National Adult Cardiac Surgery Audit Registry Data Pre-processing

Version 10.3

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With thanks to Graeme Hickey for contributions to previous versions.

Summary
This report outlines the main steps taken to pre-process the National Adult Cardiac Surgery Audit (NACSA) registry data. This comprises a merger of all operative records for adult cardiac surgery: from hospital extracts to a cleaned, uniform dataset. The report is compiled directly from the pre-processing code during each cleaning implementation, and each notable modification to raw hospital data is presented. Erroneous errors are cleaned in-field but additional data pre-processing and inferences are saved to new indicator fields. The present version is up-to-date as of May 8, 2015.

Data
The latest data extract is dated 2015-05-01 and comprises all Adult Cardiac Procedures from the NACSA registry, and includes merged ONS linkage data that is available up to 2014-07-24.

The database is a single file comprised of a concatenation of two version of the NACSA databases: v3.8 and a revised v4.1.2, which took effect from April 2011.

Two methods of mapping from v3.8 to v4.1.2 are implemented: within-field mapping and between-field mapping. For within-field mapping the fields themselves have remained the same but the field options have changed between versions. These changes are highlighted under each field-heading accordingly. In contrast, for between-field mapping the fields themselves have changed. These changes are more complicated in nature and are described together in a separate section. In addition, several fields have been removed both during the transition from v3.8 to v4.1.2 and subsequently. For documentation of the up-to-date database definitions, please see:

V4.1.2 Database Definitions
www.ucl.ac.uk/nicor/audits/adultcardiac/documents/datasets/NACSAdatasetV4.1.2

Validation
The output from the pre-processing is regularly checked by reporting data summaries back to individual units for inspection. The current data is validated from 1998-01-01 to 2013-03-31, with 2013-04-01 to 2014-03-31 data due to be validated by June 2015.
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1 Changes to Previous Versions

1.1 Changes in Version 10.3

- Data for validation extended to 2014-03-31
- New hospital introduced to dataset: AHM. BMI The Alexandra Hospital
- Temporary hospital code QEP used for external QEB patients

Categorical Variables

Minor corrections to new erroneous input for cleaning:

X3.47.Aortic.Valve.Implant.Type
“Bioprosthetic” mapped to “3. Biological”

Multivalue Variables

Minor corrections to new erroneous input for cleaning:

Numerical Variables

X2.37.Height
“False” set as missing
Variable converted from string to numerical prior to cleaning

X2.38.Weight
“False” set as missing
Additional minor corrections to erroneous input cleaning

Surgeon Variables

X3.03.Responsible.Consultant.Surgeon
Updated GMC number mappings and revised cleaning algorithm

Between-Field Mapping

Minor corrections to new erroneous input for cleaning:

“Tube graft + separate AVR” mapped to missing
1.2 Changes in Version 10.2

- Variables for ONS linkage LS.Status and LS.Date extended to 2014-07-24
- Updated removal procedure from mismatched ONS linkage
- New hospital introduced to dataset: CBS. Spire Southampton Hospital
- New clinical definition of unstable angina (see below)

Categorical Variables

Minor corrections to new erroneous input for cleaning:
- X1.08.Administrative.Category
- X3.23.Aortic.Valve.Explant
- X3.43.Aortic.Valve.Procedure
- X3.44.Mitral.Valve.Procedure
- X3.45.Tricuspid.Valve.Procedure
- X3.47.Aortic.Valve.Implant.Type
- X3.48.Mitral.Valve.Implant.Type
- X3.49.Tricuspid.Valve.Implant.Type
- X3.50.Pulmonary.Valve.Implant.Type
- X3.84.Non.cardioplegic.protection
- X4.01.1.Deep.Sternal.wound.infection
- X4.01.2.Deep.Sternal.wound.infection.treatment

**X3.47.Aortic.Valve.Implant.Type**
“Tissue” and “Biological” remapped from missing to “3. Biological”

**X3.48.Mitral.Valve.Implant.Type**
“Tissue” remapped from missing to “3. Biological”

Multivalue Variables

Minor corrections to new erroneous input for cleaning:
- X3.90.Presentation
- X3.95.Neuroprotection
- X4.02.New.CVA

Surgeon Variables

Minor corrections to new erroneous input for cleaning:
- X3.06.First.Operator.Grade
- X3.09.First.Assistant.Grade
- X3.03.Responsible.Consultant.Surgeon

Updated GMC number mappings

Between-Field Mapping

Minor corrections to new erroneous input for cleaning:
- X3.75.1.Ao.proc.Descending.Segment.Code.4

Flags

Aortic Valve Flag

Pulmonary Valve Flag
1.3 Changes in Version 10.1

Model Variables

Unstable angina field **angina** extended from definition of **X2.29.IV.Nitrates** set as “1. Yes” to:

IF X2.29.IV.Nitrates is “1. Yes”
AND X2.01.Angina.Status.Pre.Surgery is “4. Symptoms at rest or minimal activity”

1.3 Changes in Version 10.1

Fields Dropped

- Fields dropped from dataset:
  - X2.15.Carotid.Bruits
- Redundant fields:
  - Date: duplicate of **Creation.Date**
  - Ethnic.Group, LADProx, LADOther, RCA LCX, Grafts.present and Grafts.patent currently only recorded at one hospital
- V3.8 fields dropped after cleaning/mapping:

Categorical Variables


“1. Two vessels with >50% diameter stenosis” remapped from “1. One vessel with >50% diameter stenosis” to “2. Two vessels with >50% diameter stenosis”

**X2.24.3.Category.of.AVS**


**X2.29.IV.Nitrates**

“2. Within one week of operation” and “2” mapped to “1. Yes”

**X3.78.Cardiopulmonary.bypass**

“1. No” remapped from missing to “0. No”

**X3.83.Cardioplegia.timing**

“2. Intermittent” remapped from “2. Continuous” to “1. Intermittent”

**X3.84.Non.cardioplegic.protection**

“Beating heart with perfusion” remapped from missing to “5. Beating heart without cross clamp”
1.3 Changes in Version 10.1

Multivalue Variables

For native valve pathology variables:
- X3.27.Native.Aortic.Valve.Path

“2. Degenerative inc Calcific degeneration” mapped from “7. Calcific degeneration” and “2. Degenerative”

X3.27.Native.Aortic.Valve.Path
“14 - other degenerative disease” remapped from “19. Other native valve pathology” to “2. Degenerative inc Calcific degeneration”
“13 - Annuloaortic ectasia” remapped from “19. Other native valve pathology” to “6. Annuloaortic ectasia”

For reason for repeat valve replacement variables:
- X3.35.Reason.Repeat.aortic.valvereplacement

“5. Implanted valve failure” mapped from “5. Intrinsic valve failure”

X3.35.Reason.Repeat.aortic.valvereplacement
“6. Other” remapped from “6. Haemolysis” to “19. Other reason”
“7. Unknown” remapped from “7. Prior valve repair failure” to missing

