Mental Health Clustering Tool

Initial Assessment Algorithm

Technical Guidance

Version 2.5

Document Control

Purpose of this document

The purpose of this Technical Guidance is to provide sufficient detail for technical staff to understand and implement the MHCT Initial Assessment Algorithm within local IT systems.

Version Control

Date	Version	Status	Author	Comments
28/11/12	V2.0	Draft	Darren McKenna	Initial draft
05/12/12	V2.1	Draft	Darren McKenna	Expansion of the draft following development of on-line demonstration algorithm.
07/12/12	V2.2	Draft	Darren McKenna	Updated with corrections and comments from J Painter;
11/12/12	V2.3	Draft	Darren McKenna	Updated with corrections and comments from S Gardener and B Scorer.
14/12/12	V2.4	Draft	Darren McKenna	Updated algorithm version and added web algorithm links.
11/01/13	V2.5	Final	Darren McKenna	Included additional section on validation of data entry.

Version Key:
V1.0 - Outline
V2.0 - Draft
V3.0 - Final

Table of Contents

1 Purpose of the Document

The purpose of this Technical Guidance document is to provide sufficient detail for technical development staff to understand and implement the MHCT initial assessment algorithm.

The guide is aimed at:

- Anyone who would like to understand how the algorithm processes the MHCT assessment scores and derives the percentage fit against relevant clusters.
- Technical development staff that will embed the algorithm into local systems.
- Systems suppliers that wish to embed the algorithm into their systems.

The guide provides details in relation to the logic followed and calculations performed by the algorithm and provides a suggested implementation guide to assist with the presentation of the functionality to clinicians.

2 Background

The Mental Health Clustering Tool is a core component of Mental Health Payment by Results (PbR) . The tool is fully described in the Clustering Handbook, which forms part of the mental health PbR package for 2013-14. This package can be found on PbR pages of the DH website.

The purpose of the tool is to assess a service user's needs and guide clinicians to allocate the service user to 1 of 21 clusters which will be used to define the best package of care to meet the needs of the service user.

The algorithm is an electronic decision support tool to assist the clinician in allocating a service user to the correct cluster based on the clustering handbook. The decision support tool is **not** designed to replace clinical judgement. but is required to ensure consistency of clustering and to improve the overall accuracy of cluster allocation. The clinician should always make the final decision in relation to the most clinically appropriate cluster and must be able to over-ride the algorithm result.

The algorithm has been designed for use with the first MHCT assessment in any Mental Health Clustering Assessment Period (i.e. the assessment and clustering of new referrals to an organisation) and is not appropriate for use to support the decision-making in relation to MHCT reviews.

