A study to validate the Rowland Universal Dementia Assessment Scale (RUDAS) in two populations outside the Sydney South West Area Health Service

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List of Abbreviations

95% CI	95% Confidence Interval
ABS	Australian Bureau of Statistics
ACAP	Aged Care Assessment Program
AUC	Area Under the Curve
CACP	Community Aged Care Packages
CALD	Culturally and Linguistically Diverse
CDAMS	Cognitive, Dementia and Memory Service
CDR	Clinical Dementia Rating
CI	Confidence Interval
CTS	Community Therapy Service
DSMIV - TR	Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) (Text Revision)
EACH	Extended Aged Care at Home Packages
GDS	Geriatric Depression Scale
GP	General Practitioner
GPCOG	General Practitioners Assessment of Cognition
IQR	Interquartile range
LIADL	Lawton Instrumental Activities of Daily Living
LR	Likelihood ratio
MBI	Modified Bathel Index
MMSE	Mini-Mental State Examination
OR	Odds ratio
RAH	Royal Adelaide Hospital
RMH	Royal Melbourne Hospital
ROC	Receiver Operating Characteristic
RUDAS	Rowland Universal Dementia Assessment Scale
r	Pearson r correlation co-efficient
r^2	Correlation co-efficient squared, % variance explained
SD	Standard deviation
SDAC	Survey of Disability, Ageing and Carers

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  - Falls and Balance Clinic and Community Therapy Service (Royal Melbourne Hospital–Royal Park Campus).

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Partner Organisations

Liverpool Hospital

The Liverpool Hospital has been operating continuously since the late eighteenth century and in 1989 became a principal teaching hospital of the University of N.S.W. Major redevelopment of the Hospital has taken place and Stage 1 has been completed to upgrade all services to a tertiary level. These services include Aged Care, Cardiology, Coronary Care, Drug & Alcohol, Emergency Genetics, Gynaecology, Intensive Care, Mental Health Services, Neonatology (New Born Care), Obstetrics, Orthopaedics, Paediatric Services, Pathology-Diagnostics, Allied Health, Public Health, Radiology, Renal Medicine (Nephrology), Sexual Assault Service, Sexually Transmitted Disease, General Surgery, Psychiatry, Outpatients. Stage 2 planning is nearing completion and the Liverpool hospital will double in size to have more than a 1,000 beds by 2010. Improvements will include extension of the Clinical Services Building, Cancer and Pathology services and new buildings for Women's and Child Health and Aged Care Services. There will also be a dedicated research building. The Department of Geriatric Medicine at Liverpool is responsible for inpatient care as well as a range of community based health services for older people. The research focus has been multidisciplinary, clinical based research into geriatric syndromes such as falls prevention and the management of cognitive impairment. Other areas of interest have included the management of the older person in the Emergency Department and inpatient setting, long term outcomes of service provision, liaison with general practitioners, improving end of life care and enhanced communication across the continuum of care.

National Ageing Research Institute

The National Ageing Research Institute (NARI) was established in 1994 as the successor to the National Research Institute for Gerontology and Geriatric Medicine (NRIGGM). NRIGGM was formed in 1977 as the result of an agreement between Mount Royal Hospital (now Royal Melbourne Hospital - Royal Park Campus), The University of Melbourne and the Government of Victoria. NARI/NRIGGM has been providing leadership in research, program implementation and training in the areas associated with improving health and quality of life for older people for nearly 30 years. NARI has developed as a centre of excellence in research on ageing, public health research, including health service evaluation, and the delivery of quality aged care education programs for health professionals and service providers.

Royal Melbourne Hospital – Royal Park Campus

Royal Melbourne Hospital – Royal Park Campus provides health care services predominantly to older people who live in the northern and western metropolitan regions of Melbourne. Royal Melbourne Hospital – Royal Park Campus aims to be a centre of excellence in the provision of aged care and rehabilitation services. There are around 150 in-patient beds at this campus, which are located in six wards, including three Geriatric Evaluation and

Management (GEM) wards, a rehabilitation ward (primarily amputee and neurological patients), an Aged Transitional Care Unit, and a complex residential care unit (caring for residents with acquired brain injuries). The Royal Park Campus acts as the base for Aged Care Assessment Services, a community rehabilitation centre, a day activities centre and Community Support Services. It has specialist medical outpatient clinics which deal with pain, falls and balance, memory, continence and wounds.

Royal Adelaide Hospital

Founded in 1840 and incorporated under the South Australian Health Commission Act, 1976, the Royal Adelaide Hospital (RAH) has three campuses (North Terrace, Hampstead Rehabilitation Centre and St Margarets). The RAH provides more than 848 inpatient beds as well as associated outpatient and outreach services. It also provides a specific range of tertiary referral services and a broad range of clinical services. The RAH is involved in numerous areas of medical and health research and is a major teaching hospital for the University of Adelaide. It is also closely affiliated with the Hanson Institute.

1.0 EXECUTIVE SUMMARY

Over recent years there has been a recognised need for new cognitive screening tools to be developed and validated that address identified limitations of existing tools. Limitations have included that tools appear to be influenced by factors such as education level, cultural background and language, and that some important aspects of cognitive function such as frontal lobe function are not assessed. The Rowland Universal Dementia Assessment Scale (RUDAS) was developed to address some of these limitations. Initial results published in 2004 reported high reliability and good prediction accuracy for the RUDAS. A subsequent study in 2006 indicated the RUDAS compared favourably with a commonly used existing screening tool (the Mini Mental State Examination - MMSE), and indicated that unlike the MMSE the RUDAS did not appear to be influenced by language, education or gender. The next stage of the validation required evaluation of the RUDAS in a region external to the initial studies (southwest Sydney). This stage also needed to incorporate a sample with a broad range of cognitive function, including those with mild cognitive impairment.

1.1 Method

Funding was provided by the Australian Government Department of Health and Ageing through Alzheimer's Australia to undertake the project. The National Ageing Research Institute coordinated recruitment in Melbourne, and the Royal Adelaide Hospital and Alzheimer's Australia SA coordinated recruitment in Adelaide. The primary aims of the project were to validate the RUDAS in other settings (Melbourne and Adelaide) and in a broader sample population that included those with mild/moderate cognitive impairment. A secondary aim of the project was to compare the RUDAS with two existing cognitive screening tools (the MMSE and the General Practitioners Assessment of Cognition – GPCOG) in its utility and ability to accurately predict cognitive impairment. Ethics Committee approval was obtained for the project.

One hundred and fifty one people met the study inclusion criteria and completed the assessment process. Participants completed a series of cognitive assessments and measures of function and depression, in addition to the RUDAS, MMSE and GPCOG.

1.2 Results

Using DSMIV-TR classification criteria, 40% of participants had normal cognition and 60% had some form of cognitive impairment. Based on the Cognitive Dementia Rating scale, 90% of participants with cognitive impairment were classified as having questionable or mild cognitive impairment. Participants had an average age of 77 years (SD 8.9), 70% were female, and 42% were from Culturally and Linguistically Diverse (CALD) backgrounds. Median [Inter-quartile Range] scores for the full sample on the RUDAS was 23 [18-27], the MMSE 25 [19-28] and the GPCOG (two stage

process) 7 [2-9]. All three cognitive screening tools were highly correlated (rho>0.78).

Accuracy of prediction of cognitive impairment against the gold standard of the DSMIV classification was high for the three screening tools, and there was no significant differences between the tools (RUDAS Area Under Curve – AUC 0.88, MMSE AUC 0.86, GPCOG AUC 0.90). The positive and negative likelihood ratios of each tool were also similar (RUDAS 7.3 and 0.3 respectively, MMSE 5.5 and 0.4 respectively, GPCOG 4.6 and 0.1 respectively). Multifactorial logistic regression identified that each of the three cognitive screening tools was a significant predictor of cognitive status (based on the DSMIV classification) after adjusting for other covariates. With RUDAS in the multifactorial model, age and GDS score were additional significant predictors of cognitive status. With MMSE in the multifactorial model, age, gender and GDS score were additional significant predictors of cognitive status. With GPCOG in the multifactorial model, age, gender and GDS score were once again found to be significant predictors of cognitive status. In relation to factors confounding the relationship between the cognitive screening tests and cognitive status, the MMSE and GPCOG were both influenced by confounding whereas the RUDAS was not influenced by substantial confounding. CALD status affected the MMSE score in predicting cognitive status and the GDS score affected the GPCOG score in predicting cognitive status.

1.3 Summary

Results from this study provide further evidence to support the use of the RUDAS in screening people for cognitive impairment. In terms of the primary aims of the project, the RUDAS was found to have high predictive accuracy in a broader population sample, that included other settings (Melbourne and Adelaide) and a range of cognitive function (including mild to moderate cognitive impairment). In terms of the secondary aim of the project, similar prediction accuracy between the RUDAS, MMSE and GPCOG was demonstrated. However, the RUDAS was not substantially affected (confounded) by other factors in predicting cognitive status, unlike the MMSE, where CALD status was a strong confounding factor, or the GPCOG, where GDS was a strong confounding factor. The RUDAS has some advantages in its broad application, in that it does not require presence of an informant (in contrast to the GPCOG), and it does not include items that have potential to cause difficulties for some people with lower education levels or CALD background (in contrast to the MMSE).

1B PLAIN LANGUAGE EXECUTIVE SUMMARY

Over recent years there has been a recognised need for new cognitive screening tools to be developed and validated that address identified limitations of existing tools. Limitations have included that tools appear to be influenced by factors such as education level, cultural background and language, and that some important aspects of cognitive function such as frontal lobe function are not assessed. The Rowland Universal Dementia Assessment Scale (RUDAS) was developed to address some of these limitations. Initial results published in 2004 reported high reliability and good prediction accuracy for the RUDAS. A subsequent study in 2006 indicated the RUDAS compared favourably with a commonly used screening tool (the Mini Mental State Examination - MMSE), and indicated that unlike the MMSE the RUDAS did not appear to be influenced by language, education or gender. This project, funded by the Australian Government Department of Health and Ageing through Alzheimer's Australia, involves a further stage of validation for the RUDAS.

1B.1 Method

The National Ageing Research Institute coordinated recruitment in Melbourne, and the Royal Adelaide Hospital and Alzheimer's Australia SA coordinated recruitment in Adelaide.

The primary aim of the project was to validate the RUDAS in regions external to the initial studies (southwest Sydney) and in a broader sample population that included those with mild/moderate cognitive impairment (as earlier studies had samples with a high proportion of people with more severe cognitive impairment). A secondary aim was to compare the RUDAS with two existing cognitive screening tools (the MMSE and the General Practitioners Assessment of Cognition – GPCOG) in its utility and ability to accurately predict cognitive impairment. Ethics Committee approval was obtained for the project.

One hundred and fifty one people met the study inclusion criteria and completed the assessment process. Participants completed a series of cognitive assessments and measures of function and depression, in addition to the RUDAS, MMSE and GPCOG.

1B.2 Results

Participants had an average age of 77 years, 70% were female, and 42% were from Culturally and Linguistically Diverse (CALD) backgrounds. Forty percent of participants had normal cognition and 60% had some form of cognitive impairment. Based on the Cognitive Dementia Rating scale, 90% of participants with cognitive impairment were classified as having questionable or mild cognitive impairment. Average scores for the full sample on the RUDAS was 23, the MMSE 25, and the GPCOG (two stage process) 7. All three cognitive screening tools were highly correlated.

All three screening tools demonstrated a high level of accuracy in prediction of cognitive impairment against the gold standard classification (DSMIV –TR criteria), and there was no significant differences between the tools. In analyses exploring the influence of a number of potential factors on the association between scores on the various tools and prediction of cognitive impairment, CALD status was shown to affect the MMSE score, and the participant's depression score was shown to affect the GPCOG score.

1B.3 Summary

Results from this study provide further evidence to support the use of the RUDAS in screening people for cognitive impairment. In terms of the primary aims of the project, the RUDAS was found to have high predictive accuracy in a broader population sample, that included other settings (Melbourne and Adelaide) and a range of cognitive function (including mild to moderate cognitive impairment). In terms of the secondary aim of the project, similar prediction accuracy between the RUDAS, MMSE and GPCOG was demonstrated. However, the RUDAS was not substantially affected (confounded) by other factors in predicting cognitive status, whereas the MMSE and GPCOG were both influenced by other factors. The RUDAS has some advantages in its broad application, in that it does not require presence of an informant (in contrast to the GPCOG), and it does not include items that have potential to cause difficulties for some people with lower education levels or CALD background (in contrast to the MMSE).

2.0 INTRODUCTION

The Australian population is rapidly ageing. Dementia disproportionately affects the oldest age groups, causes considerable morbidity to patients and carers, and generates large health-care costs. As treatment options for dementia evolve, the accurate and early detection of dementia will become even more important.

Older persons from culturally and linguistically diverse (CALD) backgrounds are particularly vulnerable to the difficulties associated with early and accurate diagnosis of dementia (Davis et al., 1996). It is suspected that people from CALD backgrounds are more likely to be diagnosed later on in the process of the illness or to be misdiagnosed due to a number of factors. Some of these factors include communication difficulties, cultural misunderstandings and culturally inappropriate tools (Black et al., 2001).