X3.81.Cardioplegia.temperature
“2. Cold” remapped from “2. Warm” to “1. Cold”
“1. Warm” remapped from “1. Cold” to “2. Warm”

X3.82.Cardioplegia.infusion.mode
“3. Antegrade and retrograde” remapped from missing to “1. Antegrade;2. Retrograde”

X4.02.New.CVA
“0 No” remapped from missing to “0. None”

Numerical Variables

X2.38.Weight
Converted field class from integer to numerical with 1 dp

Converted field class from numerical to integer:
- X3.85.Cumulative.Bypass.time
- X3.86.Cumulative.cross.clamp.time
- X3.87.Circulatory.arrest.time

X3.86.Cumulative.cross.clamp.time
“1;2” remapped from “12” to missing
1.3 Changes in Version 10.1

Between-Field Mapping

Renal Mapping
X2.12.0.Actual.Creatinine.at.time.of.Surgery
Minor updates to renal mappings from v3.8 field

Minor updates to renal mappings from v3.8 field

Aortic Pathologies
X3.68.1.Ao.path.Root.Segment.Code.1
Minor updates to aortic pathology mappings from v3.8 field

X3.70.1.Ao.path.Ascending.Segment.Code.2
Minor updates to aortic pathology mappings from v3.8 field

X3.74.1.Ao.path.Descending.Segment.Code.4
Erroneous “8” and “9” mapped to “99. Other”

“15. Intramural haematoma” mapped to “15. Intramural haematoma

Aortic Procedures
Minor updates to aortic procedure mappings from v3.8 field

“Reduction aortoplasty” remapped from missing to “10. Reduction aortoplasty”

“4. Root replacement with composite valve graft and coronary reimplantation (Modified Bentall or Cabroll)”

to “5. Root replacement with preservation of native valve and coronary reimplantation”

Patching

Major Aortic Patching
Patching no longer applied to X3.91.Aetiology since the affected hospital records are prior to the field introduction in v4.1.2. Instead, the old v3.8 aortic pathology fields are patched, and implemented prior to mapping to X3.91.Aetiology.

Post-patching Mapping
This section has been created to move the cleaning and mapping for some fields to be conducted after the patching section. The cleaning of these fields have also been reordered to ensure that fields are only mapped from other fields that themselves have already been cleaned. This was necessary as a result of the increasing inter-relatedness of between-field mappings conducted to improve the overall data validity.

Cardiac Procedures
Minor updates to cardiac procedure mappings from v3.8 field

Aortic Aetiology
Minor updates due to changes to mapping fields
Multivalued formatting updated to check for errors in field delimitations
1.3 Changes in Version 10.1

Flags

**Single Episode Flag**
Minor corrections to script that misallocated cases with missing Apollo codes

**Previous Operation Flag**
Streamlined correction algorithm

Shortcuts

**Survival data**
Corrections to *time* field that amends mismatches from ONS
2 Variable Cleaning

2.1 Dates

The cleaning script converts date and date-time fields in the NACSA database to a standardized format.

The following date fields are converted to a YYYY-MM-DD format

- Creation.Date
- X2.08.Date.Last.Cardiac.Operation
- X2.20.Date.Last.Catheterisation
- X3.01.Admission.Date
- X3.02.Procedure.Date
- X4.06.Discharge.Date

For the following fields, all dates prior to 1967-01-01 (a proxy date for cardiac surgery in the UK) were set as missing:

- X2.08.Date.Last.Cardiac.Operation
- X2.20.Date.Last.Catheterisation

For field X3.02.Procedure.Date a separate HH:MM time field X3.02.Procedure.Time is also generated. For fields Creation.Date, X2.08.Date.Last.Cardiac.Operation and X3.01.Admission.Date the time field is removed due to the high proportion of insufficient and erroneous entries e.g. default values of 00:00 or 00:01.

2.2 Categorical Variables

Categorical variables are selected through drop-down menus and radio button controls. In principle they should be error free but due to historical data, different hospital software, ad hoc record editing and errors at the central repository, errors have inevitably emerged. For the present version (from version 10.0) all corrections are treated as variable specific. Global rules are removed and each observed permutation of error is manually inspected and categorised.

Reasons for cleaning generally fall under one or more of the following categories:

1. Erroneous entries: “n/a” “#N/A” “null” “.” “Entry not found” “Not Defined” or equivalent
2. Case sensitivity or spelling e.g.
   “0. No Angina” to “0. No angina” for X2.01.Angina.Status.Pre.Surgery
3. Text file encoding (such as occurrence of symbols) e.g.
   “1. One.” to “1. One” X2.03.N.Previous.MIs
4. Missing inputs e.g.
   “3. 1-30 days” to “3. MI 1-30 days” X2.04.Interval.between.Surgery.and.last.MI
5. Extra inputs e.g.
6. Repeated value encoding e.g.
7. Numeric prefix omissions e.g.

Further corrections or remappings not sufficiently captured by the above are presented for each applicable variable under the appropriate headings below.
2.2 Categorical Variables

**X1.07. Gender**
Set as missing: “0. Not known” “Unknown” “9. Not specified” “0” “1;2.” “2;1.”

**X1.08. Administrative.Category**
Set as “1. NHS”: “01” “3. NHS” “5. Visitor”
Set as “2. Private”: “02”

**X2.01. Angina.Status.Pre.Surgery**
Set as “0. No angina”: “0. CCS 0”
Set as “1. No limitation”: “1. CCS 1”
Set as “2. Slight limitation of ordinary activity”: “2. CCS 2”
Set as “3. Marked limitation of ordinary physical activity”: “3. CCS 3”
Set as “4. Symptoms at rest or minimal activity”: “4. CCS 4”
Set as missing: “[59]” “1;2” “2;3” “3;4”

Set as “1. No limitation of physical activity”: “1. NYHA 1”
Set as “2. Slight limitation of ordinary physical activity”: “2. NYHA 2”
Set as “3. Marked limitation of ordinary physical activity”: “3. NYHA 3”
Set as “4. Symptoms at rest or minimal activity”: “4. NYHA 4”
Set as missing: “[09]” “1.” “1001” “1002”

**X2.03. N.Previous.MIs**
Set as missing: “[347]” “10”

**X2.04. Interval.between.Surgery.and.last.MI**
Set as “3. MI 1-30 days”: “1. MI 1-30 days”
Set as missing: “9” “1. 5” “204_13”
**Between-field cleaning:** if X2.03.N.Previous.MIs == “0. None”, recode missing to “0. No previous MI”

