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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In a 60-year-old patient with hemiplegia due to stroke, does distraction through a cognitive task, compared to focusing exclusively on gait during a treadmill gait training intervention increase affected step length? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| Patients are often left with gait difficulties following a stroke. This typically involves impairments in cadence, gait speed, affected step length, and stride length. The goal for these patients is often to return to independent ambulation. However, ambulating in the community involves many dual-task components including carrying on a conversation, navigating around other moving individuals, and holding objects. While working towards the goal of community ambulation, patients post stroke are often subjected to a variety of environments during rehab – gait training sometimes occurs in a calm environment, and other times is held in a loud crowded gym. It is important for the clinician to know what type of intervention demonstrates the most improvements in affected step length for the patient: the ability to focus on the task at hand (single-task conditions) or be distracted through a cognitive task. |

**SUMMARY OF SEARCH**

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| * A total of 10 studies were selected that met the inclusion/exclusion criteria, including 7 randomized controlled trials (RCT), one cross-sectional study, one single-case design, and one case series. Three RCTs were selected as the “best evidence” based on methodological quality and relevance to the clinical question. * For individuals post-stroke, the use of a dual-task intervention during a gait training intervention demonstrates statistically significant improvements in dual-task overground walking conditions. This type of training is generally no better at improving single-task overground walking compared to more conventional treadmill training interventions. * Future research should include RCTs with a larger sample size and high methodological quality that compare dual-task treadmill training to conventional treadmill training. These studies should not include conventional physical therapy in conjunction with the gait training so that the dual-task treatment effects can be seen more clearly. |

**CLINICAL BOTTOM LINE**

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| Considered together, best evidence suggests that incorporating dual-task components, either motor-motor or cognitive-motor, will likely lead to improvements in gait parameters for high functioning patients after a stroke. However, these results are more prominent under dual-task walking conditions, which is beneficial as this type of ambulation is more representative of community ambulation. A physical therapist could utilize these results to incorporate more motor-motor or cognitive-motor dual-task interventions into their traditional treadmill training. A crowded gym will pose natural obstacles for the post-stroke patient; if the therapist is working on gait training in a quiet gym, they may consider adding progressive cognitive or motor dual-task components for distraction. |

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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*** |

**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) |
| Hemiplegia  Stroke  CVA  Cerebral infarct | Task distraction  Cognitive  Treadmill  Walk\*  Dual task\*  Dual-task\* | Focus\*  Treadmill  Ambulat\*  Gait | Step length  Stride length  Spatio-temporal  Spatial-temporal |

**Final search strategy:**

PubMed:

All Fields:

1. Hemiplegia OR stroke OR CVA OR cerebral infarct
2. Task distraction OR cognitive or dual-task\* OR dual task\*
3. Treadmill OR walk\* OR ambulat\* OR gait
4. “Step length” OR “stride length” OR spatio-temporal OR spatial-temporal
5. #1 AND #2 AND #3 AND #4 (n=1631)
6. Task distraction OR cognitive OR dual-task\* OR dual task\*
7. #1 AND #3 AND #4 AND #6
8. “Task distraction” OR task distraction OR cognitive OR dual-task\* OR dual task\*
9. #1 AND #4 AND #8 (n=247)

((((Hemiplegia OR stroke OR CVA OR cerebral infarct)) AND (“task distraction” OR task distraction OR cognitive OR dual-task\* OR dual task\*)) AND (“step length” OR “stride length” OR gait OR spatio-temporal OR spatial-temporal))

#9 plus Applied Filters: Humans, English, Publication date range from 1/1/1997 (n=154)

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed**  **PsychInfo**  **CINAHL**  **Cochrane Library** | **247**  **90**  **92**  **1** | **154:** Applied Humans, English, Publication date range from 1/1/1997  **24:** Above filters plus “Review” only  **48:** Applied Humans, English, Publication date 1/1997 – 10/2015; Middle Age, Aged, Very Old  **72:** Applied Humans, English, Publication date 1/1997 – 10/2015 |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Randomized controlled trials, controlled trials, uncontrolled trials * Published up to September 2015 * Published in English * Studied a population of individuals post stroke with hemiparetic lower extremity * Studies including patients who are able to walk without physical assistance (assistive devices and AFOs if needed are acceptable) |
| **Exclusion Criteria** |
| * Studies involving patients with cerebellar lesions or cardiorespiratory/metabolic disease * Studies including patients who recently received botulinum toxin to lower limb (within previous 6 months) * Studies involving cerebral palsy * Case studies * Abstracts, narrative review articles, conference proceedings * Published before 1997 |

**RESULTS OF SEARCH**

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

The table below lists 10 relevant studies that were located and categorized (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) using the PEDro quality assessment rating scale for Randomized Controlled Trials (RCTs) and the Downs and Black Checklist for assessing quality in case series.