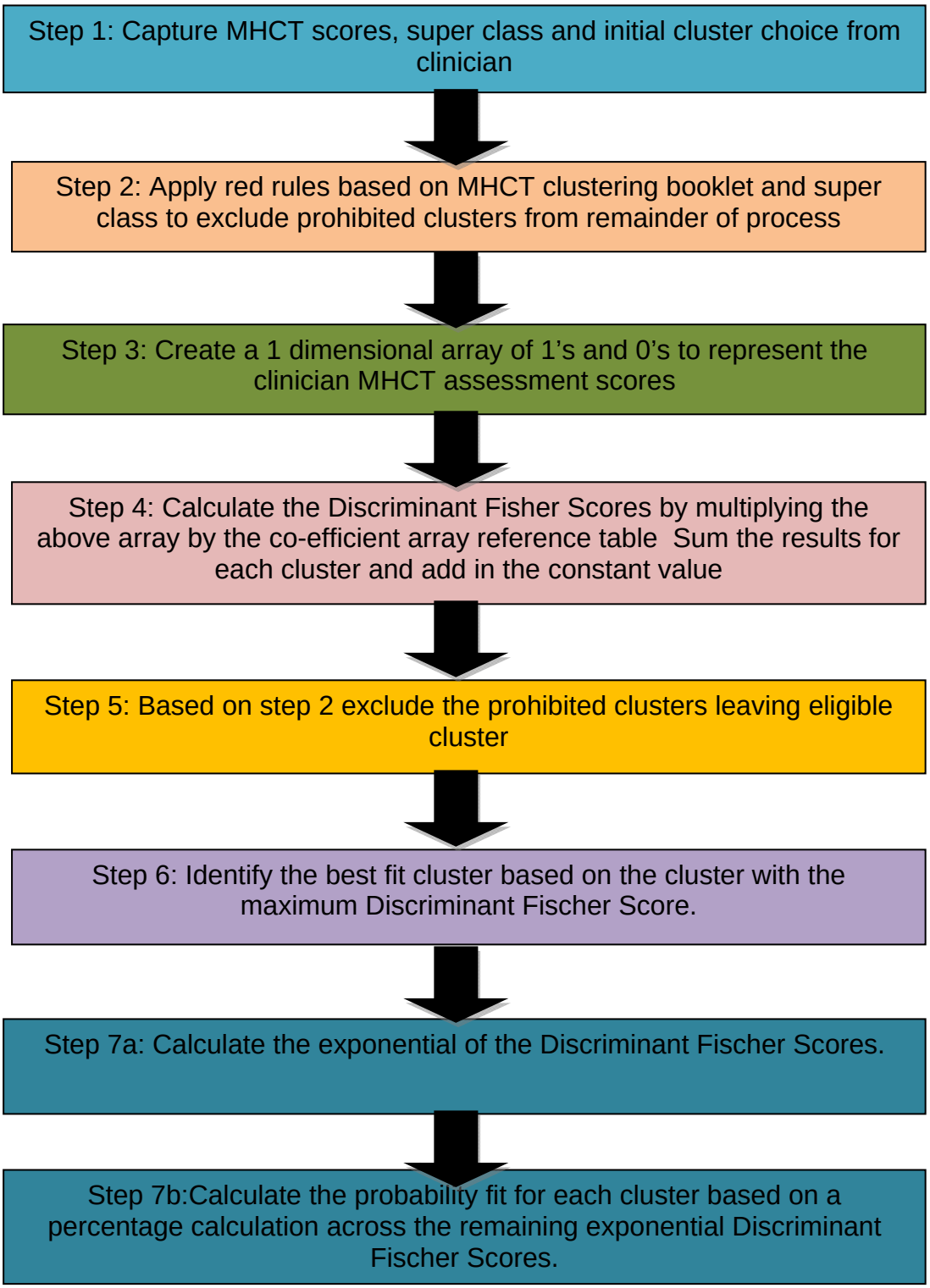
The algorithm is also designed to be used as an on-line, real-time, clinical decision support tool and ideally should be embedded within clinical systems and used as a part of routine clinical recording.

It is possible to pass initial MHCT assessments through the algorithm retrospectively to report the level of agreement between the clinician allocation and the algorithm. This may be useful to identify areas with unusual allocation behaviours that require further investigation. However, the algorithm output should not be used to over-ride the clinically allocated cluster and should never be used to retrospectively overwrite clinically entered clusters.

3 MHCT Initial Assessment Algorithm Technical Detail

3.1 High-level flowchart

The logic of the algorithm is shown below (the box shading matches the shading in algorithm tab in the supporting spreadsheet “MCHT Algorithm v3.3” (see section 6.1): A more detailed description of each step follows with a worked example.



3.1.1 Step 1: Capture Scores

For this worked example, the following information is captured from the clinician:

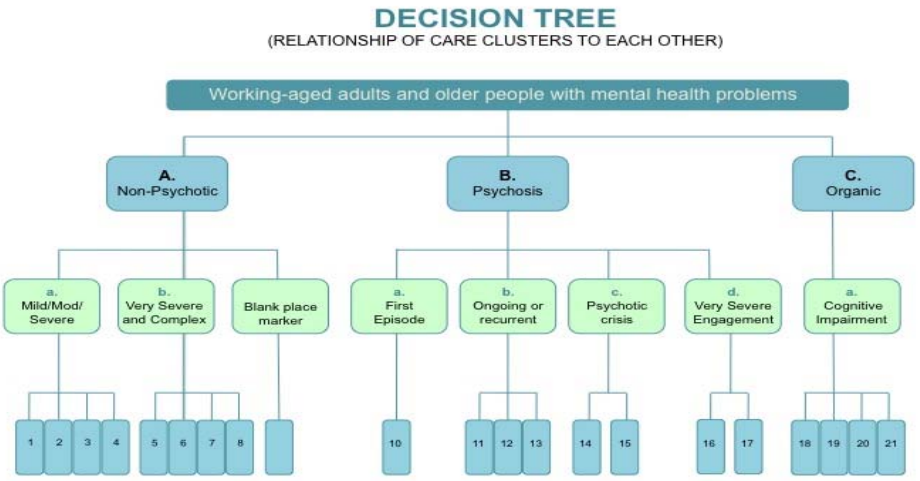
Item #	Description	Score (0 - 4)
1	Overactive, aggressive, disruptive or agitated behaviour	1
2	Non accidental self injury	1
3	Problem drinking or drug taking	1
4	Cognitive Problems	2
5	Physical Illness or disability problems	1
6	Hallucinations and Delusions	1
7	Depressed mood *	1
8	Other mental and behavioural problems *	1
9	Relationships	1
10	Activities of daily living	1
11	Living conditions	1
12	Occupation & Activities	1
13	Strong Unreasonable Beliefs	0
A	Agitated behaviour/expansive mood	0
B	Repeat Self-Harm	0
C	Safeguarding other children & vulnerable dependant adults	0
D	Engagement	0
E	Vulnerability	0

The superclass is C – Organic.

The clinician prediction for this MHCT is 19 - Cognitive Impairment or Dementia Complicated (Moderate Need)

3.1.2 Step 2: Apply Red Rules and Super Class exclusions

Based on the above data the eligible clusters can be identified using the super class/cluster relation diagram in the Clustering Handbook (see diagram below). In the worked example, the super class is C organic, so this excludes all clusters apart from 18-21.



The application of the red rules then excludes cluster 20. This is based on the colour coded rules illustrated in the grids accompanying the description of each Care Cluster in the Clustering Handbook. The grid for Cluster 20 is shown below with the scores captured in step 1 overlaid on the grid (as an X) to show how the red rule for Item 4 is not met.

No	Item Description	Score				
		0	1	2	3	4
2	Non-accidental self injury		X			
3	Problem drinking or drug taking		X			
4	Cognitive Problems			X		
5	Physical Illness or disability problems		X			
6	Hallucinations and Delusions		X			
7	Depressed mood *		X			
8	Other mental and behavioural problems *		X			
9	Relationships		X			
10	Activities of daily living		X			
11	Living conditions		X			
12	Occupation & Activities		X			
13	Strong Unreasonable Beliefs	X				
A	Agitated behaviour/expansive mood	X				
B	Repeat Self-Harm	X				
C	Safeguarding other children & vulnerable dependant adults	X				
D	Engagement	X				
E	Vulnerability	X				

Must score
Expected to score
May score
Unlikely to score
No data available

In the above example, this set of scores will not result in a Cluster 20 being classed as an eligible cluster by the algorithm, as the score for item 4 – cognitive problems is 2 and does not meet the red rules for this cluster as Item 4 must score either 3 or 4.

It is important to note that this step is merely identifying eligible clusters for the process of the algorithm and the clinician can decide to over-ride the algorithm after reviewing the results and still allocate to an non-eligible cluster if it is deemed clinically appropriate.

3.1.3 Step 3: Convert the MHCT scores to an array of 1's and 0's

The next steps require a number of calculations to be performed on the MHCT scores.

To facilitate this, the item scores (0-4) for each item must be programmatically arranged into a 1 dimensional array and the actual score represented by a 1. The start of the array is shown below. For the sake of brevity the full array is not shown but would contain 90 rows in total (18 items x 5 item selections (0-4) = 90). Using the worked example from Step 1 (section 3.1.1) the array is shown for the first 36 rows.