**X2.05. Previous.PCI**
Set as “0. No previous PCI”: “No”
Set as missing: “01/01/1995” “27/12/2007” “9”

**X2.09. Diabetes.Management**
Set as missing: “[49]” “1002”

**X2.10. Hx.of.Hypertension**
Set as “9. Unknown”: “Unkwn”
Set as missing: “2”

**X2.11. Smoking.Status**
Set as missing: “[39]”

**X2.12.1. Renal.Function.Dialysis**
See Between-Field Mapping for variable cleaning
2.2 Categorical Variables

X2.13.Hx.of.Pulmonary.Disease
Set as “0. No pulmonary disease: “n”
Set as “1. COAD/emphysema or Asthma”: “1;1” “1;1;1” “1;2”
OR starting with “1. COAD” or “2. Asthma”
OR containing “COPD” “pneumonia” “mediastinal sarcoidosis” “sleep apnoea” “pleural calcification”
“Pulmonary oedema” “Respiratory failure type 11”
Set as missing: “9. Unknown” “[34LPs]” “0;” “1;0”
OR starting with “0. No pulmonary disease”

X2.16.Hx.of.Neurological.Dysfunction
Set as “0. No”: “0. No neurological dysfunction at start of operation.”
Set as “1. Yes”: “1. Neurological dysfunction at start of operation.”
Set as missing: “9. Unknown” “3”

X2.17.Extracardiac.arteriopathy
Set as missing: “9. Unknown” “9” “-1”

X2.18.Pre.operative.heart.rhythm
Set as “2. Complete heart block/pacing”: “3. Complete heart block / paced”
Set as “3. Ventricular fibrillation or ventricular tachycardia”: “2. History VT / VF in 2 weeks before surgery”
Set as missing: “1;2;4” “1;3”

X2.19.Left.Heart.Catheterisation
Set as “1. Yes”: “2” “2. Previous admission” “1. This admission;2. Previous admission”
Set as missing: “3” “99”
OR starting with “0. Never”

Set as “0. No vessel with >50% diameter stenosis”: “0”
Set as “1. One vessel with >50% diameter stenosis”: “1”
Set as “2. Two vessels with >50% diameter stenosis”: “1. Two vessels with >50% diameter stenosis” “2”
Set as “3. Three vessels with >50% diameter stenosis”: “3”
Set as missing: “[456]” “99”
OR containing “0. No vessel with >50% diameter stenosis”
For erroneous multivalue format, those containing multiple are recoded in order:
“3. Three vessels with >50% diameter stenosis”
“2. Two vessels with >50% diameter stenosis”
“1. One vessel with >50% diameter stenosis”

X2.22.Left.Main.Stem.Disease
Set as “0. No LMS disease or LMS disease < 50% diameter stenosis”: “0. 0%” “1. 1-49%”
“2. No LMS disease / LMS disease <51% diameter stenosis”
Set as “1. LMS>50% diameter stenosis”: “2. 50-74%” “3. 75-94%” “4. 95-99%” “5. 100%”
Set as missing: “-1” “99”

X2.24.3.Category.of.AVS
Set as “1. Mild”: “1”
Set as “2. Moderate”: “1. Moderate” “2”
Set as “3. Severe”: “3”
Set as missing: “[04]”
2.2 Categorical Variables

X2.28. LV.Ejection.Fraction.Category
Set as “1. Good (LVEF > 50%)”: “1. Good (LVEF >= 50%)”
Set as “2. Fair (LVEF 30-50%)”: “2. Fair (LVEF 30-49%)”
Set as missing: “[045]”

X2.29. IV.Nitrates
Set as “1. Yes”: “1. Within one week of operation” “2. Within one week of operation” “2”
Set as missing: “2. Within one week of 1. Until operation” “11”

X2.30. Cardiogenic.Shock.Preop
Set as missing: “[-9]”

X2.31. IV.Inotropes
Set as missing: “9”

X2.31. IV.Inotropes
No cleaning needed

X2.35. Operative.Urgency
Set as missing: “9” “56” “65” “97” “100”

For valve haemodynamics variables:

Set as missing: “Ammaullah. Dr” “3612419” “4266998” “[045]” “0;0” “11” “13” “21” “22”

X3.23. Aortic.Valve.Explant
Set as “6. Prior Repair”: “6. Ring”
Set as “7. Other”: “7” “Other”
Set as missing: containing “1. Native valve” and either “2. Mechanical” or “3. Biological”
See Patching for further variable cleaning

Set as “1. Native valve”: “N”
Set as “4. Homograft”: “4”
Set as “5. Autograft”: “5”
Set as missing: “0”
    OR containing “1. Native valve” and either “2. Mechanical” or “3. Biological”
See Patching for further variable cleaning

X3.25. Tricuspid.Valve.Explant
Set as “3. Biological”: “3. Repair with ring”
Set as “6. Ring”: “6. Prior repair”
Set as missing: “0” “Autograft” “7. Inspection”
See Patching for further variable cleaning
2.2 Categorical Variables

**X3.26. Pulmonary Valve Explant**
Set as missing: “0” “Prior repair”
See Patching for further variable cleaning

**X3.43. Aortic Valve Procedure**
Set as “2. Repair”: “2”
Set as “5. Isolated commissurotomy”: “Isolated commissurotomy”
Set as missing: “0. None” “0” “11” “111”
   OR containing “1. Replacement” and “2. Repair”

**X3.44. Mitral Valve Procedure**
Set as “2. Repair”: “2”
Set as “5. Isolated commissurotomy”: “Isolated commissurotomy”
Set as missing: “[0r]” “33”
   OR containing “1. Replacement” and “2. Repair”

**X3.45. Tricuspid Valve Procedure**
Set as “2. Repair”: “2”
Set as missing: “Isolated commissurotomy” “Repair with ringReplacement” “0”
   OR containing “1. Replacement” and “2. Repair”

**X3.46. Pulmonary Valve Procedure**
Set as missing: “repair” “01-Jan-00” “0”

**X3.47. Aortic Valve Implant Type**
Set as “2. Mechanical”: “M” “1. Mechanical” “MechanicalBiological”
Set as “4. Homograft”: “H” “HomograftBiological”
Set as missing: “[01679]” “22” “33” “333” “44”
   OR containing “0. None” or “3. Biological” and either “2. Mechanical” or “5. Annuloplasty ring”

**X3.48. Mitral Valve Implant Type**
Set as “2. Mechanical”: “M” or “2. Mechanical” and “6. Annuloplasty ring”
Set as “3. Biological”: “B” “1. Tissue”
Set as “6. Annuloplasty ring”: “A”
Set as missing: “7. Annuloplasty (no ring)” “Autograft” “0. None” “Suture” “[01rR]” “66”
   OR containing “6. Annuloplasty ring” or “2. Mechanical” and “3. Biological”

**X3.49. Tricuspid Valve Implant Type**
Set as “2. Mechanical”: “M”
Set as “3. Biological”: “B”
Set as “4. Homograft”: “H”
Set as “6. Annuloplasty ring”: “5. Annuloplasty ring”
Set as “7. Other”: “7. Annuloplasty (no ring)”
Set as missing: “Valve Type (T)” “Annuloplasty ringBiological” “0. None” “[015]”
   OR containing “2. Mechanical” and “3. Biological”
**2.2 Categorical Variables**

