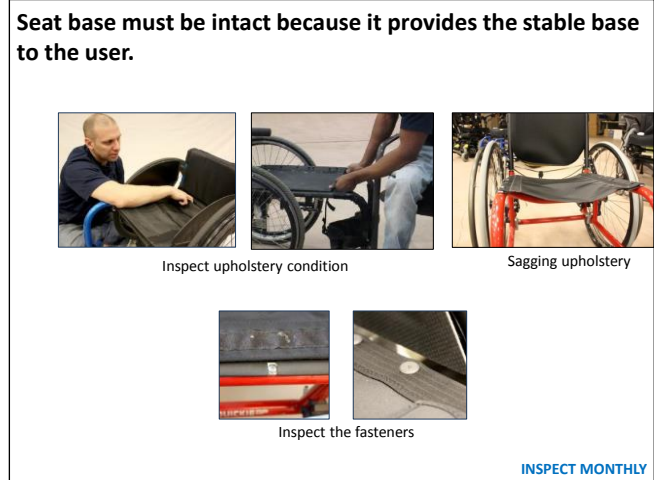
- ▶ If you unfold the backrest frequently be sure that it folds and latches easily.
- ▶ If you do not unfold it frequently, inspect that the mechanism is working properly **monthly**.

**Gather:**

- ▶ Wheelchair with stretched seat upholstery or wheelchair with solid seat pan.

**Explain:**

- ▶ Seat bases may either be rigid or an upholstery sling.
- ▶ In either case, the seat should be stiff and provide a stable support base for the cushion and the user.



**Describe while describing:**

- ▶ Inspect the seat upholstery/pan for wear, tears, dirt, or metal parts that may be sticking out.
- ▶ Seat upholstery that is stretched, torn, or more slung in the front should be replaced.
- ▶ Check all upholstery rivets or screws.
- ▶ After inspecting remember to put the privacy flap back into place.
- ▶ If problems are identified, contact a wheelchair maintenance expert to get your upholstery replaced.

**Advise:**

- ▶ Similar to the backrest upholstery, when the seat upholstery is replaced, it is best to replace the bolts or screws that hold it in place.
  - This will ensure that they are properly maintained as well.
  - Encourage your wheelchair maintenance expert to do so.
- ▶ For the rigid seat, check that it is intact, no cracks or fractures.
- ▶ Tighten any loose bolts.
- ▶ If problems are identified, contact a wheelchair maintenance expert.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with clothing guards. If possible, use one with cracked and/or loose guards.

**Explain:**

- ▶ Clothing guards provide a safety barrier between the wheelchair user and the wheel.
- ▶ They help to protect the clothing from getting caught in the wheels.



**Demonstrate while describing:**

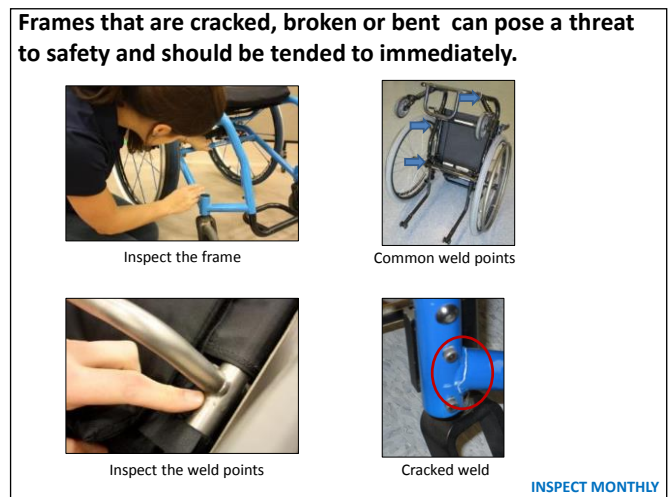
- ▶ Inspect that the clothing guards are tight and tighten nuts and bolts as necessary.
- ▶ Use an Allen wrench or screw driver.
- ▶ Contact the wheelchair maintenance expert if problems are identified to get the part replaced.
- ▶ Inspect the clothing guards for cracks and fractures **monthly**.

**Gather:**

- ▶ Folding frame wheelchair and box frame wheelchair.

**Explain:**

- ▶ All common wheelchair frames center around tubular construction.
- ▶ The tubing can either be welded together or bolted together using lugs.
- ▶ The two basic frame types are folding and rigid, and the two common rigid frame styles are box frame and cantilever frame.



**Point out the different frames in participants’ wheelchairs.**

**Demonstrate while describing:**

- ▶ Inspect the frame, weld points, holes and bends to confirm that they are intact.
- ▶ Look for cracks and fractures as they can result in catastrophic failure of the wheelchair.

- ▶ This could lead to injury and being stranded.

**Ask:**

- ▶ What do you do if you find cracks or fractures in the frame?

**Acknowledge participants' answers**

**Answer:**

- ▶ If cracks and fractures are identified, contact the wheelchair maintenance expert immediately.
- ▶ This inspection should be performed **monthly**.

**Gather:**

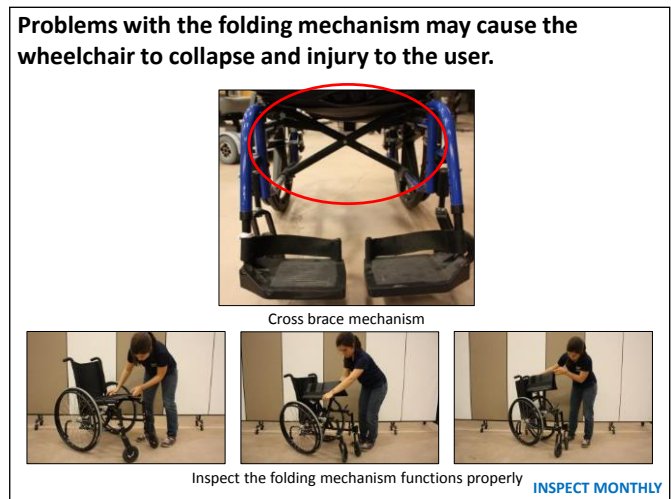
- ▶ Folding frame wheelchair.

**Explain:**

- ▶ Cross-brace frames allow for the wheelchair to collapse towards the middle for storage.

**Demonstrate while describing:**

- ▶ Inspect that the cross brace mechanism is working properly every time you use it.
- ▶ It should open and fold easily.
- ▶ If it is difficult to close or if the wheelchair is unsteady during transfers.
- ▶ Problems with the cross-brace mechanism may cause the wheelchair to collapse and injury to the user.
- ▶ If problems are identified, contact a wheelchair maintenance expert.
- ▶ If you do not fold the wheelchair frequently, this task should be performed **monthly**.



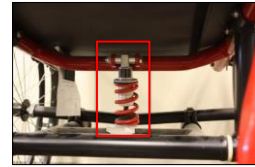
**Explain:**

- ▶ Some frames have built in or “add-on” suspension elements to decrease shock and vibration and make for a smoother ride.
- ▶ Inspect that the paint in the spring is intact and it has no cracks.
- ▶ Inspect that the damper is not leaking lubricant.

**Damaged suspension elements can make the wheelchair harder to drive and less stable when maneuvering obstacles.**



Wheelchair with suspension



Suspension elements



Damper

Spring

**INSPECT MONTHLY**

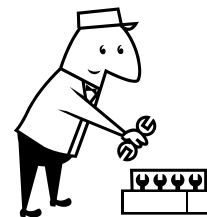
**Point out if there are any participants that have a wheelchair with suspension.**

- ▶ Contact the wheelchair maintenance expert if you find any problems.
- ▶ Get your suspension professionally inspected if you lose or gain weight significantly.
- ▶ Inspect the suspension elements monthly.

**Explain:**

- ▶ Action items are maintenance activities that the wheelchair user or caregiver performs on the wheelchair.

**Action items:** maintenance activities that the wheelchair user or caregiver performs on the wheelchair.





**Read the summary of the action items and explain:**

- ▶ We will go over in detail on how to complete each action item.
- ▶ Red is monthly
- ▶ Green is 4 times per year.
- ▶ Purple once a year.

Actions to maintain a manual wheelchair	
Cleaning your wheelchair	Wheelchair and cushion
	Caster axle
	Quick release wheel
Lubricate moving parts	
Have wheelchair professionally serviced	

**Read the slide.**



**Gather:**

- ▶ Wheelchair, rag and bucket with water.

**Demonstrate while describing:**

- ▶ Wipe down the wheelchair frame with a clean, damp rag and soap.

**Emphasize:**

- ▶ The rag should be moist and not soaked.
- ▶ Remove any fabric covers from the frame and the calf straps if possible.
- ▶ Cleaning the wheelchair may stop metal parts from rusting and may stop damage caused by dirt scraping against moving parts.
- ▶ Taking the wheel off makes cleaning that side of the frame easier.

**Wipe down the wheelchair frame with a clean, damp rag and soap.**

Wipe down the frame with a clean damp rag and soap.

Dry cover on towel away from direct sunlight

When finished, place the cushion back in the correct position

**CLEAN MONTHLY**

- ▶ Take the cover off if possible and wash in the washer. Refer to the cushion user guide for cushion washing instructions.

**Emphasize:**

- ▶ Do not machine dry the cover.
- ▶ The fabric may shrink and not fit the cushion anymore. Instead, dry over a towel preferably overnight and indoors/in the shade, avoiding direct sunlight.
- ▶ Be sure to put the cover back on the cushion in the correct orientation.
- ▶ Dirt on the cushion can cause skin breakdown and can cause odor on both the wheelchair and cushion.

**Ask:**

- ▶ How often do you clean your wheelchair and cushion?

**Acknowledge answers**

- ▶ This task should be performed **monthly**, or **twice a month** if you are in inclement weather

**Gather:**

- ▶ Wheelchair, tweezers, scissors and toothbrush.

**Demonstrate as you describe:**

- ▶ Remove dirt, lint, and hair from the caster axles bearings with scissors, tweezers, toothbrush, or plyers.
- ▶ Dirt, lint, or hair buildup on the axles and casters can eventually cause premature wear.
- ▶ Hair especially can twist around the bearings and cause breakage.



**Ask:** how often do you clean your caster axles?

**Acknowledge answers**

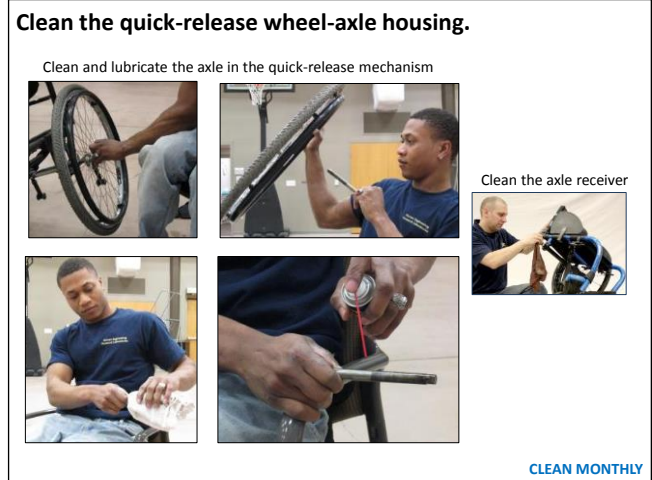
- ▶ Dirt and lint should be removed **monthly**, or **twice a month** if you are in inclement weather or have pets.

**Gather:**

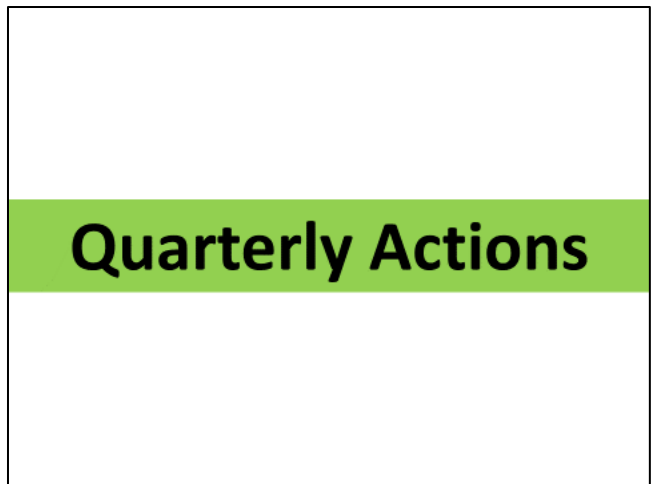
- ▶ A wheelchair with quick release wheels, rag and WD40.
- ▶ Increased friction between moving parts can accelerate wear of the parts.

**Describe while demonstrating:**

- ▶ Remove the quick-release wheel.
- ▶ Clean the axle and the wheel housing with a rag dampened with WD40, then lubricate them with the same spray and then wipe off the extra.
- ▶ Also, try and clean the axle housings and around the bearings.
- ▶ This task should be performed **monthly**.



**Read the slide.**



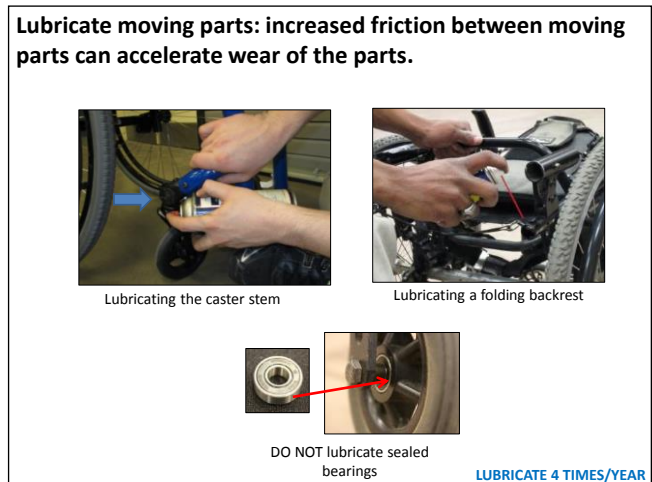
**Gather:**

- ▶ Rag and WD40 or similar lubricant.

**Explain:**

- ▶ Each wheelchair model will have different moving parts that should be lubricated.
- Increased friction between moving parts can accelerate wear of the parts.

**Demonstrate while explaining:**



- ▶ Clean, dry, and apply lubricating oil or Teflon-based spray to all moving parts, including the folding mechanism, where the front casters turn, and exposed hinges.
- ▶ Use a rag to remove excess lubricant.
- ▶ Example of lubricating oil: Liquid wrench, 3M multipurpose lubricant
- ▶ Example of teflon-based oil: Tri-Flow Lubricant ,Teflon™
- ▶ DO NOT lubricate sealed bearings!
- ▶ DO NOT use penetrating oil!

**Point out all the moving parts in the wheelchair. Emphasize which ones can be lubricated (e.g. at the top of the caster fork and caster stem ) and which ones not (e.g. caster axle)**

- ▶ This task should be performed **four times a year**.

**Read the slide.**



**Explain:**

- ▶ All wheelchairs should be professionally serviced at least once a year.
- ▶ The cost of this will depend on the wheelchair expert.
- ▶ It may not be reimbursed by a health insurance.

All wheelchairs should be professionally serviced at least **once a year**.

In places with inclement weather conditions, wheelchairs should be professionally serviced **twice a year**.

A cartoon illustration of a male mechanic with a friendly expression. He is wearing a blue cap, a blue shirt, and blue pants. He is holding a silver wrench in his right hand and a red toolbox in his left hand.

**5. Summary (5 minutes)**

**Remind participants:**

- ▶ Today we recognized the importance of wheelchair maintenance.
- ▶ Also, we reviewed each maintenance task and how frequent it should be performed.

**Inquire:**

- ▶ Are any unsolved questions?

**Acknowledge them and answer.**

**If there are unsolved questions indicate that you will search and prepare the answers for the second session.**

**Remind the participants:**

- ▶ We will keep the toolkit and maintenance cards until next session. You can take them home next session.

**Learning Objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks
- Demonstrate methods for **maintaining** your wheelchair
- Demonstrate how to **identify** common technical wheelchair **problems**

**Thank you!**  
**See you next class**



**6. Hands-on wheelchair maintenance activity (90 minutes)**

- ▶ **Welcome** the wheelchair users and thank them for participating in this training program.
- ▶ **Remind** participants your name and your co-trainer’s if you have one.
- ▶ **Answer** any unsolved questions from the first session before starting.
- ▶ **Hand out** toolkits and maintenance cards.

**Read the activities that will happen during this training session.**

**Gather:**


- ▶ 1 bucket with water and mild soap for every pair of participants.
- ▶ 1 rag per participant

**Form pairs between the participants. Try to pair up participants with different personalities, for example, a more talkative one with a shy participant.**

**Read the slide and explain:**

- ▶ Each one of you will perform the maintenance on your own wheelchair.
- ▶ I will pair you up so you can perform the maintenance at the same time and support each other if needed.
- ▶ If you prefer, you can practice the skills on the demo wheelchair that I have used through the training.
- ▶ We (you and the aids) will walk around the room and provide any assistance and answer questions as needed.

## Manual Wheelchair User Maintenance Training Day 2



Day	Duration (minutes)	Time	Activity
	90		Hands-on wheelchair maintenance activity
2	20		Summary and discussion
	5		Adjournment

### Hands-on wheelchair activity

- Bring your maintenance checklist and toolkit
- If you identify maintenance issues on your wheelchairs, write them down on *hands-on activity sheet*
- You will have 90 minutes to perform this activity
- Let us know if you have questions or need assistance

**Gather:** a checklist per participant and at least an erasable marker per pair.

**Explain:**

- ▶ We will perform the inspection and action items..
- ▶ Please follow the order on the laminated checklist that we have provided. Use the marker to check the activities that you have done. If your wheelchair does not have a part, check the box under mark if not applicable. We will have up to one hour and a half.
- ▶ Let’s start with the weekly inspections.

## Hands-on wheelchair activity

**REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY**

**Manual wheelchair maintenance hands-on activity checklist**

**REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY**

Maintenance activities	Activity done	Not applicable
<b>Weekly</b>		
Inspect cushion and cover for wear	<input type="checkbox"/>	<input type="checkbox"/>
If pneumatic tires, inspect tire pressure	<input type="checkbox"/>	<input type="checkbox"/>

**Keep track of time; there are maximum 90 minutes for this portion of the session. Continue to cue the participants so they change from one activity to the next one and they do not fall behind. Leave this slide up while you monitor participants work. Once all participants have completed the weekly, click to the next slide. Note questions than participants have and share them with all the participants on the next session.**

**Explain:**

- ▶ Now, we will practice the inspection and action items that we recommend you do monthly.
- ▶ Continue to cue the participants so they change from one activity to the next one and they don’t fall behind.

