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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In a 60-year-old female patient suffering from frequent falls 1 year after stroke (P), is the Timed Up and Go test (TUG)(I) a more accurate predictor of falls (O) than other measures (C)? |

**AUTHOR**

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| **Prepared by** | Kristen Fontela  | **Date** | December 4, 2019 |
| **Email address** | Kristen\_fontela@med.unc.edu |

**CLINICAL SCENARIO**

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| This clinical question is based on a 60-year-old female who suffered a stroke 13 months ago. Her impairments include right-sided paresis, decreased proprioception, and gait deficits, including decreased R step length, decreased R hip and knee extension during toe off and swing, and decreased gait speed. She would benefit from balance and gait measures to determine primary areas for interventions and improvements. Individuals who experience a stroke face many challenges, including motor and functional impairments.1,2 These impairments put stroke survivors at a much higher risk for falls than the general population.1,2,3 Fall prevalence has been shown to be as high as 73% in stroke survivors in the first 6 months post-stroke, and is double the prevalence for healthy controls.2,3 There are several post-stroke risk factors for falls, which lead to reduced confidence in gait and balance and fear falling.1 Advanced age, history of falls, use of assistive device, and polypharmacy are common risk factors for falls in the general population of older adults.1,3 While stroke survivors are challenged with some of the same fall risks, research indicates a variety of additional fall risk factors including gait speed, scores on various outcome measures, time since stroke, and step variability, to name a few.1,3 Because of the myriad of gait and balance components associated with falls,3 it is difficult to determine a single measure that best predicts falls in post-stroke patients. Several outcome measures attempt to predict falls in patients after stroke including the Timed Up and Go test (TUG), the Berg Balance Scale (BBS), gait speed test, and the 6 Minute Walk Test (6MWT).1,2,3 A systematic review found that components of mobility including gait speed, TUG scores, and BBS scores are the strongest predictors of falls post-stroke.3 However, other research indicates associations between TUG performance and scores on the Fast Gait Speed Test and 6MWT.2 In addition, while the BBS is commonly used to assess falls risk post-stroke, it may effectively predict falls only when combined with other measures.3 Despite this disagreement, dynamic balance measures have been found on multiple occasions to be better predictors of falls than static measures.3 However, as of 2019, there was no single balance measure deemed the best predictor of falls following strokes.3 While several studies have found good clinimetric properties of the TUG in a stroke population, there is still a deficiency in the literature regarding its ability to predict falls.1,2 One study found that the TUG was able to predict fall risk during the first year post-stroke if it was performed within 1 week of the stroke. However, another study’s results indicated that the TUG was unable to predict falls in the chronic phase after stroke.2,3 There is inconclusive data regarding the appropriate cutoff score for the TUG for falls prediction.2 While the BBS is commonly used to assess falls risk post-stroke, it requires much more time than the TUG to administer.1 Thus, the research is unclear regarding the ability of the TUG to predict falls in patients one-year post-stroke, especially compared to other balance and gait measures. If researchers are able to determine which outcome measure is best for assessing mobility and balance after a stroke, it will help clinicians anticipate falls sooner and intervene more efficiently. This could improve development of interventions for falls prevention post-stroke1 and reduce the physical and economic burden of falls in this population and for individuals like the one who inspired this CAT.  |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| * Several databases were searched, including PubMed, PEDro, Cochrane Library, and CINAHL regarding prediction of falls by balance-related outcome measures in individuals post-stroke.
* Eight articles were found according to established inclusion/exclusion criteria to include 6 observational cross-sectional design studies, 1 systematic review, and 1 prospective cohort study.
* The original PICO question compared predictive value of the TUG and ABC scales; however, none of these studies directly compared these measures’ abilities to predict falls. Thus, the PICO question was changed to compare the TUG’s predictive value to other measures.
* The literature contained evidence to suggest the predictive strength of several balance measures in patients with stroke, including the TUG, gait characteristics, Berg Balance Scale, and 6 Minute Walk Test.
* Overall, the literature does not designate a gold standard for assessing falls risk in patients post-stroke.
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**CLINICAL BOTTOM LINE**

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| More research is required to determine the best measure of fall prediction in a 60-year-old female patient 1 year after a stroke. While the TUG has been shown to have good psychometric properties in patients post-stroke, there is limited evidence suggesting its fall predictive validity. The literature demonstrates inconclusive results regarding the TUG’s superiority over other measures in predicting falls. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT*

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| StrokeCVACerebrovascular AccidentPost-stroke“Frequent falls”Fall\* | Timed Up and Go testTUG | Activities-Specific Balance Confidence scaleABC | Fall\* predict\*“Predictive validity”ValidityAccuracyMDCMinimum detectable changeMCIDMinimum clinically important differencePrediction |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*