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| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| Yang, Wang, Chen, Kao (2007)1 | **7/10** | **1b** | **RCT** |
| An, Kim, Kim, Lee, Kim, Yoo, Choi (2014)2 | **6/10** | **1b** | **RCT** |
| Cho, Kim, Lee, Lee (2015)3 | **9/10** | **1b** | **RCT** |
| Shim, Yu, Jung, Kang, Cho (2012)4 | **5/10** | **1b** | **RCT** |
| Plummer-D’Amato, Altmann, Saracino, Fox, Behrman, Marsiske (2008)5 | **15/29** | **4** | **Cross-sectional study** |
| Santos-Couto-Paz, Teixeira-Salmela, Tierra-Criollo (2013)6 | **16/29** | **4** | **Single-case design** |
| Kwon, Woo, Lee, Kim (2015)7 | **8/10** | **1b** | **RCT** |
| Kim, Han, Lee (2014)8 | **6/10** | **1b** | **RCT** |
| Plummer, Villalobos, Vayda, Moser, Johnson (2014)9 | **17/29** | **4** | **Case series** |
| Kim, Lee, Seo (2013)10 | **6/10** | **1b** | **RCT** |

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

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| * **Cho et al. (2015)**3**:** This study met the predetermined inclusion and exclusion search criteria. It has the highest methodological quality (9/10) based on my assessment and has a higher level of evidence (1b) than other reviewed studies listed above. It compared outcomes of single vs. dual task walking in stroke patients over a 4-week time frame. They used virtual reality to recreate cognitive load during dual tasking. This study includes results for both step length and stride length, which aligned with the outcomes I am considering for this CAT. * **Yang et al. (2007)**1**:** This RCT is of good methodological quality (7/10) with a high level of evidence (1b). It focuses on a 4-week dual-task intervention with walking for patients with stroke. The intervention group was required to complete dual-task activities while walking, which is similar to the intervention group of my original clinical question. Significant changes were found in many aspects of gait characteristics, including stride length, which is the focus for this CAT. Although the control group did not receive any rehabilitation, they provide pre- and post-test measures for both groups. * **Kwon et al. (2015)**7**:** This study was selected based on the overall study design, quality (8/10) and high level of evidence. It randomized subjects to one of two groups, both of which had interventions focusing exclusively on treadmill training. The experimental group, however, had to complete certain randomized tasks that altered walking patterns on a treadmill. This study took measurements at baseline, at 4 weeks into the intervention, and at completion after 8 weeks. One specific gait measure was stride length, which is the focus for this CAT. |

**SUMMARY OF BEST EVIDENCE**

**(1)** Description and appraisal of *Virtual reality training with cognitive load improves walking function in chronic stroke patients* by Cho KH, Kim MK, Lee HJ, Lee WH (2015)3

