The University of Sydney
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The Home Modification:
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Grabrail Design
An Annotated Bibliography

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Bridge, C. (1998). Grabrail prescription: Cumulative research findings 1992-1998. *Occupational Therapist's, OT Newsletter.*

There is a lack of guidelines on selection, installation and positioning of toilet grabrails competently, resulting in poor outcomes. Results from current research indicate that men and women have slightly different requirements and that individual anthropometric dimensions such as height are crucial. Overall, biomechanical results to date support grabrail prescription as a means to reduce biomechanical demands on the lower limbs. The article calls for interested occupational therapists to undertake research in the area of grabrail prescription so that there is accurate data on which to base clinical judgments.

Bridge, C. (2003). *Basic biomechanical and anatomical principles underpinning grabrail prescription for sit-to-stand transfers.* Sydney: The Home Modification and Maintenance Information Clearinghouse, University of Sydney.

This occasional paper seeks to address some of the relevant knowledge required by therapists in prescribing grabrails to improve safety and functional ability of older ambulant persons in sit to stand transfers from a toilet. It examines the basic biomechanical, anatomical and anthropometric principles underlying an understanding of how grabrail prescription impacts on normal sit-to-stand activities, particularly the activity of toileting for ambulant older persons. The significance of these issues is accentuated by confusion among therapists in the context of high caseloads, limited time, relatively low funding, and laws and regulations which are not framed to apply to individual homes or to include the community service sector.

Cheung, S. (1997). A survey on handrail installation for stroke patient. *Hong Kong Journal of Occupational Therapy, 1*(1), 10-13.

A major component of occupational therapy has been the prescription of equipment to increase independent living. However, little information exists in the literature regarding a suitable position for handrail installation. The aim of this article is to determine the most commonly recommended position for a toilet handrail for a patient with spasticity following a stroke. The rationale for the positioning of the handrail is also explored. The study failed to find the most recommended position for the position of the hand rail. Further research is needed to identify the ideal position.

City of Seattle. Dept. of Design, Construction and Land use, (2002). Getting a grip on handrails. Retrieved 24 April, 2003, from http://www.cityofseattle.net/dclu/Publications/cam/cam319.pdf

This article provides guidelines for owners and designers to evaluate their projects to identify potential safety problems relating to the number, placement, size and shape of handrails and whether to provide more than the minimum requirements of the codes. Both the Seattle Building Code and the Washington State Building Code regulate handrails and provide minimum requirements. The requirements for location and frequency of handrails are specified in SBC, Sec. 1003.3.3.6 and 1003.3.4.5. These basic requirements apply to all interior and exterior building stairs and to other stairways on the site that provide public access to, from, or between buildings. Section 1106.8.5 requires handrails on ramps that are sloped steeper than one unit in vertical direction to 20 units in horizontal direction.

Clemson, L., & Martin, R. (1996). Usage and effectiveness of rails, bathing and toileting aids. *Occupational Therapy in Health Care, 10*(1), 41-59.

There is a lack of systematic follow-up on the usage or effectiveness of rails and aids for elderly persons or persons with disabilities. One hundred and forty-four persons, mostly elderly, responded to a mailed questionnaire. This article investigates factors associated with usage and non-usage of commonly used bathing and toileting aids and rails, and rails used for access to and from the home, including reasons for non-usage, equipment acceptance, perceived benefit, ergonomic factors and equipment reliability. The questionnaire showed high internal consistency. Usage rates were high, 86% for rails and 76% for aids. Non-usage was largely attributed to change in functional status. There were also some specific areas of dissatisfaction indicated, including issues of aid prescription, methods of assessing rail placement, and design of equipment.

CSIRO Building Construction and Engineering Building Information Resource Centre. (2001). *Access for people with disabilities: Stairs, steps and handrails.* (No. 14, Building Technology File). Sydney: CSIRO.

This Building Technology File outlines general design principles and guidelines for stairs, steps and handrails for people with disabilities in and about buildings for general public use. Solutions to specific problems are not given due to the unique context and characteristics of each building situation.

Dayeh, R. J. (1985). *Horizontal loading on handrails.* Chatswood, N.S.W.: National Building Technology Centre.