At a national level in 1996, 17.8% of the Australian population were born overseas in a country that is culturally diverse and where English is not the main spoken language. This figure is projected to increase to 21.2% in 2026 (Australian Institute of Health and Welfare, 2001). This is an important and growing portion of the Australian population. In addition, approximately 12.4% of Australians with dementia do not speak English at home (Access Economics; 2006).

To be widely applicable, neuropsychological tests must be responsive to cultural and linguistic diversity, education, literacy and degree of acculturation (the exchange of cultural features which result when groups come into continuous direct contact). This is important to ensure that treatments, such as new medications, psychological interventions and support services, are targeted to those most in need in a timely manner.

Currently, one of the most widely used cognitive screening tests is the Folstein Mini-Mental State Examination (MMSE), which has been in use for almost 30 years. It is recommended by the American Academy of Neurology and others for early detection of dementia (Petersen et al., 2001), and in Australia is commonly used to determine eligibility for subsidised medication for Alzheimer's disease. The MMSE was developed in an English-speaking population, with versions in other languages mostly using direct translation rather than culturally specific adaptation. However, phrases such as "no ifs, ands or buts" are not easily translated, and items such as "spell WORLD backwards" and "serial 7s" may be less relevant to people from some cultures. MMSE scores are influenced by age, education, ethnicity and language of the interview (Escobar et al., 1986). Many older persons from culturally and linguistically diverse countries have low levels of education and speak little English, and therefore decisions based on the MMSE may be misleading. Furthermore, the MMSE is limited in its detection of frontal lobe impairment (Royall et al., 1994; Slachevsky et al., 2004).

A more recently developed screening test for dementia, designed for general practice, is the General Practitioner Assessment of Cognition (GPCOG). It consists of cognitive test items and historical questions asked of an informant, and compares favourably with the MMSE (Brodaty et al., 2002). Unlike the RUDAS, however, the need for an informant may be a limitation of the tool for those patients who do not have a carer/informant.

The RUDAS has been developed to address some of these limitations of existing cognitive screening tools such as the MMSE and GPCOG. It does not appear to be influenced by language or education, and earlier work suggests that all items can be directly translated to other languages, without the need to change the structure or the format of any item. Several items address frontal lobe impairment, and the diverse response formats allow more comprehensive assessment of overall cognition (Storey et al., 2004).

Some of the potential benefits of the RUDAS include:

1. Improved equity in health-care for CALD persons through targeted screening and earlier and more accurate identification of dementia;
2. Improved general practitioner's ability to diagnose dementia, begin appropriate assessment and referral, monitor the progress of the disease and provide ongoing management. Early detection of dementia will benefit those with cerebrovascular disease, for which there are effective treatments, as well as those with reversible conditions causing cognitive impairment. In addition, most drugs recommended for Alzheimer's disease are most useful during the mild to moderate stages of the disease;
3. Improved access to support services and treatment, including eligibility for subsidised medication through earlier identification of dementia. This should help both the client and carer and may prevent or delay institutional care;
4. Identification of frontal lobe dysfunction, unlike the widely used MMSE which is often normal in subjects with dementia predominantly affecting the frontal lobes;
5. Provides an objective measure of cognitive status that does not rely on history from an informant. A moderate proportion of persons with dementia do not have a carer/informant[1] (AIHW; 2006);
6. The RUDAS is also easy to administer (only 10 minutes), requires minimal training to administer (40 minutes) and is easily translated into over 30 different languages; and
7. The RUDAS also appears to be less confronting to recipients.

1. Based on ABS 2003 Survey of Disability, Ageing and Carers (SDAC) data for clients of ACAP (Aged Care Assessment Program), CACP (Community Aged Care Packages) and EACH (Extended Aged Care at Home Packages) programs who had dementia and were living in households (not residential care), on average 13.5% did not have a carer (ACAP =12%, CACP=26.2% and EACH = 3.3%). The 2003 SDAC data however tends to identify those with severe and profound disability.

3.0 BACKGROUND

The Rowland Universal Dementia Assessment Scale was developed and validated in the southwest of Sydney by a team at the Liverpool Hospital. The original study by Storey et al (2004) involved three stages - the developmental stage, the clinical testing of the 42 'culturally fair' cognitive items developed, and the assessment of the predictive accuracy of the final 6 item RUDAS. In the predictive accuracy stage, involving a sample of 90 community dwelling older people, the RUDAS was found to:

- assess multiple cognitive domains, including frontal lobe impairment;
- have high inter-rater (0.99) and test/retest (0.98) reliability;
- have high sensitivity (89%) and high specificity (98%) and the area under the Receiver Operating Characteristic (ROC) curve was 0.94 (95% CI 0.87 – 0.98); and
- not be influenced by gender, years of education, differential performance factors and preferred language.

In a follow-up study by Rowland et al (2006), involving 129 community dwelling persons randomly selected from a database of referrals to an aged-care team, the RUDAS was compared to the Folstein Mini-Mental State Examination (MMSE). The authors found that the RUDAS was at least as accurate as the MMSE in diagnosing dementia. The area under the ROC curve (AUC) for the RUDAS was 0.92 (95% CI 0.85-0.96) and 0.91 (95% CI 0.84-0.95) for the MMSE. Published cut points were used for each instrument (RUDAS <23/30; MMSE <25/30). The positive and negative likelihood ratios for the RUDAS were 19.4 and 0.2 respectively compared to 2.1 and 0.14 for the MMSE. The high positive likelihood ratio for the RUDAS makes it particularly useful for ruling-in disease. That is, at the recommended cut point (<23), there is a strong likelihood that cognitive impairment is in fact present. This study also reconfirmed that the RUDAS does not appear to be influenced by language, education or gender.

One considerable limitation with both studies is that the samples were over-represented with patients with moderate to severe dementia.

Results from these studies provide preliminary evidence to suggest that the RUDAS is not influenced by factors such as language, ethnicity and education, and as such it may be better than other screening instruments currently used to diagnose dementia. Further investigation is required in other populations that are more typical of the Australian population and external to the southwest Sydney area where the RUDAS was developed.

4.0 METHODOLOGY

4.1 Project rationale and aims

The rationale and primary aims for this current study were to validate the RUDAS:

(a) in populations other than that in which it was developed (that is, the South Western Sydney Area Health Service, now part of the Sydney South West Area Health Service), and

(b) in people with mild to moderate dementia. The original study was over-represented (71%) with patients with moderate to severe dementia (Storey et al, 2003).

The secondary aim of the current study was to compare the RUDAS with two existing instruments for the assessment of cognition – the Folstein Mini-Mental State Examination (MMSE) and the General Practitioners Assessment of Cognition (GPCOG) in its utility and ability to accurately predict cognitive impairment.

4.2 Multicultural populations

Given the potential utility of the RUDAS for older people of Culturally and Linguistically Diverse backgrounds, the study was planned to be conducted in two areas outside of NSW that incorporated a broad mix of cultural backgrounds. The areas targeted for recruitment were the northern / western areas of Melbourne (in the catchment of Royal Melbourne Hospital - Royal Park Campus and Sunshine Hospital), and the northern / eastern suburbs in Adelaide. In Adelaide, some additional subjects were recruited at a dementia respite program in the inner western suburbs.

4.3 Participants

The project aimed to recruit 150 participants across the Melbourne and Adelaide sites (see sample size / power calculations section). In order to incorporate a broad sample of cognitive levels, it was planned to recruit two-thirds of the sample from Memory Clinics, and one third of the sample from other out-patient services (anticipating that the majority of this latter sub-group would not have overt cognitive impairment).

Within the context of busy out-patient settings, the study aimed to recruit consecutive presenting patients to the participating services, providing they met the inclusion and exclusion criteria, and they or their next of kin / guardian consented to participation in the project.

Inclusion criteria were:

(1) Presenting to one of the participating Memory Clinics, Falls and Balance Clinic, or other similar out-patient service; and

(2) Consenting to participate in the project.

Exclusion criteria were:

(1) Severe visual impairment;

(2) Severe hearing impairment;

(3) Physical impairment that was likely to preclude tasks such as the fist-palm alternation task and cube copying (two of the 6 RUDAS items); and /or
(4) An acute decline in brain function in the week before assessment.

4.4 Sample size / power calculations

The required sample size was calculated in three ways to determine the overall number of participants required. The primary method was based on the 95% confidence interval (95% CI) on each side of the point estimate of a proportion. With this method, the 95% CI was equated to the required value and the equation solved for sample size. Apriori, it was considered that a high sensitivity would be more important than a high specificity when validating an instrument to be used for targeted screening. The equations and table showing the minimum sample sizes for several 95% CI and sensitivity options were calculated but are not included in this report. In the initial Liverpool study, the sensitivity of the RUDAS was 89%, but almost 80% of subjects with dementia had moderate or severe dementia. With a 95% CI of 5%, 140 subjects would be needed in this current study if the sensitivity proved to be similar. However, the sensitivity is likely to be lower as more subjects will have mild disease. The other two methods (one based on the 95% CI around a correlation coefficient; and the other based on the standard error (SE) for a given area under a ROC [receiver operating characteristic] curve [AUC]) both indicated that a sample of 150 should be sufficient for the planned project.

4.5 Ethics approval

Ethics approval was obtained prior to the commencement of this study in both Melbourne and Adelaide. In Melbourne ethics approval was obtained from the Mental Health Research and Ethics Committee of the Melbourne Health Research Directorate. In Adelaide approval was obtained from the Research Ethics Committee, Royal Adelaide Hospital.

4.6 Recruitment and assessment process

New patients at the participating CDAMS and Memory Clinics underwent their routine clinical assessments with the clinic staff, which included a range of the study measures. At the end of their clinic assessment, the clinic medical staff briefly described the study and what it would involve (ie – a series of additional assessments to be performed by the research team either at the clinic, the person's home or other suitable location, at a convenient time). Interested participants were introduced to the research officer or their contact details were forwarded to the research officer for follow-up.

In Melbourne, at the participating "control" clinics (eg Falls and Balance Clinic), patients who were deemed to have no cognitive impairment were approached by clinic staff who briefly described the study and what it would involve. The patient / carer was then asked whether they were interested in being involved in the study and whether the research officer could contact them to organise a home visit. Contact details were provided to the research staff on an expression of interest form. Generally, patients conducted half of the assessments with the research officer at a home visit and a time was organised for the additional assessments to be conducted by the project geriatrician at the clinic, research facility or other suitable location. Five

control patients completed the geriatrician component of the study with the Falls and Balance Clinic geriatrician (who also works at the Sunshine Hospital CDAMS).

In Adelaide, in the participating "control" clinic (Day Rehabilitation Centre, Hampstead Centre), participants were recruited and written consent obtained. Participants were then assessed by the research officer and geriatrics registrar.

To help boost recruitment numbers in Adelaide, participants (with normal and impaired cognition) were also recruited from various day respite programs, community groups and Alzheimer's carer groups with the help of Alzheimer's Australia (SA). Consent and all assessments were conducted on site by the research officer and geriatrics registrar.

An interpreter was organised for all patients who did not speak English or whose preferred language was not English. Some patients from CALD backgrounds chose to conduct the assessment in English. Written consent to participate in the study was obtained prior to assessment.

4.7 Measurements

Data collected included:

- Routine demographic data;
- Dementia diagnosis and severity (using DSMIV-TR criteria and the Clinical Dementia Rating [CDR] scale) (American Psychiatric Association, 1994; Morris JC, 1993);
- Measures of function (Modified Barthel Index [MBI] and Lawton Instrumental Activities of Daily Living scale [LIADL]) (Wade & Collin, 1998, Lawton & Brody, 1969);
- Measure of depression (15-point Geriatric Depression Scale [GDS]) (Yesavage et al, 1983, D'Ath et al, 1994);
- Cognitive screening instruments:
    - the RUDAS (Storey et al., 2004);
    - the Folstein Mini-Mental State Examination (MMSE) (Folstein et al., 1975); and
    - the GPCOG (Brodaty et al., 2002).
- Checklist of other factors that may impact on test performance (vision, hearing, musculoskeletal, neurological, psychiatric, depression, delirium, dysarthia, dysphasia, medication, fatigue and other).

Copies of the RUDAS, MMSE, GPCOG, CDR, the MBI, LIADL and GDS are included in the Appendix.

In all cases the RUDAS was conducted by the research officer independent of the other main cognitive assessments (ie, the Mini-Mental State Examination, the Clinical Dementia Rating, and the GPCOG patient section) which were

performed by the clinic/project geriatrician. At no stage were clinic staff or the project geriatrician aware of the patient's performance on the RUDAS.

4.8 Statistical analyses

Descriptive statistics were used to report the distribution characteristics of participant profile and outcome measures. Mean and standard deviation were calculated for interval or ratio data with normal distribution. For other variables, the median and interquartile range were calculated.

