

DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

**RISK ADJUSTED HOSPITAL MORTALITY
PREDICTION MODEL:
A CASE STUDY IN A TURKISH TRAINING &
RESEARCH HOSPITAL**

by

Fatma GÜNTÜRKÜN

February, 2019

İZMİR

**RISK ADJUSTED HOSPITAL MORTALITY
PREDICTION MODEL:
A CASE STUDY IN A TURKISH TRAINING &
RESEARCH HOSPITAL**

**A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Doctor of
Philosophy in Statistics, Statistics Program**

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Fatma GÜNTÜRKÜN

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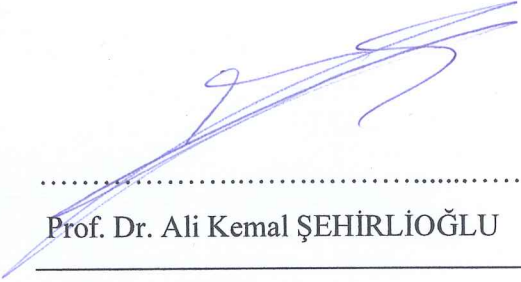
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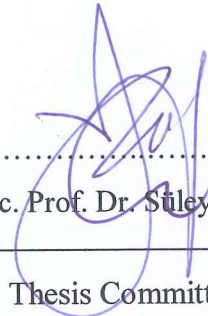
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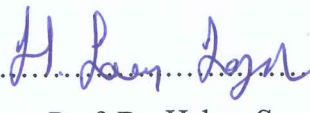
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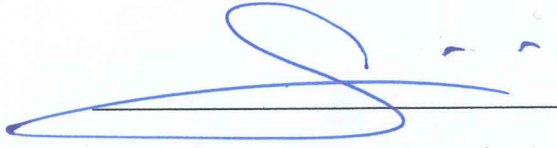
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RISK ADJUSTED HOSPITAL MORTALITY PREDICTION MODEL: A CASE STUDY IN A TURKISH TRAINING & RESEARCH HOSPITAL

ABSTRACT

In today's world, health organizations give much importance to quality and patient safety. To this end, conservation of life and prevent excessive deaths are one of the vital objectives for health services in all countries (Whalley, 2010). Although main function of hospitals is to save lives, there is a little attention to hospital mortality (Champbell et al., 2011). In this context; generating reliable mortality ratio then monitoring them are a prerequisite for improvement in care and development in patient safety. This study aimed to demonstrate the applicability of risk adjusted mortality ratio in Turkey. This is the first study conducted in this field in Turkey. To this end, various risk adjusted hospital mortality prediction models were developed by using some popular data mining techniques; logistic re-gression, decision trees, random forests and artificial neural networks. The data from 30182 inpatients of one of the Turkish training and research hospitals with 1155 beds were used. The data collected from inpatients whose discharge period was January to November in 2014. At the end, the performance of these methods were compared.

Keywords: Risk adjusted mortality, logistic regression, decision trees, artificial neural networks, random forest

RİSK AYARLI HASTANE ÖLÜM TAHMİN MODELİ: BİR TÜRK EĞİTİM VE ARAŞTIRMA HASTANESİNDE UYGULAMA ÖRNEĞİ

ÖZ

Günümüzde, sağlık kurumları kalite ve hasta güvenliğine oldukça önem vermektedir. Bu bağlamda, hayatın korunması ve yüksek ölüm oranlarının önlenmesi tüm ülkelerde sağlık hizmeti sunucularının başta gelen amaçlarından bir tanesidir (Whalley, 2010). Hastanelerin ana amacı hayatın korunması olmasına rağmen hastane ölümlerine olan ilgi azdır (Champbell ve diğer., 2011). Bu nedenle; hasta güvenliğini artırmak ve tedavi hizmetlerini iyileştirmek için öncelikle hastanede kalış sırasında gerçekleşen ölümlere dayalı güvenilir ölüm oranlarının geliştirilmesi ve izlenmesi gerekmektedir. Bu çalışmada risk ayarlı ölüm oranlarının Türkiye’de uygulanabilirliğini göstermek amaçlanmıştır. Bu çalışma bu alanda yapılmış olan ilk çalışmadır. Bu çalışmada; 1155 yataklı bir Türk Eğitim ve Araştırma Hastanesi’nde yatarak tedavi gören ve taburcu tarihi Ocak-Kasım 2014 tarihleri arasında olan 30182 hastanın verileri üzerinden popüler veri madenciliği yöntemlerinden lojistik regresyon, karar ağaçları, rastgele orman metodu ve yapay sinir ağları kullanılarak risk ayarlı hastane ölüm tahmin modelleri geliştirildi. Çalışma sonunda kullanılan tüm yöntemlerin performansı karşılaştırıldı.

Anahtar kelimeler: Risk ayarlı ölüm tahmini, lojistik regresyon, karar ağaçları, yapay sinir ağları, rastgele orman

CONTENTS

	Page
Ph.D. THESIS EXAMINATION RESULT FORM.....	ii
ACKNOWLEDGEMENTS	iii
ABSTRACT.....	iv
ÖZ.....	v
LIST OF FIGURES.....	x
LIST OF TABLES.....	xi
 CHAPTER ONE - INTRODUCTION	 1
 CHAPTER TWO - POPULATION AND HOSPITAL MORTALITY RATIOS.....	 3
 2.1 Population Mortality	 3
2.1.1 Crude Death Rate	3
2.1.2 Age Specific Death.....	3
2.1.3 Standardized Death Rates	3
2.1.4 Infant Mortality Rates	5
2.2 Hospital Mortality.....	5
2.2.1 Risk Adjusted Mortality Measures.....	5
2.2.1.1 Risk Adjusted Mortality Index.....	6
2.2.1.2 Hospital Standardized Mortality Ratio.....	6
2.2.1.3 Scottish HSMR.....	12
2.2.1.4 Summary Hospital Mortality Indicator	15
2.2.2 How to Interpret Risk Adjusted Mortality Measures?	17

2.2.3 Comparison of Risk Adjusted Mortality Measures.....	20
CHAPTER THREE - DIAGNOSES CATEGORIES AND COMORBIDITY SCORING SYSTEMS	22
CHAPTER FOUR - MATERIALS AND METHODS USED IN THIS THESIS	24
4.1 Logistic Regression	24
4.2 Decision Trees.....	26
4.2.1 Classification and Regression Trees	26
4.2.2 Chi-Squared and Exhaustive Chi-Squared Automatic Interaction Detector	27
4.2.3 Exhaustive Chi-Squared and Exhaustive Chi-Squared Automatic Interaction Detector	28
4.3 Artificial Neural Networks.....	28
4.4 Ensemble Methods.....	30
CHAPTER FIVE - CASE STUDY: DEVELOPING A HOSPITAL MORTALITY PREDICTION MODEL IN A TURKISH TRAINING AND RESEARCH HOSPITAL	32
5.1 Data Collection & Preprocessing	32
5.2 Preliminary Analysis.....	33
5.3 Updating Comorbidity Scoring Points.....	37
5.4 Logistic Regression	38
5.5 Decision Tree Modeling	42
5.6 Artificial Neural Networks.....	44
5.7 Random Forest	46

5.8 Comparison the Result of Logistic Regression, Decision Tree, ANN and Random Forest Algorithm	47
5.9 Comparison of Crude Mortality Rates and Standardized Mortality Ratios	46
CHAPTER SIX - CONCLUSION.....	51
REFERENCES.....	53
APPENDICES.....	58
APPENDIX A: CCS Groups in HSMR	58
APPENDIX B: ICD 10 codes of Charlson Categories in HSMR	59
APPENDIX C: CCS Groups & ICD 10 Codes in SHSMR	60
APPENDIX D: ICD 10 codes of Charlson Categories in SHSMR	79
APPENDIX E: CCS Groups in SHMI.....	80
APPENDIX F: Death Rates For Risk Factors.....	83
APPENDIX F 1: Age Groups and Death Rates.....	83
APPENDIX F 2: Age into Three Groups and Death Rates	83
APPENDIX F 3: Sex and Death Rates.....	83
APPENDIX F 4: Number of Emergency Admission in the Previous 12 Months and Death Rates.....	84
APPENDIX F 5: Number of Emergency Admission into Three Groups and Death Rates.....	85
APPENDIX F 6: Source of Admission and Death Rates	85
APPENDIX F 7: Charlson Comorbidity Classification and Death Rates	85
APPENDIX F 8: Charlson_Old Comorbidity Score and Death Rates.....	86
APPENDIX F 9: Charlson_Aylin Comorbidity Score and Death Rates.....	87
APPENDIX F 10: Charlson_Quan Comorbidity Score and Death Rates	88

APPENDIX F 11: Charlson_Old Comorbidity Score (3 Group) and Death Rates	88
APPENDIX F 12: Charlson_Aylin Comorbidity Score (3 Group) and Death Rate	88
APPENDIX F 13: Charlson_Quan Comorbidity Score (3 Group) and Death Rates	88
APPENDIX F 14: Admission Month and Death Rates	89
APPENDIX F 15: Admission Month (2 Group) and Death Rates	89
APPENDIX F 16: Clinical Classification System (CCS) and Death Rates	89
APPENDIX F 17: Diagnoses Classification of SHMR and Death Rates	94
APPENDIX F 18: Diagnoses Classification of SHSMR and Death Rates	97
APPENDIX F 19: Diagnoses Classification of HSMR and Death Rates	97
APPENDIX F 20: Charlson_Updated Beta Comorbidity Score and Death Rates	98
APPENDIX F 21: Charlson_Updated Odds Comorbidity Score and Death Rates	99
APPENDIX F 22: Charlson Updated Beta Comorbidity Score (3 Group) and Death Rates	99
APPENDIX F 23: Charlson_Updated Odds Comorbidity Score (3 Group) and Death Rates	99
APPENDIX G: Rules Generated From CHAID Algorithm	100
APPENDIX H: Abbreviation	130

LIST OF FIGURES

	Page
Figure 2.1 Dr Foster Intelligence Hospital Guides	7
Figure 2.2 Example of Posters in Hospital Guides.....	8
Figure 2.3 Mortality Analysis of Trusts in United Kingdom.....	9
Figure 2.4 Overview of Mortality Measures of all Trusts	9
Figure 4.1 Example of a Neural Network Architecture	29
Figure 5.1 Deaths Rates of Diagnoses Groups.....	35
Figure 5.2 Deaths Rates of Charlson Comorbidity Score Groups.....	35
Figure 5.3 Deaths Rates of Age Groups	36
Figure 5.4 Deaths Rates of Sex Groups	36
Figure 5.5 Deaths Rates of Source of Admission Groups	36
Figure 5.6 Deaths Rates of Number of Emergency Admissions in Last 12 Months Groups.....	36
Figure 5.7 Deaths Rates of Admission Month Groups	37
Figure 5.8 Contribution of Each Risk Factor to the Model.....	46
Figure 5.9 Performance Measures of the Logistic Regression, Decision Tree, ANN and Random Forest.....	48
Figure 5.10 Comparison of Crude Mortality Rates and Standardized Mortality Ratios	49

LIST OF TABLES

	Page
Table 2.1 Surgical Specialty Codes in Scottish HSMR	13
Table 2.2 Description of Elective & Non-Elective Admission	14
Table 2.3 Category Levels for Age.....	17
Table 2.4 Category Levels For Admission Method.....	17
Table 2.5 Category Levels For Charlson Comorbidity Index	17
Table 2.6 Category Levels For Sex	17
Table 2.7 Comparison of Risk Adjusted Mortality Measures.....	21
Table 5.1 Number of Deaths in Training and Test Dataset 1.....	33
Table 5.2 Number of Deaths in Training and Test Dataset 2.....	33
Table 5.3 Age Groups and Age Range.....	34
Table 5.4 Updated Charlson Comorbidity Points.....	38
Table 5.5 Performance Measures of the Logistic Regression Models	39
Table 5.6 Model Summary of Charlson Aylin Comorbidity Score Model of Logistic Regression	39
Table 5.7 Correct Prediction Rate of Charlson Aylin Comorbidity Score Model of Logistic Regression.....	40
Table 5.8 Variables in Charlson Aylin Comorbidity Score Model of Logistic Regression	40
Table 5.9 Performance Measures of the CART Algorithm	43
Table 5.10 Performance Measures of the CHAID Algorithm.....	43
Table 5.11 Performance Measures of the Exhaustive CHAID Algorithm	43
Table 5.12 Model Summary of Updated Charlson (odds) Comorbidity Score Model of CHAID.....	44
Table 5.13 Correct Prediction Rate of Updated Charlson (odds) Comorbidity Score Model of CHAID.....	44
Table 5.14 Performance Measures of the Artificial Neural Network Models	45
Table 5.15 Network Information of Charlson Comorbidity Score Model of ANN Model	45

Table 5.16 Correct Prediction Rate of Charlson Comorbidity Score Model of ANN Model	46
Table 5.17 Comparison the Result of Decision Trees and Random Forest	47
Table 5.18 Correct Prediction Rate of Charlson Aylin Comorbidity Score Model of RF Model	47
Table 5.19 Performance Measures of the Logistic Regression, Decision Tree, ANN and Random Forest	48
Table 5.20 Standardized Mortality Ratios of SHSMR Diagnoses Categories	50



CHAPTER ONE

INTRODUCTION

Florence Nightingale was one of the important person to detect the importance of measuring survival rates in the late 1850. She highlighted the variation of hospital death rates in London and pointed out that these variation was not just because of the differences in the health of local populations but also due to the differences in the quality of medical care at different hospitals. In this context; generating reliable mortality statistics then monitoring them are a pre-requisite for improvement in care and development in patient safety. And, these statistics are interested and used by different kind of sections such as clinicians, managers of hospitals, government departments, local authorities, academics, private sector organisations like banks and insurance companies (Daniels, Clarke, Swain & Studley, 2013).

One basic way of constructing mortality statistics is based on deaths in whole populations. Since wide interest on excessive deaths, there is also need for mortality measures based on deaths in hospitals only. We can measure hospital mortality in three ways: (I) examining case notes of all deaths, (II) crude mortality rates and (III) risk adjusted mortality measures (Daniels et al., 2013).

Hospital performance is monitored in Turkey since 2013. One of the monitored ratios is the crude mortality ratio. Monitoring the crude mortality ratio in hospitals with different structure is problematic. Palliative care can be provided in 16 beds of a 50-bed hospital. In another 50-bed hospital, there is no intensive care unit and only clinical services can be provided. In this case, the performance of the hospital, which provides palliative care, seems poor because of the high mortality ratio. In this thesis, risk adjusted mortality ratios that will enable us to make a more reliable comparison were studied. In this context, some popular risk adjusted mortality ratios in literature is examined. A comparison table was prepared including the information about which databases, statistical methods, covariates etc. they used. In the second part of this thesis, a case study on the developing risk adjusted mortality prediction model is presented. The aim of this study is to show whether risk adjusted mortality ratios are

applicable in Turkey or not. We collected data from different databases and processing our data. We constructed risk adjusted mortality prediction models using different data mining techniques. At the end, performance of these models were compared using different performance measures.



CHAPTER TWO

POPULATION AND HOSPITAL MORTALITY RATIOS

2.1 Population Mortality

Various population mortality measures as crude death rate, age specific death, standardized death rate and infant mortality rates are demonstrated below.

2.1.1 Crude Death Rate

It is the simplest death rate and easily computed by as follows:

$$\text{crude death rate} = \frac{\text{total number of deaths in a given year}}{\text{total mid – year population}} * 1000 \quad (2.1)$$

2.1.2 Age Specific Death

It is more beneficial than crude death rate when comparing mortality levels in different populations since it specifies the mortality variations in different age groups. It is calculated by as stated below:

$$\begin{aligned} &\text{age specific death rate at x years} \\ &= \frac{\text{number of deaths of people aged x years}}{\text{mid – year population aged x years}} * 1000 \quad (2.2) \end{aligned}$$

There are some issues in age specific death rates. If a person dies before mid-year, it is covered in the numerator but not in the denominator. Similarly; if a person's birthday is after mid-year and dies after his birthday but before the next calendar year is aged x at mid-year but aged x+1 when they die so is covered in the denominator for the age specific death rate at age x but the numerator for age specific rate aged x+1 (Daniels et al., 2013).

2.1.3 Standardized Death Rates

It takes time to compare mortality levels between populations with the help of age specific death rates. Standardisation provides us just one rate for each population so it

makes easier to make a comparison. It can be done by using one or more factors that affect mortality levels such as age (commonly used), sex, education, income etc. It can be computed as direct standardisation or indirect standardisation.

➤ **Direct standardisation by age:**

In direct standardization, the number of expected deaths for a given age can be computed by multiplying the age specific death rate in the population by the number of people at that age in the standard population. Then, add the number of expected deaths for each age and divide the obtained result by the total standard population (Daniels et al., 2013).

$$\text{Directly standardized death rate} = \frac{\text{total expected death}}{\text{total standard population}} * 1000 \quad (2.3)$$

➤ **Indirect standardization by age:**

In indirect standardisation, the number of expected deaths for a given age can be computed by multiplying the number of people at that age in the population by the age specific death rate in the standard population. Then, divide the number of observed deaths for each age by the number of expected deaths and obtain standardized mortality ratio. And, indirectly age standardized rate can be calculated by multiplying the standardized mortality ratio by the crude death rate of the standard population (Daniels et al., 2013).

$$\text{Standardized mortality ratio} = \frac{\text{observed deaths}}{\text{expected deaths}} \quad (2.4)$$

$$\begin{aligned} &\text{Indirectly standardized death rate} = \\ &\text{Stand. mortality ratio} * \text{crude death rate std. pop.} \end{aligned} \quad (2.5)$$

2.1.4 Infant Mortality Rates

As mortality rates of infants are higher than those of a little bit older children, several rates have been constructed to monitor infant mortality. The formula for infant mortality rate is shown below:

$$\text{Infant mortality rate} = \frac{\text{Deaths under one year of age}}{\text{Total live births in a calender year}} * 1000 \quad (2.6)$$

We can calculate three other infant mortality rates by taking different kind of deaths in the numerator:

- the early neonatal mortality rate (deaths under seven days),
- the neonatal mortality rate (deaths under 28 days),
- the post-neonatal mortality rate (deaths between 28 days and one year).

Moreover there are two infant mortality rates using the sum of live and stillbirths as the denominator:

- the stillbirth rate (deaths from 24 weeks gestation) and
- the perinatal mortality rate (stillbirths and early neonatal deaths) (Daniels et al., 2013)

2.2 Hospital Mortality

2.2.1 Risk Adjusted Mortality Measures

The number of factors can influence health, so when calculating the risk of death we should consider several factors like demographic properties, diagnostics and procedural information. Several methods, all of which are subjective measure, for measuring risk adjusted mortality in hospitals exists in literature and there is no true way of measuring hospital death rates (NHS, 2013). So, we should be careful when interpreting these measures. If these measures can be used accurately, they provide health systems to detect the areas for improvement.

We can use these measures:

- “1. To track change over time against a baseline.
2. To compare performance against a locally agreed target”(1000 Lives, 2010).

Four risk adjusted measures have been developed: (I) Risk Adjusted Mortality Index (RAMI), (II) Hospital Standardized Mortality Ratio (HSMR), (III) Scottish HSMR and the (IV) Summary Hospital-level Mortality Indicator (SHMI). In these measures the number of observed deaths is compared to the numbers of expected deaths which is predicted by models.

2.2.1.1 Risk-Adjusted Mortality Index

RAMI was constructed by Susan DesHarnais and her friends in 1988 (Desharnais Chesney, Wroblewski, Fleming & McMahon, 1988). Aim of the measure is to estimate the risk of death during a hospital stay for specific diagnoses and procedures (1000 Lives, 2010). It provides health system to investigate deaths and make improvements over time. It is used in Wales to monitor hospital mortality at a national and organisational level. It is calculated by private company, Caspe Healthcare Knowledge Systems (CHKS). When constructing the model, they used diagnoses related group (DRG) database in a cohort of 300 hospitals for 1983 and 1984. They regrouped DRGs and developed models for each of them. They used logistic regression (LR) model for 64 DRG clusters with cluster death rates 5% or higher and the contingency table model for the other DRG clusters. The predictive variables that used in the model are patient's age, gender, race, diagnosis related groups, presence or absence of co-morbidity, presence of any secondary diagnosis. It excludes patients receiving palliative care. After a patient is admitted to any hospital in England or Wales, the information of that patient are recorded on the CHKS system. Then, these data is demonstrated monthly to show for each Health Board and Trust the number of observed deaths, expected deaths and the RAMI (1000 Lives, 2010).

Performance awards were given every year in different categories mentioned below by CHKS. Risk adjusted mortality measures were used as an important evaluation criteria in most of the categories. They say that if a trust want to be better than its peers, it should be more efficient, more effective, safer for patients and has lower mortality.

- The CHKS Top Hospitals Award: 22 indicators (two of them are risk adjusted mortality measures) were used in the evaluation of “clinical effectiveness, health outcomes, efficiency, patient experience and quality of care”.
- Quality of Care Award: 12 indicators (two of them are risk adjusted mortality measures) were used for evaluation of the quality of care to patients.
- Patient Safety Award: 17 indicators (six of them are risk adjusted mortality measures) were used for evaluation of giving a safe hospital environment for patients.
- Patient Experience Award
- Data Quality Awards
- Quality Improvement Award
- Excellence in Delivering 24-7 Emergency Care Award (New for 2016)

2.2.1.2 Hospital Standardized Mortality Ratio

HSMR was constructed by Professor Sir Brian Jarman and his friends in more than 10 years who is the director of the Dr Foster Unit at Imperial College in 2001. In that year, they published the first national publication of standardized hospital death rates for every hospital in Sunday Times whose name is *Hospital Guide* (Dr Foster Intelligence, 2014). This is the first national publication including comparative measure of quality for trusts in the World. Thenceforth, it has been regularly produced by Dr Foster Intelligence each year (Figure 2.1). Now, it is used by several countries as US, Canada, the Netherlands etc (Wen, Sandoval, Zelmer & Webster, 2008; Jarman et al., 2010).



Figure 2.1 Dr Foster Intelligence Hospital Guides

Now, as you see in Figure 2.2 they publish Hospital Guide by using posters. They prepared four different posters the highlight one of which is “Your mortality rate is your pulse: Keep your finger on it”. In this poster there is an userface that can be reached mortality analysis for all trust in United Kingdom (Figure 2.3). In this analysis, one can see whether the performance of a trust is above/below national level for different patient groups. They analyse SHMI, HSMR (including 56 CCS categories), HSMR 100 (including all deaths), HSMR 3 (mortality level of a trust in 3 years), deaths after surgery, deaths in low risk condition patients, deaths for palliative patients and acute HSMR. If a trust mortality level is higher than national level we see it as a red line whereas if it is lower than national level we see it as a dark blue in the figure. At the end, they summarize the mortality analysis for different patient groups of all trusts in one graph as it seen in Figure 2.4.



Figure 2.2 Example of Posters in Hospital Guides (Dr Foster Intelligence, 2013)

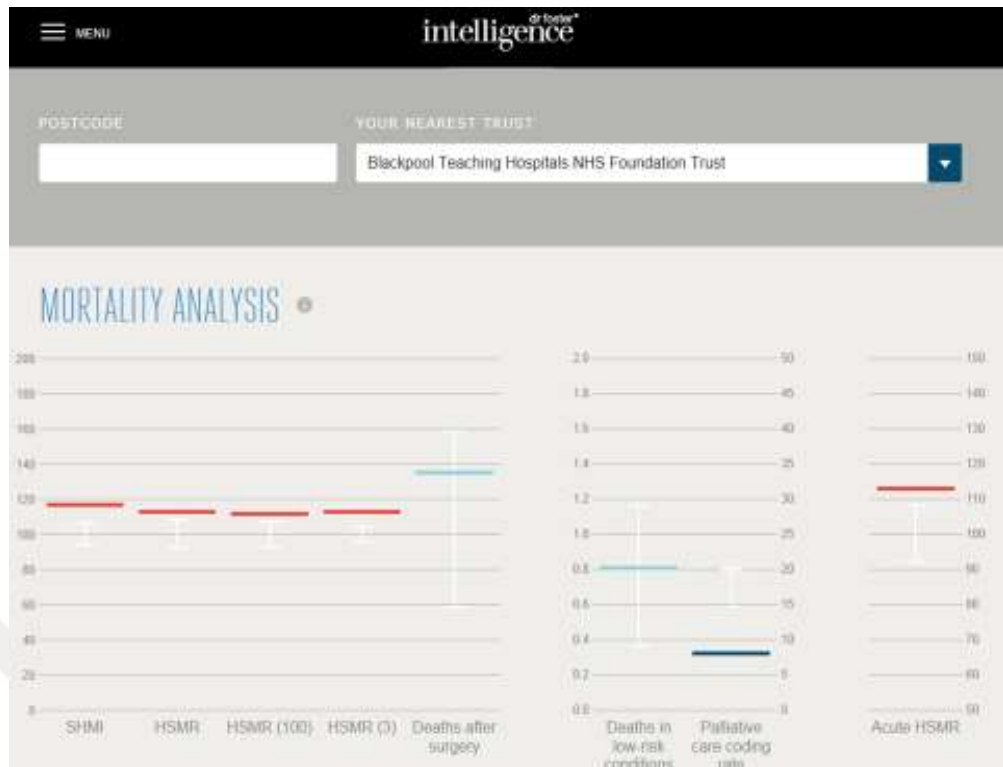


Figure 2.3 Mortality Analysis of Trusts in United Kingdom (Dr Foster Intelligence, 2013)

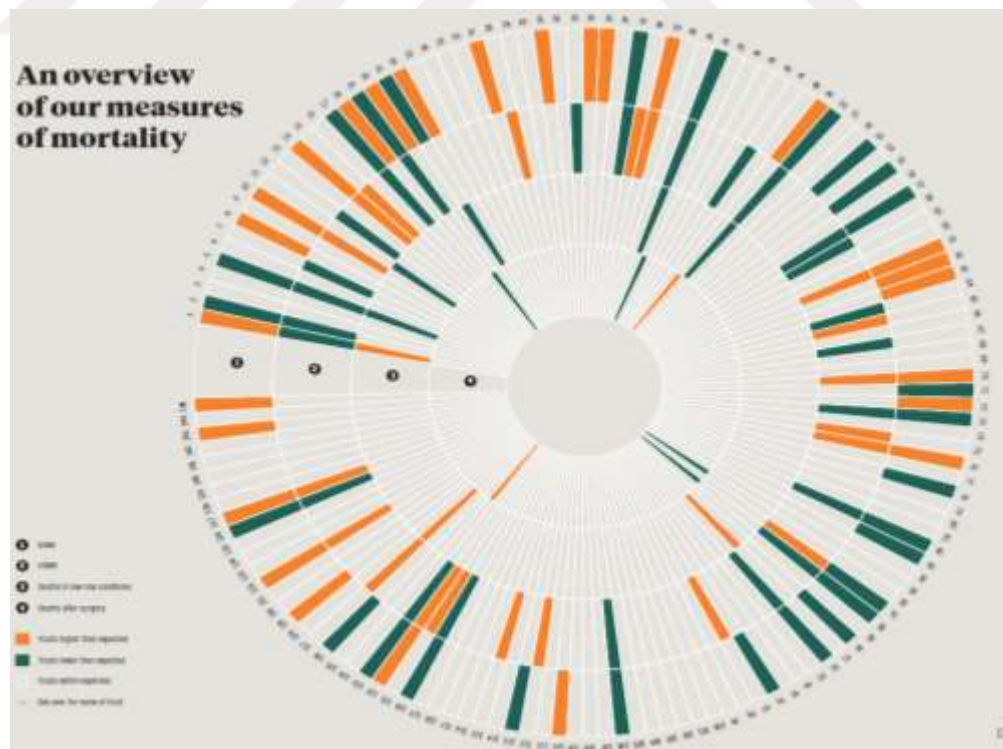


Figure 2.4 Overview of Mortality Measures of all Trusts (Dr Foster Intelligence, 2012)

The HSMR is a useful indicator of patient safety which provides hospitals to investigate deaths and make improvements over time. The Institute for Healthcare Improvement (IHI) in USA, has started to use HSMR in their organizations to developed the safety of patients. They use the headline “Move Your Dot” and try to work for hospitals know more about their organizational performance since it relates to mortality (Dr Foster Intelligence, 2014).

HSMR uses administrative data named as Hospital Episode Statistics (HES), Secondary Uses Service Data (SUS) or Commissioning Datasets (CDS). It focuses 56 CCS diagnosis groups (Appendix A) which includes approximately 83% of in-hospital deaths in England.