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this study was to investigate the effect of virtual reality training with cognitive load on walking function in patients with chronic stroke under single and dual task conditions |
| **Study Design** |
| * Randomized controlled trial * Subjects were randomly assigned to one of two groups using sealed envelopes marked with the number 1 or 2 * Both groups consisted of chronic stroke patients: the experimental group included virtual reality training with cognitive load, while the control group included virtual reality training (in addition to conventional PT/OT) * Outcome measures included overground walking for single- and dual-task conditions and were taken prior to the start of the intervention (pre-training) and 3 days after the end of the 4-week intervention period (post-training) in the rehabilitation ward * Assessors were blinded to treatment condition * Procedures were conducted in a different therapy room to maintain subject blinding * A power calculation was conducted to determine sample size; mean power was set at 0.8, requiring a total of 27 subjects were required |
| **Setting** |
| The study was conducted in the rehabilitation ward at the Myongji Choonhey Hospital in Korea. The virtual reality procedures were performed in a separate therapy room within the rehabilitation ward. |
| **Participants** |
| * 28 total subjects were recruited for this study after meeting the inclusion and exclusion criteria. Two subjects were unable to understand verbal instructions, and two subjects refused to participate in the study * 24 total subjects participated in the study, 22 subjects completed the study:   + One subject from each group dropped out due to discharge during the intervention, causing 11 subjects from each group to be included in the analysis   + Experimental group (n=11), Control group (n=11) * Both groups were similar in all general characteristics and variables at baseline: gender, age, height, weight, BMI, paretic side, etiology, post-stroke duration, MMSE (Korean) score, BBS score, and gait variables under the single- and dual-task conditions   + Age (years): 60.00±9.38 (Experimental); 58.64±11.86 (Control)   + Gender: 5 Male, 6 Female (Experimental); 2 Male, 9 Female (Control)   + Post-stroke duration (days): 273.90±191.74 (Experimental); 263.90±144.64 (Control) * All subjects completed the study protocol with a 100% attendance rate |
| **Intervention Investigated** |
| * All subjects received conventional physical therapy (increased trunk stability, lower extremity muscle strength, gait stability) and occupational therapy (upper extremity training program, ADL practice) for a total of 60 minutes a day 5 days per week for 4 weeks |
| *Control* |
| VR group: Virtual reality training   * Control subjects received conventional PT/OT (described above) in addition to a VR program for 30 minutes a day 5 days per week for 4 weeks * An overhead harness was used for safety purposes while subjects walked on a treadmill. The virtual reality environment was projected onto a screen in front of the treadmill, with surrounding loud speakers to provide auditory input. * Treadmill belt speed and the virtual reality scene movement were synchronized in three levels (1.6, 2.4, and 3.2 km/h). The virtual reality scene movement speed was changed depending on the change of treadmill belt speed |
| *Experimental* |
| VRTCL group: Virtual reality training with cognitive load   * Experimental subjects received conventional PT/OT (described above) in addition to VRTCL for 30 minutes a day 5 days per week for 4 weeks * An overhead harness was used for safety purposes while subjects walked on a treadmill. The virtual reality environment was projected on a screen in front of the treadmill with surrounding loud speakers to provide auditory input. This environment consisted of real community elements including a crosswalk, garden, and marketplace. Treadmill belt speed and the virtual reality scene movement were synchronized in three levels (1.6, 2.4, and 3.2 km/h). The virtual reality scene movement speed changed depending on the change of treadmill belt speed. * Experimental subjects viewed the virtual environment while performing cognitive load tasks:   + Week 1: Memory task. Familiar objects appeared on the video (one object per minute) and subjects were asked to remember the objects and recall them after the session   + Week 2: Arithmetic task. Addition and subjection problems were provided (one problem per minute)   + Week 3: Verbal task. Subjects were required to cite words that started with letters presented on the screen (one letter per minute)   + Week 4: Verbal task. The research assistant asked simple questions that required the subject to carry on casual conversation. * Rest breaks were not included in the study design but were allowed upon request |
| **Outcome Measures** (Primary and Secondary) |
