

Taking a Stand on Falls in the Person with Diabetes—Part 1

Having a suitable fall prevention strategy will optimize the quality of life for your diabetic patient.

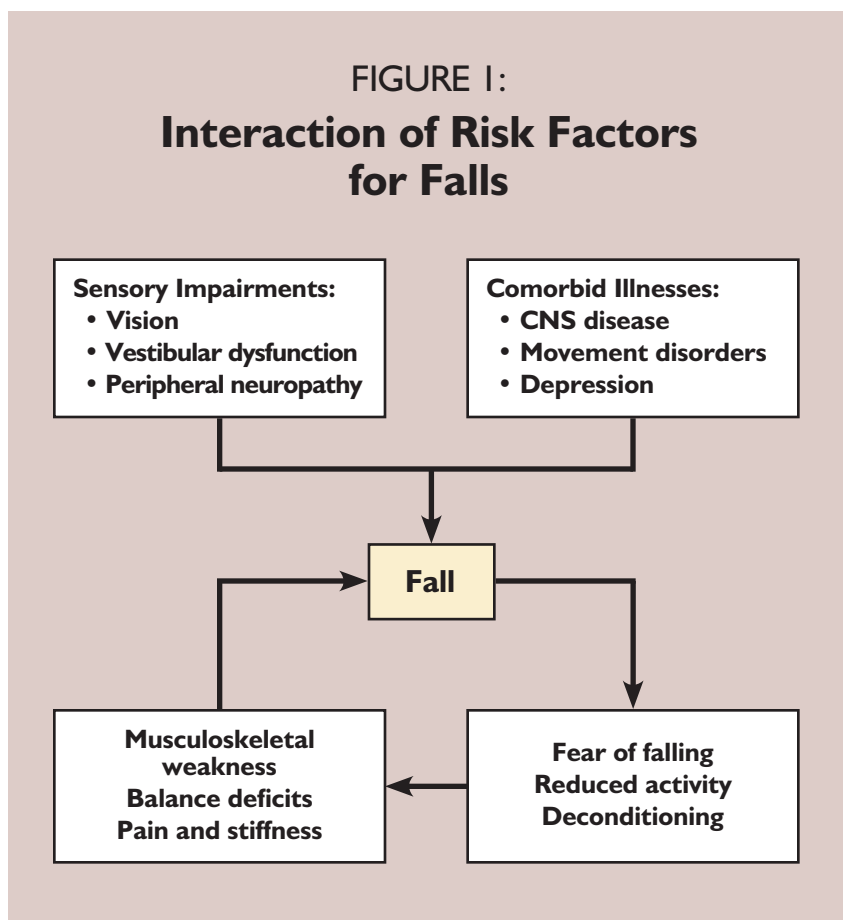
BY KENNETH B. REHM, DPM

We are all aware of it. *The New York Times* even warns us to brace for the upsurge of falls expectedly arising from an aging nation (Nov. 2, 2014). As our population matures and people live longer, the number of senior citizens who experience falls is soaring. According to an epidemiologic study¹ headed up by Dr. Christine Cigolle, the 2-year prevalence of self-reported falls among all adults 65 years or older increased from 28.2% in 1998 to 36.3% in 2010. Stratifying by age, fall prevalence increased for adults aged 65 to 89 years and was most marked at the younger end of the age range. Patients with diabetes were not explicitly factored into this study, but previous research² indicates a significant relationship between aging, diabetes mellitus and falls.

The annual incidence rates of falls for those having diabetes reaches 39% in those over 65 years old; and 35% in those over 55 years of age. In addition to the high *incidence* of falls associated with diabetes, it has been reported that these individuals are indeed at a higher *risk* for falls.²

Risk Factors for Falls Among Older Adults

Turning aside from the diabetic factor for a moment: most falls are caused by the interaction of multiple risk factors (Figure 1). The more risk factors a person has, the greater is their chances

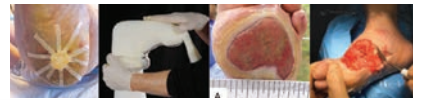


of falling. They all, however, involve some type of *balance problems and/or muscle weakness, cognitive, visual, and psychological challenges, as well as an individual's personal environmental concerns* (Figure 2).