Risk factors involved in the HSMR are demonstrated below:

- ✓ Sex
- ✓ Age on admission (in five year bands up to 90+)
- ✓ Interactions between age on admission (in five year bands up to 90+)
- ✓ Admission method (non-elective or elective)
- ✓ Socio-economic deprivation quintile of the area of residence of the patient (based on the Carstairs Index)
- ✓ Diagnosis/procedure subgroup
- ✓ Co-morbidities (based on Charlson score in Appendix B)
- ✓ Number of previous emergency admissions
- ✓ Year of discharge (financial year)
- ✓ Whether or not palliative care (The superspell with treatment function code 315 or contains Z515 in any of the diagnosis, then it is described as palliative)
- ✓ Month of admission
- ✓ Source of admission

For all of the 56 diagnosis groups, the observed number of deaths are the deaths that have occurred after admission in each NHS Trust throughout the specified time period. On the other hand, the expected number of deaths is the sum of the predicted risks of death for all patient (Dr Foster Intelligence, 2014)

The methods used for HRSM in each country are similar, but it can be modified based on the national mortality experience. For instance, the diagnosis groups involved can be differentiated from country to country (1000 Lives, 2010).

When calculating the risks; day cases were excluded from the population and if there is more than one spell with the same diagnostic group (CCS) in a superspell, just the first occurring spell was included. Logistic regression (backward elimination procedure with a cut-off of $p > 0.1$) is used to predict hospital mortality. They evaluated the success of their model by using c-statistics. Each category of risk factors should contain at least 20 events. By this reason, they merge categories starting with the first lowest category (Campbell et al., 2011). To this end, they recategorise four factors: age group, deprivation, comorbidity and number of previous admissions (Aylin, Bottle, Jen & Middleton, 2010).

Ages between 1-120 and 7001-7007 (special codes are using for age in months for children under 1 year) are included in this measure. Identical records (same date of birth, sex, postcode, date of admission and episode number), uncompleted episodes, missing/invalid date of admission and regular attenders are excluded. If spells have the same date of admission but different dates of discharge (valid only if the patient was discharged and readmitted on the same day), earliest dates of discharge spell was optionally taken the valid one. And, episodes of invalid spell are excluded. Episodes are ordered by provider, date of birth, sex, postcode, date of admission, date of discharge and episode number. Episodes are not necessary to be in rigid sequence, they should be just in chronological order. Moreover spells with invalid length of stay are excluded (Aylin et al., 2010).

For each spell they take a diagnosis on the primary diagnosis in the first episode of care. But, if the primary diagnosis is a ambiguous symptom or sign they checked the second episode to determine a diagnosis. If a patient dies after the post-transfer, the death is counted in all the trust in the superspell.

2.2.1.3 Scottish HSMR

The Scottish Patient Safety Programme (SPSP) has been started to decrease hospital mortality in 2008. Information Services Division (ISD) has developed and began to publish HSMR for all Scottish hospitals participating in the SPSP in early 2008 to monitor their progress on decreasing hospital mortality over time. The Scottish Government established the Healthcare Quality Strategy for NHS Scotland consisted of six dimensions of care as person-centred, safe, effective, efficient, equitable and timely. They used 12 quality outcome measures, one of which is HSMR, to monitor processes if they achieve their goals or not (Whalley, 2010; ISD, 2013).

Scottish HSMR and HSMR for English are not compared directly since there are differences in the model and source data. The Scottish HSMR (SHSMR) includes all acute inpatient and day case patients admitted to all specialties (medical and surgical, excluding obstetrics and psychiatry). They considers patients who died within 30 days from hospital admission both deaths that occurred in the community and in-hospital. But, they exclude patients who die in-hospital after 30-days from admission which means it doesn't include all in-hospital mortality (ISD, 2013).

26 diagnosis group including all diagnoses was developed for SHSMR which includes all 56 clinical classification groups from Dr Foster and the remainin diagnoses. These 26 diagnosis group were shown in Appendix C.

At the beginning, they were using one year data for the analysis. Then, they changed it to two years examining a larger range of diagnoses for patients. They used the data from September 2005 to August 2007 since it was the most complete data (ISD, 2013).

A primary diagnose that most account for the patient investigation is chosen as a main condition. If there is more than one such condition, the condition that needs more resources can be chosen as the main condition. Besides, if there is no diagnosis, main symptom, abnormal finding, or problem could be selected as the main condition (ISD, 2013).

Risk factors involved in the SHSMR are demonstrated below (ISD, 2013):

- ✓ Patient's primary diagnosis
- ✓ Specialty (Table 2.1)
- ✓ Age
- ✓ Sex
- ✓ The number and severity of prior morbidities in the previous (i) 12 months
(ii) 5-years (continuous) (based on Charlson categories in Appendix D)
- ✓ The number of emergency admissions in the previous 12 months (continuous)
- ✓ Whether admitted as an inpatient or day case
- ✓ Type of admission (elective / non-elective (Emergency / Transfer)) (Table 2.2)
- ✓ Scottish Index of Multiple Deprivation (Ordered categorical variable: 1 to 5)
- ✓ Where a patient was admitted from (1-Institution, 2-Private residence,
3-Temporary, 4-Transfer from other NHS provider, 5-Transfer from same
provider and 6-Other)

Table 2.1 Surgical Specialty Codes in Scottish HSMR (ISD, 2013)

Code	Surgical Specialty Description
CA	Paediatric Surgery
CB	Urology
C1	General Surgery
C4	Cardiothoracic Surgery
C41	Cardiac Surgery
C42	Thoracic Surgery
C5	Ear, Nose & Throat (ENT)
C6	Neurosurgery
C7	Ophthalmology
C8	Trauma and Orthopaedic Surgery
C9	Plastic Surgery
F2	Gynaecology
D3	Oral Surgery

Table 2.2 Description of Elective & Non-Elective Admission (ISD, 2013)

Type Of Admission	Code	Description
Elective	0	Deferred Admission
	1	Waiting List/Diary/Booked
	2	Repeat Admissions
Non-Elective	3	Transfer
	4	Emergency - Deliberate Self Injury or Poisoning
	5	Emergency - Road Traffic Accident
	6	Emergency - Home Accident (includes Accidental
	7	Emergency - Other Injury (includes Accidental Poisoning other than in the home)
	8	Emergency - Other (excludes Accidental Poisoning)

The risk model and predicted probabilities were calculated using data from October 2006 to September 2007. Then extracted probabilities applied to the data for October 2007 to June 2013. The patient's last stay within each quarter was chosen to determine the number of patients and deaths within each quarter. The outcome and the predictor variables were obtained from the first episode of the stay. If a patient was admitted in different quarters, it will be counted in each quarter. A patient can admitted in one quarter but died in the subsequent quarter, in this case any admissions in this subsequent quarter were excluded (ISD, 2013).

SHSMR does not include palliative care, which means changes over time in palliative care services could be impact on the HSMR. Besides, it doesn't include deaths occurred after 30 days. It should be better re-categorisation of diagnosis and takes account for diagnosis attributed to each patient rather than the first (ISD, 2013).

Scottish Government's Directorate for Health Workforce and Performance publishes The Hospital Scorecard. It includes several indicators one of which is SHSMR. Moreover, it covers other indicators such as readmissions, length of stay, hospital acquired infection rates, waiting times and patient experience. The aim of the scorecard is to take a look with different indicators to a common point in time (ISD, 2013).

In order to monitor long term changes, they use a regression line fitted from the baseline average (October to December 2007) through to the latest HSMR. They also

smooth the variations by adjusted data seasonally. They do it by adding the observed death for that quarter with the three preceding quarters divided by the sum of predicted deaths over the same four quarters (ISD, 2013).

They used decision trees (CHAID method) which is the commonly used data mining techniques when extracting the risk modeling. They used logistic regression also to validate their work. According to the funnel chart (the two mortality rates obtained from LR and DT were plotted on), the rates were very similar. Significance levels is chosen 5% and the minimum number of cases in each node is 100 patients. The constructed tree grouped the 26 primary diagnosis categories into 10 groups (ISD, 2013).

They divided the data into two equal parts randomly. They used one part to construct the model and the other part to test the model. They also used Receiver Operating Characteristic (ROC) curves to detect how model differentiates the two groups. Hosmer-Lemeshow goodness of fit test was also applied to the first sample to see how the model predicts the risk of dying within 30 days.

2.2.1.4 Summary Hospital Mortality Indicator (SHMI)

The HSMR criticized in certain respects such as not including all inhospital deaths, not regarding all patients' comorbidities, not taking the deaths after discharge, not consider readmissions so it may be possible double count one patient death. The Health Social Care Information Centre (HSCIC) developed new methodology based on HSMR in 2011. (Campbell et al., 2012). It is NHS hospital-wide mortality indicator for acute trusts in England.

SHMI uses 140 diagnosis groups (Appendix E) . It covers 100% of deaths in hospital and up to 30 days after discharge from hospital (excluding death on arrival and still births). Deaths are assigned to the hospital where the patient died or from which discharged within 30 days of discharge. Expected probabilities are calculated for all patients (except zero length of stay, emergency cases and day cases).

Risk factors involved in the SHMI are shown below:

- ✓ Age
- ✓ Sex
- ✓ Admission method (elective/emergency)
- ✓ Diagnosis
- ✓ Comorbidity (Based on Charlson)
- ✓ Year of discharge
- ✓ Deprivation score (IMD)
- ✓ Number of emergency admissions in previous 12 months
- ✓ Seasonality (count of days from the beginning of the 3-year data period)
- ✓ Total number of previous complex admissions
- ✓ Ethnicity
- ✓ Admission source
- ✓ Trust-year (identifying the patients admitted to each trust over each of the three included years)
- ✓ The interaction terms age×deprivation score, age×admission source

The excluded variables were palliative care, ethnicity, hospital type, number and severity of prior morbidities smaller than 1 year and greater than 5 years, length of stay and percentage of deaths in the area of the hospital that occur in the hospital (Campbell et al., 2011).

They used 3 year data, 2008/2009 to 2010/2011 (number of hospital spells n=25 414 697) to construct the model. They used 3-year data set because there are unexplained reduction in reported mortality over the 3-year period (Freemantle et al., 2013). They obtained the mortality data from ONS. They built a generalised linear model with a logit link and binomial error. They estimate probabilities of a patient's death for each record. A logistic regression model is constructed for each diagnosis group. Later, indirect standardisation by age group, sex and diagnosis group is then applied (Daniels et al., 2013).

They re-categorised age (Table 2.3), admission method (Table 2.4), diagnosis group (Appendix E), Charlson comorbidity index (Table 2.5) and sex (Table 2.6).

Table 2.3 Category Levels for Age

Category No	Values	Category No.	Values	Category No	Values
1	7000 – 7012	8	30 – 34	15	65 – 69
2	1 – 4	9	35 – 39	16	70 – 74
3	5 – 9	10	40 – 44	17	75 – 79
4	10 – 14	11	45 – 49	18	80 – 84
5	1 – 19	12	50 – 54	19	85 – 89
6	20 – 24	13	55 – 59	20	90 – 120
7	25 – 29	14	60 – 64	21	Missing

Table 2.4 Category Levels For Admission Method

Category No.	Category Description	Values
1	Elective	11, 12, 13
2	Unknown	99
3	Acute	21, 22, 23, 24, 28, 31, 32, 81, 82, 83, 84, 89, 98

Table 2.5 Category Levels For Charlson Comorbidity Index

Category No.	Values
1	0
2	1 – 5
3	> 5

Table 2.6 Category Levels For Sex

Category No.	Category Description	Values
1	Male	1
2	Female	2
3	Unknown	0, 9

2.2.2 How to Interpret Risk Adjusted Mortality Measures?

Risk adjusted mortality measures (RAMM) should be considered as a motivation indicator. It provides us to show how successful hospitals in reducing inpatient death. It shouldn't be interpreted as the number of avoidable deaths instead it should be described as above expected range. RAMM indicates that there might be a problem. In literature, it is considered as a smoke alarm. And, if there is a smoke alarm, we can not ignore it but still it does not always mean there is a fire. Some of the possible

reasons for the changes on the risk adjusted mortality measures are demonstrated below (1000 Lives, 2010):

- Improvements in the quality of care and treatment
- Reductions in injury or harm to people from healthcare they receive
- Changes in the severity of illnesses in patients admitted to hospital that are not fully corrected for (standardized) by the statistical model used to produce risk adjusted mortality measures
- Changes in the provision and variation of palliative and end-of-life care (currently not explicitly factored into the case-mix adjustment due to existing practices for capturing the information)
- Changes to the completeness and accuracy of hospital discharge summaries/clinical coding (reference data quality / clinical coding section)
- Under-reporting of comorbidities (ISD, 2013).
- Inappropriate and/or untimely care
 - Ineffective systems to identify and rescue the deteriorating patient
 - Delays in the process of care e.g. delays to theatre
 - Delays in transferring patients to high dependency unit
- Inappropriate setting of care Problems accessing critical care
 - Medical outliers on surgical wards
 - Inappropriate admissions from nursing homes, e.g. patients admitted to hospital for end-of-life care
- Poor medicines management
 - Antibiotic doses missed
 - Errors in establishing the medication history of patients on admission leading To omission of important drugs
 - Complications from high risk medications e.g. poor control of opiates and Warfarin.
- Hospital acquired infections
 - Surgical site infections
 - Central line associated bacteraemia
 - Ventilator associated pneumonia
- Non-clinical issues Non-clinical issues

The possible factors that affect the outcome of clinical care are:

- Whether the patient has existing underlying health problems when they are admitted to hospital
- Different patients respond differently to the same treatment
- There may be more than one treatment option for the same condition, both of which are acceptable but may cause different outcomes
- The genuine quality of care provided in hospital
- Lifestyle choices such as smoking, obesity and alcohol (NHS, 2013)

Moreover, since the mortality measures predicted using indirect standardisation and computed using different population structures, it shouldn't be compared with each other as a league table for hospitals (Daniels et al., 2013).

Comparison of RAMM scores among the organisations, hospitals should ask themselves:

- ✓ “Are we (really) different?
- ✓ Do we know why?
- ✓ What are we doing about the difference?
- ✓ Are we improving against ourselves?
- ✓ Are we improving relative to everyone else?” (NHS, 2013).

Risk adjusted measures are demonstrated on funnel plots (a type of statistical process control charts) commonly. In these plots y-axis shows the value of the risk adjusted measure and the x-axis presents the expected number of deaths. Upper and lower control limits showing us the random variation in data appear also in the plot. A centre line is also shown in the plot. Points outside the control limits are considered not to be caused by chance. And, it shows us performance diverges significantly from the national rate. Since The PO banding (based on Poisson distribution), assigned too many trusts performing outside the expected range it was abandoned in 2012, but still reported in the SHMI output. Now, it is replaced by OD banding. The NHS Information Centre applies OD banding between 2 but less than 3 SDs to define trusts with death rate which is ‘higher than expected’ (Freemantle et al., 2013). The Hospital Guide publishes the names of outlier trusts annually (Dr Foster Intelligence, 2014).

2.2.3 Comparison of Risk Adjusted Mortality Measures

Differences/similarities between the risk adjusted measures were summarized in Table 2.7. If the desired information of measures couldn't be reached then the related part in the table is left empty.

RAMI and HSMR considers inpatient and day case deaths in hospital whereas SHSMR includes patients who died within 30 days from hospital admission both deaths that occurred in the community and in hospital. But, it excludes patients who die in hospital after 30 days from admission. HSMR excludes episodes with missing age, sex, type of admission and year of discharge and SHSMR excludes episodes with missing sex. On the other hand, there is no exclusions of episodes in SHMI.

Leading risk factor is the patients primary diagnoses. Since the number of diagnoses is too many, a need arose to group them. 26 diagnosis group including all diagnoses was developed for SHSMR. Other measures use diagnoses categories of CCS. While HSMR is focused on 56 CCS categories, SHMI is re-grouped 260 CCS groups up to reach 140 diagnoses groups. Another risk factor Carstairs index for each output area derived from 2001 census within the United Kingdom. It was computed by normalising the unemployment, households without a car or van, households with over one persons per room and low social class variables (Aylin, Bottle, Jen & Middleton, 2010).

Table 2.7 Comparison of Risk Adjusted Mortality Measures

	RAMI	HSMR	SHSMR	SHMI
Year of developed	1988	2001	2008	2011
Who publish	CHKS	Dr Foster Unit	ISD	HSCIC
Publication period		Annually	Quarterly	Quarterly
Time period for constructed model			October 2006- September 2007	2008/2009 to 2010/2011
Databases that they used	CHKS system	HES, SUS, CDS	SMR01 & NRS	
Diagnosis group		56 (CCS)	26 (Scottish groupings)	140(CCS)
Coverage of in-hospital death	86%	83%	Only include those within 30-days of admission	100%
Method	LR	LR	DT (CHAID)	LR
Transfer patients deaths		All hospitals involved in admission	Last admitting hospital	Last admitting hospital
Zero length emergency admissions	X	X	✓	
Day cases		X	✓	X
Still-born babies		X	X	X
Un-coded clinical activity		✓	X	X
Mental health	X		X	
Obstetrics			X	
Maternity	X		X	
Live births	X		X	
Death on arrival			✓	X
Palliative care cases	X	✓	X	✓
Age	✓	✓	✓	✓
Sex	✓	✓	✓	✓
Type of admission		✓	✓	✓
Year of discharge		✓		✓
Year of admission			✓	✓
Month of admission		✓	✓	
Number of emergency admissions in previous 12 months	X	✓	✓	✓
Ethnicity		✓		✓
Source of admission		✓	✓	✓
Race	✓			
Charlson comorbidity index	X	✓	✓	✓
Deprivation	X			✓
Specialty			✓	
Interaction between age&comorbidity		✓		
Interaction between age&deprivation score				✓
Interaction between age&admission source				✓
Severity of prior morbidities in the previous 12 months			✓	
Severity of prior morbidities in the previous 5 years			✓	
Seasonality				✓
Total number of previous complex admissions				✓

CHAPTER THREE

DIAGNOSES CATEGORIES AND COMORBIDITY SCORING SYSTEMS

Diagnoses categories used in this study is based on the Clinical Classifications Software (CCS) developed at the Agency for Healthcare Research and Quality (AHRQ). CCS was developed by using Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project (HCUP) which is a family of databases sponsored by AHRQ. It combines huge number of patient diagnoses and procedures into a manageable number of categories. So researchers, policy makers can easily understand several outcome of the diseases like death, cost, patterns etc. (AHRQ, 2013). CCS includes two classification systems, single-level (260 categories) and multi-level. Single-level CCS is suitable for ranking of diagnoses and risk adjustment whereas Multi-level CCS is good for making detail analyses. ICD 10 codes for each CCS clusters can be reached from the web site (AHRQ, 2014).

The hospital mortality prediction models mentioned above grouped CCS categories into a smaller number of categories. In this study, we used original CCS categories and grouped CCS categories in the models developed by HSMR, SHSMR and SHMI in our analysis.

In this study three different comorbidity score which is computed by using the additional diagnoses of the patient were calculated. These comorbidity scores are based on the scoring system which was developed by Charlson and his friends in 1987. One of these three comorbidity scores was calculated using directly the weights in the study done by Charlson and his friends. And the second one was computed by using the weights presented in the study done by Aylin and his friends in 2010 whereas the third one by using the weights in the study done by Quan and his friends in 2011. In both of these studies the researchers used the same comorbidity classification with the study done by Charlson and his friends but they updated the weights in the scoring system.

Charlson comorbidity score considers 17 different comorbidity groups such as acute myocardial infarction (I21, I22, I23, I252, I258), diabetes (E101, E105, E106, E108 etc.), renal disease (I12, I13, N01, N03, N052-N056 etc.) (Charlson, Pompei, Ales & MacKenzie, 1987). In the training dataset, they made a cohort study during a 1 year follow up with 559 medical patients admitted New York Hospital during 1 month in 1984. And in the test data, they made a cohort study during a 10 year follow up with 685 breast cancer patients admitted to Yale New Haven Hospital between 1962 and 1969. In the training dataset they applied cox regression method and used adjusted relative risks when determining weights in their scoring system. In the test dataset since its follow up time is 10 years they consider age also when predicting the mortality. When combining the age and comorbidity, they add 1 point to risk for each one decade. Up to 40 years they add no points, ages higher than 40 years and lower than 50 years they add 1 point, up to 60 they add 2 points and etc. Except RAMI, this score were used in all measures. The most serious seconder diagnose was consired in RAMI instead of this score.

Quan and his friends were updated and validated Charlson comorbidity scoring system in their study. Since the technology and treatments were changed, the patients started to live longer when comparing with the patients used in Charlson and his friends study. So they think that Charlson weights should be reevaluated by using recent data. They used Calgary, Alberta and Canada data belongs to the year 2004 when developing new weights. They applied cox regression 1 year follow up data by using age, sex and comorbidities as an independent variable. They used rounded adjusted relative risks as new weights. If we compare the new weights with original Charlson score for 5 comorbidities the weight is zero, for 3 comorbidities the weights were decreased whereas increased for 4 comorbidities and not change for 5 comorbidities. Then, they validated their new weights by using the data obtained from 6 countries. They used C-statistics when comparing original and updated weights. And according to these statistics, updated weights gave higher C-statistics in Australian, Canadian and Japanese data and lower C-statistics in New Zealand, Swiss and French data (Quan et al., 2011).

CHAPTER FOUR

MATERIALS AND METHODS USED IN THIS THESIS

Data mining (DM) techniques, which is a new useful and powerful technology that supports institutions to derive strategic information in their databases were used in this study. Firstly, traditional statistical technique as logistic regression (LR) modeling was implemented in the scope of this study. Secondly, decision trees (DT) which is one of the commonly used data mining technique was used. Thirdly, artificial neural networks (ANN) was applied. And lastly random forest (RF) method was performed and the performance of all techniques used in this study were compared with each other. For all analyses, the statistical software R studio and SPSS 22 was used. Results of statistical tests are considered to be significant if two-sided p-value is < 0.05 .

4.1 Logistic Regression

Logistic regression is a traditional statistical technique that classifies observations with categorical response variables. Response variable can be in binary, ordinal or nominal type. It is similar to linear regression. Consider the simple linear regression model with binary response:

$$Y_i = \beta_0 + \beta_1 X_1 + e_i \quad (4.1)$$

Y_i	Probability	(4.2)
1	$P(Y_i = 1) = \pi_i$	
0	$P(Y_i = 0) = 1 - \pi_i$	

$$E\{Y_i\} = 1 * \pi_i + 0 * (1 - \pi_i) = \pi_i = P(Y_i = 1) \quad (4.3)$$

$$E\{Y_i\} = \beta_0 + \beta_1 X_1 = \pi_i \quad (4.4)$$

According to the equations given above when the response variable is binary the mean response given by the linear response function is just the probabilities. However when the response variable is categorical some problems appear like nonnormal error

terms, nonconstant error variance, constraints on response functions. In order to cope with these problems some response functions can be used as probit mean response function, logistic mean response function and complementary log-log response function. These functions approach 0 and 1 asymptotically and bounded between 0 and 1. In simple logistic regression logistic mean response function is used. Logistic distribution is alternative to the normal distribution and it is very similar to the normal distribution. The distribution and cumulative distribution function of a logistic random variable ε_i with zero mean and $\Pi/\sqrt{3}$ standard deviation has a basic form as:

$$f_i(\varepsilon_i) = \frac{\exp(\varepsilon_i)}{(1 + \exp(\varepsilon_i))^2} \quad (4.5)$$

$$F_L(\varepsilon_L) = \frac{\exp(\varepsilon_L)}{1 + \exp(\varepsilon_L)} \quad (4.6)$$

After doing some basic calculations we obtain the logistic mean response function as:

$$E\{Y_i\} = \pi_i = F_L(\beta_0 + \beta_1 X_i) = \frac{\exp(\beta_0 + \beta_1 X_i)}{1 + \exp(\beta_0 + \beta_1 X_i)} \quad (4.7)$$

$$E\{Y_i\} = \pi_i = (1 + \exp(-\beta_0 - \beta_1 X_i))^{-1} \quad (4.8)$$

$$F_L^{-1}(\pi_i) = \beta_0 + \beta_1 X_i = \pi_i' \quad (4.9)$$

$$F_L^{-1}(\pi_i) = \log_e\left(\frac{\pi_i}{1 - \pi_i}\right) \quad (4.10)$$

So, in logistic regression response function gives us the natural logarithm of the odds of the response. So, e^b shows the change in the odds of the response by increasing x by 1 unit. If $b = 0$, it means the odds and probability doesn't change in all x levels. For $b > 0$ the odds and probability increase as x increases whereas for $b < 0$ the odds and probability decrease as x increases.

4.2 Decision Trees

The nonparametric tree shaped structures, DT, were secondly implemented in the scope of this study. Construction of these trees is simple and the results can easily be understood by the users. They can be used to solve classification and prediction problems. In a DT, internal nodes indicates a test on an attribute and branches show the outcomes of the test. At the end of the tree, there are leaf nodes that represent classes. When constructing DT, the data is split into smaller subsets iteratively. At each iteration, determining the best input variable and the cut off points of that variable is an important issue. The split which gives us the most homogenous subsets with respect to the dependent variable should be chosen.

There are several DT algorithms in the literature. In this study, the most common types of decision tree algorithms such as CART, CHAID and Exhaustive CHAID were used in the prediction models.

4.2.1 Classification and Regression Trees

The CART is developed by Breiman et al. in 1984. It determines the best split which gives the most reduction in an impurity index that results from the split. Both of the response and exposure variables can be numeric or categorical. The structure of the tree is binary. It works successfully with large number of exposures and lots of missing values in data. The same exposure can be used more than one in different levels of the tree. For categorical variables, gini or twoing impurity measures can be used. And for continuous variables, the least-squared deviation (LSD) method is used. The Gini index $g(t)$ at a node t in a CART tree is defined as,

$$g(t) = 1 - \sum_j p^2(j|t) \quad (4.11)$$

where i and j are categories of the response variable, and

$$p(j|t) = \frac{p(j, t)}{p(t)} \quad (4.12)$$

Here,

$$p(j|t) = \frac{\pi(j)N_j(t)}{N_j} \quad (4.13)$$

$$g(t) = \sum_j p(j, t) \quad (4.14)$$

Here $\pi(j)$ shows prior probability value for category j . $N_j(t)$ is the number of records in category j of node t and N_j is the number of records of category j in the root node. If the observations in a node are evenly distributed across the categories the Gini index takes its maximum value and if all records in the node belong to the same category it equals to 0.

The LSD measure $R(t)$ is simply the weighted within-node variance for node t . It can be written as;

$$R(t) = \frac{1}{N_W(t)} \sum_{i \in t} w_i f_i (y_i - \bar{y}(t))^2 \quad (4.15)$$

Here, $N_W(t)$ is the weighted number of records in node t , w_i is the value of the weighting field for record i (if any), f_i is the value of the frequency field (if any), y_i is the value of the response variable, and $\bar{y}(t)$ is the (weighted) mean for node t . The split s is chosen to maximize the value of $\Phi(s, t)$. In the formula below, t_L and t_R are the nodes created by the split and p_L is the proportion of observations in t sent to the left child node whereas p_R is to the right child node.

$$\Phi(s, t) = R(t) - p_L R(t_L) - p_R R(t_R) \quad (4.16)$$

4.2.2 Chi-Squared and Exhaustive Chi-Squared Automatic Interaction Detector

The CHAID is introduced by Kass in 1980. It is a highly efficient statistical technique and it works with only nominal or ordinal exposure variables. So, continuous exposure variables are transformed into ordinal.

It can develop trees with more than two branches and deals with missing values by treating them all as a single valid category. The statistical tests are used to select optimal splits. For numeric variables F test is used whereas for categorical variables a chi-squared test is used. It includes three steps: merging, splitting and stopping. In merging step, non-significant categories are merged for each exposure variable. Adjusted p -value is also computed for the splitting step. If exposure variable has just 1 category then the adjusted p -value is equal to 1. If it has more than 2 category any pair of categories which has the highest p -value with respect to the response variable are searched. If that p value is higher than user specified alpha merge value it combines these categories. In splitting step, exposure variable is selected that gives us the smallest adjusted p -value which is less than or equal to a user-specified alpha split value. In stopping step the tree growing process should be stopped when all observations in a node have same values with respect to the response variable or if depth of the tree reaches the user specified maximum tree depth value or if the number of observations in a leaf node is less than user specified minimum leaf node size value.

4.2.3 Exhaustive Chi-Squared and Exhaustive Chi-Squared Automatic Interaction Detector

Exhaustive CHAID is introduced by Biggs et al in 1991. It is a modification of CHAID algorithm. The splitting and stopping steps are the same with CHAID algorithm. The only difference is the merging step. It doesn't use user specified alpha merge value. Rather it merges the categories up to only two categories remain for each exposure variable. So it needs more computing time.

4.3 Artificial Neural Networks

ANN are talented to learn from historical data. They could retrieve meaningful information even complicated non-linear relationship in the dataset. They learn like a human and an example of its topology is shown in Figure 4.1 similar to a human brain.

