Comorbidities and Medical Complexities of mobility device users: A Retrospective Study

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Objective: To determine the medical complexities and comorbidities of individuals who utilise wheeled mobility devices. As well as, to examine costly events including the number of urinary tract infections (UTIs), hospitalizations, urgent care(UC)/emergency department (ED) visits that are commonly seen in this population over a period of time one year prior to and one year post receiving their wheeled mobility equipment.

Design/Setting: A retrospective data review of 857 individual medical charts at a Level 1 Trauma Hospital and Clinic System

Participants: 330 male and female (24 - 92 years old) mobility device users with a wide range of diagnoses, of which: 56 used manual wheelchairs (MWC),138 scooters (POV), 123 power wheelchairs without integrated standing (PWC), and 13 power wheelchairs with integrated standing (iS-PWC).

Results: Overall, 92% (n = 304) had at least 3 medical comorbidities and medical complexities. The most common comorbidity was pain (91%). A change was noted in a lower incidence of UTIs in those using an iS-PWC, respectively 23% with at least 1 UTI in the year prior to and 8% in the year after the mobility device evaluation.

Conclusions: The large number of comorbidities and medical complexities amongst all mobility device users is concerning. The burden and the accompanying healthcare costs of this population is high. The potential that iS-PWC and other interventions could have on reducing these issues should be explored further.

Key Words: Sitting Position, Wheelchairs, Mobility Limitation, Standing Position, Comorbidity, Urinary Tract Infections, Hospitalization, Disabled Persons

Abbreviations: CVA (Cerebrovascular Accident), COPD (Chronic Obstructive Pulmonary Disease), ED (Emergency Department), iS-PWC (Integrated Standing Power Wheelchair), MWC (Manual Wheelchair), PT (Physical Therapy), POVs (Power Operated Vehicles), PWC (Power wheelchair), SCI (Spinal Cord Injury), Secondary Health Condition (SHC), TBI (Traumatic Brain Injury), UTIs (Urinary Tract Infections), UC (Urgent Care)

Prolonged sitting time has been associated with a graded increase in risk for mortality among sedentary adults; for the able-bodied population, those who spend >8 hours/day sitting are at higher risk for cardiovascular disease, Type 2 diabetes, certain cancers, depression and even mortality. [22,2] Similar behaviors are seen in a full-time wheelchair user who spends on average 10.6 hours/day seated. [36] A comorbidity has been defined as ‘any distinct additional entity that has existed or may occur during the clinical course of a patient who has the index disease under study. [17] Previous research has identified the common comorbidities or secondary conditions

such as decubitus ulcers, osteoporosis, joint deformities (especially hip joint adduction contracture) can result from prolonged wheelchair use found that only 30% of those with rare metabolic, neuromuscular or neurological diseases using power wheelchairs did not have any comorbidities. [11,9] The most common issues in this population were back pain, hypertension and scoliosis, but users of mobility scooters were not included in their study.

Comorbidities have been studied in different populations based on diagnosis. Children and adults with Cerebral Palsy (CP) who utilized power wheelchairs were identified to have sixteen comorbidities, with asthma and osteoarthritis as the most common; pain, spasticity, contractures, hip problems, pressure sores, depression, edema and (kypho)scoliosis were also present. [18] People with Duchenne Muscular Dystrophy, as they age, have major clinical issues including fractures, (kypho)scoliosis, cardiopulmonary involvement and pain. [15,28,32,35] Previously, the occurrence of 13 secondary health conditions (SHC) commonly seen in SCI (neuropathic pain, musculoskeletal pain, pressure ulcers, problematic spasticity, autonomic dysreflexia, hypertension, edema, neurogenic heterotopic ossification, pneumonia, UTI, urinary incontinence, fecal incontinence and constipation) were identified and found that 98.5% had at least one SHC; the median total number was 4 conditions, and that minimizing the impact of these should be a priority in the long-term care of persons with SCI. [1] Pressure ulcers, one of the main secondary health outcomes of spinal cord injury, have a significant impact on health, functions and quality of life. The incidence of pressure ulcers for those that utilize wheelchairs was found that >54% of those with a SCI had a current pressure injury or a history of one. [24] More than two-thirds of SCI manual wheelchair users report suffering or having suffered shoulder pain and those that begin using a wheelchair as an adult experience greater shoulder pain than those that started using one as a child. [6,33] Most research has focused on pain caused by wheelchair propulsion,

but evidence is also present that those with SCI that use crutches or canes, or motorized wheelchairs, may be at similar or greater risk for shoulder disorders leading to pain. [20]