| * Outcome measures were taken on all subjects at baseline (pre-test) and 3 days after the end of the 4-week intervention (post-test) * All measurements were performed while subjects were in the rehabilitation ward, and the assessor was blinded to training condition   Primary Outcome Measures: Velocity, cadence, paretic side step length, and stride length   * Researchers used the GAITRite walkway system to quantify spatio-temporal gait parameters. Subjects were instructed to walk at their usual comfortable speed, beginning and ending 3-meters from the mat to maintain gait speed on the mat. Subjects were allowed to use assistive devices. The values were averaged over three trials for both walking conditions:   + 1) Walking at comfortable speed (single task)   + 2) Walking while counting backwards (dual task) |
| **Main Findings** |
| *(Statistical significant level of alpha < 0.05 was used for a repeated analysis of variance within groups and between groups at pre- and post-intervention)*  Single-task Condition:   * Statistically significant within group improvements (*P*<0.05) were seen in both the experimental and control groups in all temporal and spatial gait parameters compared to baseline   + Gait speed (cm/s): mean change = 11.05±3.59 (Experimental); = 10.36±3.78 (Control)   + Cadence (steps/min): mean change = 8.23±3.98 (Experimental); = 6.47±2.66 (Control)   + Step length (cm): mean change = 6.64±4.80 (Experimental); = 5.03±1.37 (Control)   + Stride length (cm): mean change = 12.64±9.03 (Experimental); = 10.00±3.78 (Control)   Dual-task Condition:   * Statistically significant within group improvements (*P*<0.05) were seen in all spatial and temporal gait parameters for the experimental group, and only in cadence and stride length for the control group compared to baseline   + Gait speed (cm/s): mean change = 10.91±11.60 (Experimental); = 1.50±5.52 (Control)   + Cadence (steps/min): mean change = 8.00±3.63 (Experimental); = 0.62±0.28 (Control)   + Step length (cm): mean change = 5.66±2.87 (Experimental); = 0.68±1.35 (Control)   + Stride length (cm): mean change = 7.27±2.87 (Experimental); = 1.37±1.68 (Control) * Statistically significantly greater improvements (*P*<0.05) were seen in the experimental group for all measured gait parameters than the control group at the end of the 4-week intervention   No adverse events were reported |
| **Original Authors’ Conclusions** |
| The authors conclude that interactive virtual reality training with cognitive load has a beneficial effect on walking function for overground single- and dual-task walking conditions in patients with chronic stroke. They suggest that this may be an effective method for improving community ambulation. |
| **Critical Appraisal** |
| **Validity** |
| * PEDro Scale score 9/10 based on:   + Random Allocation: Yes; Concealed Allocation: Yes; Baseline Comparison: Yes; Blind Subjects: Yes; Blind Therapist: No; Blind Assessors: Yes; >85% participant outcomes: Yes; Intention to treat analysis: Yes; Between group comparison: Yes; Point estimates and variability: Yes * Subjects in both groups were receiving concurrent physical and occupational therapy, which is a potential confounding factor and the researchers did not discuss how this may have impacted overall results * The subject randomization, concealed allocation, and blinded assessor are strengths of this study * 28 subjects were recruited to meet the calculated sample size of 27, but only 22 subjects completed the study. Therefore, this study has less power and this should be considered when applying the results to clinical situations. * The subjects were high functioning individuals with chronic stroke and the results may not be representative of the entire population. |
| **Interpretation of Results** |
| This study provides favourable results that including virtual reality training with cognitive load on a treadmill can improve spatial and temporal gait parameters in individuals with chronic stroke. Statistically significant improvements were seen in overground single-task walking conditions at the end of the 4-week intervention in both experimental and control groups, but there were no significant differences between groups. In contrast, between group differences showed statistically significant improvements in dual-task gait parameters for those individuals in the experimental group. These results suggest that when patients with a stroke practice walking with cognitive load tasks, they will demonstrate improvements in dual-task gait parameters that are not seen in patients who solely practice walking.  Although the improvements in gait speed were statistically significant for the experimental group in both the single- and dual-task walking conditions, these results cannot be considered clinically meaningful. The MCID for gait speed in individuals with subacute stroke is 0.16 m/s.11 This 4-week intervention found improvements of 0.11 m/s and 0.10 m/s in the experimental group for single- and dual-task walking conditions, respectively. |