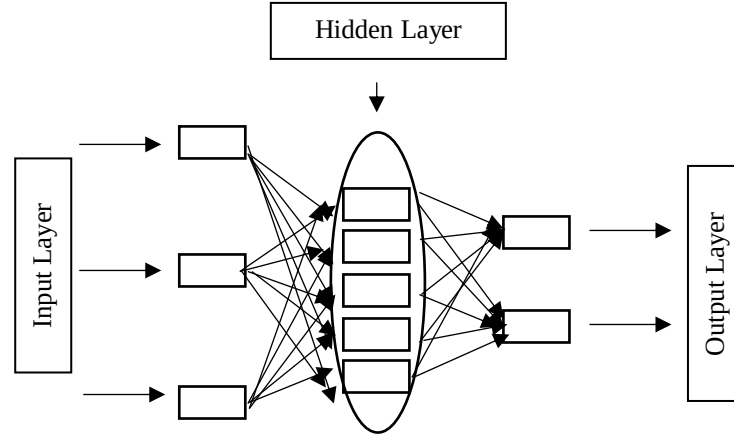


Figure 4.1 Example of a Neural Network Architecture

There are three types of layers in the architecture structure of this method as input, output and hidden layers. Perceptron which has a single neuron with multiple inputs and one output is the simplest ANN. A network of perceptrons is called a multilayer perceptron (MLP). In this method, input layer are connected with hidden layers by some weights and similarly hidden layers are connected with output layers by some weights to predict the target. There can be one or more hidden layer between the input and output layers. It is difficult to determine the number of hidden layers and nodes in each hidden layer and it depends on the study.

An activation function is used to transform the activation level of a neuron into an output signal. These functions helps us introducing nonlinearity into the network. The differentiable nonlinear functions such as step, sigmoid, gaussian, piecewise linear, hyperbolic tangent etc. can be choosen as an activation function.

The weights give us the information about how strongly influence one neuron to the other. When determinig the weights the technique called backpropagation of error is used. At the beginning of learning phase, all weights in the network can be chosen from the interval -0.5 and 0.5 randomly. The prediction is compared with the actual value and the difference between them is propagated backward through the network to adjust the weights as shown below.

$$w_{ij,new} = w_{ij,current} + \Delta w_{ij} \text{ where } \Delta w_{ij} = \eta \delta_j X_{ij} \quad (4.17)$$

$$\delta_j = \begin{cases} \text{output}_j (1 - \text{output}_j) (\text{actual}_j - \text{output}_j) & \text{for output layer nodes} \\ \text{output}_j (1 - \text{output}_j) \sum_{\text{downstream}} W_{jk} \delta_k & \text{for hidden layer nodes} \end{cases} \quad (4.18)$$

where

η : Learning Rate

x_{ij} : i^{th} input to node j

δ_j : responsibility for a particular error belonging to node j .

4.4 Ensemble Methods

Ensemble of a classifier combines several classifiers in order to increase the accuracy of a base classifier. It generates different training sets by resampling of dataset. Then, it creates models from each training sets. When determining the class of a new tuple, it aggregates predictions of the derived models. In general; there are three popular ensemble methods as bagging, boosting and random forest.

The name of bagging comes from bootstrap aggregation. In this method, several bootstrap samples derived by resampling of the original data with replacement. Then, it assigns a class for a new tuple which is most voted by derived models. On the other hand, in boosting method weights are used when generating the samples and assigning the class for a new tuple differently from bagging method. The models in boosting method are generated iteratively. After a model is generated, the weights of the tuples updated for a new model according to the results of the generated model. If the generated model misclassified the tuple then the weight of this tuple increases. By this way, when creating a new training set it focuses on more misclassified tuples. In the same way, when assigning a class for a new tuple it uses model's error rate. If a model has a higher error rate then it gives lower weight to the prediction of that model.

Random forest method uses decision tree when deriving classifiers. Since it uses several randomly generated decision trees for classification it is called random forest. CART methodology is used when growing the tree. For each node, it randomly chooses some of the candidate attributes from whole attributes to determine the split. It is faster than both bagging and boosting algorithm. Moreover, it is more robust to

errors and outliers (Han et al., 1999). Therefore, we decided to perform random forest method in the scope of this thesis.



CHAPTER FIVE
CASE STUDY: DEVELOPING A HOSPITAL MORTALITY
PREDICTION MODEL IN A TURKISH TRAINING AND RESEARCH
HOSPITAL

5.1 Data Collection & Preprocessing

The analyses are derived from DRG data (except the number of emergency admissions in the last 12 months) of one of the Turkish Training & Research Hospital. In order to collect the number of emergency admissions in the last 12 months, we used the Hospital Information Management System. Our data include the records of inpatients and day case patients for the discharge period January to November in 2014. We disregarded the patients transferred to another hospital or quit the treatment. After collecting the data we prepare it for the analyses. First of all we transform ICD 10 codes of the diagnoses into the CCS, CCS groups used in HSMR, SHSMR and SHMI. And, by using the supporting diagnoses we calculated different comorbidity scores as Charlson (Charlson et al., 1987), updating Charlson 1 (Quan, 2011) and updating Charlson 2 (Aylin et al., 2010).

We convert our data to the continuous stay. If a patient discharged from one of the ward and admitted to another ward within a 24 hour period, we considered these stays as a continuous stay. And combined the data of these kind of patients. When combining the data, we take the data of first stay of patients for input variables and the data of last stay for output variable. And for comorbidity score, we used the maximum value within the continuous stay. We excluded the patients who transfer to another hospital and give up their treatments. Then, we divided the data into quarters according to the discharge dates. And we only take the last continuous stay of the patients to the analyses to make our data patient base. As a result, our data include 7 risk factors which are age, sex, number of emergency admissions in the previous 12 month period, source of admission, main diagnoses code, comorbidity score and admission month. Totally 30182 records were used in the analyses 1006 of which belong to the death patients.

To cross validated the model, we divided the data set into two parts which were selected randomly without replacement method both from the alive and death patients. When modeling the data we used %70 (21113) of the data set as a train data and the other part (%30-9069) as a test data (Dataset 1). On the other hand, we faced with imbalanced data problem in our data. In imbalanced data, one of the classes is shown by a very small number when comparing to the other class (Garcia et al., 2012). To change the imbalanced data to a balanced one, the resampling methodology is used. Resampling methodology can be classified into three groups: (I) random undersampling, (II) random oversampling, (III) hybrid methods (Satyasree ve Murthy, 2013). In this study, we used random oversampling to handle with imbalanced data. We repeated our data belongs to the death patients up to make our data balanced and we reached 57344 patient records (Dataset 2). The number of patients whose discharge status is death/alive for each datasets are shown in Table 5.1 and Table 5.2 respectively.

Table 5.1 Number of Deaths in Training and Test Dataset 1

	Discharge Mode		Total
	Alive	Death	
Test	8761	308	9069
Train	20415	698	21113
Total	Total	1006	30182

Table 5.2 Number of Deaths in Training and Test Dataset 2

	Discharge Mode		Total
	Alive	Death	
Test	8761	8624	17385
Train	20415	19544	39959
Total	29176	28168	57344

5.2 Preliminary Analysis

We performed cross-tab analysis to understand the effect of some demographics and factors into the hospital mortality. The output from this analysis were shown Appendix F. We categorize age on admission in 5-year bands as seen in Table 5.3.

Table 5.3 Age Groups and Age Range

Age Group	Age Range	Age Group	Age Range	Age Group	Age Range	Age Group	Age Range
1	<1	6	20-25	11	45-50	16	70-75
2	1-5	7	25-30	12	50-55	17	75-80
3	5-10	8	30-35	13	55-60	18	80-85
4	10-15	9	35-40	14	60-65	19	85-90
5	15-20	10	40-45	15	65-70	20	90+

Some diagnostics groups within CCS were aggregated by clinicians for each hospital mortality prediction models since methods struggle when numbers of deaths are small. In HSMR, there are 56 diagnosis group, 140 for SHMR and 26 for Scottish HSMR. Since there is small number of deaths in our data, we have not enough deaths for each diagnoses class. So, we decided to use diagnosis group presented in Scottish HRSM. The death rates for each diagnosis group in SHSMR class were presented in Figure 5.1.

Death rates for each comorbidity class and scores were examined. The distribution of patients' comorbidity score was heavily skewed and death rate is much smaller in the patients whose comorbidity score is 0. We convert the scores into categories: Charlson_Old scoring system into three groups as 0, 1-2 and greater or equal to 3, Charlson_Aylin smaller than or equal to 0, 1-2 and greater than or equal to 3 and Charlson_Quan 0, 1-3 and greater than or equal to 4. The death rates for each Charlson_Aylin comorbidity group were presented in Figure 5.2.

The death rates for each age group were shown in Figure 5.3. The ages between 0 to 15 there is no patient whose discharge status is death. Moreover, low mortality rates were observed in the age ranges between 15 to 65. From age 65 and above mortality rates started to increase as age become higher. So, we decided to use age in three groups as 0 up to 39, 40 to 64 and greater than or equal to 65.

%3.1 of the women and %3.6 of the men admissions were died during their hospital stay (Figure 5.4). As it can be seen in Figure 5.5, death rates for admissions from emergency is much greater than that for elective admissions. Death rate rises up to 5 previous acute admissions (except 2) and then it falls up in 6. There is a few number of patients whose number of previous admissions are higher than 13. So, it is not

reliable to draw any conclusion about these kind of patients. As a result, we decided to group number of previous acute admissions into three groups as 0, 1-6 and greater or equal to 7 (Figure 5.6).

We calculated the number of deaths by month of admission and observed that there is a higher number of deaths on months November and December. So, we decided to convert months into two groups one includes the months November and December and the other class includes the rest of the months (Figure 5.7).

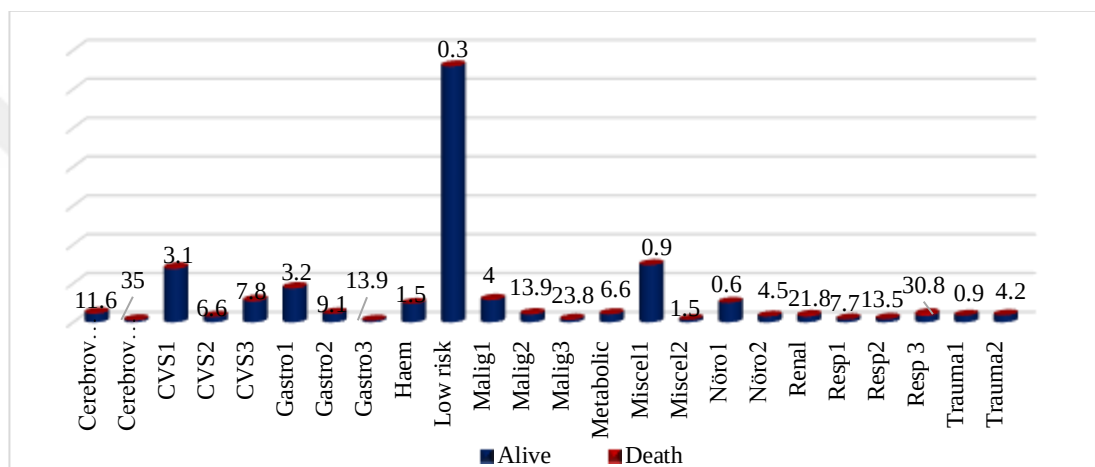


Figure 5.1 Deaths Rates of Diagnoses Groups

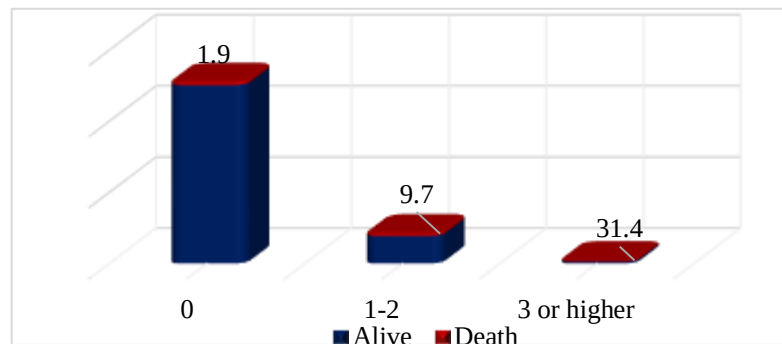


Figure 5.2 Deaths Rates of Charlson Comorbidity Score Groups

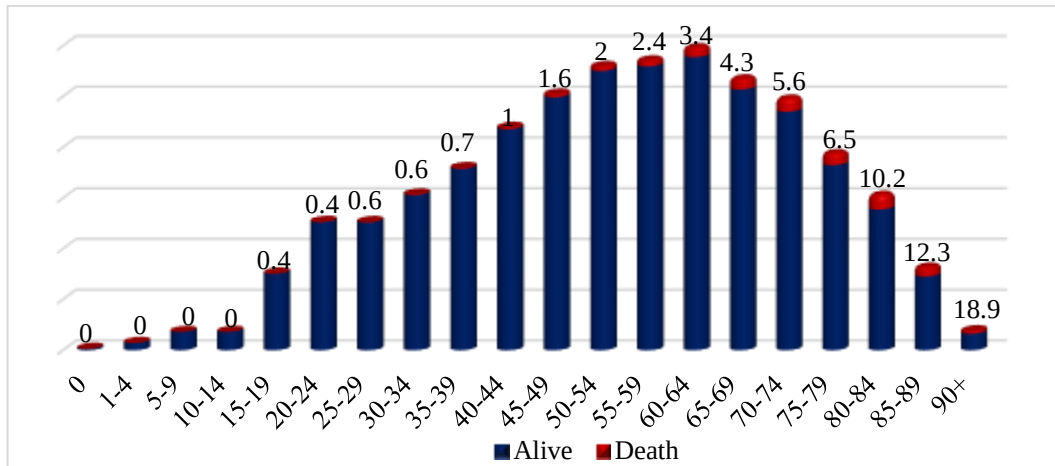


Figure 5.3 Deaths Rates of Age Groups

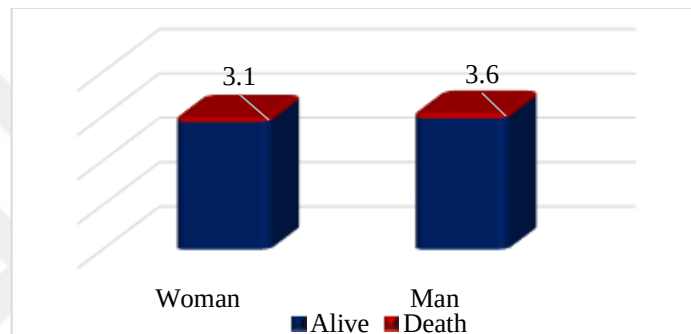


Figure 5.4 Deaths Rates of Sex Groups

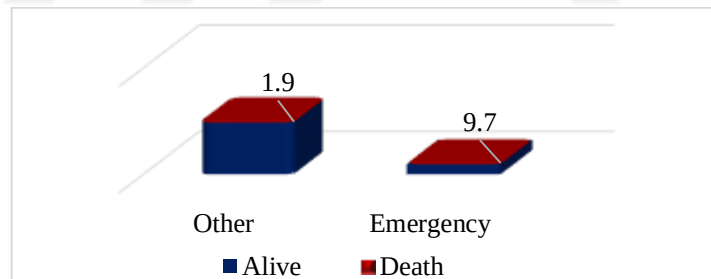


Figure 5.5 Deaths Rates of Source of Admission Groups

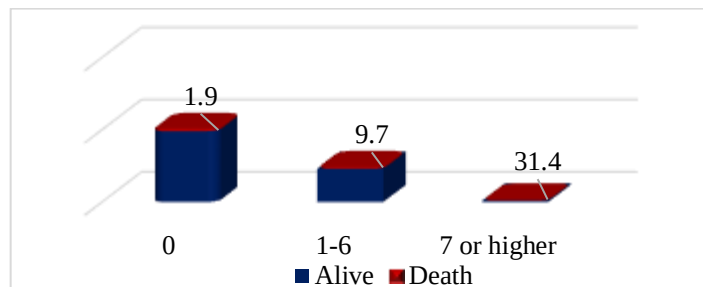


Figure 5.6 Deaths Rates of Number of Emergency Admissions in Last 12 Months Groups

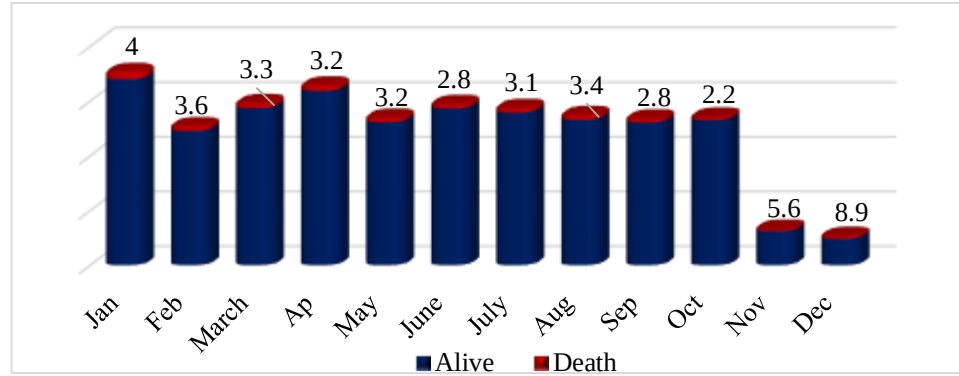


Figure 5.7 Deaths Rates of Admission Month Groups

5.3 Updating Comorbidity Scoring Points

We reevaluated and updated the comorbidity points presented in the literature by using our data. Logistic regression analysis were applied when determining the points for each comorbidity groups. We used two different methodology to decide weights; one of which is using odds ratios and the other one is using beta coefficients as mentioned in the study done by van Walvaren and his friends in 2009. We divided each regression coefficient with the smallest absolute value in the model. Then we rounded this number to the smallest nearest integer number. And we used these coefficients as a weight rather than relative risks which were used as a weight in the comorbidity scoring studies mentioned above. The result of the analysis and updated weights are shown in Table 5.4.

Table 5.4 Updated Charlson Comorbidity Points

Charlson Group	B	Wald	Sig.	Exp(B)	95,0% C.I.for Exp(B)		Beta/ Absolute (minbeta)	New Points (Beta)	New Points (odds)	Old Points
					Lower	Upper				
Acute myocardial infarction	-	-	-	-	-	-	-	-	-	1
Cerebral vascular accident	.664	11.872	.001	1.943	1.332	2.836	1.1	1	2	1
Congestive heart failure	1.630	91.580	.000	5.102	3.654	7.123	2.7	3	5	1
Connective tissue disorder	-	-	-	-	-	-	-	-	-	1
Dementia	1.743	48.675	.000	5.717	3.503	9.330	2.9	3	6	1
Diabetes	-	-	-	-	-	-	-	-	-	1
Liver disease	1.855	21.872	.000	6.392	2.938	13.907	3.1	3	6	1
Peptic ulcer	1.398	7.094	.008	4.045	1.447	11.312	2.3	2	4	1
Peripheral vascular disease	.997	5.346	.021	2.711	1.164	6.315	1.7	2	3	1
Pulmonary disease	1.067	40.960	.000	2.907	2.097	4.031	1.8	2	3	1
Cancer	1.393	75.385	.000	4.029	2.942	5.518	2.3	2	4	2
Diabetes complications	1.158	13.663	.000	3.183	1.723	5.881	1.9	2	3	2
Paraplegia	.598	4.981	.026	1.818	1.076	3.074	1.0	1	2	2
Renal disease	1.064	48.159	.000	2.899	2.146	3.915	1.8	2	3	2
Metastatic cancer	1.933	72.330	.000	6.908	4.425	10.783	3.2	3	7	3
Severe liver disease	3.117	16.800	.000	22.57	5.086	100.19	5.2	5	23	3
HIV	-	-	-	-	-	-	-	-	-	6
Constant	-5.338	741.12	.000	.005						-

Death rates for each updated comorbidity score were presented in Appendix F. After evaluating the distribution of death rates, we decided to convert the scores into three categories for Charlson beta comorbidity scores as 0, 1-2 and greater or equal to 3 and Charlson odds comorbidity scores as 0, 1-4 and greater or equal to 5.

5.4 Logistic Regression

We used oversampled data in analysis since the number of patients whose discharge mode is death is small. We repeated the cases with discharge mode is death 27 times. In this data 29176 of the patients discharge mode is alive whereas 28168 is death. We partitioned our data into two parts. In train data, we have 39959 cases (%70) and in test data we have 17385 cases (%30). We developed models by using training data set and then test them with their test data. We used age (3 group), sex, source of admission,

CCS Scottish, number of emergency admissions in the previous 12 month period (3 group), admission month (2 group) as a risk factor in the analysis. Besides these risk factors we add and tried different comorbidity classification systems and scoring systems in the models. Different performance measures of the train and the test dataset for each combination of risk factors was given in Table 5.5. Here:

- Sensitivity ($TP/(TP+FN)$) indicates true positive rate whereas specificity ($TN/(TN+FP)$) true negative rate.
- Accuracy ($(TP+TN)/((TP+TN+FP+FN))$) is the degree of closeness of measurements to its real value.
- Precision ($TP/(TP+FP)$) is the degree of repeated measurements show the same results under same conditions.
- F-value ($2*precision*sensitivity/(precision+sensitivity)$) is the harmonic mean of sensitivity and precision.
- Area under curve (AUC) shows us the area under receiver operating curve (ROC) which is a plot of the true positive rate against the false positive rate at various threshold values.

Table 5.5 Performance Measures of the Logistic Regression Models

MODELS	Sensitivity (%)		Specificity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC (%)	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Charlson	83.7	82.8	81.0	81.7	82.3	82.2	80.8	81.6	82.2	82.2	.903	.904
Charlson Old Points	84.1	86.0	80.2	80.7	82.1	83.4	80.3	81.5	82.2	83.7	.898	.905
Charlson Quan Points	82.8	85.4	80.3	80.9	81.5	83.1	80.1	81.5	81.4	83.4	.896	.903
Charlson Aylin Points	83.4	85.7	80.8	81.1	82.0	83.4	80.6	81.7	82.0	83.7	.901	.909
Charlson Updated Beta Points	84.0	85.4	80.5	81.0	82.2	83.2	80.5	81.6	82.2	83.4	.898	.906
Charlson Updated Odds Points	84.0	85.7	80.4	81.0	82.1	83.3	80.4	81.6	82.1	83.6	.899	.906

If we compare the performance measures of each model, we can say that the model which includes Charlson Aylin comorbidity score and the rest of the risk factors gave a little bit better result than the other models. The summary, correct prediction rate and coefficient of the variables of this model was shown below.

Table 5.6 Model Summary of Charlson Aylin Comorbidity Score Model of Logistic Regression

Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
1	31617.988 ^a	.448	.598

Table 5.7 Correct Prediction Rate of Charlson Aylin Comorbidity Score Model of Logistic Regression

Observed		Predicted					
		Train			Test		
		Discharge mode		Percentage Correct	Discharge mode		Percentage Correct
		Alive	Death		Alive	Death	
Discharge mode	Alive	16487	3928	80.8	7108	1653	81.1
	Death	3248	16296	83.4	1232	7392	85.7
Overall Percentage				82.0			83.4

Table 5.8 Variables in Charlson Aylin Comorbidity Score Model of Logistic Regression

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.	
							Lower	Upper
Sex (Man)	0.165	0.029	31.984	1	0.000	1.179	1.114	1.249
Source of admission (Emergency)	1.898	0.041	2146.768	1	0.000	6.672	6.157	7.230
Age Group			1071.757	2	0.000			
Age Group (40-64)	0.742	0.054	192.243	1	0.000	2.101	1.892	2.333
Age Group (65 and above)	1.481	0.053	788.242	1	0.000	4.398	3.966	4.878
Num of emergency admissions in previous 12 months			1081.068	2	0.000			
Number of emergency admissions in previous 12 months (1-6)	1.212	0.037	1063.385	1	0.000	3.361	3.125	3.615
Number of emergency admissions in previous 12 months (7&higher)	1.238	0.102	146.248	1	0.000	3.449	2.822	4.216
Admission Month (November-December)	0.777	0.063	152.083	1	0.000	2.174	1.922	2.460
Comorbidity score			1913.478	2	0.000			
Comorbidity score (1-2)	1.242	0.033	1406.505	1	0.000	3.464	3.246	3.696
Comorbidity score (3&higher)	2.536	0.095	716.826	1	0.000	12.631	10.490	15.207
Primary Diagnose Group			5577.458	23	0.000			
Cerebrovasc2	-1.969	0.081	590.718	1	0.000	0.140	0.119	0.164
CVS1	0.374	0.092	16.689	1	0.000	1.454	1.215	1.739
CVS2	1.490	0.104	205.040	1	0.000	4.436	3.617	5.439
CVS3	1.415	0.138	104.790	1	0.000	4.117	3.140	5.398
Gastro1	-0.053	0.112	0.225	1	0.636	0.948	0.761	1.181
Gastro2	-1.533	0.093	274.613	1	0.000	0.216	0.180	0.259
Gastro3	-1.702	0.251	45.888	1	0.000	0.182	0.111	0.298
Haem	-1.749	0.135	168.946	1	0.000	0.174	0.134	0.227
Low risk	0.147	0.126	1.350	1	0.245	1.158	0.904	1.483
Malig1	0.910	0.105	74.712	1	0.000	2.483	2.020	3.052
Malig2	2.313	0.153	227.788	1	0.000	10.101	7.480	13.639
Malig3	0.519	0.149	12.158	1	0.000	1.681	1.255	2.251
Metabolic	0.950	0.133	50.770	1	0.000	2.585	1.991	3.357
Miscel1	1.411	0.101	196.502	1	0.000	4.100	3.366	4.994
Miscel2	-2.005	0.219	83.763	1	0.000	0.135	0.088	0.207
Neuro1	-0.367	0.116	9.957	1	0.002	0.693	0.552	0.870
Neuro 2	-0.414	0.081	25.973	1	0.000	0.661	0.564	0.775
Renal	-0.782	0.125	38.876	1	0.000	0.457	0.358	0.585
Resp 1	0.186	0.085	4.774	1	0.029	1.205	1.019	1.424
Resp 2	-0.831	0.087	92.210	1	0.000	0.436	0.368	0.516
Resp 3	-0.009	0.104	0.008	1	0.928	0.991	0.808	1.215
Trauma1	1.117	0.173	41.868	1	0.000	3.054	2.178	4.284
Trauma2	-1.164	0.105	122.973	1	0.000	0.312	0.254	0.384
Constant	-2.322	0.094	607.218	1	0.000	0.098		

First, the model agreement is determined considering the Cox & Snell R^2 and Nagelkerke R^2 statistics values. These values show the variance amount produced by the LR model and 1.00 shows the perfect model agreement. Therefore, greater values correspond to a better model agreement (Hair et al., 2006). Since, Cox & Snell R^2 never reaches to 1, and therefore it is not easy to interpret, the Nagelkerke R^2 – which is the modified version of and greater than this coefficient – is calculated (Field, 2005; Hair et al., 2006; Allison, 2013). In this study, the Nagelkerke R^2 statistics value is 0.603, whereas Cox & Snell R^2 is found 0.452.

For the sex variable in the LR model, the Wald test statistics score (31.98) is found high, the p value ($0.00 < 0.05$) is found low, the odds ratio (1.179) is found interpretable and the pertaining confidence interval (1.114-1.125) is found statistically significant since it does not contain the value 1. This significance is interpreted as being male increased the chance of mortality by approximately 1.2 times, when compared to being female. In a similar fashion; the Wald test scores for mode of intervention, age, the number of emergency admittances in the last 12 months, the month of admission, the comorbidity disease score and diagnosis group are found high; p values low, odds ratios interpretable and the pertaining confidence intervals are found statistically significant. Accordingly, the chance of mortality for patients admitted to emergency service is found 6.7 times higher than the ones which have not been admitted to emergency. When the age groups are considered, it is found that the rate of mortality in older ages is higher when compared to the patients under 40 years of age. In this respect, the mortality rate of 65-and-above patients is 4.4 times higher than patients under 40 years of age, whereas it is 2.1 times higher than patients in the 40-64 age group. When the number of emergency admissions in the last 12 months is examined, it is found that the patients, who had been admitted to emergency less than 6 times in the last 12 months, have a mortality rate 3.4 times higher than the ones who had not been admitted to emergency. A similar situation is observed in patients who had been admitted to emergency for more than 7 times. It is also found that, the mortality rate in patients, who had been admitted to hospitals in November and December, is 2.2 times higher when compared to other months. It is determined statistically that patients with a comorbidity disease score 2 and below have mortality rates 3.5 times higher

than patients without any comorbidity diseases. This score is found 12.6 times higher in patients with comorbidity disease score 3 and higher. When the diagnosis groups are examined in 24 categories, the “cerebrovascular1” category comprising diagnoses such as cerebral infarction (I63), acute myocarditis (I40), artery embolism and thrombosis (I74) is taken as reference group. Accordingly, Wald test statistics score, p value, odds ratio and pertaining confidence intervals for 23 categories are examined. Considering these examinations, it was found that patients in the “malig2” group – comprising of diagnoses for malignant neoplasm of hypopharynx (C13), malignant neoplasm of pancreas (C25), malignant neoplasm of stomach (C16) and malignant neoplasm of brain (C71) – have mortality rates 10.1 times higher than the patients in the “cerebrovascular1”. Similarly, the mortality rate for the patients in “CVS2” diagnosis group – which includes disease diagnoses such as rheumatic aortic valve (I06), pulmonary embolism (I26), acute and subacute endocarditis (I33) – is found 4.4 times higher than patients in the “cerebrovascular1” group. On the other hand, the mortality rate for “cerebrovascular1” patients is found ($1/0.182=5.494$) approximately 5.5 times higher than patients in the “gastro3” group which includes diagnoses such as peritonitis (K65), hepatic failure not elsewhere classified (K72), ascites (R18).