Unfortunately there are limited options for the population of individuals that utilize wheeled mobility [a manual wheelchair (MWC), scooter (POV), or power chair (PWC)] to change or alter their position in space throughout the day. There is an assumption that this therefore places mobility device users at an increased risk of comorbidities. Research on comorbidities has been studied in persons with specific diagnosis or limitations however, the full extent of comorbidities, secondary health conditions and medical complexities that affect any user of mobility devices has not, to the authors' knowledge, been reviewed. [30,21,19,26,4] An accurate knowledge of these issues will assist the medical team involved in the mobility device procurement process, to match the correct equipment to the specific individual needs; increasing their safety, independence, and quality of life. Comorbidities may be linked to a considerable amount of sitting, and one alternative to prolonged sedentary time is the use of standing. The benefits of standing and other forms of light movement have shown to strongly reduce the risks that come from sedentary behavior. [25] Standing has also been shown to promote medical benefits including reduction in spasticity, improvement in bone mineral density and range of motion, and pressure management. [3,12,14,37] Unfortunately, a majority of mobility device users don't have the access to a separate standing frame or a power wheelchair with integrated standing (iS-PWC). As the knowledge on the relation between iS-PWC use and comorbidities is limited, it is therefore warranted to study this further.

The complexities and comorbidities that were investigated in this study were: pain, cardiac issues, history of falls, respiratory issues, incontinence, digestive issues, edema/swelling, bowel issues, spasticity, and history of wounds. It has been identified in previous studies that these

issues have an impact on the quality of life and increased risk of a person not participating in as many daily activities. [31,1] The primary objective was to describe the prevalence of medical complexities and comorbidities in all mobility device users, not specific to one primary diagnosis. Prevalence was described for the total group of mobility device users, as well as separately for users of MWC, POVs, PWCs and iS-PWC. A secondary objective was to describe the amount of urinary tract infections (UTIs), hospitalizations and urgent care (UC)/emergency department (ED) visits of mobility device users one year prior and one-year post receiving their mobility device evaluation. The cost of a hospital stay that is associated with these events is often high averaging $15,000 in 2017. [16] In order to have a standard time frame of reference for this study and future studies, one year prior to and one year after the physical therapy evaluation was chosen appropriately.

Method:

The model of care at the study's healthcare facility to receive a mobility device requires a physician or medical provider to identify a patient that has a mobility limitation and then refer them to be seen by a Physical Therapist (PT) for an outpatient evaluation. An initial computerized report gathering potential participants was compiled from the EPIC System (the Electronic Medical Record) with the date range of the report from 3/1/2009 - 3/1/2020. To be included in the report, patients had to have attended a session within the Physical Therapy (PT) Department or the CSC (Clinic and Specialty Center) Physical Therapy Department, as well as, have at least one of the following as a physician or therapist ordered procedure code listed in their medical chart: Wheelchair Management Training, Evaluation for wheelchair requiring Face to Face visit with a Physician, DME power wheelchair or scooter, PC wheelchair management training, or PT custom wheelchair evaluation.

A chart review was completed by the Principal Investigator (PI) who was familiar with and regularly uses EPIC for medical documentation. The charts that met the inclusion criteria as listed above, were reviewed and data collection by both the PI and Secondary Author were recorded.

Figure 1.

The outpatient PT Evaluation and treatment notes were reviewed and included details such as: total time spent seated in their wheeled mobility device (<7 hours/day or >8 hours/day) and whether they had a separate standing device to use as a therapeutic intervention, which were both reported by the patient, to the PT. Data collection for co-morbidities and medical complexity diagnoses were derived from the PT evaluation and the patient's diagnosis specific Problem List in the medical chart (**Tables 1-5**).

The date of the completed PT evaluation was used as a reference point, and data one year prior and one-year post evaluation was examined for additional medical visits and conditions. Hospitalizations were defined as each time the patient completed a hospital admission and was discharged (this counted as 1 hospitalization). ED and UC visits were defined as each time the patient was seen in the ED or UC and discharged home. If an ED visit resulted in a hospitalization, this was considered one hospitalization visit, not two separate visits for the ED and Hospital. An occurrence of a UTI was counted if it was listed as the reason for a hospitalization, ED or UC visit.

Summary statistics (n, %) were used to describe age, gender, the proportion of users in the most common neurological diagnoses, as well as the self-reported amount patients were sitting per day. Similarly, the number of comorbidities for the total group and for each of the prescribed

mobility devices separately (iS-PWC, PWC, POV, or MWC) were presented. For the comparison on the occurrence of at least 1 event of UTIs, hospitalizations and UC/ED visits of mobility device users the year before and the year after their mobility device evaluation, a difference in occurrence of more than 10% was considered clinically relevant. Summary statistics were determined using SPSS version 26 (IBM).

