University of Glasgow | College of Medical, Veterinary & Life Sciences

Head of College Scholars List Scheme

Summer Studentship

Report Form

This report should be completed by the student with his/her project supervisor. It should summarise the work undertaken during the project and, once completed, should be sent by email to: jill.morrison@glasgow.ac.uk within four weeks of the end of the studentship.

1. Student

   Surname: **Moran** Forename: **Daisy**

   E-mail address: **2014926m@student.gla.ac.uk**

2. Supervisor:

   Surname: **Quinn** Forename: **Terry**

   E-mail address: **Terry.Quinn@glasgow.ac.uk**

3. Research Project Report

   3.1 Project Title (maximum 20 words):

   The Comparative Utility of Delirium Prediction Tools in an Acute Geriatric Unit

   3.2 Project Lay Summary (copied from application):

   Delirium is a term used to describe a sudden onset, fluctuating disturbance of consciousness that can often accompany illness. Delirium is common in hospitalised adults and is associated with increased length of stay and complications. Various tools to identify patients at high risk of delirium have been developed and can be used to target treatments, but there is no consensus on which tool to use.
   Delirium is particularly common in older adults admitted to hospital as an emergency. Our study will compare different delirium prediction tools, to see how well they work in a "real world" acute medical setting.

3.3 Start Date: **23/06/14** Finish Date: **1/08/14**

3.4 Original project aims and objectives (100 words max):

The aim of this project was to describe the utility of delirium prediction tools in an acute geriatric assessment setting.

Phase 1: we planned to use focussed, systematic literature review to find delirium prediction tools.

Phase 2: we planned to extract data from the casenotes of patients included in a prospective study of delirium screening to allow calculation of our chosen delirium prediction scores. These data allows us to compare the predictive accuracy of various tools.

Phase 3: we planned to perform an external validation of the various prediction tools using an existing dataset from a previous study of delirium.

3.5 Methodology: Summarise and include reference to training received in research methods etc. (250 words max):

This project provided exposure to a variety of clinical research methods, from synthesis of available research; through data management to interpreting results in a clinical context.

Firstly, a systematic literature review was performed using a list of key words to search electronic databases. I screened titles and abstracts for relevance and retrieved full papers. Another independent researcher performed the same search and the results were compared to ensure consistency. This process provided training in critical appraisal; formulating search strategy and using literature search engines.

The selected journal articles described a variety of delirium prediction tools. I tabulated common predictive variables in Excel and incorporated them into a data collection proforma. I used the proforma to extract clinical and demographic data from the electronic medical records of patients enrolled in a clinical study looking at delirium and dementia. This was an opportunity to become familiar with data management and medical terminology. There were also opportunities to observe a geriatric ward round and shadow researchers carrying out cognitive screening assessments.

Following data collection, SPSS software was used to perform comparative univariate and multivariate analysis. Parametric and non-parametric approaches were employed to compare the Delirium and No-delirium diagnosis groups. The Chi-squared statistical test

was used for nominal data and the Mann-Whitney U test was used for interval and ordinal data.

Finally three predictive tools, aligned with the available data from the existing patient cohort, were externally validated. I calculated risk scores for patients and compared the models on sensitivity, specificity and ROC curves.

3.6 Results: Summarise key findings (300 words max). Please include any relevant tables or images as an appendix to this report:

The systematic literature review identified 6341 journal titles (4987 de-duplicated). From these, I identified 34 relevant full texts and found 2 additional articles from screening reference lists. This process is illustrated as a PRISMA diagram. [See Figure 1] The final 36 selected journal articles described 26 different delirium prediction tools. These tools had been developed with sample sizes ranging from 20 to 3570 patients. Healthcare settings included general medicine, acute geriatric units, stroke units, surgery, emergency medicine and critical care.