MHCT Item 1 Score 0	0
MHCT Item 2 Score 0	0
MHCT Item 3 Score 0	0
MHCT Item 4 Score 0	0
MHCT Item 5 Score 0	0
MHCT Item 6 Score 0	0
MHCT Item 7 Score 0	0
MHCT Item 8 Score 0	0
MHCT Item 9 Score 0	0
MHCT Item 10 Score 0	0
MHCT Item 11 Score 0	0
MHCT Item 12 Score 0	0
MHCT Item 13 Score 0	1
MHCT Item A Score 0	1
MHCT Item B Score 0	1
MHCT Item C Score 0	1
MHCT Item D Score 0	1
MHCT Item E Score 0	1
MHCT Item 1 Score 1	1
MHCT Item 2 Score 1	1
MHCT Item 3 Score 1	1
MHCT Item 4 Score 1	0
MHCT Item 5 Score 1	1
MHCT Item 6 Score 1	1
MHCT Item 7 Score 1	1
MHCT Item 8 Score 1	1
MHCT Item 9 Score 1	1
MHCT Item 10 Score 1	1
MHCT Item 11 Score 1	1
MHCT Item 12 Score 1	1
MHCT Item 13 Score 1	0
MHCT Item A Score 1	0
MHCT Item B Score 1	0
MHCT Item C Score 1	0
MHCT Item D Score 1	0
MHCT Item E Score 0	0

3.1.4 Step 4 : Calculate the Discriminant Fischer Scores

The next step requires the use of a reference table which contains a set of pre-determined co-efficient values that were derived through Discriminant Analysis applied to a nationally representative data set.

This reference table is contained in Appendix A.

When this table is compared to the array created in the previous step, there is a corresponding column for each row in the array. The column contains a co-efficient value for each item score. The reference table contains 21 rows of these co-efficient values, one row for each cluster. A mathematical calculation is required to multiply each of the values (1 or 0) in the array created in step 3 (section 3.1.3) by the corresponding co-efficient value in the column in the reference table. These calculations are performed for each eligible cluster, so for the worked example this would be clusters 18, 19 and 21.

The sum of all of the multiplications create a total for each eligible cluster and is added to a corresponding constant value for each cluster (also included in the reference table). The total of the multiplication total and the constant is known as the Discriminant Fischer Score.

Using the worked example, this produces a set of values for each cluster and this is shown in detail in appendix B. For brevity, only the co-efficients where a corresponding 1 is present in the array are shown and only eligible clusters are shown. All other values in the array would be 0.

A summary of the resulting calculation from Appendix B is shown below:

Cluster	Array Multiplication TOTAL	Constant Value	Array TOTAL plus Constant
18	26957.67	-13418.23	13539.44
19	26922.28	-13396.31	13525.97
21	26369.67	-13077.37	13292.30

Discriminant Fischer Score

The final total column on the right is the Discriminant Fischer Score for each of the eligible clusters in the worked example.

3.1.5 Step 5 : Exclude prohibited clusters

This step is included for consistency with the spreadsheet model, however, this is effectively implemented in Step 2 (section 3.1.2) above and can be omitted from system development.

3.1.6 Step 6 : The Best Fit Cluster

The “Best Fit Cluster” is the eligible cluster with the maximum Discriminant Fischer Score based on the calculations in step 4 (section 3.1.4).

In the worked example, the Best Fit Cluster is cluster 18 with a value of 13539.44.

3.1.7 Step 7 : Calculate the percentage fit for each eligible cluster

From the Discriminant Fischer Scores for each cluster, the percentage fit for each cluster can be calculated.

This is done by calculating the exponential of the Discriminant Fischer score. In order to ensure that that Excel and programmatic languages can cope with the exponential that is calculated (sometimes the values can be very large) the result is also divided by 100 as shown in the table below.