Results:

Table 6.

Figure 2a

Figure 2b

Figure 3a, 3b, and 3c

Figure 3a, 3b, and 3c represent the comparison of mobility device users the year before and the year after their mobility device evaluation for high healthcare cost occurrences such as UTI's, hospitalizations and ED/UC visits.

The number of UTI occurrences for the entire study sample in the year prior to the PT evaluation was 0-4 infections, and for one-year post was 0-6 infections. Of the total patients, 6% had at least 1 UTI in the year prior to their mobility device evaluation compared to 3% the year after. The only clinically relevant difference (>10%) was for persons using an iS-PWC amongst which 23% had at least 1 UTI in the year prior to their mobility device evaluation and 8% had at least UTI in the year post.

The range of hospitalizations for all patients one year prior to the PT evaluation was 0-17 (while 1 subject had 17 hospitalizations, the highest incidence of hospitalizations per patient otherwise was 9). For ED/UC visits, there was no significant difference between the year prior and year post evaluation, with data noting 0-22 events in each category. The range of events was from 0 to 22 before and for 0 to 22 after evaluation. No clinical relevance was noted comparing the year before and after device evaluation for hospitalizations nor for ED/UC visits.

Discussion:

This retrospective study found that 92% of mobility device users, across all diagnoses, had at least three significant comorbidities or medical complexities that directly affected their overall health and wellbeing. Pain was overall the most common reported comorbidity, while the only clinically relevant change noted between before and after device evaluation, was a lower number of UTIs in those using an iS-PWC. This large number of comorbidities is concerning, as those individuals that use a mobility device often require additional equipment or features on their device in order to break up prolonged sitting time regardless of their diagnosis. Unfortunately, due to the current funding structure, access to this equipment and/or features are highly limited.

Funding that was allocated for the mobility device in this study (including iS-PWC) required qualification to be medical in nature and was not related to age, cognitive ability, or current school or employment status. All standing devices were acquired through the patient's individual funding source whether it be state or private insurance. Only five patients reported utilizing a separate standing device in addition to their mobility device. Therefore, only a small

percentage (N=18) of total participants have the ability to change from the sitting position throughout the day using their device.

Across all mobility device groups pain was the most common comorbidity, with the exception for those using iS-PWC. Pain often treated with medications is costing the United States upwards to $560–635 billion a year. [34] Other comorbidities such as pressure injuries, cost an estimate of 26.8 billion dollars in healthcare each year; 22.6 percent of patients with pressure injury are re-hospitalized due to their wounds and an average of 60,000 patients die yearly. [27] The average number of patients in this study that had a documented history of pressure injuries was 30%, while large differences were noted between mobility devices. Those patients that utilize iS-PWC had considerably higher reported histories of pressure injuries then those that utilize POVs (85% to 4%, respectively). It should be noted that those individuals that qualify for a POV must be able to perform a stand pivot transfer on and off the device safely. Therefore, they are able to provide a form of pressure relief from sitting during the day. Standing has been shown to reduce load to both the seat, as well as the backrest to increase pressure distribution. [37] The patients with integrated standing features on their PWCs were likely recommended those specific devices in order to assist with pressure management and skin integrity concerns that they could not manage by sitting alone.

Almost half of the mobility device users were hospitalized at least once and were at the ED/UC at least once in the year prior and the year following receiving their mobility device. It is estimated overall hospitalization costs in the year 2018 were 1.9 trillion dollars while at the time of the study the 2020 yearly cost was close to 1.32 trillion in the United States. [13] ED visits in the United States account for 8.3 billion dollars in healthcare costs. [7] Comorbidities and medical complexities that are unstable or progress, tend to require emergent care, thus leading to frequent

hospitalizations and ED or UC visits. For example, incontinence issues are common among individuals that utilize mobility devices, these incontinence issues often lead to barriers to voiding, hygiene concerns, and result in problems such as, UTIs, urolithiasis, and renal function impairment. [23] The first three to six months following a SCI, individuals are at the greatest risk of developing kidney stones, increasing with SCI severity. [5] The elderly population have also documented risk of increased kidney stone development due to immobility. [10] It is common that severe UTIs require hospitalizations, whereas less severe infections are managed in the community by primary care providers. Therefore, reducing the number of comorbidities, hospitalizations, ED, and UC visits in these populations, overall healthcare costs would decline significantly.