**X3.50.Pulmonary.Implant.Type**
Set as “7. Other”: “7” “7. Annuoplasty (no ring)”
Set as missing: “Valve Type (P)” “0. None” “[016]”

**X3.78.Cardiopulmonary.bypass**
Set as “0. No”: “1. No” Set as missing: erroneous numerical entries

**X3.79.Myocardial.Protection**
Set as missing: “2”

**X3.80.Cardioplegia.solution**
Set as “8. Not applicable”: “8”
Set as missing: “[03]” “1; 2” “2;1”

**X3.83.Cardioplegia.timing**
Set as “1. Intermittent”: “Intermittent;Continuous” “2. Intermittent”
Set as missing: “0” “1; 2” “53”

**X3.84.Non.cardioplegic.protection**
Set as “5. Beating heart without cross clamp”: “Beating heart + perfusion” “Beating Heart with perfusion”
Set as missing: “Cerebral perfusion” “0. Not applicable” “[06]” “99” “1;2” “1;4”
“1;5”

**X4.01.1.Deep.Sternal.wound.infection**
Set as “0. None”: “0. No” Set as missing: “2” “8”

**X4.01.2.Deep.Sternal.wound.infection.treatment**
Set as missing: “[0489]” “1;2”

**X4.03.Post.Op.Dialysis**
Set as “0. No”: “0 No > creatinine” “0 No; Trancient renal failur; full recovery”
“Chronic renal (on dialysis preop)”
Set as “1. Yes”: “1 Yes cvvh” “1 Yes (cvvh)”
Set as missing: “5” “10” “99”

**X4.04.Discharge.Destination**
Set as missing: “3 Other ward” “5. Transferred to different Consultant” “Another dept within the trust”
“Second op” “[05789]”

**X4.05.Status.at.Discharge**
No cleaning needed
2.3 Multivalue Variables

Multivalue variables, as with the previous categorical variables are also selected through drop-down menus and radio button controls. However, in contrast the input allows multiple options to be selected, with each selected option delimited by ‘;’ in the output. The cleaning process for the categorical variables is repeated for each selected option, but additionally the selected options are reordered and duplicates removed, with extra care taken to check for erroneous delimitation.

This applies to the following fields:

- X2.07.Previous.Surgical.Interventions
- X3.35.Reason.Repeat.aortic.valve.replacement
- X3.81.Cardioplegia.temperature
- X3.82.Cardioplegia.infusion.mode
- X3.90.Presentation
- X3.95.Neuroprotection
- X4.01.Return.to.Theatre
- X4.02.New.CVA

Further corrections or remappings beyond the core categorical variable cleaning are presented for each applicable variable under the appropriate headings below.

**X2.07.Previous.Surgical.Interventions**

Set as “0. No history of neurological disease”: “0. No history of Cerebrovascular disease”
Set as missing: “[4AeEnP]” OR containing either “0. No history of Cerebrovascular disease” or “0. No history of neurological disease” and another variable

**X3.27.Native.Aortic.Valve.Path**
Set as “6. Annuloaortic ectasia”: “13 - Annuloaortic ectasia”
Set as “19. Other native valve pathology”: “15 - dissection”
Set as missing: “12” “22”
See Patching for further variable cleaning

Set as “2. Degenerative inc Calcific degeneration”: “2. Degenerative inc Calcific degeneration”
Set as “7. Calcific degeneration”: “7”
Set as missing: “22”
See Patching for further variable cleaning

**X3.29.Native.Tricuspid.Valve.Path**
Set as “7. Calcific degeneration”: “7”
See Patching for further variable cleaning
2.3 Multivalue Variables

Set as "7. Calcific degeneration": "7"
See Patching for further variable cleaning

X3.35. Reason. Repeat. aortic. valve. replacement
Set as "2. Dehiscence;4. Infection": "2;4"
Set as "5. Implanted valve failure": "5. Intrinsic valve failure"
Set as "19. Other reason": "6. Other"
Set as missing: "0. Not applicable" "[0]" "7. Unknown"

X3.36. Reason. Repeat. Mitral. valve. replacement
Set as "1. Thrombosis": "1. Thromobosis"
Set as "2. Dehiscence;19. Other reason": "2;19"
Set as "4. Infection;19. Other reason": "4;19"
Set as "5. Implanted valve failure;19. Other reason": "5;19"
Set as missing: "0. Not applicable" "[08MRR]" "99" "1919"

X3.37. Reason. Repeat. Tricuspid. valve. replacement
Set as "5. Implanted valve failure": "5. Intrinsic valve failure"
Set as missing: "0. Not applicable" "0"

X3.38. Reason. Repeat. Pulmonary. valve. replacement
Set as "4. Infection;5. Implanted valve failure": "4;5"
Set as "5. Implanted valve failure": "5. Intrinsic valve failure"
Set as "5. Implanted valve failure;19. Other reason": "5;19"
Set as missing: "0. Not applicable" "7. Prior valve repair failure" "[07]"

X3.81. Cardioplegia. temperature
Set as "1. Cold": "2. Cold" "1. Cold;8. Not applicable"
Set as "2. Warm": "1. Warm" "2. Warm;8. Not applicable"
Set as "1. Cold;2. Warm": containing "1. Cold;2. Warm;8. Not applicable"
Set as "8. Not applicable": "8"
Set as missing: "[03]"

X3.82. Cardioplegia. infusion. mode
Set as "1. Antegrade": "1. Antegrade;8" "1. Antegrade;down grafts" "1. Antegrade;8. Not applicable"
Set as "1. Antegrade;2. Retrograde": "1. Antegrade;2. Retrograde;down grafts" "3. Antegrade and retrograde"
Set as "2. Retrograde": "2. Retrograde;down grafts" "2. Retrograde;8. Not applicable"
Set as "8. Not applicable": "8"
Set as missing: "Down grafts" "Down ostia" "[03]" "1004"

X3.90. Presentation
Standard multivalue formatting only

X3.95. Neuroprotection
Set as "1. Deep Hypothermic Circulatory Arrest": "0. None required;1. Deep Hypothermic Circulatory Arrest"
Set as missing: 2-3 digit numbers
2.4 Numerical Variables

X4.01. Return to Theatre
Set as “0. No re-operation necessary”: “0. No re-operation required” “0. None” “00”
Set as “1. Re-operation for bleeding or tamponade”: “1. Re-operation for bleeding”
Set as “2. Re-operation for valvular problems”: “2. Other (exclusive of sternal resuturing)”
Set as “4. Re-operation for other cardiac problems”: “LVAD”
“excision of sternal sinus”
Set as missing: containing “0. No re-operation necessary” and another variable

X4.02. New CVA
Set as “0. None”: “0. No” “0 No”
Set as “2. Permanent”: “Left Sided Weakness”
Set as missing: “0;2” “99” “0 No TIA”
OR containing “0. None”

2.4 Numerical Variables

Numerical variables herein are those that are defined as either numeric or integer variables after cleaning. The cleaning has generally occurred in the direction: string -> numeric -> integer.