5.5 Decision Tree Modeling

We developed trees by using CART, CHAID and exhaustive CHAID algorithms. When constructing the trees we limited the minimum number of records in leaf nodes in order to prevent overfitting. The obtained performance measures for the train and the test dataset are shown in Table 5.9, 5.10 and 5.11.

Table 5.9 Performance Measures of the CART Algorithm

MODELS	Sensitivity (%)		Specifity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Charlson	92.0	85.1	76.3	76.4	84.0	80.7	78.8	78.0	84.9	81.4	.900	.863
Charlson Old Points	89.7	84.1	78.1	78.7	83.8	81.4	79.7	79.5	84.4	81.7	.901	.872
Charlson Quan Points	92.0	84.4	76.7	77.3	84.2	80.8	79.1	78.5	85.1	81.4	.903	.861
Charlson Aylin Points	90.8	84.7	78.2	78.5	84.4	81.6	80.0	79.5	85.1	82.0	.904	.879
Charlson Updated Beta Points	89.4	84.7	78.5	79.0	83.8	81.9	79.9	79.9	84.4	82.3	.902	.875
Charlson Updated Odds Points	89.7	84.4	78.3	78.8	83.8	81.6	79.8	79.7	84.4	82.0	.902	.874

Table 5.10 Performance Measures of the CHAID Algorithm

MODELS	Sensitivity (%)		Specifity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Charlson	87.7	81.2	80.7	80.7	84.1	80.9	81.3	80.5	84.4	80.8	.923	.862
Charlson Old Points	89.7	81.8	78.7	79.2	84.1	80.5	80.1	79.5	84.6	80.6	.920	.876
Charlson Quan Points	88.7	80.8	79.5	80.1	84.0	80.5	80.5	80.0	84.4	80.4	.921	.871
Charlson Aylin Points	89.8	81.8	79.3	79.4	84.4	80.6	80.6	79.6	84.9	80.7	.923	.877
Charlson Updated Beta Points	89.4	83.1	79.2	79.7	84.2	81.4	80.5	80.2	84.7	81.6	.921	.880
Charlson Updated Odds Points	89.0	83.1	79.9	80.1	84.3	81.6	80.9	80.5	84.7	81.8	.923	.878

Table 5.11 Performance Measures of the Exhaustive CHAID Algorithm

MODELS	Sensitivity (%)		Specifity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Charlson	86.7	77.9	81.7	81.8	84.1	79.9	81.9	80.8	84.2	79.4	.922	.861
Charlson Old Points	89.5	80.5	78.9	79.2	84.1	79.9	80.3	79.2	84.7	79.9	.921	.870
Charlson Quan Points	88.8	79.5	79.5	79.4	84.0	79.5	80.6	79.2	84.5	79.4	.921	.865
Charlson Aylin Points	89.0	77.6	80.1	79.9	84.5	78.7	81.1	79.1	84.8	78.4	.924	.871
Charlson Updated Beta Points	89.4	80.2	79.6	79.9	84.4	80.0	80.8	79.7	84.9	79.9	.923	.871
Charlson Updated Odds Points	89.1	81.5	79.8	79.9	84.3	80.7	80.8	80.0	84.8	80.7	.923	.871

If we look at the averages of the different algorithms we see that updated Charlson (odds) comorbidity score model of CHAID algorithm gave better results than the other algorithms. The depth of the tree is seven and 177 rules were derived from this tree (Table 5.12). The correct prediction rate of updated Charlson (odds) Comorbidity Score Model of CHAID algorithm for the train and the test dataset are shown in Table 5.13. The derived rules from CHAID algorithm were presented in Appendix G.

Table 5.12 Model Summary of Updated Charlson (odds) Comorbidity Score Model of CHAID

Specifications	Growing Method	CHAID
	Dependent Variable	Discharge mode
	Independent Variables	ccsscottish, source of admission, number of previous emergency admission, age, charlson_updated_odds, sex, month of admission
	Validation	Split Sample
	Maximum Tree Depth	20
	Minimum Cases in Parent Node	100
	Minimum Cases in Child Node	50
Results	Independent Variables Included	ccsscottish, source of admission, number of previous emergency admission, age, charlson_updated_odds, sex, month of admission
	Number of Nodes	322
	Number of Terminal Nodes	177
	Depth	7

Table 5.13 Correct Prediction Rate of Updated Charlson (odds) Comorbidity Score Model of CHAID

Sample	Observed	Predicted		
		Alive	Death	Percent Correct (%)
Training	Alive	16307	4108	79.9
	Death	2156	17388	89.0
	Overall Percentage	46.2%	53.8%	84.3
Test	Alive	7020	1741	80.1
	Death	1456	7168	83.1
	Overall Percentage	48.8%	51.2%	81.6

5.6 Artificial Neural Networks

Performance measures of ANN algorithm for the train and the test dataset are shown in Table 5.14. The model which includes Charlson comorbidity and the rest of the risk factors gave better result than the other models. Network information and the correct prediction rate of this model were shown in Table 5.15 and 5.16. The feedforward neural network consisted of three layers with fully connected. There were 70 nodes in

input layer, 51 nodes in hidden layer and 2 nodes in output layer. The training process was done with the backpropagation algorithm.

Table 5.14 Performance Measures of the Artificial Neural Network Models

MODELS	Sensitivity (%)		Specifity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Charlson	85.5	82.8	81.2	81.7	83.3	82.3	81.3	81.7	83.4	82.2	.907	.902
Charlson Old Points	83.8	84.7	80.8	81.0	82.3	82.8	80.7	81.4	82.2	83.1	.901	.908
Charlson Quan Points	83.0	85.4	80.8	81.5	81.8	83.4	80.5	81.9	81.7	83.6	.900	.906
Charlson Aylin Points	81.7	83.1	81.4	81.8	81.5	82.5	80.8	81.8	81.2	82.5	.900	.910
Charlson Updated Beta Points	82.4	82.1	80.4	80.7	81.4	81.4	80.1	80.8	81.2	81.4	.890	.900
Charlson Updated Odds Points	81.4	83.1	81.5	82.3	81.5	82.7	80.8	82.2	81.1	82.7	.895	.903

Table 5.15 Network Information of Charlson Comorbidity Model of ANN Model

Input Layer	Factors	1	Sex	13	C7
		2	Source of admission	14	C8
		3	Ccscottish	15	C9
		4	Admission month	16	C10
		5	Age	17	C11
		6	Num. of prev. emergency admis. in last 12	18	C12
		7	C1	19	C13
		8	C2	20	C14
		9	C3	21	C15
		10	C4	22	C16
		11	C5	23	C17
		12	C6		
	Number of Units				70
Hidden Layer(s)	Number of Hidden Layers				1
	Number of Units in Hidden Layer 1				51
	Activation Function				Hyperbolic tangent
Output Layer	Dependent Variables				Discharge mode
	Number of Units				2
	Activation Function				Softmax
	Error Function				Cross-entropy

Table 5.16 Correct Prediction Rate of Charlson Comorbidity Score Model of ANN Model

Sample	Observed	Predicted		
		Alive	Death	Percent Correct (%)
Training	Alive	16582	3833	81.2
	Death	2828	16716	85.5
	Overall Percent	48.6%	51.4%	83.3
Testing	Alive	7160	1601	81.7
	Death	1484	7140	82.8
	Overall Percent	49.7%	50.3%	82.3

5.7 Random Forest

Performance measures of random forest for the train and the test dataset is shown in Table 5.17. And, the correct prediction rate of random forest model were shown in Table 5.18. The decreases in Gini index for each variable were shown in Figure 5.8. According to this, main diagnoses of the patient is the most important risk factor when determining the discharge status.

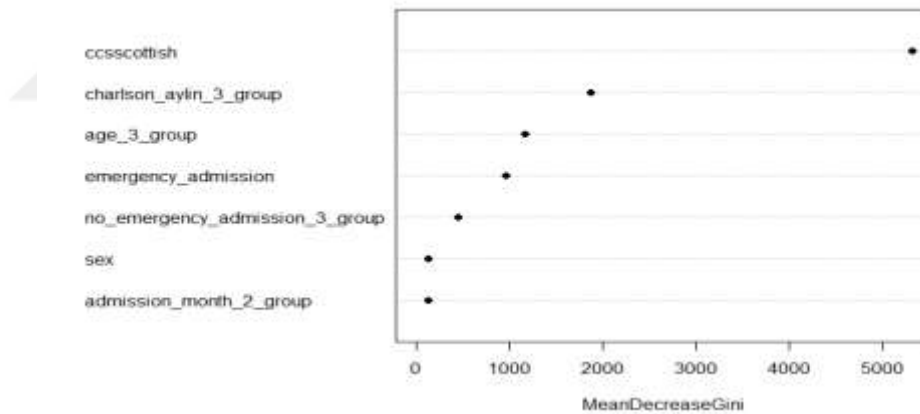


Figure 5.8 Contribution of Each Risk Factor to the Model

Since random forest method use CART algorithm and Charlson Aylin comorbidity score gives the best results for CART algorithm, random forest model is derived using just Charlson Aylin comorbidity score and the rest of the risk factors. And, in order to see if it improves the performance measures of decision tree models, it is compared with CART algorithm and CHAID algorithm which has the highest performance scores. The random forest model gave better performance result except sensitivity than the other decision tree models as expected.

Table 5.17 Comparison the Result of Decision Trees and Random Forest

MODELS		Sensitivity (%)		Specifity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC	
		Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
RF	Charlson												
	Aylin Points	92.7	84.7	78.9	79.1	85.7	81.9	80,8	80.0	86.2	82.3	.923	.895
CART	Charlson												
	Aylin Points	90.8	84.7	78.2	78.5	84.4	81.6	80.0	79.5	85.1	82.0	.904	.879
CHAID	Charlson												
	Updated Odds Points	89.10	81.50	79.80	79.90	84.30	80.70	80.80	80.00	84.80	80.70	.923	.871

Table 5.18 Correct Prediction Rate of Charlson Aylin Comorbidity Score Model of RF Model

Sample	Observed	Predicted		
		Alive	Death	Percent Correct (%)
Training	Alive	16113	4302	78.93
	Death	1428	18116	92.69
	Overall Percent	43.90%	56.10%	85.7
Testing	Alive	6926	1835	79.05
	Death	1316	7308	84.74
	Overall Percent	47.41%	52.59%	81.90

5.8 Comparison the Result of Logistic Regression, Decision Tree, ANN and Random Forest Algorithm

Models are set up using LR, DT, ANN and random forest, and their performances are evaluated on training and test data. The performances obtained from the models are presented in Table 5.19 and Figure 5.9. When evaluating the performances of different models, the performance of the model on the independent data set, i.e. the test data, is considered more. In this respect, it can be seen that the results obtained from the LR and ANN models are close to each other. Since LR is easier to understand and to interpret by the users, compared to the ANN model, the results obtained from the LR model are used to calculate the standardized mortality ratios. When the models

in the literature are examined, it is seen that LR method is used in all measurements except for the SHSMR.

Table 5.19 Performance Measures of the Logistic Regression, Decision Tree, ANN and Random Forest

MODELS	Sensitivity (%)		Specificity (%)		Accuracy (%)		Precision (%)		F value (%)		AUC	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
LR / Charlson Aylin Points	83.40	85.70	80.80	81.10	82.00	83.40	80.60	81.70	82.00	83.70	0.901	0.909
DT / Charlson Updated Odds Points	89.10	81.50	79.80	79.90	84.30	80.70	80.80	80.00	84.80	80.70	0.923	0.871
ANN / Charlson	85.50	82.80	81.20	81.70	83.30	82.30	81.30	81.70	83.40	82.20	0.907	0.902
RF/Charlson Aylin Points	92.5	84.7	78.9	79.1	85.6	81.9	80,8	80.0	86.2	82.3	0.923	0.895

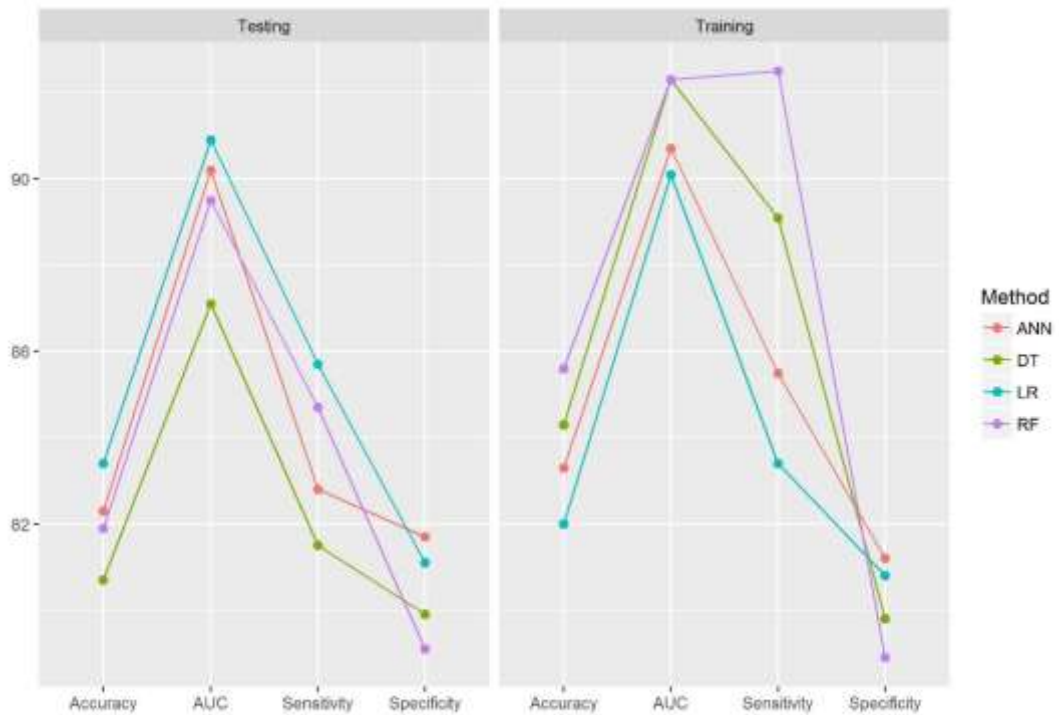


Figure 5.9 Performance Measures of the Logistic Regression, Decision Tree, ANN and Random Forest

5.9 Comparison of Crude Mortality Rates and Standardized Mortality Ratios

The results obtained in the study by measuring the crude mortality rates and the standardized mortality ratios obtained in the three months periods are presented in Figure 5.10. The crude mortality rate is obtained by dividing the number of deaths to total number of patients. The calculation of standardized mortality ratio is conducted

by dividing the number of deaths to the total of mortality probability obtained from the LR method.

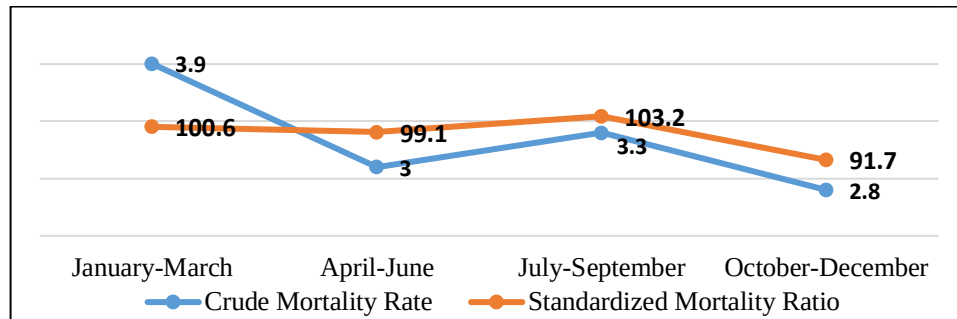


Figure 5.10 Comparison of Crude Mortality Rates and Standardized Mortality Ratios

When the crude mortality rates are considered, the highest mortality rate of the hospital occurs between January and March, while the lowest rate occurs between July and September. As for standardized mortality ratios, it is seen that the actual number of deaths in the hospital exceeded the expected mortality ratio between July and September. When a performance evaluation is conducted with regard to crude mortality rates, it is seen that the hospital had presented the worst performance between January and March; whereas when the same evaluation is conducted using standardized mortality ratios, it is seen that the hospital had performed the worst between July and September. The structure of the hospital is also important in the deaths that occur in the hospital. There is finding in the literature that there is a correlation between mortality and number of physicians, nurses and even cleaning staff per 100 beds (NHS, 2013). In this respect, the underperformance in summer period can be explained by the change in the structure of the hospital due to holiday period.

Another evaluation that could be performed using the standardized mortality ratios is to monitor the performance in different diagnosis groups with regard to periods of the year. The standardized mortality ratios for 24 diagnosis groups, calculated for three months periods, are presented in Table 5.20. Accordingly, actual mortality for “Metabolic” and “Respiratory1” diagnosis groups remained higher than expected mortality in the July-December period; whereas actual mortality for “Gastro1” diagnosis group remained higher than expected mortality in the January-June period.

In “CVS1” diagnosis group expected mortality remained mostly lower than expected; while it remained mostly higher in “CVS2” diagnosis group.

Table 5.20 Standardized Mortality Ratios of SHSMR Diagnoses Categories

Diagnoses Group	January-March	April-June	July-September	October-December	Diagnoses Group	January-March	April-June	July-September	October-December
Cerebrovasc1	97.8	92.9	102.6	90.4	Malig3	104.1	106.5	95.3	110.1
Cerebrovasc2	98.3	98.7	100.5	97.2	Metabolic	70.6	98.4	111.5	110.5
CVS1	100.9	96.2	95.7	85.5	Miscel1	100.9	139.3	128.8	0.0
CVS2	104.8	109.6	115.3	123.3	Miscel2	237.7	0.0	203.9	0.0
CVS3	101.8	92.6	104.2	75.0	Neuro 1	129.4	58.4	60.7	152.2
Gastro1	104.8	116.8	97.7	98.7	Neuro 2	93.4	102.4	85.2	96.2
Gastro2	108.2	101.8	104.0	104.2	Renal	99.9	102.2	96.8	100.9
Gastro3	93.0	100.7	90.9	105.6	Resp 1	65.1	92.0	126.5	124.7
Haem	106.5	0.0	124.7	115.8	Resp 2	97.3	101.6	90.5	88.0
Low risk	89.4	91.1	122.4	31.5	Resp 3	99.3	100.7	99.8	103.0
Malig1	99.2	87.2	97.1	106.5	Trauma1	145.6	174.6	0.0	0.0
Malig2	94.7	104.4	105.1	84.6	Trauma2	130.4	75.0	87.1	0.0

CHAPTER SIX

CONCLUSION

Nowadays, it comes into prominence doing performance measurements in service sector as well as industry. For the leading one of these organizations, hospitals, this case is also be imminent. Indicators such as infection rates, waiting times, and readmission rates can be used to evaluate performance of hospitals. Since the main aim of the hospitals is to save life, measuring and monitoring mortality rates has a special importance in these indicators. In this respect, using standardized mortality ratios when determining wheather the number of deaths are high or low can be more objective since it considers different risk factors.

It is needed to developed mortality prediction models to calculate risk adjusted mortality measures. In literature, particularly in United Kingdom, there are various developed models by counties in this respect. In this study, we examined four different risk adjusted mortality prediction models developed in United Kingdom. We compare these models in terms of their risk factors, focused patients, diagnoses groups, patient groups disregarded, their approach to transferred patients, methods used for modelling etc. and summarize this information in comparison tables.

In the second part of this study, we apply a case study to answer the question if we could develop our national risk adjusted mortality prediction model in Turkey. The data of 30182 inpatients of one of the Turkish Training and Research Hospital whose discharge period is January to November in 2014 was gathered. After collecting the data we prepare it for the analyses towards literature and developed models by using three different popular data mining techniques. The developed models are evaluated by using different performance criteria and it was seen that logistic regression method gives better results when comparing it with the other methods.

After constructing our risk adjusted mortality prediction model, we calculated standardized mortality ratios for each quarter. We also compute cude mortality ratios for these periods. Although the highest mortality rate of the hospital occurs between

January and March according to the crude mortality rate, when evaluating the mortality by using standardized mortality ratio it is seen that the hospital exceeded the expected mortality ratio most between July and September.

The crude mortality rates are calculated directly over the number of deaths, without considering the case mixes of the patients admitted to the hospital. Standardized mortality ratios, on the other hand, a case mix approach is used and the expected mortality rates and actual mortality rates of the hospitals are compared. Thus, the performance evaluation of the hospitals can be conducted objectively. Similarly, the performance values presented in Figure 5.10 could belong to different hospitals, instead of different periods of the year. In such a case, a performance evaluation on the crude mortality rates would yield a misevaluation by indicating hospitals with higher actual performance as low, and hospitals with lower actual performance as high. Indeed, when the structures of the hospitals are considered, there are hospitals which include a palliative care centre, and hospitals which provide service to more complicated diseases compared to counterparts due to its geographical status and structure. In these hospitals, no matter how high the service quality is, the crude mortality rates would be higher compared to another hospital with a similar capacity. Therefore, it is of great significance to use risk adjusted measurement methods in evaluating hospital mortality.

In the future, different oversampling and undersampling methods can be tried to cope with imbalanced data problem (Han et al., 2005; Garcia et al., 2012). And the performance of these data can be compared for different algorithms. Moreover, comorbidity scoring systems can be updated for Turkish patients by using our national data. Similarly, disease groups can be constructed in terms of CCS categories or ICD 10 codes directly like SHSMR for our country. And, different mortality prediction models can be developed for each disease groups instead of constructing one model for all disease groups.

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APPENDICES

APPENDIX A CCS Groups in HSMR (Aylin et al., 2010)

CCS groups	Description of CCS group
2	Septicemia (except in labour)
12	Cancer of oesophagus
13	Cancer of stomach
14	Cancer of colon
15	Cancer of rectum and anus
17	Cancer of pancreas
19	Cancer of bronchus, lung
24	Cancer of breast
27	Cancer of ovary
29	Cancer of prostate
32	Cancer of bladder
38	Non-Hodgkin's lymphoma
39	Leukaemias
42	Secondary malignancies
43	Malignant neoplasm without specification of site
55	Fluid and electrolyte disorders
59	Deficiency and other anaemia
68	Senility and organic mental disorders
100	Acute myocardial infarction
101	Coronary atherosclerosis and other heart disease
103	Pulmonary heart disease
106	Cardiac dysrhythmias
107	Cardiac arrest and ventricular fibrillation
108	Congestive heart failure, nonhypertensive
109	Acute cerebrovascular disease
114	Peripheral and visceral atherosclerosis
115	Aortic, peripheral, and visceral artery aneurysms
117	Other circulatory disease

CCS groups	Description of CCS group
122	Pneumonia
125	Acute bronchitis
127	Chronic obstructive pulmonary disease and bronchiectasis
129	Aspiration pneumonitis, food/vomitus
130	Pleurisy, pneumothorax, pulmonary collapse
131	Respiratory failure, insufficiency, arrest (adult)
133	Other lower respiratory disease
134	Other upper respiratory disease
145	Intestinal obstruction without hernia
148	Peritonitis and intestinal abscess
149	Biliary tract disease
150	Liver disease, alcohol-related
151	Other liver diseases
153	Gastrointestinal haemorrhage
154	Noninfectious gastroenteritis
155	Other gastrointestinal disorders
157	Acute and unspecified renal failure
158	Chronic renal failure
159	Urinary tract infections
197	Skin and subcutaneous tissue infections
199	Chronic ulcer of skin
224	Other perinatal conditions
226	Fracture of neck of femur (hip)
231	Other fractures
233	Intracranial injury
237	Complication of device, implant or graft
245	Syncope
251	Abdominal pain

APPENDIX B ICD 10 codes of Charlson Categories in HSMR (Aylin et al., 2010)

No	Condition Name	New Coding	New Weight	Old Weight
1	Acute myocardial infarction	I21, I22, I23, I252, I258	5	1
2	Cerebral vascular accident	G450, G451, G452, G454, G458, G459, G46, I60-I69	11	1
3	Congestive heart failure	I50	13	1
4	Connective tissue disorder	M05, M060, M063, M069, M32, M332, M34, M353	4	1
5	Dementia	F00, F01, F02, F03, F051	14	1
6	Diabetes	E101, E105, E106, E108, E109, E111, E115, E116, E118, E119, E131, E131, E136, E138, E139, E141, E145, E146, E148, E149 3 1	3	1
7	Liver disease	K702, K703, K717, K73, K74	8	1
8	Peptic ulcer	K25, K26, K27, K28	9	1
9	Peripheral vascular disease	I71, I739, I790, R02, Z958, Z959	6	1
10	Pulmonary disease	J40-J47, J60-J67	4	1
11	Cancer	C00-C76, C80-C97	8	2
12	Diabetes complications	E102, E103, E104, E107, E112, E113, E114, E117, E132, E133, E134, E137, E142, E143, E144, E147	-1	2
13	Paraplegia	G041, G81, G820, G821, G822	1	2
14	Renal disease	I12, I13, N01, N03, N052-N056, N072-N074, N18, N19, N25	10	2
15	Metastatic cancer	C77, C78, C79	14	3
16	Severe liver disease	K721, K729, K766, K767	18	3
17	HIV	B20, B21, B22, B23, B24	2	6

APPENDIX C CCS Groups & ICD 10 Codes in SHSMR (ISD, 2013)

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Cerebrovasc1	I66	Occlusion/stenosis cerebral arts not result cerebral infarct	Miscel1	A02	Other salmonella infections
Cerebrovasc1	P52	Intracranial nontraumatic haemorrhage of fetus and newborn	Miscel1	A06	Amoebiasis
Cerebrovasc1	I63	Cerebral infarction	Miscel1	A22	Anthrax
Cerebrovasc1	S06	Intracranial injury	Miscel1	A26	Erysipeloid
Cerebrovasc2	I60	Subarachnoid haemorrhage	Miscel1	A43	Nocardiosis
Cerebrovasc2	I61	Intracerebral haemorrhage	Miscel1	A48	Other bacterial diseases, not elsewhere classified
Cerebrovasc2	I62	Other nontraumatic intracranial haemorrhage	Miscel1	A78	Q fever
Cerebrovasc2	I64	Stroke, not specified as haemorrhage or infarction	Miscel1	B00	Herpesviral (herpes simplex) infections
CVS1	I05	Rheumatic mitral valve diseases	Miscel1	B02	Zoster (herpes zoster)
CVS1	I07	Rheumatic tricuspid valve diseases	Miscel1	B05	Measles
CVS1	I08	Multiple valve diseases	Miscel1	B25	Cytomegaloviral disease
CVS1	I10	Essential (primary) hypertension	Miscel1	B37	Candidiasis
CVS1	I12	Hypertensive renal disease	Miscel1	B65	Schistosomiasis (bilharziasis)
CVS1	I20	Angina pectoris	Miscel1	B67	Echinococcosis
CVS1	I24	Other acute ischaemic heart diseases	Miscel1	B87	Myiasis
CVS1	I25	Chronic ischaemic heart disease	Miscel1	C03	Malignant neoplasm of gum
CVS1	I30	Acute pericarditis	Miscel1	C40	Malignant neoplasm of bone and articular cartilage of limbs
CVS1	I31	Other diseases of pericardium	Miscel1	C44	Other malignant neoplasms of skin
CVS1	I34	Nonrheumatic mitral valve disorders	Miscel1	C62	Malignant neoplasm of testis
CVS1	I35	Nonrheumatic aortic valve disorders	Miscel1	D30	Benign neoplasm of urinary organs
CVS1	I38	Endocarditis, valve unspecified	Miscel1	D39	Neoplasm uncert or unkn behaviour of female genital organs
CVS1	I40	Acute myocarditis	Miscel1	D50	Iron deficiency anaemia
CVS1	I42	Cardiomyopathy	Miscel1	D51	Vitamin B12 deficiency anaemia
CVS1	I44	Atrioventricular and left bundle-branch block	Miscel1	D52	Folate deficiency anaemia
CVS1	I45	Other conduction disorders	Miscel1	D55	Anaemia due to enzyme disorders
CVS1	I47	Paroxysmal tachycardia	Miscel1	D61	Other aplastic anaemias
CVS1	I48	Atrial fibrillation and flutter	Miscel1	D69	Purpura and other haemorrhagic conditions
CVS1	I49	Other cardiac arrhythmias	Miscel1	D76	Certain dis invol lymphoretic tis and reticulohistioct sys