Sub-group analysis comparing subjects grouped by cognitive impairment or CALD background were conducted using t-tests for continuous, normally distributed variables, chi squared tests for dichotomous variables, and Mann-Whitney U test for ordinal variables or non-normally distributed interval or ratio variables. Sub-group analysis based on severity of cognitive impairment (mild vs moderate) was not possible given the small number of subjects who had moderate/severe cognitive impairment (n=9).

Receiver Operating Characteristic (ROC) analysis were used to measure the accuracy of the RUDAS, the GPCOG, and the MMSE for dementia diagnosis, using the DSMIV-TR as the gold standard. Both the areas under the curves (AUC) and the 95% confidence intervals were calculated. Bivariate statistical analysis was used to compare the AUC for each instrument for any statistically significant difference.

The sensitivity and specificity of each of the above instruments for dementia diagnosis were also calculated.

Positive and negative likelihood ratios were calculated for each instrument.

Correlations between the instrument scores were measured using the Spearman correlation coefficient.

To further assess the relationship between the cognitive screening tools and cognitive status univariate and multifactorial logistic regression was undertaken to assess the effects of possible covariates. The covariates considered were age, gender, years of education, performance factors, GDS score, CALD status, marital status and reading/writing status. Firstly the cognitive screening tools and numerically valued covariates were assessed for a linear association with the log odds of cognitive status by using the likelihood ratio test to compare models with a linear and categorical representation of the exposure variables. Numerically valued variables found to have a linear association were entered into the logistic equation as continuously valued (numeric) variables. Dichotomous variables were entered into the logistic regression unaltered. Univariate logistic regression was initially performed to find the cognitive screening tools and covariates associated with dementia diagnosis. Following the univariate analysis multifactorial modelling was performed. The covariates of age, gender and CALD status were entered into the model as *a priori* risk factors/confounders. The covariates of GDS score, performance factors, years of education, marital status and reading/writing status were considered potential risk

factors/confounders. Significant association was judged using the likelihood ratio test (p=0.05). Confounding was judged to be present when there was approximately 20% change in the coefficient for the cognitive screening tests.

SPSS statistical analysis software package was used for all data analysis except multivariate logistic regression. The software package used for logistic regression was STATA.

4.9 Cognitive diagnoses and instrument cut points

The DSMIV-TR criteria (American Psychiatric Association, 1994) was used to assign cognitive diagnosis. Each patient was classified as:

- normal,
- cognitively impaired but not demented (includes those with age related cognitive decline), or
- having dementia.

Although there is no gold standard for dementia diagnosis per se, decisions based on the DSMIV-TR criteria have the advantage of broad acceptance and good reproducibility (Balderschi et al., 1994; O'Connor et al., 1996).

Based on the previous study by Rowland et al (2006), including those with mild cognitive impairment (MCI) [DSMIV classification cognitive disorder not otherwise specified (NOS)] in the group with dementia or the normal group made no quantitative difference to the results. In this report results are primarily presented with participants with any form of cognitive impairment (any form of dementia or other cognitive disorder NOS) grouped together and compared to those with normal cognition. This is more representative of practice, where any form of cognitive impairment would be further investigated and monitored. However some comparative analysis has been included where those with a cognitive disorder NOS have been grouped with those with normal cognition or excluded all together.

Using **recommended** cut points for each of the three instruments – RUDAS, MMSE & GPCOG - the diagnostic accuracy of each instrument was compared to the DSM-IV TR criteria classification.

For the RUDAS (see Appendix 9.1), Storey et al (2004) recommend a cut point of 22 or less to indicate cognitive impairment.

For the MMSE (see Appendix 9.2), a comprehensive review by Tombaugh and McIntyre (1992) recommended a cut point of 23 or less to indicate cognitive impairment. [The review also recommended that for question 4, both subtracting by 7s backwards (serial 7s) and spelling World backwards should be administered (rather than one or the other) and that the higher of the two scores should be used.]

The GPCOG (see Appendix 9.3) consists of two sections – a patient section (9 questions totalling 9 points) and an informant section (6 items totalling 6 points). Brodaty et al (2002) recommend a two stage scoring method. If a patient scores 4 or less in the patient section, this indicates cognitive impairment. If a patient scores 9 (all patient questions are correct) this

indicates no cognitive impairment. However, if the patient score is between 5 and 8, the informant score needs to be considered. If the informant score is 3 or less ('no' responses) this indicates cognitive impairment, if the informant score is 4 or more, this indicates no impairment.

Calculations were also undertaken to determine the **optimal** cut point for the RUDAS.

5.0 RESULTS

5.1 Overall subject characteristics

One hundred and sixty two people were recruited to the study. Of these, nine (6%) withdrew from the project after providing consent to participate (eight participants due to concurrent health problems or behavioural issues, and one who declined further involvement with the assessing CDAMS clinic). Another two (1%) participants were excluded in the final analysis. These two exclusions were due to:

- a substantial proportion of the key measures, including the DSMIV diagnosis, was missing for one participant, and
- a second participant, although assessed, met one of the exclusion criteria – acute decline in brain function due a general medical condition that had not been resolved and a final conclusive diagnosis was not possible within the project timelines.

A total of 151 participants were included in the final analysis.

Based on the DSMIV-TR criteria classification, 58 participants (38%) had some form of dementia and thirty three (22%) had a cognitive disorder not otherwise specified (mild cognitive impairment but not dementia). Sixty (40%) participants had normal cognition, although three of these participants had an affective/depressive disorder and one a generalised anxiety disorder. The main set of analyses described below have been undertaken combining those with some form of dementia and those with a cognitive disorder not otherwise specified (NOS) into one group (cognitive impairment).

5.2 Comparison of cognitive impairment versus normal cognition groups

Based on the DSMIV (gold standard) classification, ninety one (60%) participants were diagnosed with some form of cognitive impairment. This included participants with any form of dementia or other cognitive disorder not otherwise specified (mild cognitive impairment but not dementia). Sixty (40%) participants had normal cognition, although three of these participants had an affective/depressive disorder and one a generalised anxiety disorder.

Of those who were diagnosed (DSMIV) with some form of cognitive impairment (n=91, 60%) based on the Cognitive Dementia Rating (CDR) scale, 90% had questionable (49%) or mild (41%) cognitive impairment. Eight percent (8%; n=7) had moderate cognitive impairment and only 2% (n=2) of participants had severe cognitive impairment. Of those who were diagnosed as having normal cognition (DSMIV) (n=60, 40%), 20% were rated as having questionable cognitive impairment on the CDR and 80% were rated as having no cognitive impairment.

Table 1 details the demographic profile of the participants with and without cognitive impairment (based on the DSMIV). There were a number of significant differences between the two groups. Participants with cognitive impairment were significantly older (mean age 80 compared to 73) and most had a resident or non-resident carer (79% compared to 32%). A significantly larger proportion of participants with cognitive impairment also had an informant present during their assessment (82% compared to 23%). A significantly larger percentage of participants diagnosed with normal cognition were female (80% compared to 63%) and most did not require/have a carer (68% compared to 20%). Carer assistance for the group without cognitive impairment was generally required due to physical impairments.

Table 2 provides a detailed breakdown of participants' country of birth, preferred language and whether an interpreter was used. Years in Australia is also reported for those born overseas. A CALD participant is defined as someone who was born overseas and/or English is not their preferred language. There was a non-significant trend evident that a higher proportion of participants with cognitive impairment had a CALD background compared to those with normal cognition ($p=0.068$). However, there was a significant difference ($p=0.025$) between groups in terms of English being the preferred language of the participant. A significantly higher proportion of participants whose preferred language was English had normal cognition. (This also included two participants who were born overseas and identified themselves with a particular ethnic group and spoke a language other than English more fluently, yet they stated their preferred language in Australia was English.) CALD status is explored further in Section 5.5.5. The CALD participants in this study predominately came from Europe, the majority from Italy and Greece. Most of the participants born overseas have lived in Australia for over 30 years (mean: 42 years). There was no significant difference between the two groups in the number of years lived in Australia.

Table 1: Participant general characteristics by cognitive diagnosis (DSMIV-TR classification)

Characteristics	*Participants diagnosed with cognitive impairment (n=91)*	*Participants diagnosed with normal cognition (n =60)*	*All participants (n=151)*
Age mean (SD)	80 (7.1)	73 (9.5)*	77 (8.9)
Age range	60 - 97	46 - 90	46 - 97
Gender (%)			
• Female	63%	80%*	70%
• Male	37%	20%	30%
CALD background (%)	48%	33%	42%
Years of education (Mean; SD)	7 (3.7)	9 (4.7)*	8 (4.2)+
Marital status (%)			
• Married	44%	48%	46%
• Widowed	47%	35%	42%
• Other#	9%	17%	12%
Living arrangements (%)			
• Alone	30%	38%	33%
• With family	60%	57%	59%
• Other✈	9%	5% (n=3)	7%
• Missing data	1%	0%	1%
Principal carer (%)			
• No carer required / available	20%	68%*	39%
• Resident carer	53%	22%	40%
• Non-resident carer	26%	10%	20%
• Missing data	1%	0%	1%
Informant present:			
• Yes	82%	23%*	59%
• Contacted by phone	9%	19%	13%
• No	9%	58%	28%
Informant relationship	(n=83)	(n=25)	(n=108)
• Son/daughter	42%	56%	45%
• Spouse	23%	28%	24%
• Other family member ☆	18%	8%	16%
• Other ^	17%	4%	14%
• Missing data	0%	4%	1%
How long informants have known participant Mean (SD) [n]	48 (14.2) [n=47]	45 (13.0) [n=21]	48 (13.8) [n=68]
Melbourne data only▲			

* p<0.05 + Years of education: missing data (n=11) # Other marital status includes: single (n=4), separated (n=6), divorced (n=8) ✈ Other living arrangements include: with non-relative (n=3); hostel (n=4); other (including boarding house, retirement village etc) (n=4) ☆ Other family members included: having more than one family member present (n= 10), daughter in law (n=9), grandson, niece/s (n=2), nephew, sibling. ^ Other informant included: residential care staff (n=2), respite program staff (n=12) and a friend ▲ How long informant had known the participant was not recorded in Adelaide.

Table 2: Further participant CALD details by cognitive diagnosis (DSMIV-TR classification)

Characteristics	*Participants diagnosed with cognitive impairment (n=91)*	*Participants diagnosed with normal cognition (n=60)*	*All participants (n=151)*
CALD background (%)	44 (48%)	20 (33%)	64 (42%)
Preferred language #			
• English	47 (52%)	42 (70%)*	89 (59%)
• Italian	18 (20%)	5 (8%)	23 (15%)
• Greek	14 (15%)	11 (18%)	25 (17%)
• German	2 (2%)	1 (2%)	3 (2%)
• Arabic	2 (2%)	- (0%)	2 (1%)
• Other⍋	8 (9%)	1 (2%)	9 (6%)
Country of Birth			
• Australia	38 (42%)	32 (53%)	70 (46%)
• Italy	19 (21%)	6 (10%)	25 (17%)
• Greece	14 (15%)	9 (15%)	23 (15%)
• United Kingdom	9 (10%)	5 (8%)	14 (9%)
• Lebanon	2 (2%)	- (0%)	2 (1.3%)
• Egypt	2 (2%)	- (0%)	2 (1.3%)
• Germany	1 (1%)	1 (2%)	2 (1.3%)
• Other✈	6 (7%)	5 (12%)	13 (9%)
Interpreter used	35 (38%)	14 (23%)	49 (32%)
Years in Australia (for those born overseas) Mean (SD) [n]	42 (13.3) [n=45]	43 (8.6) [n=27]	42 (11.7) ♟ [n=72]

Note: significance levels calculated for CALD background, preferred language (English vs other) and Years in Australia only.

* $p<0.05$ (chi squared analysis, data grouped to include >5 participants in each cell)

+ $p<0.05$ (independent group t-test analysis)

= English vs other language (including multilingual) $p = 0.025$.

⍋ Other preferred languages included: Spanish and a number of multi-lingual (n=8) participants.

✈ Other Country of Birth included: Poland, Turkey, Bulgaria, Chile, Romania, Sri Lanka, USA, Ukraine, Netherlands, Austria, Canada, Serbia/Montenegro, Zimbabwe.

Note: 5 CALD people were born in another country different to their preferred language. For example two Greek speaking participants were not born in Greece.

♟ Years in Australia = 9 missing data.