Search #18 is my final search strategy



*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed****PEDro****Cochrane Library****CINAHL** | **53****0****2****6** | Changed “OR” to “AND” ; 9 resultsAdded “fall risk” to search; 13 resultsHad clinical trials only (no reviews)Broadened search (see below) and got 29 results; filtered to include only “Academic journals” and got 22 results; narrowed publication date to last 10 years and got 12 results |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Involves subjects with previous diagnosis of stroke
* Randomized control trials or systematic reviews
* Description of systematic, standardized measurements and interpretations by qualified researchers/clinicians
* Articles in English
* Involves standardized patient measures of falls risk
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| **Exclusion Criteria** |
| * Includes subjects without stroke diagnosis
* Studies not published in English
* Poster presentations
* Dissertations/Theses
* Textbooks
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**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| **Author (Year)** | **Risk of bias (quality score)** | **Level of Evidence** | **Relevance** | **Study design** |
| SeungHeon An (2017) | 6/11 “yes” \*Moderate | 2b – in “prognosis” column, without “poor quality,” but not a systematic review | Moderate | Non-experimental (observational) retrospective cross-sectional design |
| Peggy P. Chan (2017) | 8/11 “yes” \*Low | 2b - in “prognosis” column, without “poor quality,” but not a systematic review | Moderate | Non-experimental (observational) cross-sectional design |
| Anette Forsberg (2013) | 8/11 “yes” \*Low | 2b - in “prognosis” column, without “poor quality,” but not a systematic review | Moderate  | Non-experimental (observational) cross-sectional design  |
| Nancy M. Salbach (2006) | 7/11 “yes” \*Moderate | 2b - in “prognosis” column, without “poor quality,” but not a systematic review | Moderate | Non-experimental (observational) cross-sectional design |
| Thóra B. Hafsteinsdóttir (2014) | 6/11 AMSTARModerate  | 2a – systematic review of cross-sectional, descriptive, and longitudinal studies (retrospective) | Low | Systematic Review  |
| Kelly Bower (2019) | QUIPS – low(5/6 sections scored low; 1/6 sections scored moderate) | 1b – a validating cohort with good reference standards | Moderate | Prospective cohort study |
| Erica M. Botner (2005) | 8/11 “yes” \*Low  | 2b - in “prognosis” column, without “poor quality,” but not a systematic review | Low | Non-experimental (observational) cross-sectional design |
| Elen Beatriz Pinto (2014) | QUIPS – moderate (2/6 sections scored low, 3/6 sections scored moderate, 1/6 sections scored high) | 2b - in “prognosis” column, without “poor quality,” but not a systematic review | Moderate - high  | Non-experimental (observational) cross-sectional design |

\*\* Jerosch-Herold, C. (2005). An Evidence-Based Approach to Choosing Outcome Measures: A Checklist for the Critical Appraisal of Validity, Reliability and Responsiveness Studies. *British Journal of Occupational Therapy*, *68*(8), 347–353.

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * **Bower et al. (2019) –** I have chosen this study because it is one of few that I have determined to have a low risk of bias. In addition, it has moderate relevance to my PICO question as it investigates falls prediction, the true outcome desired by my PICO question. This study assesses the predictive strength of various gait and balance measures, including the TUG – one of the components of my PICO question. Because this study addresses several aspects of my PICO question, it’s moderate relevance and its low risk for bias caused me to select it as ‘best’ evidence.
* **Pinto et al. (2014) –** While this study has moderate risk for bias according to my appraisal with the QUIPS tool, it appears to have the most relevance to my PICO question. It addresses the TUG (my outcome measure), as well as falls prediction, which is the outcome in my PICO question. While there are other studies in my selected 8 that have a lower risk for bias, I am choosing this one because, as long as the risk for bias is not high, I am placing more value in the study’s relevance to my PICO question. And, as mentioned above, there is subjectivity in these measures, which may cause another appraiser to find a different amount of bias (possible lower) in this study.
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**SUMMARY OF BEST EVIDENCE**

**(1)** **Description and appraisal of (Dynamic Balance and Instrumented Gait Variables are Independent Predictors of Falls Following Stroke) by (Bower et al, 2019)3**