**(2)** Description and appraisal of *Dual-task exercise improves walking ability in chronic stroke: a randomized controlled trial* by Yang YR, Wang RY, Chen YC, Kao MJ (2007)1

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this study was to determine the effectiveness of a dual-task-based exercise program on walking ability in subjects with chronic stroke. |
| **Study Design** |
| * Single-blind randomized controlled trial * Subjects were recruited from a community group * All participants were randomly assigned to either the control or experimental group by an independent individual selecting sealed envelopes prior to the start of the intervention * All subjects were evaluated by a physical therapist who was unaware of the subject’s group assignment and was not involved in the training program   + All evaluations were performed before and after the 4-week intervention |
| **Setting** |
| Details of the study location are unspecified, but it was completed in Taiwan in a general community setting. |
| **Participants** |
| * 34 subjects were recruited for the study from community groups   + Seven subjects did not meet the inclusion criteria; two subjects did not sign an informed consent form * 25 total subjects competed the study   + Experimental group: n = 13; Control group: n = 12 * All subjects had chronic stroke and had to be capable of limited (gait velocity between 58-80 cm/s) and full (gait velocity >80 cm/s) community ambulation * Both groups were similar in all demographics and selected outcome measures at baseline:   + Age (years): Experimental = 59.46±11.83; Control = 59.17±11.98   + Years post-stroke: Experimental = 4.08±3.13; Control = 4.68±7.40   + Gender: Experimental = 7 Male, 6 Female; Control = 7 Male, 5 Female   + Hemiparetic side: Experimental = 10 Right, 3 Left; Control = 6 Right, 6 Left * Experimental group had attendance rate of 100% for the 4-week training program |
| **Intervention Investigated** |
| *Control* |
| * Control subjects (n=12) did not receive any rehabilitation training during the 4 weeks |
| *Experimental* |
| * Experimental subjects completed 30 minutes of a ball exercise program 3x per week for 4 weeks * Subjects ambulated while manipulating 1 or 2 balls (therapy balls with diameters of 45, 55, 85, and 95cm) * The training program included:   1) Walking while holding 1 or 2 balls on both hands  2) Walking to match the rhythm of bouncing one ball with one or both hands  3) Walking holding one ball on one hand and concurrently bounding another ball with the other hand  4) Walking in time while kicking a basketball (which was placed into a net and held by the subject)  5) Walking while holding a ball in one hand and concurrently kicking a basketball (within the net)  6) Walking while bouncing one ball and concurrently kicking a basketball within a net  7) Walking while reciprocally bounding one ball with both hands   * Tasks became increasingly difficult to challenge subjects * Variable practice for the conditions included walking forward, backwards, in a circular route, and forward on an S-shaped route |
| **Outcome Measures** (Primary and Secondary) |
| * Outcome measures were taken on all subjects before the start of the intervention (pre-training) and at the end of the 4-week training period (post-training) * All subjects were evaluated by a physical therapist who was not involved in the training program and was unaware of group assignments   Primary Outcome Measure: Gait speed (cm/s)  Secondary Outcome Measures: Cadence (step/min), stride time (s), stride length (cm), and temporal symmetry index calculated using the formula:  unaffected single limb support (% of gait cycle)  affected single limb support (% of gait cycle)   * Researchers used the GAITRite walkway system to quantify subjects’ walking patterns. All subjects walked on the 3.66m walkway in a 10-m hallway to eliminate effects of difficulty initiating or stopping walking   + Gait performance was measured for 2 conditions:     - 1) Preferred walking at comfortable speed (single-task)     - 2) Walking while carrying a tray with glasses (tray-carrying task)   + The average of three successful trials of each walking condition was taken to ensure representative samples   + One physical therapist took all measures to minimize inter-tester differences |
| **Main Findings** |
| *(Statistical significance level of alpha = 0.05 was used for a 1-way multivariate analysis of variance to determine differences of mean difference scores of each dependent variable between groups)*  Single-task Measures:   * Only the experimental group saw statistically significant changes at 4 weeks post-training compared to baseline for spatial and temporal measures:   + Speed (cm/s): mean change = 29.74±15.66 (Experimental); = -12.84±21.61 (Control)   + Cadence (step/min): mean change = 14.98±9.42 (Experimental); = -3.16±10.07 (Control)   + Stride time (s): mean change = -0.16±0.10 (Experimental); = -0.06±0.08 (Control)   + Stride length (cm): 18.08±9.97 (Experimental); = 2.97±12.84 (Control)   + Temporal symmetry index: mean change = -0.04±0.09 (Experimental); 0.04±0.08 (Control) * Between groups comparisons revealed statistically significantly greater changes in the experimental group for speed (*P*<0.001), cadence (*P*<0.001), stride time (*P*=0.007), and stride length (*P*=0.003)   Dual-task Measures:   * Only the experimental group saw statistically significant changes at 4 weeks post-training compared to baseline:   + Speed (cm/s): mean change = 31.08±13.36 (Experimental); = 12.93±13.52 (Control)   + Cadence (step/min): mean change = 15.66±10.64 (Experimental); = 7.91±9.08 (Control)   + Stride time (s): mean change = -0.19±0.14 (Experimental); = -0.09±0.09 (Control)   + Stride length (cm): mean change = 20.61±11.44 (Experimental); = 7.08±7.39 (Control)   + Temporal symmetry index: mean change = -0.05±0.08 (Experimental); -0.02±0.12 (Control) * Between group comparisons revealed statistically significantly greater changes in the experimental group for speed (*P*=0.003), stride time (*P*=0.045), and stride length (*P*=0.002)   No adverse events were reported |
| **Original Authors’ Conclusions** |
| The authors conclude that a 4-week ball exercise program is able to improve single-task and dual-task overground walking ability in patients post stroke. The significant improvements seen under dual-task conditions may be a better indicator of daily function. The use of a task-oriented ball program for improving walking ability could encourage patient participation. |
| **Critical Appraisal** |
| **Validity** |
| * PEDro Scale score 7/10 based on:   + Random Allocation: Yes; Concealed Allocation: Yes; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: Yes; >85% participant outcomes: Yes; Intention to treat analysis: No; Between group comparison: Yes; Point estimates and variability: Yes * Strengths of the study include randomized and concealed group allocation and assessor blinding * Subjects were not blinded; all subjects were informed of the study purposes and procedures prior to beginning the intervention * The participants in this study were individuals with chronic stroke capable of community ambulation and may not be representative of the entire population   + As mentioned by the authors, all participants volunteered for the study and may be a self-selected group of highly motivated individuals. Again, this would not be representative of the entire population of individuals with chronic stroke |
| **Interpretation of Results** |
| The results of this study provide some evidence that a ball exercise program can improve single- and dual-task overground walking abilities after 4 weeks, as demonstrated by statistically significant improvements in speed, stride time, and stride length compared to the non-experimental control condition.  These results favor a dual-task based ball exercise program for individuals with chronic stroke (on average over 4 years since onset of injury). These individuals are capable of improving characteristics of gait. However, it’s important to note that the control group received no rehabilitation training and were not required to complete selected exercises at home throughout the 4-week intervention. While the treatment effects of the dual-task program were statistically significant, it is unknown how this type of intervention compares to a single-task program in this patient population. Based on the MCID of 0.16 m/s for gait speed in subacute stroke patients11, the experimental group experienced clinically significant changes in gait speed for both single- and dual-task overground walking conditions. |