Table 3: Participant educational details by cognitive diagnosis (DSMIV-TR classification)

Characteristics	*Participants diagnosed with cognitive impairment (n=91)*	*Participants diagnosed with normal cognition (n =60)*	*All participants (n=151)*
Type of Education n (%): #			
Primary:	41 (45%)✈	17 (28%)*	58 (38%)
Lower secondary:	26 (28%)	21 (35%)	47 (31%)
Upper secondary	6 (7%)	9 (15%)	15 (10%)
Tertiary	8 (9%)	11 (18%)	19 (13%)
No education	4 (4%)	2 (4%)	6 (4%)
Missing data	6 (7%)	- (0%)	6 (4%)
Years of Education n (%):			
0 –3 months✈	5 (5%)	2 (3%)	7 (5%)
1-3	6 (7%)	4 (7%)	10 (7%)
4-6	22 (24%)	11 (18%)	33 (22%)
7-9	31 (34%)	18 (30%)	49 (32%)
10-12	11 (12%)	13 (22%)	24 (16%)
13 or more	6 (7%)	11 (18%)	17 (11%)
Missing data	10 (11%)	1 (2%)	11 (7%)
Years of Education:			
Mean (SD)	7 (3.7)	9 (4.7)*	8 (4.2)
Age left school: +			
Mean (SD)	13 (4.4)	14 (5.2)	14 (4.7)
Able to read/write in preferred language n (%):			
Yes	81 (89%)	58 (97%)	139 (92%)
No, previously was able	5 (6%)	- (0%)	5 (3%)
No, was never able (illiterate)	4 (4%)	2 (3%)	6 (4%)
Missing data	1 (1%)	- (0%)	1 (1%)

Type of education (categorised into primary schooling or no formal education and secondary or above, n=145) p = 0.011.
* p<0.05 (chi squared analysis, data grouped to include >5 participants in each cell)
✈ One participant had only 3 months of primary schooling. Year of Education: Missing data for 10 with cognitive impairment and 1 with normal cognition.
+ Age left school: Missing data for 12 with cognitive impairment and 4 without cognitive impairment. Also one additional control participant had returned to school as an adult student and completed a number of post graduate qualifications, completing her education at the age of 73. As this represents more than 2 standard deviations from the mean, this outlier was excluded in the analysis of age left school.

Table 4: Participants functional and cognitive characteristics by cognitive diagnosis (DSMIV-TR classification).

Characteristics	***Participants diagnosed with cognitive impairment (n=91)***	***Participants diagnosed with normal cognition (n=60)***	***All participants (n = 151)***
GDS score of 5 or more (yes/no)	28 (31%)	23 (38%)	51 (34%)
GDS Score (median, IQR)	3 (1-6)	3 (1-7)	3 (1-6)
MBI Score (median, IQR)	20 (17-20)	20 (19-20)*	20 (18-20)
Lawton IADL Score (median, IQR)	4 (2-7)	8 (6-8)*	6 (3-8)
Has one or more factors potentially affecting performance (yes/no) (%)	33%	22%	28%
Factors include: Vision	3 (3%)	1 (2%)	4 (3%)
Hearing	17 (19%)	3 (5%)	20 (13%)
Musculoskeletal	3 (3%)	3 (5%)	6 (4%)
Neurological	5 (6%)	2 (3%)	7 (5%)
Psychiatric	2 (2%)	1 (2%)	3 (2%)
Depression	4 (4%)	4 (7%)	8 (5%)
Delirium	- (0%)	- (0%)	- (0%)
Dysarthia	2 (2%)	2 (3%)	4 (3%)
Dysphasia	2 (2%)	1 (2%)	3 (2%)
Medication	1 (1%)	1 (2%)	2 (1%)
Fatigue	2 (2%)	- (0%)	2 (1%)
Other#	6 (7%)	- (0%)	6 (4%)
RUDAS (median, IQR)	20 (15 – 23)	27 (25 – 28)*	23 (18 – 27)
MMSE (median, IQR)	21 (16 - 25)	29 (27-30)*	25 (19 - 28)
GPCOG patient score (median, IQR) [n]	3 (1 - 6) [n=87]	8 (7 – 9)* [n=58]	6 (2 – 8) [n=137]
GPCOG informants score (median, IQR) [n]	1 (0 - 2) [n=79]	4 (3 – 6)* [n=53]	2.5 (1 – 4) [n=132]
GPCOG Total score (median, IQR) [n=]	5 (2 - 8) [n=79]	12 (10.5 – 14)* [n=53]	8 (3.25 - 12) [n=132
GPCOG modified score based on 2 stage process✈ [n]	3 (1 – 6) [n=84]	9 (9 –9)* [n=56]	7 (2 –9) [n=140]

* p<0.05 (Mann-Whitney U test) ** p<0.05 (Chi squared analysis) GDS: 3 missing scores for those with cognitive impairment and 1 with normal cognition. The medical factors affecting performance listed above were identified by the clinic/project medical staff. # Other factors included: extremely hot room, being upset over a sick dog; grieving about a recent bereavement; interpreter issues, anxiety, illiteracy. ✈ See page 21 explaining how this single score based on the two stage method was derived.

Table 3 describes the type and years of education participants completed, and the age participants left school. Most participants (with and without cognitive impairment) had completed either primary or lower secondary education. There were significant differences in the number of years and type of education completed by the two groups. The median years of education completed for those with normal cognition was 9 compared to 7 for those with some form of cognitive impairment. A significantly higher proportion of participants with normal cognition (68%) had secondary schooling or above compared to those with cognitive impairment (44%). Most participants (92%) were able to read and write. Five participants with cognitive impairment were previously able to read/write but are not able to now. Four participants with cognitive impairment and three with normal cognition were never able to read/write (illiterate).

Age and years of education remained as significant differences between groups when those with a cognitive disorder NOS were included with those with normal cognition or when they were excluded altogether (dementia vs normal). Under these two scenarios CALD status was also a significant difference between the groups. That is, a significantly larger proportion of participants with dementia had a CALD background compared to those who did not (normal cognition only or normal cognition and cognitive disorder NOS combined). Gender only remained significant when those with a cognitive disorder NOS were excluded altogether. That is, there were significantly more females in the group with normal cognition compared to those with dementia (see Appendix 9.8 and 9.10).

Table 4 details the functional and cognitive characteristics of the two groups – those with and those without cognitive impairment. As expected, the group diagnosed with cognitive impairment had significantly lower scores for all three cognitive instruments (RUDAS, MMSE,GPCOG). Performance on all instrument scores (RUDAS, MMSE & GPCOG) remained a significant difference between groups regardless of whether cognitive disorder NOS was included with those with dementia, those with normal cognition or excluded all together (see Appendix 9.9 and 9.11).

Although the median score for the Modified Barthel Index (MBI), which includes more basic activities of daily living (grooming, feeding, mobilising etc) were similar for the two groups, statistically there was a significant difference between the two groups ($p=0.015$). Those with cognitive impairment had lower scores on the MBI. For the more complex activities of daily living, the Lawton Instrumental Activities of Daily Living (managing finances, self medication, housekeeping, shopping etc), once again demonstrated that the group with cognitive impairment had significantly lower scores (median score of 4 compared to 8). A larger proportion of this group also had one or more factor (vision, hearing etc) that could have impacted on performance (33% compared to 22%), but this was not statistically significant. There was no significant difference in GDS scores between the two groups or in the proportion who scored 5 or more on the GDS (indicating the presence of depressive symptoms). Differences on the MBI and Lawton remained

significant regardless of whether cognitive disorder NOS was included with those with dementia, those with normal cognition or excluded all together (see Appendix 8.8 and 8.10). GDS scores and factors affecting performance were not significantly different under any of the three scenarios ($p>0.05$).

5.3 Correlations between instruments

Correlations between the instrument scores were calculated using the Spearman correlation coefficient. The correlation between the RUDAS and MMSE was 0.777, between the RUDAS and GPCOG (2 stage score) it was 0.794, and between the MMSE and the GPCOG (2 stage score) it was 0.781 (See Table 5). Performance on all three instruments were highly correlated and significant at the 0.01 level.

To make it possible to analyse and compare the GPCOG two stage scoring method to the other two instruments (for all analyses) a single score had to be derived that captured the relationship of the patient/informant score. To derive a single representative score the following method was used. If the patient score was 0 to 4 or 9, the patient score was the relevant score. For participants with a patient score of 5 to 8, the informant score determined the final modified GPCOG score. If the informant score was zero the modified two stage GPCOG score was 5, if the informant score was 1, the modified score was 6, if the informant score was 2, the modified score was 7, if the informant score was 3, the modified score was 8. If the informant score was 4 or more the modified GPCOG score was nine, the maximum score possible.

Table 5: Correlations (Spearman's rho) between the instruments

	rho	rho^2
RUDAS/MMSE	0.777	0.604
RUDAS/2 stage modified GPCOG	0.794	0.630
MMSE/2 stage modified GPCOG	0.781	0.610

5.4 Prediction accuracy of the cognitive screening tools

5.4.1 Receiver Operating Characteristic curves

The Receiver Operating Characteristic (ROC) curves indicate how accurately an instrument correctly classifies patients with and without the disease/condition. In this study, the accuracy of the different cognitive screening instruments in classifying those with and without cognitive impairment was compared to a gold standard, in this case the DSMIV-TR Classification. The area under the ROC curve (AUC) is one indicator, with higher scores indicating better classification accuracy. The area under the ROC curve (AUC) for the RUDAS was 0.88 [95% confidence interval (95% CI) 0.82-0.94]. For the MMSE the AUC was 0.86 [95% CI 0.80 – 0.93] For the two stage GPCOG score the AUC was 0.90 [95% CI 0.85 – 0.96]. (See Table 6 and Figures 1 to 3).

To compare the differences in the AUC for all 3 instruments (RUDAS, MMSE, GPCOG two stage score) the AUC was converted into standard scores (z scores). There were no significant differences between the AUCs of the three instruments [RUDAS/MMSE p=0.65; RUDAS/GPCOG (2 stage) p=0.43; MMSE/GPCOG (2 stage) p=0.24].

Figure 1: ROC for RUDAS total score

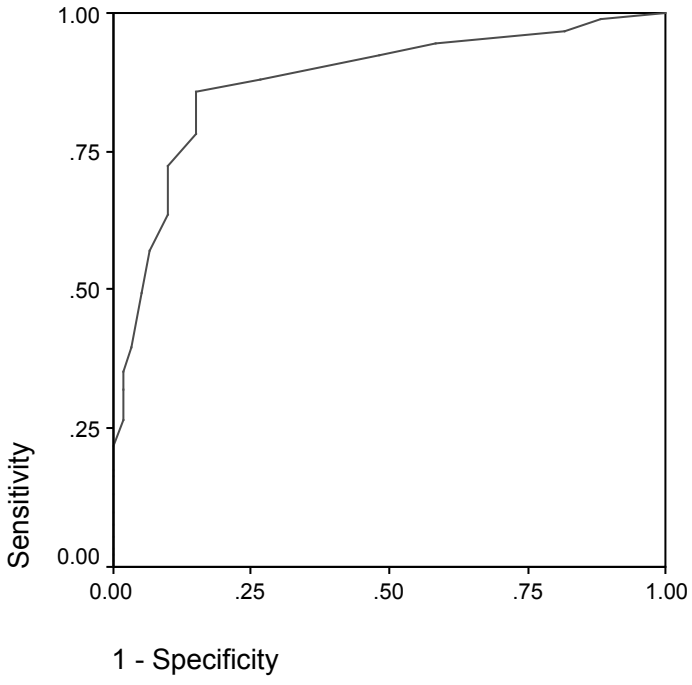


Figure 2: ROC for MMSE total score

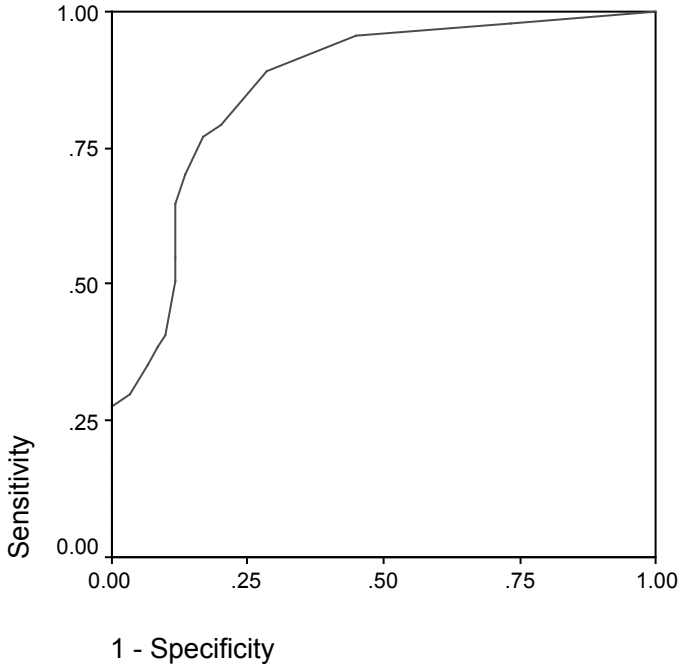
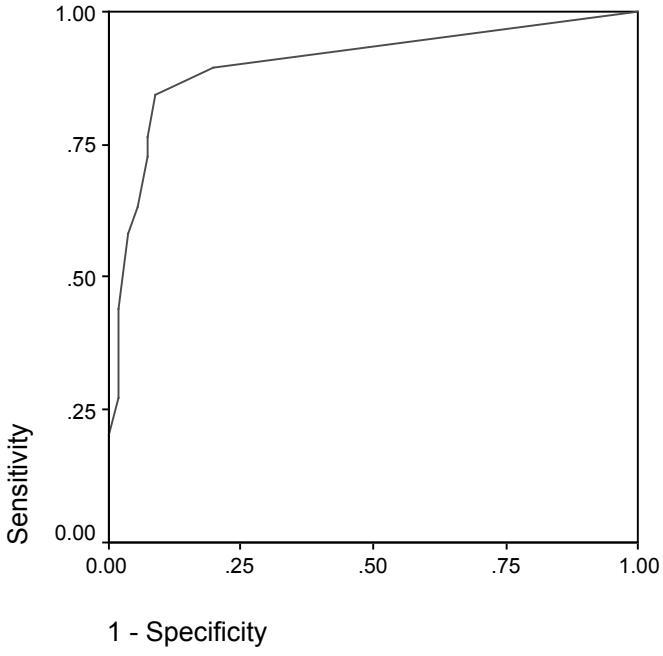


Figure 3: ROC for GPCOG (2 stage method) score



There were no significant differences in the AUC for the three instruments regardless of whether those with a cognitive disorder (NOS) were included with those with normal cognition [RUDAS/MMSE p=0.45; RUDAS/GPCOG (2 stage) p=0.61; MMSE/GPCOG(2 stage) p=0.19] or excluded altogether [RUDAS/MMSE p=0.52; RUDAS/GPCOG (2 stage) p=0.34; MMSE/GPCOG (2 stage) p=0.11]. As there are no significant differences in the AUC for the

three different sample groupings, the remainder of the report relates to the primary sample grouping, that is where those with any cognitive impairment (dementia or other cognitive disorder NOS) are compared to those with normal cognition. (See Appendix 9.12 and 9.13).