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| **Aim/Objective of the Study/Systematic Review:** |
| To determine the ability of gait and balance variables to predict fall risk in patients post-stroke, 12 months after discharge from rehabilitation.  |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This prospective cohort study involved patients within 3 months post-stroke. Baseline testing was performed within one week before each patient’s discharge from their respective inpatient rehabilitation facility. Fall occurrence was prospectively collected regarding the 12 months following discharge from rehabilitation. Participants received a 12-month calendar on which they were instructed to record any falls following discharge from the facility. Participants returned these calendars to the researchers via mail each month. Data analysis in this study consists of several different models. The researchers presented all baseline characteristics and outcome variables with descriptive statistics and between groups comparisons. Between group differences for fallers and non-fallers were assessed via independent t-tests, Mann-Whitney U tests, and Chi Square tests when applicable. Regression analysis adjusted for the country location, assistance needed, and falls that occurred before the stroke to limit potential confounders selected a priori. In addition, the researchers completed two separate regression analyses, one that *included* individuals requiring assistance or gait aids, and one that *excluded* these individuals to further determine the influence of gait assistance on the gait and balance variables. Lastly, the researchers used IQR-ORs in order to produce more clinically meaningful comparisons between the variables because they were assessed on different scales. These IQR-ORs had a 95% confidence interval and were presented by comparing the 25th – 75th percentiles for each variable to ensure their ORs were greater than 1.0.1  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| Inpatient rehabilitation centers: 2 facilities in Australia and 2 facilities in Singapore |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| A purposive sample of 81 participants post-stroke completed baseline testing and the 12-months of prospective falls follow-up. Participants were an average of 63 years old (+13.22), 43 of them were males, and they were assessed a median of 24 days post-stroke. Participants were recruited via consecutive sampling from 4 different rehabilitation facilities in Singapore and Australia (56 participants from Singapore). While there was no formal neuropsychological assessment of the participants, the researchers consulted the patients’ treatment team to ensure participants had appropriate cognition and communication abilities. Interpreters were used in Singapore as needed.Eligibility criteria included stroke within 3 months of study, ability to walk 10m with minimal assistance or less, cognition and language abilities sufficient to provide consent and participation in the study, medically stable, and no condition that could confound physical testing (i.e., severe arthritis, progressive neurological disorder)Of the originally recruited 96 participants, 15 were lost to follow up for various reasons: voluntary withdrawal (n=7), unable to contact or moved overseas (n=5), and death or other serious medical event (n=3). The authors note that the participants retained in the study and participants who dropped out had no significant differences in baseline characteristics or clinical tests. |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| Because this was a prospective cohort study, there was no control group.Baseline testing included the Functional Independence Measure (FIM), Modified Rankin Scale, Montreal Cognitive Assessment, Short Falls Efficacy Scale – International, Hospital Anxiety and Depression Scale, Star Cancellation test (for presence of inattention), Functional Comorbidity Index (for comorbidities), and falls history. Gait variables measured included a 6-minute walk test on a 10-meter track. Other gait variables were measured via a Kinect camera and included gait speed, stride length, step width, gait speed variability, step length asymmetry, mediolateral pelvic displacement, and vertical pelvic displacement. Dynamic standing balance was measured via the TUG (including a dual task TUG) and step test. Static balance was assessed via a Wii Balance Board. Participants were permitted to use shoes, gait aides, or minimal physical assistance during the TUG if necessary. Researchers averaged 2 successful trials for each gait and balance test. Follow-up: Participants used the 12-month calendar provided to record any falls they had. They submitted this record to researchers monthly. Fall details recorded included time, location, activity, and injuries sustained.  |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Experienced physical therapists and exercise physiologists collected demographic and stroke characteristics information including country, age, sex, time since stroke, lesion side, and type of stroke. Participants underwent baseline testing in their respective inpatient rehabilitation facility one week before they were discharged from their respective facility. Experienced physical therapists and exercise physiologists performed outcome measures on participants. Outcome measures used included the Functional Independence Measure (FIM), Modified Rankin Scale, Montreal Cognitive Assessment (MoCA), Short Falls Efficacy Scale – International, Hospital Anxiety and Depression Scale, Star Cancellation test (for presence of inattention), and Functional Comorbidity Index (for comorbidities). The FIM assess an individual’s functional status and independence. Scores range 18-126, with higher scores indicating higher function. The Modified Rankin measures one’s level of disability after a stroke. Scores range from 0 (no symptoms of disability) to 6 (dead). The MoCA is used to assess cognitive impairment. The highest possible score on the MoCA is 30 points, with higher scores indicating better cognition. The Short Falls Efficacy Scale assesses fear of falling. Scores range 16-64 with higher scores indicating a greater fear of falling. The Hospital Anxiety and Depression Scale measures anxiety and depression levels in individuals with health problems. The maximum score on the Hospital Anxiety and Depression Scale is 42, with higher scores indicating greater levels of anxiety and depression. The Functional Comorbidity Index measures the impact of having several comorbidities and the resulting impaired function. Scores range 0-18, with higher scores indicate greater comorbidity and impaired physical function. Falls were recorded daily on 12-month calendar. Fall details included time, location, activity, and injuries sustained. The dynamic balance tests include the TUG and the step test. The TUG was performed with a dual task component (i.e. counting backwards by certain multiples of numbers). Lower values (times)n on the TUG indicate better performance. Higher scores on the step test indicate better performance. The Wii Balance Board assesses total, mediolateral, and anteroposterior center of pressure velocity to determine static balance. Smaller values on this test indicate better performance.  |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| The study’s results determined that baseline characteristics were similar across groups for the majority of items. There were significant between-group differences between fallers and non-fallers observed for the Modified Rankin Scale, Short Falls Efficacy Scale-International, prior stroke, and falls in the 12 months preceding stroke (p = 0.008-0.046). The remaining baseline characteristics demonstrated no between-group differences. Over the 12-month period of the study, 28% of participants fell at least once, and 16% fell more than once. 47% of the falls occurred in the home, 32% of which occurred when negotiating stairs, and 24% occurred during walking.

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| Variables | Non-FallersMean + SD | FallersMean + SD | Between-group p-value | Adjusted for country, prior falls, gait assistanceIQR-OR (95% CI) | P-value |
| Stride length | 1.03±0.26 | 0.87±0.31 | 0.043\* | 4.23 (1.14-15.66) | 0.031\* |
| Gait speed variability | 0.17±0.09 | 0.13±0.04 | 0.048\* | 1.82 (0.78-4.26) | 0.169 |
| Mediolateral Pelvic Displacement | 7.00±1.26 | 5.24±1.39 | <0.001\* | 7.85 (2.56-24.05) | <0.001\* |
| Vertical Pelvic Displacement  | 3.42±1.25 | 2.83±0.96 | 0.047\* | 2.03 (0.74-5.56) | 0.168 |
| Step length asymmetry | 1.15±0.16 | 1.54±1.10 | 0.458 | 1.37 (1.01-1.85) | 0.040\* |

\*indicates significant value at p < 0.05The above table is adapted from Table 2 in the article to illustrate the major findings of the gait variables with significant between-group differences. There were no significant differences between the faller and non-faller groups for comfortable or fast gait speeds. Thus, significant predictors of falls, after adjustment for country, prior falls, and assistance, were mediolateral pelvic displacement (IQR-OR = 7.85), stride length (IQR-OR = 4.23), and step length asymmetry (IQR-OR = 1.37). When participants requiring physical assistance or gait aids (n = 24) were excluded from the regression, there were significant between-group differences for stride length, gait speed variability, mediolateral and vertical pelvic displacement (see table above). It is important to note that mediolateral pelvic displacement was the only significant variable for both regression models (IQR-OR = 9.35 including assistance; IQR-OR = 8.54 excluding assistance) and was the strongest predictor of falling for patients with stroke after discharge from inpatient rehabilitation. This smaller mediolateral pelvic displacement is likely because individuals who fear falling use a compensatory movement strategy in which they are cautious to maintain their COM well over their BOS to increase their stability. This is reflected in the smaller pelvic displacement during walking in the faller group.