Cluster	Array Multiplication TOTAL	Constant Value	Array TOTAL plus Constant	EXP/100
18	26957.67	-13418.23	13539.44	6.32481E+58
19	26922.28	-13396.31	13525.97	5.52766E+58
21	26369.67	-13077.37	13292.30	5.34228E+57
			TOTAL	1.23867E+59

From the exponential figure, the percentage fit can be calculated by dividing each exponential value by the total of all the exponentials (1.23867E+59) and multiplying by 100, as shown below:

Cluster	Array Multiplication TOTAL	Constant Value	Array TOTAL plus Constant	EXP/100	% Fit
18	26957.67	-13418.23	13539.44	6.32481E+58	51%
19	26922.28	-13396.31	13525.97	5.52766E+58	45%
21	26369.67	-13077.37	13292.30	5.34228E+57	4%
				1.23867E+59	

4 Results Presentation

The final results need to be presented back to the clinician.

It is recommended that the data captured in stage 1 is displayed along with the algorithm output. This would include the original MHCT assessment item scores, the superclass and the clinician's original cluster.

A list of all of the clusters and their descriptions should be presented to the user as the algorithm output, with the in-eligible clusters as determined in stage 2 (section 3.1.2) greyed out.

For the remaining clusters, the best fit cluster should be highlighted and the percentage fit figure calculated in step 7 (section 3.1.7) displayed against the relevant clusters.

The table below illustrates the algorithm output for the worked example:

	Probability of cluster membership (based on statistical algorithm scores & taking Red Rules into account)	
1	Common Mental Health Problems (Low Severity)	0%
2	Common Mental Health Problems (Low Severity with greater need)	0%
3	Non Psychotic (Moderate Severity)	0%
4	Non-psychotic (Severe)	0%
5	Non-psychotic Disorders (Very Severe)	0%
6	Non psychotic Disorder of Over-valued Ideas	0%
7	Enduring Non psychotic Disorders (High Disability)	0%
8	Non Psychotic Chaotic and Challenging Disorders	0%
10	First Episode Psychosis	0%
11	Ongoing Recurrent Psychosis (Low Symptoms)	0%
12	Ongoing or recurrent Psychosis (High Disability)	0%
13	Ongoing or Recurrent Psychosis (High Symptom & Disability)	0%
14	Psychotic Crisis	0%
15	Severe Psychotic Depression	0%
16	Dual Diagnosis	0%
17	Psychosis and Affective Disorder – Difficult to Engage	0%
18	Cognitive Impairment (Low Need)	51%
19	Cognitive Impairment or Dementia Complicated (Moderate Need)	44%
20	Cognitive Impairment or Dementia Complicated (High Need)	0%
21	Cognitive Impairment or Dementia (High Physical or Engagement)	4%

To further support clinical decision making, a hyperlink from each of the clusters could be presented which would display the relevant scoring grid from the cluster booklet with the scores entered by the clinicianl overlaid on to the grid. An example of this presentation is shown in section 3.1.2

5 Final Clinician Decision

5.1 Clinician Override

Following the presentation of the original MHCT data and the final results, the clinician should be asked to confirm which cluster represents their final clinical decision. This could be the original cluster they chose, the best fit from the algorithm or any of the clusters allowed in the super-class, or Cluster 0 which is the variance cluster signifying that the needs of the service user are not met by any of the clusters (1-21).

In short, the clinician should have the flexibility to completely over-ride the algorithm, and choose any cluster permitted within the super class they have selected or Cluster 0 (see diagram in section 3.1.2)

5.2 MHCT assessment data capture validation

Though the MHMDS v4 specification allows the use of the value “9- not known” in the MHCT assessment, any MHCT assessments including a value of 9 cannot be reliably processed by the algorithm.

When building the algorithm into systems, there should be validation of the scores, and an appropriate alert should be presented to the user where an MHCT assessment including a value of 9 is entered.

It is important that no MHCT assessments including the value “9” are processed through the algorithm so as to avoid anomalous results being presented back to the user.

Batch routines that use the algorithm should also not process MHCTs including values of 9.”

5.3 Additional Data Capture

In addition to the MHCT item scores and super class, it is recommended that the following data items are captured and stored in the database along with each MHCT where the algorithm is used:

1) Clinician’s originally chosen cluster prior to the algorithm presentation
2) The percentage fit for each eligible cluster as calculated in step 7
3) The Clinician’s final choice of cluster following algorithm output presentation
4) A version number relating to the MHCT algorithm cluster (current version 3.3)
5) A version number relating to the software version of the local algorithm

Items 1-3 are required so that further analysis can be carried out on the performance and influence of the algorithm, particularly where frequent changes in the original clinical choice occur or where frequent clinical override of the algorithm is occurring. The capture of these items will allow the analysis of the clinician’s original choice of cluster, the outputs of the algorithm and the final clinical choice.