5.4.2 Sensitivity/specificity analyses

The sensitivity of an instrument determines how well the tool accurately classifies patients as having a disease/condition (cognitive impairment), against a gold standard (DSMIV-TR Classification). The specificity of an instrument determines how well the tool accurately classifies patients as not having a disease/condition against the gold standard. Based on cut points recommended in the literature the RUDAS had a sensitivity and specificity of 73% and 90% respectively, compared to 65% and 88% for the MMSE and 89% and 80% for the two stage GPCOG score (See Table 6).

The optimal cut point for the RUDAS was calculated based on the best mix of sensitivity and specificity and the sum of both sensitivity and specificity. For this sample, with a high proportion of participants with mild cognitive impairment, a cut point of 24 or less for the RUDAS had a sensitivity of 86% and specificity 85%.

Table 6: Predictive accuracy measures for all three instruments.

Measure	**RUDAS (n=151)**	**MMSE (n=151)**	**GPCOG Two stage method (n=140#)**
AUC (95% CI) based on score	0.879 (0.822-0.935)	0.864 (0.802-0.926)	0.904 (0.851-0.957)
Recommended cut point	**(<23)**	**(<24)**	**(<9)**
Sensitivity (95% CI)	72.5% (65.4 - 79.6)	64.8% (57.2 - 72.4)	89.3% (84.2 - 94.4)
Specificity (95% CI)	90.0% (85.2 - 94.8)	88.3% (83.2 - 93.4)	80.4% (73.8 - 87.0)
Sum of sensitivity and specificity	162.5%	151.1%	169.7%
Positive LR	7.250	5.538	4.556
Negative LR	0.306	0.398	0.133
Optimal cut point	**(<25)**		
Sensitivity (95% CI)	85.7% (80.1 - 91.3)		
Specificity (95% CI)	85.0% (79.3 - 90.7)		
Sum of sensitivity and specificity	170.7%		
Positive LR	5.713		
Negative LR	0.168		

#Six participants did not complete the GPCOG and an additional 13 participants did not have an informant (n=132). However 8 participant scores were sufficient (less than 5 or 9) to determine a final GPCOG score (without the need of an informant score) based on the two stage method.
(LR = likelihood ratio)

Sensitivity and specificity, and the sum of both, based on the recommended cut points for the three sample groupings are tabled in Appendix 9.14. As one would expect higher sensitivity and specificity scores are evident when those with a cognitive disorder (NOS) are excluded all together (dementia vs normal).

5.4.3 Likelihood ratios

The likelihood ratio (LR) of a positive test and a negative test were also calculated. The likelihood ratio of a positive test indicates how much more likely a positive test is to be found in a person with the condition than in a person without the condition. The likelihood ratio of a negative test indicates how much more likely a negative test is to be found in a person without the condition than in a person with the condition. A positive LR above 10 or a negative LR under 0.1 generally provide strong evidence to rule in or rule out a diagnosis respectively. As a guide the following ranges have been suggested (Jaeschke et al, 1995):

- LRs >10 or <0.1 provide strong evidence (probability),
- LRs of 5-10 and 0.1-0.2 provide moderate evidence (probability),
- LRs of 2-5 and 0.5-0.2 provide small (but sometimes important) evidence (probability), and
- LRs of 1-2 and 0.5-1 provide small (and rarely important) evidence.

Based on the recommended cut points the positive and negative likelihood ratios for the RUDAS was 7.25 and 0.31 respectively, for the MMSE it was 5.54 and 0.4 and for the GPCOG it was 4.56 and 0.13 (See Table 6). At the recommended cut points all three tools were similar in the strength of the likelihood ratios. When the optimal cut point for the RUDAS was used the positive and negative likelihood ratios were 5.71 and 0.17 respectively.

The positive and negative likelihood ratios for all three instruments based on both the recommended and optimal cut points are tabled in Appendix 9.15 based on the three sample groupings. Once again, as to be expected, stronger positive and negative likelihood ratios are evident when those with a cognitive disorder NOS are excluded all together.

5.5 Effects of other covariates such as age, gender, education, CALD status, other performance factors, marital status and reading/writing status

Sub-group analyses, univariate and multifactorial logistic regression were performed to determine the influence of factors considered to have a possible effect on classification of cognitive impairment by the different cognitive screening tools.

5.5.1 Age

There was a significant difference in age between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 1). Participants in the cognitively impaired group were significantly older than the group with normal cognition ($p<0.05$).

Univariate logistic regression indicated that age (linearly related to the log odds of cognitive status) was a significant predictor of cognitive status in this sample (Odds Ratio – OR: 1.13, $p<0.001$).

5.5.2 Gender

There was a significant difference in gender between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 1). There was a significantly greater proportion of males in the cognitively impaired group than the group with normal cognition ($p<0.05$). This however is likely to be related to the significant differences in gender of participants recruited into the two groups.

Univariate logistic regression indicated that gender was a significant predictor of cognitive status in this sample (OR 0.42, $p=0.025$). Being male was associated with an increase in the odds of a diagnosis of dementia/cognitive impairment.

5.5.3 Education

There was a significant difference in level of education between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 1). There was a significantly smaller proportion of participants with some form of secondary schooling or higher in the cognitively impaired group than the group with normal cognition ($p<0.05$).

Univariate logistic regression indicated that years of education (linearly related to the log odds of cognitive status) was a significant predictor of cognitive status in this sample (OR 0.90, $p=0.021$).

5.5.4 Culturally and Linguistically Diverse (CALD) status

A participant was defined as having a CALD background if they were born overseas and/or English is not their preferred language. Demographic and cognitive assessment details are reported for CALD and non-CALD participants (Appendix 9.16).

There were no significant differences between the two groups in relation to age, marital status or living arrangements. There were significant differences

between the two groups in relation to gender, years and type of education completed, the availability of the carer and whether an informant was present.

Although there was no significant difference (0.069) in the percentage of CALD and Non-CALD participants who were classified as having a cognitive impairment based on the DSMIV classification, a trend was evident. Based on the Cognitive Dementia Rating Scale only 19% of CALD participants had no cognitive impairment compared to 41% of non-CALD participants. This is a significant difference (0.003) between the two groups.

Univariate logistic regression indicated that CALD status was not a significant predictor of cognitive status in this sample (OR 1.87, p=0.069).

5.5.5 Other performance factors

A range of performance factors considered to possibly impact upon performance on the cognitive screening tools were identified (Table 4). There was no significant difference in the proportion of participants with one or more factors between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 4).

Univariate logistic regression indicated that the number of performance factors (linearly related to the log odds of cognitive status) was not a significant predictor of cognitive status in this sample (OR 1.45, p=0.134).

5.5.6 Geriatric Depression Scale

There was no significant difference in the proportion of participants who scored 5 or more on the GDS (indicating the presence of depressive symptoms) between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 4).

Univariate logistic regression indicated that GDS score (linearly related to the log odds of cognitive status) was not a significant predictor of cognitive status in this sample (OR 0.93, p=0.21).

5.5.7 Marital status

There was no significant difference in marital status (married, widowed, other) between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 1).

Univariate logistic regression indicated that marital status was not a significant predictor of cognitive status. In the comparison of married versus widowed

the OR was 1.76 (p=0.14) and in the comparison of married versus other the OR was 0.70 (p=0.51).

5.5.8 Reading / writing status

There was no significant difference in reading/writing status between the group with cognitive impairment (based on DSMIV classification, n=91) and those with normal cognition (n=60) for the full sample analysis (Table 3).

Univariate logistic regression indicated that reading/writing status (able/unable) was not a significant predictor of cognitive status in this sample (OR 2.72, p=0.23). However it is important to note the number of participants unable to read/write was low, with only 11 participants in this category.

5.5.9 Univariate and multiple logistic regression for cognitive screening scores

In the univariate analysis all three cognitive screening tools were found to be significant predictors of cognitive status [RUDAS – OR 0.66 (95% CI 0.57 – 0.76) p value<0.001; MMSE - OR 0.71 (95% CI 0.637 – 0.81) p value<0.001; GPCOG - OR 0.46 (95% CI 0.34 – 0.60) p value<0.001]. A linear relationship was found between all three tools and the log odds of cognitive status, hence the RUDAS, MMSE and GPCOG were treated as continuously valued variables in the analysis.

In the multifactorial model, with the addition of the *a priori* determined covariates (age, gender and CALD status) and other significant predictors (GDS score), each tool remained a significant predictor of cognitive status (Table 7 to 9). The covariates of other performance factors, years of education, marital status and reading / writing status were not significant predictors of cognitive status or confounders of the relationship between the cognitive screening tool and cognitive status. In the multifactorial model containing the RUDAS, age (OR: 1.08, p= 0.05) and GDS score (OR: 0.84, p=0.04) were additional significant predictors of cognitive status. No covariates were found to confound the relationship between the RUDAS and cognitive status. In the multifactorial model containing the MMSE, age (OR: 1.09, p= 0.02), gender (OR: 0.35, p=0.05) and GDS score (OR: 0.85, p= 0.05) were found to be significant predictors of cognitive status, using the likelihood ratio test. In addition, CALD status was also found to confound the relationship between the MMSE and cognitive status. Without the addition of CALD status to the multifactorial model the slope coefficient of the MMSE was underestimated by 23%. In the multifactorial model containing the GPCOG, age (OR: 1.08, p= 0.06), gender (OR: 0.18, p= 0.01) and GDS score (OR: 0.71, p= 0.01) were found to be significant predictors of cognitive status, using the likelihood ratio test. In addition, the GDS score was found to confound the relationship between the GPCOG and cognitive status. Without the addition of the GDS score to the multifactorial model the slope coefficient of the GPCOG was underestimated by 19%.

Table 7: Multifactorial logistic regression - RUDAS

Risk factor n=137	Multifactorial OR (95% CI)	P value
RUDAS	0.68 (0.58 – 0.79)	0.00
Age in years	1.08 (1.00 –1.15)	0.05
Female	0.37 (0.12 – 1.14)	0.08
CALD background	1.29 (0.43 – 3.91)	0.65
GDS score	0.84 (0.71 – 0.99)	0.04

Table 8: Multifactorial logistic regression - MMSE

Risk factor n=137	Multifactorial OR (95% CI)	P value
MMSE	0.67 (0.57 – 0.80)	0.00
Age in years	1.09 (1.02 –1.16)	0.02
Female	0.35 (0.12 – 1.01)	0.05
CALD background	0.33 (0.09 – 1.28)	0.11
GDS score	0.85 (0.72 – 1.00)	0.05

Table 9: Multifactorial logistic regression - GPCOG:

Risk factor n=127	Multifactorial OR (95% CI)	P value
GPCOG	0.41 (0.28 – 0.59)	0.00
Age in years	1.08 (1.00 –1.17)	0.06
Female	0.18 (0.04 – 0.70)	0.01
CALD background	1.96 (0.49 – 7.78)	0.34
GDS score	0.71 (0.56 – 0.92)	0.01

Note: (Tables 7 - 9): The participant numbers were reduced due to missing data in a number of fields.