In the iS-PWC group, the majority of patients had a diagnosis of SCI, a group which is known to commonly have spasticity and was therefore being prescribed the iS-PWC to assist with spasticity management. The presence of increased muscle tone, or spasticity, often has detrimental results on joint range of motion, ultimately leading to joint contractures, a condition in which joint movement is severely restricted.[8]. This can affect a person's ability to participate in ADL's including sitting, dressing, and transferring. Standing has been researched to have a positive effect on muscle tone management, and those who participate in consistent standing programs report a decrease in muscle spasms and spasticity. [3,14,12,38] Interestingly, the patients that used a iS-PWC feature had the lowest percentage of reported falls and cardiac issues compared to those patients that were seated for prolonged periods in another mobility device. iS-PWC should be considered as a medical intervention, specifically addressing the benefits of reducing comorbidities in the population of mobility users confined to sitting for prolonged periods of time, similar to the act of standing for the able bodied population.

Study Limitations:

Although this was a unique retrospective study of medical records in a large group of mobility device users, the study had limitations. Medical care outside of the study center was not included and could have contributed to additional complexities and comorbidities unknown to the authors. There is however no reason to believe that these amounts would differ amongst the subgroups of mobility device users. Additionally, some data was self-reported regarding health conditions and the usage of the patient's mobility device. The total time a person has had their disability, their education and income level as well as employment status can contribute to secondary health conditions. Greater than 50% of the patients served in this study's healthcare system are on either federal or state funded insurance plans, however the specific socioeconomic details were not included in the demographics for this study. A possible bias of the overall sample was if a patient within the healthcare system chose to purchase their mobility device independently; there would be no record of this or an evaluation that occurred and thus the patient was excluded from the study.

Additionally, UTIs for this population of mobility device users are often managed in a primary care setting. We could therefore have an under reported occurrence of this medical complexity as only the most severe cases requiring an ED visit or hospitalization were included.

A small sample of iS-PWCs were included in the study, which has limited the power of this study and therefore the statistics that could be used. Future studies that have the means to specifically assess total time standing as well as other lifestyle habits in relation to the occurrence of comorbidities and medical complexities in the population that uses mobility devices are needed.

Conclusions:

This retrospective study reviewed a diverse diagnosis population and found that 100% of all mobility device [MWC, PWC, POV, and iS-PWC] users have at least one comorbidity or medical complexity, 92% have at least three. Pain was the most common overall comorbidity. UTIs were less frequently occurring in those with iS-PWC after the mobility device evaluation compared to before. Further studies on the reduction of burden and accompanying costs of comorbidities and medical complexities in mobility device users are necessary, while the potential of how iS-PWC could reduce these issues and costs is worth exploring.

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Dedicated to the memory of Brandon Edmondson, OTR, ATP.

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Figures

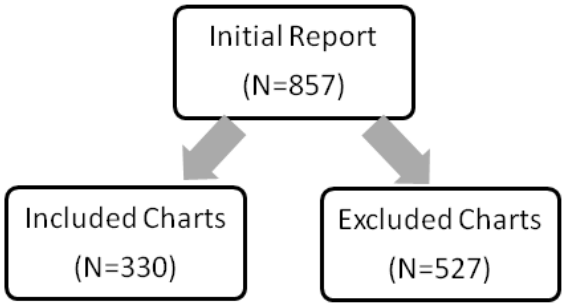

Figure 1: From the initial report, the reasons for exclusion from this study were: the patient's evaluation in PT was either before or after the date range of the report, the patient attended inpatient PT session only, documentation was lacking demonstration that the mobility device was actually received, the patient did not follow through with recommended therapy and therefore did not receive the equipment, or the patient passed away before receiving the equipment. If a patient within the system chose to purchase their mobility device independently no record or evaluation was present thus the patient was excluded from the study.