The matter of loading on handrails was referred to the NBTC by the Standards Association of Australia as part of the Center's involvement in the revision of AS1170 Part 1. Provisions for design loads on handrails vary significantly for the American, Australian, British and Canadian codes. Because it is difficult to find the source data upon which these provisions were made and thereby determine their adequacy, it was decided to establish experimentally the magnitude of the horizontal thrusts on handrails resulting from some basic loading situations. This book describes such an experiment to determine the horizontal loads applied to handrails by users.

Disabled Living Foundation. (2007). Choosing and fitting grab rails. Retrieved April 30, 2007, from http://www.dlf.org.uk/factsheets/pdf/Choosing_and_fitting_grab_rails.pdf

This fact sheet provides information on the types of grab rails available in England that can be universally applied to help with specific difficulties, and details about their useful features and positioning.

Dusenberry, D. O., & Simpson, H. (1996). Handrail graspability, *Conference on Engineering Mechanics, Part 1 (of 2).* (Vol. 1, pp. 466-469). Fort Lauderdale, Florida: ASCE, U.S.A.

As part of an experimental program to develop design criteria for cross-sectional profiles of stairway handrails, measurements were made of the maximum grasp force (the maximum restraining force exerted by the subject as the rail is moved away from the subject) on two wood handrail designs - a 6010 decorative ('milled') handrail (the most common residential handrail style in use today) and a 51-mm (2-in.) round handrail. A total of 292 tests were performed with 73 subjects, ranging in age from 10 years to 83 years. The authors conclude that the milled shape performs at least as well as the round shape, and that the maximum restraining force is developed with a hook grip (rather

than, as is commonly assumed, a 'power' grip).

Feeney, R. J., & Webber, G. M. B. (1994). *Safety aspects of handrail design.* (No. BR 260 Building Research Establishment Report). Garston, U.K.: Building Research Establishment.

The aim of this review was to identify and recommend design criteria for the ease of gripping and grasping stair handrails and for their height, and to make the detailed findings known to a wider range of professional bodies, designers and manufacturers, building owners and user groups.

Gibson, A. (1996). *Canterbury concepts grabrails: Australian standards compliant.* Sydney: Independent Living Centre NSW.

Discusses the uses of grab rails and gives detailed instructions with illustrations on how to install them according to Australian Standards specifications.

Independent Living Centre N.S.W. (1994). *Guidelines to help you select suitable grabrails for safety in the home.* Sydney: Independent Living Centre, N.S.W.

This guide offers advice on the types of rails to purchase, provides information on rail installation, maintenance of rails and equipment to consider for additional safety.

Independent Living Centre S.A. (2002). Get a grip on it. Retrieved 16 May, 2003, from http://www.ilc.asn.au/resources/brochures/

Covers safety issues with regards to grab rails and provides installation guidelines.

Kennedy, M. (1986). Adapted grab bar for an armchair. *Canadian Journal of Occupational Therapy, 53*(3), 159-160.

This article discusses how an adapted grab bar attached to an armchair ensured the return of an elderly client to her own home following temporary hospitalization.

Lockett, D., Aminzadeh, F., & Edwards, N. (2002). Development and evaluation of an instrument to measure seniors' attitudes towards the use of bathroom grab bars. *Public Health Nursing, 19*(5), 390-397.

Bath grab bars can minimize the effects of many age-related deficits that may contribute to bath-related falls. Despite their potential value, bathroom safety devices remain largely underutilized by many community-living older adults and knowledge concerning attitudinal factors that influence the use of grab bars is sparse.

This study examined the psychometric properties of a newly developed Grab Bar Use Attitude scale (GUAS). Instrument formation, including item generation, evaluation by a panel of experts, and pilot testing of the draft instrument to establish its face and content validity, was followed by instrument validation using 546 community-living seniors. Results of principal components analysis of the GUAS revealed a two-factor solution, explaining 56% of the variance.

The two constructs may best be described as functional/safety and psychosocial consequences of using grab bars. Psychometric analyses of the 9-item scale provided empirical evidence of the internal consistency of the total scale and each subscale. Finally, the GUAS distinguished between regular grab bar users and non-regular users. Implications for use are discussed.

Lynch, T. P. (1991). Spring loaded pole forms removable supports; convalescing patients get safety rails at home without the expense of permanent installation. *Design News, 47*(9), 84-85.