## Hands-on wheelchair activity

**REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY**

Monthly		
Inspect push handles	<input type="checkbox"/>	<input type="checkbox"/>
Inspect back posts and back support hardware	<input type="checkbox"/>	<input type="checkbox"/>
Inspect the wheelchair frame	<input type="checkbox"/>	<input type="checkbox"/>
Inspect cross brace function	<input type="checkbox"/>	<input type="checkbox"/>
Inspect suspension	<input type="checkbox"/>	<input type="checkbox"/>
Inspect anti-tip wheels	<input type="checkbox"/>	<input type="checkbox"/>
Inspect casters	<input type="checkbox"/>	<input type="checkbox"/>
Inspect caster bearings	<input type="checkbox"/>	<input type="checkbox"/>
Inspect tires	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel locks (brakes)	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel spokes and wheel trueness	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel handrims	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel axles	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel bearings	<input type="checkbox"/>	<input type="checkbox"/>
Inspect foot supports	<input type="checkbox"/>	<input type="checkbox"/>
Inspect clothing guards	<input type="checkbox"/>	<input type="checkbox"/>
Inspect arm supports	<input type="checkbox"/>	<input type="checkbox"/>
Inspect seat upholstery (including stitching and rivets)	<input type="checkbox"/>	<input type="checkbox"/>
Inspect back support upholstery (including stitching and rivets)	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down cushion and cover	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down back support	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down seat upholstery	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down the wheelchair frame	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down and lubricate wheel axles	<input type="checkbox"/>	<input type="checkbox"/>
Clean caster axles	<input type="checkbox"/>	<input type="checkbox"/>

**Remember that you have maximum 90 minutes for the hands-on activity. Leave this slide up while you monitor participants work. Once all participants have completed the monthly inspections and action, click to the next slide. Note questions that participants have and share them with all the participants on the next session.**

**Explain:**

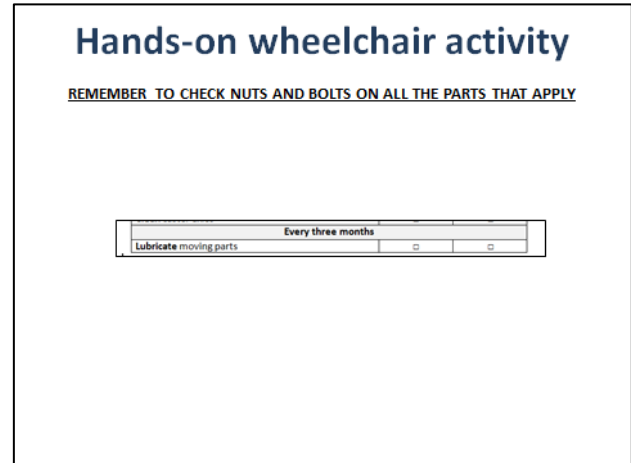
- ▶ Now we practice lubricating moving parts which we recommend you do every three months.
- ▶ Remember to wipe the lubricant thoroughly so it does not collect dust and debris.

**Leave this slide up while you monitor participants work.**

**Once all participants have completed lubricating, explain:**

- ▶ Remember that we recommend that you have your wheelchair professionally serviced at least once a year.

**Note questions than participants have and share them with all the participants on the next session.**



**7. Summary and discussion (20 minutes)**

**Summarize the questions that were raised during the hands-on activity.**

**Encourage participants to answer these questions and acknowledge their answers.**

**Clarify confusing points.**

**Ask the less talkative participant from each pair to share with the group what up to two problems that were identified and how to address them**

**(hint: they should have written them down in the hands-on activity sheet).**

**Acknowledge answers and clarify confusing points.**

**Explain:**

- ▶ We will summarize all the inspection activities we learned and practice during these two sessions.
- ▶ You can follow this summary using the maintenance cards in your toolkit.





**Encourage** participants to ask any additional questions that they think remain unanswered.

**Read the slide**

**Weekly**

**Inspection**

- Pneumatic tires
- Cushion and cover

*Maximum estimated time: 30 minutes*

**Read the slide and emphasize that nuts and bolts should be inspected on all the items listed here.**

**Monthly**

<b>Nuts and bolts</b>	<b>Inspection</b>	<b>Action</b>
	- Wheel locks	- Wipe down wheelchair and cushion
	- Supports alignment and function	- Clean caster axle
	- Wheels and casters condition and function	- Clean quick release wheel axle housing
	- Spokes	
	- Upholstery	
	- Frame	

*Maximum estimated time: 60minutes*

**Read the slide.**

**Every three months**

**Action**

- Lubricate moving parts

*Maximum estimated time: 15 minutes*

**Read the slide.**

**Yearly**

**Action**

- Have wheelchair professionally serviced

*Estimated time: 60 minutes*

**8. Adjournment**

**Explain:** Briefly describe that the learning objectives mentioned at the beginning of the first session have been met.

**Learning objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks
- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

**Explain:**

- ▶ That as part of their participation in the study, they will receive 4 reminders throughout the year.
- ▶ They can chose up to 2 format of reminders.

**Read the information that the participants will receive in the reminder.**

**Read the reminders page and ask participants to fill it out.**

**Reminders**

REMINDERS

Date: \_\_\_/\_\_\_/\_\_\_

Name: \_\_\_\_\_

▶ Please choose at least one but not more than two types of reminders that you would like to receive related to your wheelchair maintenance tasks. Reminders will be sent every three months for the duration of the study.

Email:  
Email address: \_\_\_\_\_

Text message:  
Cellphone number: \_\_\_\_\_  
Cellphone carrier (e.g. AT&T, Sprint, T-mobile, etc): \_\_\_\_\_

Phone-call:  
Telephone number: \_\_\_\_\_

Electronic calendar:  
Email address: \_\_\_\_\_

**Reminders**

Remember that regular maintenance is important for your wheelchair to perform properly. Review the maintenance cards that you received in your toolkit and be sure that you are following the directions in a timely manner. If you are in need of a repair, remember to contact a wheelchair maintenance expert.

**List and show** the resources that the wheelchair users are taking home.

**Remember you have with you**

- Maintenance cards
- Toolkit
- Reminders
  - Every 3 months for 1 year

**Point out that these are the main scientific article references.**

**Be willing to forward the copies of the articles if wheelchair users are interested.**

### References

Berg K, Hines M, Allen S. Wheelchair users at home: few home modifications and many injurious falls. *Am.J.Public Health* 2002;48.

Calder CJ, Kirby RL. Fatal wheelchair-related accidents in the United States. *Am.J.Phys.Med.Rehabil.* 1990;184-90.

Chen WY, Jang Y, Wang JD, Huang WN, Chang CC, Mao HF, Wang YH. Wheelchair related accidents: relationship with wheelchair-using behavior in active community wheelchair users. *Arch.Phys.Med.Rehabil.* 2011;892-8.

Gaal RP, Rebholtz N, Hotchkiss RD, Pfaelzer PF. Wheelchair rider injuries: causes and consequences for wheelchair design and selection. *J.Rehabil.Res.Dev.* 1997;58-71.

Hansen R, Tresse S, Gunnarsson RK. Fewer accidents and better maintenance with active wheelchair check-ups: a randomized controlled clinical trial. *Clin.Rehabil.* 2004;631-9.

Kirby RL, Ackroyd-Stolarz SA, Brown MG, Kirkland SA, MacLeod DA. Wheelchair-related accidents caused by tips and falls among noninstitutionalized users of manually propelled wheelchairs in Nova Scotia. *Am.J.Phys.Med.Rehabil.* 1994;319-30.

### References

McClure LA, Boninger ML, Oyster ML, Williams S, Houlihan B, Lieberman JA, Cooper RA. Wheelchair repairs, breakdown, and adverse consequences for people with traumatic spinal cord injury. *Arch.Phys.Med.Rehabil.* 2009;2034-8.

Nelson AL, Groer S, Palacios P, Mitchell D, Sabharwal S, Kirby RL, Gavin-Dreschnack D, Powell-Cope G. Wheelchair-related falls in veterans with spinal cord injury residing in the community: a prospective cohort study. *Arch.Phys.Med.Rehabil.* 2010;1166-73.

Wang H, Liu HY, Pearlman J, Cooper R, Jeffers A, Connor S, Cooper RA. Relationship between wheelchair durability and wheelchair type and years of test. *Disabil.Rehabil.Assist.Technol.* 2010;318-22.

World Health Organization. (Accessed 2013, May 8). *Trainers Manual for Wheelchair Service Training Package: Basic Level* [Online]. Available: <http://www.who.int/disabilities/technology/wheelchairpackage/en/>

World Health Organization. (Accessed 2013, May 8). *Reference Manual for Participants* [Online]. Available: <http://www.who.int/disabilities/technology/wheelchairpackage/en/>

Worobey L, Oyster ML, Nemunaitis G, Cooper R.A., Boninger M.L. Increases in Wheelchair Repairs, Breakdown, and Adverse Consequences for People with traumatic Spinal Cord Injury. *Am.J.Phys. Med.Rehab.* 2012;463-9;

5.2 POWER WHEELCHAIR MAINTENANCE

1. Introduction (5 minutes)

- ▶ **Welcome** the wheelchair users and thank them for participating in this training program.
- ▶ **Introduce** yourself and your co-trainer if you have one.
- ▶ **Ask** participants to introduce themselves.

**Power wheelchair User Maintenance Training**



Draft 2014-07-24

This training material was supported by the U.S. Department of Health and Human Services, National Institute on Disability Independent Living and Rehabilitation Research (H133A120004). The contents of this manual are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. Department Health and Human Services.

- ▶ **Fill** in the slide with the appropriate times that are applicable to the training session.

**Explain:**

- ▶ This is an interactive learning approach to training.
- ▶ Today, we will watch a video, have a presentation and show examples of how to do maintenance.
- ▶ Tomorrow we will do hands-on practice either on your wheelchair or on a demo wheelchair that we have here available.
- ▶ **Remind the participants the time for the next session’s class.**
- ▶ **Emphasize that participants are free to ask questions at any time.**
- ▶ Before starting **read** the slide.

**Wheelchair maintenance training agenda for the next two days.**

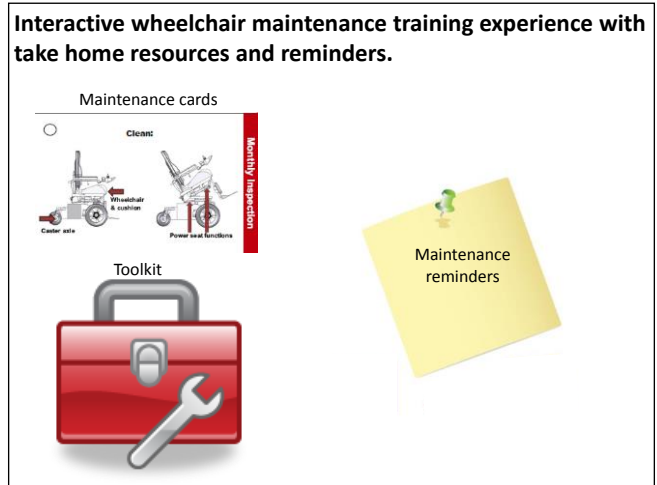
Day	Duration (minutes)	Time	Activity
1	5		Introduction
	15		Objectives and relevance
	5		How to take care of a wheelchair at home DVD
	60		Caring for a wheelchair at home
	5		Summary
2	90		Hands-on wheelchair maintenance activity
	20		Summary and discussion
	5		Adjournment

We will teach you how to identify problems and how to do basic maintenance.

These two sessions are **not** intended to be a wheelchair repair clinic.

**Explain:**

- ▶ This is an interactive learning approach to training.
- ▶ Today, we will watch a video, have a presentation and show examples of how to do maintenance.
- ▶ In the next session, we will do hands-on practice either on your wheelchair or on a demo wheelchair that we have available.
- ▶ **Remind the participants the time for the next session’s class.**
- ▶ **Emphasize that participants are free to ask questions at any time.**



**2. Objectives and relevance (15 minutes)**

- ▶ **Read** the learning objectives
- ▶ **Click to highlight the first two objectives.**
- ▶ **Explain: our goal is to accomplish the first two objectives today and the last two objectives in the next session.**

**Learning objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks
- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

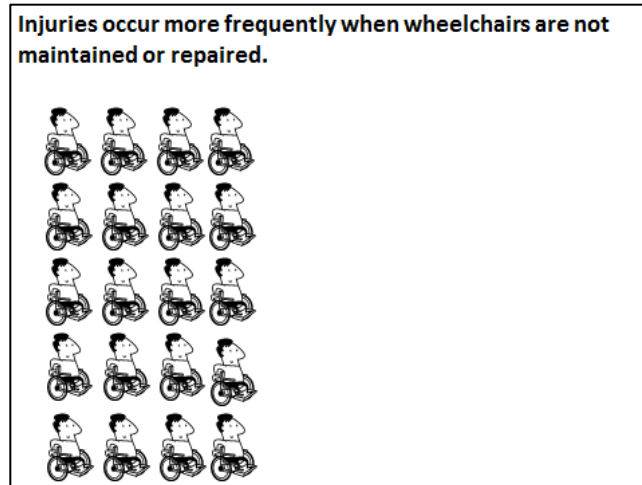
**Learning objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks

- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

**Explain:**

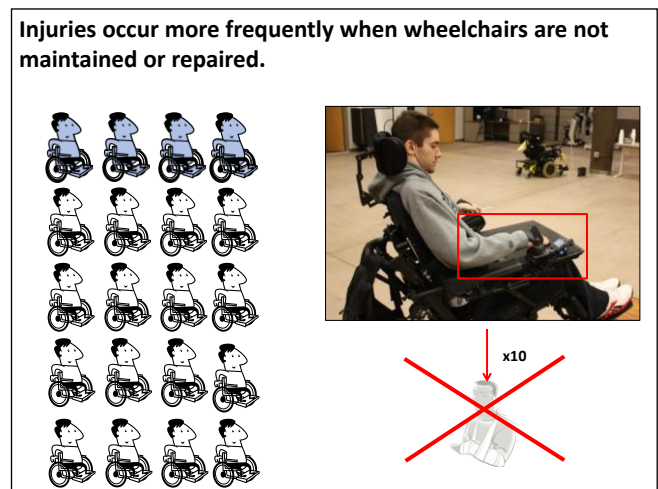
- ▶ Between 5 and 18% of wheelchair users in the community experience wheelchair-related injuries each year.



Click so 4 images are highlighted

**Explain:**

- ▶ This means, of every 20 wheelchair users, between one to four wheelchair users will experience a wheelchair-related injury.
- ▶ Causes of wheelchair-related injuries include tipping over and wheelchair malfunction among others.
- ▶ In fact, wheelchairs that are poorly maintained increase the risk of their users being injured due to a wheelchair breakdown.
- ▶ Wheelchair users who maintain their wheelchair are 10 times less likely to sustain an injury than those who do not maintain it.



**Explain:**

- ▶ It is concerning that the majority of wheelchairs available in the US have been found non-compliant to minimum ANSI/RESNA Wheelchair durability standards.
- ▶ This means that many wheelchairs are of lower quality than the expected standards.
- ▶ The image on the left shows an example of durability testing in a laboratory setting. The wheelchair is located on a double-drum device that simulates

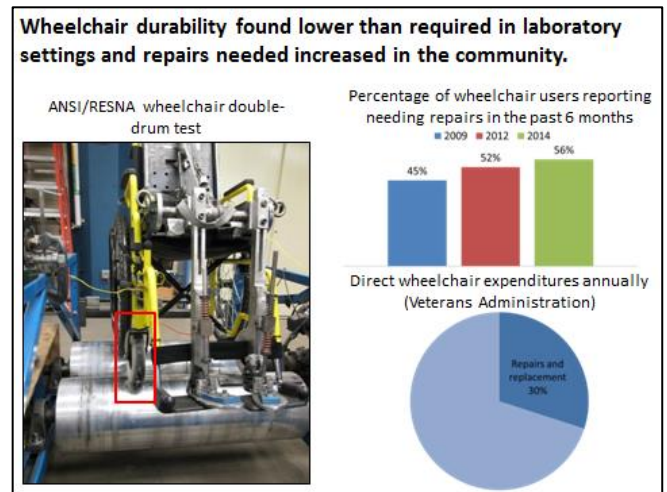


rolling, much like how cars are tested. The wheelchair is expected to last at least 200,000 cycles which are equivalent to 3-5 years of wheelchair use.

- ▶ The wheelchair right caster wheel is broken and shows an example of wheelchair breakdown.

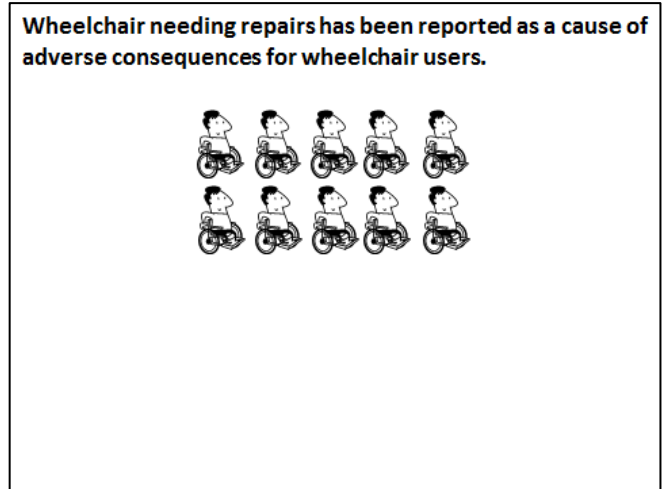
**Click to appear the bar chart and pie chart and explain:**

- ▶ Research has shown that the number of wheelchair breakdowns reported by wheelchair users in the US has been increasing over time.
- ▶ From 45% of wheelchair users in 2009 to 56% in 2014.
- ▶ These is concerning because breakdowns increase the cost to the health care system. In fact, repairs and replacement costs account for 30% of the direct wheelchair expenditures annually (VA National Prosthetics Patient Database).



**Explain:**

- ▶ Research has shown that approximately 60% of wheelchair users have reported a needing a wheelchair repair in the previous 6 months.