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| Variables | Non-FallersMean + SD | FallersMean + SD | Between-group p-value | Adjusted for country, prior falls, gait assistanceIQR-OR (95% CI) | P-value |
| TUG time | 16.49±9.26 | 27.61±23.84 | 0.014\* | 4.06 (1.44-11.46) | 0.008\* |
| Step Test Score | 10.19±5.08 | 6.35±4.20 | 0.005 | 4.50 (1.64-12.35) | 0.004\* |

The above table is adapted from Table 2 in the article to illustrate the major findings of the balance variables with significant between-group differences. This study’s findings indicate that dynamic assessments were better predictors of falls than static measures, as no static variables were significantly associated with falls. This is likely due to the fact that falls typically occur during dynamic activities such as transfers and walking. As seen in this table, results indicate that fallers had significantly increased TUG time and reduced step test scores. In fact, one IQR increase in TUG scores indicated between 4.06-7.84 times greater falls risk and one IQR decrease in step test scores was associated with a 4.06-10.29 increased odds of falling. |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| Researchers in the current study found that reduced mediolateral displacement of the pelvis during walking is the strongest predictor of falls within 3 months after stroke. This reduced displacement in the frontal plane is likely due to the reduced weight shift onto one’s paretic leg as well as the cautious maintenance of center of mass within the base of support after stroke. Because mediolateral pelvic displacement is not easy to measure in a clinic setting, the researchers found that dynamic balance measures including the step test and the TUG were also strong predictors and were particularly stronger predictors of falls than static balance measures.  |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| **QUIPS score (prognostic)** – low risk of bias (5/6 sections scored low; 1/6 sections scored moderate). Overall, this study demonstrates a low level of bias and a resulting high validity due to its methods and analysis. Strengths: The study provides details about sampling, subject recruitment (i.e. use of interpreters, consults with patients’ physicians), eligibility criteria (see “Participants” section in CAT), and baseline characteristics via descriptive statistics. The authors include a fairly detailed discussion of patient drop-out, including reasons for drop-out, number of drop-outs, and a comparison of drop-outs to the participants retained in the study (“i.e. no significant differences between those lost to follow-up and those retained” (pg. 4). There was an 84% response rate as 81 of 96 participants recruited completed tests. The study mentions other evidence about the utility of the included outcome measures (i.e. TUG), defines the outcome (“fall”), and discusses the psychometric properties of the balance and gait variables included in the current study and verified by other studies. Regarding study confounding, the study mentions potential confounders (walking speed, stepping pattern, use of walking aid, influence of missing data from dropouts); lists findings in other studies to support potentially confounding variables; adjusts for potential confounders (i.e. country location, prior falls, walking assistance) in the analysis; and performs statistical analyses with and without patients who required a walking aid. The statistical analysis included appropriate statistical models and reports for ordinal data, continuous data, etc. The researchers outlined descriptive statistics for all baseline characteristics and outcome variables. They also included student’s t-test, Mann-Whitney U test, and Chi-square tests when appropriate depending on how they were comparing the fallers group and the non-fallers groups. The analysis included adjustment for the country location, assistance needed, and falls that occurred before stroke to limit unnecessary results. The researchers performed 2 regression models: one model that included the participants that required physical assistance or gait aides, and one model that excluded these individuals. Weaknesses: According to the QUIPS tool, this study had few weaknesses. For “Study Participation,” there was no specific recruitment time frame mentioned. For the “Prognostic Factor Measurement,” there was no mention of a cut-off point for continuous variables. While the researchers made attempts to standardize the methods and setting of measurements, the baseline testing and gait and balance variables were measured in the patients’ respective facilities. There were 4 different facilities across 2 different countries, which limits same-ness in these methods. While this study mentions several potential confounders, it does not describe them or discuss them in detail – information that would have made this study more valid and credible. Lastly, the researchers suggest a potential for measurement error with the Kinect-derived mediolateral pelvic displacement that could have influenced the results of this study.**External Validity**The external validity of this study’s findings appears to match previous studies in many ways. However, it may be limited because of the high functioning level of the participants in this study. These researchers found a lower rate of falls in participants when compared to similar populations samples in other studies. This is possibly because the individuals included in this study were able to walk with no more than minimal assistance and who were discharged home after inpatient rehab, suggesting their higher level of functioning. In addition, the researchers mention that their results may have been influenced by the missing data from the participants who did not perform certain tests due to inability or technical issues. Lastly, while these researchers accounted for the use of assistive aids in the results analysis, there is evidence that suggests an association between gait assistive devices and improved TUG scores, which can influence the overall validity of the use of TUG scores for predicting post-stroke falls. |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| In pursuit of my clinical question, this study provides evidence that the TUG is a strong predictor of falls in patients post-stroke. While the TUG is clinically useful and feasible for predicting falls in this population, this study’s results indicate that mediolateral pelvic displacement was the strongest predictor of falls among all gait and balance variables included. The high odds ratio values (>1) and ranges for each variable suggest the high probability of falls in individuals with these variables present. I am confident in the validity of this study’s procedures and findings because of its low risk of bias and its strong statistical analysis in which the researchers attempt to account for several confounding variables. These results indicate that, regardless of the use of assistive devices or gait speed by individuals post-stroke, the individual’s pelvic displacement, stride length, and gait speed variability are able to predict their falls risk. These variables are extremely relevant to this population as individuals post-stroke struggle with maintaining balance during ambulation, transfers, and other mobility tasks. Thus, this study’s results offer good clinical utility across several physical therapy settings depending on the equipment and expertise available. In fact, if clinics lack a depth-sensing camera device (like the Kinect camera used in this study), the TUG and step test appear to be able to predict falls in this population. |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| This study is moderately applicable to my clinical question as it involves relevant measures, outcomes, and sample population. Average age is 63 years old, which is very similar to that of the patient in the clinical question. While the study mainly focuses on gait variables measured by a depth-sensitive, it also includes measurement of falls prediction via various balance measures, including the TUG. Several other studies assess the psychometric properties of outcome measures in the stroke population; however, this study is more relevant to the clinical question because of its outcome measure of falls prediction. The participants in this study are fairly similar to those in the clinical question in terms of age, however, they differ in length of time since their stroke (3 months vs. 1-year post-stroke). In addition, participants in this study are both men and women, while the clinical question is seeking information regarding a female post-stroke. The participants in this study were divided into 2 groups for analysis based on their falls: fallers (n = 58) and non-fallers (n = 58). Baseline characteristics across both groups demonstrate insignificant differences for the majority of characteristics. However, there was a statistically significant difference for the Modified Rankin Scale, the short FES-I, and presence of falls in the past month in fallers and non-fallers (fallers had higher score in all 3 measures). This study appears to be low risk, as there is no intervention provided, and it simply includes balance and functional measures followed by a 12-month follow-up period during which participants record their falls. Thus, the study’s benefits outweigh any potential harms and most of its balance measures would be safe to perform in a clinic setting. Parts of this study are practical to complete in a clinic. The self-report outcome measures (i.e. FIM, MoCA, etc.), dynamic balance measures (i.e. step test, TUG), and static balance measures (via Wii Balance Board) are feasible to complete in the clinic setting suggested in the clinical question as long as the therapist has the required time and equipment. However, the depth-sensing cameras (Kinect) that measure gait variables are appropriate for a research setting, but not for a clinical setting, as it requires substantial time, equipment, and training of personnel. But, because the researchers found that the step test and TUG were strong predictors of falls, they can be used when the Kinect system is not feasible. These measures present low risk for these patients when performed by a trained professional. This would be an important characteristic of the study, as patients select preferred interventions or measures based on their potential risk, cost-benefit analysis, and their confidence in the therapist administering the test. The researchers of the study adapt measures by allowing participants to use shoes, gait aids, or other assistance when necessary during the walking trials and balance measures, which can increase one’s feeling of safety. Because this study appears safe and does not appear to interfere much with participants’ time (one baseline test and a daily journal for recording falls), it is likely feasible for this population.  |