This article discusses sturdy-grip as a modular system of removable supports for patients convalescing at home. It is a mechanically simple device that can be installed by non-professionals and is easy to install and remove. It does more than simply replace conventional grab bars and hand rails, for example, stroke victims sometimes lose the use of one side of their bodies. Sturdy Grip can be easily configured for such a patient's special needs.

Maki, B. E., Bartlett, S. A. & Fernie, G. R. (1984). Influence of stairway handrail height on the ability to generate stabilizing forces and moments. *Human Factors, 26*(6), 705-715.

An experimental study investigating the influence of handrail height on the ability of stairway users to generate stabilizing forces and moments, with the aim of improving stairway safety by developing better handrail design standards. The experiments involved measurements of the maximum forces and moments that subjects were able to exert on a handrail while they stood stationary in an upright position. Two age groups were tested: young (20 to 45 years) and elderly (59 years and over), with a total of 35 subjects. All subjects showed a strong linear dependence on handrail height in generating forces and moments. Based on the results, an optimal design range for handrail height was estimated.

Maki, B. E., Perry, S. D., & McIlroy, W. E. (1998). Efficacy of handrails in preventing stairway falls: A new experimental approach. *Safety Science, 28*(3), 189-206.

This article describes a novel and safe experimental approach developed to study the biomechanical efficacy of handrail use under dynamic conditions. This technique uses support surface motion to perturb the balance of a subject who stands on a small (three steps) heavily padded mock staircase. The authors attempt to determine factors such as perturbation magnitude, stance, and leg proximity to the handrail, initial hand position and the ability to complete a step whilst holding the handrail. This article primarily answers the question "Is it ever possible to grab a handrail with sufficient speed and accuracy to prevent a fall on a stairway after losing balance?" Implications for safe handrail design are discussed.

McDonald, G. (1997). *An investigation into vertical grabrail use and grabrail grasp height for older women with bilateral knee osteoarthritis.* Unpublished Bachelor of Applied Science (Occupational Therapy) (Honors), University of Sydney, Faculty of Health Sciences, Sydney.

Grabrail prescription is an intervention strategy frequently employed by occupational therapists to facilitate the independence and safety of older people and people with a disability in their home. This practice is likely to increase with increasing proportions of older people with a disability living in the community. Current protocols available to guide grabrail prescription such as the height at which they should be grasped, vary considerably, are inadequately documented and under researched. This is particularly true for the elderly and disabled, such as people with osteoarthritis. Therefore the purpose of this study was to investigate the effect of vertical grabrail use on sit-to-stand performance and investigate the height at which a vertical grabrail may be grasped to assist the sit-to-stand transfer for ten women, aged 60 years and over, who were diagnosed with bilateral knee osteoarthritis.

McDonald, G., Bridge, C., & Smith, R. (1996). Osteoarthritis, grabrail use and positioning; what are the implications., *NSW AOT Annual State Conference*. Sydney.

The purpose of this paper was to highlight the variance in current grabrail prescription guidelines and to present a biomechanical research project and its findings designed to specifically investigate the use and positioning of a grabrail for women with bilateral knee osteoarthritis.

O'Meara, D. M. (2003). *Properties of manual support fixtures.* Unpublished Doctor of Philosophy, School of Exercise and Sport Science, Faculty of Health Science, The University of Sydney, Sydney.

This thesis provides an objective assessment of manual support fixture properties, in particular on the assessment of grabrails because of the precise way in which they provide assistance during the sit-to-stand transfer. To analyse the impact of grabrail properties on performance, two areas were investigated: stability at the hand/handle interface and the impact of grabrail position and orientation on the mechanics of the sit-to-stand and stand-to-sit transfers. Two functional tests of friction involving a handgrip action determined the interaction at the hand/handle interface. Both assessments involved the investigation of friction characteristics of five commercially available grabrails with palmer skin that was dry, wet and soapy.

O'Meara, D. M., & Smith, R. M. (2001). A direct and indirect measure of friction between palmer skin and grabrail materials, *The 18th Congress of the International Society of Biomechanics* (pp. 3 p.). Zurich: International Society of Biomechanics.

This study attempts to incorporate a direct and an indirect measurement technique to determine friction and normal forces at the hand/handle interface, without the introduction of a sensor or alternations to natural conditions. The two experiments provide a closer insight into the actual mechanisms that occur at the hand/handle interface at the moment of hand slip. A group of thirty subjects aged 17 to 45 participated in each of the two parts to this study to assess friction properties between five grabrail materials (stainless steel. powder-coated steel, chrome, textured aluminium and knurled steel) and three hand treatments (dry, wet and soapy).