**(3)** Description and appraisal of *Effects of task-oriented treadmill-walking training on walking ability of stroke patients* by Kwon O, Woo Y, Lee J, Kim K (2015)7

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this study was to examine the effects of diversified task-oriented treadmill gait training on stroke patients’ walking ability, using tasks involving changes in treadmill speed, gradient, weight bearing, and direction. |
| **Study Design** |
| * Randomized controlled trial * Subjects were recruited to the study between June 2013 and August 2013 * Subjects were randomly assigned to two groups by selecting a card from a box (odd numbers = experimental group, even numbers = control group) * Both groups consisted of patients post-stroke: the experimental group included task-oriented treadmill-walking training, while the control group included conventional treadmill-walking training * Outcome measures were taken at baseline, 4 weeks, and 8 weeks after training began * Assessors and therapists were not blinded to treatment condition |
| **Setting** |
| Details of study setting are unspecified, but authors note that conservative physical therapy treatment was performed in an adult exercise therapy room and that the 6-minute walk test (6-MWT) was administered in a hospital corridor. All recruited subjects were from B Hospital in Bundang, Korea. |
| **Participants** |
| * 44 total subjects were recruited for the study   + Two subjects in the experimental group chose to end training, two subjects in the control group were transferred to other hospitals * 40 total subjects completed the study   + Experimental group: n = 20; Control group: n = 20 * Subjects were recruited if they had been diagnosed with stroke, had been admitted to the hospital (B Hospital in Bundang, Korea), and if they received physical therapy * In order to participate, subjects needed to be able to walk independently without an assistive device and have no serious visual disorder or hearing impairment * Both groups were similar in all demographics and variables at baseline: height, weight, age, MMSE score, stroke onset, diagnosis (infarction or hemorrhage), side of brain lesion, and functional ambulation category   + Gender: 26 male, 14 female   + Mean age (years): Experimental = 50.70±15.16; Control = 47.15±18.65   + Onset of stroke (months): Experimental = 14.25±6.27; Control = 15.25±6.54 * Authors do not indicate how participants were recruited for the study |
| **Intervention Investigated** |
| Both groups received 30 minutes of physical therapy treatment prior to treadmill training. Treatment included ROM exercises, stretching, and strengthening. |
| *Control* |
| * Control subjects received conventional treadmill-walking training for 30 minutes 5 days per week for 8 weeks * Subjects walked a distance of 7 meters to determine comfortable overground walking speed * For the intervention, the treadmill speed was set at 3x the comfortable walking speed * Three physical therapists assisted during the intervention: one stood behind the patient to support the trunk and assist in contralateral and ipsilateral weight-bearing, and two were positioned on the sides of both legs to assist the subject with stepping during the stance and swing phases of gait and to correct asymmetrical gait pattern * Researchers gave voice prompts to subjects to promote proper gait patterns * Subjects were allowed five minutes to rest due to pain, abnormal breathing, or changes in complexion |
| *Experimental* |
| * Experimental subjects completed 30 minutes of task-oriented treadmill-walking training 5 days per week for 8 weeks completing six treadmill tasks, which were randomized by subjects selecting pieces of paper labeled A-F * Speed, direction, slope gradient, and weight bearing were the main independent variables within the experimental group. Two were changed for each walking condition:   + A: changing speed and direction   + B: changing speed and gradient   + C: changing speed and weight-bearing   + D: changing direction and gradient   + E: changing direction and weight-bearing   + F: changing gradient and weight-bearing * All walking interventions lasted for 4 minutes with a 1-minute rest break between tasks (which is when subjects randomly selected pieces of paper to determine next task) * The gradient of the treadmill was gradually increased from 0°, to 2.5°, 5°, and 10°, while the percentage of weight bearing was reduced from 40% to 10% by increments of 10. Every time subjects performed a task incorporating changing gait speeds, the speed was increased by 0.1 km/hour. * Three physical therapists assisted during the intervention: one stood behind the patient to help improve weight bearing on the affected or unaffected side, and two were positioned on the sides of both legs to assist the subject with stepping during the swing and stance phases of gait and to correct asymmetrical gait patterns |
| **Outcome Measures** (Primary and Secondary) |
| * Outcome measures were taken on all subjects at baseline, 4 weeks, and 8 weeks into the intervention * For all measures, maximum scores, ranges, and/or normative data were not discussed * Administration of secondary outcome measures was unspecified * Primary Outcome Measure: Gait Analysis   + Researchers used the OptoGait to quantify subjects’ walking patterns. Subjects walked on a 7-meter platform while sensors on the feet collected information related to stride length, stride time, cadence, and average walking speed   + The affected (hemiplegic) lower extremity was then further assessed for affected step length, single support, step time, and average walking speed   + Subjects were not allowed to use assistive devices or suspension systems during data collection   + One physical therapist took all measures to minimize inter-tester differences   + Intra-rater reliability was r=0.99; test-retest reliability was r=0.98–0.99 * Secondary Outcome Measure: Timed Up and Go (TUG) test   + Time it takes a patient to stand from a chair, walk 3m, turn, and return to the chair   + This time was averaged from a total of three trials   + High test-retest reliability for patients post-stroke of r=0.95 * Secondary Outcome Measure: 6-minute walk test   + Subjects completed this test unaided in a 25-meter walkway within the hospital. Markers were placed on the floor at 1-meter intervals to help the researcher determine total distance walked   + Subjects self-selected walking speeds and rest periods   + Intra-rater reliability for patients post-stroke was r=0.99 |