**(2) Description and appraisal of (Risk Factors Associated with Falls in Adult Patients After Stroke Living in the Community: Baseline Data From a Stroke Cohort in Brazil) by (Pinto et al, 2014)1**

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| **Aim/Objective of the Study/Systematic Review:** |
| “To estimate fall frequency and to identify factors related to fall occurrence in a sample of patients with stroke recruited from a reference stroke clinic living in the community.” (page 221) |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This study is a retrospective, cross-sectional, cohort study. Data from March 2009 to September 2010 from 150 stroke patients was collected, and baseline testing was applied (includes modified Barthel Index, Timed Up & Go Test, National Institutes of Health Stroke Scale).The article includes no discussion about blinding or allocation concealment in the study (no intervention implemented)There is no discussion about who collected and read these data from clinical records or who performed the clinical testing. The Statistical Package for the Social Sciences (SPSS) was used for all statistical analysis. Univariate analyses were performed and the Fisher exact test or the Pearson chi-square test were used to determine any associations of categorical variables, while the Student t test and Mann-Whitney U test were used to determine associations of continuous variables between fallers and non-fallers. Multivariate analyses were performed to determine predictors of falls in patients post-stroke. The Pearson correlation test was also used to determine correlations between continuous variables of fallers and non-fallers.  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| Participants were recruited from the Stroke Clinic of the Federal University of Bahia - a multidisciplinary outpatient clinic to which many post-acute stroke patients from emergency services in Bahia, Brazil are referred. There is no mention of the location of the clinical testing, however, it can be assumed that it occurred at this outpatient clinic. |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| 150 (94 classified as non-fallers, 56 as fallers) consecutive (convenience sample) patients were recruited from the Stroke Clinic of the Federal University of Bahia. All patients had a diagnosis of chronic stroke. There is no discussion about the specific methods for recruitment. Eligibility criteria includes community-living, ability to walk independently or with walking aid, ability to walk 10 feet with assistance from no more than 1 person, absence of disease affecting comprehension of the tests performed or balance (i.e. Parkinson disease, vestibulopathy). Average age of all patients was 55.8 (SD 31.1); average age of non-fallers and fallers was 54.7 (SD 14.1) and 57.8 (SD 10.9) respectively. 77 of the 105 patients were female (43 were non-fallers, 34 were fallers). The median number of months since the patients’ stroke was 13.5 (range 5.0-32.5 months) for all patients. For fallers and non-fallers, median number of months since stroke was 11.0 (range 4-24) months and 23 (9.0-57.5) months respectively. Seventy-four of the patients had a right-sided stroke lesion (38 fallers, 36 non-fallers). Twenty-one of the patients used some type of gait assist (9 fallers, 12 non-fallers). Univariate analyses revealed that there was no statistical difference between falls and non-fallers in terms of walking aids or use of vasodilator medications. However, there does appear to be significant differences in other demographic data. The fallers group was an average of 3 years older, more frequently had right-sided lesions, and had longer times since stroke onset than non-fallers. However, they were similar in terms of stroke severity (NIHSS data) and male-female ratios. There is no mention of dropouts in the study.  |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| There was no control group – not an experimental study |
| *Experimental* |
| Researchers collected demographic data including age, sex, time since stroke, use of orthoses or walking aid, and brain hemisphere that was affected by stroke. A neurologist identified drugs with possible adverse effects that could increase fall risk and classified them as ambulatory hypotensive (i.e. beta blockers, diuretics, vasodilators), sedatives/hypnotics, and anticonvulsants. Fall history referred to the occurrence of any fall in the past year. This is how individuals were classified as “fallers” and “non-fallers.”Participants completed the modified Barthel Index (mBI), the National Institutes of Health Stroke Scale (NIHSS), and the Timed Up & Go Test (TUG). There is no discussion of these measures’ administrators, location, and duration. Data analysis included descriptive analysis of baseline sociodemographic and clinical characteristics presenting median, range, and proportion for all characteristics. The researchers used the Fisher exact test and Pearson chi-square tests for univariate analyses of categorical variables, while the Student t test and the Mann-Whitney U tests were used for analyses of continuous variables. The Pearson Correlation test was used to determine correlations between continuous variables. The researchers presented results as odds ratios with 95% confidence intervals denoting results with p-value<0.05 as significant. They also used ROC curves to identify optimal cut-off points of the TUG for falls prediction. Lastly, to account for confounders (other variables that could be fall predictors), the researchers included in the logistic regression multivariable model other variables that may possibly be associated (p < 0.1) with fall occurrence.  |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Demographic/clinical data included – age, gender, severity of stroke (NIHSS), months since stroke, lesion location, assisted gait, used of vasodilators. Modified Barthel Index (mBI) – measures physical disability and functional capacity for ADLs in patients with stroke. Each of the 10 items is graded 0 to 2 or 0 to 3 with lower scores indicating higher disability. The maximum score is 20, and scores below 15 and below 10 represent moderate disability and severe disability respectively. National Institutes of Health Stroke Scale (NIHSS) – evaluates stroke-related neurological disability. Each of the 11 items on this assessment is rated either 0 to 3 or 0 to 4 (0 indicates normal functioning, 4 indicates completely impaired). The total NIHSS score is determined by adding the scores of all 11 items. The maximum score is 42, and higher score indicated more impairment. Timed Up and Go Test (TUG) – test to assess basic functional mobility. This test requires a patient to stand up from a chair, walk 3 meters, return, and sit in the chair as quickly as they can (stopwatch used). Lower times indicate better performance and reduced falls risk. A time above 14 seconds has been associated with increased risk of falls in the elderly. However, this study reports that the TUG cut-off point for falls prediction is currently unknown in the stroke population. There is no discussion about the administration of the outcomes measures (who or where)  |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
| Overall, mBI results indicate that the functional capacity was 49 points (range 47-50) for all patients, classifying them as “slightly dependent.” A fall history was found in 37% of patients, and all patients reported a median of 2 falls during the study, most of which were at home, in the morning, and during walking.

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| **Fallers (vs. Non-fallers)** |
| Avg 3 years older |
| Similar NIHSS severity score |
| Similar male : female ratio |
| R-hemisphere lesions more common\* |
| Longer time since stroke onset \*  |
| Worse TUG score – median of 18 seconds (range 13.2-28.0) \*  |

The above table outlines between-group differences in baseline characteristics between fallers and non-fallers.

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| **Fall Predictor** | **Odds Ratio** | **95% Confidence Interval** | **P value** |
| **Time (mo.) since stroke onset** | 1.012 | 1.002-1.020 | 0.015 |
| **R-hemisphere location** | 2.621 | 1.196-5.740 | 0.016 |
| **TUG time** | 1.035 | 1.003-1.069 | 0.034 |