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
CVS1	I70	Atherosclerosis	Miscel1	D84	Other immunodeficiencies
CVS1	I72	Other aneurysm	Miscel1	D86	Sarcoidosis
CVS1	I73	Other peripheral vascular diseases	Miscel1	E06	Thyroiditis
CVS1	I74	Arterial embolism and thrombosis	Miscel1	E24	Cushing's syndrome
CVS1	I77	Other disorders of arteries and arterioles	Miscel1	E75	Disorders sphingolipid metab other lipid storage disorders
CVS1	I80	Phlebitis and thrombophlebitis	Miscel1	E83	Disorders of mineral metabolism
CVS1	I87	Other disorders of veins	Miscel1	F07	Personality and behav disord brain dis dam and dysfunction
CVS1	I89	Oth noninfective disorders lymphatic vessels and lymph node	Miscel1	F10	Mental and behavioural disorders due to use of alcohol
CVS1	I95	Hypotension	Miscel1	F11	Mental and behavioural disorders due to use of opioids
CVS1	L89	Decubitus ulcer	Miscel1	F15	Men & behav dis due use oth stims inc caffeine
CVS1	L97	Ulcer of lower limb, not elsewhere classified	Miscel1	F20	Schizophrenia
CVS1	M31	Other necrotizing vasculopathies	Miscel1	F29	Unspecified nonorganic psychosis
CVS1	Q20	Congenital malformations of cardiac chambers and connections	Miscel1	F31	Bipolar affective disorder
CVS1	Q23	Congenital malformations of aortic and mitral valves	Miscel1	F32	Depressive episode
CVS1	Q24	Other congenital malformations of heart	Miscel1	F33	Recurrent depressive disorder
CVS1	Q25	Congenital malformations of great arteries	Miscel1	F41	Other anxiety disorders
CVS1	Q26	Congenital malformations of great veins	Miscel1	F44	Dissociative (conversion) disorders
CVS1	Q27	Other congenital malformations of peripheral vascular system	Miscel1	F50	Eating disorders
CVS1	Q28	Other congenital malformations of circulatory system	Miscel1	F71	Moderate mental retardation
CVS1	R02	Gangrene, not elsewhere classified	Miscel1	G25	Other extrapyramidal and movement disorders
CVS1	R55	Syncope and collapse	Miscel1	G58	Other mononeuropathies
CVS1	R60	Oedema, not elsewhere classified	Miscel1	H16	Keratitis
CVS1	T82	Comps cardiac & vasc prosthetic devs implants & grafts	Miscel1	H18	Other disorders of cornea
CVS2	I06	Rheumatic aortic valve diseases	Miscel1	H20	Iridocyclitis
CVS2	I11	Hypertensive heart disease	Miscel1	H53	Visual disturbances
CVS2	I26	Pulmonary embolism	Miscel1	I86	Varicose veins of other sites

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
CVS2	I27	Other pulmonary heart diseases	Miscel1	J39	Other diseases of upper respiratory tract
CVS2	I33	Acute and subacute endocarditis	Miscel1	K06	Other disorders of gingiva and edentulous alveolar ridge
CVS2	I36	Nonrheumatic tricuspid valve disorders	Miscel1	K10	Other diseases of jaws
CVS2	I51	Complications and ill-defined descriptions of heart disease	Miscel1	K12	Stomatitis and related lesions
CVS2	I67	Other cerebrovascular diseases	Miscel1	K14	Diseases of tongue
CVS2	I82	Other venous embolism and thrombosis	Miscel1	L00	Staphylococcal scalded skin syndrome
CVS2	I99	Other and unspecified disorders of circulatory system	Miscel1	L03	Cellulitis
CVS2	R58	Haemorrhage, not elsewhere classified	Miscel1	L04	Acute lymphadenitis
CVS2	S26	Injury of heart	Miscel1	L29	Pruritus
CVS3	I13	Hypertensive heart and renal disease	Miscel1	L51	Erythema multiforme
CVS3	I21	Acute myocardial infarction	Miscel1	L56	Other acute skin changes due to ultraviolet radiation
CVS3	I22	Subsequent myocardial infarction	Miscel1	L88	Pyoderma gangrenosum
CVS3	I23	Certain current complication follow acute myocardial infarct	Miscel1	L95	Vasculitis limited to skin, not elsewhere classified
CVS3	I28	Other diseases of pulmonary vessels	Miscel1	M00	Pyogenic arthritis
CVS3	I50	Heart failure	Miscel1	M02	Reactive arthropathies
CVS3	I71	Aortic aneurysm and dissection	Miscel1	M10	Gout
CVS3	I81	Portal vein thrombosis	Miscel1	M11	Other crystal arthropathies
CVS3	J81	Pulmonary oedema	Miscel1	M15	Polyarthrosis
CVS3	K55	Vascular disorders of intestine	Miscel1	M21	Other acquired deformities of limbs
CVS3	O87	Venous complications in the puerperium	Miscel1	M25	Other joint disorders, not elsewhere classified
CVS4	D65	Dissem intravascular coagulation (defibrination syndrome)	Miscel1	M30	Polyarteritis nodosa and related conditions
CVS4	I46	Cardiac arrest	Miscel1	M48	Other spondylopathies
CVS4	R57	Shock, not elsewhere classified	Miscel1	M53	Other dorsopathies, not elsewhere classified
Gastro1	A09	Diarrhoea and gastroenteritis of presumed infectious origin	Miscel1	M60	Myositis
Gastro1	B17	Other acute viral hepatitis	Miscel1	M71	Other bursopathies
Gastro1	B18	Chronic viral hepatitis	Miscel1	M79	Other soft tissue disorders, not elsewhere classified
Gastro1	B19	Unspecified viral hepatitis	Miscel1	M84	Disorders of continuity of bone

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Gastro1	I85	Oesophageal varices	Miscel1	M85	Other disorders of bone density and structure
Gastro1	K20	Oesophagitis	Miscel1	M86	Osteomyelitis
Gastro1	K22	Other diseases of oesophagus	Miscel1	M96	Postprocedural musculoskeletal disorders NEC
Gastro1	K25	Gastric ulcer	Miscel1	N10	Acute tubulo-interstitial nephritis
Gastro1	K27	Peptic ulcer, site unspecified	Miscel1	N39	Other disorders of urinary system
Gastro1	K28	Gastrojejunal ulcer	Miscel1	N49	Inflammatory disorders of male genital organs NEC
Gastro1	K31	Other diseases of stomach and duodenum	Miscel1	N61	Inflammatory disorders of breast
Gastro1	K41	Femoral hernia	Miscel1	N73	Other female pelvic inflammatory diseases
Gastro1	K45	Other abdominal hernia	Miscel1	N99	Postprocedural disorders of genitourinary system NEC
Gastro1	K46	Unspecified abdominal hernia	Miscel1	P00	Fetus and newborn affected mat conds unrel present preg
Gastro1	K52	Other noninfective gastroenteritis and colitis	Miscel1	P01	Fetus and newborn affect by maternal comps of pregnancy
Gastro1	K57	Diverticular disease of intestine	Miscel1	P02	Fetus and newborn affect comps placenta cord and membr
Gastro1	K59	Other functional intestinal disorders	Miscel1	P03	Fetus and newborn affected by oth comps of lab and deliv
Gastro1	K62	Other diseases of anus and rectum	Miscel1	P04	Fet newborn affect nox influencetransmit placent breast milk
Gastro1	K63	Other diseases of intestine	Miscel1	P22	Respiratory distress of newborn
Gastro1	K66	Other disorders of peritoneum	Miscel1	P24	Neonatal aspiration syndromes
Gastro1	K73	Chronic hepatitis, not elsewhere classified	Miscel1	P25	Interstitial emphysema rel conds origin in perinatal period
Gastro1	K75	Other inflammatory liver diseases	Miscel1	P27	Chron resp disease originating in the perinatal period
Gastro1	K81	Cholecystitis	Miscel1	P29	Cardiovascular disorders originating in the perinatal period
Gastro1	K82	Other diseases of gallbladder	Miscel1	P35	Congenital viral diseases
Gastro1	K83	Other diseases of biliary tract	Miscel1	P37	Other congenital infectious and parasitic diseases

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Gastro1	K85	Acute pancreatitis	Miscel1	P38	Omphalitis of newborn with or without mild haemorrhage
Gastro1	K86	Other diseases of pancreas	Miscel1	P39	Other infections specific to the perinatal period
Gastro1	K91	Postprocedural disorders of digestive system NEC	Miscel1	P51	Umbilical haemorrhage of newborn
Gastro1	N13	Obstructive and reflux uropathy	Miscel1	P53	Haemorrhagic disease of fetus and newborn
Gastro1	N28	Other disorders of kidney and ureter NEC	Miscel1	P54	Other neonatal haemorrhages
Gastro1	N32	Other disorders of bladder	Miscel1	P61	Other perinatal haematological disorders
Gastro1	N42	Other disorders of prostate	Miscel1	P70	Transitory disord carbohydrate metabol spec fetus newborn
Gastro1	N76	Other inflammation of vagina and vulva	Miscel1	P74	Oth transitory neonatal electrolyte and metabol disturbance
Gastro1	N82	Fistulae involving female genital tract	Miscel1	P76	Other intestinal obstruction of newborn
Gastro1	Q39	Congenital malformations of oesophagus	Miscel1	P78	Other perinatal digestive system disorders
Gastro1	Q42	Congenital absence, atresia and stenosis of large intestine	Miscel1	P80	Hypothermia of newborn
Gastro1	Q44	Congenital malformations of gallbladder, bile ducts & liver	Miscel1	P81	Other disturbances of temperature regulation of newborn
Gastro1	R10	Abdominal and pelvic pain	Miscel1	P90	Convulsions of newborn
Gastro1	R11	Nausea and vomiting	Miscel1	P94	Disorders of muscle tone of newborn
Gastro1	R13	Dysphagia	Miscel1	P96	Other conditions originating in the perinatal period
Gastro1	R14	Flatulence and related conditions	Miscel1	Q02	Microcephaly
Gastro1	R16	Hepatomegaly and splenomegaly, not elsewhere classified	Miscel1	Q22	Congenital malformations of pulmonary and tricuspid valves
Gastro1	R19	Oth symptoms & signs involving digestive system and abdomen	Miscel1	Q36	Cleft lip
Gastro1	R33	Retention of urine	Miscel1	Q37	Cleft palate with cleft lip
Gastro1	R87	Abnormal findings in specimens from female genital organs	Miscel1	Q61	Cystic kidney disease
Gastro1	R93	Abn findings on diagnostic imaging of other body structures	Miscel1	Q67	Cong musculoskel deformities of head face spine and chest
Gastro1	T18	Foreign body in alimentary tract	Miscel1	Q76	Congenital malformations of spine and bony thorax
Gastro1	T54	Toxic effect of corrosive substances	Miscel1	Q79	Congenital malformations of the musculoskel system NEC

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Gastro1	T83	Complications of genitourinary prosth devs implants & grafts	Miscel1	Q87	Oth spec cong malform syndromes affecting multiple sys
Gastro2	A04	Other bacterial intestinal infections	Miscel1	Q99	Other chromosome abnormalities, not elsewhere classified
Gastro2	K26	Duodenal ulcer	Miscel1	R07	Pain in throat and chest
Gastro2	K56	Paralytic ileus and intestinal obstruction without hernia	Miscel1	R22	Localized swelling, mass & lump of skin/subcutaneous tissue
Gastro2	K71	Toxic liver disease	Miscel1	R23	Other skin changes
Gastro2	K74	Fibrosis and cirrhosis of liver	Miscel1	R27	Other lack of coordination
Gastro2	K92	Other diseases of digestive system	Miscel1	R31	Unspecified haematuria
Gastro2	P77	Necrotizing enterocolitis of fetus and newborn	Miscel1	R42	Dizziness and giddiness
Gastro2	R17	Unspecified jaundice	Miscel1	R45	Symptoms and signs involving emotional state
Gastro3	K65	Peritonitis	Miscel1	R50	Fever of unknown origin
Gastro3	K70	Alcoholic liver disease	Miscel1	R52	Pain, not elsewhere classified
Gastro3	K72	Hepatic failure, not elsewhere classified	Miscel1	R76	Other abnormal immunological findings in serum
Gastro3	K76	Other diseases of liver	Miscel1	R79	Other abnormal findings of blood chemistry
Gastro3	Q41	Congenital absence, atresia and stenosis of small intestine	Miscel1	R82	Other abnormal findings in urine
Gastro3	R18	Ascites	Miscel1	S43	Disloc sprain and strain of joints ligs of shoulder girdle
Haem	B23	Human immunodef virus dis resulting in other conditions	Miscel1	S50	Superficial injury of forearm
Haem	B24	Unspecified human immunodeficiency virus (HIV) disease	Miscel1	S53	Dislocation sprain & strain of joints & ligs elbow
Haem	C82	Follicular (nodular) non-Hodgkin's lymphoma	Miscel1	T37	Poisoning by oth systemic anti-infective and antiparasitics
Haem	C90	Multiple myeloma and malignant plasma cell neoplasms	Miscel1	T40	Poisoning by narcotics and psychodysleptics (hallucinogens)
Haem	C91	Lymphoid leukaemia	Miscel1	T42	Poison antiepileptic sed-hypnotic and antiparkinsonism drug
Haem	D46	Myelodysplastic syndromes	Miscel1	T44	Poison by drug primarily affecting the autonomic nervous sys
Haem	D53	Other nutritional anaemias	Miscel1	T46	Poison by agents primarily affecting the cardiovascular sys

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Haem	D58	Other hereditary haemolytic anaemias	Miscel1	T47	Poison agents primarily affecting the gastrointestinal sys
Haem	D59	Acquired haemolytic anaemia	Miscel1	T49	Pois top ag prim affect skin muc memb by ophth oto dent drug
Haem	D64	Other anaemias	Miscel1	T50	Poison diuretics & oth/unsp drugs medics & biol subs
Haem	D68	Other coagulation defects	Miscel1	T73	Effects of other deprivation
Haem	D70	Agranulocytosis	Miscel1	T75	Effects of other external causes
Haem	D72	Other disorders of white blood cells	Miscel1	T80	Comps following infusion transfusion and therapeutic inject
Haem	D73	Diseases of spleen	Miscel1	T81	Complications of procedures, not elsewhere classified
Haem	R72	Abnormality of white blood cells, not elsewhere classified	Miscel1	T84	Comps of internal orthopaedic prosth devs implants & grafts
Haem	R77	Other abnormalities of plasma proteins	Miscel1	T85	Comps oth internal prosthetic devices implants & grafts
Lowrisk	A08	Viral and other specified intestinal infections	Miscel1	T86	Failure and rejection of transplanted organs and tissues
Lowrisk	A46	Erysipelas	Miscel1	T87	Complications peculiar to reattachment and amputation
Lowrisk	B01	Varicella (chickenpox)	Miscel1	T88	Other complications of surgical and medical care NEC
Lowrisk	B26	Mumps	Miscel1	Z22	Carrier of infectious disease
Lowrisk	B27	Infectious mononucleosis	Miscel1	Z43	Attention to artificial openings
Lowrisk	B34	Viral infection of unspecified site	Miscel1	Z45	Adjustment and management of implanted device
Lowrisk	D02	Carcinoma in situ of middle ear and respiratory system	Miscel1	Z50	Care involving use of rehabilitation procedures
Lowrisk	D04	Carcinoma in situ of skin	Miscel1	Z53	Persons encount health services spec procs not carried out
Lowrisk	D05	Carcinoma in situ of breast	Miscel1	Z54	Convalescence
Lowrisk	D07	Carcinoma in situ of other and unspecified genital organs	Miscel1	Z63	Oth probs related to prim sup grp, inc family circumstances
Lowrisk	D09	Carcinoma in situ of other and unspecified sites	Miscel1	Z75	Problems related to medical facilities and other health care

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	D11	Benign neoplasm of major salivary glands	Miscel2	B35	Dermatophytosis
Lowrisk	D12	Benign neoplasm of colon, rectum, anus and anal canal	Miscel2	B99	Other and unspecified infectious diseases
Lowrisk	D13	Benign neoplasm of other and ill-def parts of digestive sys	Miscel2	E44	Protein-energy malnutrition of moderate and mild degree
Lowrisk	D14	Benign neoplasm of middle ear and respiratory system	Miscel2	E46	Unspecified protein-energy malnutrition
Lowrisk	D18	Haemangioma and lymphangioma, any site	Miscel2	E85	Amyloidosis
Lowrisk	D21	Other benign neoplasms of connective and other soft tissue	Miscel2	F01	Vascular dementia
Lowrisk	D22	Melanocytic naevi	Miscel2	F03	Unspecified dementia
Lowrisk	D23	Other benign neoplasms of skin	Miscel2	F05	Delirium not induced by alcohol and other psychoactive subs
Lowrisk	D24	Benign neoplasm of breast	Miscel2	F06	Oth mental disord brain damag and dysfunction/physical dis
Lowrisk	D25	Leiomyoma of uterus	Miscel2	F30	Manic episode
Lowrisk	D27	Benign neoplasm of ovary	Miscel2	F34	Persistent mood (affective) disorders
Lowrisk	D33	Benign neoplasm brain and oth parts of central nervous sys	Miscel2	F80	Specific developmental disorders of speech and language
Lowrisk	D35	Benign neoplasm of other and unspecified endocrine glands	Miscel2	G30	Alzheimer's disease
Lowrisk	D36	Benign neoplasm of other and unspecified sites	Miscel2	G31	Other degenerative diseases of nervous system NEC
Lowrisk	D41	Neoplasm of uncertain or unknown behaviour of urinary organs	Miscel2	H44	Disorders of globe
Lowrisk	D45	Polycythaemia vera	Miscel2	L12	Pemphigoid
Lowrisk	D56	Thalassaemia	Miscel2	L27	Dermatitis due to substances taken internally
Lowrisk	D60	Acquired pure red cell aplasia (erythroblastopenia)	Miscel2	M50	Cervical disc disorders
Lowrisk	D75	Other diseases of blood and blood-forming organs	Miscel2	M76	Enthesopathies of lower limb, excluding foot
Lowrisk	D80	Immunodeficiency with predominantly antibody defects	Miscel2	M88	Paget's disease of bone (osteitis deformans)
Lowrisk	D81	Combined immunodeficiencies	Miscel2	Q77	Osteochondrodysplasia with defect growth tub bones spine
Lowrisk	E03	Other hypothyroidism	Miscel2	Q81	Epidermolysis bullosa
Lowrisk	E04	Other nontoxic goitre	Miscel2	Q90	Down's syndrome
Lowrisk	E05	Thyrotoxicosis (hyperthyroidism)	Miscel2	Q91	Edwards' syndrome and Patau's syndrome (chromosomal abnormality)

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	E23	Hypofunction and other disorders of pituitary gland	Miscel2	R46	Symptoms and signs involving appearance and behaviour
Lowrisk	E61	Deficiency of other nutrient elements	Miscel2	R53	Malaise and fatigue
Lowrisk	E66	Obesity	Miscel2	R54	Senility
Lowrisk	E76	Disorders of glycosaminoglycan metabolism	Miscel2	R68	Other general symptoms and signs
Lowrisk	F09	Unspecified organic or symptomatic mental disorder	Miscel2	R69	Unknown and unspecified causes of morbidity
Lowrisk	F53	Mental and behav disorders assoc with the puerperium NEC	Miscel2	Z51	Other medical care
Lowrisk	G37	Other demyelinating diseases of central nervous system	Miscel2	Z60	Problems related to social environment
Lowrisk	G43	Migraine	Miscel2	Z72	Problems related to lifestyle
Lowrisk	G44	Other headache syndromes	Miscel2	Z74	Problems related to care-provider dependency
Lowrisk	G47	Sleep disorders	Mort	A81	Slow virus infections of central nervous system
Lowrisk	G50	Disorders of trigeminal nerve	Mort	B22	Human immunodef virus dis resulting in other spec dis
Lowrisk	G51	Facial nerve disorders	Mort	B49	Unspecified mycosis
Lowrisk	G56	Mononeuropathies of upper limb	Mort	C58	Malignant neoplasm of placenta
Lowrisk	G57	Mononeuropathies of lower limb	Mort	G92	Toxic encephalopathy
Lowrisk	G61	Inflammatory polyneuropathy	Mort	R75	Laboratory evidence of human immunodeficiency virus (HIV)
Lowrisk	G62	Other polyneuropathies	Mort	R96	Other sudden death, cause unknown
Lowrisk	G80	Infantile cerebral palsy	Mort	R99	Other ill-defined and unspecified causes of mortality
Lowrisk	H00	Hordeolum and chalazion (stye)	Neuro1	A86	Unspecified viral encephalitis
Lowrisk	H02	Other disorders of eyelid	Neuro1	A87	Viral meningitis
Lowrisk	H04	Disorders of lacrimal system	Neuro1	G35	Multiple sclerosis
Lowrisk	H05	Disorders of orbit	Neuro1	G40	Epilepsy
Lowrisk	H11	Other disorders of conjunctiva	Neuro1	G45	Transient cerebral ischaemic attacks and related syndromes
Lowrisk	H25	Senile cataract	Neuro1	G60	Hereditary and idiopathic neuropathy
Lowrisk	H26	Other cataract	Neuro1	G70	Myasthenia gravis and other myoneural disorders
Lowrisk	H33	Retinal detachments and breaks	Neuro1	G71	Primary disorders of muscles
Lowrisk	H35	Other retinal disorders	Neuro1	G82	Paraplegia and tetraplegia

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	H40	Glaucoma	Neuro1	G83	Other paralytic syndromes
Lowrisk	H43	Disorders of vitreous body	Neuro1	G90	Disorders of autonomic nervous system
Lowrisk	H57	Other disorders of eye and adnexa	Neuro1	G97	Postprocedural disorders of nervous system, NEC
Lowrisk	H60	Otitis externa	Neuro1	H47	Other disorders of optic (2nd) nerve and visual pathways
Lowrisk	H61	Other disorders of external ear	Neuro1	H49	Paralytic strabismus
Lowrisk	H71	Cholesteatoma of middle ear	Neuro1	H54	Blindness and low vision
Lowrisk	H83	Other diseases of inner ear	Neuro1	H55	Nystagmus and other irregular eye movements
Lowrisk	I78	Diseases of capillaries	Neuro1	I65	Occlusion/stenosis of precerebral arteries not resulting in cerebral infarction
Lowrisk	I83	Varicose veins of lower extremities	Neuro1	M54	Dorsalgia
Lowrisk	I84	Haemorrhoids	Neuro1	M62	Other disorders of muscle
Lowrisk	J02	Acute pharyngitis	Neuro1	Q03	Congenital hydrocephalus
Lowrisk	J03	Acute tonsillitis	Neuro1	Q04	Other congenital malformations of brain
Lowrisk	J05	Acute obstructive laryngitis (croup) and epiglottitis	Neuro1	R20	Disturbances of skin sensation
Lowrisk	J06	Acute upper respiratory infections multiple and unspecified sites	Neuro1	R29	Other symptoms and signs involving nervous and musculoskeletal systems
Lowrisk	J21	Acute bronchiolitis	Neuro1	R44	Other symptoms & signs involving general sensation and perception
Lowrisk	J30	Vasomotor and allergic rhinitis	Neuro1	R56	Convulsions, not elsewhere classified
Lowrisk	J31	Chronic rhinitis, nasopharyngitis and pharyngitis	Neuro2	A17	Tuberculosis of nervous system
Lowrisk	J33	Nasal polyp	Neuro2	A39	Meningococcal infection
Lowrisk	J34	Other disorders of nose and nasal sinuses	Neuro2	A52	Late syphilis
Lowrisk	J37	Chronic laryngitis and laryngotracheitis	Neuro2	G00	Bacterial meningitis, not elsewhere classified
Lowrisk	J38	Diseases of vocal cords and larynx, not elsewhere classified	Neuro2	G03	Meningitis due to other and unspecified causes
Lowrisk	J45	Asthma	Neuro2	G04	Encephalitis, myelitis and encephalomyelitis
Lowrisk	K01	Embedded and impacted teeth	Neuro2	G06	Intracranial and intraspinal abscess and granuloma
Lowrisk	K02	Dental caries	Neuro2	G08	Intracranial and intraspinal phlebitis and thrombophlebitis
Lowrisk	K04	Diseases of pulp and periapical tissues	Neuro2	G10	Huntington's disease

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	K07	Dentofacial anomalies (including malocclusion)	Neuro2	G12	Spinal muscular atrophy and related syndromes
Lowrisk	K08	Other disorders of teeth and supporting structures	Neuro2	G20	Parkinson's disease
Lowrisk	K13	Other diseases of lip and oral mucosa	Neuro2	G21	Secondary parkinsonism
Lowrisk	K21	Gastro-oesophageal reflux disease	Neuro2	G41	Status epilepticus
Lowrisk	K29	Gastritis and duodenitis	Neuro2	G72	Other myopathies
Lowrisk	K30	Dyspepsia	Neuro2	G81	Hemiplegia
Lowrisk	K35	Acute appendicitis	Neuro2	G91	Hydrocephalus
Lowrisk	K40	Inguinal hernia	Neuro2	G93	Other disorders of brain
Lowrisk	K42	Umbilical hernia	Neuro2	G95	Other diseases of spinal cord
Lowrisk	K43	Ventral hernia	Neuro2	H51	Other disorders of binocular movement
Lowrisk	K44	Diaphragmatic hernia	Neuro2	R26	Abnormalities of gait and mobility
Lowrisk	K50	Crohn's disease (regional enteritis)	Neuro2	R40	Somnolence, stupor and coma
Lowrisk	K51	Ulcerative colitis	Neuro2	R41	Other symptoms & signs involving cognitive function and awareness
Lowrisk	K58	Irritable bowel syndrome	Neuro2	R47	Speech disturbances, not elsewhere classified
Lowrisk	K60	Fissure and fistula of anal and rectal regions	Neuro2	R83	Abnormal findings in cerebrospinal fluid
Lowrisk	K61	Abscess of anal and rectal regions	Neuro2	R90	Abn findings on diagnostic imaging of central nervous system
Lowrisk	K80	Cholelithiasis	Neuro2	T60	Toxic effect of pesticides
Lowrisk	K90	Intestinal malabsorption	Renal	E86	Volume depletion
Lowrisk	L01	Impetigo	Renal	N17	Acute renal failure
Lowrisk	L02	Cutaneous abscess, furuncle and carbuncle	Renal	N19	Unspecified renal failure
Lowrisk	L05	Pilonidal cyst	Renal	R34	Anuria and oliguria
Lowrisk	L08	Other local infections of skin and subcutaneous tissue	Resp1	A18	Tuberculosis of other organs
Lowrisk	L30	Other dermatitis	Resp1	B20	Human immunodeficiency virus disease resulting in infectious parasitic disease
Lowrisk	L40	Psoriasis	Resp1	E84	Cystic fibrosis
Lowrisk	L44	Other papulosquamous disorders	Resp1	J10	Influenza due to identified influenza virus
Lowrisk	L50	Urticaria	Resp1	J11	Influenza, virus not identified
Lowrisk	L57	Skin changes due to chronic exposure to nonionizing radiation	Resp1	J20	Acute bronchitis
Lowrisk	L60	Nail disorders	Resp1	J40	Bronchitis, not specified as acute or chronic
Lowrisk	L81	Other disorders of pigmentation	Resp1	J42	Unspecified chronic bronchitis

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	L90	Atrophic disorders of skin	Resp1	J46	Status asthmaticus
Lowrisk	L94	Other localized connective tissue disorders	Resp1	J92	Pleural plaque
Lowrisk	L98	Other disorders of skin and subcutaneous tissue NEC	Resp1	J93	Pneumothorax
Lowrisk	M05	Seropositive rheumatoid arthritis	Resp1	J95	Postprocedural respiratory disorders NEC
Lowrisk	M06	Other rheumatoid arthritis	Resp1	M40	Kyphosis and lordosis
Lowrisk	M13	Other arthritis	Resp1	R04	Haemorrhage from respiratory passages
Lowrisk	M16	Coxarthrosis (arthrosis of hip)	Resp1	R05	Cough
Lowrisk	M17	Gonarthrosis (arthrosis of knee)	Resp1	R06	Abnormalities of breathing
Lowrisk	M19	Other arthrosis	Resp1	R91	Abnormal findings on diagnostic imaging of lung
Lowrisk	M20	Acquired deformities of fingers and toes	Resp1	R94	Abnormal results of function studies
Lowrisk	M23	Internal derangement of knee	Resp1	T59	Toxic effect of other gases, fumes and vapours
Lowrisk	M24	Other specific joint derangements	Resp2	A15	Resp TB bacteriologically and histologically confirmed
Lowrisk	M32	Systemic lupus erythematosus	Resp2	A16	Respiratory TB not confirmed bact or histologically
Lowrisk	M33	Dermatopolymyositis	Resp2	A31	Infection due to other mycobacteria
Lowrisk	M34	Systemic sclerosis	Resp2	A42	Actinomycosis
Lowrisk	M35	Other systemic involvement of connective tissue	Resp2	B44	Aspergillosis
Lowrisk	M41	Scoliosis	Resp2	D19	Benign neoplasm of mesothelial tissue
Lowrisk	M43	Other deforming dorsopathies	Resp2	J12	Viral pneumonia, not elsewhere classified
Lowrisk	M45	Ankylosing spondylitis	Resp2	J22	Unspecified acute lower respiratory infection
Lowrisk	M46	Other inflammatory spondylopathies	Resp2	J41	Simple and mucopurulent chronic bronchitis
Lowrisk	M47	Spondylosis	Resp2	J43	Emphysema
Lowrisk	M51	Other intervertebral disc disorders	Resp2	J44	Other chronic obstructive pulmonary disease
Lowrisk	M65	Synovitis and tenosynovitis	Resp2	J47	Bronchiectasis
Lowrisk	M66	Spontaneous rupture of synovium and tendon	Resp2	J67	Hypersensitivity pneumonitis due to organic dust
Lowrisk	M67	Other disorders of synovium and tendon	Resp2	J82	Pulmonary eosinophilia, not elsewhere classified