For fields originally stored as strings, entries with non-numerical symbols are evaluated as strings first. Methods such as character removal, imputation or parsing/evaluation are then undertaken, prior to converting the field class.

As numeric fields, some may need to be rescaled. For example, “X2.37.Height”, which may be stored as m, cm or mm, requires appropriate rescaling to allow equivalent comparisons.

Converting to integers either involves variable rounding or truncation. By default rounding is applied unless the metric of interest is to be evaluated as > than a criterion. For example, “Age at operation” whereby > 18 is an important consideration.

Those stored as numeric values:

- X2.12.0. Actual Creatinine at time of Surgery
- X2.24.1. Severity of AVS EOA
- X2.24.2. Severity of AVS Gradient
- X2.38. Weight

Those stored as integer values:

- Age at operation
- X2.23. PA Systolic
- X2.27. Ejection Fraction
- X2.36. N Previous Heart Operations
- X2.37. Height
- X3.18. N Valves Repaired Replaced
- X3.54. Aortic valve or ring size
- X3.58. Mitral valve or ring size
- X3.62. Tricuspid valve or ring size
- X3.66. Pulmonary valve or ring size
- X3.67. N Aortic Segments operated on
- X3.85. Cumulative Bypass time
- X3.86. Cumulative cross clamp time
- X3.87. Circulatory arrest time

Variable cleaning is presented for each applicable variable under the appropriate headings below.
2.4 Numerical Variables

**Age.at.operation**
Values < -5 are increased by 100
Values <= 0 or > 105 are set as missing
Variable truncated and converted from numerical to integers

**X2.12.0.Actual.Creatinine.at.time.of.Surgery**
See Between-Field Mapping for variable cleaning

**X2.23.PA.Systolic**
Values containing “MM” or “<” are removed
Variable converted from string to integers
Values > 200 are set as missing
**Patching:** records at Morriston Hospital for procedure dates prior to 2006-04-01 are set as missing

**X2.24.1.Severity.of.AVS.EOA**
Values < 0.1 or > 6 are set as missing

**X2.24.2.Severity.of.AVS.Gradient**
See Between-Field Mapping for variable cleaning

**X2.27.Ejection.Fraction**
Values containing “-” “%” “<” or “>” are removed
Variable converted from string to integers
Values < 10 or > 99 are set as missing

**X2.36.N.Previous.Heart.Operations**
Variable converted from string to integers
Values > 6 are set as missing

**X2.37.Height**
Values of “False” set as missing
Variable converted from string to numerical
Values between > 1.4 and < 2.2 are multiplied by 100
Values between > 12000 and < 22000 are divided by 100
Variable converted from numerical to integers
Values < 107 or > 250 are set as missing

**X2.38.Weight**
Variable converted from string to numerical
Values < 25 or > 250 are set as missing
Variable rounded to 1 dp

**X3.14.NGrafts**
See Between-Field Mapping for variable cleaning

**X3.18.NValves.Repaired.Replaced**
Values > 4 are set as missing
2.5 Free Text Variables

For valve or ring size variables:
- X3.54.Aortic.valve.or.ring.size
- X3.58.Mitral.valve.or.ring.size
- X3.62.Tricuspid.valve.or.ring.size
- X3.66.Pulmonary.valve.or.ring.size

Values containing ‘-’ ‘.’ ‘/’ ‘;’ space or alphabetical characters are removed
Variable converted from string to integers
Values < 16 or > 40 are set as missing

X3.67.N.Aortic.Segments.operated.on
Values containing non-digit characters are removed
Variable converted from string to integers
Values < 5 are set as missing

X3.85.Cumulative.Bypass.time
Values containing ‘-’ are removed
Values containing equations are parsed and evaluated
Variable converted from string to integer
Values > 10080 are set as missing

X3.86.Cumulative.cross.clamp.time
Set as missing: “1;2”
Variable converted from string to integer
Values < 0 or > 360 are set as missing

X3.87.Circulatory.arrest.time
Values > 240 are set as missing
Variable converted from numeric to integer

2.5 Free Text Variables

Free text fields at present are only minimally cleaned, and restricted to the standardization of ‘Not specified’ options. To harmonise output, all fields have been transformed to uppercase characters. This applies to the following fields:
- X3.31.Native.Aortic.valve.other.path
- X3.32.Native.Mitral.valve.other.path
- X3.33.Native.Tricuspid.valve.other.path
- X3.34.Native.Pulmonary.valve.other.path

Cleaning of these fields is subject to review, with comprehensive mapping of options to be completed for a subsequent update.
2.6 Surgeon Data

Surgeon variables have previously been documented according to their corresponding class of variable. However, for clarity these have been split out to better highlight these fields and the cleaning implemented.

X3.03. Responsible. Consultant. Surgeon

All input recorded as surgeon names are converted to GMC numbers.

Additional remapping from initials are conducted after co-ordinating with hospitals.

Set as “0602828”: “2641315”
Set as “2733526”: “2733521”
Set as “2800752”: “C28006752”
Set as “3136168”: “3131618”
Set as “3226274”: “C3226262”
Set as “3246515”: “32465151”
Set as “3279753”: “327953”
Set as “3467822”: “3431681”
Set as “4120771”: “41207701”
Set as “7090362”: “7030362”
Set as missing: “General Surgeon” “Other” “John Keates” “Mr Clyde Saldanha” “Prof M Thompson” “xas” “04H04610”

X3.06. First. Operator. Grade


OR seven digit numbers representing GMC numbers

Set as “9. Other”: “7. Surgeon’s assistant”


Set as missing: “0” “99” “0. Not applicable” “9. Not applicable”

OR initials representing surgeons’ names

Set as “6. Year 6 and above”: “6. Year 6”

X3.09. First. Assistant. Grade

Set as missing: “[48]” “36” “41” “46” “50” “57” “58” “70” “97” “99” “2. Staff grade/Clinical Assistant”

OR seven digit numbers representing GMC numbers


X3.10. First. Assistant. Calman. Year

Set as missing: “[07]” “99” “9. Not applicable”

OR initials representing surgeons’ names

Set as “6. Year 6 and above”: “6. Year 6”
3 Between-Field Mapping

The mapping phase of cleaning involves taking values from one or more fields and using that information to improve the utility or validity of subsequent fields. Notably, this is particularly pertinent for information contained in old v3.8 database fields that are recorded in a different format after subsequent modifications to the database. Due to the complexity of some of these mappings, associated fields are cleaned and mapped together. These are presented below under the following sections:

- Renal Function
- Aortic Valve Gradient
- Intra-Aortic Balloon Pump
- Grafts
- Aortic Pathologies
- Aortic Procedures

The specific sequence for each mapping proceeds as outlined accordingly.

