Assessing wheelchair breakdowns in Kenya to inform wheelchair test standards for low-resource settings.

Norman Reese, Karen Rispin
Interdisciplinary Mobility Lab, LeTourneau University, Longview, TX

ABSTRACT

A multiyear study compared the occurrence of breakdowns among 87 wheelchairs of six models designed for low-resource settings. The study benefitted from a population living at a boarding school, thus reducing variation of environment and service. Evaluations occurred after 12 to 24 months of use and were done with the Wheelchair Components Questionnaire for Condition. Results showed statistically significant differences among wheelchair components and indicated common areas of weakness. Across wheelchair models, frames and canes (uprights) generally scored well, and brakes, seats, footrests and castors were frequent weak points. These weaknesses likely indicate components that may require more rigorous test standards in wheelchairs designed for use in low-resource settings.

BACKGROUND

Wheelchairs provided for developing nations and other less resourced settings are typically manufactured at low cost, have limited long-term service support, and are used in the harshest environments.

Poor wheelchair condition associated with inadequately robust design or poor maintenance can impair a wheelchair users ability to participate in normal activities of daily living (Toro 2012). The first author is a member of the ISO wheelchair test standards seating working group, and is involved in an effort to determine what additional test standards may be necessary for wheelchairs intended for these conditions. Determining what is currently breaking on wheelchairs in the field is the first step to determining what additional testing should be undertaken.

To date, literature in the field has generally focused more on the number and impact of repairs than the specific cause of failure. McClure and colleagues surveyed 1364 manual wheelchair users in 2009 and found they averaged 0.81 repairs in the previous six months (McClure, 2009). In a survey of 110 manual and power wheelchair users, Fitzgerald and colleagues (Fitzgerald, 2005) asked users about the occurrence of repairs on their wheelchairs in various categories. Over a period of six months, 4.5% of users had frame repairs, 20% had mechanical component repairs, 18% had electrical component repairs, and 28% had tire problems. While these studies provide some insight, data from high-end wheelchairs in modern-world conditions, they are unlikely to be accurate predictors of failure modes in low-resource settings. More relevant was a study done by Armstrong, et.al (4) that tracked the number and type of repairs necessary on 100 Whirlwind wheelchairs provided in Afghanistan. During the first 10 weeks in operation, there were a large number of brake and seat fabric issues due to defective product. Besides these manufacturer issues, 2-7% needed replacements of push rim nuts, footplate, calf sling, rear tire, caster wheels, rear tire, or inner tube. While this study was done in a low-resource setting, it only referred to new wheelchairs and one type.

A survey in Mexico of 23 pediatric wheelchairs an average of 14 months old found that breaks and seat condition was especially problematic in those wheelchairs and called for additional studies on wheelchair durability and maintenance (Toro 2012)

Wheelchairs for low-resource settings are often distributed at centers and clinics to which users come from more rural areas. The wheelchairs are fit to the users and then the people return to their homes. While manufacturers generally value knowing what service issues may arise, feedback on long term quality is difficult due to geographic and communication barriers.

This study looks at wheelchair usage at a boarding school for children with disabilities in Kenya. Because the children live at this school year after year, tracking individual wheelchairs is possible. Furthermore the wheelchairs there have a similar environmental exposure and service opportunity, making comparisons possible. As part of several long term comparative studies of wheelchair function the Wheelchair Components Questionnaire has been developed and utilized to rate the condition of the study wheelchairs (Rispin et al 2013). Our goal in this paper is to use the data obtained in these studies on wheelchairs 12 to 24 months in age to shed light on patterns of failures across wheelchair types to inform the ISO standards for wheelchairs designed for use in low resource settings.

METHOD

Over the study period our host site at a boarding school for children with disabilities in Kenya was serving approximately 500 students with disabilities which included an average of 200 wheelchair users. Wheelchair

manufacturer's provided wheelchairs directly to our host organization for use by the students. Annual evaluations of study wheelchairs were done year after year. Only results from wheelchairs in service between 12 and 24 months are included in this study. These included six types of chairs provided by five manufacturers: 12 and 14 inch pediatric supportive wheelchairs provided by the Association of the Physically Disabled of Kenya (APDK 12s and APDK 14s); 12 inch wide Regency pediatric supportive chairs provided by Joni and Friends (Regency 12s); 14 inch wide pediatric supportive chairs provided by Hope Haven (HHaven 14s); and two types of adult sized wheelchairs for active users: the Whirlwind RoughRider (Whirlwind-RRs) and the Motivation Rough Terrain wheelchair (Motivation RTs).

The WCQc relies on wheelchair experts, typically physical or occupational therapists, to rate each chair on specific categories using a 100 mm visual analog scale while noting comments. Evaluators were not associated with any manufacturer and were able to give independent third party evaluations. Rated categories include seat and cushions, seat back, frame, uprights/handles, foot support, casters, wheels/pushrims, wheel locks, lap belt/harness, head and trunk supports, "other" components, and an overall rating. Initial validation has been positive and ongoing validation is underway (Rispin et al 2013).

ANOVA analysis on these results were done with the commercially available MiniTab[1] statistical package using a 95% confidence interval.

RESULTS

Included in the analysis were 5 APDK 12s, 9 APDK 14s, 15 Regency 12s, 23 HHaven 14s, 16 Whirlwind RRs and 19 Motivation RTs wheelchairs. Figure 1 shows the combined scoring of all models in each category. The categories of greatest concern are the brakes with a mean of 65 mm and footrests with a mean of 68 mm. Close behind these categories are seats 77mm, casters 72mm, and rear wheels 74mm. On the up-side, frames and uprights/handles indicate generally high durability across all the models.