Many of these delirium prediction tools used the same predictive co-variates. [See Table 1] We selected the most commonly employed co-variates and extracted corresponding data from the local clinical study resource. Delirium diagnoses were available for 131 of the total 153 patients (85.6%). Univariate analysis of these predictive factors against an outcome of Delirium or No-delirium revealed no significant associations when analysed in isolation (all p values were above 0.05). [See Table 2]

Multivariate analysis of these variables was then performed using binary logistic regression (backwards conditional method). Input co-variates were: Age, history of delirium, history of cognitive impairment, sedative use, functional impairment, infection, combined haematology, combined biochemistry, alcohol dependency, visual impairment and the Charlson co-morbidity index. This analysis also showed no significant differences between the Delirium and No-delirium groups.

I selected three predictive models, as described by *Marcantonio* (1994), *Pompei* (1994) and *Martinez* (2012), for independent validation using the existing dataset. The sensitivity, specificity, positive predictive value, negative predictive value and Area Under Curve (AUC) were calculated for each tool. [See Table 3] SPSS statistical software was used to generate corresponding Receiver Operating Characteristic curves. [See Figure 1] The AUCs for the three tools were: 0.606 (Martinez), 0.498 (Pompei) and 0.557 (Marcantonio). None of these exceeded 0.7, the value that is often taken as representing clinical utility.

3.7 Discussion (500 words max):

This project looked at the utility of delirium prediction models in an acute geriatric assessment unit.

Univariate and multivariate analysis suggested no significant association between the risk factors included in delirium prediction tools and the development of delirium in this cohort of patients. Validation of three selected prediction tools found that the chosen models were not sufficiently predictive to have clinical utility.

These findings suggest that tools developed in one medical setting may not be suitable for direct application to other settings, and that external validation is also required. I decided to validate models derived from various settings; 2 of the 3 prediction tools were developed in cohorts either partly or entirely made up of surgical patients. This difference in patient characteristics may explain the lack of significance in our data.

A particular strength of the project was that the systematic review involved a sensitive search strategy and was independently replicated. The clinical data were derived from a study with a robust outcome diagnosis of delirium (recorded by consultant clinicians using the DSM-V criteria).The sample size was modest but still large enough to carry out statistical analysis for the chosen number of variables.

Missing data for certain variables (eg. MEWS Score) was a limitation I encountered during data collection. I had planned to re-run the selected models exactly as described in the original papers; however this proved difficult due to variability between the tools in the way that certain co-variates were operationalised (eg. cognitive impairment and co-morbidity).

I did not find my results to have statistical significance; however they still have relevance to clinical care. The systematic review identified that there are many different delirium prediction tools currently available. These tools have been developed in a variety of medical settings, and involve patients of differing ages and medical conditions. The findings suggest that selecting a pre-formed model and applying it to a different patient group does not necessarily retain the model's predictive power. This means that alterations and further validation may be required if a medical unit were to adopt a delirium prediction tool for routine use. The data would suggest that a multivariate model is required to predict incident delirium, as association with individual covariates was not apparent.

Out of the three prediction tools, Martinez (2012) appears to have the best predictive utility in this group of patients, with a sensitivity of 100%. Its low specificity of 16%, however, means that the tool incorrectly identifies many patients who do not develop delirium. In this setting, high specificity may not be essential as interventions to reduce delirium risk have no medical side effects on non-delirious patients (eg. ensure glasses are worn by visually impaired patients and prevent dehydration). Despite this, there may be implications in regards to cost, resources and staff time that would require consideration.

It would be useful to confirm these findings in future studies, ideally with a larger sample size. Another possible area of investigation would be to compare how the other prediction models compare in utility.

4. Reflection by the student on the experience and value of the studentship (300 words max):

I have found this studentship to be an extremely valuable experience, providing me with an insight into the everyday tasks involved in clinical research. I have learned a number of transferable skills during my time here, including the searching of electronic literature databases, navigating the NHS IT system and clinical records, as well as using Excel and SPSS to statistically analyse data.

This project has taught me how important it is to have a clear research aim and plan; whilst also being flexible due to the occasional unpredictability of research. I have also learned the importance of being accurate and consistent, particularly when extracting and tabulating large amounts of data from patient case notes.

Delirium is a condition I had not come across before starting this studentship. I feel I now have a much better understanding of its prediction, precipitating factors and diagnosis, which I am sure will prove useful in my future clinical years.