Both intrinsic and extrinsic fac-

tors are involved (Figure 3). *Intrinsic factors* include advanced age, previous falls, poor vision, gait and balance impairments, peripheral neuropathy, vestibular dysfunction coupled with postural dizziness, muscle weakness

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especially in the lower body, functional as well as cognitive impairment such as dementia—which by itself increases the incidence of falls by impairing judgment, visuospatial perception, and orientation ability. Falls also occur when these persons wander, attempt to get out of wheelchairs, or climb over bedside rails. All types of dementia, cognitive impairment and confusion almost double the risk for falling.

Similarly, depression is associated with about a twofold-increased risk of falling, for it may result in inattention to the environment, or cause more risk-taking behaviors (e.g., poor self-rated health, cognitive impairment, functional impairment, slow gait speed). Postural hypotension, chronic conditions aside from DM, arthritis, sequelae of stroke, Parkinson's disease and incontinence are all intrinsic risk factors and direct causes of falls.

Extrinsic factors incorporate complications associated with improper foot wear, inappropriate use of assistive devices and restraints, and physical environment. Examples include poor stair design and lack of stair handrails, lack of bathroom handrails and grab bars, poor lighting or glare, slippery or

uneven surfaces, obstacles and tripping hazards. Psychoactive medications are included among extrinsic factors because they are considered factors outside the person (Figure 4).

footprint on the dynamics of falling. It does so via three pathways of influence.

Firstly: the effect of diabetes, in and of itself, is profound. Studies have demonstrated diabetes mellitus to be an independent risk factor even without any complications or blood

A higher risk of falling indoors was associated with going barefoot or wearing socks alone.

uneven surfaces, obstacles and tripping hazards. Psychoactive medications are included among extrinsic factors because they are considered factors outside the person (Figure 4).

The Three Diabetic Pathways

Although the risk factors just discussed apply to all older adults, *diabetes, nevertheless, plants its own unique*

sugar control issues. Interestingly, the disorder is not widely recognized as such. Still more, there is substantial evidence³ that no matter what diabetic complications exist, *poorly controlled diabetes is associated with an even greater risk of falling than is controlled diabetes.* Other studies⁴ have shown an association between hyperglycemic

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FIGURE 2:
Risk Factors for Falls

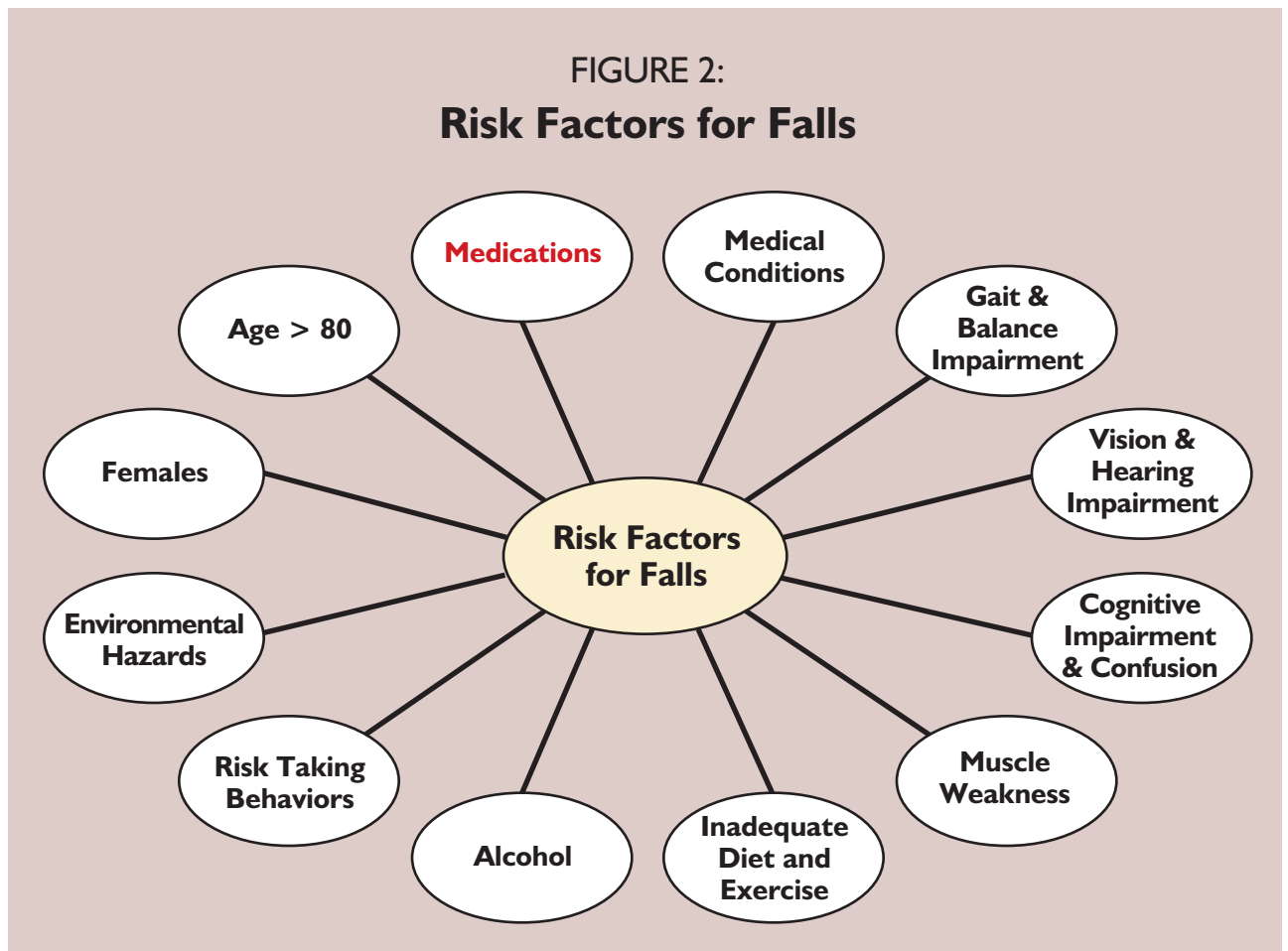
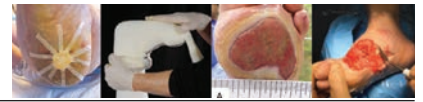


