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Gait Speed as a Fall Predictor for Elderly Patients in Rehabilitation

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Clinical Scenario: In the rehabilitation hospital where my clinical was we performed many functional assessment tests on patients to determine their fall risk and to justify what assistive device they might need. Also they were used to detect meaningful changes after therapy for insurance purposes. I wanted to find a functional assessment test that could be used on any population and predict falls in the elderly population that I was working with.

Brief Introduction: For the purpose of my clinical question I want to know what the research says about the accuracy of using gait speed to predict falls in an elderly population, 65 years old or older. There are many different assessment tests that are used to predict falls but currently none is the "gold standard." Many like the Berg or the TUG are specific to a certain population and have little predictive value in other populations. The best way to determine falls in a mixed population is to wait and see, and then collect fall information directly from patients or caregivers. The studies that I focused on all used patient report to determine falls.

My clinical question: Can gait speed predict falls in the elderly?

Clinical PICO:
Population: 65+ year-old males and females
Intervention: Gait Speed
Comparison: Subject Report
Outcome: Falls

Overall Clinical Bottom Line: Based on the results of the outcomes from Verghese et al and Beauchet et al I might be more inclined to add gait speed testing into my evaluations of a patient but only because it is so quick, easy and inexpensive to perform. Most likely it would only be a minor factor in the decision making of any of my treatments. I feel gait speed would be more useful as an objective measure to determine whether my treatments had an effect on the patient.

Based on article evidence, decreased gait speed is an indicator of increased risk for falls in an elderly population. Verghese et al even went so far as to quantify it saying that a gait speed less than 100 cm/s has a 28% increase in risk of falling which increases to 54% with a gait speed slower than 70 cm/s. However neither study reported data in such a manner that I was able to statistically analyze myself, so all results are based on author's calculations.

Both studies had a subject population over 200. The population Verghese et al used was much more representative of the patients one might see in an outpatient clinic, as they included anyone over the age of 70 in Bronx County that lived in the community and could walk. The subject population in the Beauchet et al study were not generalizable to any population one would see in clinic since they used only healthy elderly subjects from 13 senior housing facilities in France.

Verghese et al only had minor threats to internal validity, the biggest being that they could have been more consistent in their follow-up calls with patients, so the number of falls could actually be underreported. The biggest threat to internal validity of the Beauchet et al article was the dissimilarity of their subjects to the majority of physical therapy patients. Also during testing of gait speed researchers walked with patients in order to guard them, but this could have affected the subject's selected gait speed.

Search Terms: Gait, falls, functional assessment tests, elderly

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Rationale for Chosen Articles:
Verghese et al was by far the strongest article that I found. It was actually part of a larger study, the Einstein Aging Study, but was very inclusive and took everyone in the Bronx County population that agreed to take part. It did use GAITRite technology to determine gait speed and other gait measurements, but the gait speed portion that I am interested in could just as easily be done with a stopwatch in the clinic. Subjects were allowed to use assistive devices and blinded research assistants were used to analyze that data. They had a very long follow up period, 42 months, and determined falls through phone interviews every 2-3 months, at baseline and at annual follow-up visits. They analyzed the data several ways, taking into account separately disability and cognitive impairment and still found significant differences in gait speed between fallers and non-fallers.

Beauchet et al was second in a series of studies done by the same authors on a similar subject so they often neglected to mention details that were already addressed in the previous study. They didn't state exactly how the subjects were recruited but did say they were from senior housing facilities, presumably in France. They excluded anyone with a recent acute illness or neurological condition, so it wasn't a very representative sample of what we might see in rehabilitation. They measured gait speed using a 10-meter walkway and a stopwatch; very re-creatable in the clinic. They followed subjects for 12 months, getting fall data by telephone every month. Any study losses were not mentioned so it is assumed there were none.

Barak et al did not talk at all about how they got subjects, and excluded anyone with any cardiopulmonary, musculoskeletal or neurological disorders. So the population in the study was not very representative of anyone that I would see in clinic. Also there was no follow up, they based falls on whether they had fallen in the last 6 months prior to the study. This study was really about testing gait mechanics at preset gait speeds. They tested gait speed on a treadmill, taking subjects from 0.18 m/s to 1.52 m/s in preset 0.225 m/s intervals. Each speed was held for a minute and if a subject held onto the handrails or complained of feeling unsafe the trial was stopped and this data was not included. For my purposes the

gait speed data in this study is somewhat biased since subjects did not get to self select their gait speed and walking on a treadmill is quite different from walking on ground.