5.5.10 Summary

Each of the three cognitive screening tools was a significant predictor of cognitive status in the multifactorial models. With the MMSE and GPCOG in the multifactorial models, age, gender and GDS score were significant predictors of cognitive status. With RUDAS in the model, only age and GDS score were significant predictors. As would be expected older age increased the odds of a diagnosis of dementia. In the category of gender, being female was also found to be associated with an decrease in the odds of a diagnosis of dementia/cognitive impairment. In the three multifactorial models increasing GDS score significantly lowered the odds of a diagnosis of dementia/cognitive impairment. This unexpected result needs further investigation. However, there is some questions regarding whether the GDS is reliable in screening depression in individuals with mild to moderate dementia, and the suggestion that people with dementia may deny symptoms of depression (Encyclopedia of Mental Disorders).

In relation to covariates that may confound the relationship between the cognitive screening tests and cognitive status, the MMSE and GPCOG were both influenced by confounding more than the RUDAS. CALD status was found to affect the MMSE score in predicting cognitive status and the GDS score was found to affect the GPCOG score in predicting cognitive status.

6.0 DISCUSSION

This study aimed to provide an external validation of the predictive accuracy of a relatively new cognitive screening tool (the RUDAS) and to compare it to two commonly used cognitive screening tools (the MMSE and the GPCOG) that have had some limitations reported regarding their general use. The widely used MMSE, in use world wide since 1975, was developed in an English speaking population and has been found to be influenced by age, education, ethnicity and language of the interview (Escobar et al.,1986). Limitations of the GPCOG include that one of the exclusion criteria in the original study was poor English language abilities (Brodaty et al., 2002), and it is reliant on informant history which is not always available. In a subsequent study, the patient score was found to be highly correlated to age, education and depression, although based on regression analysis only age remained associated. The informant score was found to be bias free (Brodaty et al 2004). The RUDAS was developed initially with the goal of addressing some of these limitations with existing tools.

The six item RUDAS (totalling 30 points) is a tool that is easy and quick to administer, taking about 10 minutes to complete and requiring as little as 40 minutes of training (using a videotape). The RUDAS includes items that address several cognitive domains, including frontal lobe impairment, and includes diverse response formats (verbal, non-verbal, written and praxis) providing a comprehensive screening of overall cognition (Storey et al., 2004). It is also easily translated into over 30 languages without effecting the structure or format of any item and all items were reviewed (by a cultural advisory group) and tested (in a multicultural study population) to establish cultural appropriateness ("fairness"). The RUDAS is also not reliant on information from a carer/informant.

Results of the present study indicate comparable results on most of the outcomes evaluated between the RUDAS, MMSE and GPCOG in a sample of 151 older people. Approximately two thirds of the sample for this study were recruited through Memory Clinics/Alzheimer's Respite Programs, the remainder from other geriatric outpatient services and other sources (including research volunteers). Sixty percent of the sample had some level of cognitive impairment (DSMIV classification), although of these, 90% were classified as having questionable or mild cognitive impairment (CDR classification). All three screening tools had high, and similar levels of prediction accuracy for cognitive status. Multifactorial logistic regression identified that all three screening tools were predictive of cognitive status independent of other covariates. In terms of confounding factors affecting the relationship of the screening tools and the diagnosis of cognitive status, the RUDAS score was not substantially confounded by any of the covariates, whereas the MMSE was effected by CALD status and the GPCOG score was affected by the GDS score. In the clinical setting, depression can present with signs and symptoms similar to dementia and needs to be evaluated as part of the screening or assessment process.

There were significant demographic differences found between the participants from a CALD background compared to those from a non-CALD background. This included gender, years of education, and the presence of some form of cognitive impairment (questionable, mild, moderate, severe) based on the Cognitive Dementia Rating (CDR) Scale. Only 19% of CALD participants were found to have no cognitive impairment based on the CDR compared to 41% of those from a non-CALD background. Those from a CALD background performed significantly worse on all three cognitive instruments (RUDAS, MMSE, and the GPCOG – patient, informant, combined total score and the recommended two stage method of scoring.) This is likely to be related primarily to the demographic group differences between the two groups. This warrants further investigation.

Unlike the previous studies by Storey et al (2004) and Rowland et al (2006), which included a high proportion of participants with moderate to severe cognitive impairment, the current study included a large proportion of participants with questionable or mild cognitive impairment (based on the CDR classification). The effect of this would be expected to increase the difficulty of correct classification of cognitive status, and therefore to result in lower AUC and sensitivity and specificity analysis. However, the prediction accuracy of each of the three screening tools remained high in this sample when compared against the gold standard of the DSMIV classification. All three screening tools were highly correlated (over 0.7) and had an AUC of over 0.80 and a sum of sensitivity and specificity over 150%. There were no significant differences in the predictive accuracy of the three tools.

Predictive accuracy was high for each tool regardless of whether those with a cognitive impairment NOS were grouped with those with dementia (primary sample grouping), with those who had normal cognition or were excluded all together. There were no significant differences between the AUC for each of the three instruments under any of these three sample groupings.

The positive and negative likelihood ratios (odds of the disease being present when a test is positive and the odds of the disease being absent when a test is negative) of the three screening tools were also similar in strength. The RUDAS, at the optimal cut point of <25, provided moderate evidence to both rule in and rule out cognitive impairment (positive LR 5.7, negative LR 0.17).

Based on the current study, there is insufficient evidence to support recommending a change to the recommended cut point for the RUDAS. However further investigation is warranted. At the optimal cut point of <25 (24 or less) there was a significant difference in sensitivity and an increased sum of sensitivity and specificity (170.7% compared to 162.5% for the recommended cut point). Further evaluation of the RUDAS with the current recommended and optimal cut points may be warranted.

There were a number of limitations in this current study that may have impacted on outcomes. First, in the absence of longitudinal follow-up and brain pathology for those who were not fully assessed at a memory clinic,

some of these participants may have been misclassified despite the use of the current DSMIV gold standard. Second, there were significant differences between groups in key factors such as age, gender, years and type of education, and preferred language, this difference may have been influenced to some degree by the inclusion of a number of research volunteers as part of the cognitively normal group (37%) whose demographics may have less in common with older people recruited from geriatric outpatient services/respite programs. Third, there were significant differences between CALD and non-CALD participants on key factors such as age, gender, education and cognitive impairment based on the CDR.

Another key limitation of the current study, impacting on the secondary aim of the project (the comparison between tools) is that the current methodology was biased towards the MMSE and GPCOG. The medical staff conducted both the MMSE and GPCOG and provided the final diagnosis - DSMIV classification - but were blinded to the RUDAS results. The final DSMIV diagnosis would have been informed by the MMSE and GPCOG results but not the RUDAS.

7.0 CONCLUSION

In terms of the primary aims of the current study, the RUDAS has been found to be a valid screening tool for cognitive impairment that can be used in multiple settings and in people with a broad range of cognitive function.

In terms of the secondary aims of the project, performance on all three instruments were highly correlated, there were no significant differences in the AUC for each of the instruments, sensitivity and specificity and both the positive and negative likelihood ratios of all three instruments were relatively similar. Hence all three instruments are equally valid/acceptable as a screening tools for cognitive impairment.

Although each screening tool is equally effective in its predictive accuracy there are some advantages of the RUDAS over the two other tools. It is not dependent on an informant (28% of participants in this current did not have an informant in the current study), it includes diverse response formats and items that address frontal lobe impairment, it is easily translated without the need to change the structure or format of any question, it is easy and quick to administer and it has been consistently demonstrated that it is not influenced by education or preferred language/CALD status.

Further evaluation of the RUDAS is warranted to provide conclusive evidence that the RUDAS is more useful than other screening tools in hetergeneous populations and to conclusively determine the most appropriate cut point. A study that includes participants with more similar demographic profiles between groups may help reduce the possible influence of key factors.

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9.0 APPENDIX

Tools used in assessment of cognitive and functional performance in the study:

Tables related to the three sample groupings and CALD vs Non-CALD status

Appendix 9.1: RUDAS

RUDAS

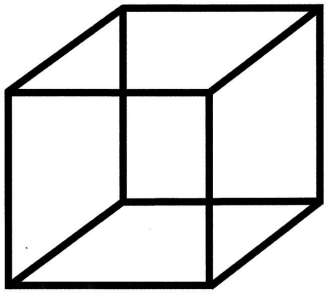
The Rowland Universal Dementia Assessment Scale (RUDAS):
A Multicultural Cognitive Assessment Scale

Storey, Rowland, Basic, Conforti & Dickson (2004). *International Psychogeriatrics*, 16 (1), 13-31

Date: _____ Patient Name: _____

Item		Max Score
Memory		
1. *(Instructions)* I want you to imagine that we are going shopping. Here is a list of grocery items. I would like you to remember the following items which we need to get from the shop. When we get to the shop in about 5 mins time, I will ask you what it is that we have to buy. You must remember the list for me. **Tea, Cooking Oil, Eggs, Soap.** Please repeat this list for me *(Ask person to repeat the list 3 times). (If person did not repeat all four words, repeat the list until the person has learned them and can repeat them, or, up to a maximum of five times.)*		
Visuospatial Orientation		
2. I am going to ask you to identify/show me different parts of the body. *(Correct = 1). Once the person correctly answers 5 parts of this question, do not continue, as the maximum score is 5.*		
(1) Show me your right foot	1	
(2) Show me your left hand	1	
(3) With your right hand touch your left shoulder	1	
(4) With your left hand touch your right ear	1	
(5) Which is (indicate/point to) my left knee	1	
(6) Which is (indicate/point to) my right elbow	1	
(7) With your right hand indicate/point to my left eye	1	
(8) With your left hand indicate/point to my left foot	1	
		...../5
Praxis		
3. I am going to show you an action/exercise with my hands. I want you to watch me and copy what I do. Copy me when I do this... *(One hand in fist, the other palm down on table - alternate simultaneously.)* Now do it with me: Now I would like you to keep doing this action at this pace until I tell you to stop - approximately 10 seconds. *(Demonstrate at moderate walking pace).*		
Score as:		
Normal = 2 (very few if any errors; self-corrected, progressively better; good maintenance; only very slight lack of synchrony between hands)		
Partially Adequate = 1 (noticeable errors with some attempt to self-correct; some attempt at maintenance; poor synchrony)		
Failed = 0 (cannot do the task; no maintenance; no attempt whatsoever)		...../2
Visuoconstructional Drawing		
4. Please copy/draw this picture exactly as it looks to you. (Show cube on back page) *(Yes = 1).*		
Score as:		
(1) Has person drawn a picture based on a square? 	1	
(2) Do all internal lines appear in person's drawing?	1	
(3) Do all external lines appear in person's drawing? 	1	
		...../3
Judgement		
5. You are standing on the side of a busy street. There is no pedestrian crossing and no traffic lights. Tell me what you would do to get across to the other side of the road **safely.** *(If person gives incomplete response that does not address both parts of answer, use prompt: "Is there anything else you would do?") Record exactly what patient says and circle all parts of response that were prompted.*		
.....		
.....		
Score as:		
Did person indicate that they would look for traffic? (YES = 2;YES PROMPTED = 1; NO = 0)	2	
Did person make any additional safety proposals? (YES = 2;YES PROMPTED = 1; NO = 0)	2	
		...../4

Memory Recall		
1. *(Recall)* We have just arrived at the shop. Can you remember the list of groceries we need to buy? *(Prompt: If person cannot recall any of the list, say "The first one was 'tea'." (Score 2 points each for any item recalled which was not prompted use only 'tea' as a prompt.)*		
Tea	2	
Cooking Oil	2	
Eggs	2	
Soap	2	
		...../8
Language		
6. I am going to time you for one minute. In that one minute, I would like you to tell me the names of as many different animals as you can. We'll see how many different animals you can name in one minute. *(Repeat instructions if necessary). Maximum score for this item is 8. If person names 8 new animals in less than one minute there is no need to continue.*		
1. ..... 5.		
2. ..... 6.		
3. ..... 7.		
4. ..... 8.		
TOTAL SCORE		**/30**



Appendix 9.2: MMSE

MINI-MENTAL STATE EXAMINATION

(Folstein et al., 1978)

Please circle number: 0 = wrong 1 = correct NA = not asked

"Now I would like to ask you some questions to check your memory and concentration. Some of them may seem easy and some of them may be hard."

0 1 NA **1) What is the year?**

_____

0 1 NA **2) What is the season of the year?**

_____

0 1 NA **3) What is the date?** _____

0 1 NA **4) What is the day of the week?** _____

0 1 NA **5) What is the month?** _____

0 1 NA **6) Can you tell me where we are now? Which state?**

0 1 NA **7) What are two main streets nearby?** _____

(or near your home if unfamiliar in this area)

0 1 NA **8) What city/town are we in?** _____

0 1 NA **9) What floor of the building are we on?**

(if at home, what room are we in?) _____

0 1 NA **10) What is the name or address of this place?**

_____

11) I am going to name three objects. After I have said them, I want you to repeat them. Remember what they are because I am going to ask you to name them again in a few minutes. Apple, Table, Penny.

Please repeat the names for me:
(Score first try. Repeat objects for three trials only.)