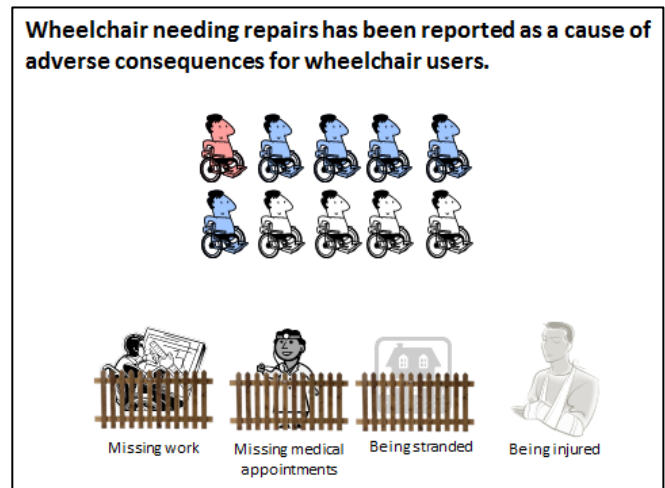
Click to highlight this proportion and explain:

- ▶ This means 6 out of every 10 wheelchair users.



Click to appear next images on the slide and explain:

- ▶ In addition, one of these 6 wheelchair users that needed repairs, which represents approximately 23% of the 6 wheelchair users will have suffered an adverse consequence such as missing a medical appointment, missing work or school, or being stranded or injured, due to the wheelchair repair.





**Explain:**

- ▶ Because most of the wheelchairs in the US are provided through health insurance, it is important to understand how health insurance relates to wheelchair maintenance and repairs. In the US, many health insurance policies follow Medicare’s coverage.

**Emphasize:**

- ▶ Routine periodic servicing, such as testing, cleaning, regulating, and checking of the beneficiary’s equipment, is not covered.
- ▶ Therefore, unless a specific maintenance task is specified by the manufacturer as required to be done by a technician, maintenance is not covered and considered the user’s responsibility.
- ▶ But, repairs are covered when necessary to make the equipment usable.
- ▶ Remember, maintenance issues lead to injuries and can be avoided.
- ▶ Currently insurance coverage does not address them until they become a repairable item (which may be after injury!).
- ▶ Thus, this maintenance training should help avoid these injuries.

**Medicare does not cover maintenance but does cover repairs.**



Maintenance such as routine cleaning is not covered.



Necessary repairs are covered.

**BE PROACTIVE !!**

**Ask participants:**

- ▶ Raise your hand if you know how to contact a wheelchair maintenance expert.

**Acknowledge the number of people who raised their hand.**

- ▶ A wheelchair maintenance expert can include the wheelchair vendor, a wheelchair clinic, a wheelchair technician or a wheelchair supplier.
- ▶ It is important to be proactive! Call your wheelchair maintenance expert right away when you identify problems.
- ▶ If the wheelchair maintenance expert is not compliant, contact your local wheelchair clinic.
- ▶ They can advocate for you or help you get assessed for a more functional wheelchair.

**Explain:**

- ▶ All wheelchairs require periodic maintenance to operate properly.
- ▶ Examples include tightening loose bolts like this loose head support hardware.
- ▶ Some wheelchair parts require periodic repair and replacement.
- ▶ Repair and replacement of components can extend the life of the wheelchair and make using it much easier.
- ▶ Examples include replacing faulty motors.
- ▶ Much like a car, if a wheelchair is not properly maintained, it can become more difficult to operate, and it will not perform as well as when it was new.

**Wheelchair check-ups are likely to reduce adverse events related to wheelchair breakdowns.**

Tightening loose bolts



Listening to motor noises



All wheelchairs require periodic maintenance to operate properly

**Emphasize:**

- ▶ Wheelchair check-ups are likely to reduce adverse events related to wheelchair breakdowns.


**Gather:**

- ▶ Wheelchair and damp rag.

**Explain:**

- ▶ Today we are going to go in detail over the proposed maintenance schedule. The schedule includes inspection and action items.
- ▶ You will inspect the wheelchair components to check their integrity and proper function. When problems are identified during the inspection they are followed by an action item.

**Inspection and action items are included in the maintenance schedule.**




Inspection

→

✓

No problems




Continue using the wheelchair

→

✗

Found a problem



Action

**Demonstrate on the wheelchair while explaining:**

- ▶ An example of an inspection item is to check that the weld points on the frame are intact.

**Click to appear next images on the slide and explain:**

- ▶ In addition, action items are activities that are performed on the wheelchair.

**Demonstrate on the wheelchair while explaining:**

- ▶ An example of an action item is to wipe down the wheelchair frame.

**Explain:**

- ▶ Another way of understanding the difference between inspection and action is an inspection is looking for a problem and an action is trying to fix the problem. For example, an inspection item for your car is to check the gas level and an action item is to fill it up with gas if the level is close to empty.

**Gather:**

- ▶ Tool kit

**Explain:**

- ▶ As mentioned at the beginning, each one of you is receiving a toolkit which will have basic tools for maintenance. The toolkit has the following tools:

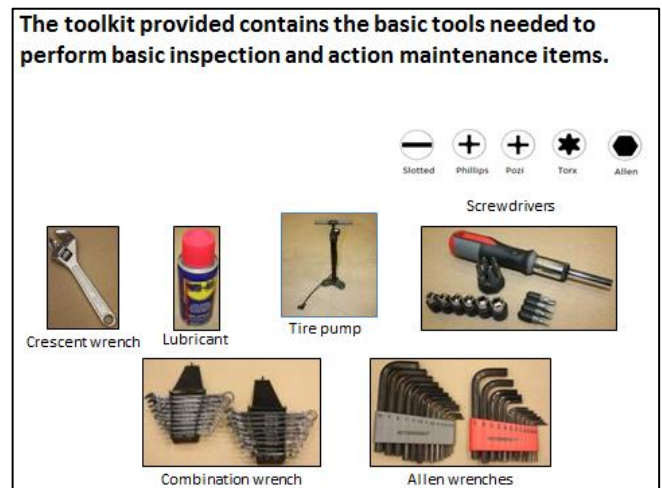
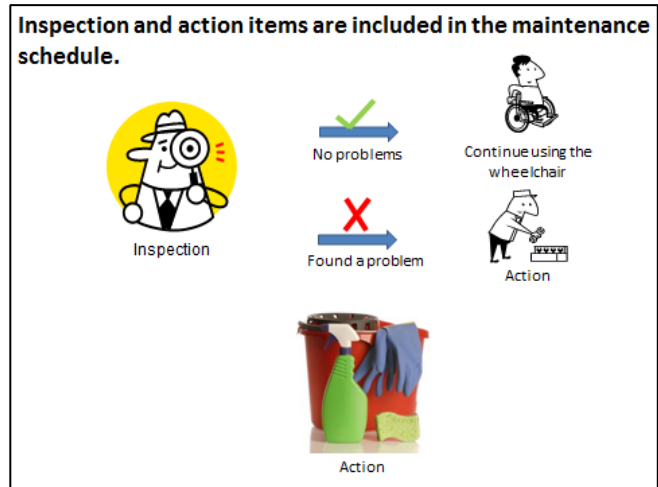
**Invite participants to open the toolkit and identify the tools that you are naming.**

**Show each tool from one of the toolkits as you explain them.**

**Demonstrate on the wheelchair while you explain each tool.**

**Explain:**

- ▶ Screwdriver: A tool for turning screws. Always use a screwdriver tip that properly fits the slot of the screw. Your toolkit has a multi bit screwdriver with different tips that will fit the slots of the screws that we see on the slide.



- ▶ Allen wrench: A tool for turning screws that have a hexagonal socket in the head (**point to image on slide.**) Always use the correct size needed for the job, as using an Allen wrench on a socket that is too large may result in rounding. Which means that the Allen wrench in the future would not be able to grab a hold of the socket. You have in your toolkit both standard and metric Allen wrenches.
- ▶ Open-end box-end wrench or Crescent wrench: Tools to turn nuts and bolts or keep them from turning. Be sure to use the proper size wrench, and only use adjustable wrenches when you do not have the proper size. An adjustable wrench may cause bolts or nuts to round off if not used correctly.
- ▶ Tire pump and gauge: A foot pump, compressor or high pressure hand pump is necessary to inflate tires over 50psi. Tires can also be filled using gas station airlines, but a valve adaptor may need to be used. **Emphasize:** the pump is not provided with this toolkit.
- ▶ WD40: Lubricates and protects against corrosion. It also removes grease, gum, dirt, & scuff marks.

**Show the maintenance cards and you explain:**

- ▶ In addition, in the tool case, you will have a set of maintenance cards that you can use to remind you of the maintenance tasks and how often to perform them. We encourage you to store the maintenance cards with the toolkit.

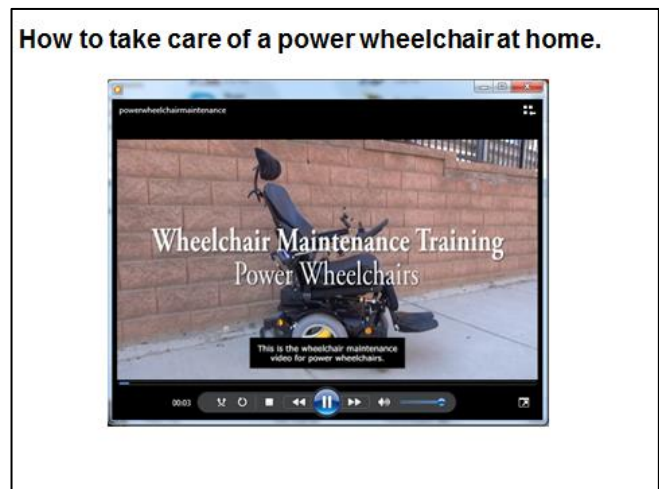
**3. How to take care of a wheelchair at home DVD**

**(5 minutes)**

**Explain:**

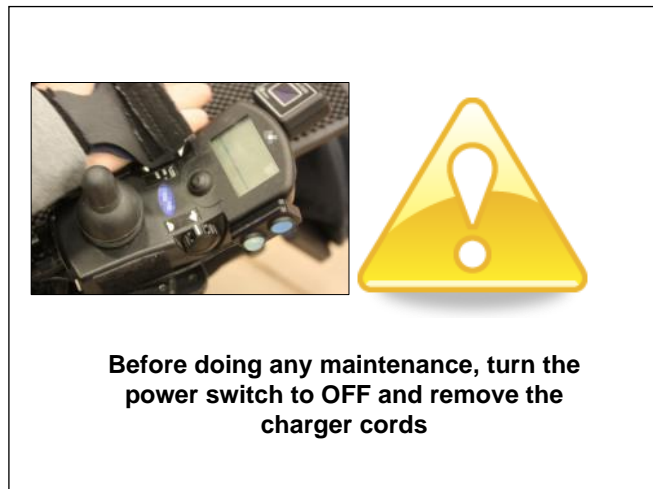
- ▶ We are going to watch a video that summarizes all the inspection and action items that we are going to learn today and practicing tomorrow.

**Play the file [powerwheelchairmaintenance.wmv](#)**



**Explain:**

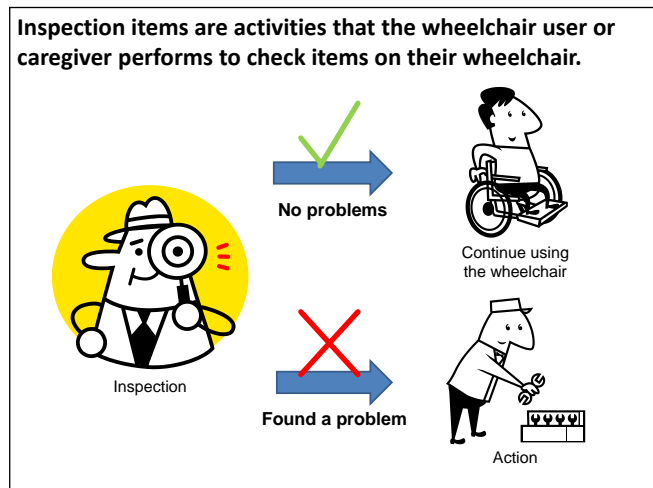
- ▶ Before doing any maintenance, turn the power switch to OFF and remove the charger cords.



**4. Caring for a wheelchair at home (60 minutes)**

**Explain:**

- ▶ Now we are going to go over in detail each maintenance activity.
- ▶ We will start with the inspection items.
- ▶ You will inspect the wheelchair components to check their integrity and proper function.
- ▶ When problems are identified during the inspection they are followed by an action item.



**Read the summary of the inspection items and explain:**

- ▶ We will go over in detail on how to do it and what to do if problems are identified.
- ▶ Blue highlights the inspections that are done daily.
- ▶ Orange highlights the inspections that are done weekly.
- ▶ The rest are done monthly.

Inspections are done daily, weekly, and monthly.

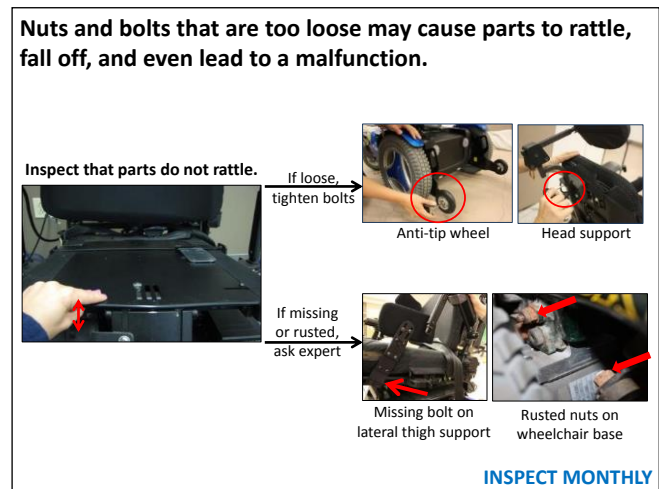
	Shrouds
	Welds
	Suspension
	Drive wheels
	Tires
	Caster wheels
	Anti-tip casters
	Cushion
	Cover
Nuts and bolts	Arm
	Foot
	Leg
	Back
	Others: thigh, trunk, etc
	Positioning belts
	Controls, indicators, and horn
	Motor sound
	Motor disengage lever
	Controller box
	Battery
Electrical system	Wiring and electric connections

**Gather:**

- ▶ Power wheelchair with loose headrest.  
Allen wrench, wrench, screwdriver.

**Explain:**

- ▶ Most maintenance consists of ensuring that nuts and bolts are properly adjusted.
- ▶ Inspecting nuts and bolts should be done while you inspect different parts of the wheelchair, as we will see throughout the presentation.
- ▶ Nuts and bolts that are too loose will loosen further or not hold the part properly.

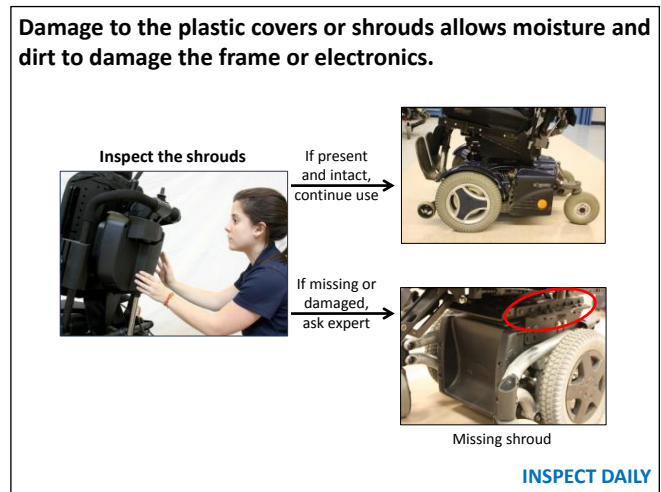


**Demonstrate while describing:**

- ▶ Visually identify loose bolts. Move parts and check that they do not rattle. Tighten all loose nuts and bolts until snug. Depending on the bolt, you can use a screwdriver, wrench or Allen wrench. Tighten to the point where the parts that the nuts and bolts are holding do not move at all. Do not over tighten! Some bolts are not to be tightened all the way, such as lock nuts. Over tightening a loose nut or bolt could damage the part and/or bolt.
- ▶ Bolts are graded for strength and hardness. The specific grade is selected by the manufacturer for the part where the bolt is to be used. Bolts used on wheelchairs must be replaced with the proper size and type bolt.
- ▶ If nuts or bolts are missing, stripped or broken, contact a wheelchair maintenance expert to get the bolts/nuts replaced.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Power wheelchair with loose plastic shrouds.
- ▶ Plastic covers or shrouds protect the electronics and battery of the wheelchair.
- ▶ Always keep protective plastic covers ("shrouds") in place.
- ▶ If the shrouds are damaged, dirt and moisture can impact the proper function of the wheelchair.



**Demonstrate while describing:**

- ▶ Inspect that the shrouds are present and intact.
- ▶ Jiggle the shrouds to inspect they are not loose.

**Point out the shrouds on the demo wheelchair.**

**Explain:**

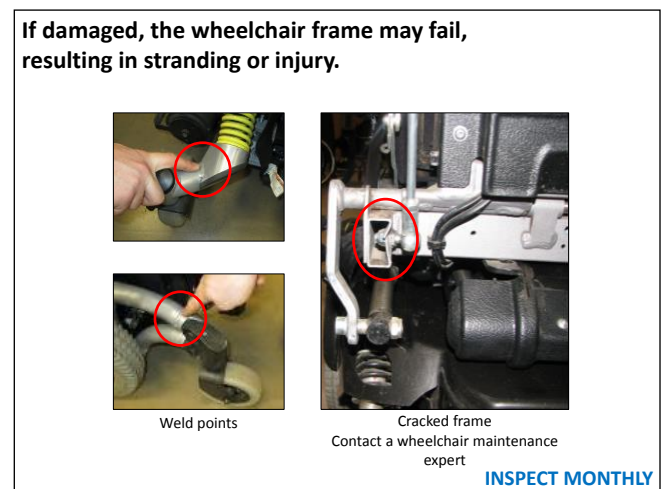
- ▶ If shrouds become damaged, they should be replaced.
- ▶ If you find problems, contact a wheelchair maintenance expert immediately.
- ▶ Inspecting the shrouds should be performed **every day**.

**Gather:**

- ▶ Power wheelchair.

**Demonstrate while describing:**

- ▶ Inspect the frame and weld points and confirm that they are intact.
- ▶ Check the weld points, holes, and bends.
- ▶ Look for cracks and fractures as they can result in catastrophic failure of the wheelchair.
- ▶ This could lead to injury and being stranded.
- ▶ If you find problems, contact a wheelchair maintenance expert immediately.
- ▶ Inspection of the frame should be performed **monthly**.