| **Main Findings** |
| *(Statistical significance level of alpha = 0.05 was used for a repeated analysis of variance within the two groups at 0, 4, and 8 weeks of training as well as differences between the two groups at the same time points)*   * Both groups saw statistically significant changes at 8 weeks compared to baseline for stride length, gait cycle, cadence, and average speed   + Stride length (cm): mean change = 39.34 (Experimental); = 23.15 (Control)   + Gait cycle (sec): mean change = -1.06 (Experimental); = -0.85 (Control)   + Cadence (step/s): mean change = 0.27 (Experimental); = 0.14 (Control)   + Average speed (m/s): mean change = 0.4 (Experimental); = 0.23 (Control) * Changes in stride length (*P*=0.008), gait cycle (*P*=0.008), cadence (*P*=0.033), and average speed (*P*=0.007) were statistically significantly different between the two groups at 8 weeks of training, with the greatest improvements seen in the experimental group for all measures. * Both groups saw statistically significant improvements at 8 weeks compared to baseline in affected step length, affected single support, affected step time, and affected speed   + Affected step length (cm): mean change = 20.33 (Experimental); = 11.55 (Control)   + Affected single support (%): mean change = 14.02 (Experimental); = 7.47 (Control)   + Affected step time (sec): mean change = -0.48 (Experimental); = -0.4 (Control)   + Affected speed (m/s): mean change = 0.36 (Experimental); = 0.19 (Control) * Changes in affected step length (*P*=0.022), affected single support (*P*=0.031), affected step time (*P*=0.048), and affected speed (*P*=0.029) were statistically significantly different between the two groups at 8 weeks of training, with the greatest improvements seen in the experimental group for all measures * The time scores of the TUG test significantly decreased while the 6-MWT distances significantly increased in both groups at 8 weeks compared to baseline. These changes at the 4- and 8-week periods were statistically significant between groups with the experimental group having the greater improvements.   + TUG: mean change = -6.99 s (Experimental); = -3.82 s (Control)   + 6-MWT: mean change = 32.8 m (Experimental); = 15.75 m (Control) * No adverse events were reported. |
| **Original Authors’ Conclusions** |
| The authors concluded that the improvements demonstrated by patients post-stroke in overall walking ability are improved through task-oriented treadmill-walking training. This type of training includes changes in treadmill speed, direction, slope gradient, and weight bearing, and significantly improves general and affected gait characteristics compared to conventional treadmill training alone. Of greater importance, subjects in the experimental group had significant improvements compared to the controls when specifically looking at the characteristics of the hemiparetic side. |
| **Critical Appraisal** |
| **Validity** |
| * PEDro Scale score 8/10 based on:   + Random Allocation: Yes; Concealed Allocation: Yes; Baseline Comparison: Yes; Blind Subjects: Yes; Blind Therapist: No; Blind Assessors: No; >85% participant outcomes: Yes; Intention to treat analysis: Yes; Between group comparison: Yes; Point estimates and variability: Yes * Subjects in both groups were undergoing 30 minutes of daily (5 times per week) physical therapy intervention, which included range of motion exercises, stretching, and strengthening. This was then followed by 30 minutes of participation in either the control or experimental treadmill-walking group.   + This is a potential confounding factor as the researchers did not discuss how conservative therapy may have impacted overall results * Researchers gave subjects verbal cues to correct walking pattern, but there was no mention of the type or frequency of these instructions * Study location and recruitment methods were not specified, so it is not clear whether the sample is representative of the target population * The authors did not address validity of the TUG, 6-MWT, or expected values for general and affected gait characteristics within a stroke population * Authors state that 40 subjects completed the study, but do not provide any information on session attendance |
| **Interpretation of Results** |
| The results of this study provide some evidence that task-oriented treadmill training improves general and affected side gait characteristics. Overall, the data demonstrate statistically significant changes at 4- and 8-weeks compared to baseline for both the control and experimental group, and the experimental group had significantly greater improvements than the control group at 8 weeks for each measure.  Although the authors do not mention MCIDs for the selected outcome measures, the statistically significant results demonstrate clinical significance. The experimental group had a treatment effect on average gait speed of 0.40 m/s, while the control group had a treatment effect of 0.23 m/s. Similarly, the between group difference in treatment effect for average gait speed is 0.17 m/s. The MCID for gait speed in patients with subacute stroke and severe gait impairments is 0.16 m/s.11 This demonstrates that both TOTWT and CTWT are capable of producing clinically meaningful improvements in this population. The suggested MCID for the 6MWT in patients with stroke is 34.4 meters.12 The average change in the experimental group came close to the suggested MCID at 32.4 meters, but was not enough change to be considered clinically significant. Unfortunately, there are currently no established MCIDs for the TUG test in a stroke population. However, it has been shown that a TUG score of greater than 14 seconds is 50% sensitive and 78% specific for predicting falls 6-12 months following rehab in patients with stroke.13 The post-intervention TUG scores of the experimental (19.95±4.89 sec) and control (20.03±5.79 sec) indicate that these individuals are still at a risk for falls. Although the TUG times decreased in both groups, these differences cannot be considered clinically significant.  The changing variables in the experimental group are designed to simulate environmental challenges that community ambulators experience daily. Clinicians can use the information presented in this study to design an intervention based on components of community ambulation with the intention of demonstrating meaningful differences in patients post-stroke. |