O'Meara, D. M., & Smith, R. M. (2001). Static friction properties between human palmar skin and five grabrail materials. *Ergonomics, 44*(11), 973-988.

The purpose of this study was to investigate the static friction properties between human palmer skin and five grabrail materials (chrome, stainless steel, power-coated steel, textured aluminium and knurled steel) for dry, wet and soapy hands. Thirty subjects (15 female, 15 male) participated in this study, their ages ranging from 19 to 45 years with a mean age of 28 years. The normal force, friction force, and coefficient of static friction were determined by measuring three-dimensional forces while slipping the palm of the hand over the surface of a grabrail. A repeated measures ANOVA indicated that gender, age, hand size and trial effect had no significant influence ($p>0.05$) on these results. The coefficient of friction ($p<0.001$) and friction force ($p<0.001$) were significantly lower when the hand was soapy than when it was dry or wet. The normal force applied when the hand was soapy was significantly greater ($p<0.001$) than when it was dry or wet. No significant difference was found between dry and wet hands. The two textured materials displayed superior friction properties when the hand was soapy, while the smooth materials performed best when the hand was dry.

O'Meara, D. M., & Smith, R. M. (2002). Centre of mass motion during a grabrail assisted sit-stand-sit cycle, *3rd College of Health Science Research Conference* (pp. p. 25). University of Sydney, Sydney.

Grabrail assistance during the sit-stand-sit cycle can contribute to maintaining independence for individuals with limited strength and coordination, such as a frail older aged adult. Control of the body's centre of mass (COM) motion is an important component of successful transfer performance. Older aged adults reduce their COM velocity (COMV) and adopt a strategy based on stability rather than efficient use of upper body momentum. This paper investigates the effect of grabrail assistance on COMV.

O'Meara, D. M., & Smith, R. M. (2002). The effects of grabrail position and orientation on body motion and handle force. In T. M. Bach, D. Orr, R. Baker & W. A. Sparrow (Eds.), *4th Australasian Biomechanics Conference* (pp. 28-29). La Trobe University, Melbourne.

In this paper the effect of grabrail assistance on centre of mass (COM) motion and force applied to the grabrail is investigated to determine the strategy that healthy older aged adults adopt when performing the sit-stand-sit cycle. This data can aid in determination of appropriate grabrail design features.

O'Meara, D. M., & Smith, R. M. (2002). Functional handgrip test to determine the coefficient of static friction at the hand/handle interface. *Ergonomics in Design, 45*(10), 717-731.

The aim of this article was to devise a method of measuring friction at the hand/handle interface during a functional handgrip task. No descriptions of methods of this kind were found in the literature. An indirect technique of measuring normal grip force was employed to determine friction at the hand/handle interface while performing a functional handgrip action with a grabrail. The coefficient of static friction was calculated between palmer skin (dry, wet, and soapy hands) and five grabrail materials (stainless steel, powder-coated steel, chrome, textured aluminium and knurled steel). Thirty subjects participated (15 female, 15 male), who were aged from 17 to 45 years with a mean age of 30 years. Knurled steel produced a significantly larger mean coefficient of static friction than chrome, powder-coated steel and stainless steel, and textured aluminium had a significantly larger coefficient of static friction than stainless steel. Soapy hands produced the lowest mean coefficients (0.46+/-0.04), significantly less then dry (1.72+/-0.16, $p<0.001$) and wet hands (1.42+/-0.16, $p<0.001$). This study has demonstrated the influence of grabrail material and palmer skin treatments on static friction at the hand/handle interface.

O'Meara, D. M., & Smith, R. M. (2003). The effect of grabrail position on peak lower body net joint forces during assisted sit-to-stand transfers. In P. Milburn, B. Wilson & T. Yanai (Eds.), *XIXth Congress of the International Society of Biomechanics* (pp. 306-308). University of Otago, Dunedin, New Zealand.

Grabrails can enable frail older aged adults to maintain independence while experiencing aged related changes and associated degeneration due to inactivity. The sit-to-stand transfer is an essential activity of daily living that enables frail older aged adults to remain independent in the community. As very few studies specifically focus on assistive devices such as grabrails, this issue is addressed in this paper by determining the impact of grabrail position on lower body peak net joint forces during grabrail assisted sit-to-stand transfers.