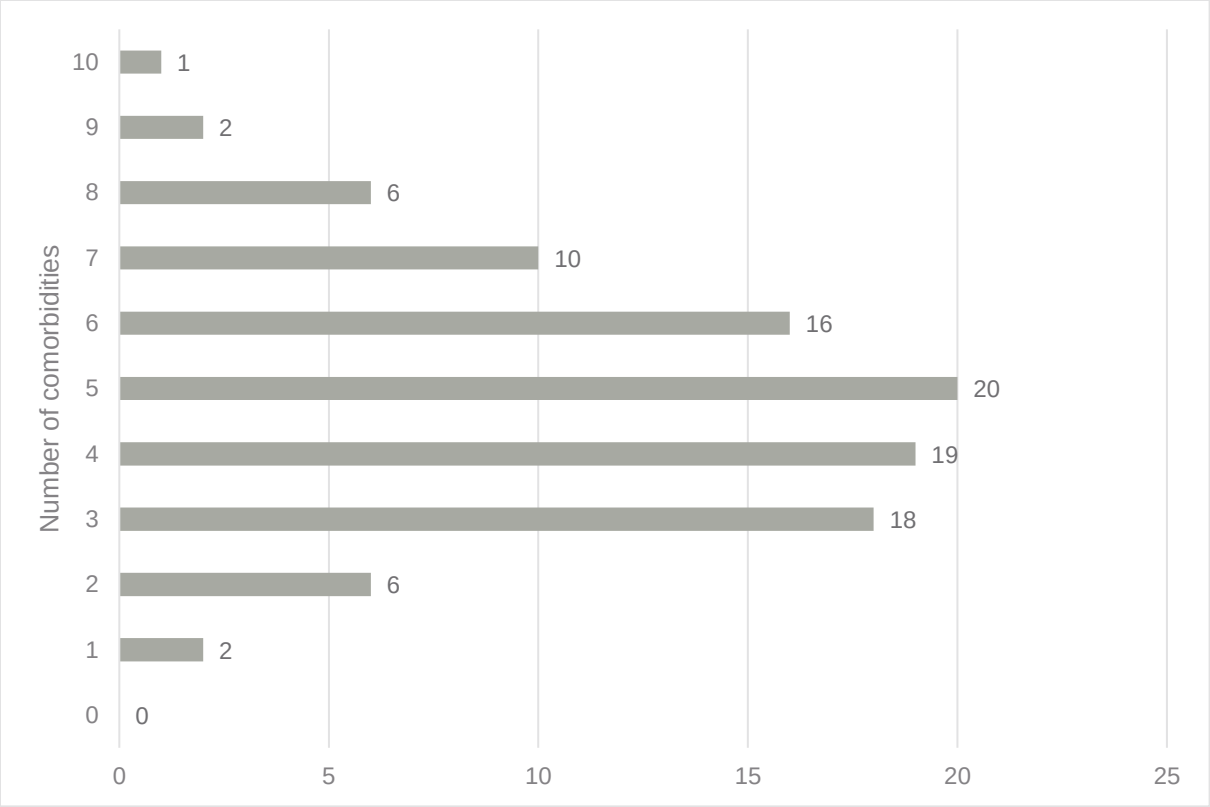

Figure 2a: Total number of comorbidities in power mobility device users (n=330; history of falls, bowel issues, digestive issues, spasticity, history of wounds, respiratory issues, cardiac issues, incontinence, edema/swelling and pain)

	Mobility device				All users
	Manual wheelchair	Scooter	Power wheelchair (without standing)	Power wheelchair (with standing)	
n	56	138	123	13	330
Comorbidities					
Pain, %(n)	79% (44)	98% (135)	89% (110)	85% (11)	91% (300)
Cardiac issues, %(n)	55% (31)	77% (106)	70% (86)	46% (6)	69% (228)
History falls, %(n)	47% (26)	77% (106)	55% (68)	31% (4)	62% (205)
Respiratory issues, %(n)	30% (17)	57% (79)	46% (57)	54% (7)	49% (162)
Incontinence, %(n)	50% (28)	30% (41)	52% (64)	85% (11)	44% (145)
Digestive issues, %(n)	43% (24)	43% (59)	37% (46)	54% (7)	41% (135)
Edema/Swelling, %(n)	27% (15)	27% (37)	45% (55)	77% (10)	36% (119)
Bowel issues, %(n)	36% (20)	29% (40)	34% (42)	69% (9)	34% (112)

Spasticity, %(n)	50% (28)	8% (11)	38% (47)	92% (12)	30% (99)
Wounds, %(n)	41% (23)	4% (6)	47% (58)	85% (11)	30% (99)

Figure 2b

Figure (2a) and (2b) shows the cumulative occurrence of comorbidities of all persons included in this study as well as each mobility device group and each comorbidity. Of all mobility device users, a total of 92% (n=304) participants had at least 3 comorbidities. Pain was overall the most common comorbidity (91% of all users) and was the most common comorbidity in those using POVs (98%), those in PWC (89%) and those in MWC (79%). In those included using iS-PWC, spasticity was the most common comorbidity (92%).