Figure 2: Multiple risk factors increase the chance of falling



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status and poorer mobility, with an increased fall risk even in younger patients and in those with shorter disease duration.

In another study⁵ involving older patients, both diabetic and non-diabetic, poor balance and diabetes were shown to be independent risk factors. According to multivariate logistic regression models detailed in this study, diabetes was found to be a major risk factor even after poor balance is corrected.

Secondly: having diabetes mellitus, with its many complications, has a deleterious effect on, and therefore increases the jeopardy associated with, the established general risk factors for falls previously mentioned in this report. In other words, *having diabetes makes everything worse.* For example, diabetes-related complications such as poor vision, poor depth perception, and cerebrovascular accidents are a few reasons why patients may have poor balance and a greater probability for falls.

Furthermore, many DM-related factors—such as taking more medications, walking slower, taking shorter strides, reduced grip strength, higher levels of pain, poorer self-perceived health,

FIGURE 4:
Modifiable Fall Risk Factors

- Muscle weakness
- Imbalance
- Gait problems
- Mobility deficits
- Syncope
- Orthostatic hypotension
- Polypharmacy
- Psychotropic meds
- Decreased health
 > Frailty
- Incontinence

Figure 4: Modifiable risk factors should be addressed first

lower physical activity, more limitations in ADLs, faulty lower-extremity physical performance, as well as cognitive impairment—are intensified as a result of DM, and were shown to be more instrumental in causing falls in people with this disease.⁵ Several preventative programs that include medication therapy management, balance exercises, and cognitive training were found to be beneficial in older adults suffering from diabetes in reducing the risk of falls.⁵

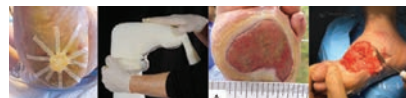
Whenever fall risk is discussed in relation to diabetes, it is assumed that the type of shoe plays an important role. However, in one study⁶ footwear characteristics were not significantly associated with falls either inside or outside the home. However, a higher risk of falling indoors was associated with going barefoot or wearing socks alone. It's advisable, therefore, for people with DM, especially those with sensation deficit, to always wear shoes and socks whether they are inside or outside of their house.