3.1 Renal Function

Mapping from old v3.8 field X2.12.Renal to new v4.1.2 fields:

- X2.12.0.Actual.Creatinine.at.time.of.Surgery

   - Set as missing: “[49]” “[12][2349]”
   - Set as “0. None”: “0;”
   - Set as “1. Dialysis for acute renal failure: onset within 6 weeks of cardiac surgery”: “1;”
   - Set as “2. Dialysis for chronic renal failure: onset more than 6 weeks prior to cardiac surgery”: “2;”
   - Set as “3. No dialysis but pre-operative acute renal failure (anuria or oliguria > 10ml/hour)”: “3;”


   - Set as “0. None”, mapped values: “0. No renal disease” “1. Functioning transplant”
   - Set as “1. Dialysis for acute renal failure: onset within 6 weeks of cardiac surgery”, mapped values:
     “3. Dialysis for acute renal failure”
   - Set as “2. Dialysis for chronic renal failure: onset more than 6 weeks prior to cardiac surgery”, mapped values:
     “4. Dialysis for chronic renal failure”

   - Set as “80”, original and mapped values: “0. No renal disease” “1. Functioning transplant”
   - Set as “250”, original and mapped values: “2. Creatinine” “3. Dialysis for acute renal failure”
     “4. Dialysis for chronic renal failure”

3.2 Aortic Valve Gradient

Mapping from old v3.8 field X2.24.Aortic.Valve.Gradient to new v4.1.2 field:

- X2.24.2.Severity.of.AVS.Gradient

1. Mapping from X2.24.Aortic.Valve.Gradient defined as when X2.24.2.Severity.of.AVS.Gradient is missing

3. **X2.24.2.Severity.of.AVS.Gradient** (Cleaning/Mapping)
Set as missing, original and mapped values: \(< 15 \text{ OR } 200\)

### 3.3 Intra-Aortic Balloon Pump

The intra-aortic balloon pump fields have proved to be particularly problematic, with errors evident in the transition to the new v4.1.2 fields. Consequently, the original v3.8 fields X2.33.Intra.aortic.balloon.pump.used and X2.34.Reason.for.IABP.Use are mapped to the new v4.1.2 fields, and these themselves are then mapped to a new restricted set:

- X2.33.0.Intra.aortic.balloon.pump.used
- X2.33.1.Impeller.device.used
- X2.33.2.Ventricularassist.device.used
- X2.33.3.Other.Support.device.used
- X2.34.0.IABP.Ind
- X2.34.1.Impeller.Ind
- X2.34.2.Ventricular.Ind
- X2.34.3.Other.Ind

The original v4.1.2 fields comprised 3 sub-categories for each of the above to indicate whether the device was used pre-op, intra-op or post-op. However, erroneous options were provided that resulted in conflicting output.

**X2.33.0.Intra.aortic.balloon.pump.used**
Concatenate v3.8 field X2.33.Intra.aortic.balloon.pump.used and pre-op, intraop and post-op v4.1.2 fields
Clean derived concatenation according to standard multivalue procedure, with four options: “0. No” “1. Pre-operation” “2. Intra-operation” “3. Post-operation”
Set as missing: containing “0. No” and another option

**X2.33.1.Impeller.device.used**
Concatenate pre-op, intraop and post-op v4.1.2 fields
Clean derived concatenation according to standard multivalue procedure, with three options: “1. Pre-operation” “2. Intra-operation” “3. Post-operation”

**X2.33.2.Ventricular.assist.device.used**
Concatenate pre-op, intraop and post-op v4.1.2 fields
Clean derived concatenation according to standard multivalue procedure, with three options: “1. Pre-operation” “2. Intra-operation” “3. Post-operation”

**X2.33.3.Other.Support.device.used**
Concatenate pre-op, intraop and post-op v4.1.2 fields
Clean derived concatenation according to standard multivalue procedure, with three options: “1. Pre-operation” “2. Intra-operation” “3. Post-operation”

**X2.34.0.IABP.Ind**
Directly mapped from v4.1.2 field X2.34.0.1.IABP.Ind.Preop
If X2.34.0.IABP.Ind missing, mapped from v3.8 field X2.34.Reason.for.IABP.Use

**X2.34.1.Impeller.Ind**
Directly mapped from only v4.1.2 field X2.34.1.1.Impeller.Ind.Preop

**X2.34.2.Ventricular.Ind**
Directly mapped from only v4.1.2 field X2.34.2.1.Ventricular.Ind.Preop
3.4 Grafts

A validation mapping is conducted from v4.1.2 field X3.14.NGrafts to the v4.1.2 fields:

- X3.15.Graft.site
- X3.16.Graft.conduit
- X3.17.Graft.Anastomoses

Notably, for the mapped fields the input is multivalue but both the order and repeat entries of the same option are valid. Problematically, many of the delimiters are omitted from the output. As a consequence, a new method of cleaning is applied, whereby recognised valid entries are cleaned by reference to their position, in an iterative manner, and redelimited. The exact procedure is omitted from the document due to the length and complexity. The cleaning of this section is subject to review.

X3.14.NGrafts

Variable converted from string to integers
Values > 11 are set as missing

3.5 Aortic Pathologies

Mapping from old v3.8 fields to new v4.1.2 fields:


Mapping rules for v3.8 Aortic pathology fields:

- “2. Syphilis” to “1. Aneurysm”
- If X2.35.Operative.Urgency recorded as “1. Elective”
  - “3. Dissection” to “2. Chronic Dissection”
  - “3. Dissection” to “3. Acute Dissection”
- If X2.35.Operative.Urgency is missing
  - “3. Dissection” to “99. Other”
- “4. Transection” to “4. Trauma”
- “5. Coarctation” to “99. Other”
- “6. Atheromatous” to “99. Other”
- “7. Marfan’s” to “99. Other”
- “9. Mycotic” to “99. Other”
- “10. Other connective tissue disorder” to “99. Other”
- “11. Congenital” to “99. Other”
- “12. Infection - native” to “99. Other”
- “13. Infection - graft” to “99. Other”
- “99. Unknown” to “99. Other”
3.6 Aortic Procedures

X3.68.1.Ao.path.Root.Segment.Code.1
Set as missing: "[05789]" "13"
Set as "16. Normal": "161616"
Set as "16. Normal;99. Other": "1699"
Set as "99. Other": "10" "11" "9999"
If X3.68.1.Ao.path.Root.Segment.Code.1 missing, mapped from v3.8 X3.68.Aortic.pathology.Root
Multivalue formatting

X3.70.1.Ao.path.Ascending.Segment.Code.2
Set as missing: "5" "22" "31" "33"
Set as "99. Other": "[789]" "10" "11" "13"
If X3.70.1.Ao.path.Ascending.Segment.Code.2 missing, mapped from v3.8 X3.70.Aortic.pathology.Ascending
Multivalue formatting