Table 1. Comparison of QUADAS scores

Item	Verghese et al	Beauchet et al	Barak et al
Representation of pts in practice	Yes	No	No
Selection criteria described	Y	N, in other study	N
Reference standard correct	Y	Y	Y
Reasonable time period between RF and IT	Y	Y	Y
Whole sample verified	Y	Y	Y
Same RF regardless of IT	Y	Y	Y
RF independent of IT	Y	Y	Y
Can you replicate	Y	Y	Y
IT interpreted w/o knowing RF	Y	Y	Y
RF interpreted w/o knowing IT	Y	Y	Y
Clinical data available	N	Y	N
Intermediate test results reported	N	N	N
Withdrawls explained	Y	U	Y
Total	12/14	11/14	10/14

Based on the above comparisons, I have chosen to write this critically appraised paper on the articles by Verghese et al and Beauchet et al.

Article 1: Verghese J, Holtzer R, Lipton RB, Wang C. Quantitative gait markers and incident fall risk in older adults. *Journal of Gerontology* 2009; 64A (8); 896-901.

Clinical Bottom Line: The population of subjects used in this study did not match the types of people I would see in rehabilitation as closely as I would have liked since they were all community dwelling older adults. However it could be generalized to some rehabilitation patients immediately before discharge to their home in the community. I was unable to calculate my own statistics from the numbers reported in this study but according to authors those with a gait speed less than 100 cm/s are 28% more likely to fall and those with a gait speed below 70 cm/s are 54% more likely to fall than those with a gait speed above 100 cm/s. Also every 10 cm/s decrease in gait speed was associated with a 7% increase in risk of falling. Based on the evidence in this study I would be more inclined to add a quick gait speed assessment into my initial and discharge evaluation with a patient. In the rehabilitation hospital I worked at it was already general procedure to cover fall recovery and home safety with all patients regardless of their fall risk, so knowing a patient walked slower than 100 cm/s wouldn't really change many of treatments I would do in clinic. However I might be more inclined to add in a few treatments that were known to help improve gait speed, depending on the complexity of these treatments. The internal

validity in this study was fairly strong, a minor threat was that they could have contacted subjects more frequently and consistently to ask about falls, so the number of falls could actually be underreported in this study. Gait speed is very inexpensive, quick and easy to measure in the clinic. This study used GAITRite technology to measure gait speed but it could have just as easily been done with a stopwatch. The results in this study are more generalizable to the types of elderly patients one would see in an outpatient setting but could be applicable to a small portion of rehabilitation clients.

Article PICO:
Population: 597 adults 70 years old and older living in Bronx County. Exclusion criteria: severe audiovisual loss, bed bound, or institutionalization.
Intervention: Gait speed using GAITRite
Comparison: Follow-up phone calls every 2-3 months for 42 months
Outcome: Falls

Representative Sample: This study was fairly representative of any community dwelling population in an urban setting. As long as people could walk and see enough to walk a straight line they were included. The study recruited subjects from Bronx County population lists that were contacted first by letter and then by telephone to enroll them in the study.

Blind Comparison: None of the personnel performing the tests knew whether or not participants were going to fall since they used future falls in this study. Also when participants used an assistive device to walk on the GAITRite pad this data was edited by blinded researchers.

Independent Reference Standard: There was no overlap in clinical data collected from the GAITRite and the reference standard of telephone and in-home interviews.

Reliability of Clinical Test and Reference Test: The study addressed reliability of the GAITRite machinery for clinical walking information by citing several other studies, but did not test the reliability themselves as a part of this study.

Ascertainment: All subjects received both the GAITRite analysis and the fall follow-up calls and appointments. However the number of calls and appointments per person varied depending on their availability.

Validation of Second Independent Sample: The study itself did not validate with a second sample but they did cite other studies, including some these authors had done previously, that predicted falls using similar markers.

Study: Participants were asked to walk at a “normal pace” down the GAITRite pathway in a well-lit hallway. All participants were allowed to self-select their footwear and there were no external monitors attached. Start and stop points were marked three feet prior to and at the end of the walkway to allow for acceleration and deceleration. Falls were defined as the individual unintentionally coming down on the floor or to a lower level, not due to a major

intrinsic or extrinsic event. Participants were contacted every 2-3 months by telephone to collect data for any new falls. Fall data was also collected at baseline and at annual follow-up visits about falls in the previous year. This fall data continued to be collected for 42 months.

Summary of Internal Validity: This article has fairly high internal validity. The population was representative of a community dwelling urban population of those over 70 years old. The reference standard could have been improved by contacting the participants more often or more consistently regarding their fall status, but I don't think they necessarily missed any using the method that they did. I also like that they had such a long follow-up period, nearly 4 years.