Interestingly, research by Dr. Mettelinge et. Al.⁷ found that the strongest mediator of the relationship between diabetes and falls was the number of medications that a person was taking. Those with diabetes were taking on the average a total of nine medications while persons without diabetes were taking around four medications. Another study²¹ revealed that taking four or more medications daily was associated with an increased risk and incidence of falls among adult diabetes patients, while no specific glucose-lowering agent was linked to that increased risk. It was hypothesized that blood sugar parameters between different glycemic regulating medications might have contributed to this increased risk, but this was found not to be a significant factor. It is reasonable to presume, then, that the preventative programs mentioned previously could certainly help people with DM to be more controlled with their medications, and

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FIGURE 3:
Intrinsic and Extrinsic Risk Factors

INTRINSIC	EXTRINSIC
<ul style="list-style-type: none"> • Previous falls history • Age • Gender • Living alone • Polypharmacy • Multiple co-morbidities • Impaired mobility • Psychological status • Nutritional deficiencies • Cognition • Visual impairments 	<ul style="list-style-type: none"> • Poor lighting • Slippery floors • Uneven surfaces • Cluttered living space • Inappropriate walking aid • Poor footwear and clothing



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that these programs might help prevent them from suffering falls in the future.

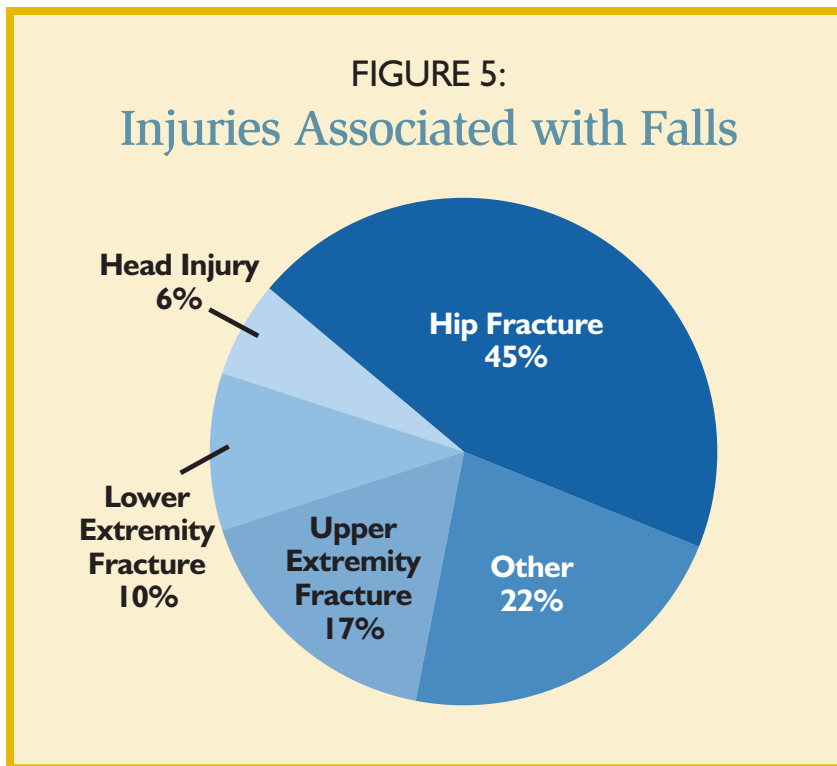
Thirdly: because of its multiple well-known complications and the different combinations of such, every person with DM presents with their own tessellation of causes and risks of falling. In other words, there are usually many different blends of complications in play at any given time, and thus the clinical picture is different for each person.

Neuropathy and Falls

Perhaps the most relevant complication of DM is neuropathy. From the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)⁸ about 60 to 70 percent of people with diabetes have some form of neuropathy. People with diabetes can form nerve problems at any time, but this condition advances with age and duration of diabetes. This firmly places the elderly person with diabetes at higher risk for all types of neuropathic challenges, including those that pose risk factors for falls.

Diabetic neuropathy can be classified as peripheral, sensory, motor, autonomic, proximal or focal. Each affects different parts of the body in various ways. Persons with diabetes often have a mixture of these types that may lead to a diverse clinical picture. Peripheral neuropathy, also called distal symmetric neuropathy or sensorimotor neuropathy, commonly causes pain and/or numbness in the toes, feet, hands and arms. Loss of balance and coordination is a common sequel to this clinical picture. In addition, these symptoms are known to be worse at night; and the feet and legs are likely to be affected before the hands and arms. This constellation portends fall risk stridently.