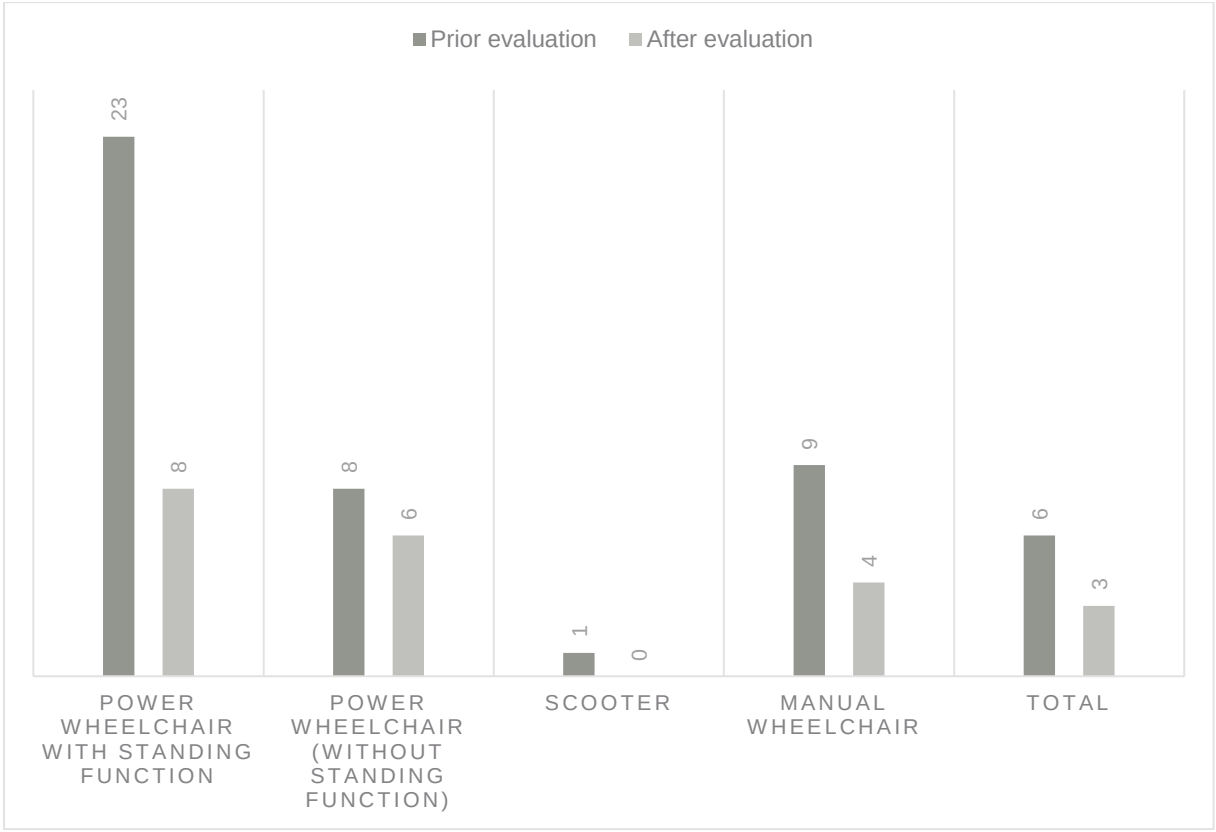

Figure 3a: Percentage of users with at least 1 UTI during the 1 year prior to and during the 1 year after PT evaluation.