Set as missing: "11" "16" "16. Normal"
Multivalue formatting

X3.74.1.Ao.path.Descending.Segment.Code.4
Set as missing: "7" "16" "16. Normal"
Set as "99. Other": "11"
Multivalue formatting

Set as missing: "16" "16. Normal"
Set as "3. Acute Dissection": "3. Dissection"
Multivalue formatting

3.6 Aortic Procedures

Mapping from old v3.8 fields to new v4.1.2 fields:

Set as "4. Root replacement with composite valve graft and coronary reimplantation (Modified Bentall or Cabroll)": "4;"
Set as "5. Root replacement with preservation of native valve and coronary reimplantation": "5;"
Set as "6. Homograft root replacement": "6;"
Set as "9. Sinus of Valsalva repair": "Sinus of Valsalva repair Interposition tube graft with/without extension into the arch": "9;"
Set as missing: "Aortic patch graft" "Interposition tube graft with/without extension into the arch" "Tube graft + separate AVR" "Interposition tube graft with reimplantation of major vessels" "Reduction aortoplasty" "B2040965A" "b062162" "[1238]" "10" "12" "44" "46" "99" "1;2;3;" "1;99;" "3;99;"

Set as “1. Interposition tube graft with/without extension into the arch”: “Interposition tube graft with reimplantation of major vessels” “1;”
Set as “3. Tube graft + separate AVR”: “Tube graft + separate AVR Interposition tube graft with/without extension into the arch” “3;”
Set as “4. Root replacement with composite valve graft and coronary reimplantation (Modified Bentall or Cabroll)”: “4;”
Set as “5. Root replacement with preservation of native valve and coronary reimplantation”: “5;”
Set as missing: “Sinus of Valsalva repair” “[02]” “99”


5. **X3.73.1.Ao.proc.Arch.Segment.Code.3**

Set as “2. Interposition tube graft with reimplantation of major vessels”: “Interposition tube graft with/without extension into the arch” “2;”
Set as missing: “[1345]” “99”


Set as “1. Interposition tube graft”: “Interposition tube graft with reimplantation of major vessels” “Interposition tube graft with/without extension into the arch” “1;”
Set as “11. Concomitant endovascular aortic procedure”: “Concomitant endovascular aortic procedure Interposition tube graft with/without extension into the arch”
Set as missing: “Tube graft + separate AVR” “Reduction aortoplasty” “2;” “4;” “6;” “99”


Set as “1. Interposition tube graft”: “Interposition tube graft with/without extension into the arch”
Set as missing: “Aortic patch graft” “Tube graft + separate AVR”
4 Patching

Obvious database record errors that were isolated to one particular hospital and / or one particular time period were ‘patched’ pending a resolution at the trust-level or central database repository. In these cases, trusts were contacted directly. In principle these patches can be removed from the cleaning scripts after confirmation of amendments at the source level. CSV files are written out for each ‘patch’ for review by NICOR and hospital units.

4.1 Major Aortic Patching

**Affected records**: “St. Thomas’ Hospital” for procedure dates before “2002-12-31”.

**Field affected:**
- X3.68.1.Ao.path.Root.Segment.Code.1
- X3.70.1.Ao.path.Ascending.Segment.Code.2
- X3.74.1.Ao.path.Descending.Segment.Code.4
- X3.73.1.Ao.proc.Arch.Segment.Code.3
- X3.75.1.Ao.proc.Descending.Segment.Code.4
- Old v3.8 aortic pathology fields subsequently mapped to X3.91.Aetiology

**Error**: all records indicate major aortic surgery (on all 5 segments). Patients are recorded as having an interposition tube graft for an aneurysm in the root, ascending, arch and descending segments, and a dissection in the abdominal segment.

**Resolution**: all records where X3.67.N.Aortic.Segments.operated.on was recorded as zero AND X3.13.Other.thoracic.and.vascular.procedures does not contain “1. Aortic or peripheral vascular”, has the corresponding procedure and pathology fields wiped.

4.2 Native Valve Patching

**Affected records**: “Liverpool Heart and Chest Hospital” and “Papworth Hospital” for all procedure dates.

**Fields affected:**
- X3.23.Aortic.Valve.Explant
- X3.25.Tricuspid.Valve.Explant

**Error**: for any valve(s) having undergone a cardiac operation, the explant field of (some) valves not operated on were recorded as ‘Native valve’. There was no other evidence these valves were operated on. In many cases it made it look as if patients had received quadruple valve surgery. This is likely to be a software malfunction at the base hospitals.

**Notes**: this only seems to affect pre-2009 data.

**Affected records**: “Liverpool Heart and Chest Hospital”, “Papworth Hospital” and “St. Thomas’ Hospital” for all procedure dates.
4.2 Native Valve Patching

Fields affected:

- X3.27.Native.Aortic.Valve.Path

Error: for any valve(s) having undergone a cardiac operation, the native valve pathology of the valves not operated on was recorded as '0. Native valve not present' or '19. Other valve pathology'. This is likely to be a software malfunction at the base hospital.

Notes: St. Thomas' were aware of this issue for 2008-04-01 to 2011-03-31 period after previous data validation exercises and subsequently resolved the issues. No attempt to revise previous and / or future records has been made.

Resolution: Separate patches were created for associated Aortic, Mitral, Tricuspid and Pulmonary valve fields. These flag if a valid entry is present in any of the associated fields: haemodynamics, reason for repeat replacement, procedure, implant type, prosthesis name, prosthesis model or ring size. Furthermore if uncleaned explant field is NOT missing or "1. Native valve", and if uncleaned pathology field is NOT missing, "0. Native valve not present" or "19. Other native valve pathology".

For the Explant fields at the affected hospitals, the records were set as missing if the above patch was FALSE, AND if the valve specific explant field was set as "1. Native valve"

For the Pathology fields at the affected hospitals, the records were set as missing if the above patch was FALSE, AND if the valve specific pathology field was set as "0. Native valve not present" or "19. Other native valve pathology"
5  Post-patching Mapping

This section has been created to move the cleaning and mapping for some fields to be conducted after the patching section. The cleaning of these fields have also been reordered to ensure that fields are only mapped from other fields that themselves have already been cleaned. This was necessary as a result of the increasing inter-relatedness of between-field mappings conducted to improve the overall data validity.