0 1 NA **Apple**

0 1 NA **Table**

0 1 NA **Penny**

0 1 2 3 4 5 NA **12) Now I am going to ask you to take 7 from 100. Now take 7 away from the number you get. Now keep subtracting until I tell you to stop. 93, 86, 79, 72, 65.** *(see instructions)*

0 1 2 3 4 5 NA **I would like you to spell WORLD for me. Now spell it backwards.** *(Repeat if necessary and help patient spell forward if necessary.) Score number of letters given in correct order (0- 5) when word is spelt backwards:D L R O W (see instructions)*

13) What were the three objects I asked you to remember?

0 1 NA **Apple** _____

0 1 NA **Table** _____

0 1 NA **Penny** _____

0 1 NA **14)** *(Show wrist watch)* **What is this called?** _____

0 1 NA **15)** *(Show pencil)* **What is this called?** _____

16) I would like you to repeat a phrase after me:

0 1 NA *(The phrase is)* **"NO IFS ANDS OR BUTS"** *Allow only one trial.*

0 1 NA **17) Read the words on this page, then do that it says.**
Code correct if subject closes eyes.

18) I'm going to give you a piece of paper. When I do, take the paper in your right hand, fold the paper in half with both hands, and put the paper down on your lap.

0 1 NA Right hand

0 1 NA Folds

0 1 NA On lap

Read full statement, THEN hand paper over. Do not repeat instructions or coach.

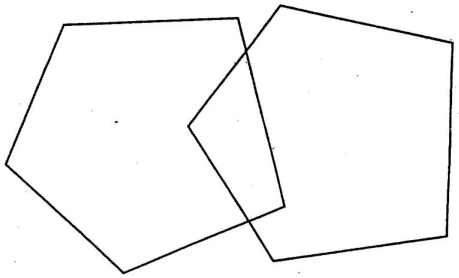
0 1 NA **19) Write any complete sentence on that piece of paper for me.**

0 1 NA **20) Here is a drawing. Please copy the drawing on the same paper.**
Score correct if the two five sided figures intersect to form a four sided figure and if all angles in the five sided figure are preserved. (see instructions)

TOTAL SCORE: Using serial sevens ___/ 30 ; Using WORLD ____/ 30

(MMSE continued overleaf)

CLOSE YOUR EYES



Appendix 9.3: GPCOG

Appendix

GPCOG Patient Examination

Unless specified, each question should only be asked once.

Name and address for subsequent recall test

1. *"I am going to give you a name and address. After I have said it, I want you to repeat it. Remember this name and address because I am going to ask you to tell it to me again in a few minutes: John Brown, 42 West Street, Kensington."* (Allow a maximum of 4 attempts but do not score yet)

	Correct	Incorrect
Time Orientation		
2. *What is the date?* (exact only)	☐	☐
Clock Drawing (visuospatial functioning) - use page with printed circle		
3. *Please mark in all the numbers to indicate the hours of a clock* (correct spacing required)	☐	☐
4. *Please mark in hands to show 10 minutes past eleven o'clock* (11:10)	☐	☐
Information		
5. *Can you tell me something that happened in the news recently?* (recently = in the last week)	☐	☐
Recall		
6. *What was the name and address I asked you to remember?*		
John	☐	☐
Brown	☐	☐
42	☐	☐
West (St)	☐	☐
Kensington	☐	☐

Scoring guidelines

Clock drawing: For a correct response to question 3, the numbers 12, 3, 6, and 9 should be in the correct quadrants of the circle and the other numbers should be approximately correctly placed. For a correct response to question 4, the hands should be pointing to the 11 and the 2, but do not penalize if the respondent fails to distinguish the long and short hands.

Information: Respondents are not required to provide extensive details, as long as they demonstrate awareness of a recent news story. If a general answer is given, such as "war," "a lot of rain," ask for details—if unable to give details, the answer should be scored as incorrect.

GPCOG Informant Interview

Ask the informant: *"Compared to a few years ago,*

		Yes	No	Don't Know	N/A
I.	*Does the patient have more trouble remembering things that have happened recently?*	☐	☐	☐	
II.	*Does he or she have more trouble recalling conversations a few days later?*	☐	☐	☐	
III.	*When speaking, does the patient have more difficulty in finding the right word or tend to use the wrong words more often?*	☐	☐	☐	
IV.	*Is the patient less able to manage money and financial affairs (e.g., paying bills, budgeting)?*	☐	☐	☐	☐
V.	*Is the patient less able to manage his or her medication independently?*	☐	☐	☐	☐
VI.	*Does the patient need more assistance with transport (either private or public)?*	☐	☐	☐	☐

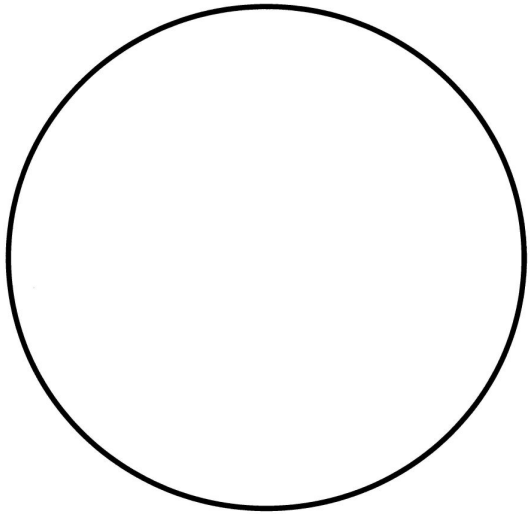
Date of assessment:

UR No. (sticker):

Name:

Address:

Age: Gender:



Appendix 9.4: CDR

RC

CLINICAL DEMENTIA RATING (CDR)

Date of assessment:

UR Number (sticker):

Name:
Address:

DOB: Gender

	Impairment Level and CDR Score (0, 0.5, 1, 2, 3)				
	None 0	Questionable 0.5	Mild 1	Moderate 2	Severe 3
Memory	No memory loss or slight inconsistent forgetfulness	Consistent slight forgetfulness; partial recollection of events; "benign" forgetfulness	Moderate memory loss; more marked for recent events; defect interferes with everyday activities	Severe memory loss; only highly learned material retained; new material rapidly lost	Severe memory loss; only fragments remain
Orientation	Fully oriented	Fully oriented except for slight difficulty with time relationships	Moderate difficulty with time relationships; oriented for place at examination; may have geographic disorientation elsewhere	Severe difficulty with time relationships; usually disoriented to time, often to place	Oriented to person only
Judgment & Problem Solving	Solves everyday problems & handles business & financial affairs well; judgment good in relation to past performance	Slight impairment in solving problems, similarities, and differences	Moderate difficulty in handling problems, similarities, and differences; social judgment usually maintained	Severely impaired in handling problems, similarities, and differences; social judgment usually impaired	Unable to make judgments or solve problems
Community Affairs	Independent function at usual level in job, shopping, volunteer and social groups	Slight impairment in these activities	Unable to function independently at these activities although may still be engaged in some; appears normal to casual inspection	No pretense of independent function outside home Appears well enough to taken to functions outside a family home	No pretense of independent function outside home Appears too ill to be be taken to functions outside a family home
Home and Hobbies	Life at home, hobbies, and intellectual interests well maintained	Life at home, hobbies, and intellectual interests slightly impaired	Mild but definite impairment of function at home; more difficult chores abandoned; more complicated hobbies and interests abandoned	Only simple chores preserved; very restricted interests, poorly maintained	No significant function in home
Personal Care	Fully capable of self-care		Needs prompting	Requires assistance in dressing, hygiene, keeping of personal effects	Requires much help with personal care; frequent incontinence

Score only as decline from previous usual level due to cognitive loss, not impairment due to other factors.

Overall CDR Score: _____

UR No: (sticker)

Name: Age:

Address: Gender: M / F

MODIFIED BARTHEL INDEX SCORE
(as modified by Wade & Collin)

Using the Barthel ADL Index, circle the appropriate score for each of the following:

1.	**Bathing** 0 = dependent 1 = independent (or in shower)	**0 - 1** Comments:	
2.	**Dressing** 0 =dependent 1 =needs help, but can do about half unaided 2 =independent (including buttons, zips, laces etc.)	**0 - 1 - 2** Comments:	
3.	**Grooming** 0 = needs help with person care 1 = independent face/hair/teeth/shaving (implements provided)	**0 - 1** Comments:	
4.	**Toilet Use** 0 = dependent 1 = needs some help, but can do some things alone 2 = independent (on and off, dressing, wiping)	**0 - 1 - 2** Comments:	
5.	**Bladder** 0 = incontinent, or catheterised, unable to manage 1 = occasional accident (max. Once per 24 hours) 2 = continent (for 7 days)	**0 - 1 - 2** Comments:	
6.	**Bowels** 0 = incontinent (or needs to be given enema) 1 = occasional accident (once/week) 2 = continent	**0 - 1 - 2** Comments:	
7.	**Transfers** 0 = unable - no sitting balance 1 = major help (one or two people) can sit 2 = minor help (verbal or physical) 3 = independent	**0 - 1 - 2 - 3** Comments:	
8.	**Mobility** 0 = immobile 1 = wheelchair independent including corners 2 = walks with help of one person (verbal or physical) 3 = independent (but may use aid, e.g. stick)	**0 - 1 - 2 - 3** Comments:	
9.	**Stairs** 0 = unable 1 = needs help (verbal, physical, carrying aids) 2 = independent up and down	**0 - 1 - 2** Comments:	
10.	**Feeding** Feeding 0 = unable 1 = needs help cutting, spreading butter etc. 2 = independent (food provided in reach)	**0 - 1 - 2** Comments:	

TOTAL = _____/20

Date of assessment:

25-07-05:05:54PM: 0038387215337353S#:612 9364526S # 2/

Appendix 9.6: Lawton IADL

LAWTON - BRODY
INSTRUMENTAL ACTIVITIES OF DAILY LIVING SCALE (I.A.D.L.)

A. Ability to Use Telephone		**E. Laundry**	
1. Operates telephone on own initiative-looks up and dials numbers, etc.	1	1. Does personal laundry completely	1
2. Dials a few well-known numbers	1	2. Launders small items-rinses stockings, etc.	1
3. Answers telephone but does not dial	1	3. All laundry must be done by others	0
4. Does not use telephone at all	0		
B. Shopping		**F. Mode of Transportation**	
1. Takes care of all shopping needs independently	1	1. Travels independently on public transportation or drives own car	1
2. Shops independently for small purchases	0	2. Arranges own travel via taxi, but does not otherwise use public transportation	1
3. Needs to be accompanied on any shopping trip	0	3. Travels on public transportation when accompanied by another	1
4. Completely unable to shop	0	4. Travel limited to taxi or automobile with assistance of another	0
		5. Does not travel at all	0
C. Food Preparation		**G. Responsibility for Own Medications**	
1. Plans, prepares and serves adequate meals independently	1	1. Is responsible for taking medication in correct dosages at correct time	1
2. Prepares adequate meals if supplied with ingredients	0	2. Takes responsibility if medication is prepared in advance in separate dosage	0
3. Heats, serves and prepares meals, or prepares meals, or prepares meals but does not maintain adequate diet	0	3. Is not capable of dispensing own medication	0
4. Needs to have meals prepared and served	0		
D. Housekeeping		**H. Ability to Handle Finances**	
1. Maintains house alone or with occasional assistance (e.g. "heavy work domestic help")	1	1. Manages financial matters independently (budgets, writes checks, pays rent, bills, goes to bank), collects and keeps track of income	1
2. Performs light daily tasks such as dish washing, bed making	1	2. Manages day-to-day purchases, but needs help with banking, major purchases, etc.	1
3. Performs light daily tasks but cannot maintain acceptable level of cleanliness	1	3. Incapable of handling money	0
4. Needs help with all home maintenance tasks	1		
5. Does not participate in any housekeeping tasks	0		

UR No: (sticker)

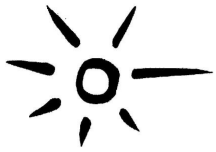
Name: Age:

Address: Gender: M / F

Total score: _____

Date of assessment:

Appendix 9.7: GDS



Geriatric Depression Scale
Short Form

Choose the best answer for how you felt during the past week:

	Yes	No	
1	☐	☐	Are you basically satisfied with your life?
2	☐	☐	Have you dropped many of your activities and interests?
3	☐	☐	Do you feel that your life is empty?
4	☐	☐	Do you often get bored?
5	☐	☐	Are you in good spirits most of the time?
6	☐	☐	Are you afraid that something bad is going to happen to you?
7	☐	☐	Do you feel happy most of the time?
8	☐	☐	Do you often feel helpless?
9	☐	☐	Do you prefer to stay at home, rather than going out and doing new things?
10	☐	☐	Do you feel you have more problems with memory than most?
11	☐	☐	Do you think it is wonderful to be alive now?
12	☐	☐	Do you feel pretty worthless the way you are now?
13	☐	☐	Do you feel full of energy?
14	☐	☐	Do you feel that your situation is hopeless?
15	☐	☐	Do you think that most people are better off than you are?