Evidence: Unfortunately the data in this study were not presented in such a way that I could calculate any of my own numbers regarding sensitivity, specificity or likelihood ratios. This author used generalized estimating equations with a binomial distribution to assess all data, citing that this had been used in previous fall studies.

Results found from the study were that of the 597 participants 226 had falls during the follow-up period with 155 falling only once and 111 falling 2 or more times. The mean gait speed of all participants in the study was 92.8 +/- 24.1 cm/s. In accordance with the data in Table 2 below participants with a gait speed below 100 cm/s had an increased risk of falls. Those with a gait speed below 70 cm/s were 54% more likely to fall and those with a gait speed below 100cm/s were 28% more likely to fall. Every 10 cm/s decrease in gait speed was associated with a 7% increase in risk for falls. All 95% CI's are small and none are negative, so if the study was repeated many times the results would still be similar.

Table 2. Gait speed and associated risk ratios as calculated by Verghese et al

Gait Speed	**Risk Ratio**	**95% CI**
10 cm/s decrease	1.069	1.001-1.142
Below 70 cm/s	1.540	1.095-2.150
Below 100 cm/s	1.276	0.906-1.768

Applicability of Study Results: The GAITRite system is not very applicable in clinic because it's very expensive and not many people have them. They are more common in research settings. However, gait speed can be measured just as accurately and very easily in clinic using a stopwatch.

The internal validity was fairly strong in this study. The population in this study is more similar to what I would see in an outpatient setting. It's not a complete picture of those in a rehabilitation setting because some may have come from the community, but regardless they are in an acute period of disability. The study population is more representative of the rehabilitation population prior to their admit, or immediately before discharge. The results of this study can be generalized to anyone over the age of 70 that is community dwelling in an urban setting and able to walk.

Article 2: Beauchet O, Annweiler C, Allali G, Berrut G, Herrmann FR, Dubost V. Recurrent falls and dual task-related decrease in walking speed: Is there a relationship? *JAGS* 2008; 56 (7); 1265-1269.

Clinical Bottom Line: The subjects in this study were not representative of what I would see in rehabilitation since they excluded subjects with any recent medical or neurological issues. From the data the authors presented I was unable to calculate any of my own statistics. The authors found that those with slower walking speeds were 4.2% more likely have 2 or more falls within the next year and those with slower dual-task walking speeds were 66.7% more likely to have recurrent falls. However they did not qualify what a slow walking speed was so the results aren't very applicable to anything I would be able to use in clinic. Walking speed is quick, easy and inexpensive to test in clinic. Based on the dissimilarity of the study subjects to my patients and the vagueness of these study results I wouldn't change anything I do in clinic.

Article PICO:
Population: 213 males and females from 13 senior housing facilities (probably in France). Exclusion criteria: Acute medical illness in the past 3 months, neurological disorders, cerebellar disease, myelopathy, peripheral neuropathy, and severe cognitive impairment.
Intervention: Gait speed and dual task gait speed (counting backwards), measured by stopwatch over a 10 m distance.
Comparison: Monthly questionnaire for 12 months
Outcome: Falls

Representative Sample: The subjects in this study are not very representative of the general American elderly. This study used 213 subjects 75 years of age and older that were living in 13 different senior housing facilities in France. Also the authors state they may have been more health conscious than the general population; this may be due to their recruitment process; however, it was not described in this study.

Blind Comparison: None of the researchers performing the gait speed testing knew whether or not a subject would fall, since all falls were in the future.

Independent Reference Standard: There was no overlap in data used to calculate gait speed and the follow-up telephone calls to ascertain falls.

Reliability of Clinical Test and Reference Test: The authors did not address reliability of their test measures nor did they cite any other studies.

Ascertainment: All subjects did receive gait speed testing and the 12-month telephone follow-up for falls.

Validation of Second Independent Sample: The authors did not use a second independent sample to validate themselves in this study. They did cite a previous study they had done which was similar but used community dwelling individuals.

Study: Subjects began standing at the start line and were instructed to walk to the finish line 10 meters away and continue to walk a few steps past the finish. A stopwatch with 0.01 second resolution was used to time the subjects. The subjects completed 2 trials once walking normal speed and once while counting down from 50 in ones. All subjects wore their own footwear and were spotted by gait belt and researchers following behind each subject. Fall information was collected by monthly telephone calls, for a total of 12 months. A fall was defined as unintentionally coming to rest on the ground, floor, or other lower level. If a subject was cognitively impaired fall information was obtained from a caregiver.