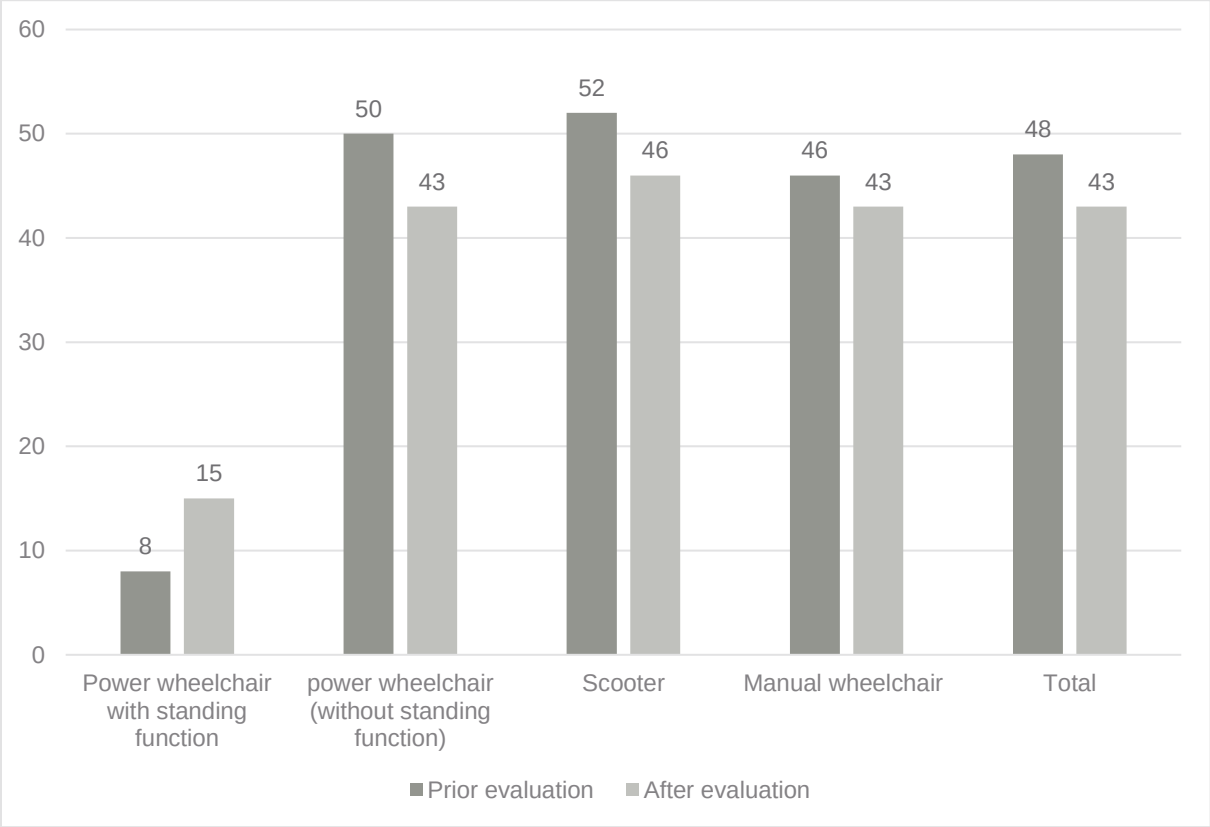

Figure 3b: Percentage of users with at least 1 hospitalization during the 1 year prior to and during the 1 year after PT evaluation.

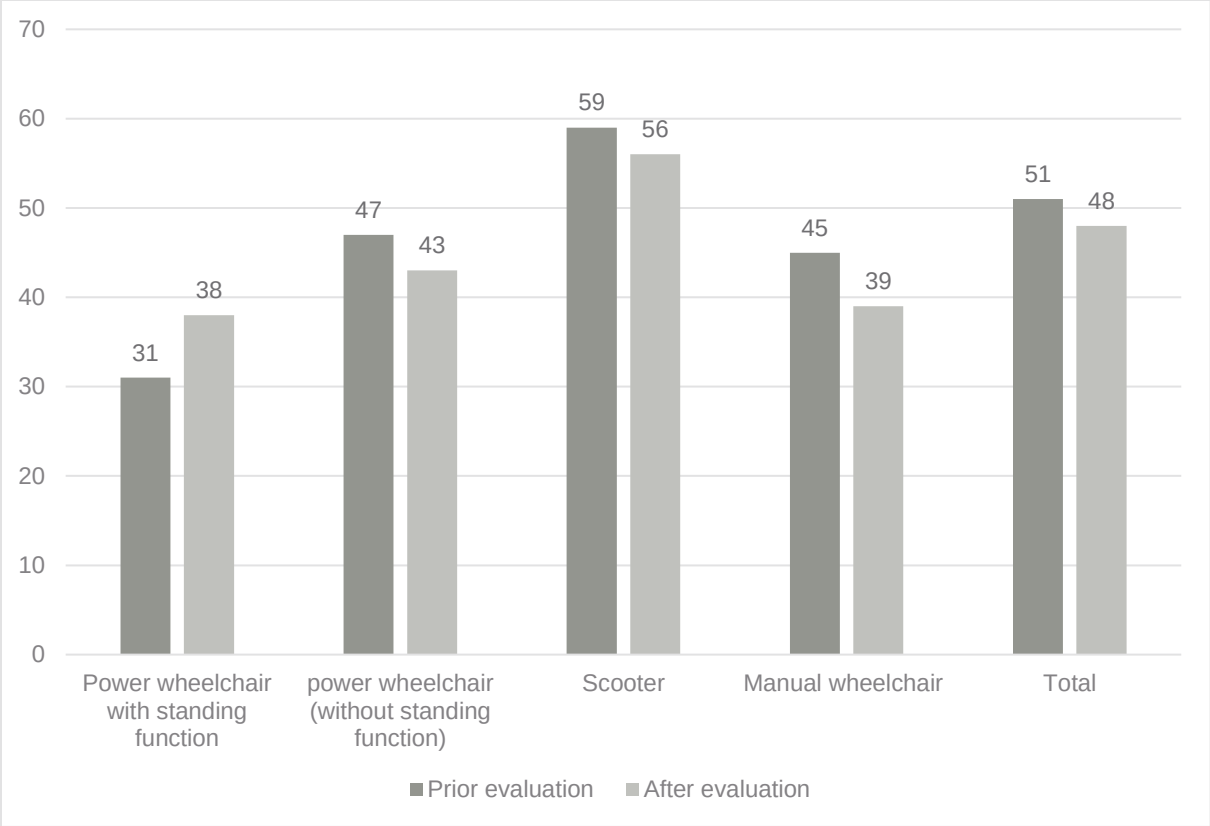

Figure 3c: Percentage of users with at least 1 ED/UC visit during the 1 year prior to and during the 1 year after PT evaluation.

