# Clock Drawing Test (CDT) and Activities of Daily Living (ADL) Questionnaire as a Short Screening Test for Dementia in Thai Population

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***Objective:*** *This paper was to develop a short bedside cognitive behavioral test for screening dementia in Thai population.*
***Material and Method:*** *The 182 elderly subjects were gathered from a community near the vicinity of Siriraj Hospital. Family interview, CDT, ADL assessment were assessed by trained nurse. Neurology residents conducted TMSE and Physical examination. The diagnosis of dementia was using the DSM IV criteria.*
***Results:*** *67 subjects were diagnosed with dementia by DSM IV criteria. The CDT at cut off score of 7 had sensitivity 83.8% and specificity 65.2% with area under ROC being 0.825. For ADL assessment at the cut off score of 5 had sensitivity 74.6% and specificity 79.1% with the area under ROC being 0.849. Using CDT and ADL questionnaires together increased the area under the curve from 0.825 to 0.905.*
***Conclusion:*** *The combination of CDT and ADL questionnaire help increase sensitivity and specificity for screening dementia.*

***Keywords:*** *Clock drawing test, Activities of daily living, Dementia, Thai elderly*

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The incidence of dementia is increasing in developing countries with the aging populations. From current data, the prevalence of age related dementia estimate in 65 years old or older are $\geq$ 5% in certain Asian and Latin America while it is about 3-4% in Thailand[1,2]. The recent study have demonstrated that dementia is underestimates in developing countries[1,2]. The underestimation of dementia in a developing country is due to difficulties in defining and using DSM IV dementia criteria[3] and the barriers to testing including increasingly abbreviated office visits, lack of routine use of cognitive screening tools, lack of specificity and sensitivity of screening tools and the fear of offending patient[4].

In Thailand, the authors have been developed many screening tool for Thai elderly population. The screening test in primary care should be short, simple, easy to learn and perform with high specificities and sensitivity with suitable to low educated Thai elderly. The purpose of this article is to develop a short bedside cognitive behavioral test for diagnosis of dementia in Thai population.

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## Material and Method

The subjects for the present study consisted of 182 elderly (Age more than 65 years) gathered from a community near the vicinity of Siriraj Hospital during 2001-2002. Exclusion criteria were 1) subject who had physical inability to write and to see, 2) absence of caregivers who could report reliability of patient history, behavioral problem and activity of daily living (ADL) performance. The subject's history were gathered by family interview. Information on ADL performance was obtained from caregivers, most of whom were spouses, children, or daughters-in-law. Caregiver is defined by those who have spent at least 20 hours per week in direct contact with subjects. The subjects were asked to draw a clock face, the Clock Drawing Test (CDT), on a piece of paper with pre-drawn circle (8 cm in diameter). They were asked to put in the numbers on the face of a clock and the arms of clock which indicated the time at ten past eleven (11.10). All of the above were assess by trained nurse. The TMSE (Train the Brain Forum Committee, 1993)[5] and Physical examination were

conducted by neurologist or neurology residents. All the elders who were suspected of dementia were re-evaluated at memory clinic, Siriraj Hospital. Diagnosis of dementia was based on Diagnosis and Statistic Manual of Mental Disorders, 4th edition (DSM IV) criteria (American Psychiatric Association,1994)[3].

***Instrumentation***

The CDT was scored by using combination of Sunderland et al (1989)[6] and Wolf-Klein et al (1989)[7] scoring systems. A 10-point scoring system with cut off at 7 points was base on both the numbers and hands on the clock face. The score of this CDT ranges from 1 (most impaired) to 10 (normal). The ADLs were assessed by using Thai ADL scale (Senanarong et al 2003)[8]. The Thai ADL scale consists of 6 basic ADL items and 7 instrumental ADL items. The ADL scale score each activity from 0 to 2, which 0 = being independent, 1 = needs mild/moderate assistance or supervision, 2 = need maximum/total assistance or support. The scores of ADL scale range from 0 (best performance) to 26 (most impaired). The total score of TMSE is 30 with the lower the score, the greater of cognitive impairment. TMSE includes orientation, registration, mental control, calculation, language assessment, picture copying and recall memory.

Statistical analysis was done by using SPSS 9.0 software program, which Pearson Chi-square, Pearson's correlation and receiver operating characteristic (ROC) analysis. The study was approved by the Siriraj Hospital Ethics Committee.