**Explain:**

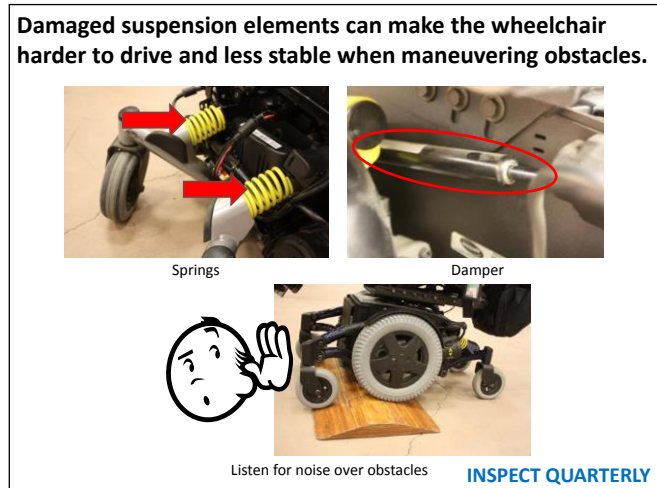
- ▶ Power wheelchairs have suspension to improve ride comfort, reduce driving fatigue, and accommodate rough terrain.

**Point out:**

- ▶ The dampers and/or shock absorber springs on your demo wheelchair.

**Explain while describing:**

- ▶ Inspect springs looking for cracks on the paint.
- ▶ Inspect that the dampers are not leaking fluid.
- ▶ Be aware that when you are going over obstacles, for example a speed bump, the wheelchair does not make noises and it is safe (at least 3 wheels must be in contact with the ground all the time).
- ▶ If problems are identified contact your wheelchair maintenance expert.



**Emphasize:**

- ▶ If you have had significant changes in weight this may mean that the suspension is not providing the same damping.
- ▶ Contact a wheelchair maintenance expert if you had significant changes in weight.
- ▶ Inspect the suspension **every 3 months**.

**Gather:**

- ▶ Broken bearing, worn out tires.

**Explain:**

- ▶ The wheels have a profound effect on the performance of the wheelchair.
- ▶ Drive tires can be pneumatic tires or solid.

**Demonstrate while describing:**

- ▶ Check for wear on the drive tires.





- ▶ When tread depth is low it can easily lead to power chair slippage, making braking distances longer.
- ▶ Wear can also negatively impact the maneuverability and stability of the wheelchair.
- ▶ Therefore replace the tires as early as possible when they are found to have insufficient tread depth.
- ▶ Contact a wheelchair maintenance expert to do so.
- ▶ This inspection should be performed **monthly**.

**Gather:**

- ▶ Power wheelchair with pneumatic tire with low pressure.

**If you cannot access a power wheelchair with pneumatic tires, identify if participants have pneumatic tires and point those tires out to demonstrate to the group.**

**Explain:**

- ▶ For pneumatic (inflatable) tires if the tire lacks sufficient pressure, the wheelchair will be difficult to maneuver and less stable.
- ▶ The tire and wheel will also wear much more quickly.
- ▶ If you have inflatable tires, check the tire pressure by pressing down firmly on the tire with your thumb.
- ▶ If the tire is able to be pressed down more than 5mm (roughly the thickness of three pennies stacked together), add air with an air pump.
- ▶ A bicycle pump or pneumatic air pump can be used to inflate wheelchair tires.

**Ask:**

- ▶ How much do you pump the tires?

**Acknowledge answers.**

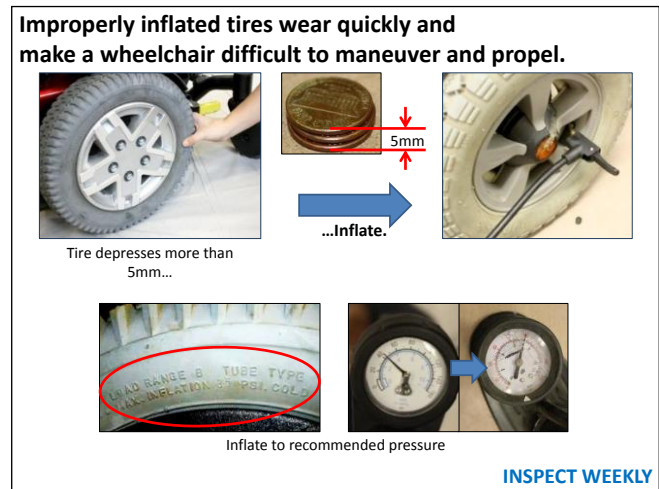
**Click to appear the next images on the slide.**

**Answer:**

- ▶ Refer to the user tire to determine what the recommended tire pressure is for your tires.

**Emphasize:**

- ▶ Sometimes users prefer to have the tires underinflated because it provides better suspension and the wheelchair doesn’t feel too “hard”.
- ▶ Please be aware that if this is your personal preference your tires will wear out quicker.
- ▶ This task should be performed **weekly**. Check more often during winter.



**Gather:**

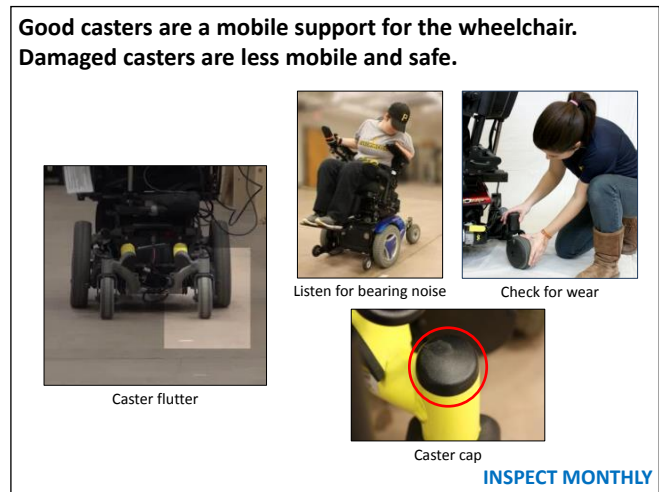
- ▶ Broken bearing. Wheelchair with caster flutter, if possible.

**Explain:**

- ▶ The casters have an important effect on the performance of the wheelchair.

**Demonstrate while describing:**

- ▶ Check for wear, cracks, and bulges on the caster wheels.
- ▶ Wear can negatively impact the maneuverability and stability of the wheelchair.
- ▶ Caster stem housing should be aligned vertically.



**Demonstrate while describing:**

Check while driving the wheelchair for wobbling of caster wheel and looseness.

**Click on the video on the left and explain (the video is also available in the DVD [casterflutter.wmv](#)):**

- ▶ Check for caster flutter.
- ▶ Fluttering is the term used to describe the shimmy or rapid vibration of the caster wheels.
- ▶ Excessive flutter can cause the wheelchair to move in an unwanted direction.
- ▶ This might cause a collision and injure the user.
- ▶ Contact a wheelchair maintenance expert to get repaired.

**Explain:**

- ▶ Bearings will wear out on a caster wheel during normal use.
- ▶ Problems in the bearings are identified when noises like clicking or grinding are present.
- ▶ They need to be replaced before they fail.

**Emphasize:**

- ▶ Caster wheels wear out faster than the drive tires.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Front wheel or rear wheel drive wheelchair with anti-tippers

**Explain while identifying and pointing out participants' wheelchairs with anti-tip casters present:**

- ▶ Anti-tip wheels may be located in the front or rear of the wheelchair.
- ▶ When they are in use and properly adjusted, if the wheelchair begins to tip over it is caught by the anti-tip casters.
- ▶ Therefore, they can help to prevent some tipping accidents.

**Demonstrate while describing:**

- ▶ Check that the anti-tip wheels are not loose and do not squeak or drag.
- ▶ If wheels are loose, tighten any screws until snug using an Allen wrench, open end box end wrench.
- ▶ Also, inspect that there are no cracks or the wheels are not wore out.
- ▶ If problems are identified, contact wheelchair maintenance expert to get the anti-tip replaced.
- ▶ This task should be performed **monthly**.

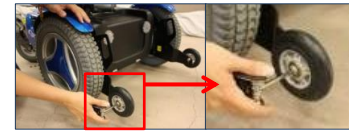
**Malfunctioning anti-tip casters can increase the risk of a tipping accident.**



Anti-tip casters



Spinning the anti-tip caster



Tighten if loose

**INSPECT MONTHLY**

**Gather:**

- ▶ Different type of cushions, e.g. foam, gel, air, etc.

**Explain:**

- ▶ Cushions are a very important component of the wheelchair AND
- ▶ Cushions do not last as long as the frame.
- ▶ The interaction between the cushion and the body determines the user's comfort, function, and clinical safety.



- ▶ Deterioration in the cushion can increase the risk of developing a pressure ulcer.

**Explain while demonstrating:**

- ▶ Remove the cover so you can inspect both cushion and cover.
- ▶ That means that you must be out of the wheelchair.
- ▶ Look for tears or holes in the cover or zipper malfunction, which might expose the cushion surface or create a wrinkled sitting surface.
- ▶ The cushion cover on the top right of the slide has a hole.
- ▶ If the cover contains a foam liner, look for tears or flaking in the foam.
- ▶ The cushion on the bottom right has flaking in the foam liner of the cover.
- ▶ The bottom of most covers has a Velcro or a nonskid surface.
- ▶ Inspect this surface for worn or torn Velcro or breakdown of the nonskid material.
- ▶ The cover is designed to protect the cushion, so it should be replaced if damaged.
- ▶ After inspecting the cover inspect the cushion for shape and contour.

**Explain:**

- ▶ There are many types of cushions.
- ▶ Depending of the type there are signs you should look for.
- ▶ We are going to discuss some examples.

**Explain while demonstration (if you have that type of cushion available):**

- ▶ Keep air cushions properly inflated.
- ▶ Inspect that the valve is in good condition and does not leak.
- ▶ If you suspect that there is a leak, remove the cover and submerge the cushion in water and look for bubbles.
- ▶ A rubber air cushion (e.g. ROHO) can be patched using the same procedure we saw for patching a tire.

**Ask:**

- ▶ Those of you who are using ROHO'S, do you have the patching kits that came with the cushion?

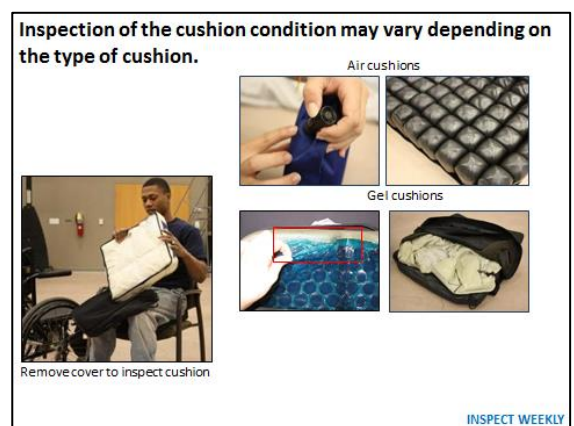
**Acknowledge answers.**

**Emphasize:**

- ▶ When you travel by air pay special attention to the cushion because the pressure will change. Always travel with a patch kit.

**Click to appear the next images on the slide and explain:**

- ▶ If you have a gel cushion, knead the gel daily so it moves under bony prominences.
- ▶ Inspect that the gel is not hard and also there are no leaks.
- ▶ An example of a worn out cushion can be seen on the left with the blue gel that is leaking.



**Click to appear the next image on the slide and explain:**

- ▶ If you have a foam cushion, inspect that the foam is intact and not deteriorated and chipping.
- ▶ When you press it, it should bounce back.

**Explain:**

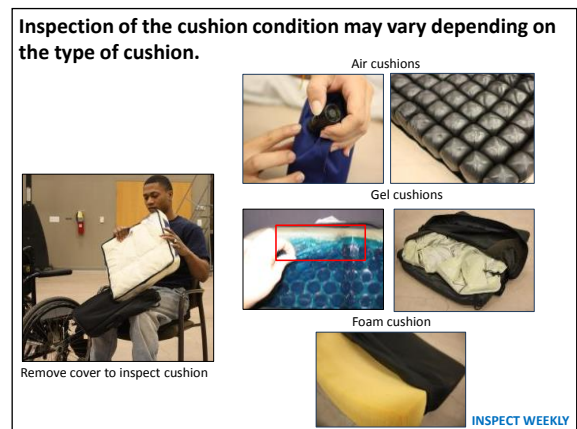
- ▶ If the cushion has a solid seat insert, check that it is not broken.

**Emphasize and show on the cushion you are holding:**

- ▶ Be aware of the direction of the cushion.
- ▶ After inspecting, place the cushion properly back on the wheelchair.

**Explain:**

- ▶ This task should be performed **weekly** and if problems are identified a wheelchair maintenance expert must be contacted immediately to get the cushion replaced. If a cushion is not replaced it may lead to unwanted consequences such as pressure sores.

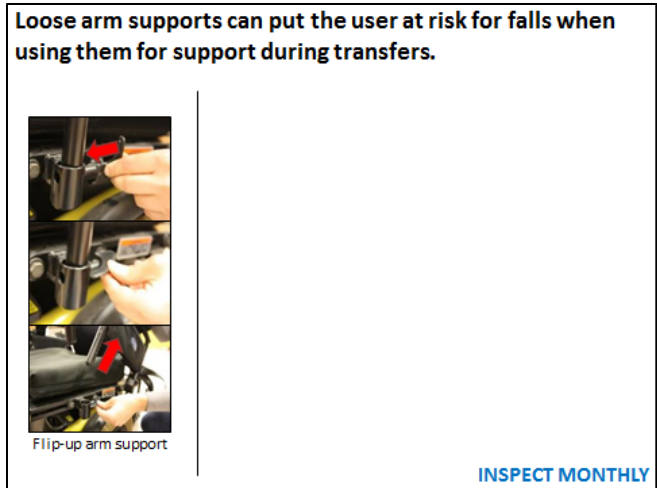


**Gather:**

- ▶ Wheelchair with loose and/or wore out arm support.

**Explain:**

- ▶ The primary purpose of the arm support is to provide good resting posture for the arms.
- ▶ In addition, arm supports provide a form of support and a place for users to grab on to when the leaning to one side or the other.
- ▶ They are also helpful when attempting to reach higher places and also assist some people with transfers.



**Explain while demonstrating on demo wheelchair and/or participants' wheelchair:**

- ▶ Arm supports can be fixed or adjustable.
- ▶ Most can be moved in order to provide clearance for transferring in and out of the wheelchair.
- ▶ They can be removed or flip back.
- ▶ Removable arm supports usually fit into two sockets.
- ▶ Commonly, the front socket contains a latch to lock the armrest in place.

**As seen on the images on the slide:**

- ▶ Flip back arm supports are hinged at the back near the intersection of the seat and backrest.
- ▶ Some flip back styles use a latch in the front to help secure them in place.

**Click to appear images on slide**



**Demonstrate while describing:**

- ▶ Inspect that the arm supports are intact, tightened and can be released (if originally designed to do so), put back into place with ease and latch easily.
- ▶ The supports should move freely, but not be too loose to rattle.
- ▶ Loose arm support can make the user fall when using them for support during transfers.
- ▶ Tighten with Allen wrench, open end box end wrench.
- ▶ Lubrication may be necessary in hinges/movable parts if the supports do not adjust easily.
- ▶ Inspect for sharp edges that could harm you.
- ▶ If a problem is identified, contact the wheelchair maintenance expert.
- ▶ This inspection should be performed **monthly**.



**Gather:**

- ▶ Wheelchair with loose and/or worn out head support

**Explain:**

- ▶ Users may require head and neck supports to provide the necessary stability required to control a power wheelchair and to prevent the head from extending beyond the plane of the back support.



- ▶ This is especially important if the seating system is tilted or reclined.

**Point out the different head supports in participants' wheelchairs while explaining:**

- ▶ There are many types of head supports including: flat, flip-down, removable, curved, winged, vertical wedge, U-shaped, lateral, among others.
- ▶ Head supports are mounted to the seating system using adjustable hardware so that the support can be moved, adjusted, and removed as needed.

**Demonstrate while explaining:**

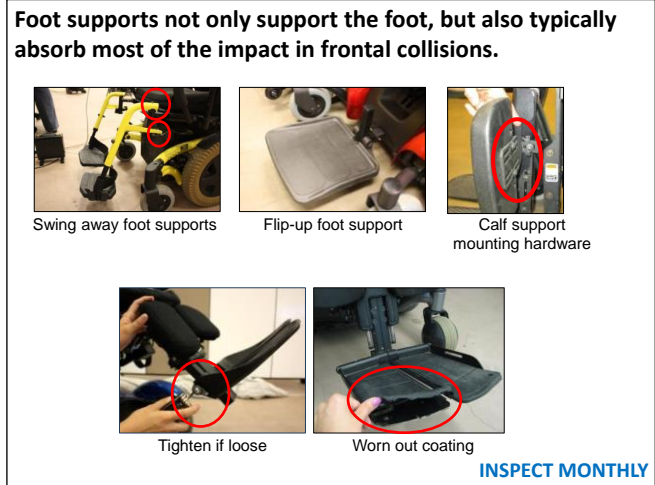
- ▶ Check that the head support is properly tightened and intact.
- ▶ If the head support is designed to move, it should move freely, but not be too loose that it rattles.
- ▶ Loose and/or worn out head supports can be uncomfortable, do not provide appropriate postural support, or can fall out.
- ▶ Tighten loose bolts using an Allen wrench, open end box end wrench.
- ▶ Lubrication may be necessary in hinges/movable parts if the supports do not adjust easily.
- ▶ If problems are identified contact the wheelchair maintenance expert.
- ▶ This inspection should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with loose and/or wore out foot support

**Explain:**

- ▶ Foot supports are used to support the feet and legs.
- ▶ There are different foot supports that can flip up or down, swivel, elevate, or can be removed.



**Point out the different foot supports in participants’ wheelchairs.**

**Explain:**

- ▶ Often the foot supports are the first part of the wheelchair to come in contact with an obstacle.
- ▶ They are used to open doors, act as bumpers, and also scraped along the ground when the wheelchair is loaded into a motor vehicle.
- ▶ Swing-away foot supports are not as durable as rigid foot support.
- ▶ It is common that swing away foot support bend upon impact.

**Explain while pointing the image on the top left:**

- ▶ Inspect the swing away foot supports, look for wear in the pins, bolts and bushings.

**Demonstrate while describing:**

- ▶ Inspect that the foot supports are intact, are tightened and can be released (if originally designed to do so), put back into place with ease and latch easily.
- ▶ You can use a screwdriver or wrench or Allen wrench to tighten loose bolts.
- ▶ Lubrication may be necessary in hinges/movable parts if the supports do not adjust easily.
- ▶ If problems are identified, contact the manufacturer.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with damaged back support.