Comorbidities and Medical Complexities of mobility device users: A Retrospective Study
Tables

Table 1: Included "Respiratory" diagnosis

Asthma	Mild intermittent asthma
Severe persistent asthma	Pulmonary emboli
Trach	Reactive Airway Disease without complication
Wheezing	Upper respiratory infection
Hypoxia	COPD
Dyspnea	Exertional SOB
Restrictive Lung disease due to muscle weakness	Pneumonia
Hospital - acquired pneumonia	Bronchitis (chronic obstructive)
Simple chronic bronchitis	Emphysema
Interstitial lung disease	Elevated CO2 level

Chronic Obstructive Pulmonary Disease	Pulmonary Hypertension
Pulmonary Nodules	

Table 2: Included “Bowel” Diagnosis

Diarrhea	Colostomy
Constipation	Neurogenic Bowel
Slow transit constipation	Drug induced constipation
Irritable Bowel Syndrome	Diverticulitis of colon

Table 3: Included "Incontinence" Diagnosis

Neurogenic Bladder	Continuous leakage of urine
Urostomy	Incontinence

Functional Urinary Incontinence	Urinary Frequency
Indwelling Catheter	Urinary Urgency
Urgency - Frequency Syndrome	

Table 4: Included "Digestive" Diagnosis

GERD	Reflux
Acid Reflux	Hiatal Hernia
Esophagitis	Heartburn
Digestive System Complication	Gastroesophageal Reflux
Epigastric Pain	Dyspepsia

Table 5: Included as "Cardiac" Diagnosis.

(Myocardial Infarction)	Tachycardia
HTN	Hypertension
Essential HTN	Orthostatic Hypotension
Racing heartbeat	CAD
Coronary Artery Disease	Hyperlipidemia
Bradycardia	S/P CABG
S/P Mitral Valve Repair	Hypotension
Postural Hypotension	

Table 6 shows the demographics of the 330 included participants, including their age, gender and the proportions of the most common neurological diagnoses. Half of participants, in particular those using POV, were not allocated one of these most common neurological diagnoses but a different reason to prescribe the mobility device. Furthermore, self-reported sitting time was presented with those in PWC sitting most often more than 8 hours /day (92%) and those in scooters the least (55%).

	Mobility device				*All users*
	Manual wheelchair	**Scooter**	**Power wheelchair (without standing)**	**Power wheelchair (with standing)**	
n	56	138	123	13	***330***
Age, mean (SD)	54 (16)	60 (10)	57 (13)	53 (16)	*58 (13)*
Gender, %female (n)	41% (23)	60% (83)	40% (49)	62% (8)	*49% (163)*
Diagnosis*					
Amputation, %(n)	5% (3)	3% (4)	10% (12)	0 (0)	*6% (19)*
CVA/stroke/TBI, %(n)	18% (10)	9% (12)	20% (25)	0 (0)	*14% (47)*
SCI, spina bifida, polio, %(n)	27% (15)	2% (3)	18% (22)	77% (10)	*15% (50)*
Muscle disease/CNS, %(n)	14% (8)	4% (5)	7% (9)	8% (1)	*7% (23)*
CP or similar diagnosis, %(n)	9% (5)	1% (1)	7% (8)	8% (1)	*5% (15)*
Other, %(n)	27% (15)	82% (113)	38% (47)	8% (1)	*53% (176)*
Sitting time					
>8 hours per day	80% (45)	55% (76)	92% (113)	83% (11)	*71% (234)*

Implications of Rehabilitation

- Regardless of a person's primary diagnosis or the wheeled mobility device they use, 100% have at least one and 92% have at least three comorbidities and medical complexities if they spend the majority of their day sitting
- The high healthcare cost situations such as Emergency Department visits, Urgent Care visits, hospitalizations, and Urinary Tract Infections are present across those that use all mobility device types and the means to potentially reduce these incidences should be further explored
- The introduction of integrated standing within a power wheelchair, as a means to minimize the frequency of comorbidities and medical complications, should also be investigated further