## Results

One hundred and eighty two subjects were clinically evaluated and tested. Sixty seven were diagnosed with dementia base on DSM IV criteria. Seventeen subjects were diagnosed with cognitive impairment. Most of the dementia patients were diagnosed with Alzheimer's disease (56.7%). Number of subject and diagnosis are shown in Table 1. Demographic data is shown in Table 2. Most were female (58%). The mean age of the dementia subjects was 70.29 years and for normal/impaired subjects was 66.99 years. One hundred and thirteen subjects (60%) had 4 or fewer years of education. There was no different of statistical significance of sex, education and mean age between demented subjects and normal/impaired subjects. The mean of TMSE scores is 17.82 in dementia group and 26.11 in normal/impaired group (Table 3). The mean of CDT scores is 3.94 in dementia group and 7.64 in normal/impaired group. The mean of Sum ADL scores is 11.55 in dementia group and 2.08 in normal/impaired group. There have a significant difference in TMSE, CDT, Sum ADL scores between dementia and normal/impaired subjects (p-value $< 0.001$). There is a good positive correlation between TMSE scores and CDT scores ($r = 0.68$, $p < 0.001$, $n = 182$) and between the TMSE score and sum ADL scores ($r = 0.67$, $p < 0.001$, $n = 182$) (Table 3). The outcome of

**Table 1.** The subjects' diagnoses

| Diagnosis of Dementia | Number (%) |
|---|---|
| Normal | 98 |
| Cognitive Impairment | 17 |
| Dementia | 67 |
| Alzheimer's disease | 38 (56.7) |
| Vascular dementia | 17 (25.4) |
| Mixed (Alzheimer's disease + Vascular dementia) | 5 (7.5) |
| Alcoholic dementia | 3 (4.5) |
| DLBD | 2 (3.0) |
| Hydrocephalus | 1 (1.5) |
| Unknown cause | 1 (1.5) |

**Table 2.** Demographic data of the subjects

| | Dementia (n = 67) | N/Impaired (n = 115) | p-value |
|---|---|---|---|
| Age (years): Mean ± SD | 70.2 | 66.9 | 0.055 |
| Sex | | | |
| Male | 27 (40.3%) | 46 (40%) | 1.000 |
| Female | 40 (59.7%) | 69 (60.0%) | |
| Education | | | |
| None | 11 (16.4%) | 8 (7%) | 0.199 |
| 1-4 yrs | 33 (49.3%) | 61 (53%) | |
| 5-6 yrs | 2 (3%) | 7 (6.1%) | |
| >6 yrs | 21 (31.3%) | 39 (33.9%) | |

sensitivity, specificity and area under ROC curves of CDT and Thai ADL were calculated as exhibited in Table 4-6 and Fig. 1-3. The area under ROC curve of CDT is 0.825. By using cut off point at 7 (positive if score is 7 or less), CDT had sensitivity 83.8% (95% CI 72.5-91.3) and specificity 65.2% (95% CI 55.7-73.7), PPV 58.8% (95% CI 48.3-68.5), NPV 87.2% (95% CI 77.9-95.1). The area under ROC of Thai ADL is 0.849. When the optimal cut off score on Thai ADL scale is 5 (positive if score is 5 and above), it gives a sensitivity of 74.6% (95% CI, 62.3-84.1) and a specificity of 79.1% (95% CI, 70.3-85.9), PPV 67.6% (95% CI, 55.6-77.7), NPV 84.3% (95% CI, 75.7-90.3). When utilizing the 2 tests together (combining inversed Thai ADL scale scores with CDT test scores, then the total score is 36), the area under the ROC curve is increased to 0.905 (Table 3 and Fig. 3). Thus, this will increase sensitivity and specificity for the dementia screening.

**Discussion**

The authors found that utilizing both CDT and Thai ADL together makes a good screening tools