**Explain:**

- ▶ Back supports provide comfort and postural support while sitting.

**Point out the different back supports in participants' wheelchairs while explaining:**

- ▶ Back supports can be sling upholstery or rigid.



**Demonstrate while describing:**

- ▶ For upholstery back support, inspect it for wear, tears, stretched upholstery, or metal parts that may be sticking out.
- ▶ Inspect all upholstery rivets or screws and check that the upholstery is not tearing in those spots.
- ▶ Loose upholstery may provide less postural support and can lead to deformities. Contact a wheelchair maintenance expert to replace the upholstery when these problems are identified.

**Advise:**

- ▶ When the upholstery is replaced, it is best to replace the bolts or screws that hold it in place. This will ensure that they are properly maintained as well. Encourage your wheelchair maintenance expert to do so.

**Demonstrate while describing:**

- ▶ For rigid back supports inspect that the surface is intact. If the fabric is worn out and/or the foam is rigid, contact the wheelchair maintenance expert to get a replacement. Inspect that the back support hardware is properly attached to the back support canes and do not rattle. Tighten loose bolts with a screw driver, Allen wrench, or wrench.

**Demonstrate while describing:**

- ▶ For both rigid and sling back supports. Inspect that the back support posts are attached tight and do not rattle. If loose, tighten the bolts/nuts and if problems continue contact the wheelchair maintenance expert.
- ▶ This task should be performed **monthly**.

**Gather:**

- ▶ Wheelchair with several supports (e.g. thigh, trunk, pommel).

**Explain:**

- ▶ Proper seating can improve a person’s stamina and provide greater comfort.
- ▶ Supports are used to align and hold a person in a manner that improves seated posture and alignment while maintaining or improving function.

**Point out participants wheelchairs to demonstrate types of postural supports such as:**

- ▶ These include: abductor pommels, hip adductors, leg abductors, leg adductors, and lateral trunk supports.

**Demonstrate while explaining:**

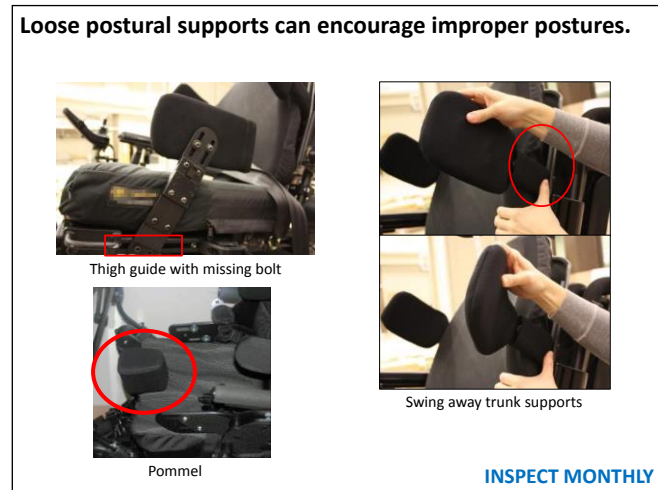
- ▶ If the supports are swing-away or flip-up, inspect that they move freely, but are not too loose to rattle.
- ▶ If they are fixed, inspect that they are tightened.
- ▶ Loose nuts and bolts can eventually work themselves all the way out, and could cause the support to fall off.
- ▶ However, over tightening a loose nut or bolt could damage the housing and/or break the bolt.
- ▶ Tighten loose bolts using an Allen wrench, open end box end wrench.

**Emphasize:**

- ▶ After tightening be aware of red spots on the skin that is in contact with the support.
- ▶ If red spots are found, loosen the support and contact the wheelchair maintenance expert.

**Demonstrate while explaining:**

- ▶ Inspect that the fabric and cushioning of the support are intact.
- ▶ Hard supports may be uncomfortable and increase pressure to the skin that they are in contact with. This can increase the risk of pressure sores.
- ▶ If problems are identified, contact the wheelchair maintenance expert.
- ▶ This task should be performed **monthly**.



**Gather:**

- ▶ Wheelchair with frail seat belt.

**Explain:**

- ▶ Pelvic support and positioning can be achieved using a pelvic belt or lap belt, which can prevent or correct a slouching posture and prevent the person from sliding forward on the seat.

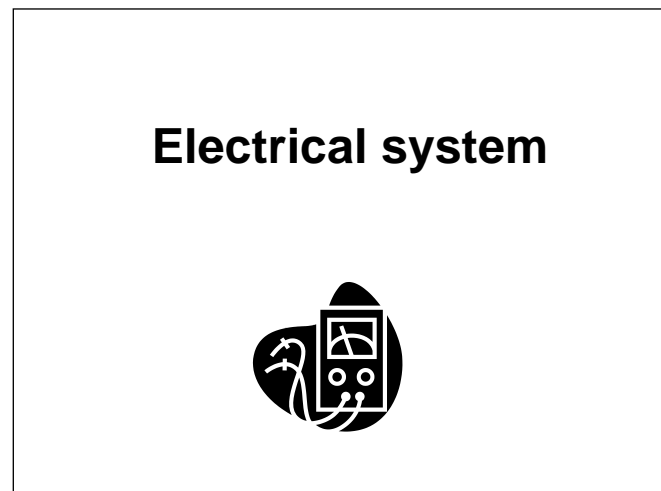
**Demonstrate while describing:**

- ▶ Check that the buckle latches and the hardware that attaches the strap to the frame are undamaged. Inspect the strap and velcro (when applicable) for any signs of wear.
- ▶ The strap, buckle, and hardware should all be in good condition.
- ▶ The latch on the belt should not slip or become unlatched inadvertently.
- ▶ Contact a wheelchair maintenance expert if problems are identified.
- ▶ This task should be performed **monthly**.



**Explain:**

- ▶ Power wheelchairs must have a properly operating electrical system to be functional.
- ▶ This requires periodic inspection of cables, connectors, interfaces, the battery charger, and all electrical components.
- ▶ Minor damage to battery cables, motor connectors, or interface connectors can lead to severe problems if not addressed.



**Gather:**

- ▶ Power wheelchair with at least one power seat functions.

**Explain while demonstrating:**

- ▶ Inspect that the full range of controls, indicators, driving, and horn are working smoothly and consistently.

**Explain while demonstrating:**

- ▶ Power seat functions are options that benefit people who are unable to move or reposition themselves effectively independently.
- ▶ These options redistribute pressure, manage posture and tone, provide comfort, and help with personal care activities.
- ▶ When inspecting that the power seat functions first tilt, then recline and finally elevate the legs.
- ▶ If the power seat function(s) malfunctions, the user can be left in an unsafe position for driving or at risk of pressure sores.
- ▶ Contact a wheelchair maintenance expert if you identify problems such a grinding noises, jerking, or not working consistently.

**Advise:**

- ▶ When checking full range power seat functions, check that the wheelchair is not poking the shrouds, also that hanging items (e.g. backpacks) are not in the way.

**Ask:**

- ▶ Those who have power seat functions, how often do you use the power seat functions to their full range?

**Acknowledge answers.**

**Answer:**

- ▶ We recommend this inspection should be done every day while you use your wheelchair.

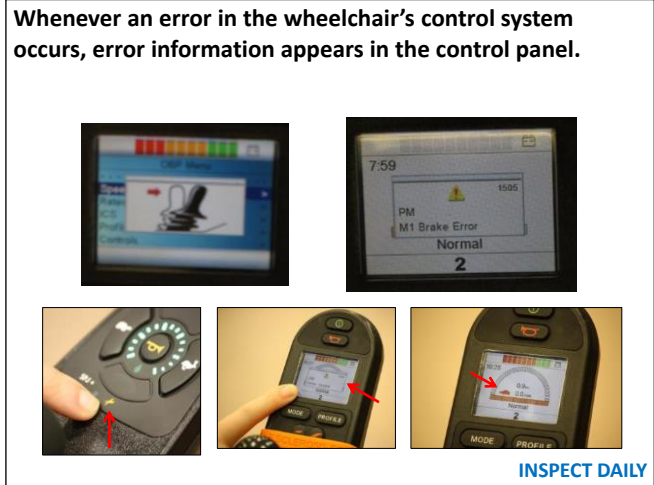


**Gather:**

- ▶ User manual to be used in demonstrating errors.

**Explain:**

- ▶ Whenever an error in the wheelchair's control system occurs, error information appears in the control panel.
- ▶ This may vary depending on the type of wheelchair.



**Release the motor disengage lever and turn on the wheelchair.**

**Demonstrate while describing:**

- ▶ Follow these steps when an error is displayed:
  1. Read the error and act accordingly.
  - ▶ If you do not understand the error or the error persists:
    2. Turn off the wheelchair.
    3. Turn the wheelchair back on.
    - ▶ If error persists, note the error and/or number of blinking lights and refer to user's manual for further instructions.

**Explain:**

- ▶ Be aware of any errors that are displayed.
- ▶ Contact the wheelchair maintenance expert if you are not able to fix the error displayed.



**Explain:**

- ▶ Brake failure is a serious problem that can result in severe injury.
- ▶ If you feel that your brakes are not working properly, you can try the following strategies to inspect them:

**Demonstrate while explaining:**

- ▶ Turn down the speed.
- ▶ Push the joystick forward until you hear the brakes click, then immediately (choose one):
  - Release joystick.
  - Put joystick in reverse.
  - Turn the wheelchair off (recommended). This is the only way to check if it brakes immediately.

**Explain:**

- ▶ Inspect daily.
- ▶ If problems are identified, contact a wheelchair maintenance expert immediately.

**Brake failure is a serious problem that can result in severe injury.**

Turn down the speed



Push the joystick forward



Release



**INSPECT DAILY**

**Gather:**

- ▶ A power wheelchair with motor noise if possible.

**Explain:**

- ▶ The motors are the heart of any power wheelchair.
- ▶ They convert the electrical energy of the batteries to mechanical work.
- ▶ In many cases one motor is used to drive each wheel.

**Motor failure can leave the wheelchair user stranded.**



INSPECT DAILY

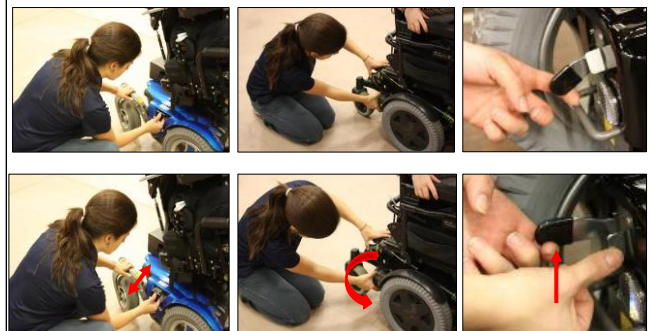
**Turn on the wheelchair and drive it while explaining:**

- ▶ Listen to your motor.
- ▶ It is a good idea to become familiar with the healthy sound of your wheelchair when it is new.
- ▶ Over time, just like a car, it will become a little noisier, but if your ear is tuned to how it sounds when it is healthy, you will be able to notice when there is excessive noise.
- ▶ Increased noise might indicate worn bearings, out of line belts or gears, or frame problems.
- ▶ If the wheelchair has two motors, each should sound the same.
- ▶ Motor failure can leave the wheelchair user stranded.
- ▶ If any unfamiliar or unrecognized noises are heard, contact a wheelchair maintenance expert.
- ▶ This task should be performed **every day**.

**Demonstrate while describing:**

- ▶ Inspect that the wheelchair cannot manually move when the lever is engaged and it can be moved when it is disengaged.
- ▶ There are different types of motor disengage lever.
- ▶ Motor lever failure can leave the wheelchair user stranded as well as injured.
- ▶ This task should be performed **every day**.
- ▶ If problems are identified, contact a wheelchair maintenance expert.

**Motor lever failure can leave the wheelchair user stranded as well as injured.**



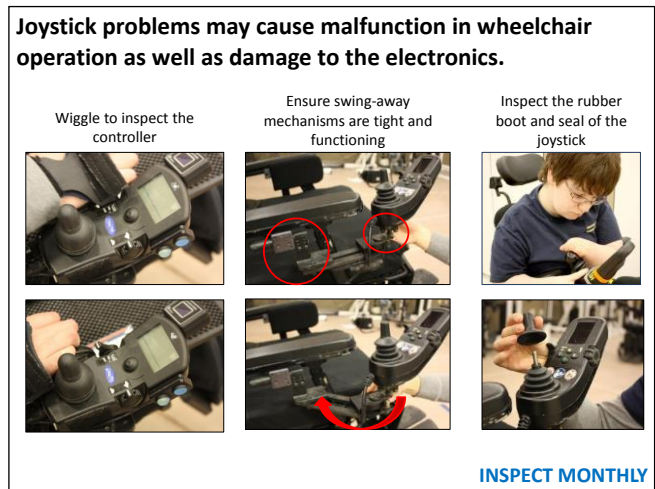
INSPECT DAILY

**Gather:**

- ▶ Gallon plastic bag.

**Explain:**

- ▶ Joysticks are the most common control interface between the user and the wheelchair.
- ▶ Joysticks and switches can be used to effectively control a power wheelchair.
- ▶ Joystick problems may cause malfunction in wheelchair operation as well as damage to the electronics.



**Demonstrate while describing:**

- ▶ Turn OFF the controller.
- ▶ Check the joystick and rubber boot around the base of the joystick for damage.
- ▶ Check that the joystick returns freely to neutral without binding.
- ▶ Check that the seal on the joystick is intact; it keeps dirt and water out. Check that all switches and controls are tightly in place.
- ▶ Check that the controller clamp holds the joystick firmly in place.
- ▶ If found loose, tighten appropriately.
- ▶ Contact a wheelchair maintenance expert immediately if problems are identified.

**Explain while demonstrating:**

- ▶ There are tips to avoid excessive moisture in the controller:
- ▶ Always carry a gallon plastic bag to cover the joystick and controller if it rains, to prevent moisture accumulation.
- ▶ If the joystick/controller gets wet, use a hair dryer to blow through the charge/controller plug.
- ▶ This task should be performed **monthly**.

**Gather a battery charger:**

- ▶ Batteries are the fuel system for power wheelchairs.
- ▶ If the batteries do not work properly, the wheelchair will not work properly.
- ▶ Maintaining the batteries is vital to the performance of the wheelchair.

**Demonstrate while describing:**

- ▶ It is important that the appropriate charger be used with each battery set.
- ▶ Only use the charger that came with the wheelchair.
- ▶ Inspect the battery charger cable.
- ▶ This task should be performed **monthly**.
- ▶ If problems are found contact a wheelchair maintenance expert.

**A damaged charger can decrease the wheelchair battery life.**



**INSPECT MONTHLY**

**Gather:**

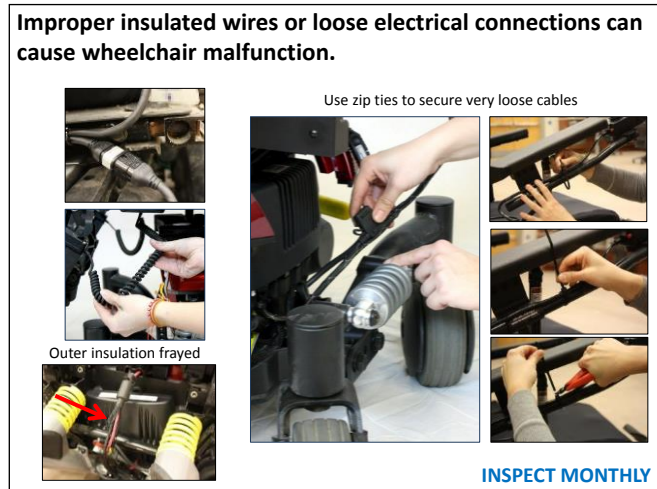
- ▶ Zip ties and wheelchair with loose cables.

**Explain:**

- ▶ Wires and connectors are part of the wheelchair's electrical system.

**Demonstrate while describing:**

- ▶ Check all electrical connections to ensure they are firmly in place and free of grime and corrosion. Connectors can loosen with bumps and vibration.
- ▶ Inspect that they are firmly connected.
- ▶ Corrosion can render connectors useless, resulting in motors that will not drive or batteries that will not charge.
- ▶ Inspect that all cables and wires are intact.



**Click to appear next images on the slide.**

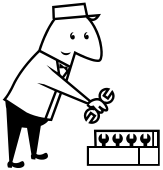
**Demonstrate while describing:**

- ▶ Check wires to make sure they are safely away from all moving parts such as belts, gears, and wheels, with no chance of being caught or tangled.
- ▶ It may be necessary to tie cables down to the frame or in a bunch.
- ▶ Use cable ties for this purpose.
- ▶ If the wheelchair has power seat functions, ensure that cable ties do not restrict the seat positioning.
- ▶ Wires that become caught in moving parts can become disconnected or even snap.
- ▶ Inspect that wires and cables are intact and not frail.
- ▶ Contact a wheelchair maintenance expert if problems are identified.
- ▶ This task should be performed **monthly**.

**Explain:**

- ▶ Action items are maintenance activities that the wheelchair user or caregiver performs on the wheelchair.

**Action items:** Maintenance activities that the wheelchair user or caregiver performs on the wheelchair



**Read the summary of the action items and explain:**

- ▶ We will go over in detail on how to complete each action item.
- ▶ Blue is daily
- ▶ Red is monthly.
- ▶ Purple once a year.

**Caring for a power wheelchair at home: Action items**

<u>Actions to maintain a power wheelchair</u>	
Charge batteries	
Cleaning your wheelchair	Wheelchair and cushion
	Caster axle
	Power seat functions
Have wheelchair professionally serviced	

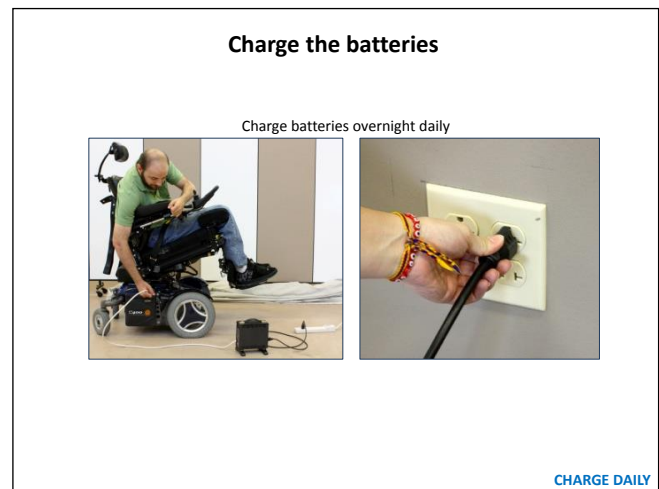
■ Daily actions  
■ Monthly actions  
■ Yearly actions

**Gather:**

- ▶ Battery charger.