This project has shown me how interesting medical research can be, and also how important it is in informing clinical practice. Taking part in the Head of College Scholars List Scheme has encouraged me to get involved in more research in the future and I am now planning to undertake an intercalated BSc degree after my third year. I would recommend other students to take this opportunity, particularly if they have had no prior research experience.

I would like to thank my supervisor and all the members of the delirium research team at the Glasgow Royal Infirmary for their help and for being very welcoming.

5. Dissemination: (note any presentations/publications submitted/planned from the work):

I have been invited to present the findings of this project at the Young Delirium Researchers meeting at the University of Birmingham in September.

The dataset used in this project is part of an ongoing clinical study and there will be an opportunity to update the analysis with a larger sample size. The systematic review and prognostic analyses are related but could be presented as individual work.

The ultimate aim is to share results with clinicians and researchers through presentation at local hospital meetings; national/international scientific meetings and as original research publication(s).

6. Signatures:

Supervisor	Date
	**12.08.14**

Student	Date
	**14.08.14**

APPENDIX

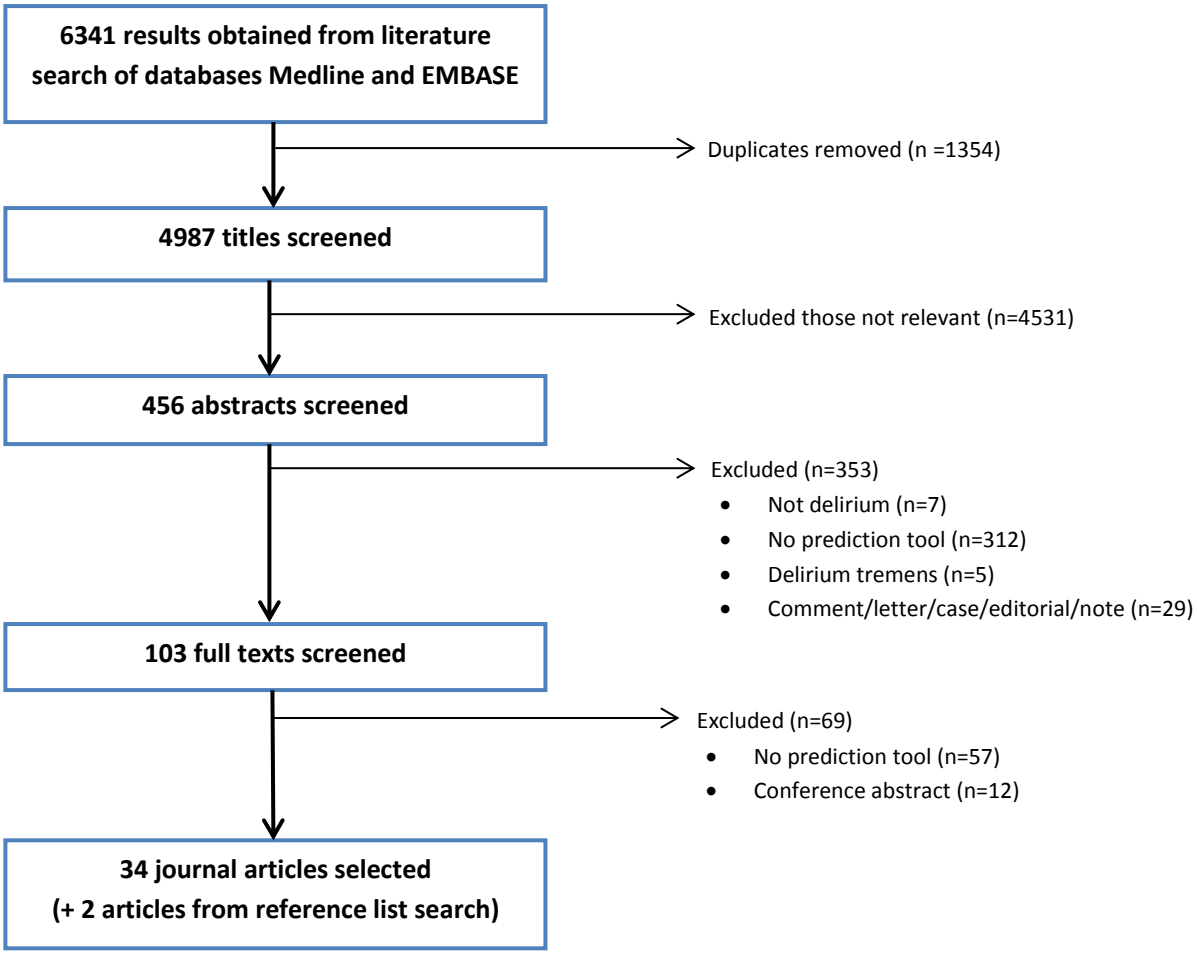

Figure 1. PRISMA Diagram

Delirium Prediction Tool	Age	Vision impairment	History of delirium	Cognitive impairment	Severe illness	Co-morbidity	Depression	Alcohol dependancy	Abnormal biochem.	Functional impairment	Surgical factors	Infection	Coma	Abnormal haematology	Sedative use	Stroke factors
Fisher & Flowerdew (1995)				X												
Pompei (1994)				X		X	X	X								
Marcantonio (1994) & Weed (1995)	X			X				X	X	X	X					
Inouye (1993) Kalisvaart (2006) & Rudolph (2011)		X		X	X				X							
Inouye (1996) & Voyer (2010)		X		X	X				X						X	
Eden (1998)	X					X			X			X				
O'Keeffe & Lavan (1996)				X	X				X							
Levkoff (1988)									X			X		X		
Shah (2012)	X			X				X			X			X		
PRE-DELIRIC (2012)	X				X				X			X	X		X	
Kennedy (2014)	X			X								X				X