\*Indicates statistically significant Note: no statistical difference between fallers and non-fallers in terms of assistive devices or vasodilator useThe above table suggests these three variables (time since stroke onset, R-hemisphere location, and TUG time) are significant predictors of falls in this patient population. When looking at the ROC curve depicting the association between the TUG and falls in the study’s participants (Figure 1 in study), sensitivity is 36% (low), and specificity is 90% (high). While a low sensitivity is not desirable, the test’s high specificity gives researchers the confidence that an individual who tests positive on the TUG (i.e. regarding the 25-second cut-off point) can be confidently “ruled in” as having the condition (i.e. fall risk). Thus, the optimum cut-off point on the TUG was found to be 25 seconds (with 36% sensitivity – 95% CI = 23%-50% and 90% specificity – 85% CI = 85%-96%). The area under the ROC curve in this case is 66% (95% CI = 57%-75%), which means there is a 66% change that the TUG will be able to distinguish between fallers and non-fallers in this population. When looking at the ROC curve depicting the association between the TUG and the affected cerebral hemisphere (Figure 2 in study), for the R hemisphere, sensitivity is high at 89% (95% CI = 74%-97%), and low-moderate specificity is 46% (95% CI = 29%-63%). This high sensitivity value gives researchers the confidence that an individual who tests negative on the TUG (i.e. regarding the 13-second cut-off point) can be confidently “ruled out” as having the condition (i.e. affected R hemisphere). The area under the ROC curve in this case is 69% (95% CI = 56%-81%), which is considered poor. The opposite is true when looking at the ROC curve depicting the association between the TUG and the L affected hemisphere (Figure 2 in study). In this case, sensitivity is low at 29% (95% CI = 10%-56% and specificity is high at 94% (95% CI = 82%-99%), which allows the researchers to confidently “rule in” individuals who test positive on the TUG (regarding the 28-second cut-off point) as having the condition (i.e. affected L hemisphere). The area under the ROC curve in this case is 57% (95% CI = 37%-75%), which is fairly low and insignificant. Notice how the TUG cut-off point in patients with R-hemisphere lesions (13 seconds) was lower than in patients with L-hemisphere lesions (28 seconds). Thus, time required to complete the TUG was significantly different in fallers vs. non-fallers, suggesting that the TUG can differentiate fallers from non-fallers after stroke. Results indicate little to no correlation between TUG time and time since stroke onset, as demonstrated by Pearson’s r value of 0.020.  |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| Evidence from this study indicates that significant predictors of falls in patients with stroke include poor TUG performance, longer time since stroke occurrence, and right-hemisphere stroke location. While age and stroke severity are often associated with increased fall risk, neither was a significant predictor of falls in this sample of stroke survivors. In addition, the TUG was able to distinguish fallers from non-fallers after stroke in this population sample. Thus, there is significance in identifying an instrument (i.e. TUG) that assesses balance and mobility in post-stroke patients to help develop falls prevention strategies and treatments in this population. |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| **QUIPS score (prognostic):** moderate risk of bias; (2/6 sections scored low, 3/6 sections scored moderate, 1/6 sections scored high)Strengths: The study demonstrates an overall low risk of bias for the “study participation” section of the QUIPS tool as the authors describe the source of the sample of participants (specific clinic from University) as well as the inclusion/exclusion criteria (see “Participants” section of CAT), and there is adequate participation of eligible participants in this study. This study provides moderate detail about the prognostic factors measured. It includes a discussion about how balance and stroke impairments cause fall risk, and it provides specific cut-off points used for the outcome measures. In addition, the study demonstrates a moderately adequate response rate of participants to create adequate data. This study has a low risk of bias for the “Outcome Measurement” section of QUIPS tool as it clearly defines outcome measures (i.e. fall, TUG results, mBI, NIHSS) and the methods of these outcome measures. However, there is no discussion of who administered the outcome measures or where the outcome measures were administered. Regarding “study Confounding,” while there is not much discussion about consideration of confounders in the study design, the researchers do perform a specific logistic regression analysis to correct for falls-related confounding variables in the analysis of the results. There is an overall low-to-moderate risk of bias for “Statistical Analysis and Reporting” section of QUIPS. The researchers used appropriate statistical analysis of results including ROC curves for TUG cut-off points, descriptive analysis for baseline characteristics, comparative analysis tool for both groups (fallers and non-fallers), statistical correction for confounders, and odds ratios with 95% confidence intervals where appropriate. For univariate analyses, they appropriately used the Fisher exact test or Pearson chi-square test for categorical variables (nominal data); for continuous variables, they appropriately used the Student t test and Mann-Whitney U test with the use of the Pearson correlation test for correlations between continuous variables (regarding fallers and non-fallers variables).Weaknesses: This study was limited in that there is no discussion about specific recruitment methods (i.e. sampling, selection, recruitment period). In addition, there is no mention of dropouts or loss of follow-up in this study or an attempt to understand reasons for dropouts or loss of follow-up. While there is mention of correction for confounders, there is no specific discussion about the measurement of these variables, suggesting a high risk of bias for “Study Attrition” on the QUIPS. **External Validity** – The use of a convenience sample in this study limits its external validity. In addition, the fact that this study’s results and analysis is based on retrospective falls data may also limit the external validity. This study’s sample consisted of mostly young stroke survivors with moderate impairments. Thus, the results may not be applicable to older individuals or individuals with greater impairment severity.  |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| Relevant to the clinical question, the results of this study suggest that the TUG does have significant predictive ability to distinguish fallers from non-fallers among individuals post-stroke. However, one’s TUG score alone is not the only predictive factor of fall risk. This study found significant results indicating time since stroke onset and R-hemisphere stroke lesion are both also significant predictive factors of falls in this patient population. However, these results must be considered in light of the strengths and weaknesses of this study. As mentioned above, there are gaps in the procedures, recruitment, and attrition in this study, all of which are not appropriately addressed. In addition, the retrospective and convenience sampling aspects of this study limit its validity. Conversely, the researchers in this study appear to have performed very thorough and appropriate statistical analyses of the results (i.e. correcting for confounders) to determine relevant and significant conclusions.Overall, the findings of statistically significant falls predictors are encouraging to apply to this population for further research. In addition, the high sensitivity and specificity of the TUG in various situations also appears strong enough to be useful in distinguishing between fallers and non-fallers. However, the lower ROC values surrounding the TUG and the L vs. R hemisphere stroke locations indicate a need for further research to determine the true predictive value of the TUG.  |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| This study is highly related to my PICO question in that it addresses the question’s population, outcome measure, and the outcome. The population in this study includes community-residing individuals, an average of 13.5 months post-stroke, 75% of whom were female. Like my PICO question, the authors of this study sought to determine fall risk in this population, as well as the ability of the TUG to predict falls. The average age of participants in this study was 55.8, which is close to the age included in my PICO question (60 years old). The data included in this study was representative of a larger cohort of adults with post-stroke impairments. Regarding clinical relevance, the measures in this study are appropriate for patients post-stroke. The MBI, NIHSS, and TUG require less than 10 minutes each to administer or perform and require little equipment, making them feasible in most settings. This article demonstrates the ability of the TUG to distinguish “fallers” and “non-fallers” in patients post-stroke, which is clinically important information that allows a physical therapist to make clinical judgments about future care and recovery. While this article mentions the use of other predictors of falls including age, gender, use of assistive devices, and stroke severity, this study did not find them to be significant. Thus, the use of the TUG appears to be an appropriate and valid measure of falls risk in this population. While this is not an intervention study, the study still offers valuable, practical outcome measures with clinical utility. This practicality is likely increased by the safety and beneficence for patients. There is very little risk for adverse outcome or danger via the use of these measures. In fact, the TUG allows for the use of assistive devices during the test, which is a need for many stroke patients. In addition, if patients trust their physical therapist and evidence in the research, these measures are appropriate to use. |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| **Synthesis of Evidence**Both of these studies demonstrate findings that support the use of the TUG for predicting falls in individuals post-stroke,1,3 however there is no single study that directly addresses the clinical question. While there are certainly other variables and tools that can predict falls as well as or better than the TUG, such as a depth-sensing camera, gait features, or characteristics of the actual stroke, there is valid evidence that the TUG is an appropriate prognostic tool for falls prediction in the acute and subacute time periods.Both of these studies demonstrate fair to good validity; however, their study designs do not demonstrate high levels of evidence. Quality was decreased by small sample sizes, lack of blinding or concealment, study design, and lack of a control group. These were common themes throughout my search for evidence on this clinical question. Most studies were non-experimental, observational designs which simply cannot offer as high-quality evidence as a systematic review or RCT. These study designs do not lend themselves well to blinding or concealment of information, which can create unwanted bias. Their small sample sizes also reduce the power and quality of the studies. Thus, the overall evidence regarding the ability of the TUG and other measures to predict falls in patients post-stroke is limited in both quality and number. **Implications for Clinical Practice**As mentioned previously in this CAT, the TUG is both feasible, and clinically relevant in most physical therapy settings. Physical therapists are trained and able to perform the TUG in any setting because of its simplicity and low equipment requirement. In fact, administration of the TUG requires less time than other frequently selected measures such as the Berg Balance scale.1 There is low risk involved in administering and performing this test, which may increase a patient’s willingness to participate, despite the fear of falling that often accompanies a stroke. In addition to the validity and statistical significance of these studies, it is important to consider the clinical expertise and judgment required to use these measures, in addition to the patients’ preferences. As mentioned, physical therapists are able to perform the TUG (or other measures mentioned) with their training, education, and clinical expertise. Therapists are also equipped to administer this test safely and with no cost to the patient or the therapist. However, this is most successful if the patient has confidence in the therapist, appreciates and values scientific evidence, and believes that the benefits outweigh the costs of the assessment. Because of the falls that occurred in these patients at home, while walking, during transfers, and while negotiating stairs,1,3 there is a substantial need for falls prevention programs for these patients and their caregivers to appropriately and effectively educate them on characteristics of fall risk, preventative exercises, home safety, and other medical evaluations to reduce their risk for falling. **Implications for Future Research**There is a great need for future research to reduce falls in chronic stroke patients. Future research should use study designs that have higher levels of evidence and quality. While there is a major lack of RCTs and systematic reviews for this clinical question, research may need to start simply with a longitudinal study with patients post-stroke to determine falls-related factors.1 The majority of studies that exist regarding the predictive ability of the TUG are cross-sectional studies with small samples and short follow-up periods.1 Future studies should have more standardized, uniform methods including the time after stroke that patients are evaluated in the study as well as the methods for bias-reduction used in these studies. Both studies mention that there is currently no specific TUG cut-off point for falls prediction in the stroke population.1,3 This would be beneficial to identify in future research as well. If we can find a tool that is able to capture both mobility and balance after a stroke, the development of treatment and falls prevention interventions to reduce the number of stroke-related falls would be significantly more effective and beneficial for both patients and clinicians.1 This clinical question attempts to compare the TUG to other clinical measures in their ability to predict falls after a stroke. The current evidence about other clinical measures, such as the Berg Balance scale, is mixed and conflicting.1 A study by Tilson4 compared several screening tools in their ability to prospectively predict falls in patients post-stroke. This study examined stroke location, stroke type, cognition, FIM scores, gait speed, 6MWT, ABC scale, and participation measures to determine which was the best indicator of fall risk.4 While this study found the Berg Balance to be the single best predictor of falls,4 others have found other measures more predictive. A study1 found that stroke lesion location affects fall risk, while another study4 found no association between these variables. Another study found that balance confidence was the best predictor of falling when compared to the ABC scale and TUG in patients with and without pathology.5 Future research is needed to address not only the TUG’s ability to predict falls but other measures as well (i.e. Berg Balance, ABC Scale, etc.) because of the current inconclusive results.  |

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[List all references cited in the CAT]

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