**Explain:**

- ▶ Batteries are the fuel system for power wheelchairs.
- ▶ If the batteries do not work properly, the wheelchair will not work properly.
- ▶ Maintaining the batteries is vital to the performance of the wheelchair.
- ▶ Batteries last longer if they are never run completely flat.
- ▶ However, charging too frequently when the batteries have only been used a little will also decrease the batteries' life.
- ▶ Only the charger provided with the wheelchair should be used.
- ▶ Batteries should be stored fully charged.
- ▶ A well-maintained battery should last from 1 to 1.5 years.
- ▶ If the batteries are having difficulty keeping a charge, contact a wheelchair maintenance expert.
- ▶ Batteries **must** be installed and maintained by a wheelchair maintenance expert.

**Ask participants:**

- ▶ How often do you charge your battery?

**Acknowledge answers.****Answer:**

- ▶ If you use the wheelchair everyday charge it everyday.
- ▶ If going on vacation and not using it or if you are sick and not using it, leave it charging.

**Gather:**

- ▶ Wheelchair, rag and bucket with water.

**Demonstrate while describing:**

- ▶ Wipe down the wheelchair frame with a clean, damp rag and soap.

**Emphasize:**

- ▶ The rag should be moist and not soaked.
- ▶ Remove the fabric covers that the frame may have and the calf straps if possible.
- ▶ Cleaning the wheelchair may stop metal parts from rusting and may stop damage caused by dirt scraping against moving parts.
- ▶ **Note** that taking the wheel off makes cleaning that side of the frame easier.
- ▶ Take the cushion cover off if possible and wash in the washer. Refer to the cushion user guide for cushion washing instructions.



**Emphasize:**

- ▶ Do not machine dry the cover.
- ▶ The fabric may shrink and not fit the cushion anymore. Instead, dry over a towel in the shade, avoid direct sunlight.
- ▶ Be sure to put the cover back on the cushion the correct way.
- ▶ Refer to the cushion user guide for cushion washing instructions.
- ▶ Dirt on the cushion can cause skin breakdown.
- ▶ Dirt can cause odor on both the wheelchair and cushion.

**Ask:**

- ▶ How often do you clean your wheelchair and cushion?

**Acknowledge answers.**

- ▶ This task should be performed **monthly**, or **twice a month** if you are in inclement weather



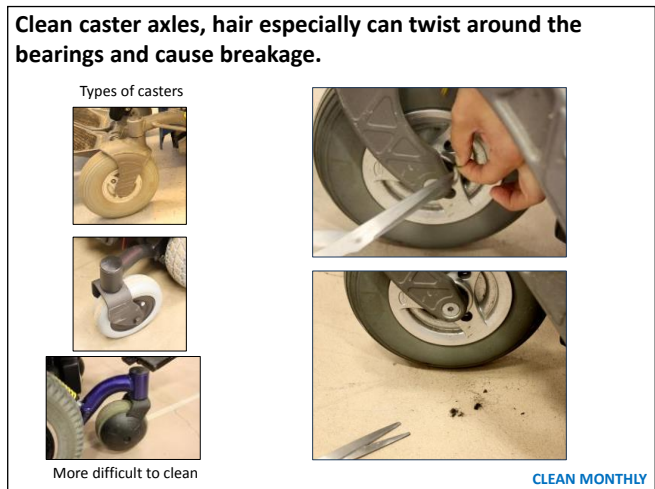
**Gather:**

- ▶ Wheelchair, scissors and toothbrush.

**Explain:**

- ▶ There are different types of casters and some are easier to clean than others.

**Point out on participants wheelchairs which ones are more difficult to clean. Emphasize that these larger plastic hubs are designed to keep dirt away.**



**Demonstrate as you describe:**

- ▶ Remove dirt, lint, and hair from the caster axles bearings with scissors, tweezers, toothbrush, or pliers.
- ▶ Dirt, lint, or hair buildup on the axles and casters can eventually cause premature wear.
- ▶ Hair especially can twist around the bearings and cause breakage.

**Ask:**

- ▶ How often do you clean your caster axles?

**Acknowledge answer.**

**Explain:**

- ▶ Dirt and lint should be removed **monthly**, or **twice a month** if you are in inclement weather or have pets.

**Gather:**

- ▶ Wheelchair with all power seat functions and a dry rag.

**Explain**

- ▶ If the power seat function(s) malfunction the user can be left in an unsafe position for driving or at risk of pressure sores.

**Demonstrate while explaining:**

- ▶ Excessive dirt build-up can make the tracks wear over time and may stop working.
- ▶ Clean the power seat functions and all the tracks (including tilt, recline, leg support elevator, and seat elevator) with a dry soft cloth.
- ▶ The seat should be at the maximum range.

**Click to appear next images on slide.**

**CAUTION:**

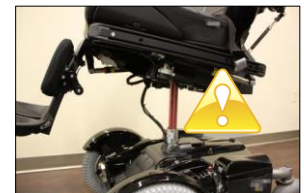
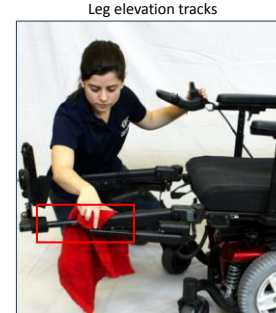
- ▶ If there is grease/lubricant on the track do not clean it.
- ▶ An example is the red grease on the seat elevation mechanism on the wheelchair on the right.
- ▶ This task should be performed **monthly**.

**Power seat function(s) malfunction the user can be left in an unsafe position for driving or at risk of pressure sores.**



CLEAN MONTHLY

**Power seat function(s) malfunction the user can be left in an unsafe position for driving or at risk of pressure sores.**



CLEAN MONTHLY

**Explain:**

- ▶ All wheelchairs should be professionally serviced at least once a year.
- ▶ The cost of this will depend on the wheelchair expert.
- ▶ It may not be reimbursed by a health insurance.

All wheelchairs should be professionally serviced at least **once a year**.

In places with inclement weather conditions, wheelchairs should be professionally serviced **twice a year**.



**5. Summary (5 minutes)**

**Remind participants:**

- ▶ Today we recognized the importance of wheelchair maintenance.
- ▶ Also, we reviewed each maintenance task and how frequent it should be performed.

**Inquire:** If there are any unsolved questions.

**Acknowledge them and answer.**

**If there are unsolved questions, search and prepare the answers for the second session.**

**Learning Objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks
- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

**Remind:**

- ▶ The participants that they have the option to take the toolkit and maintenance cards home but they need to bring it back next session or we can keep them so they do not forget to bring them.

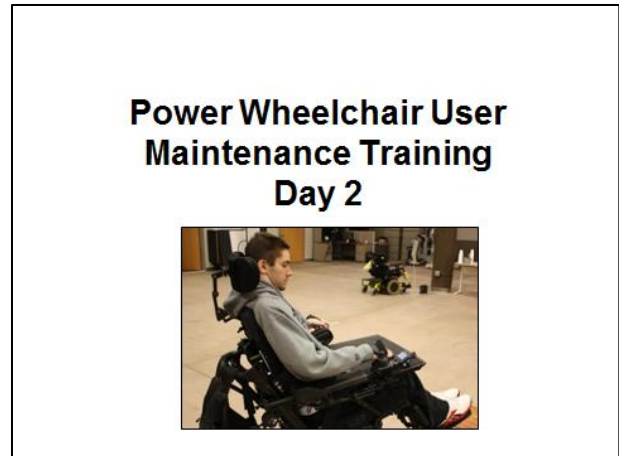
**Thank you!  
See you next class**



**6. Hands-on wheelchair maintenance activity (90 minutes)**

- ▶ **Welcome** the wheelchair users and thank them for participating in this training program.
- ▶ **Remind** participants your name and your co-trainer’s if you have one.
- ▶ **Answer** any unsolved questions from the first session before starting.

**Read the activities that will happen during this training session.**



Day	Duration (minutes)	Time	Activity
2	90		Hands-on wheelchair maintenance activity
	20		Summary and discussion
	5		Adjournment

**Gather:**

- ▶ 1 bucket with water and mild soap for every pair of participants.
- ▶ 1 rag per participant.

**Form pairs between the participants. Try to pair up participants with different personalities, for example, a more talkative one with a shy participant.**

**Explain:**

- ▶ Each one of you will perform the maintenance on your own wheelchair.
- ▶ I will pair you up so you can perform the maintenance at the same time and support each other if needed.
- ▶ If you prefer not to do so you can practice the skills on the demo wheelchair that I have used through the training.
- ▶ We (you and the aids) will walk around the room and provide any assistance and answer questions as needed.

**Hands-on wheelchair activity**

- Bring your maintenance checklist and toolkit
- If you identify maintenance issues on your wheelchairs, write them down on *hands-on activity sheet*
- You will have 90 minutes to perform this activity
- Let us know if you have questions or need assistance

**Gather:** a checklist per participant and at least an erasable marker per pair.

**Explain:** We will perform the inspection and action items starting on the bottom section of the wheelchair moving to middle section and then finishing on the top section. Please follow the order on the laminated checklist that we have provided. Use the marker to check the activities

**Hands-on wheelchair activity**

REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY

Maintenance activities	Activity done	Mark if Not applicable	Frequency
<b>Lower section</b>			
Inspect tires	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
If pneumatic tires, inspect tires' pressure	<input type="checkbox"/>	<input type="checkbox"/>	Weekly
Inspect casters	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Clean caster axles	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect arm tips	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect motor disengage levers	<input type="checkbox"/>	<input type="checkbox"/>	Daily
Inspect frame	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect shrouds	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect foot supports	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect leg supports	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect suspension elements	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
<b>Middle section</b>			
Inspect arm support	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect thigh support	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect seat-position strap and buckle	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect cushion and cover	<input type="checkbox"/>	<input type="checkbox"/>	Weekly
Wipe down cushion and cover	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect seat base	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect controller and joystick	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect motor noise	<input type="checkbox"/>	<input type="checkbox"/>	Daily
Inspect driving and braking	<input type="checkbox"/>	<input type="checkbox"/>	Daily
Inspect power seat functions	<input type="checkbox"/>	<input type="checkbox"/>	Daily
Clean power seat functions mechanism and track	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect all other controls, indicators, and horn	<input type="checkbox"/>	<input type="checkbox"/>	Daily
Inspect wiring and electronic connections	<input type="checkbox"/>	<input type="checkbox"/>	Monthly

that you have done. If your wheelchair does not have a part, check the box under mark if not applicable. We will have up to one hour and a half.

Let’s start with the bottom section by inspecting the tires.

**Keep track of time, there are maximum 90 minutes for this portion of the session.**

101

Continue to cue the participants so they change from one activity to the next one and they do not fall behind. Leave this slide up while you monitor participants work.

Once all participants have completed the bottom and middle section, click to the next slide. Note questions than participants have and share them with all the participants on the next session.

**Explain:**

- ▶ Now we will finish with the top section.
- ▶ Let’s inspect the back support.
- ▶

Continue to cue the participants so they change from one activity to the next one and they don’t fall behind. Remember you have maximum 90 minutes for the hands-on activity. Leave this slide up while you monitor participants work. Once all participants have completed all the top section, click to the next slide. Note questions than participants have and share them with all the participants on the next session.

## Hands-on wheelchair activity

REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY

Maintenance activities	Activity done	Mark if Not applicable	Frequency
<b>Top section</b>			
Inspect back support	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Wipe down back support	<input type="checkbox"/>	<input type="checkbox"/>	Monthly
Inspect trunk supports	<input type="checkbox"/>	<input type="checkbox"/>	Monthly

**7. Summary and discussion**

Summarize the questions that were raised during the hands-on activity.

Encourage participants to answer these questions and acknowledge their answers.

Clarify confusing points.

Ask the less talkative participant from each pair to share with the group what up to two problems that were identified and how to address them (hint: they should have written them down in the hands-on activity sheet).

Acknowledge answers and clarify confusing points.

## Summary and discussion

**Explain:**

- ▶ We will summarize all the inspection activities we learned and practice during these two sessions.
- ▶ You can follow this summary using the maintenance cards in your toolkit.

**Encourage** participants to ask any additional questions that they think remain unanswered.

**Read the slide.**

Daily

<b>Inspection</b>	<b>Action</b>
<ul style="list-style-type: none"> <li>- Control, indicator, horn</li> <li>- Motor noise</li> <li>- Motor disengage lever</li> </ul>	<ul style="list-style-type: none"> <li>- Charge battery</li> </ul>

Maximum estimated time: 5 minutes

**Read the slide.**

Weekly

**Inspection**

- Cushion and cover
- Pneumatic tires

Maximum estimated time: 10 minutes

**Read the slide and emphasize that nuts and bolts should be inspected on all the items listed here.**

Monthly

	<b>Inspection</b>	<b>Action</b>
Nuts and bolts	<ul style="list-style-type: none"> <li>- Frame and shrouds</li> <li>- Drive wheel</li> <li>- Casters</li> <li>- Anti-tippers</li> <li>- Supports: head, arm, back, etc.</li> <li>- Seat belt</li> <li>- Controller box</li> <li>- Batteries</li> <li>- Wires</li> </ul>	<ul style="list-style-type: none"> <li>- Wipe down wheelchair and cushion</li> <li>- Clean caster axle</li> <li>- Clean power seat function tracks</li> </ul>

Maximum estimated time: 60 minutes

**Read the slide.**

Yearly

**Action**

- Have wheelchair professionally serviced

*Estimated time: 60 minutes*

**8. Adjournment**

**Explain:** Briefly describe that the learning objectives mentioned at the beginning of the first session have been met.

**Learning objectives**

- Recognize the importance of completing wheelchair maintenance
- List the appropriate timing for wheelchair maintenance tasks
- Demonstrate methods for maintaining your wheelchair
- Demonstrate how to identify common technical wheelchair problems

**Explain:**

- ▶ That as part of their participation in the study, they will receive 4 reminders throughout the year.
- ▶ They can chose up to 2 formats of reminders.

**Read the information that the participants will receive in the reminder.**

**Read the reminders page and ask participants to fill it out.**

**Reminders**

REMINDERS

Date: \_\_\_/\_\_\_/\_\_\_

Name: \_\_\_\_\_

▶ Please choose at least one but not more than two types of reminders that you would like to receive related to your wheelchair maintenance tasks. Reminders will be sent every three months for the duration of the study.

Email:  
Email address: \_\_\_\_\_

Text message:  
Cellphone number: \_\_\_\_\_  
Cellphone carrier (e.g. AT&T, Sprint, T-mobile, etc): \_\_\_\_\_

Phone-call:  
Telephone number: \_\_\_\_\_

Electronic calendar:  
Email address: \_\_\_\_\_

**Reminders**

Remember that regular maintenance is important for your wheelchair to perform properly. Review the maintenance cards that you received in your toolkit and be sure that you are following the directions in a timely manner. If you are in need of a repair, remember to contact a wheelchair maintenance expert.



**List and show** the resources that the wheelchair users are taking home.

**Remember you have with you**

- Maintenance cards
- Toolkit
- Reminders
  - Every 3 months for 1 year

**Point out that these are the main scientific article references.**

**Be willing to forward the copies of the articles if wheelchair users are interested.**

### References

Berg K, Hines M, Allen S. Wheelchair users at home: few home modifications and many injurious falls. *Am.J.Public Health* 2002;48.

Calder CJ, Kirby RL. Fatal wheelchair-related accidents in the United States. *Am.J.Phys.Med.Rehabil.* 1990;184-90.

Chen WY, Jang Y, Wang JD, Huang WN, Chang CC, Mao HF, Wang YH. Wheelchair related accidents: relationship with wheelchair-using behavior in active community wheelchair users. *Arch.Phys.Med.Rehabil.* 2011;892-8.

Gaal RP, Rebholtz N, Hotchkiss RD, Pfaelzer PF. Wheelchair rider injuries: causes and consequences for wheelchair design and selection. *J.Rehabil.Res.Dev.* 1997;58-71.

Hansen R, Tresse S, Gunnarsson RK. Fewer accidents and better maintenance with active wheelchair check-ups: a randomized controlled clinical trial. *Clin.Rehabil.* 2004;631-9.

Kirby RL, Ackroyd-Stolarz SA, Brown MG, Kirkland SA, MacLeod DA. Wheelchair-related accidents caused by tips and falls among noninstitutionalized users of manually propelled wheelchairs in Nova Scotia. *Am.J.Phys.Med.Rehabil.* 1994;319-30.

### References

McClure LA, Boninger ML, Oyster ML, Williams S, Houlihan B, Lieberman JA, Cooper RA. Wheelchair repairs, breakdown, and adverse consequences for people with traumatic spinal cord injury. *Arch.Phys.Med.Rehabil.* 2009;2034-8.

Nelson AL, Groer S, Palacios P, Mitchell D, Sabharwal S, Kirby RL, Gavin-Dreschnack D, Powell-Cope G. Wheelchair-related falls in veterans with spinal cord injury residing in the community: a prospective cohort study. *Arch.Phys.Med.Rehabil.* 2010;1166-73.

Wang H, Liu HY, Pearlman J, Cooper R, Jeffers A, Connor S, Cooper RA. Relationship between wheelchair durability and wheelchair type and years of test. *Disabil.Rehabil.Assist.Technol.* 2010;318-22.

World Health Organization. (Accessed 2013, May 8). *Trainers Manual for Wheelchair Service Training Package: Basic Level* [Online]. Available: <http://www.who.int/disabilities/technology/wheelchairpackage/en/>

World Health Organization. (Accessed 2013, May 8). *Reference Manual for Participants* [Online]. Available: <http://www.who.int/disabilities/technology/wheelchairpackage/en/>

Worobey L, Oyster ML, Nemunaitis G, Cooper R.A., Boninger M.L. Increases in Wheelchair Repairs, Breakdown, and Adverse Consequences for People with traumatic Spinal Cord Injury. *Am.J.Phys. Med.Rehab.* 2012;463-9.

## APPENDIX 1: BOLT BOARD INSTRUCTIONS

### Overview

The bolt board is designed to provide examples of common hardware and problems typical for wheelchairs. The board is divided into seven sections that demonstrate different parts.

### Important note

Occasionally these instructions call for the incorrect tool to turn a part. In these situations, the part should be very loose and easy to turn. Never force a part to turn when trying an incorrect tool.