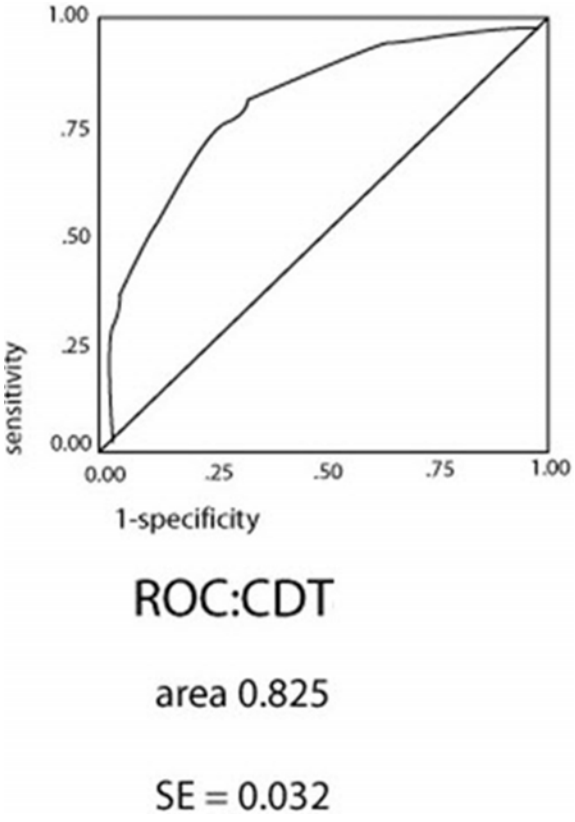


**Fig. 1** The Receiver Operating Characteristic Curve (ROC) analysis of CDT

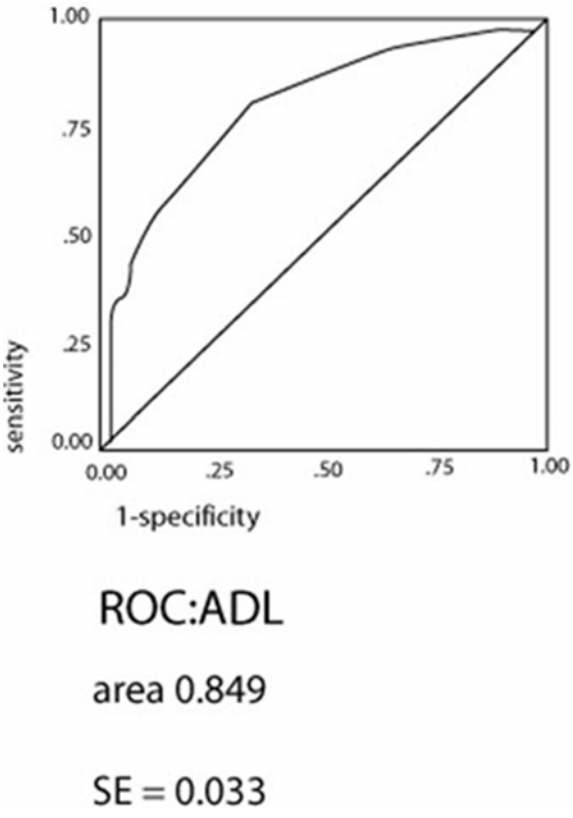


**Fig. 2** The Receiver Operating Characteristic Curve (ROC) analysis of ADL

**Table 3.** Results of cognitive and functional evaluations

| | Mean ± SD | | |
|---|---|---|---|
| | Dementia (n = 67) | Normal/Impaired (n = 115) | p-value |
| TMSE | 17.8 ± 6.0 | 115.0 ± 26.1 | < 0.001 |
| CDT | 3.9 ± 3.0 | 7.6 ± 2.5 | < 0.001 |
| Sum ADL | 11.5 ± 8.1 | 2.0 ± 3.0 | < 0.001 |

TMSE = Thai Mental State Examination, CDT = Clock drawing test, ADL = Activity of daily living

**Table 4.** The sensitivity and specificity of Thai ADL, CDT, sum of ADL and CDT

| | | DSM IV | | | | | |
|---|---|---|---|---|---|---|---|
| | | Dx group Dementia (n = 67) | Normal/ Impaired (n = 115) | Sensitivity (95%CI) | Specificity (95%CI) | PPV (95%CI) | NPV (95%CI) |
| CDT | + (≤ 7) | 57 | 40 | 84.2% (74.0%, 90.1%) | 65.2% (56.1%, 73.3%) | 59.6% (49.7%, 68.7%) | 87.2% (78.5%, 92.7%) |
| | - (> 7) | 10 | 75 | | | | |
| ADL | + (≥ 5) | 51 | 26 | 75.7% (64.5%, 84.2%) | 77.4% (68.9%, 84.1%) | 67.1% (56.1%, 76.4%) | 83.9% (75.8%, 89.7%) |
| | - (< 5) | 16 | 89 | | | | |
| ADL&CDT | ++ , +-, ++ | 63 | 50 | 92.9% (84.3%, 96.9%) | 56.5% (47.3%, 65.5%) | 56.5% (47.4%, 65.2%) | 92.9% (84.3%, 96.9%) |
| | — | 4 | 65 | | | | |