There is evidence^{9,10,11} that gait changes do also appear in people with diabetes mellitus. These changes, coupled with local soft tissue changes from advanced glycosylated end products, can further affect a person's gait and hence puts him/her at greater risk for falls. Also, older people with diabetes and neuropathy demonstrate an impaired ability to stabilize their body when walking on irregular surfaces, even if they adopt a more conservative gait pattern. These outcomes provide



further insights into the role of peripheral sensory input in the control of gait stability, and reveal probable mechanisms underlying the increased risk of falling in older people with diabetic neuropathy.

Persons with a significant motor component to their neuropathy may exhibit major functional problems with their lower extremities, including balance and coordination of their gait. A quick test of the ability of a person with sensorimotor neuropathy to rise repeatedly on the toes from a neutral standing position may very well reveal an inability to do so due to weakness of the triceps surae muscle. Furthermore, loss of strength in the ankle dorsiflexors can lead to an abnormal gait, which may demonstrate a foot drop and/or a step-page pattern. Persons with these gait problems could drag their toes during the stance-to-swing portion of the gait cycle, and in turn, toes might be injured or they might catch on the floor—both of which are not uncommon causes of falls in the elderly diabetic (Figure 5).

Both motor and sensory neuropathy, which often occur together, affect the afferent nerves relative to balance; hence, neuropathic patients fall more often than those without neuropathy. A Romberg test, with a person standing with their feet touching, having

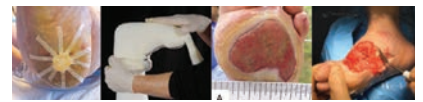
their eyes open and then closed, can reveal truncal instability due to vision problems, proprioception deficit and/or motor neuropathy. Truncal instability speaks to weakness and balance challenges, and therefore often heralds future falls.

At the Gillis Long U.S. Public Health Service Hospital in Carville, Louisiana, the physicians who were responsible for the intake of patients with diabetes (and/or Hansen's Disease-Leprosy) were encouraged to incorporate a detailed monofilament test in their workup, using multiple mono-filaments of different thicknesses. This testing establishes the threshold for touch sensation, rather than the presence or absence of protective sensation, the results of which can be highly predictive of postural instability, a condition that commonly leads to falls. It is interesting to note that a person who cannot feel just the 10-gm monofilament can be expected to sway while trying to stand, clearly marking loss of protective sensation as a risk factor for falling.

High-Risk Activities, Reaction Times and Motion Detection

Hazardous high-risk activities that should not be overlooked when con-

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sidering fall risk in the patient with DM include getting up from a chair or wheelchair, sofa, toilet, getting out of a car, walking up or down stairs and grabbing a bannister up or down stairs for support. The potential of tripping while doing any high-risk activity should always be in the forefront of any fall prevention strategy. There are a number of factors at play here, but connections to falling specific to diabetes must be considered.

Falling due to tripping in a person with DM is often the result of *changes in blood sugar, which in turn can cause blurry vision, muscle weakness and fatigue, along with dizziness and numbness in the hands and feet*, separate from the typical manifestations of peripheral neuropathy. Tripping is frequently an unfortunate outcome of *slower reflexes and increased reaction*

Other research¹³ indicates that, in addition to the *increased reaction times*, even mild diabetes can have profound effects on a person's ability to detect and react to motion, which leads to insights on their ability to detect and prevent slips and falls.

Summary

Part I of this brief review was designed to emphasize the importance of including the topic of falls when discussing diabetes, its challenges and sequelae. The reasons why falls among the elderly occur, and how diabetes enhances those causative factors, were addressed. What's needed to complete this treatise is some consideration of the functional, biomechanical and therapeutic aspects of an ideal fall prevention strategy. This will be addressed in part II of this article.