Fuqua Center for Late-Life Depression
Wesley Woods Center of Emory University
1841 Clifton Road NE, 4th floor
Atlanta, GA 30329
(877) 498-0096
fuquacenter@emory.edu

UR No: (sticker)

Name:
Address:

Age: Gender

Appendix 9.8

Table 9.8: Participant general characteristics by cognitive diagnosis (DSMIV-TR classification) Dementia vs Normal (cognitive disorder NOS excluded)

Characteristics	***Participants diagnosed with dementia (n=58)***	***Participants diagnosed with normal cognition (n =60)***	***All participants (n=118)***
Age mean (SD)	80 (7.1)	73 (9.5)*	76 (9.1)
Age range	60 - 93	46 - 90	46 - 93
Gender (%)			
• Female	62%	80%*	71%
• Male	38%	20%	29%
CALD background (%)	57%	33%*	45%
Years of education (Mean; SD)	7 (3.1)	9 (4.7)*	8 (4.1)
Marital status (%)			
• Married	31%	48%	40%
• Widowed	57%	35%	46%
• Other	12%	17%	14%*
Living arrangements (%)			
• Alone	38%	38%	36%
• Other	66%	62%	64%
Principal carer (%))			
• No carer required / available	10%	68%*	40%
• Resident carer	53%	22%	37%
• Non-resident carer	34%	10%	22%*
Informant present:			
• Yes	83%	23%*	53%
• Contacted by phone	12%	18%	15%
• No	5% (n=3)	58%	32%

* $p<0.05$

Type of education (primary schooling or no formal education and secondary schooling or above) p=0.001

Appendix 9.9

Table 9.9: Participants functional and cognitive characteristics by cognitive diagnosis (DSMIV-TR classification). Dementia vs Normal (cognitive disorder NOS excluded)

Characteristics	Participants diagnosed with dementia (n=58)	Participants diagnosed with normal cognition (n =60)	All participants (n = 118)
GDS score of 5 or more	18 (31%) (2 missing scores)	23 (38%) (1 missing scores)	41 (35%) (3 missing scores)
GDS score (median, IQR)	3 (1-6)	3 (1-7)	3 (1-6)
MBI Score (median, IQR)	19 (16-20)	20 (19-20)*	20 (17-20)
Lawton IADL Score (median, IQR)	3 (2-6)	8 (6-8)*	6 (3-8)
Has one or more factors potentially affecting performance (%)	31%	22%	26%
RUDAS (median, IQR)	17.5 (12.75 – 20.25)	27 (25 – 28)*	23 (17 – 27)
MMSE (median, IQR)	19 (14 - 23)	29 (27-30)*	25 (18 - 29)
GPCOG patient score (median, IQR)	2 (0 - 4)	8 (7 – 9)*	5 (2 – 8)
GPCOG informants score (median, IQR)	1 (0 - 2)	4 (3 – 6)*	3 (0 – 56)
GPCOG total score (median, IQR)	3 (1 –5)	12 (10.5 – 14)*	8 (3 – 12)
GPCOG modified 2 stage score (median, IQR)	2 (0 –3.25)	9 (9 –9)*	7 (2 –9)

* $p<0.05$

Appendix 9.10

Table 9.10: Participant general characteristics by cognitive diagnosis (DSMIV-TR classification) Dementia vs Other (normal or cognitive disorder NOS)

Characteristics	*Participants diagnosed Dementia (n=58))*	*Participants diagnosed without dementia (n = 93)*	*All participants (n=151)*
Age mean (SD) (p=0.004)	80 (7.1)	76 (9.5)*	77 (8.9)
Age range	60 - 93	46 - 97	46 - 97
Gender (%)			
• Female	62%	74%	70%
• Male	38%	26%	30%
CALD background (%)	57%	33%*	42%
Years of education (Mean; SD)	7 (3.1)	9 (4.6)*	8 (4.2)
Marital status (%)			
• Married	31%	55%*	46%
• Widowed	57%	31%	42%
• other	12%	12%	12%*
Living arrangements (%)			
• Alone	33%	33%	33%
• Other	66%	67%	66%
Principal carer (%)			
• No carer required / available	10%	57%*	39%
• Resident carer	53%	32%	40%
• Non-resident carer	34%	11%	20%*
Informant present:			
• Yes	83%	44%*	59%
• Contacted by phone	12%	12%	13%
• No	5% (n=3)	43%	28%

*p<0.05
Type of education (primary schooling or no formal education and secondary schooling or above) p=0.000

Appendix 9.11

Table 9.11: Participants functional and cognitive characteristics by cognitive diagnosis (DSMIV-TR classification). Dementia vs Other (normal or cognitive disorder NOS)

Characteristics	Participants diagnosed with dementia (n=58)	Participants diagnosed with normal cognition or other cognitive impairment NOS (n =93)	All participants (n = 151)
GDS score of 5 or more	18 (31%) (2 missing scores)	33 (35%) (2 missing scores)	51 (34%) (4 missing)
GDS score (median, IQR)	3 (1-6)	3 (1-6)	3 (1-6)
MBI Score (median, IQR)	19 (16-20)	20 (19-20)*	20 (18-20)
Lawton IADL Score (median, IQR)	3 (2-6)	7 (5-8)*	6 (3-8)
Has one or more factors potentially affecting performance (%)	31%	26%	28%
RUDAS (median, IQR)	17.5 (12.75 – 20.25)	26 (23 – 28)*	23 (18 – 27)
MMSE (median, IQR)	19 (14 - 23)	28 (25-29)*	25 (19 - 28)
GPCOG patient score (median, IQR)	2 (0 - 4)	8 (5.7 – 9)*	6 (2 – 8)
GPCOG informants score (median, IQR)	1 (0 - 2)	4 (2 – 5)*	2.5 (1 – 4)
GPCOG total score (median score, IQR)	3 (1 –5)	11 (8 –13)*	8 (3.25 - 12)
GPCOG modified 2 stage score (median score, IQR)	2 (0 –3.25)	9 (7 – 9)*	7 (2 –9)

* $p<0.05$

Appendix 9.12

Table 9.12: Area Under the ROC Curve for all cognitive screening tools (and the various scoring methods) based on three variation of sample grouping.

Instrument	Dementia sample includes 33 other subjects with a cognitive disorder NOS (any cognitive impairment vs normal cognition)	Normal sample includes 33 subjects with a cognitive disorder NOS (dementia vs non-dementia)	Analysis sample excludes 33 subjects with a cognitive disorder NOS (dementia vs normal cognition)
RUDAS total score (n=151)	0.879	0.897	0.939 (n=118)
MMSE total score (based on the best result for either serial 7/world backwards)* (n=151)	0.864	0.874	0.921 (n=118)
MMSE total score based on serial 7 (n=146)	0.858	0.888	0.926 (n= 113)
MMSE total score based on world backward (143)	0.860	0.872	0.918 (n=111)
GPCOG modified score based on 2 stage process* (n=140)	0.904	0.912	0.963 (n=110)
GPCOG total score (combined patient and informant. (n=132)	0.918	0.923	0.959 (n=105)
GPCOG patient score (n=145)	0.878	0.901	0.948 (n=113)
GPCOG informant score (132)	0.881	0.856	0.918 (n=105)

* Recommended scoring methods for the MMSE and the GPCOG.

Appendix 9.13

Table 9.13: Significance values (p values) when comparing the area under the ROC curve for the three screening tools based on recommended scoring methods

Instruments compared	Dementia sample includes 33 other subjects with a cognitive disorder NOS (any cognitive impairment vs normal cognition)	Normal sample includes 33 subjects with a cognitive disorder NOS (dementia vs non-dementia)	Analysis sample excludes 33 subjects with a cognitive disorder NOS (dementia vs normal cognition)
RUDAS/MMSE	0.65	0.45	0.52
RUDAS/GPCOG 2 stage	0.43	0.61	0.34
MMSE/ GPCOG 2 stage	0.24	0.19	0.11

Appendix 9.14

Table 9.14: Sensitivity, specificity and the sum of both, based on three variations of sample grouping

Instruments	Dementia sample includes 33 other subjects with a cognitive disorder NOS (any cognitive impairment vs normal cognition)	Normal sample includes 33 subjects with a cognitive disorder NOS (dementia vs non-dementia)	Analysis sample excludes 33 subjects with a cognitive disorder NOS (dementia vs normal cognition)
RUDAS – Recommended <23 (22 or less)	Sensitivity: 72.5% Specificity: 90% Sum of both: 162.5%	Sensitivity: 87.9% Specificity: 77.4% Sum of both: 165.3% **(Optimal)**	Sensitivity: 87.9% Specificity: 90% Sum of both: 177.9%
RUDAS – at <25 (24 or less)	Sensitivity: 85.7% Specificity: 85% Sum of both: 170.7% **(Optimal)**	Sensitivity: 96.6% Specificity: 66.7% Sum of both: 163.3%	Sensitivity: 96.6% Specificity: 85.5% Sum of both: 182.1% **(Optimal)**
MMSE – Recommended <24 (23 or less)	Sensitivity: 64.8% Specificity: 88.3% Sum of both: 153.1%	Sensitivity: 79.3% Specificity: 78.5% Sum of both: 157.8%	Sensitivity: 79.3% Specificity: 88.3% Sum of both: 167.6%
GPCOG (2 stage) – Recommended <9 (8 or less)	Sensitivity: 89.3% Specificity: 80.4% Sum of both: 169.7%	Sensitivity: 98.1% Specificity: 61.6% Sum of both: 160.3%	Sensitivity: 98.1% Specificity: 80.4% Sum of both: 178.5%

*

Appendix 9.15

Table 9.15: Positive and negative likelihood ratios for all three screening tools based on recommended and optimal cut points

Instrument	Likelihood ratio (LR) measure	Dementia sample includes 33 other subjects with a cognitive disorder NOS (any cognitive impairment vs normal cognition)	Normal sample includes 33 subjects with a cognitive disorder NOS (dementia vs non-dementia)	Analysis sample excludes 33 subjects with a cognitive disorder NOS (dementia vs normal cognition)
RUDAS – (<23) Recommended	Positive LR Negative LR	7.250 (m) 0.306 (smbi)	3.889 (smbi) 0.156 (m) **(Optimal**)	8.79 (m) 0.134 (m)
RUDAS – (<26) Optimal	Positive LR Negative LR	5.713 (m) 0.168 (m) **(Optimal**)	2.901 (smbi) 0.051 **(s)**	6.662 (m) 0.040 **(s)** **(Optimal**)
MMSE – Recommended	Positive LR Negative LR	5.538 (m) 0.398 (smbi)	3.688 (smbi) 0.264 (smbi)	6.778 (m) 0.234 (smbi)
GPCOG (2 stage) - Recommended	Positive LR Negative LR	4.556 (smbi) 0.133 (m)	2.55 (smbi) 0.031 **(s)**	5.005 (m) 0.024 **(s)**

(s -strong evidence, m = moderate evidence, smbi = small but may be important)

Appendix 9.16

Table 9.16: Demographic characteristics - CALD vs Non-CALD

Characteristics	***CALD (n=64)***	***NON –CALD (n=87)***
Age mean (SD)	78 (7.5)	77 (9.8)
Age range	53 - 94	46 - 97
Gender (%)		
• Female	78%	63%*
• Male	22%	37%
Years of education (Mean; SD)	5 (2.8)	10 (3.5)*
Type of education (%)		
• Primary or no formal education	81%*	14%
• Secondary or above	14%	83%*
• Missing data	5%	3%
Marital status (%)		
• Married	45%	46%
• Widowed	45%	40%
• other	10%	14%
Living arrangements (%)		
• Alone	25%	39%
• Other (with family etc)	73%	61%
• Missing data	2%	0%
Principal carer (%)		
• No carer required / available	20%	53%*
• Resident carer	59%	26%
• Non-resident carer	19%	21%
• Missing data	2%	0%
Informant present:		
• Yes	69%	52%*
• Contacted by phone	17%	9%
• No	14%	39%

Years of education: 8 missing data

* p = < 0.05

Appendix 9.17:

Table 9.17: Cognitive assessment characteristics CALD vs Non-CALD

Cognitive assessment instrument	***CALD (n=64)***	***NON –CALD (n=87)***
Cognitively impaired (yes/no) based DSMIV classification	44 (69%)	47 (54%)
No cognitive impairment based on the CDR total score[#]	19%	41%*
RUDAS (median, IQR))	20 (15 – 25)	25 (20 – 28)*
MMSE (median, IQR)	19 (15 – 24)	28 (24 – 29)*
GPCOG patient score (median, IQR)	3 (1 – 6) [n=60]	7 (4 – 9)* [n=87]
GPCOG informants score (median, IQR)	2 (0 – 4) [n=58]	3 (1 – 5)* [n=74]
GPCOG Total score (median, IQR)	5.5 (2 – 9) [n=58]	10.5 (5.75 – 13)* [n=74]
GPCOG modified score based on 2 stage process	3 (1 – 8) [n=59]	9 (4 – 9)* [n=81]

The overall CDR score has 5 categories of cognitive impairment: none, questionable, mild, moderate and severe. The above analysis compared those with no cognitive impairment versus other (which includes, questionable impairment, mild, moderate and severe impairment).
*p<0.05