**Table 5.** Clock drawing test scores: sensitivity and specificity

| Score# | Sensitivity (%) | Specificity (%) |
|---|---|---|
| 1 | 31.3 | 98.3 |
| 2 | 46.3 | 93.9 |
| 3 | 53.7 | 88.7 |
| 4 | 58.2 | 86.1 |
| 5 | 64.2 | 82.6 |
| 6 | 74.6 | 73.9 |
| 7 | 83.8 | 65.2 |
| 8 | 92.5 | 45.1 |
| 9 | 97.0 | 32.2 |
| 10 | 100.0 | 0 |




**Fig. 3** The Receiver Operating Characteristic Curve (ROC) analysis of CDT and ADL

for dementia in Thai elders. The screening tools for dementia have been developed in different languages and different scoring systems. The lack of standardization of screening tools may play an important role in hiding the true prevalence of dementia in developing countries. The authors have demonstrated that there is a good correlation between

**Table 6.** The sensitivity and specificity of Thai ADL assessment

| Score # | Sensitivity (%) | Specificity (%) | Score # | Sensitivity (%) | Specificity (%) |
|---|---|---|---|---|---|
| 0 | 86.4 | 55.7 | 14 | 34.3 | 100.0 |
| 1 | 82.1 | 61.7 | 15 | 32.8 | 100.0 |
| 2 | 80.6 | 69.6 | 16 | 29.9 | 100.0 |
| 3 | 79.1 | 71.3 | 17 | 25.4 | 100.0 |
| 4 | 76.1 | 77.4 | 18 | 22.4 | 100.0 |
| 5 | 74.6 | 79.1 | 19 | 17.9 | 100.0 |
| 6 | 70.1 | 87.8 | 21 | 16.4 | 100.0 |
| 7 | 64.2 | 95.7 | 22 | 13.4 | 100.0 |
| 9 | 59.7 | 98.3 | 23 | 10.4 | 100.0 |
| 10 | 53.7 | 99.1 | 24 | 7.5 | 100.0 |
| 11 | 47.8 | 99.1 | 25 | 4.5 | 100.0 |
| 12 | 43.3 | 99.1 | 26 | 0 | 100.0 |
| 13 | 40.3 | 99.1 | | | |

TMSE and CDT and between TMSE and Sum Thai ADL scores. By using CDT alone, the area under ROC curves is 0.825 and by using ADL assessment alone, the area under ROC curves is 0.849. With the combination of CDT and Thai ADLs assessment, the area under the ROC curves increased from 0.825 to 0.905.

The CDT could represent semantic memory, visuospatial function and executive functions and the ADL assessment determines any assistance needed and longitudinal monitoring of the decline.

In the previous studies using CDT score, Karnchanatawan et al (2006)[4] developed a clock drawing test scoring system called "Chula Clock-Drawing Scoring System (CCSS)". This test demonstrated its satisfaction of sensitivity and specificity. The CCSS considered 5 domains consisting of the amount of digits, errors in the amount of digits in the worst quadrant, spatial arrangement and number sequencing, hand and placement of hands. The CCSS study assessed 669 Thai elderly aged 50 years or older in Romklao community, Bangkok. The present study has shown competency of CDT to detected dementia. Senanarong et al (2003)[8] developed Thai ADL scale that was adjusted by Thai cultures and demonstrated significant relationship between Neuropsychiatric Inventory (NPI) and Functional Assessment Questionnaire (FAQ). Thai ADL scale has shown high reliability and validity in the present study. From the recent review literature, Pinto and Peters (2009)[9] had reviewed the literature of the CDT as a tool for cognitive screening in Medline (1996-June 2008), Psychinfo (1967-June 2008) and EMBASE (1980-June 2008). A total 41 research papers were selected in the review. They considered each literature in the administration of the CDT, CDT scoring systems, Comparison studies of scoring methods, influence of language and level of education, and the CDT validity in screening very mild and questionable dementia. In the administration, They found that adding the predrawn circle, asking the patients for time setting and giving a copying command could help decrease error and detect early stages of dementia. The CDT had good correlation to MMSE and good inter-rater reliability in most studies. The language and education also influence the performance of CDT. They found that the CDT perform better in participants with a medium level of education. Most of the studies showed that CDT had higher sensitivity and specificity to detect moderate to severe dementia.