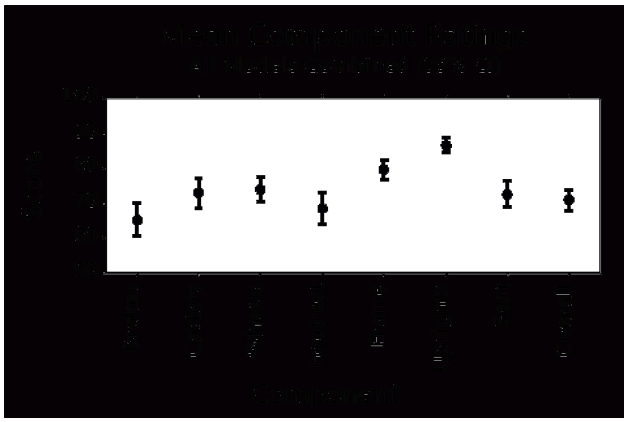

Figure 1. Combined scores for all wheelchair models by component.

Comments offer additional insight on the rationale for scoring in each category. Comments on the brakes indicate high occurrence of loosening, becoming rusty or stiff, and becoming misadjusted (too tight or too loose). Comments on casters indicated many had been replaced or repaired, others were described with missing bearings, tires cracked or peeling off, as well as paint chips and rust. Comments on wheels indicated high occurrence of loose, wobbly hubs, some missing hand-rims or nuts, worn tread, and flat tires. Footrest problems were noted as rotation stiffness, broken parts and obvious repairs, excessive looseness, cracked/broken foot plates, and rust and paint chips. The major comments on frames related to rust spots and paint chips, though about 5% had bent significantly. Models that had pads on armrests often showed significant degradation, breakage, or loosening. Uprights/handles generally had secure grips and only minor paint chips and wear spots. Finally, comments on seats and seat backs showed thinning or collapsing of the foam and cracking and tearing of the seat covers.

Two models had supplier issues with their casters; one changed all the castors before this study, and the other provided replacement bearings. Both of these actions resulted in higher castor scores at the time of the study likely underrepresenting overall weakness of castor design.

DISCUSSION

While items such as minor rust and paint chips would be expected after 1-2 years of use, manufacturers should be greatly concerned about issues such as loose or stiff bearings, loose or stiff brakes, seat cover and cushion break-down, caster tires and bearings disintegrating, non-functioning or broken foot supports, and armrests falling off or degrading to expose sharp T-nuts.

Some failures could be addressed by improved maintenance, replacing of cushioning and tightening, adjusting and lubricating brakes. However, maintenance regimes are complicated by inadequate numbers of trained wheelchair providers or lack of access to such providers (Pearlman, 2008). Because maintenance is often problematic, this study would indicate that ISO standards should require more rigorous testing for the components which often fail. Better reliability and durability would have an obvious positive effect on wheelchair users' mobility and health.

Study Limitations.

Actual conditions in the field provide sources of variability that must be noted. One such source of variability is initial quality. For example, one brand of wheelchairs had many issues "out of the box". Over the period of these studies the

host organization committed to prioritizing wheelchair maintenance and sent two clinicians to obtain the World Health Organizations Intermediate level Wheelchair Training Program qualification (WHO 2014). Uneven provision of maintenance from year to year also impacted results.

Inter-user reliability validation for the WCQc is underway but not yet complete so results may be impacted by user variability among evaluators.

CONCLUSION

While the limitations of this study must be kept in mind, the use of a quantitative assessment of wheelchair condition is an important tool in identifying significant mechanical failure in the field. As more data is gathered from various parts of the world, test standards can be updated for application to low-resource settings to help companies produce durable wheelchairs from the outset.

ACKNOWLEDGEMENTS

The authors would like to thank our host organization and the clinicians who worked with us.

REFERENCES

Armstrong, W., Reisinger, K., Smith, W (2007). Evaluation of CIR-Whirlwind Wheelchair and service provision in Afghanistan. Disability and Rehabilitation, 29(11-12), 935-948.

Fitzgerald, Shirley, et al. (2005). Issues in maintenance and repairs of wheelchairs: A pilot study. Journal of Rehabilitation Research and Development, 42(6), 853-862.

McClure, Laura, et al. (2009). Wheelchair repairs, breakdown, and adverse consequences for people with traumatic spinal cord injury. Arch Phys med Rehabil, 90, 2034-2038.

Rispin K, Goodwin S, Wesley C, Wee J. (2013) Preliminary development and validation of the wheelchair parts questionnaire to assess the condition of individual wheelchairs and the design of wheelchairs. 2013 Annual Conference Proceedings of the Rehabilitation Engineering and Assistive Technology Society of North America.

Toro, M. L., Garcia, Y., Ojeda, A. M., Dausey, D. J., & Pearlman, J. (2012). Quantitative Exploratory Evaluation of the Frequency, Causes and Consequences of Rehabilitation Wheelchair Breakdowns Delivered at a Paediatric Clinic in Mexico. *Disability, CBR & Inclusive Development, 23*(3), 48-64

World Health Organization 2014, Wheelchair Service Training Package, Available from http://www.who.int/disabilities/technology/wheelchairpackage/en/, Last Accessed 31 December, 2014

FOOTNOTES

[1] Minitab version 17.1.0, (2013) Minitab Inc., Quality Plaza, 1829 Pine Hall Rd., State College, PA 16801-3210. http://www.minitab.com.