**EVIDENCE SYNTHESIS AND IMPLICATIONS**

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| **Implications for clinical practice:**  All evidence reviewed in this clinical appraisal suggests that dual-task oriented interventions are safe for patients with stroke. Although statistically significant changes occurred in all experimental groups for gait parameters, it’s important to note that only one study by Kwon et al. (2015) demonstrated clinically meaningful changes. Although not all changes are clinically significant, distraction through dual-task interventions has the potential to improve gait parameters more so than traditional gait training or no intervention at all.  It’s important to know what type of dual-task intervention is occurring, motor-motor or cognitive-motor. Kwon et al. (2015) and Yang et al. (2007) used motor-motor dual tasks for their interventions through task-oriented treadmill training and a dual-task ball exercise program, respectively. Cho et al. (2015) used a progressive cognitive-motor dual task. One cannot draw conclusions on what type of dual-task intervention has the greatest improvements on overground gait parameters without comparing them directly. Therefore, the findings need to be considered separately.  Two RCTs used overground single- and dual-task walking conditions to determine treatment effects on gait parameters. This made for an ideal comparison of treatments and showed that dual-task interventions are more likely to have statistically significant effects on dual-task walking conditions. Therapists should take this into consideration when designing interventions for gait training with their post-stroke patients. As typical community ambulation requires more dual-task processes, gait interventions should include either cognitive loads or dual-task motor components to further challenge the patient.  While the changes may not be clinically significant, improvements in gait parameters are possible in individuals with chronic stroke. This highlights the importance for the therapist to educate the patient on the possible improvements a dual-task gait training intervention can have on walking ability.  In regards to the original clinical question, distraction through a cognitive task demonstrates improvements in affected step length. All reviewed studies had statistically significant changes in average step or stride length compared to the control intervention. If a physical therapist is working with a patient in a crowded, busy gym, the environment may provide enough natural stimuli to challenge the patient during gait training. However, if the therapist is working with a post-stroke patient in a quiet environment, the patient may see better improvements in gait parameters if the therapist incorporates cognitive-motor or motor-motor dual task components.  **Implications for future research:**  In the future, more studies of high methodological quality and large sample sizes should be conducted to compare dual-task interventions with conventional walking interventions. These studies should include randomly selected participants (as opposed to motivated volunteers) to better represent the entire population of individuals post-stroke. This would also allow for participants to be of varying ambulation levels, instead of focusing only on the highly functional ambulators included in this appraisal. Future research should aim to compare task-oriented treadmill training to conventional treadmill training without concurrent physical therapy interventions. This would allow for stronger outcomes that are specifically a result of the treadmill intervention and with clearer treatment effects. There is also a need for studies to include follow-up to better establish the role of motor learning in an extensive task-oriented gait-training program. |

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