Oldenbeuving (2014)	X			X								X				X
Kobayashi (2013)	X			X						X						
Leung (2013)				X							X		X			
AWOL (2013)	X			X	X											
Vochteloo (2011)	X	X	X	X				X		X					X	
Koster (2008)	X				X	X			X	X	X					
Isfandiaty. (2012)				X						X		X				
Martinez (2012)	X									X					X	
Radcliff (2012)	X		X	X						X						
Kostalova (2012) Model 1	X								X							X

Kostalova (2012) Model 2	X				X											X
Rudolph (2009)				X			X		X							X
Goldenberg (2006)	X			X					X					X	X	
Bohner (2003)	X			X			X				X					
Williams (1985)	X			X						X						

Table 1. Simplified table showing co-variate comparison between prediction models

Surgical factors, Stroke factors and Coma were excluded from data collection due to absence of data for this patient cohort

Table 2. Univariate Analysis of Delirium Predictors

Variable		Delirium Absent (n=111)	Delirium Present (n=20)	P value
Age	Data available: n = 131	84 (IQR=8)	84.5 (IQR=8)	0.387
History of delirium	Data available: n = 120	n= 6 (5%)	n=1 (1%)	1.000
Cognitive impairment	Data available: n = 100	n=60 (60%)	n=10 (10%)	0.749
Severity of Illness (MEWS)	Data available: n = 24	1 (IQR=2)	0 (IQR=2)	0.329
Charlson Comorbidity Index	Data available: n = 119	7 (IQR=3)	6.5 (IQR=3)	0.697
Previous Depression	Data available: n = 119	n= 23 (19%)	n= 3 (2.5%)	0.559
Sedative Use	Data available: n = 130	n = 56 (43%)	n= 11 (8.5%)	0.736
Functional Impairment	Data available: n = 115	n= 79 (69%)	n= 18 (16%)	0.071
Infection at admission	Data available: n = 110	n=66 (60%)	n=12 (11%)	0.776
Sodium (mmol/L)	Data available: n = 130	139 (IQR=6)	139 (IQR=9)	0.719
Potassium (mmol/L)	Data available: n = 119	4.10 (IQR=0.8)	4.25 (IQR=1.0)	0.591
Glucose (mmol/L)	Data available: n = 119	6.4 (IQR=2.9)	6.7 (IQR=3.1)	0.873
Albumin (g/dL)	Data available: n = 130	33 (IQR=7)	32.5 (IQR=10)	0.720
Urea (mmol/L)	Data available: n =130	7.50 (IQR=4.3)	8.75 (IQR=7.6)	0.151
Bilirubin (µmol/L)	Data available: n =130	9.0 (IQR=7)	10.5 (IQR=10)	0.164
WBC Count ($X10^9$/L)	Data available: n =130	9.6 (IQR=6.2)	10.4 (IQR=4.0)	0.649
Mean Cell Volume (f/L)	Data available: n =130	90.35 (IQR=10.1)	90.65 (IQR=10.8)	0.951
Haematocrit (L/L)	Data available: n =130	0.377 (IQR=0.066)	0.378 (IQR=0.075)	0.951