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	M70	Soft tissue disorders related to use, overuse and pressure	Resp2	J85	Abscess of lung and mediastinum
Lowrisk	M72	Fibroblastic disorders	Resp2	J86	Pyothorax
Lowrisk	M75	Shoulder lesions	Resp2	J90	Pleural effusion, not elsewhere classified
Lowrisk	M81	Osteoporosis without pathological fracture	Resp2	J91	Pleural effusion in conditions classified elsewhere
Lowrisk	M87	Osteonecrosis	Resp2	J94	Other pleural conditions
Lowrisk	M89	Other disorders of bone	Resp2	J98	Other respiratory disorders
Lowrisk	M95	Oth acq deformities musculoskel sys and connective tis	Resp2	P36	Bacterial sepsis of newborn
Lowrisk	N02	Recurrent and persistent haematuria	Resp2	T17	Foreign body in respiratory tract
Lowrisk	N04	Nephrotic syndrome	Resp2	T52	Toxic effect of organic solvents
Lowrisk	N11	Chronic tubulo-interstitial nephritis	Resp3	A19	Miliary tuberculosis
Lowrisk	N12	Tubulo-interstitial nephritis not spec as acute or chronic	Resp3	A32	Listeriosis
Lowrisk	N20	Calculus of kidney and ureter	Resp3	A40	Streptococcal septicaemia
Lowrisk	N21	Calculus of lower urinary tract	Resp3	A41	Other septicaemia
Lowrisk	N23	Unspecified renal colic	Resp3	A49	Bacterial infection of unspecified site
Lowrisk	N30	Cystitis	Resp3	B45	Cryptococcosis
Lowrisk	N31	Neuromuscular dysfunction of bladder NEC	Resp3	B47	Mycetoma
Lowrisk	N34	Urethritis and urethral syndrome	Resp3	B58	Toxoplasmosis
Lowrisk	N35	Urethral stricture	Resp3	B59	Pneumocystosis
Lowrisk	N36	Other disorders of urethra	Resp3	J13	Pneumonia due to Streptococcus pneumoniae
Lowrisk	N40	Hyperplasia of prostate	Resp3	J14	Pneumonia due to Haemophilus influenzae
Lowrisk	N43	Hydrocele and spermatocele	Resp3	J15	Bacterial pneumonia, not elsewhere classified
Lowrisk	N45	Orchitis and epididymitis	Resp3	J16	Pneumonia due to other infectious organisms NEC
Lowrisk	N47	Redundant prepuce, phimosis and paraphimosis	Resp3	J18	Pneumonia, organism unspecified
Lowrisk	N48	Other disorders of penis	Resp3	J61	Pneumoconiosis due to asbestos and other mineral fibres
Lowrisk	N50	Other disorders of male genital organs	Resp3	J64	Unspecified pneumoconiosis
Lowrisk	N60	Benign mammary dysplasia	Resp3	J69	Pneumonitis due to solids and liquids
Lowrisk	N63	Unspecified lump in breast	Resp3	J70	Respiratory conditions due to other external agents

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	N71	Inflammatory disease of uterus, except cervix	Resp3	J80	Adult respiratory distress syndrome
Lowrisk	N81	Female genital prolapse	Resp3	J84	Other interstitial pulmonary diseases
Lowrisk	N83	Noninflammatory disord ovary fallopian tube & broad ligament	Resp3	J96	Respiratory failure, not elsewhere classified
Lowrisk	N84	Polyp of female genital tract	Resp3	P23	Congenital pneumonia
Lowrisk	N87	Dysplasia of cervix uteri	Resp3	P26	Pulmonary haemorrhage originating in the perinatal period
Lowrisk	N89	Other noninflammatory disorders of vagina	Resp3	R09	Oth symptoms and signs involv circul and resp systems
Lowrisk	N90	Other noninflammatory disorders of vulva and perineum	Resp3	T71	Asphyxiation
Lowrisk	N92	Excessive, frequent and irregular menstruation	Trauma1	M80	Osteoporosis with pathological fracture
Lowrisk	N93	Other abnormal uterine and vaginal bleeding	Trauma1	S00	Superficial injury of head
Lowrisk	N94	Pain and oth conds assoc fem gen organs and mens cycle	Trauma1	S01	Open wound of head
Lowrisk	N95	Menopausal and other perimenopausal disorders	Trauma1	S02	Fracture of skull and facial bones
Lowrisk	O00	Ectopic pregnancy	Trauma1	S09	Other and unspecified injuries of head
Lowrisk	O04	Medical abortion	Trauma1	S11	Open wound of neck
Lowrisk	P28	Other respiratory conds originating in the perinatal period	Trauma1	S13	Dislocation sprain and strain of joints and ligaments neck level
Lowrisk	P83	Other conditions of integument specific to fetus and newborn	Trauma1	S20	Superficial injury of thorax
Lowrisk	P92	Feeding problems of newborn	Trauma1	S22	Fracture of rib(s), sternum and thoracic spine
Lowrisk	Q05	Spina bifida	Trauma1	S29	Other and unspecified injuries of thorax
Lowrisk	Q21	Congenital malformations of cardiac septa	Trauma1	S30	Superficial injury of abdomen, lower back and pelvis
Lowrisk	Q43	Other congenital malformations of intestine	Trauma1	S39	Other and unspecified injuries of abdomen lower back and pelvis
Lowrisk	Q53	Undescended testicle	Trauma1	S42	Fracture of shoulder and upper arm
Lowrisk	R00	Abnormalities of heart beat	Trauma1	S46	Injury of muscle and tendon at shoulder and upper arm level
Lowrisk	R03	Abnormal blood-pressure reading, without diagnosis	Trauma1	S49	Other and unspecified injuries of shoulder and upper arm
Lowrisk	R12	Heartburn	Trauma1	S70	Superficial injury of hip and thigh
Lowrisk	R15	Faecal incontinence	Trauma1	S80	Superficial injury of lower leg

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	R21	Rash and other nonspecific skin eruption	Trauma1	S81	Open wound of lower leg
Lowrisk	R25	Abnormal involuntary movements	Trauma1	S89	Other and unspecified injuries of lower leg
Lowrisk	R30	Pain associated with micturition	Trauma1	S90	Superficial injury of ankle and foot
Lowrisk	R32	Unspecified urinary incontinence	Trauma1	S99	Other and unspecified injuries of ankle and foot
Lowrisk	R35	Polyuria	Trauma1	T08	Fracture of spine, level unspecified
Lowrisk	R39	Other symptoms and signs involving the urinary system	Trauma1	T09	Other injuries of spine and trunk, level unspecified
Lowrisk	R49	Voice disturbances	Trauma1	T10	Fracture of upper limb, level unspecified
Lowrisk	R51	Headache	Trauma1	T11	Other injuries of upper limb, level unspecified
Lowrisk	R59	Enlarged lymph nodes	Trauma1	T13	Other injuries of lower limb, level unspecified
Lowrisk	R74	Abnormal serum enzyme levels	Trauma1	T14	Injury of unspecified body region
Lowrisk	R92	Abnormal findings on diagnostic imaging of breast	Trauma1	T20	Burn and corrosion of head and neck
Lowrisk	S05	Injury of eye and orbit	Trauma1	T22	Burn and corros shoulder & upr limb exc wrist/hand
Lowrisk	S10	Superficial injury of neck	Trauma1	T25	Burn and corrosion of ankle and foot
Lowrisk	S19	Other and unspecified injuries of neck	Trauma1	T26	Burn and corrosion confined to eye and adnexa
Lowrisk	S21	Open wound of thorax	Trauma1	T65	Toxic effect of other and unspecified substances
Lowrisk	S31	Open wound of abdomen, lower back and pelvis	Trauma2	S12	Fracture of neck
Lowrisk	S41	Open wound of shoulder and upper arm	Trauma2	S14	Injury of nerves and spinal cord at neck level
Lowrisk	S51	Open wound of forearm	Trauma2	S15	Injury of blood vessels at neck level
Lowrisk	S52	Fracture of forearm	Trauma2	S24	Injury of nerves and spinal cord at thorax level
Lowrisk	S60	Superficial injury of wrist and hand	Trauma2	S27	Injury of other and unspecified intrathoracic organs
Lowrisk	S61	Open wound of wrist and hand	Trauma2	S32	Fracture of lumbar spine and pelvis
Lowrisk	S62	Fracture at wrist and hand level	Trauma2	S35	Inj of blood vessels at abdomen lower back and pelvis level
Lowrisk	S63	Disloc sprain strain joint and ligaments at wrist and hand level	Trauma2	S36	Injury of intra-abdominal organs
Lowrisk	S66	Injury of muscle and tendon at wrist and hand level	Trauma2	S40	Superficial injury of shoulder and upper arm

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	S67	Crushing injury of wrist and hand	Trauma2	S72	Fracture of femur
Lowrisk	S68	Traumatic amputation of wrist and hand	Trauma2	S75	Injury of blood vessels at hip and thigh level
Lowrisk	S69	Other and unspecified injuries of wrist and hand	Trauma2	S79	Other and specified injuries of hip and thigh
Lowrisk	S71	Open wound of hip and thigh	Trauma2	T01	Open wounds involving multiple body regions
Lowrisk	S73	Dislocation, sprain and strain of joint and ligaments of hip	Trauma2	T02	Fractures involving multiple body regions
Lowrisk	S76	Injury of muscle and tendon at hip and thigh level	Trauma2	T06	Other injuries involving multiple body regions NEC
Lowrisk	S82	Fracture of lower leg, including ankle	Trauma2	T21	Burn and corrosion of trunk
Lowrisk	S83	Dislocation sprain & strain of joints and ligaments of knee	Trauma2	T24	Burn and corrosion hip & lower limb exc ankle & foot
Lowrisk	S86	Injury of muscle and tendon at lower leg level	Trauma2	T28	Burn and corrosion of other internal organs
Lowrisk	S91	Open wound of ankle and foot	Trauma2	T29	Burns and corrosions of multiple body regions
Lowrisk	S92	Fracture of foot, except ankle	Trauma2	T30	Burn and corrosion, body region unspecified
Lowrisk	T00	Superficial injuries involving multiple body regions	Trauma2	T31	Burns class according to extent of body surface involved
Lowrisk	T23	Burn and corrosion of wrist and hand	Trauma2	T55	Toxic effect of soaps and detergents
Lowrisk	T36	Poisoning by systemic antibiotics	Trauma2	T66	Unspecified effects of radiation
Lowrisk	T38	Pois by hormone and synthetic substitute and antagonist NEC	Trauma2	T68	Hypothermia
Lowrisk	T39	Poison by nonopioid analgesic antipyretic and antirheumatics	Malig1	B21	Human immunodef virus dis resulting malignant neopl
Lowrisk	T43	Poisoning by psychotropic drugs, not elsewhere classified	Malig1	C00	Malignant neoplasm of lip
Lowrisk	T45	Poison by primarily systemic and haematological agents NEC	Malig1	C01	Malignant neoplasm of base of tongue
Lowrisk	T51	Toxic effect of alcohol	Malig1	C02	Malignant neoplasm of other and unspecified parts of tongue
Lowrisk	T78	Adverse effects, not elsewhere classified	Malig1	C04	Malignant neoplasm of floor of mouth
Lowrisk	T79	Certain early complications of trauma NEC	Malig1	C05	Malignant neoplasm of palate
Lowrisk	Z03	Med observ and evaluation for suspected diseases and conds	Malig1	C06	Malignant neoplasm of other and unspecified parts of mouth
Lowrisk	Z04	Examination and observation for other reasons	Malig1	C07	Malignant neoplasm of parotid gland

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Lowrisk	Z08	Follow-up examination after treatment for malignant neoplasm	Malig1	C08	Malignant neoplasm of other and unspecified major salivary glands
Lowrisk	Z09	Follow-up examination after treatment for conditions other than malignant neoplasms	Malig1	C09	Malignant neoplasm of tonsil
Lowrisk	Z12	Special screening examination for neoplasms	Malig1	C10	Malignant neoplasm of oropharynx
Lowrisk	Z13	Special screening examination for other diseases and disorders	Malig1	C11	Malignant neoplasm of nasopharynx
Lowrisk	Z29	Need for other prophylactic measures	Malig1	C12	Malignant neoplasm of pyriform sinus
Lowrisk	Z40	Prophylactic surgery	Malig1	C18	Malignant neoplasm of colon
Lowrisk	Z42	Follow-up care involving plastic surgery	Malig1	C19	Malignant neoplasm of rectosigmoid junction
Lowrisk	Z46	Fitting and adjustment of other devices	Malig1	C20	Malignant neoplasm of rectum
Lowrisk	Z47	Other orthopaedic follow-up care	Malig1	C21	Malignant neoplasm of anus and anal canal
Lowrisk	Z48	Other surgical follow-up care	Malig1	C30	Malignant neoplasm of nasal cavity and middle ear
Lowrisk	Z49	Care involving dialysis	Malig1	C32	Malignant neoplasm of larynx
Lowrisk	Z71	Persons encountering health services for health counseling and medical advice NEC	Malig1	C37	Malignant neoplasm of thymus
Metabolic	E01	Iodine-deficiency-related thyroid disorders and allied conditions	Malig1	C38	Malignant neoplasm of heart, mediastinum and pleura
Metabolic	E10	Insulin-dependent diabetes mellitus	Malig1	C41	Malignant neoplasm of bone + articular cartilage of other + unspecified sites
Metabolic	E11	Non-insulin-dependent diabetes mellitus	Malig1	C43	Malignant melanoma of skin
Metabolic	E13	Other specified diabetes mellitus	Malig1	C48	Malignant neoplasm of retroperitoneum and peritoneum
Metabolic	E14	Unspecified diabetes mellitus	Malig1	C49	Malignant neoplasm of other connective and soft tissue
Metabolic	E16	Other disorders of pancreatic internal secretion	Malig1	C50	Malignant neoplasm of breast
Metabolic	E20	Hypoparathyroidism	Malig1	C51	Malignant neoplasm of vulva
Metabolic	E21	Hyperparathyroidism and other disorders of parathyroid gland	Malig1	C52	Malignant neoplasm of vagina
Metabolic	E22	Hyperfunction of pituitary gland	Malig1	C53	Malignant neoplasm of cervix uteri
Metabolic	E27	Other disorders of adrenal gland	Malig1	C54	Malignant neoplasm of corpus uteri
Metabolic	E34	Other endocrine disorders	Malig1	C55	Malignant neoplasm of uterus, part unspecified
Metabolic	E51	Thiamine deficiency	Malig1	C56	Malignant neoplasm of ovary

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Metabolic	E63	Other nutritional deficiencies	Malig1	C57	Malignant neoplasm of other and unspec female genital orgs
Metabolic	E71	Disord branched-chain amino-acid metab + fatty-acid metab	Malig1	C60	Malignant neoplasm of penis
Metabolic	E72	Other disorders of amino-acid metabolism	Malig1	C61	Malignant neoplasm of prostate
Metabolic	E78	Disorders of lipoprotein metabolism and other lipidaemias	Malig1	C65	Malignant neoplasm of renal pelvis
Metabolic	E87	Other disorders of fluid, electrolyte and acid-base balance	Malig1	C66	Malignant neoplasm of ureter
Metabolic	E88	Other metabolic disorders	Malig1	C67	Malignant neoplasm of bladder
Metabolic	N03	Chronic nephritic syndrome	Malig1	C68	Malignant neoplasm of other and unspecified urinary organs
Metabolic	N15	Other renal tubulo-interstitial diseases	Malig1	C69	Malignant neoplasm of eye and adnexa
Metabolic	N18	Chronic renal failure	Malig1	C72	Malig neopl spinal cord, cranial nerves & oth parts of CNS
Metabolic	N25	Disorders resulting from impaired renal tubular function	Malig1	C73	Malignant neoplasm of thyroid gland
Metabolic	R63	Symptoms and signs concerning food and fluid intake	Malig1	C74	Malignant neoplasm of adrenal gland
Metabolic	R73	Elevated blood glucose level	Malig1	C75	Malignant neo other endocrine glands and related structures
Metabolic	R78	Findings of drugs and oth substances not norm found in blood	Malig1	C77	Secondary and unspecified malignant neoplasm of lymph nodes
Malig3	C22	Malignant neoplasm of liver and intrahepatic bile ducts	Malig1	C81	Hodgkin's disease
Malig3	C26	Malignant neoplasm of other and ill-defined digestive organs	Malig1	C83	Diffuse non-Hodgkin's lymphoma
Malig3	C34	Malignant neoplasm of bronchus and lung	Malig1	C84	Peripheral and cutaneous T-cell lymphomas
Malig3	C39	Malig neo oth + ill-def sites resp sys + intrathorac orgs	Malig1	C85	Other and unspecified types of non-Hodgkin's lymphoma
Malig3	C45	Mesothelioma	Malig1	C88	Malignant immunoproliferative diseases
Malig3	C47	Malignant neo peripheral nerves and autonomic nervous syst	Malig1	C92	Myeloid leukaemia
Malig3	C70	Malignant neoplasm of meninges	Malig1	C96	Oth & unspec malig neop lymphoid, haematopoietic & rel tiss
Malig3	C78	Sec malignant neoplasm of respiratory and digestive organs	Malig1	D00	Carcinoma in situ of oral cavity, oesophagus and stomach

APPENDIX C continues

Group	ICD 10	Diagnosis Description	Group	ICD 10	Diagnosis Description
Malig3	C80	Malignant neoplasm without specification of site	Malig1	D01	Carcinoma in situ of other and unspecified digestive organs
Malig3	D42	Neoplasm of uncertain or unknown behaviour of meninges	Malig1	D03	Melanoma in situ
Malig3	R64	Cachexia	Malig1	D32	Benign neoplasm of meninges
Malig2	C23	Malignant neoplasm of gallbladder	Malig1	D37	Neoplasm uncert or unkn behaviour oral cav and diges organs
Malig2	C24	Maligt neoplasm of other and unspec parts biliary tract	Malig1	D38	Neo uncert or unkn behav middle ear/resp/intrathor organ
Malig2	C25	Malignant neoplasm of pancreas	Malig1	D40	Neoplasm uncert or unknown behaviour of male genital organs
Malig2	C31	Malignant neoplasm of accessory sinuses	Malig1	D44	Neoplasm of uncertain/unknown behaviour of endocrine glands
Malig2	C33	Malignant neoplasm of trachea	Malig1	D47	Oth neo uncert / unkn behav lymphoid/haematopoietic rel tis
Malig2	C46	Kaposi's sarcoma	Malig1	D48	Neoplasm uncert or unknown behaviour other and unspec sites
Malig2	C64	Malignant neoplasm of kidney, except renal pelvis	Malig1	Z85	Personal history of malignant neoplasm
Malig2	C71	Malignant neoplasm of brain	Malig2	C13	Malignant neoplasm of hypopharynx
Malig2	C76	Malignant neoplasm of other and ill-defined sites	Malig2	C14	Mal neo oth ill-def sites lip/oral cavity/pharynx
Malig2	C79	Secondary malignant neoplasm of other sites	Malig2	C15	Malignant neoplasm of oesophagus
Malig2	C93	Monocytic leukaemia	Malig2	C16	Malignant neoplasm of stomach
Malig2	C94	Other leukaemias of specified cell type	Malig2	C17	Malignant neoplasm of small intestine
Malig2	C95	Leukaemia of unspecified cell type	Malig2	D43	Neoplasm of uncertain or unknown behaviour of brain and CNS
Malig2	C97	Malignant neoplasms of independent (primary) multiple sites			

APPENDIX D ICD 10 codes of Charlson Categories in SHSMR (ISD, 2013)

Category	ICD-10 code
Acute Myocardial Infarction	I21, I22, I252
Congestive Heart Failure	I50
Peripheral Vascular Disease	I71, I790, I739, R02, Z958, Z959
Cerebral Vascular Accident	I60, I61, I62, I63, I65, I66, G450, G451, G452, G458, G459, G46, I64, G454, I670, I671, I672, I674, I675, I676, I677, I678, I679, I681, I682, I688, I69
Dementia	F00, F01, F02, F051
Pulmonary Disease	J40, J41, J42, J44, J43, J45, J46, J47, J67, J44, J60, J61, J62, J63, J66, J64, J65
Connective Tissue Disorder	M32, M34, M332, M053, M058, M059, M060, M063, M069, M050, M052, M051, M353
Peptic Ulcer	K25, K26, K27, K28
Liver Disease	K702, K703, K73, K717, K740, K742, K746, K743, K744, K745
Diabetes	E109, E119, E139, E149, E101, E111, E131, E141, E105, E115, E135, E145
Diabetes Complications	2 2504, 2505, 2506 E102, E112, E132, E142 E103, E113, E133, E143 E104, E114, E134, E144
Paraplegia	G81 G041, G820, G821, G822
Renal Disease	N03, N052, N053, N054, N055, N056, N072, N073, N074, N01, N18, N19, N25
Cancer	C0, C1, C2, C3, C40, C41, C43, C45, C46, C47, C48, C49, C5, C6, C70, C71, C72, C73, C74, C75, C76, C80, C81, C82, C83, C84, C85, C883, C887, C889, C900, C901, C91, C92, C93, C940, C941, C942, C943, C9451, C947, C95, C96
Metastatic Cancer	C77, C78, C79, C80
Severe Liver Disease	K729, K766, K767, K721
HIV	B20, B21, B22, B23, B24

APPENDIX E CCS Groups in SHMI (Campbell et al., 2012)

CCS	CCS LABEL(S)		
1	1 Tuberculosis	36	48, 51 Thyroid disorders, Other endocrine disorders
2	2, 249 Septicaemia (except in labour), Shock	37	55 Fluid and electrolyte disorders
3	3 Bacterial infection; unspecified site	38	52, 53, Nutritional deficiencies, Disorders of lipid metabolism, Other nutritional; endocrine; and metabolic disorders
4	4 Mycoses	39	59, 60 Deficiency and other anemia, Acute posthemorrhagic anemia
5	5 HIV infection	40	63 Diseases of white blood cells
6	6, 7, 8, Hepatitis, Viral infection, Other infections; including parasitic, Sexually transmitted infections (not HIV or hepatitis), Immunizations and screening for infectious disease	41	57, 61, Immunity disorders, Sickle cell anemia, 62, 64 Coagulation and hemorrhagic disorders, Other hematologic conditions
7	11 Cancer of head and neck	42	65, 68 Mental retardation, Senility and organic mental disorders
8	12 Cancer of oesophagus	43	66, 67, Alcohol-related mental disorders, 69, 72 Substance-related mental disorders, Affective disorders, Anxiety; somatoform; dissociative; and personality disorders
9	13 Cancer of stomach	44	71 Other psychoses
10	14 Cancer of colon	45	70, 73, Schizophrenia and related disorders, 74, 75 Preadult disorders, Other mental conditions, Personal history of mental disorder
11	15 Cancer of rectum and anus	46	76, 77, Meningitis (except that caused by tuberculosis or sexually transmitted disease), Encephalitis (except that caused by tuberculosis or sexually transmitted disease), Other CNS infection and poliomyelitis
12	16 Cancer of liver and intrahepatic bile duct	47	79 Parkinson's disease
13	17 Cancer of pancreas	48	80, 81 Multiple sclerosis, Other hereditary and degenerative nervous system conditions
14	18 Cancer of other GI organs; peritoneum	49	82, Paralysis, Late effects of cerebrovascular disease
15	19 Cancer of bronchus; lung	50	83 Epilepsy; convulsions
16	20 Cancer; other respiratory and intrathoracic	51	85 Coma; stupor; and brain damage
17	22, 23 Melanomas of skin, Other non-epithelial cancer of skin	52	84, 86, Headache; including migraine, Cataract, 87, 88, Retinal detachments; defects; vascular 89, 90, occlusion; and retinopathy, Glaucoma, 91, 92, Blindness and vision defects, 93, 94 Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease), Other eye disorders, Otitis media and related conditions, Conditions associated with dizziness or vertigo, Other ear and sense organ disorders
18	24 Cancer of breast	53	95 Other nervous system disorders
19	25 Cancer of uterus	54	96 Heart valve disorders
20	26, 28 Cancer of cervix, Cancer of other female genital organs		
21	27 Cancer of ovary		
22	29, 30, Cancer of prostate, Cancer of testis, 31 Cancer of other male genital organs		
23	32 Cancer of bladder		
24	33, 34 Cancer of kidney and renal pelvis, Cancer of other urinary organs		
25	35 Cancer of brain and nervous system		
26	37, 38 Hodgkin's disease, Non-Hodgkin's lymphoma		
27	39 Leukemias		
28	40 Multiple myeloma		
29	41, 45 Cancer; other and unspecified primary, Maintenance chemotherapy; radiotherapy		
30	42 Secondary malignancies		
31	21, 36, Cancer of bone and connective tissue, 43 Cancer of thyroid, Malignant neoplasm without specification of site		
32	44, Neoplasms of unspecified nature or uncertain behavior, Nonmalignant breast conditions		
33	46, 47 Benign neoplasm of uterus, Other and unspecified benign neoplasm		
34	49 Diabetes mellitus without complication		
35	50 Diabetes mellitus with complications		

APPENDIX E continues

55	97	Peri-; endo-; and myocarditis; cardiomyopathy (except that caused by tuberculosis or sexually transmitted disease)	85	139	Gastroduodenal ulcer (except hemorrhage)
56	98, 99	Essential hypertension, Hypertension with complications and secondary hypertension	86	140, 141	Gastritis & duodenitis, Other disorders of stomach and duodenum
57	100	Acute myocardial infarction	87	143	Abdominal hernia
58	101	Coronary atherosclerosis and other heart disease	88	144	Regional enteritis and ulcerative colitis
59	102	Nonspecific chest pain	89	145	Intestinal obstruction without hernia
60	103	Pulmonary heart disease	90	146, 147	Diverticulosis & diverticulitis, Anal and rectal conditions
61	104	Other and ill-defined heart disease	91	142, 148	Appendicitis and other appendiceal conditions, Peritonitis and intestinal abscess
62	105	Conduction disorders	92	149	Biliary tract disease
63	106	Cardiac dysrhythmias	93	150	Liver disease; alcohol-related
64	107	Cardiac arrest and ventricular fibrillation	94	151	Other liver diseases
65	108	Congestive heart failure; nonhypertensive	95	152	Pancreatic disorders (not diabetes)
66	109	Acute cerebrovascular disease	96	153	Gastrointestinal hemorrhage
67	110, 111, 112	Occlusion or stenosis of precerebral arteries, Other and ill-defined cerebrovascular disease, Transient cerebral ischemia	97	154	Noninfectious gastroenteritis
68	114	Peripheral and visceral atherosclerosis	98	155	Other gastrointestinal disorders
69	115	Aortic; peripheral; and visceral artery aneurysms	99	157	Acute and unspecified renal failure
70	116	Aortic and peripheral arterial embolism or thrombosis	100	156, 158	Nephritis; nephrosis; renal sclerosis, Chronic renal failure
71	117	Other circulatory disease	101	159	Urinary tract infections
72	118, 119, 120, 121	Phlebitis; thrombophlebitis and thromboembolism, Varicose veins of lower extremity, Hemorrhoids, Other disease of veins and lymphatics	102	160, 161, 162	Calculus of urinary tract, Other diseases of kidneys and ureters, Other diseases of bladder and urethra
73	122	Pneumonia (except that caused by tuberculosis or sexually transmitted disease)	103	163	Genitourinary symptoms and ill-defined conditions
74	125	Acute bronchitis	104	164, 165, 166	Hyperplasia of prostate, Inflammatory conditions of male genital organs, Other male genital disorders
75	127	Chronic obstructive pulmonary disease and bronchiectasis	105	168, 169, 170, 171, 172, 173, 175	Inflammatory diseases of female pelvic organs, Endometriosis, Prolapse of female genital organs, Menstrual disorders, Ovarian cyst, Menopausal disorders, Other female genital disorders
76	128	Asthma	106	174, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 1	Female infertility, Contraceptive & procreative management, Spontaneous abortion, Induced abortion, Prostabortion complications, Ectopic pregnancy, Other complications of pregnancy, Hemorrhage during pregnancy; abruption placenta; placenta previa, Hypertension complicating pregnancy; childbirth; or the puerperium, Early or threatened labor, Prolonged pregnancy, Diabetes or abnormal glucose tolerance complicating pregnancy; childbirth; or the puerperium, Malposition; malpresentation, Fetopelvic disproportion; obstruction, Previous C-section, Fetal distress and abnormal
77	129	Aspiration pneumonitis; food/vomitus			
78	130	Pleurisy; pneumothorax; pulmonary collapse			
79	131	Respiratory failure; insufficiency; arrest (adult)			
80	132	Lung disease due to external agents			
81	56, 133	Cystic fibrosis, Other lower respiratory disease			
82	123, 124, 126, 134, 136, 137	Influenza, Acute and chronic tonsillitis, Other upper respiratory infections, Other upper respiratory disease, Disorders of teeth and jaw, Diseases of mouth; excluding dental			
83	135	Intestinal infection			
84	138	Esophageal disorders			