O'Meara, D. M., & Smith, R. M. (2005). Differences between grab rail position and orientation during the assisted sit-to-stand for able-bodied older adults. *Journal of Applied Biomechanics, 21*(1), 57 - 71.

This study compares the effects of grabrail position, orientation, and the number of hands used on the kinetics of assisted sit-to-stand transfers. Participants were 12 able-bodied older adults between the ages of 69 and 88. The study demonstrates grabrail position, orientation, and the amount of upper body contribution that influenced the assisted sit-to-stand transfer performance. The outcomes of this study suggest that grabrail prescription requires careful consideration of position and orientation in order to optimize grabrail assistance during sit-to-stand transfer. Includes tables and graphs.

Ongley, J. (1999). *An investigation of the sit-to-stand transfer in healthy older women when standing up from different toilet pan heights with and without grabrail assistance.* Unpublished Bachelor of Applied Science (Occupational Therapy) (Honors), University of Sydney, Sydney.

The aim of this thesis was to devise a method of measuring friction at the hand/handle interface during a functional handgrip task. No description of methods of this kind was found in the literature. An indirect technique of measuring normal grip force was employed to determine friction at the hand/handle interface while performing a functional handgrip action with a grabrail. The coefficient of static friction was calculated between palmer skin (dry, wet, and soapy hands) and five grabrail materials (stainless steel, powder-coated steel, chrome, textured aluminium and knurled steel). Thirty subjects participated (15 female, 15 male), who were aged from 17 to 45 years with a mean age of 30 years. Knurled steel produced a significantly larger mean coefficient of static friction than chrome, powder-coated steel and stainless steel, and textured aluminium had a significantly larger coefficient of static friction than stainless steel. Soapy hands produced the lowest mean coefficients (0.46+/-0.04), significantly less then dry (1.72+/-0.16, $p<0.001$) and wet hands (1.42+/-0.16, $p<0.001$). This study has demonstrated the influence of grabrail material and palmer skin treatments on static friction at the hand/handle interface. The use of a functional test that incorporates an indirect determination of normal handgrip force has provided a quantitative method of observing stability at the hand/handle interface.

Packer, T. L., Wyss, U. P., & Costigan, P. A. (1993). Elbow kinematics during sit-to-stand and stand-to-sit movements. *Clinical Biomechanics, 8*, 322 - 328.

In this study, the sit-to-stand and stand-to-sit movements of 10 healthy women (mean age 52.4 years) were subjected to a descriptive analysis that yielded a definition of phases, determination of the peak angles reached, maximum angular velocity during each movement, and the sequencing of key events. While subjects showed little intra-subject variability, inter-subject variability was evident. Subjects differed in the joint angles and angular velocity recorded, but the sequence of flexion/extension and rotation events were unchanged. Changes in direction of flexion/extension and rotation tended to occur very close in time, if not at the same time.

Pauls, J. (1991). Are functional handrails within our grasp? *Building Standards, 60*(1), 6-12.

This article discusses how a designer's mental grasp of handrail function and form should be more influenced by simple, readily understood concepts of hand reach and grasp. Includes definition and mechanics of functional handrails.

Rakatansky, M. (1992). Prototype handrail. *Progressive Architecture, 73*(1), 80-85.

This article discusses the project "Prototype design intervention in the adult day care centre", Parkside Senior Services, Illinois. The aim was to understand the relationship between architecture and the social and psychological space of older participants in an existing adult day care centre and to enrich this environment. The intervention and subsequent findings (designs) are meant to be a model from this building type rather than a single project endeavor.

Roland, M. (1996). *Effectiveness of grabrails during sit-to-stand transfers.* Unpublished Master of Applied Science (Occupational Therapy), University of Sydney, Sydney.

This study involved a biomechanical analysis of the sit-to-stand transfer with the assistance of a grabrail. The aim of this study was to use biomedical research to enhance the scientific base for grabrail prescription. Nine women aged over 69 were the subjects. They performed three conditions of movement: sit-to-stand unaided, sit-to-stand grasping the rail at their preferred height, and sit-to-stand grasping the rail at the height of their greater trochanter (thigh bone). Data were collected and analysed using the Expert Vision motion analysis system.