The CDT and Thai ADL scale are short and easy to use. The limitations of this study are small sample size, and subjects are urban dwelling only in Bangkok. Further research with larger sample size and using country wide subjects could be done in the future. The reliability of this combination test also should be explored. Nonetheless, the authors have succeeded in verification of effectiveness of utilizing both CDT and Thai ADL as dementia screening tools in Thai elders.

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**Potential conflicts of interest**

None.

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## Appendix

The Clock Drawing test [8-10] adapted from Sunderland et al (1989) and Wolf-Klein et al (1989) scoring systems.
A 10 point scoring system is as follows

| | |
|---|---|
| 10 | Normal, appropriated hands. |
| 9 | Almost normal except one missing number, slight errors in placement of hands. |
| 8 | Almost normal except one missing number, slight errors in placement of hands. |
| 7 | Very inappropriate spacing in number, placement of the hands significantly off course. |
| 6 | Inappropriate use of clock hands, perseveration of numbers or reversal of numbers. |
| 5 | Perseveration, inappropriate arrangement of numbers, numbers indicated by dots or lines, hand not appropriate. |
| 4 | Hands not clearly represented, numbers absent or in distorted sequence or written outside the clock. |
| 3 | Numbers and clock face no longer connected in drawing, hands not present. |
| 2 | Irrelevant spatial arrangement. |
| 1 | Irrelevant figures. |

## การใช้การวาดรูปหน้าปัดนาฬิกา Clock Drawing Test (CDT) และแบบสอบถามประเมิน Activity of daily living (ADL) เพื่อการตรวจคัดกรองอย่างง่าย สำหรับภาวะสมองเสื่อมในประชากรไทย

**จันจิรา สาธุกิจชัย, วรพรรณ เสนาณรงค์**

***วัตถุประสงค์:*** *เพื่อการศึกษาและพัฒนาเครื่องมืออย่างง่ายในการคัดกรองภาวะสมองเสื่อมในประชากรชาวไทย*

***วัสดุและวิธีการ:*** *กลุ่มตัวอย่างผู้สูงอายุ 182 คน ในชุมชนใกล้เคียงโรงพยาบาลศิริราช โดยได้รับการสัมภาษณ์ ประวัติ ทดสอบการวาดรูปหน้าปัดนาฬิกา Clock drawing test (CDT) และตอบแบบประเมินความสามารถในการประกอบตามกิจวัตรประจำวันของผู้สูงอายุ Thai Activities of Daily Living scale (Thai ADL) และแบบทดสอบสมรรถภาพการทำงานของสมองด้วย Thai Mini Mental State Examination (TMSE) จากพยาบาลที่ได้รับการฝึกพิเศษ โดยการตรวจร่างกายทั่วไป และระบบประสาทตรวจโดยแพทย์ระบบประสาท โดยการวินิจฉัยภาวะสมองเสื่อม อาศัยเกณฑ์ตาม DSM IV*

***ผลการศึกษา:*** *พบผู้สูงอายุที่มีภาวะสมองเสื่อมตามเกณฑ์การวินิจฉัย DSM IV จำนวน 67 ราย พบว่าในกลุ่มนี้ ถ้าใช้คะแนน CDT เท่ากับ 7 จะมีความไวของการวินิจฉัยอยู่ที่ 83.8% โดยมีความจำเพาะอยู่ที่ 65.2% และมีพื้นที่ใต้กราฟตาม ROC ที่ 0.825 เมื่อใช้แบบประเมินความสามารถในการประกอบตามกิจวัตรประจำวัตร ของผู้สูงอายุไทย โดยใช้คะแนนเท่ากับ 5 จะมีความไวในการวินิจฉัยอยู่ที่ 74.6% โดยที่ความจำเพาะอยู่ที่ 79.1% และมีพื้นที่ใต้กราฟตาม ROC ที่ 0.849 ค่าพื้นที่ใต้กราฟตาม ROC จะสูงขึ้นถึง 0.905 เมื่อใช้การทดสอบทั้ง 2 แบบรวมกัน*

***สรุป:*** *คือการใช้การทดสอบวาดรูปหน้าปัดนาฬิกา (CDT) และแบบประเมินความสามารถในการประกอบกิจวัตรประจำวันของผู้สูงอายุไทย Thai Activities of Daily Living scale (Thai ADL) พร้อมกันสามารถใช้ในการวินิจฉัยคัดกรองภาวะสมองเสื่อมได้ โดยมีความจำเพาะที่สูงกว่าการใช้การทดสอบอย่างใดอย่างหนึ่ง*