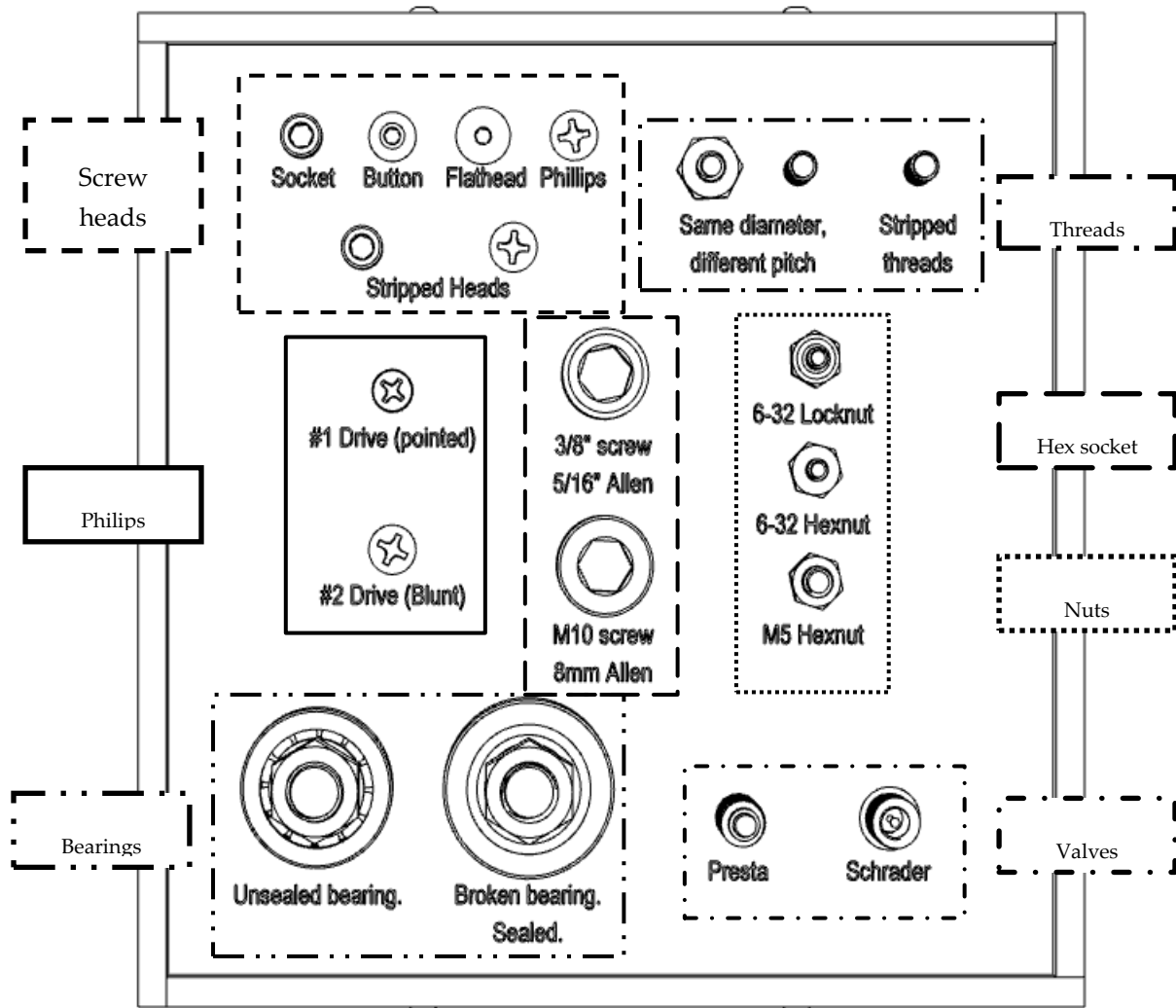


Figure 1: Bolt board sections

**Screw heads**

**Tools**

9/64” hex key

#2 Phillips head screwdriver

3/32” hex key (optional)

**Information**

Screws should always be turned with the appropriately sized tool. An inappropriately sized tool will strip the head of the screw, making it difficult or impossible to turn.

**Instructions**

Use the 9/64” Hex key to turn the good socket screw. Compare with the stripped socket screw.

Use the 3/32” hex key to turn the button and flathead screws, if desired.

Use the screw driver to turn the good Phillips screw. Compare with the stripped Phillips screw.

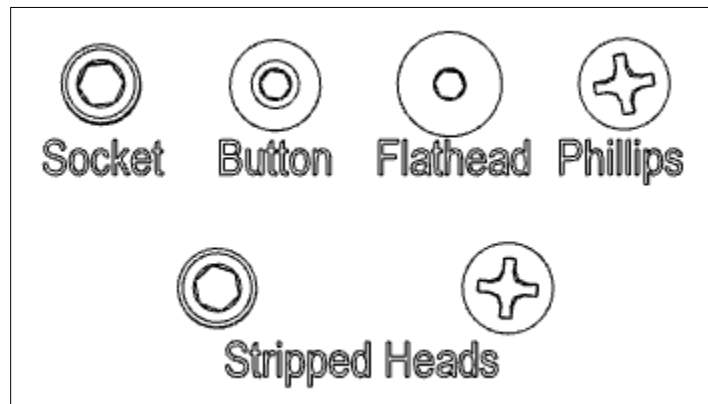


Figure 2: Close up of screw head section

## Threads

### Tools

3/8" wrench (optional)

Spare 10-32 hex nut (optional)

### Information

Threads are defined by diameter and pitch. Diameter refers to the width of the screw, while pitch refers to the distance between each thread.

Compare the two screws with the same diameter but different pitch. Note how the screw on the left has fewer threads per inch than the one on the right.

### Instructions

Try turning the nut on the middle screw. Since the nut and screw have the same size threads, they turn without problems.

Remove the hex nut from the middle screw.

Attempt to put the nut on the left screw, stopping at the first sign of resistance. DO NOT FORCE THE NUT. The nut should go about a half turn before seizing. Since the threads on the left screw are not the same as the threads on the nut, the nut will not go on this screw.

Attempt to put the nut on the right screw, stopping at the first sign of resistance. DO NOT FORCE THE NUT. The nut will turn until it reaches the stripped threads.

Place the nut back on the middle screw, turning until it is about halfway down the screw.

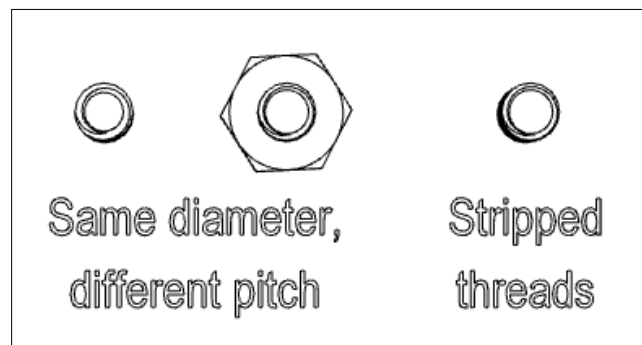


Figure 3: Close up of thread section

**Philips****Tools**

#1 drive Phillips screwdriver

#2 drive Phillips screwdriver

**Information**

Phillips head screws are designed to cam out in case of excess torque, making them extremely easy to strip. Therefore, it is important to choose the correctly sized tool.

Phillips tools are described by drive sizes in order of increasing size.

Most screws use a #1, #2, or #3 drive.

#1 has an almost pointed tip.

#2 has a blunt tip.

#3 has a large flat upper face with no defined tip.

If in doubt, try a larger drive.

**Instructions**

Use a #1 driver to turn the upper screw.

Use a #2 driver to turn the lower screw. Pay attention to how the drive feels in the screw.

Use a #1 driver to turn the lower screw. Note the looseness between the drive and the head.

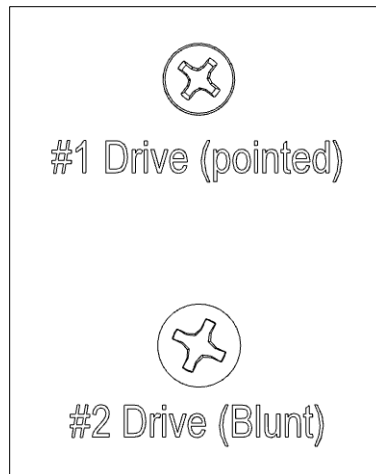


Figure 4: Close up of Phillips section

**Hex socket**

**Tools**

5/16" hex key

8mm hex key

**Information**

While screws with a hex socket are more resistant to stripped heads than Phillips drive screws, it is still a possibility.

Always make sure the key is fully seated in the socket. If the key is only in part way, the head could strip.

Always make sure the key is the correct size. A key that is too small may strip the head during high torque applications.

**Instructions**

Use the 5/16" hex key to turn both screws. Note the looseness of the hex key in the lower screw. Since 5/16" is smaller than 8mm, this key will turn the lower screw but could strip the head during tightening.

Use the 8mm hex key to turn both screws, if possible. Depending on the exactness of the screw and hex key, the upper screw may not accept the 8mm hex key.



Figure 5: Close up of hex socket section

**Nuts**

**Tools**

5/16" wrench

8mm wrench

**Information**

Hexnuts (top and bottom) are easy to turn, but once clamped down they work well in static situations.

Lock nuts (middle) are more difficult to turn and resist vibration.

**Instructions**

Use the 5/16" wrench to turn each nut, if possible. The top should fit well and turn easily. The middle should fit well but turn with some resistance. The bottom will be very tight or may not fit.

Use the 8mm wrench to turn the top and bottom nuts only. The top should be loose and the bottom should fit well, but both should turn easily.

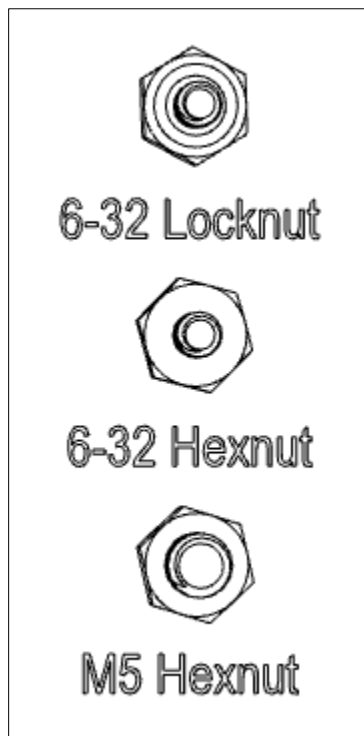


Figure 6: Close up of nut section

**Bearings****Tools**

9/16" wrench (optional)

**Information**

Bearings allow parts to rotate with minimal friction.

Many wheelchair bearings are ball bearings.

Ball bearings have balls held in place by a cage.

The outer and inner circular surfaces are called races.

Many bearings have plastic seals or metal shields to block dirt. Dirt can significantly increase the friction in a bearing.

**Instructions**

The bearings can be taken off the board by using the wrench to loosen the nuts, if desired.

Turn the two bearings. Note the feel of the left (good) bearing vs the right (bad) bearing.

Look at the unsealed bearing. Try to visually identify the balls, cage, and races.

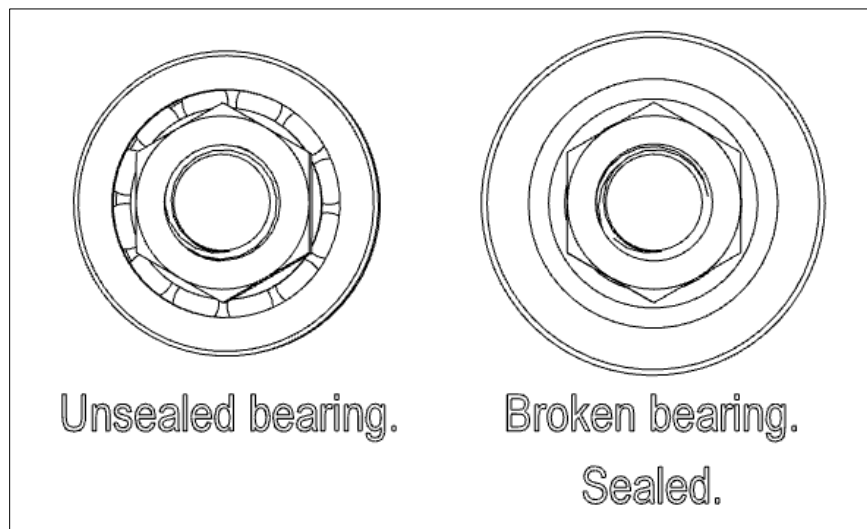


Figure 7: Close up of bearing section



**Valves****Tools**

Air pump with Schrader and Presta attachment

**Information**

Schrader and Presta valves are used on pneumatic tires.

Schrader valves are the same as the valves used on car tires. Many bicycles also use these valves.

Presta valves are also commonly used for road bicycles.

**Instructions**

To use the Presta valve, unscrew the nut and attach the pump. The board is not air tight, so you should hear air rush out.

To use the Schrader valve, just attach the pump.

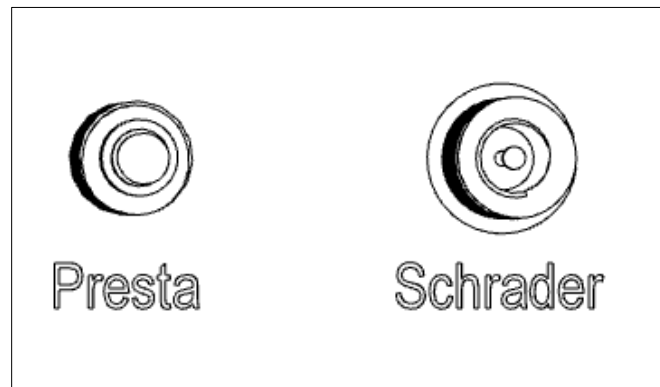
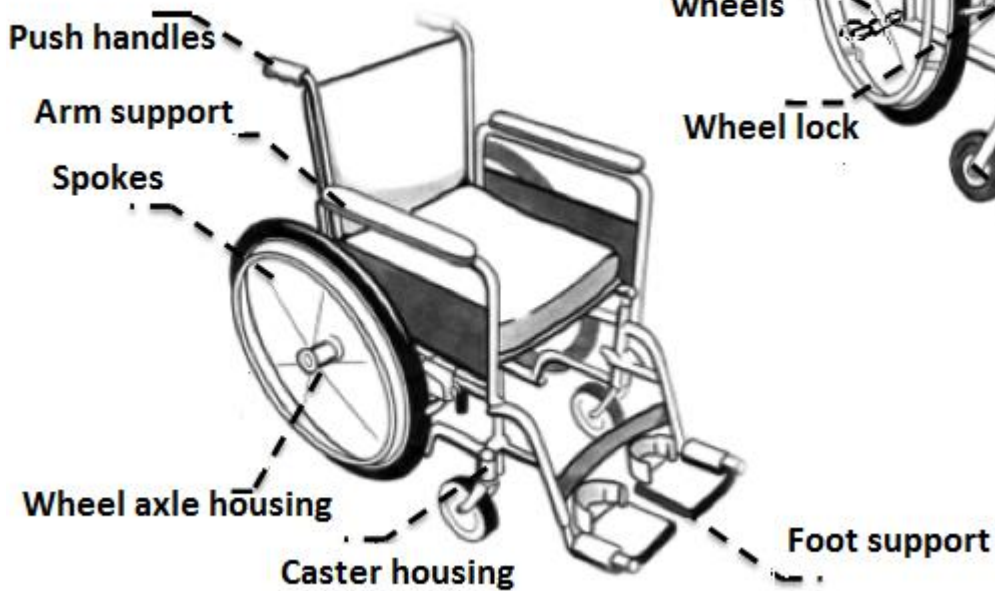
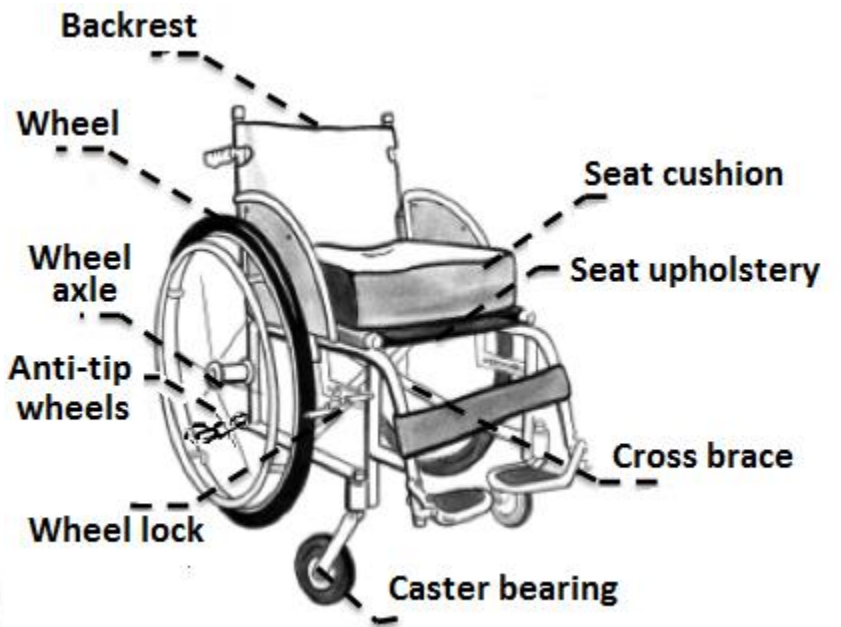
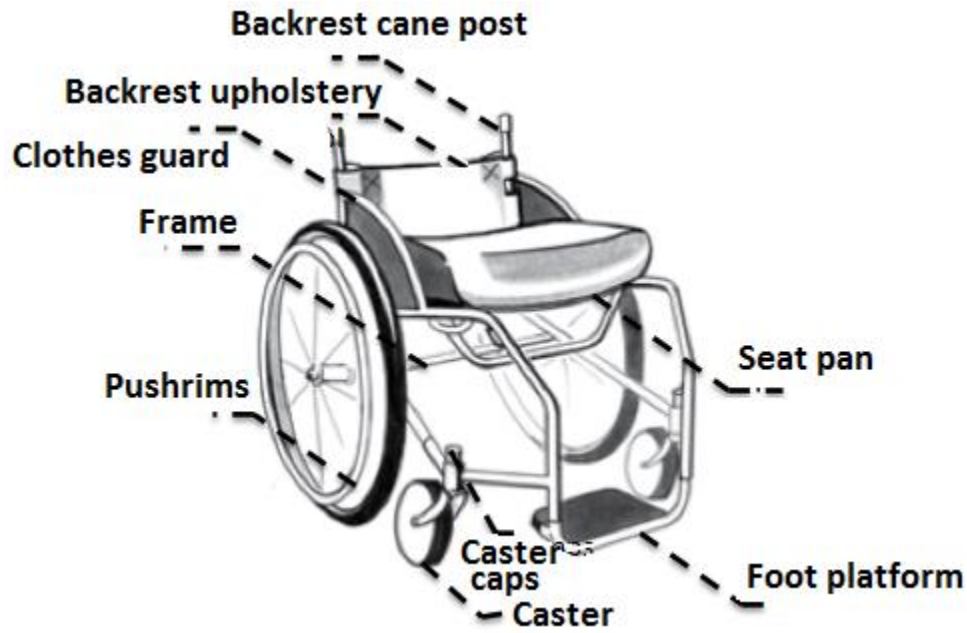