Sanford, J. A. (2002). Time to get rid of those old gray grab bars and get yourself a shiny new pair. *Alzheimer's Care Quarterly, 3*(1), 27-31.

DA accessibility guidelines are based primarily on the capabilities of young people with disabilities and, as such, may not compensate adequately for the range of physical and cognitive disabilities that are common among older adults. This article reviews findings from several studies of toilet transfer that not only suggest that ADA accessibility guidelines. (ADAAG) for toilet and grab bar configurations do not meet the needs of older adults, but that other, non-ADAAG compliant designs are better suited for an older population.

Sanford, J. A., & Megrew, M. B. (1995). An evaluation of grab bars to meet the needs of elderly people. *Assistive Technology, 7*(1), 36-47.

This article evaluates the effect of grab bar placement and toilet seat height on ambulatory and non-ambulatory older persons' ability to toilet independently and safely. Participants were 116 persons age 60 and over who could transfer independently on and off a toilet and who were cognitively intact. Sixty-six participants were ambulatory, and 50 were non-ambulatory.

The test apparatus consisted of a toilet room with accommodations for two toilet seat heights and four grab bar configurations. During eight videotaped trials (four grab bar configurations at two toilet heights), participants were asked to approach and get on the toilet, stay seated for a few seconds, and get off. After each trial, participants rated the safety, ease of use, and helpfulness of the grab bars. Video-based data were coded by two trained raters, and chi-square analysis was used to assess self-rated and video data on safety, difficulty, helpfulness, frequency and location of grab bar use, and frequency of assistive device use.

Results indicated that grab bar configurations that were not code-compliant were preferred and were used more often than configurations that met Americans with Disabilities Act Accessibility Guidelines (ADAAG). These results raise questions concerning the applicability of the ADAAG to the toileting needs of older people.

Sanford, J. A., & Megrew, M. B. (1999). Using environmental simulation to test the validity of code requirements. Chap. 8. In E. Steinfeld & G. S. Danford (Eds.), *Enabling environments: Measuring the impact of environments on disability and rehabilitation.* New York: Kluwer Academic.

This chapter reports the findings of a study that utilized environmental simulation to evaluate the effect of grab bar placement and toilet seat height on an older person's ability to toilet independently and safely. Different grab bar configurations have different impacts on the safety and independence of older people in toileting activities. This chapter also discusses the advantages and disadvantages of simulation as a research approach and the application of simulation to other types of environmental assessments.

Seton, H. (2005). *Which grabrail orientation provides the best assistance to older people during the sit-to-stand transfer? A systematic review of the literature.* Unpublished Bachelor of Applied Science (Occupational Therapy) Honours, University of Sydney, Sydney.

This research reviews the evidence on grabrail orientation, horizontal or vertical, which provides better support to healthy older people when performing the sit-to-stand toilet transfer. Looks at the current best practices discussed in the existing literature.

Sloane, J. (2000). Steps and stairways: Guidelines for accessible design. *Independent Living, 16*(3), 10-12.

The article looks at the variations in handrail diameter that may be required for some individuals.

Stevenson, K. (2002). Get a grip: Guide to grab rails. *Independent Living, 18*(1), p. 24.

Briefly describes different types of rails - coloured, with slip resistant grip, plastic, PVC, angled rails, tap rails, custom made rails. Gives brand and company names.

Travers, A. F. (1991). Ramps and rails: Everyday aids and appliances. *British Medical Journal, 302*(6782), 951-954.

The authors discuss the use of ramps and rails in Great Britain. About 1 percent of the population uses a wheelchair. Some people with disabilities often have difficulty travelling or entering buildings. For many people with disabilities, ramps and rails are the keys to accessibility. Ramps may be portable or fixed and can be constructed of various materials. The surface should be non-slip and the grade of the ramp should not exceed 5 degrees. Portable ramps are useful for active people with disabilities; folding ramps may also be used to swing across or down when needed. Ramps for entering vehicles are available, along with short rise lifts. Another aid to mobility is the installation of household rails. Handrails on staircases should be continuous and extend beyond the top and bottom of the stair, and door handles are preferable to door knobs. The author recommends that rails placed in bathrooms should be horizontal and parallel to the side of the toilet.

Zelinsky, M. K. (1994). Finding solutions. *Interiors, 153*(8), 54-55.

The Rayne's Rail incorporates audio and touch tools (Braille) into a handrail.