APPENDIX E continues

107	197	Skin and subcutaneous tissue infections	123	225,	Joint disorders and dislocations; trauma-
108	198,	Other inflammatory condition of skin,		227,	related, Spinal cord injury, Skull and
	199,	Chronic ulcer of skin, Other skin		228,	face fractures, Other fractures, Sprains
	200	disorders		231	and strains
109	201	Infective arthritis and osteomyelitis	124	233	Intracranial injury
		(except that caused by tuberculosis or	125	234	Crushing injury or internal injury
		sexually transmitted disease)	126	235	Open wounds of head; neck; and trunk
110	204	Other non-traumatic joint disorders	127	236	Open wounds of extremities
111	205,	Spondylosis; intervertebral disc	128	237	Complication of device; implant; or graft
	206	disorders; other back problems,	129	238	Complication of surgical procedures or
		Osteoporosis			medical care
112	207	Pathological fracture	130	239	Superficial injury; contusion
113	211	Other connective tissue disease	131	240	Burns
114	54,	Gout and other crystal arthropathies,	132	241,	Poisoning by psychotropic agents,
	202,	Rheumatoid arthritis and related disease,		242,	Poisoning by other medications and
	203,	Osteoarthritis, Acquired foot		243	drugs, Poisoning by nonmedicinal
	208,	deformities, Other acquired deformities,			substances
	209,	Systemic lupus erythematosus and	133	244	Other injuries & conditions due to
	210,	connective tissue disorders, Other bone			external causes
	212	disease and musculoskeletal deformities	134	245	Syncope
115	213	Cardiac & circulatory congenital	135	246	Fever of unknown origin
		anomalies	136	247,	Lymphadenitis, Gangrene
116	214,	Digestive congenital anomalies,		248	
	215,	Genitourinary congenital anomalies,	137	250	Nausea and vomiting
	216,	Nervous system congenital anomalies,	138	251	Abdominal pain
	217	Other congenital anomalies	139	252	Malaise and fatigue
117	219	Short gestation; low birth weight; and	140	253,	Allergic reactions, Rehabilitation care;
		fetal growth retardation		254,	fitting of prostheses; and adjustment of
118	220,	Intrauterine hypoxia and birth asphyxia,		255,	devices, Administrative/social
	221,	Respiratory distress syndrome,		256,	admission, Medical
	222,	Hemolytic jaundice and perinatal		257,	examination/evaluation, Other aftercare,
	223	jaundice, Birth trauma		258,	Other screening for suspected conditions
119	224	Other perinatal conditions		259,	(not mental disorders or infectious
120	226	Fracture of neck of femur (hip)		260	disease), Residual codes; unclassified, E
121	229	Fracture of upper limb			Codes: All (external causes of injury and
122	230	Fracture of lower limb			poisoning)

APPENDIX F Death Rates For Risk Factors

APPENDIX F 1 Age Groups and Death Rates

		Discharge mode		Total			Discharge mode		Total
		Alive	Death				Alive	Death	
1	Count	14	0	14	11	Count	2493	40	2533
	%	100	0	100		%	98.4	1.6	100
2	Count	72	0	72	12	Count	2753	56	2809
	%	100	0	100		%	98	2	100
3	Count	181	0	181	13	Count	2798	68	2866
	%	100	0	100		%	97.6	2.4	100
4	Count	181	0	181	14	Count	2890	101	2991
	%	100.0%	0	100		%	96.6	3.4	100
5	Count	754	3	757	15	Count	2570	116	2686
	%	99.6	0.4	100		%	95.7	4.3	100
6	Count	1262	5	1267	16	Count	2351	140	2491
	%	99.6	0.4	100		%	94.4	5.6	100
7	Count	1260	7	1267	17	Count	1825	126	1951
	%	99.4	0.6	100		%	93.5	6.5	100
8	Count	1529	10	1539	18	Count	1387	158	1545
	%	99.4	0.6	100		%	89.8	10.2	100
9	Count	1788	13	1801	19	Count	727	102	829
	%	99.3	0.7	100		%	87.7	12.3	100
10	Count	2178	23	2201	20	Count	163	38	201
	%	99	1	100		%	81.1	18.9	100

APPENDIX F 2 Age into Three Groups and Death Rates

		Discharge mode		Total
		Alive	Death	
<39	Count	7041	38	7079
	%	99.5	0.5	100
40-64	Count	13112	288	13400
	%	97.9	2.1	100
65+	Count	9023	680	9703
	%	93	7	100

APPENDIX F 3 Sex and Death Rates

		Discharge mode		Total
		Alive	Death	
Woman	Count	14387	457	14844
	%	96.9	3.1	100
Man	Count	14789	549	15338
	%	96.4	3.6	100

**APPENDIX F 4 Number of Emergency Admission in the Previous 12 Months
and Death Rates**

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
0	Count	19597	567	20164	20	Count	6	0	6
	%	97.2	2.8	100		%	100	0	100
1	Count	5570	239	5809	21	Count	2	0	2
	%	95.9	4.1	100		%	100	0	100
2	Count	1902	80	1982	22	Count	2	0	2
	%	96	4	100		%	100	0	100
3	Count	848	47	895	23	Count	4	0	4
	%	94.7	5.3	100		%	100	0	100
4	Count	451	30	481	24	Count	5	0	5
	%	93.8	6.2	100		%	100	0	100
5	Count	262	12	274	25	Count	2	0	2
	%	95.6	4.4	100		%	100	0	100
6	Count	154	5	159	26	Count	2	0	2
	%	96.9	3.1	100		%	100	0	100
7	Count	97	10	107	27	Count	2	0	2
	%	90.7	9.3	100		%	100	0	100
8	Count	77	6	83	28	Count	1	0	1
	%	92.8	7.2	100		%	100	0	100
9	Count	41	3	44	31	Count	1	0	1
	%	93.2	6.8	100		%	100	0	100
10	Count	46	0	46	36	Count	2	0	2
	%	100	0	100		%	100	0	100
11	Count	15	1	16	37	Count	1	0	1
	%	93.8	6.3	100		%	100	0	100
12	Count	22	3	25	38	Count	1	0	1
	%	88	12	100		%	100	0	100
13	Count	17	2	19	42	Count	1	0	1
	%	89.5	10.5	100		%	100	0	100
14	Count	8	0	8	43	Count	2	0	2
	%	100	0	100		%	100	0	100
15	Count	8	0	8	49	Count	1	0	1
	%	100	0	100		%	100	0	100
16	Count	4	0	4	50	Count	2	0	2
	%	100	0	100		%	100	0	100
17	Count	7	0	7	54	Count	1	0	1
	%	100	0	100		%	100	0	100
18	Count	6	1	7	56	Count	1	0	1
	%	85.7	14.3	100		%	100	0	100
19	Count	4	0	4	66	Count	1	0	1
	%	100	0	100		%	100	0	100

APPENDIX F 5 Number of Emergency Admission into Three Groups and Death Rates

		Discharge mode		Total
		Alive	Death	
0	Count	19597	567	20164
	%	97.2	2.8%	100
1	Count	9187	413	9600
	%	95.7	4.3%	100
2	Count	392	26	418
	%	93.8	6.2%	100

APPENDIX F 6 Source of Admission and Death Rates

		Discharge mode		Total
		Alive	Death	
Elective	Count	24399	557	24956
	%	97.8	2.2	100
Emergency	Count	4777	449	5226
	%	91.4	8.6	100

APPENDIX F 7 Charlson Comorbidity Classification and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
C1	Count	402	28	430	C10	Count	446	74	520
	%	93.5	6.5	100		%	85.8	14.2	100
C2	Count	531	66	597	C11	Count	550	110	660
	%	88.9	11.1	100		%	83.3	16.7	100
C3	Count	269	86	355	C12	Count	121	20	141
	%	75.8	24.2	100		%	85.8	14.2	100
C4	Count	40	1	41	C13	Count	251	33	284
	%	97.6	2.4	100		%	88.4	11.6	100
C5	Count	103	34	137	C14	Count	584	91	675
	%	75.2	24.8	100		%	86.5	13.5	100
C6	Count	1390	74	1464	C15	Count	124	56	180
	%	94.9	5.1	100		%	68.9	31.1	100
C7	Count	52	15	67	C16	Count	4	7	11
	%	77.6	22.4	100		%	36.4	63.6	100
C8	Count	44	6	50	C17	Count	11	1	12
	%	88	12	100		%	91.7	8.3	100
C9	Count	63	12	75					
	%	84	16	100					

APPENDIX F 8 Charlson_Old Comorbidity Score and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
0	Count	25087	495	25582	5	Count	66	34	100
	%	98.1	1.9	100		%	66	34	100
1	Count	2231	198	2429	6	Count	22	4	26
	%	91.8	8.2	100		%	84.6	15.4	100
2	Count	1313	164	1477	7	Count	4	2	6
	%	88.9	11.1	100		%	66.7	33.3	100
3	Count	361	76	437	8	Count	1	0	1
	%	82.6	17.4	100		%	100	0	100
4	Count	91	32	123	9	Count	0	1	1
	%	74	26	100		%	0	100	100

APPENDIX F 9 Charlson_Aylin Comorbidity Score and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
-1	Count	62	5	67	20	Count	6	6	12
	%	92.5	7.5	100		%	50	50	100
0	Count	25013	476	25489	21	Count	20	8	28
	%	98.1	1.9	100		%	71.4	28.6	100
1	Count	92	14	106	22	Count	41	28	69
	%	86.8	13.2	100		%	59.4	40.6	100
2	Count	20	2	22	23	Count	23	7	30
	%	90.9	9.1	100		%	76.7	23.3	100
3	Count	1074	38	1112	24	Count	21	10	31
	%	96.6	3.4	100		%	67.7	32.3	100
4	Count	376	42	418	25	Count	10	6	16
	%	90	10	100		%	62.5	37.5	100
5	Count	296	15	311	26	Count	7	7	14
	%	95.2	4.8	100		%	50	50	100
6	Count	42	5	47	27	Count	11	5	16
	%	89.4	10.6	100		%	68.8	31.3	100
7	Count	42	5	47	28	Count	4	3	7
	%	89.4	10.6	100		%	57.1	42.9	100
8	Count	422	57	479	29	Count	3	1	4
	%	88.1	11.9	100		%	75	25	100
9	Count	62	9	71	30	Count	3	0	3
	%	87.3	12.7	100		%	100	0	100
10	Count	465	46	511	31	Count	2	2	4
	%	91	9	100		%	50	50	100
11	Count	299	41	340	32	Count	3	0	3
	%	87.9	12.1	100		%	100	0	100
12	Count	103	8	111	33	Count	3	0	3
	%	92.8	7.2	100		%	100	0	100
13	Count	215	49	264	34	Count	0	1	1
	%	81.4	18.6	100		%	0	100	100
14	Count	249	68	317	35	Count	1	1	2
	%	78.5	21.5	100		%	50	50	100
15	Count	55	8	63	36	Count	1	0	1
	%	87.3	12.7	100		%	100	0	100
16	Count	44	6	50	37	Count	1	1	2
	%	88	12	100		%	50	50	100
17	Count	34	10	44	41	Count	0	1	1
	%	77.3	22.7	100		%	0	100	100
18	Count	37	12	49	42	Count	1	0	1
	%	75.5	24.5	100		%	100	0	100
19	Count	13	3	16					
	%	81.3	18.8	100					

APPENDIX F 10 Charlson_Quan Comorbidity Score and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
0	Count	25919	604	26523	5	Count	67	32	99
	%	97.7	2.3	100		%	67.7	32.3	100
1	Count	1745	139	1884	6	Count	16	8	24
	%	92.6	7.4	100		%	66.7	33.3	100
2	Count	1014	137	1151	7	Count	4	4	8
	%	88.1	11.9	100		%	50	50	100
3	Count	265	33	298	8	Count	0	1	1
	%	88.9	11.1	100		%	0	100	100
4	Count	146	48	194					
	%	75.3	24.7	100					

APPENDIX F 11 Charlson_Old Comorbidity Score (3 Group) and Death Rates

		Discharge Mode		Total
		Alive	Death	
0	Count	25087	495	25582
	%	98.1	1.9	100
1	Count	3544	362	3906
	%	90.7	9.3	100
2	Count	545	149	694
	%	78.5	21.5	100

APPENDIX F 12 Charlson_Aylin Comorbidity Score (3 Group) and Death Rates

		Discharge Mode		Total
		Alive	Death	
0	Count	25075	481	25556
	%	98.1	1.9	100
1	Count	3856	413	4269
	%	90.3	9.7	100
2	Count	245	112	357
	%	68.6	31.4	100

APPENDIX F 13 Charlson_Quan Comorbidity Score (3 Group) and Death Rates

		Discharge Mode		Total
		Alive	Death	
0	Count	25919	604	26523
	%	97.7	2.3	100
1	Count	3024	309	3333
	%	90.7	9.3	100
2	Count	233	93	326
	%	71.5	28.5	100

APPENDIX F 14 Admission Month and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
1	Count	3397	143	3540	7	Count	2788	88	2876
	%	96	4	100		%	96.9	3.1	100
2	Count	2451	91	2542	8	Count	2655	94	2749
	%	96.4	3.6	100		%	96.6	3.4	100
3	Count	2868	99	2967	9	Count	2607	75	2682
	%	96.7	3.3	100		%	97.2	2.8	100
4	Count	3185	105	3290	10	Count	2651	59	2710
	%	96.8	3.2	100		%	97.8	2.2	100
5	Count	2613	85	2698	11	Count	618	37	655
	%	96.8	3.2	100		%	94.4	5.6	100
6	Count	2864	83	2947	12	Count	479	47	526
	%	97.2	2.8	100		%	91.1	8.9	100

APPENDIX F 15 Admission Month (2 Group) and Death Rates

		Discharge Mode		Total
		Alive	Death	
0	Count	28079	922	29001
	%	96.8	3.2	100
1	Count	1097	84	1181
	%	92.9	7.1	100

APPENDIX F 16 Clinical Classification System (CCS) and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
1	Count	4	1	5	121	Count	101	0	101
	%	80	20	100		%	100	0	100
2	Count	74	38	112	122	Count	215	39	254
	%	66.1	33.9	100		%	84.6	15.4	100
4	Count	16	3	19	124	Count	28	0	28
	%	84.2	15.8	100		%	100	0	10
5	Count	13	0	13	125	Count	5	0	5
	%	100	0	100		%	100	0	100
6	Count	82	1	83	126	Count	6	0	6
	%	98.8	1.2	100		%	10	0	100
7	Count	18	0	18	127	Count	119	19	138
	%	100	0	100		%	86.2	13.8	100
8	Count	30	1	31	128	Count	7	0	7
	%	96.8	3.2	100		%	100	0	100
9	Count	2	0	2	129	Count	8	7	15
	%	100	0	100		%	53.3	46.7	100
11	Count	133	6	139	130	Count	38	10	48
	%	95.7	4.3	100		%	79.2	20.8	100
12	Count	21	6	27	131	Count	30	66	96
	%	77.8	22.2	100		%	31.3	68.8	100
13	Count	84	16	100	133	Count	37	2	39
	%	84	16	100		%	94.9	5.1	100
14	Count	128	10	138	134	Count	783	8	791
	%	92.8	7.2	100		%	99	1	100

APPENDIX F 16 continues

15	Count	84	2	86	135	Count	10	0	10
	%	97.7	2.3	100		%	100	0	100
16	Count	47	6	53	136	Count	162	0	162
	%	88.7	11.3	100		%	100	0	100
17	Count	75	9	84	137	Count	23	0	23
	%	89.3	10.7	100		%	100	0	100
18	Count	34	6	40	138	Count	67	1	68
	%	85	15	100		%	98.5	1.5	100
19	Count	29	12	41	139	Count	80	2	82
	%	70.7	29.3	100		%	97.6	2.4	100
21	Count	28	0	28	140	Count	151	4	155
	%	100	0	100		%	97.4	2.6	100
22	Count	5	1	6	141	Count	57	3	60
	%	83.3	16.7	100		%	95	5	100
23	Count	244	1	245	142	Count	292	1	293
	%	99.6	0.4	100		%	99.7	0.3	100
24	Count	174	8	182	143	Count	447	5	452
	%	95.6	4.4	100		%	98.9	1.1	100
25	Count	64	2	66	144	Count	64	0	64
	%	97	3	100		%	100	0	100
26	Count	25	0	25	145	Count	86	7	93
	%	100	0	100		%	92.5	7.5	100
27	Count	33	2	35	146	Count	42	1	43
	%	94.3	5.7	100		%	97.7	2.3	100
28	Count	5	0	5	147	Count	80	0	80
	%	100	0	100		%	100	0	100
29	Count	42	4	46	148	Count	27	3	30
	%	91.3	8.7	100		%	90	10	100
30	Count	9	0	9	149	Count	1405	32	1437
	%	100	0	100		%	97.8	2.2	100
31	Count	2	0	2	150	Count	19	5	24
	%	100	0	100		%	79.2	20.8	100
32	Count	161	3	164	151	Count	126	12	138
	%	98.2	1.8	100		%	91.3	8.7	100
33	Count	37	2	39	152	Count	349	6	355
	%	94.9	5.1	100		%	98.3	1.7	100
34	Count	1	0	1	153	Count	256	38	294
	%	100.0	0	100		%	87.1	12.9	100
35	Count	48	9	57	154	Count	45	5	50
	%	84.2	15.8	100		%	90	10	100
36	Count	99	0	99	155	Count	79	8	87
	%	100	0	100		%	90.8	9.2	100
37	Count	26	1	27	156	Count	35	2	37
	%	96.3	3.7	100		%	94.6	5.4	100
38	Count	92	6	98	157	Count	294	83	377
	%	93.9	6.1	100		%	78	22	100
39	Count	60	6	66	158	Count	234	8	242
	%	90.9	9.1	100		%	96.7	3.3	100
40	Count	42	3	45	159	Count	182	3	185
	%	93.3	6.7	100		%	98.4	1.6	100
41	Count	12	1	13	160	Count	369	1	370
	%	92.3	7.7	100		%	99.7	0.3	100

APPENDIX F 16 continues

42	Count	159	33	192	161	Count	73	1	74
	%	82.8	17.2	100		%	98.6	1.4	100
43	Count	3	1	4	162	Count	162	0	162
	%	75	25	100		%	100	0	100
44	Count	132	5	137	163	Count	154	2	156
	%	96.4	3.6	100		%	98.7	1.3	100
46	Count	200	0	200	164	Count	222	0	222
	%	100	0	100		%	100	0	100
47	Count	456	4	460	165	Count	45	2	47
	%	99.1	0.9	100		%	95.7	4.3	100
48	Count	213	0	213	166	Count	208	0	208
	%	100	0	100		%	100	0	100
49	Count	46	0	46	167	Count	59	1	60
	%	100	0	100		%	98.3	1.7	100
51	Count	75	2	77	168	Count	94	0	94
	%	97.4	2.6	100		%	100	0	100
52	Count	11	3	14	170	Count	133	0	133
	%	78.6	21.4	100		%	100	0	100
53	Count	9	0	9	171	Count	740	0	740
	%	100	0	100		%	100	0	100
54	Count	3	0	3	172	Count	134	0	134
	%	100	0	100		%	100	0	100
55	Count	90	15	105	173	Count	238	0	238
	%	85.7	14.3	100		%	100	0	100
57	Count	2	0	2	175	Count	358	0	358
	%	100	0	100		%	100	0	100
58	Count	42	2	44	178	Count	16	0	16
	%	95.5	4.5	100		%	100	0	100
59	Count	1035	4	1039	180	Count	52	0	52
	%	99.6	0.4	100		%	100	0	100
62	Count	122	5	127	197	Count	243	3	246
	%	96.1	3.9	100		%	98.8	1.2	100
63	Count	70	4	74	198	Count	113	0	113
	%	94.6	5.4	100		%	100	0	100
64	Count	8	0	8	199	Count	70	3	73
	%	100	0	100		%	95.9	4.1	100
66	Count	73	0	73	200	Count	169	0	169
	%	100	0	100		%	100	0	100
67	Count	13	0	13	201	Count	58	2	60
	%	100	0	100		%	96.7	3.3	100
68	Count	39	0	39	202	Count	36	0	36
	%	100	0	100		%	100	0	100
69	Count	148	1	149	203	Count	4	0	4
	%	99.3	0.7	100		%	100	0	100
70	Count	44	0	44	204	Count	16	1	17
	%	100	0	100		%	94.1	5.9	100
71	Count	47	0	47	205	Count	689	1	690
	%	100	0	100		%	99.9	0.1	100
72	Count	34	1	35	206	Count	220	0	220
	%	97.1	2.9	100		%	100	0	100
75	Count	2	0	2	207	Count	69	0	69
	%	100	0	100		%	100	0	100
76	Count	7	0	7	208	Count	43	0	43
	%	100	0	100		%	100	0	100

APPENDIX F 16 continues

77	Count	10	1	11	209	Count	128	0	128
	%	90.9	9.1	100		%	100	0	100
78	Count	1	0	1	210	Count	82	3	85
	%	100	0	100		%	96.5	3.5	100
79	Count	25	1	26	211	Count	375	0	375
	%	96.2	3.8	100		%	100	0	100
80	Count	160	0	160	212	Count	79	0	79
	%	100	0	100		%	100	0	100
81	Count	56	2	58	213	Count	83	1	84
	%	96.6	3.4	100		%	98.8	1.2	100
82	Count	135	0	135	214	Count	10	0	10
	%	100	0	100		%	100	0	100
83	Count	233	4	237	215	Count	5	0	5
	%	98.3	1.7	100		%	100	0	100
84	Count	57	0	57	216	Count	6	0	6
	%	100	0	100		%	100	0	100
85	Count	10	4	14	217	Count	11	0	11
	%	71.4	28.6	100		%	100	0	100
86	Count	690	0	690	225	Count	143	0	143
	%	100	0	100		%	100	0	100
87	Count	737	0	737	226	Count	218	8	226
	%	100	0	100		%	96.5	3.5	100
88	Count	40	0	40	227	Count	2	0	2
	%	100	0	100		%	100	0	100
89	Count	7	0	7	228	Count	102	0	102
	%	100	0	100		%	100	0	100
90	Count	16	0	16	229	Count	235	0	235
	%	100	0	100		%	100	0	100
91	Count	496	0	496	230	Count	199	3	202
	%	100	0	100		%	98.5	1.5	100
93	Count	32	0	32	231	Count	80	4	84
	%	100	0	100		%	95.2	4.8	100
94	Count	67	0	67	232	Count	3	0	3
	%	100	0	100		%	100	0	100
95	Count	865	7	872	233	Count	68	6	74
	%	99.2	0.8	100		%	91.9	8.1	100
96	Count	97	9	106	234	Count	210	2	212
	%	91.5	8.5	100		%	99.1	0.9	100
97	Count	53	4	57	235	Count	39	1	40
	%	93	7	100		%	97.5	2.5	100
98	Count	25	1	26	236	Count	60	0	60
	%	96.2	3.8	100		%	100	0	100
99	Count	6	2	8	237	Count	136	6	142
	%	75	25	100		%	95.8	4.2	100
100	Count	606	48	654	238	Count	176	7	183
	%	92.7	7.3	100		%	96.2	3.8	100
101	Count	1908	35	1943	239	Count	92	2	94
	%	98.2	1.8	100		%	97.9	2.1	100
102	Count	51	0	51	240	Count	16	0	16
	%	100	0	100		%	100	0	100
103	Count	37	5	42	241	Count	114	0	114
	%	88.1	11.9	100		%	100	0	100
104	Count	19	0	19	242	Count	281	0	281
	%	100	0	100		%	100	0	100

APPENDIX F 16 continues

105	Count	55	5	60	243	Count	31	1	32
	%	91.7	8.3	100		%	96.9	3.1	100
106	Count	202	6	208	244	Count	28	3	31
	%	97.1	2.9	100		%	90.3	9.7	100
107	Count	8	0	8	245	Count	27	0	27
	%	100	0	100		%	100	0	100
108	Count	379	30	409	246	Count	22	0	22
	%	92.7	7.3	100		%	100	0	100
109	Count	473	103	576	247	Count	29	1	30
	%	82.1	17.9	100		%	96.7	3.3	100
110	Count	56	0	56	248	Count	5	0	5
	%	100	0	100		%	100	0	100
111	Count	208	9	217	250	Count	9	0	9
	%	95.9	4.1	100		%	100	0	100
112	Count	111	1	112	251	Count	145	1	146
	%	99.1	0.9	100		%	99.3	0.7	100
114	Count	121	11	132	252	Count	13	0	13
	%	91.7	8.3	100		%	100	0	100
115	Count	80	11	91	253	Count	77	0	77
	%	87.9	12.1	100		%	100	0	100
116	Count	26	5	31	254	Count	475	1	476
	%	83.9	16.1	100		%	99.8	0.2	100
117	Count	62	6	68	256	Count	25	0	25
	%	91.2	8.8	100		%	100	0	100
118	Count	54	3	57	257	Count	653	0	653
	%	94.7	5.3	100		%	100	0	100
119	Count	202	0	202	258	Count	194	0	194
	%	100	0	100		%	100	0	100
120	Count	34	0	34	259	Count	38	0	38
	%	100	0	100		%	100	0	100

APPENDIX F 17 Diagnoses Classification of SHMR and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
1	Count	4	1	5	71	Count	62	6	68
	%	80	20	100		%	91.2	8.8	100
2	Count	74	38	112	72	Count	391	3	394
	%	6.1	33.9	100		%	99.2	0.8	100
4	Count	16	3	19	73	Count	215	39	254
	%	84.2	15.8	100		%	84.6	15.4	100
5	Count	13	0	13	74	Count	5	0	5
	%	100	0	100		%	100	0	100
6	Count	132	2	134	75	Count	119	19	138
	%	98.5	1.5	100		%	86.2	13.8	100
7	Count	133	6	139	76	Count	7	0	7
	%	95.7	4.3	10		%	100	0	100
8	Count	21	6	27	77	Count	8	7	15
	%	77.8	22.2	100		%	53.3	46.7	100
9	Count	84	16	100	78	Count	38	10	48
	%	84	16.0	100		%	79.2	20.8	100
10	Count	128	10	138	79	Count	30	66	96
	%	92.8	7.2	100		%	31.3	68.8	100
11	Count	84	2	86	81	Count	37	2	39
	%	97.7	2.3	100		%	94.9	5.1	100
12	Count	47	6	53	82	Count	1002	8	1010
	%	88.7	11.3	100		%	99.2	0.8	10
13	Count	75	9	84	83	Count	10	0	10
	%	89.3	10.7	100		%	100	0	100
14	Count	34	6	40	84	Count	67	1	68
	%	85	15	100		%	98.5	1.5	100
15	Count	29	12	41	85	Count	80	2	82
	%	70.7	29.3	100		%	97.6	2.4	100
17	Count	249	2	251	86	Count	208	7	215
	%	99.2	0.8	100		%	96.7	3.3	100
18	Count	174	8	182	87	Count	447	5	452
	%	95.6	4.4	100		%	98.9	1.1	100
19	Count	64	2	66	88	Count	64	0	64
	%	97	3	100		%	100	0	100
20	Count	30	0	30	89	Count	86	7	93
	%	100	0	100		%	92.5	7.5	100
21	Count	33	2	35	90	Count	122	1	123
	%	94.3	5.7	100		%	99.2	0.8	100
22	Count	53	4	57	91	Count	319	4	323
	%	93	7	100		%	98.8	1.2	100
23	Count	161	3	164	92	Count	1405	32	1437
	%	98.2	1.8	100		%	97.8	2.2	100
24	Count	38	2	40	93	Count	19	5	24
	%	95	5	100		%	79.2	20.8	100
25	Count	48	9	57	94	Count	126	12	138
	%	84.2	15.8	100		%	91.3	8.7	100
26	Count	118	7	125	95	Count	349	6	355
	%	94.4	5.6	100		%	98.3	1.7	100
27	Count	60	6	66	96	Count	256	38	294
	%	90.9	9.1	100		%	87.1	12.9	100