Summary of Internal Validity: The major threat to internal validity in this study is that the sample of subjects they used were not very representative of what one might see in rehabilitation. They excluded anyone with a recent acute illness and anyone with neurological disorders. They tested gait speed by having someone walk with the subject to guard them; this could have influenced their gait speed. However it did say that they walked behind the subject so this was probably a minor threat.

Evidence: Unfortunately the data in this study were not presented in such a way that I could calculate any of my own numbers regarding sensitivity, specificity or likelihood ratios. This author split the fallers into 2 groups, those with recurrent falls in the last year (2+ falls) and those with only one fall. In Table 3 is the authors reported mean walking speeds and their calculated odds ratio with a 95% confidence interval and p value. The odds ratios were calculated comparing the recurrent fallers to the non-fallers.

According to the odds ratios calculated from this study those with slower normal walking speeds are 4.2% more likely to have recurrent falls and those with slower dual task walking speeds are 66.7% more likely to have recurrent falls. Also all 95% CI's are small and none are negative, so if the study was repeated many times the results would still be similar. This study showed that slower walking speeds can indicate an increased risk of falling, but the study is unable to specify what the cutoff for a slow walking speed might be.

Table 3. Walking speed and falls as calculated by Beauchet et al

	No Falls	**1 Fall**	**2 or More Falls**	**Odds Ratio (95% CI) P value**
Number of Subjects	156	37	20	
Normal walking speed (cm/s), mean +/- SD	75.4 +/- 19.8	73.9 +/- 22.6	59.7 +/- 17.8	0.96 (0.94-0.99) .002
Dual task walking speed (cm/s), mean +/- SD	57.1 +/- 19.1	53.7 +/- 18.9	43.8 +/-16.8	0.60 (0.41-0.85) .005

Applicability of Study Results: Using a stopwatch and a few premeasured lines on the floor is very re-creatable in the rehabilitation setting or in clinic. It is also very inexpensive.

The internal validity is of this study is such that I couldn't apply it to the majority of the population that I would see in rehabilitation, just because of the population they chose to use. Also minor threats are that they had someone walking with the subject while testing walking speed and that the statistics reported from this study were such that I was unable to calculate my own numbers from their data. So hopefully they did a good job when they came up with those numbers. The population of subjects used in this study are not very similar to those I would see in the rehabilitation setting because they excluded anyone with a recent acute illness or a neurological or cerebellar disorder, which is who I would primarily see in rehabilitation. These results really only apply to healthy older adults 75 years of age or older living in senior housing facilities, especially those in France.

Discussion: In conclusion, gait speed can be used to predict who is more likely to fall in an elderly population. It is a very simple and inexpensive way to screen. The study Verghese et al specified that for a community dwelling elderly population in an urban setting adults were 28% more likely to fall if their gait speed was below 100 cm/s and 54% more likely to fall if their gait speed was below 70 cm/s. Beauchet et al was able to demonstrate a correlation between slower gait speed and falls but was unable to specify a cut-off for what slow was. However neither study provided data sufficient for my calculation of results, so all calculations presented here are based on the authors findings.

Verghese et al had very strong internal and external validity with minor threats being that they could have been more consistent with their fall follow-up since they contacted participants only every two or three months. Also all participants were community dwelling so they wouldn't fully depict the variety of patients I would see in rehabilitation. A few strong points of this study were that they follow-up period was quite long, nearly four years and that the study was very inclusive, if a patient could walk they were included.

Beauchet et al had more concerning threats to their validity including the dissimilarity to any population I would see in rehabilitation, and that researchers walked with the subjects during their trials in order to guard them. Also subjects began walking from the start line and were not given a lead-in to get up to full speed before timing began. On a positive note they did consistently contact their subjects every month for a year to ascertain falls and had a study population over 200.

Based on the results from these two studies I would be more likely to test gait speed as a physical therapist because it is a relatively quick and easy screen with very little set-up. Since falls result from a variety of internal and external factors I see gait speed as another objective way to quantify what I already know. For this reason knowing that a patient's gait speed may put them at a higher risk for falls wouldn't necessarily change my treatment of a patient, but I could use it as an objective measure to determine if I had made an improvement in the patient's condition. Verghese et al specifies that each 10 cm/s increase in gait speed decreases a patient's risk for falling 7%.

References:

1. Barak Y, Wagenaar RC, Holt KG. Gait characteristics of elderly people with a history of falls: A dynamic approach. *Physical Therapy* 2006; 86 (18); 1501-1510.