Having a suitable fall prevention strategy will ultimately optimize the

A Prospective Cohort Study." National Center for Biotechnology Information. U.S. National Library of Medicine, 25 June 2013. Web. 2013; 8(6): e67055. Published online 2013 Jun 25. doi: 10.1371/journal.pone.0067055 <http://www.ncbi.nlm.nih.gov/pubmed/23825617

⁶ Menz H.B.a · Morris M.E.b · Lord S.R.c, Footwear Characteristics and Risk of Indoor and Outdoor Falls in Older People, *Gerontology* 2006;52:174-180

⁷ Elbert S. Huang, MD, MPH, 1,4 Andrew J. Karter, PhD,2 Kirstie K. Danielson, PhD,3 E. Margaret Warton, MPH,2 and Ameena T. Ahmed, MD, MPH2, The Association Between the Number of Prescription Medications and Incident Falls in a Multi-ethnic Population of Adult Type-2 Diabetes Patients: The Diabetes and Aging Study, *J Gen Intern Med.* 2010 Feb; 25(2): 141-146. Published online 2009 Dec 5. doi: 10.1007/s11606-009-1179-2, PMID: PMC2837501

⁸ <https://www.niddk.nih.gov/health-information/diabetes/preventing-diabetes-problems/nerve-damage-diabetic-neuropathies>

⁹ S. I. Lin, Y. R. Chen, C. F. Liao, and C. W. Chou, "Association between sensorimotor function and forward reach in patients with diabetes," *Gait & Posture*, vol. 32, no. 4, pp. 581-585, 2010.

¹⁰ J. S. Wrobel, R. T. Crews, and J. E. Connolly, "Clinical factors associated with a conservative gait pattern in older male veterans with diabetes," *Journal of Foot and Ankle Research*, vol. 2, no. 1, article 11, 2009.

¹¹ Michael DeBrule, DPM. A Closer Look At Gait Analysis In Patients With Diabetes. *Podiatry Today*, Volume 27—Issue 3—March 2014.

¹² Samantha J Richerson, Charles J Robinson, and Judy Shum. A comparative study of reaction times between type II diabetics and non-diabetics. *Biomed Eng Online.* 2005; 4: 12. Published online 2005 Feb 21. doi: 10.1186/1475-925X-4-12.

¹³ George D FulkEmail author, Charles J Robinson, Sumona Mondal, Christopher M Storey and Anne M Hollister. The effects of diabetes and/or peripheral neuropathy in detecting short postural perturbations in mature adults. *Journal of NeuroEngineering and Rehabilitation*20107:44, DOI: 10.1186/1743-0003-7-44.

A person who cannot feel just the 10-gm monofilament can be expected to sway while trying to stand.

time to varied stimuli, which is part and parcel of normal aging. However, the effect of Type II diabetes on these same reaction times has a powerful impact. Diabetes affects peripheral nerves in the somatosensory and auditory system, slows psychomotor responses, and has cognitive effects on those individuals without proper metabolic control, all of which may affect reaction times. The additional slowing of reaction times may affect everyday tasks that require balance, thereby increasing the probability of tripping and falling.

Studies¹² demonstrate that *whole body reaction time, an important consideration when trying to avoid falling when tripping, differs among young adults, healthy mature adults, and mature diabetic adults.* This gives reasoning to the finding of increased falls among older people with diabetes. Also significant, results of this research indicate that in these subjects with diabetes, increased reaction times to plantar pressure and touch, as well as increased lateral whole body reaction times may, in fact, be an important cause of increased slips and falls.

quality of life in the person with diabetes; and isn't that simply the outcome that we all work so hard to achieve anyway? **PM**

References

¹ Christine Cigolle, M.D., M.P.H. More older Americans report falling: the epidemiology of falls, 1998-2010. *JAMA Intern Med.*, Jan.19, 2015, doi:10.1001/jamainternmed.2014.7533.

² Ryan T. Crews, Sai V. Yalla, Adam E. Fleischer, and Stephanie C. Wu. A Growing Troubling Triad: Diabetes, Aging, and Falls. *Journal of Aging Research*, Volume 2013 (2013), Article ID 342650, 6 pages. <http://dx.doi.org/10.1155/2013/342650>

³ L. M. Tilling, K. Darawil, and M. Britton, "Falls as a complication of diabetes mellitus in older people," *Journal of Diabetes and Its Complications*, vol. 20, no. 3, pp. 158-162, 2006.

⁴ P. P. Oliveira, S. Maria Fachin, J. Jozatti, et al., "Comparative analysis of risk for falls in patients with and without type 2 diabetes mellitus," *Revista da Associação Médica Brasileira*, vol. 58, no. 2, pp. 234-239, 2012

⁵ Mettelinge, Roman D. et. al. "Understanding the Relationship between Type 2 Diabetes Mellitus and Falls in Older Adults:



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