APPENDIX F 17 continues

28	Count	42	3	45	97	Count	45	5	50
	%	93.3	6.7	100		%	90	10	100
29	Count	12	1	13	98	Count	79	8	87
	%	92.3	7.7	100		%	90.8	9.2	100
30	Count	159	33	192	99	Count	294	83	377
	%	82.8	17.2	100		%	78	22	100
31	Count	130	1	131	100	Count	269	10	279
	%	99.2	0.8	100		%	96.4	3.6	100
32	Count	191	6	197	101	Count	182	3	185
	%	97	3	100		%	98.4	1.6	100
33	Count	656	4	660	102	Count	604	2	606
	%	99.4	0.6	100		%	99.7	0.3	100
34	Count	46	0	46	103	Count	154	2	156
	%	100	0	100		%	98.7	1.3	100
36	Count	288	2	290	104	Count	475	2	477
	%	99.3	0.7	100		%	99.6	0.4	100
37	Count	90	15	105	105	Count	1697	0	1697
	%	85.7	14.3	100		%	100	0	100
38	Count	62	5	67	106	Count	68	0	68
	%	92.5	7.5	100		%	100	0	100
39	Count	1035	4	1039	107	Count	243	3	246
	%	99.6	0.4	100		%	98.8	1.2	100
40	Count	70	4	74	108	Count	352	3	355
	%	94.6	5.4	100		%	99.2	0.8	100
41	Count	132	5	137	109	Count	58	2	60
	%	96.4	3.6	100		%	96.7	3.3	100
42	Count	39	0	39	110	Count	16	1	17
	%	100	0	100		%	94.1	5.9	100
43	Count	268	2	270	111	Count	909	1	910
	%	99.3	0.7	100		%	99.9	0.1	100
44	Count	47	0	47	112	Count	69	0	69
	%	100	0	100		%	100	0	100
45	Count	46	0	46	113	Count	375	0	375
	%	100	0	100		%	100	0	100
46	Count	18	1	19	114	Count	375	3	378
	%	94.7	5.3	100		%	99.2	0.8	100
47	Count	25	1	26	115	Count	83	1	84
	%	96.2	3.8	100		%	98.8	1.2	100
48	Count	216	2	218	116	Count	32	0	32
	%	99.1	0.9	100		%	100	0	100
49	Count	135	0	135	120	Count	218	8	226
	%	100	0	100		%	96.5	3.5	100
50	Count	233	4	237	121	Count	235	0	235
	%	98.3	1.7	100		%	100	0	100
51	Count	10	4	14	122	Count	199	3	202
	%	71.4	28.6	100		%	98.5	1.5	100
52	Count	2142	0	2142	123	Count	330	4	334
	%	100	0	100		%	98.8	1.2	100
53	Count	865	7	872	124	Count	68	6	74
	%	99.2	0.8	100		%	91.9	8.1	100
54	Count	97	9	106	125	Count	210	2	212
	%	91.5	8.5	100		%	99.1	0.9	100
55	Count	53	4	57	126	Count	39	1	40
	%	93	7	100		%	97.5	2.5	100

APPENDIX F 17 continues

56	Count	31	3	34	127	Count	60	0	60
	%	91.2	8.8	100		%	100	0	100
57	Count	606	48	654	128	Count	136	6	142
	%	92.7	7.3	100		%	95.8	4.2	100
58	Count	1908	35	1943	129	Count	176	7	183
	%	98.2	1.8	100		%	96.2	3.8	100
59	Count	51	0	51	130	Count	92	2	94
	%	100	0	100		%	97.9	2.1	100
60	Count	37	5	42	131	Count	16	0	16
	%	88.1	11.9	100		%	100	0	100
61	Count	19	0	19	132	Count	426	1	427
	%	100	0	100		%	99.8	0.2	100
62	Count	55	5	60	133	Count	28	3	31
	%	91.7	8.3	100		%	90.3	9.7	100
63	Count	202	6	208	134	Count	27	0	27
	%	97.1	2.9	100		%	100	0	100
64	Count	8	0	8	135	Count	22	0	22
	%	100	0	100		%	100	0	100
65	Count	379	30	409	136	Count	34	1	35
	%	92.7	7.3	100		%	97.1	2.9	100
66	Count	473	103	576	137	Count	9	0	9
	%	82.1	17.9	100		%	100	0	100
67	Count	375	10	385	138	Count	145	1	146
	%	97.4	2.6	100		%	99.3	0.7	100
68	Count	121	11	132	139	Count	13	0	13
	%	91.7	8.3	100		%	100	0	100
69	Count	80	11	91	140	Count	1462	1	1463
	%	87.9	12.1	100		%	99.9	0.1	100
70	Count	26	5	31					
	%	83.9	16.1	100					

APPENDIX F 18 Diagnoses Classification of SHSMR and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
Cerebrovasc 1	Count	448	59	507	Malig3	Count	128	40	168
	%	88.4	11.6	100		%	76.2	23.8	100
Cerebrovasc 2	Count	93	50	143	Metabolic	Count	413	29	442
	%	65	35	100		%	93.4	6.6	100
CVS1	Count	2750	87	2837	Miscel1	Count	2938	28	2966
	%	96.9	3.1	100		%	99.1	0.9	100
CVS2	Count	284	20	304	Miscel2	Count	129	2	131
	%	93.4	6.6	100		%	98.5	1.5	100
CVS3	Count	1078	91	1169	Neuro1	Count	1007	6	1013
	%	92.2	7.8	100		%	99.4	0.6	100
Gastro1	Count	1746	58	1804	Neuro2	Count	297	14	311
	%	96.8	3.2	100		%	95.5	4.5	100
Gastro2	Count	437	44	481	Renal	Count	298	83	381
	%	90.9	9.1	100		%	78.2	21.8	100
Gastro3	Count	87	14	101	Resp1	Count	156	13	169
	%	86.1	13.9	100		%	92.3	7.7	100
Haem	Count	955	15	970	Resp2	Count	166	26	192
	%	98.5	1.5	100		%	86.5	13.5	100
Lowrisk	Count	13166	45	13211	Resp3	Count	337	150	487
	%	99.7	0.3	100		%	69.2	30.8	100
Malig1	Count	1146	48	1194	Trauma1	Count	349	3	352
	%	96	4	100		%	99.1	0.9	100
Malig2	Count	404	65	469	Trauma2	Count	364	16	380
	%	86.1	13.9	100		%	95.8	4.2	100

APPENDIX F 19 Diagnoses Classification of HSMR and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
100	Count	606	48	654	154	Count	45	5	50
	%	92.7	7.3	100		%	90	10	100
101	Count	1908	35	1943	155	Count	79	8	87
	%	98.2	1.8	100		%	90.8	9.2	100
103	Count	37	5	42	157	Count	294	83	377
	%	88.1	11.9	100		%	78	22	100
107	Count	8	0	8	158	Count	234	8	242
	%	100	0	100		%	96.7	3.3	100
108	Count	379	30	409	159	Count	182	3	185
	%	92.7	7.3	100		%	98.4	1.6	100
109	Count	473	103	576	17	Count	75	9	84
	%	82.1	17.9	100		%	89.3	10.7	100
114	Count	121	11	132	19	Count	29	12	41
	%	91.7	8.3	100		%	70.7	29.3	100
115	Count	80	11	91	197	Count	243	3	246
	%	87.9	12.1	100		%	98.8	1.2	100
117	Count	62	6	68	199	Count	70	3	73
	%	91.2	8.8	100		%	95.9	4.1	100
12	Count	21	6	27	2	Count	74	38	112
	%	77.8	22.2	100		%	66.1	33.9	100

APPENDIX F 19 continues

122	Count	215	39	254	226	Count	218	8	226
	%	84.6	15.4	100		%	96.5	3.5	100
125	Count	5	0	5	231	Count	80	4	84
	%	100	0	100		%	95.2	4.8	100
127	Count	119	19	138	237	Count	136	6	142
	%	86.2	13.8	100		%	95.8	4.2	100
129	Count	8	7	15	24	Count	174	8	182
	%	53.3	46.7	100		%	95.6	4.4	100
13	Count	84	16	100	245	Count	27	0	27
	%	84	16	100		%	100	0	100
130	Count	38	10	48	251	Count	145	1	146
	%	79.2	20.8	100		%	99.3	0.7	100
131	Count	30	66	96	27	Count	33	2	35
	%	31.3	68.8	100		%	94.3	5.7	100
133	Count	37	2	39	29	Count	42	4	46
	%	94.9	5.1	100		%	91.3	8.7	100
134	Count	783	8	791	300	Count	18212	202	18414
	%	99	1	100		%	98.9	1.1	100
14	Count	128	10	138	32	Count	161	3	164
	%	92.8	7.2	100		%	98.2	1.8	100
145	Count	86	7	93	38	Count	92	6	98
	%	92.5	7.5	100		%	93.9	6.1	100
148	Count	27	3	30	39	Count	60	6	66
	%	90	10	100		%	90.9	9.1	100
149	Count	1405	32	1437	42	Count	159	33	192
	%	97.8	2.2	100		%	82.8	17.2	100
15	Count	84	2	86	43	Count	3	1	4
	%	97.7	2.3	100		%	75	25	100
150	Count	19	5	24	55	Count	90	15	105
	%	79.2	20.8	100		%	85.7	14.3	100
151	Count	126	12	138	59	Count	1035	4	1039
	%	91.3	8.7	100		%	99.6	0.4	100
153	Count	256	38	294	68	Count	39	0	39
	%	87.1	12.9	100		%	100	0	100

APPENDIX F 20 Charlson_Updated Beta Comorbidity Score and Death Rates

		Discharge		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
0	Count	2648	551	27032	5	Count	108	65	173
	%	98	2	100		%	62.4	37.6	100
1	Count	451	48	499	6	Count	15	4	19
	%	90.4	9.6	100		%	78.9	21.1	100
2	Count	1549	180	1729	7	Count	10	8	18
	%	89.6	10.4	100		%	55.6	44.4	100
3	Count	447	110	557	8	Count	3	6	9
	%	80.3	19.7	100		%	33.3	66.7	100
4	Count	112	33	145	10	Count	0	1	1
	%	77.2	22.8	100		%	0	100	100

APPENDIX F 21 Charlson_Updated Odds Comorbidity Score and Death Rates

		Discharge Mode		Total			Discharge Mode		Total
		Alive	Death				Alive	Death	
0	Count	26481	551	27032	12	Count	2	0	2
	%	98	2	100		%	100	0	100
2	Count	451	48	499	13	Count	2	0	2
	%	90.4	9.6	100		%	100	0	100
3	Count	944	103	1047	14	Count	5	7	12
	%	90.2	9.8	100		%	41.7	58.3	100
4	Count	605	77	682	15	Count	1	0	1
	%	88.7	11.3	100		%	100	0	100
5	Count	248	55	303	16	Count	0	1	1
	%	81.8	18.2	100		%	0	100	100
6	Count	176	44	220	23	Count	3	3	6
	%	80	20	100		%	50	50	100
7	Count	124	39	163	26	Count	0	1	1
	%	76.1	23.9	100		%	0	100	100
8	Count	50	28	78	27	Count	0	1	1
	%	64.1	35.9	100		%	0	100	100
9	Count	19	8	27	29	Count	1	1	2
	%	70.4	29.6	100		%	50	50	100
10	Count	9	5	14	31	Count	0	1	1
	%	64.3	35.7	100		%	0	100	100
11	Count	55	33	88					
	%	62.5	37.5	100					

APPENDIX F 22 Charlson Updated Beta Comorbidity Score (3 Group) and Death Rates

		Discharge Mode		Total
		Alive	Death	
0	Count	26481	551	27032
	%	98	2	100
1	Count	2000	228	2228
	%	89.8	10.2	100
2	Count	695	227	922
	%	75.4	24.6	100

APPENDIX F 23 Charlson_Updated Odds Comorbidity Score (3 Group) and Death Rates

		Discharge Mode		Total
		Alive	Death	
0	Count	26481	551	27032
	%	98	2.0	100
1	Count	2000	228	2228
	%	89.8	10.2	100
2	Count	695	227	922
	%	75.4	24.6	100

APPENDIX G Rules Generated From CHAID Algorithm

1.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.681818.

2.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.628205.

3.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0) AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.811594.

4.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D EQ "Cerebrovasc1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.555556.

5.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D EQ "Cerebrovasc1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (VALUE(C_U_O_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.682927.

6.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D EQ "Cerebrovasc1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.854962.

7.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D EQ "Cerebrovasc1") AND (VALUE (C_U_O_3_group) EQ 2).
COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.875000.

8.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D NE "Cerebrovasc1") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1). COMPUTE
pre_001 = 1. COMPUTE prb_001 = 0.868217.

9.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D NE "Cerebrovasc1") AND (SYSMIS(admission_month_2_group)OR VALUE(admission_month_2_group) NE 1) AND (VALUE(age_3_group) EQ 3 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 0 AND VALUE(C_U_O_3_group) NE 2).
COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.868217.

10.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D NE "Cerebrovasc1") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(age_3_group) EQ 3 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 0 OR VALUE(C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.672000.

11.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (D NE "Cerebrovasc1") AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.933333.

12.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (VALUE(EA) EQ 1) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (D NE "Malig2") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 1).
COMPUTE pre_001 = 1.COMPUTE prb_001 = 0.571429.

13.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (VALUE(EA) EQ 1) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (D NE "Malig2") AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.835821.

14.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (VALUE(EA) EQ 1) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (D EQ "Malig2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.881890.

15.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (VALUE(EA) EQ 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (D NE "Malig2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.911628.

16.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (VALUE(EA) EQ 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (D EQ "Malig2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.800000.

17.IF (D EQ "Cerebrovasc1" OR D EQ "Malig2") AND (VALUE(EA) EQ 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.958175.

18.IF (D EQ "Cerebrovasc2") AND (VALUE(EA) EQ 0).

COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.886076.

19.IF (D EQ "Cerebrovasc2") AND (SYSMIS(EA) OR VALUE(EA) NE 0) AND (VALUE(C_U_O_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.927152.

20.IF (D EQ "Cerebrovasc2") AND (SYSMIS(EA) OR VALUE(EA) NE 0) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.973144.

21.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 0) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND

(SYSMIS(EA) OR VALUE(EA) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.768595.

22.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 0) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (VALUE(EA) EQ 1).COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.528302.

23.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 0) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

24.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.666667.

25.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS (admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.768977.

26.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS (admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.588235.

27.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS (admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

28.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.615385.

29.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.548387.

30.IF (D EQ "CVS1") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.949153.

31.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.672000.

32.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.835821.

33.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(sex) EQ 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.549020.

34.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group)

NE 1) AND (VALUE(sex) EQ 2) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.636364.

35.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.774194.

36.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.685714.

37.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.717949.

38.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.800000.

39.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.732026.

40.IF (D EQ "CVS1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.875000.

41.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 0). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.608392.

42.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1).COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.743363.

43.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.525424.

44.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.982456.

45.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2) AND (D EQ "CVS2"). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.525424.

46.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2) AND (D NE "CVS2"). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.770492.

47.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.631579.

48.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND

(SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.543689.

49.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.809249.

50.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

51.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 2) AND (D EQ "CVS2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.805755.

52.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 2) AND (D NE "CVS2") AND (VALUE(EA) EQ 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.903226.

53.IF (D EQ "CVS2" OR D EQ "Metabolic") AND (VALUE(C_U_O_3_group) EQ 2) AND (D NE "CVS2") AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.982456.

54.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE (NEA_3_group) EQ 0) AND (D NE "Gastro2" AND D NE "Resp1"). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.626667.

55.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(NEA_3_group) EQ 0) AND (D EQ "Gastro2" OR D EQ "Resp1"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.788732.

56.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS (NEA_3_group) OR VALUE(NEA_3_group) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.769231.

57.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.933333.

58.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 0) AND (VALUE(NEA_3_group) EQ 0). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.768595.

59.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 0) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.533333.

60.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.642857.

61.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.777778.

62.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 2) AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.918033.

63.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0) AND (SYSMIS(sex) OR VALUE(sex) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.565891.

64.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.672000.

65.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (VALUE(C_U_O_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.828402.

66.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (D EQ "CVS3"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.733624.

67.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (D NE "CVS3"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.844828.

68.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND

VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1) AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.615385.

69.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2) AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND (VALUE(C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.949153.

70.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2) AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1) AND (VALUE(sex) EQ 2) AND (VALUE(C_U_O_3_group) EQ 1 OR VALUE(C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.903226.

71.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2) AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1) AND (VALUE(sex) EQ 2) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1) AND VALUE(C_U_O_3_group) NE 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.765027.

72.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2) AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (D NE "Gastro2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.893617.

73.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2) AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (D EQ "Gastro2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.805755.

74.IF (D EQ "CVS3" OR D EQ "Gastro2" OR D EQ "Resp1") AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

75.IF (D EQ "Gastro1") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (VALUE(EA) EQ 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.672000.

76.IF (D EQ "Gastro1") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.942308.

77.IF (D EQ "Gastro1") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.565657.

78.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 0 OR VALUE(NEA_3_group) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

79.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.626667.

80.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.517241.

81.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

82.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 0) AND (VALUE(NEA_3_group) EQ 0 OR VALUE(NEA_3_group) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

83.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 0) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.560000.

84.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 0) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.766667.

85.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.714286.

86.IF (D EQ "Gastro1") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

87.IF (D EQ "Gastro1") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND

VALUE(age_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.957265.

88.IF (D EQ "Gastro1") AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(age_3_group) EQ 3 OR VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.777778.

89.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(EA) OR VALUE (EA) NE 1) AND (VALUE(C_U_O_3_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.823529.

90.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(EA) OR VALUE (EA) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.605634.

91.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.777778.

92.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS (EA) OR VALUE(EA) NE 1) AND (D EQ "Gastro3"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.941176.

93.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS (EA) OR VALUE(EA) NE 1) AND (D NE "Gastro3"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.688525.

94.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR

VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.908108.

95.IF (D EQ "Gastro3" OR D EQ "Resp2") AND (VALUE(C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.930748.

96.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(C_U_O_3_group) EQ 1 OR VALUE(C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.574359.

97.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE (sex) EQ 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (VALUE(NEA_3_group) EQ 0 OR VALUE(NEA_3_group) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.626667.

98.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE (sex) EQ 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.629213.

99.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE (sex) EQ 2) AND (VALUE(age_3_group) EQ 3 OR VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

100.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS (sex) OR VALUE(sex) NE 2) AND (SYSMIS(age_3_group) OR

VALUE(age_3_group) NE 3). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

101.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS (sex) OR VALUE(sex) NE 2) AND (VALUE(age_3_group) EQ 3) AND (VALUE(NEA_3_group) EQ 0 OR VALUE(NEA_3_group) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

102.IF (D EQ "Haem") AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS (sex) OR VALUE(sex) NE 2) AND (VALUE(age_3_group) EQ 3) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE(NEA_3_group) NE 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.720000.

103.IF (D EQ "Haem") AND (VALUE(admission_month_2_group) EQ 1).

COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.913043.

104.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

105.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"

AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(sex) EQ 1). COMPUTE prb_001 = 0.752212.

106.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.711864.

107.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 1) AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.518519.

108.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.525424.

109.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(NEA_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.705882.

110.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (SYSMIS (admission_month_2_group) OR VALUE(admission_month_2_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.970495.

111.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (VALUE (admission_month_2_group) EQ 1)

AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

112.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (VALUE (admission_month_2_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.708333.

113.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(age_3_group) EQ 3) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

114.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE

1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(age_3_group) EQ 3) AND (VALUE(NEA_3_group) EQ 1).
COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.800000.

115.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

116.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND (VALUE(age_3_group) EQ 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1).
COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.616438.

117.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND

(VALUE(age_3_group) EQ 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0.
COMPUTE prb_001 = 1.000000.

118.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND
D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2"
AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE
"Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND
D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"
AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE
"Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE
1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND
(VALUE(age_3_group) EQ 3) AND (SYSMIS(sex) OR VALUE(sex) NE 1).
COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.589474.

119.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND
D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2"
AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE
"Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND
D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"
AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE
"Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE
1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND
(VALUE(age_3_group) EQ 3) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0.
COMPUTE prb_001 = 0.619048.

120.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND
D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2"
AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE
"Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND
D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"
AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE
"Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE
1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND
(SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND

VALUE(age_3_group) NE 3) AND (SYSMIS(sex) OR VALUE(sex) NE 1).
COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

121.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND
D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2"
AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE
"Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND
D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"
AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE
"Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE (C_U_O_3_group) NE
1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND
(SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND
VALUE(age_3_group) NE 3) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 0.
COMPUTE prb_001 = 0.865385.

122.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND
D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2"
AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE
"Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND
D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"
AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE
"Trauma2") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(sex) OR
VALUE(sex) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1). COMPUTE
pre_001 = 1. COMPUTE prb_001 = 0.800000.

123.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND
D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2"
AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE
"Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND
D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal"
AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE
"Trauma2") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(sex) OR
VALUE(sex) NE 1) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1.
COMPUTE prb_001 = 1.000000.

124.IF (D NE "Cerebrovasc1" AND D NE "Cerebrovasc2" AND D NE "CVS1" AND D NE "CVS2" AND D NE "CVS3" AND D NE "Gastro1" AND D NE "Gastro2" AND D NE "Gastro3" AND D NE "Haem" AND D NE "Malig1" AND D NE "Malig2" AND D NE "Malig3" AND D NE "Metabolic" AND D NE "Miscel1" AND D NE "Miscel2" AND D NE "Neuro1" AND D NE "Neuro2" AND D NE "Renal" AND D NE "Resp1" AND D NE "Resp2" AND D NE "Resp3" AND D NE "Trauma2") AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.549020.

125.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(age_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.513761.

126.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.734082.

127.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (D NE "Neuro2" AND D NE "Trauma2"). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.815182.

128.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1) AND (D EQ "Neuro2" OR D EQ "Trauma2"). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

129.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(age_3_group) EQ 3). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.636364.

130.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

131.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.730435.

132.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (VALUE(EA) EQ 1) AND (D EQ "Malig1" OR D EQ "Neuro2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.714894.

133.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1) AND (VALUE(EA) EQ 1) AND (D NE "Malig1" AND D NE "Neuro2"). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.546559.

134.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND

VALUE(C_U_O_3_group) NE 2) AND (VALUE(NEA_3_group) EQ 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.649275.

135.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(NEA_3_group) EQ 1) AND (VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.605634.

136.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(age_3_group) EQ 2) AND (D NE "Neuro2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.674699.

137.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(age_3_group) EQ 2) AND (D EQ "Neuro2"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 1.000000.

138.IF (D EQ "Malig1" OR D EQ "Neuro2" OR D EQ "Trauma2") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.881890.

139.IF (D EQ "Malig3" OR D EQ "Renal") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(EA) EQ 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.595745.

140.IF (D EQ "Malig3" OR D EQ "Renal") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.848485.

141.IF (D EQ "Malig3" OR D EQ "Renal") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.866667.

142.IF (D EQ "Malig3" OR D EQ "Renal") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND

(VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.577320.

143.IF (D EQ "Malig3" OR D EQ "Renal") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (VALUE(EA) EQ 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.756757.

144.IF (D EQ "Malig3" OR D EQ "Renal") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.903226.

145.IF (D EQ "Malig3" OR D EQ "Renal") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.867257.

146.IF (D EQ "Malig3" OR D EQ "Renal") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 0) AND (D EQ "Malig3"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.835821.

147.IF (D EQ "Malig3" OR D EQ "Renal") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 0) AND (D NE "Malig3"). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.935561.

148.IF (D EQ "Malig3" OR D EQ "Renal") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(sex) OR VALUE(sex) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.965517.

149.IF (D EQ "Malig3" OR D EQ "Renal") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(sex) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.896000.

150.IF (D EQ "Malig3" OR D EQ "Renal") AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(EA) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.991150.

151.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(NEA_3_group) EQ 0 OR VALUE(NEA_3_group) EQ 2) AND (VALUE (sex) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

152.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(NEA_3_group) EQ 0 OR VALUE(NEA_3_group) EQ 2) AND (SYSMIS (sex) OR VALUE(sex) NE 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.681818.

153.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (VALUE(C_U_O_3_group) EQ 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0 AND VALUE (NEA_3_group) NE 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.548387.

154.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (VALUE(C_U_O_3_group) EQ 1) AND (VALUE(admission_month_2_group) EQ 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.777778.

155.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

156.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 1) AND

(SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.808874.

157.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 1) AND (VALUE(age_3_group) EQ 3). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

158.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 1) AND (VALUE(age_3_group) EQ 1) AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

159.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(NEA_3_group) EQ 1) AND (VALUE(age_3_group) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.821656.

160.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND (VALUE (age_3_group) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.740741.

161.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND (SYSMIS (age_3_group) OR VALUE(age_3_group) NE 2 AND VALUE(age_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.608696.

162.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1 AND VALUE(C_U_O_3_group) NE 2) AND (VALUE(EA) EQ 1) AND (VALUE (age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

163.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (VALUE(C_U_O_3_group) EQ 2) AND (SYSMIS(age_3_group) OR VALUE(age_3_group) NE 3 AND VALUE(age_3_group) NE 1). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.875000.

164.IF (D EQ "Miscel1" OR D EQ "Miscel2") AND (VALUE(C_U_O_3_group) EQ 2) AND (VALUE(age_3_group) EQ 3 OR VALUE(age_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.555556.

165.IF (D EQ "Neuro1") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (VALUE(C_U_O_3_group) EQ 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.616438.

166.IF (D EQ "Neuro1") AND (SYSMIS(EA) OR VALUE(EA) NE 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 1). COMPUTE pre_001 = 0. COMPUTE prb_001 = 1.000000.

167.IF (D EQ "Neuro1") AND (VALUE(EA) EQ 1) AND (VALUE(sex) EQ 2). COMPUTE pre_001 = 0. COMPUTE prb_001 = 0.636364.

168.IF (D EQ "Neuro1") AND (VALUE(EA) EQ 1) AND (SYSMIS(sex) OR VALUE(sex) NE 2). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.602151.

169.IF (D EQ "Resp3") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (VALUE(EA) EQ 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.730435.

170.IF (D EQ "Resp3") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1) AND (SYSMIS(admission_month_2_group) OR VALUE(admission_month_2_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE 0). COMPUTE pre_001 = 1. COMPUTE prb_001 = 0.909091.

171.IF (D EQ "Resp3") AND (VALUE(age_3_group) EQ 2 OR VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2) AND (SYSMIS(sex) OR VALUE(sex) NE 1)

AND (VALUE (admission_month_2_group) EQ 1). COMPUTE pre_001 = 1.
COMPUTE prb_001 = 0.982456.

172.IF (D EQ "Resp3") AND (VALUE(age_3_group) EQ 2 OR
VALUE(age_3_group) EQ 1) AND (SYSMIS(C_U_O_3_group) OR
VALUE(C_U_O_3_group) NE 2) AND (VALUE(sex) EQ 1). COMPUTE pre_001
= 1. COMPUTE prb_001 = 0.674699.

173.IF (D EQ "Resp3") AND (VALUE(age_3_group) EQ 2 OR
VALUE(age_3_group) EQ 1) AND (VALUE(C_U_O_3_group) EQ 2). COMPUTE
pre_001 = 1. COMPUTE prb_001 = 0.945148.

174.IF (D EQ "Resp3") AND (SYSMIS(age_3_group) OR VALUE(age_3_group)
NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE
1) AND (VALUE(NEA_3_group) EQ 0). COMPUTE pre_001 = 1. COMPUTE
prb_001 = 0.666667.

175.IF (D EQ "Resp3") AND (SYSMIS(age_3_group) OR VALUE(age_3_group)
NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE
1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND
(SYSMIS(C_U_O_3_group) OR VALUE(C_U_O_3_group) NE 2). COMPUTE
pre_001 = 1. COMPUTE prb_001 = 0.924528.

176.IF (D EQ "Resp3") AND (SYSMIS(age_3_group) OR VALUE(age_3_group)
NE 2 AND VALUE(age_3_group) NE 1) AND (SYSMIS(EA) OR VALUE(EA) NE
1) AND (SYSMIS(NEA_3_group) OR VALUE(NEA_3_group) NE 0) AND
(VALUE (C_U_O_3_group) EQ 2). COMPUTE pre_001 = 1. COMPUTE prb_001 =
0.963441.

177.IF (D EQ "Resp3") AND (SYSMIS(age_3_group) OR VALUE(age_3_group)
NE 2 AND VALUE(age_3_group) NE 1) AND (VALUE(EA) EQ 1). COMPUTE
pre_001 = 1. COMPUTE prb_001 = 0.959843.

D: Disease group, EA=Emergency admission, NEA: Number of emergency admission

APPENDIX H ABBREVIATION

CCS: Clinical Classifications System

CDS: Commissioning Datasets

CHKS: Caspe Healthcare Knowledge Systems

HES: Hospital Episode Statistics

HSMR: Hospital Standardized Mortality Ratio

ISD: Information Service Division

IHI: Institute for Healthcare Improvement

IMD: Index of multiple deprivation

NHS: National Health Service

ONS: Office for national statistics

RAMI: Risk-Adjusted Mortality Index

RAMM: Risk Adjusted Mortality Measures

SUS: Secondary Uses Service Data

SPSP: Scottish Patient Safety Programme

SHMI: Summary Hospital-Level Mortality Indicator

SHSMR: Scottish Hospital Standardized Mortality Ratio