Figure 8: Close up of valve section

**APPENDIX 2: MANUAL WHEELCHAIR NOMENCLATURE**



**APPENDIX 3: SCHEDULE FOR MANUAL WHEELCHAIR MAINTENANCE**

<b>Frequency</b>	<b>Items to <u>check</u> to ensure proper manual wheelchair function</b>	<b>If problems identified, action(s) to take:</b>
Weekly	If pneumatic tires, check tire pressure	Inflate, patch or change inner tube if necessary
	Cushion and cover	Contact wheelchair maintenance expert
Monthly	Wheel locks function properly	Adjust. Contact wheelchair maintenance expert if unable to do so.
	Foot, leg, arm, and back support, anti-tip wheels, and side guards are tight, aligned, and function properly	Tighten if lose and align. Contact wheelchair maintenance expert if unable to do so or if not functioning properly.
	Wheel and caster bearings	Contact wheelchair maintenance expert
	Spokes	
	Wheels and casters alignment and condition	
	Quick release wheel functioning	
	Upholstery (including stitching and rivets)	
	Cracks: handrims, push handles, surface coating, and frame tubes and weld points	
	Cross brace functioning properly	
Suspension		

<b><u>Actions</u> to maintain a manual wheelchair</b>	<b>Frequency</b>
Wipe down wheelchair and cushion	Monthly, twice a month if inclement weather
Clean caster axle	
Clean quick release wheel axle housing	
Lubricate moving parts	Quarterly
Have wheelchair professionally serviced	Yearly, every six months if inclement weather

**APPENDIX 4: CHANGING MANUAL WHEELCHAIR TIRE INNER TUBES<sup>3</sup>****▶ To change tire inner tubes, you will need:**

- A pump compatible with the valve
- A tire pressure gauge (one built into the pump is the most convenient)
- Plastic tire levers (help to lift the tire bead over the rim)
- A patch kit with extra patches, rubber cement and a piece of sandpaper or a buffer

**▶ Tire and tube removal**

- Mark the tire next to the valve to help locate the puncture later.
- Let all the air out of the tire by pressing the little stem in the middle of the valve. (If you have a Presta valve, unscrew the top and press it in).
- Release the bead from the rim all the way around (it tends to stick).
- Then push the bead in towards the rim well.
- Unscrew the nut holding the valve to the rim (if it has one).
- Use tire levers to ease the tire off the rim.
- Pull the tube out of the tire.

**▶ Fixing the tube**

- Inflate the tube using the pump.
- Hold the tube close to your face to listen and feel for the air escaping (this is easier than looking). If you cannot find the puncture, submerge the tube in water and you will see the bubbles of escaping air from the puncture.
- When you find the puncture, scrape the area around it with the sand paper. This cleans the rubber and roughens it so that the patch adheres better; it also marks where the puncture is so you can find it again when the tube dries.
- Let the majority of the air out of the tube.

---

<sup>3</sup> Adapted from: Denison I. 2006. Wheelchair maintenance series.

[http://www.assistive-technology.ca/studies/wm\\_full.pdf](http://www.assistive-technology.ca/studies/wm_full.pdf)

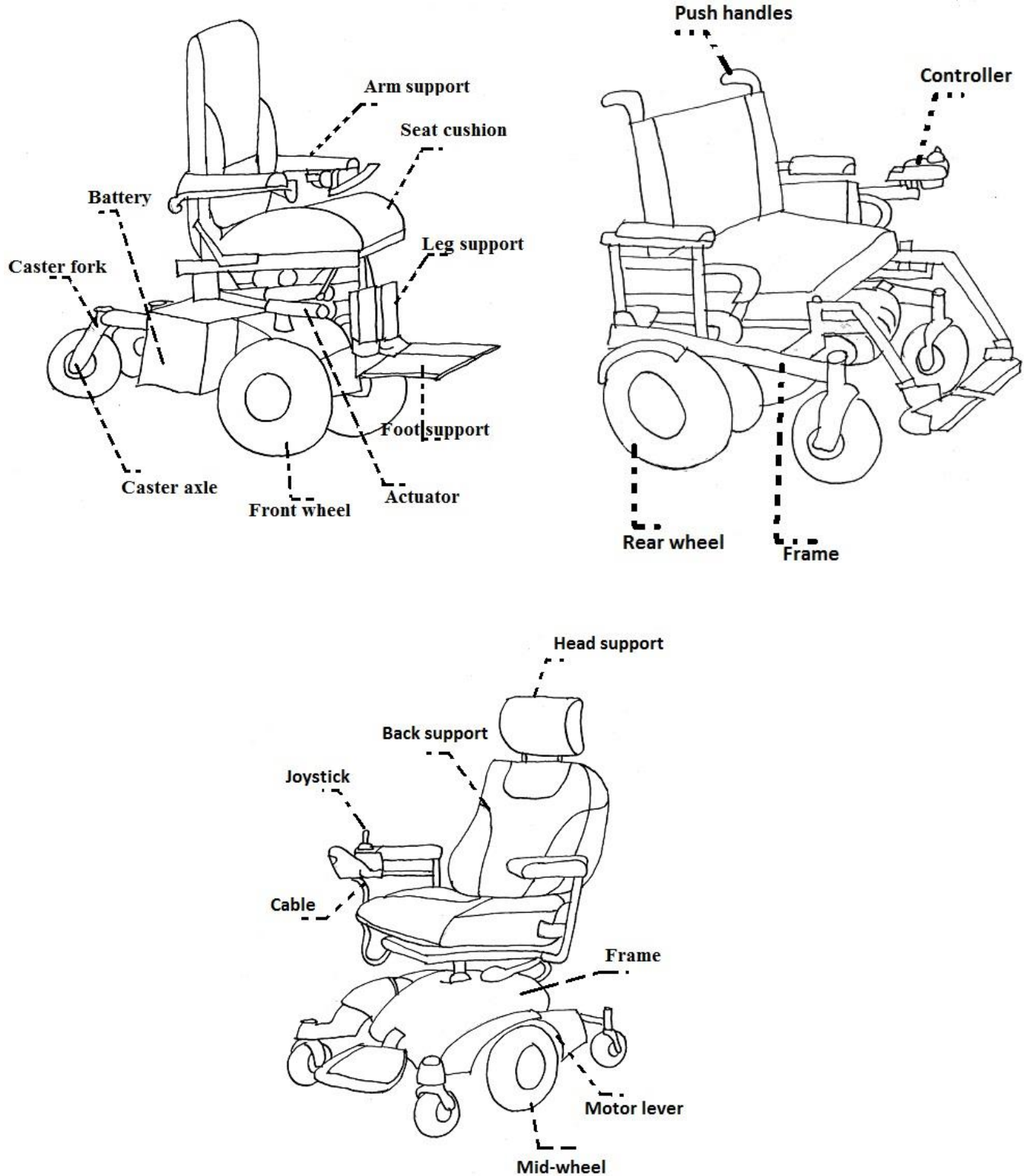
- Cover the area with the glue from the patch kit; make sure that the area covered is greater than the size of the patch. Larger holes will need bigger patches.
- Wait for the cement to dry.
- While the cement is drying, look for the sharp object that caused the puncture. If you use the mark you made on the tire to see how the tube was lined up with the tire, it should not be hard to figure out which section has the offending object in it.
- Take a piece of cloth and run it along the inside of the tire; it will stick on the protruding object that punctured the tube. Remove the object.
- When the cement is completely dry, peel the silver foil off the patch and apply that side to the tire. Rub hard from the center toward the edges so that it sticks really well. Leave the cellophane on; it can be tricky to remove without damaging the patch and it helps protect the patch.
- Dust the excess glue with chalk to stop it from adhering to the tire.

▶ **Replacing the tube and tire**

- Make sure the rubber band is in place around the rim, it protects the tube from the spoke nipples.
- Inflate the tube slightly and pack it back into the tire, pushing the valve through the hole in the rim. Make sure the valve stays perpendicular to the rim.
  - Tip: a little liquid dish soap can make it easier to put a tire on.
- Now, slide the bottom bead over the rim, this should be easy to do.
- Ease the second bead over the rim working your way around on both sides towards the opposite side.
- The last part of the bead will be very difficult to lift over the rim. Make sure the bead where you started is pushed all of the way in to the rim, this will give you a little more slack. Gradually work the top bead up and over the rim taking care not to pinch the tube. If you do pinch the tube, you will have to go back to the beginning. If possible, try to complete this without using the tire levers to reduce the likelihood of damaging the tube.

- When the tire is on, push both beads into the well of the rim all the way around the wheel to make sure the tube is not pinched in the tire.
- Inflate the tube to the pressure marked on the sidewall.
- Tires have a reference line that should be the same distance from the edge of the rim all the way around; this ensures the tire is seated properly on the wheel. If the line is off center, let air out, adjust the tire on the rim and re-inflate.

**APPENDIX 5: POWER WHEELCHAIR NOMENCLATURE**



**APPENDIX 6: SCHEDULE FOR POWER WHEELCHAIR MAINTENANCE TASKS**

Frequency	Items to <u>inspect</u> to ensure proper power wheelchair function:	If problems identified, action(s) to take:
Daily	Protective plastic covers "shrouds"	Contact wheelchair maintenance expert
	Motor noise and motor disengage lever	
	Controls, indicators, and horn function properly and not worn out	
	Driving and braking	
Weekly	If pneumatic tires, check pressure	Inflate and if unable to do so, contact wheelchair maintenance expert
	Cushion and cover	Contact wheelchair maintenance expert
Monthly	Drive tires, caster wheels, and anti-tip wheels for wear, adjustment, and alignment	Tighten nuts and bolts if possible. If not, contact wheelchair maintenance expert
	Head, arm, back, leg, foot, lateral, thigh and trunk supports	If loose and/or misaligned, tighten. Contact wheelchair maintenance expert if sharp edges are found or supports not working properly
	Wiring and electric connections	Reposition if caught in belts, gear, or wheels. Contact wheelchair maintenance expert if frail.
	Seat base	Tighten and contact wheelchair maintenance expert if not possible
	Upholstery	Contact wheelchair maintenance expert
	Joystick and rubber boot	
	Seat-positioning strap, buckle, and strap hardware	
	Battery charger cable	



<b>Actions to maintain a power wheelchair:</b>	<b>Frequency</b>
Charge batteries	Daily
Wipe down wheelchair and cushion	Monthly
Clean caster axles	
Clean power seat function mechanism or tracks	
Have wheelchair professionally serviced	Yearly

## APPENDIX 7: REMINDERS

Remember that regular maintenance is important for your wheelchair to perform properly. Review the maintenance cards that you received in your toolkit and be sure that you are following the directions in a timely manner. If you are in need of a repair, remember to contact a wheelchair maintenance expert.

**APPENDIX 8: MANUAL WHEELCHAIR MAINTENANCE HANDS-ON ACTIVITY CHECKLIST**

**REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY**

Maintenance activities	Activity done	Not applicable
<b>Weekly</b>		
Inspect cushion and cover for wear	<input type="checkbox"/>	<input type="checkbox"/>
If pneumatic tires, inspect tire pressure	<input type="checkbox"/>	<input type="checkbox"/>
<b>Monthly</b>		
Inspect push handles	<input type="checkbox"/>	<input type="checkbox"/>
Inspect back posts and back support hardware	<input type="checkbox"/>	<input type="checkbox"/>
Inspect the wheelchair frame	<input type="checkbox"/>	<input type="checkbox"/>
Inspect cross brace function	<input type="checkbox"/>	<input type="checkbox"/>
Inspect suspension	<input type="checkbox"/>	<input type="checkbox"/>
Inspect anti-tip wheels	<input type="checkbox"/>	<input type="checkbox"/>
Inspect casters	<input type="checkbox"/>	<input type="checkbox"/>
Inspect caster bearings	<input type="checkbox"/>	<input type="checkbox"/>
Inspect tires	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel locks (brakes)	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel spokes and wheel trueness	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel handrims	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel axles	<input type="checkbox"/>	<input type="checkbox"/>
Inspect wheel bearings	<input type="checkbox"/>	<input type="checkbox"/>
Inspect foot supports	<input type="checkbox"/>	<input type="checkbox"/>
Inspect clothing guards	<input type="checkbox"/>	<input type="checkbox"/>
Inspect arm supports	<input type="checkbox"/>	<input type="checkbox"/>
Inspect seat upholstery (including stitching and rivets)	<input type="checkbox"/>	<input type="checkbox"/>
Inspect back support upholstery (including stitching and rivets)	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down cushion and cover	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down back support	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down seat upholstery	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down the wheelchair frame	<input type="checkbox"/>	<input type="checkbox"/>
Wipe down and lubricate wheel axles	<input type="checkbox"/>	<input type="checkbox"/>
Clean caster axles	<input type="checkbox"/>	<input type="checkbox"/>
<b>Every three months</b>		
Lubricate moving parts	<input type="checkbox"/>	<input type="checkbox"/>

**APPENDIX 9: POWER WHEELCHAIR MAINTENANCE HANDS-ON ACTIVITY CHECKLIST**

**REMEMBER TO CHECK NUTS AND BOLTS ON ALL THE PARTS THAT APPLY**

Maintenance activities	Activity done	Mark if Not applicable	Frequency
<b>Lower section</b>			
<b>Inspect tires</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
If pneumatic tires, <b>inspect tires’ pressure</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Weekly</b>
<b>Inspect casters</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Clean caster axles</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect anti-tips</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect motor disengage levers</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Daily</b>
<b>Inspect frame</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect shrouds</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect foot supports</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect leg supports</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect suspension elements</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Middle section</b>			
<b>Inspect arms support</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect thigh support</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect seat-position strap and buckle</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect cushion and cover</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Weekly</b>
<b>Wipe down cushion and cover</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect seat base</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect controller and joystick</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect motor noise</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Daily</b>
<b>Inspect driving and braking</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Daily</b>
<b>Inspect power seat functions</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Daily</b>
<b>Clean power seat functions mechanism and track</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect all other controls, indicators, and horn</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Daily</b>
<b>Inspect wiring and electronic connections</b>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>

**FLIP TO THE BACK**



Maintenance activities	Activity done	Mark if Not applicable	Frequency
<b>Top section</b>			
<b>Inspect</b> back support	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Wipe down</b> back support	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>
<b>Inspect</b> trunk supports	<input type="checkbox"/>	<input type="checkbox"/>	<b>Monthly</b>

## REFERENCE LIST

1. Ummat, S. and R. Kirby, *Nonfatal wheelchair-related accidents reported to the National Electronic Injury Surveillance System*. American Journal of Physical Medicine and Rehabilitation, 1994. **73**(3): p. 163-7.
2. Kirby, R. and D. MacLeod. *Wheelchair-related injuries reported to the National Electronic Injury Surveillance System: an update*. in RESNA annual meeting. 2001. Reno, NV.
3. Kirby, R.L. and S.A. Ackroyd-Stolarz, *Wheelchair safety-adverse reports to the United States Food and Drug Administration*. American journal of physical medicine & rehabilitation, 1995. **74**(4): p. 308-312.
4. Calder, C.J. and R.L. Kirby, *Fatal wheelchair-related accidents in the United States*. American Journal of Physical Medicine & Rehabilitation, 1990. **69**(4): p. 184-190.
5. Xiang, H., A. Chany, and G. Smith, *Wheelchair related injuries treated in US emergency departments*. Injury Prevention, 2006. **12**: p. 8-11.
6. Fass, M.V., et al., *Durability, value, and reliability of selected electric powered wheelchairs*. Archives of physical medicine and rehabilitation, 2004. **85**(5): p. 805-814.
7. Wang, H., et al., *Relationship between wheelchair durability and wheelchair type and years of test*. Disability & Rehabilitation: Assistive Technology, 2010. **5**(5): p. 318-322.
8. Gebrosky, B., et al., *Evaluation of lightweight wheelchairs using ANSI/RESNA testing standards*. J Rehabil Res Dev, 2013. **50**(10): p. 1373-1390.
9. Kirby, R.L., et al., *Wheelchair-related accidents caused by tips and falls among noninstitutionalized users of manually propelled wheelchairs in Nova Scotia*. American Journal of Physical Medicine & Rehabilitation, 1994. **73**(5): p. 319-330.
10. Nelson, A.L., et al., *Wheelchair-related falls in veterans with spinal cord injury residing in the community: a prospective cohort study*. Archives of physical medicine and rehabilitation, 2010. **91**(8): p. 1166-1173.
11. Gaal, R., et al., *WC rider injuries: cause and consequences for wheelchair design and selection*. Journal of Rehabilitation Research and Development, 1997. **34**(1): p. 58-71.
12. Berg, K., M. Hines, and S. Allen, *Wheelchair users at home: few home modifications and many injurious falls*. American journal of public health, 2002. **92**(1): p. 48.
13. Chen, W.-Y., et al., *Wheelchair-related accidents: relationship with wheelchair-using behavior in active community wheelchair users*. Archives of Physical Medicine and Rehabilitation, 2011. **92**: p. 892-898.
14. McClure, L., et al., *Wheelchair repairs, breakdown, and adverse consequences for people with traumatic spinal cord injury*. Archives of Physical Medicine and Rehabilitation, 2009. **90**: p. 2034-2038.

15. Worobey, L., et al., *Increases in wheelchair breakdowns, repairs, and adverse consequences for people with traumatic spinal cord injury*. *American Journal of Physical Medicine and Rehabilitation*, 2012. **91**(6).
16. Toro, M.L., et al. *Type and Frequency of Reported Wheelchair Repairs and Adverse Consequences Among People with Spinal Cord Injury*. in *Rehabilitation Engineering and Assistive Technology Society of North America Conference*. 2014. Indianapolis.
17. Hansen, R., S. Tresse, and R. Gunnarsson, *Fewer accidents and better maintenance with active wheelchair check-ups: a randomized controlled clinical trial* *Clinical Rehabilitation*, 2004. **8**: p. 631-639.