Alcohol Dependency	Data available: n = 131	n= 5 (4%)	n= 0 (0%)	1.000
Visual Impairment	Data available: n = 131	n= 32 (24%)	n= 3 (2%)	0.198

Where *n* is not indicated, numerical data is expressed as the median value
IQR = Inter-quartile range

Categorical data is expressed as the number of patients who were positive for each variable
Percentage of cases is in proportion to the total population that data was available for

Table 3. Sensitivity and specificity values of the selected delirium prediction tools

Prediction Tool	Sensitivity	Specificity	Positive predictive value	Negative predictive value	AUC
Martinez *risk score ≥ 1*	100% (83-100)	16% (10-24)	18% (11-26)	100% (81-100)	0.606
Pompei *medium to high risk*	20% (6-44)	74% (65-82)	12% (3-28)	84% (75-90)	0.498
Marcantonio *risk score ≥ 2*	90% (68-98)	15% (9-23)	16% (10-24)	89% (67-98)	0.557

Figures in brackets indicate 95% confidence interval

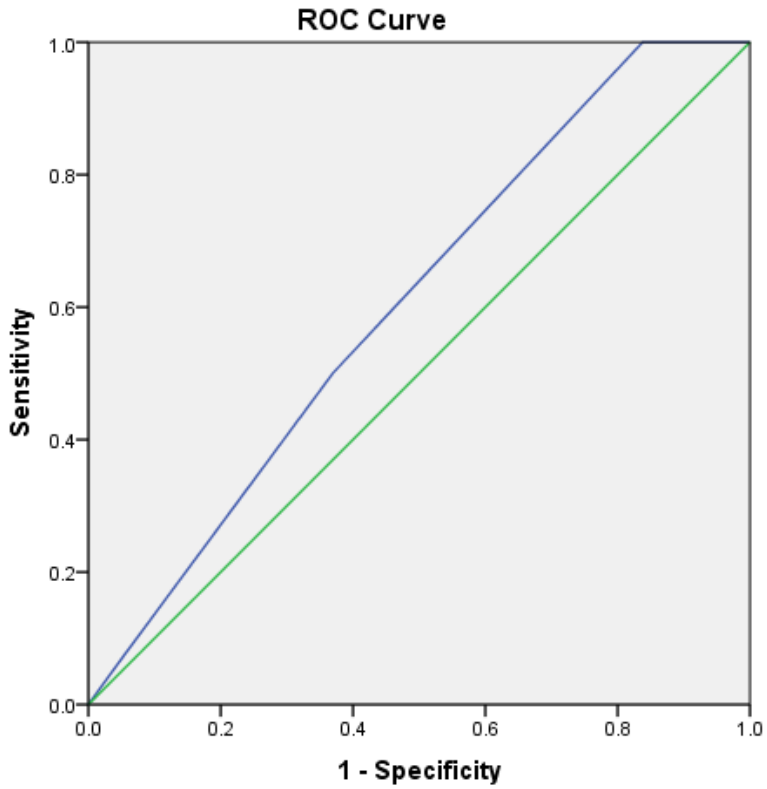

Figure 2. ROC curve for the prediction tool described by Martinez et al. (2012)