Items 4 and 5 are important to maintain a record of the version of the algorithm at the time of clustering and will assist change control should the algorithm itself be updated or should change control in the local implementation be necessary (ie bug fixes).

6 Developer Resources

6.1 Excel Spreadsheet

An excel spreadsheet is available and should be viewed in conjunction with this document.

The spreadsheet contains a tab entitled “front sheet” which captures the clinical data and presents the algorithm results.

The “algorithm” tab shows the calculations described in section 3 of this document and is colour coded to match the flowchart in section 3.1.

Important Note
There are 2 versions of this spreadsheet a .xls version for Excel 2003 and earlier and .xlsx for Excel 2007 and later. It is imperative that the correct version is loaded and corresponds with the installed version of Excel. The .xlsx version will load in Excel 2003 if the Microsoft Office compatibility pack is installed, but it will show incorrect results in some circumstances as the number of columns in the .xlsx version exceeds the maximum limit of Excel 2003 and earlier and these columns are truncated without warning. The ,xls version was created specifically for Excel 2003 and earlier and conforms to the column limits of these earlier versions of Excel.

The spreadsheets form part of the mental health PbR guidance package for 2013-14.

6.2 Web based example implementation

The Care Package and Pathways Consortium (CPPP) website hosts an example web based implementation of the algorithm from the clinical capture of data through to the presentation of the output.

This can be accessed at http://www.cppconsortium.nhs.uk/algorithm/

6.3 Web service implementation

In addition to the web based implementation, the Care Package and Pathways Consortium (CPPP) website hosts a web service which allows MHCT assessment item scores to be sent to the site via HTML and the algorithm results returned via XML.

This will allow Trusts to implement the algorithm from local systems/Intranets by calling the web service.

Documentation for the web service is provided on the CPPP website at the address in section 6.2 above.

As noted in section 5.2 above, the algorithm cannot process any MHCT assessments where items are scored as “9 – not know”. If an assessment with an item scored of 9 is presented to the web service, an appropriate error will be returned and the MHCT assessment will not be processed. Developers using the web service should ensure they refer to the documentation provided and build suitable error handling processes into any development that accesses the web service.

6.4 Version control and change management

It is not anticipated that there will be frequent updates to the algorithm, however, as the algorithm is used and its performance analysed, there may be some minor refinement particularly in relation to the scoring grids and red rules as used in Step 2 (section 3.1.2) and the co-efficient values shown in Appendix A and used in step 4 (section 3.1.4).

To ensure consistent version control, developers should record the algorithm version used to during clinical decision support as outlined in section 5.2 above.

To assist change management, it is recommended that the reference table of co-efficient values shown in Appendix A and used in step 4 (section 3.1.4) and the scoring grids and red rules as used in Step 2 (section 3.1.2) are maintained in editable reference tables rather than hard coded into software. The reference tables should be accessible to system administration staff to allow ease of update without the need for suppliers to issue software upgrades. It is important that access to these reference tables is restricted to authorised system administration staff so that strict change control processes can be applied.

Any changes to the data in the reference tables should also require the user to update the algorithm version number (currently 3.3) as referenced in section 5.2 above to maintain an audit trail of which algorithm version has been used at any given time.

7 Acknowledgements

In addition to the Transitions and Algorithms sub group of the Mental Health Product Review Group, the following were involved in the development of the algorithm model and developer resources:

Sam Gardener, Box Clever Consulting
http://boxcleverconsulting.com/

Ben Scorer, Systems Development Manager, Northumberland, Tyne and Wear
http://www.ntw.nhs.uk/

Care Package and Pathways Consortium
http://www.cppconsortium.nhs.uk/

Appendix A – Co-efficient reference table

See separate file

Appendix B – Discriminant Fischer Scores for Worked example

See separate file