- Cardiac Procedures
- Other Cardiac Procedures
- Aortic Aetiology

5.1 Cardiac Procedures

Mapping from old v3.8 field X3.11.Cardiac.Procedures to fields:

- X3.11.1.CABG
- X3.11.2.Valve
- X3.11.3.Major.aortic

X3.11.3.Major.aortic requires further mapping from:

- Cleaned aortic pathology and procedure fields
- X3.13.Other.thoracic.and.vascular.procedures
- X3.67.N.Aortic.segments.operated.on

1. Mapping from X3.11.Cardiac.Procedures when associated fields are missing

2. X3.11.1.CABG (Mapping)
   Set as “0. No”, mapped values: “5. Valve alone” “6. Valve + other” “8. Other”
   Set as “1. Yes”, mapped values: “1. CABG alone” “2. CABG + valve” “3. CABG + valve + other”
   “4. CABG + other”

3. X3.11.2.Valve (Mapping)
   Set as “0. No”, mapped values: “1. Yes” “1. CABG alone” “4. CABG + other” “8. Other”
   Set as “1. Yes”, mapped values: “2. CABG + valve” “3. CABG + valve + other” “5. Valve alone”
   “6. Valve + other”

4. X3.11.3.Major.aortic (Mapping)
   If any aortic pathology or procedure recorded as not missing, set missing to “1. Yes”
   If X3.13.Other.thoracic.and.vascular.procedures is missing or “1. Aortic or peripheral vascular”
   AND X3.67.N.AorticSegments.operated.on > 0, set missing to “1. Yes”
   Set as “0. No”, mapped values: “1. Yes” “1. CABG alone” “2. CABG + valve” “3. CABG + valve + other”

5.2 Other Cardiac Procedures

Mapping from old v3.8 field X3.13.Other.thoracic.and.vascular.procedures to field:

- X3.12.Other.Cardiac.Procedures

Requires further mapping from variables:

- X3.11.3.Major.aortic
- X3.67.N.Aortic.segments.operated.on
5.3 Aortic Aetiology

   Set as “0. No other cardiac procedure performed”: “0. No”
   Set as “4. Pulmonary embolectomy”: “4. Acute Pulmonary embolectomy”
   Set as “7. Cardiac trauma;8. Epicardial pacemaker”: “7;8”
   Set as “7. Cardiac trauma;9. Pericardiectomy”: “7;9”
   Set as missing: “20” or any text strings

2. If X3.13.Other.thoracic.and.vascular.procedures contains “2. Carotid endarterectomy”
   append “17. Carotid endarterectomy” to selected multivalue options

3. If X3.13.Other.thoracic.and.vascular.procedures contains “3. Other thoracic”
   append “19. Other procedure not listed above” to selected multivalue options

4. If X3.13.Other.thoracic.and.vascular.procedures contains “1. Aortic or peripheral vascular”
   AND if X3.11.3.Major.aortic == “1. Yes”
   AND if X3.67.N.Aortic.segments.operated.on == “1. Yes”
   append “19. Other procedure not listed above” to selected multivalue options

5. Multivalue formatting

6. Subsequent mapping from old v3.8 field X3.11.Cardiac.Procedures to fields:
   - X3.11.4.Cardiac.Procedures.Other

Requirements further mapping from variables:
X3.11.3.Major.aortic
X3.12.Other.Cardiac.Procedures

**X3.11.4.Cardiac.Procedures.Other (Mapping)**

Set as “0. No”: “0”
Set as “1. Yes”: “1”
Set as “0. No”, mapped values: “1. Yes” “1. CABG alone” “2. CABG + valve” “5. Valve alone”

If X3.11.3.Major.aortic and X3.11.4.Cardiac.Procedures.Other are both missing
   AND if X3.11.3.Major.aortic and X3.11.4.Cardiac.Procedures.Other are both “1. Yes”
   AND if X3.12.Other.Cardiac.Procedures is “0. No other cardiac procedure performed” or “16. Peripheral vascular”, set as “0. No”

5.3 Aortic Aetiology

Mapping to new v4.1.2 field X3.91.Aetiology from old v3.8 fields:

- X3.68.Aortic.pathology.Root
- X3.70.Aortic.pathology.Ascending
- X3.72.Aortic.pathology.Arch
- X3.74.Aortic.pathology.Desc
- X3.76.Aortic.pathology.Abd

Requirements further mapping from variables:
X2.07.Previous.Surgical.Interventions
X2.10.Hx.of.Hypertension
X3.11.3.Major.aortic
1. **X3.91.Aetiology** (Cleaning)
   Set as “5. Other connective tissue disease”: “5. Other connective tissue disorder”
   Set as missing: “70” “80” “84” “86” “112” “114” “146” “181”

2. **X3.91.Aetiology** (Mapping Rule 1)
   Mapping rules for v3.8 Aortic pathology fields:
   - “6. Atheromatous” to “2. Atherosclerosis”
   - “7. Marfan’s” to “3. The Marfan Syndrome”
   - “4. Transection” to “6. Trauma”
   - “5. Coarctation” to “7. Coarctation”
   - “11. Congenital” to “8. Other congenital”
   - “2. Syphilis” to “9. Infection”
   - “10. Other connective tissue disorder” to “10. Aortitis”

3. **X3.91.Aetiology** (Mapping Rule 2)
   If X2.10.Hx.of.Hypertension == “1. Treated or BP>140/90 on >1 occasion prior to admission”

4. **X3.91.Aetiology** (Mapping Rule 3)
   If X2.07.Previous.Surgical.Interventions == “5. Aortic surgery - ascending or arch”,
   set as “11. Previous aortic surgery”

5. Concatenate mapping rules, and map to **X3.91.Aetiology** if set as missing

6. Multivalue formatting
6 Removed records

Two sets of records were removed prior to the cleaning process: 1 record for a dummy hospital and 17474 records where either the admission, procedure or discharge date was recorded as before 1998-01-01. These were removed from the database due to the poor quality of the data prior to this time.

After the cleaning process, additional records were removed according to the following criteria:

Date Conflicts
Admission > Procedure OR Procedure > Discharge

Age Filter
Age.at.operation < 18

Non-Cardiac Procedures
Any record that is classified as isolated abdominal aortic surgery by satisfying the following conditions:

- An aortic procedure only, characterised by: X3.11.3.Major.aortic == “1. Yes” AND X3.11.1.CABG == “0. No” X3.11.2.Valve == “0. No” X3.11.4.Cardiac.Procedures.Other == “0. No”
- Operated on just one segment, characterised by: X3.67.N.Aortic.Segments.operated.on == “1”

Duplicate Records
1. Create two temporary variables:
   - A “tempID” variable set as the Apollo code, or if missing the Artemis code
   - A “tempOperative” variable set X2.35.Operative.Urgency, or if missing “1. Elective”
2. Variables re-ordered, according to hierarchy: “X3.02.Procedure.Date” “Hospital” “Apollo” “X3.01.Admission.Date” “X4.06.Discharge.Date”
3. Duplicates (set 1) removed if records equal on the following variables: “Hospital” “X1.07.Gender” “tempOperative” “X3.11.1.CABG” “X3.11.2.Valve” “X3.02.Procedure.Date” “Age.at.operation” “tempID”

TAVI Procedures
1. TAVI procedures (set 1) removed:
   If X3.51.Aortic.implant.prosthesis.name contains “9300TFX” “9000TFX” “SAPIEN” “TAVI” “THV” OR X3.52.Aortic.implant.prosthesis.model contains “9300TFX” “9000TFX” “SAPIEN” “TAVI” “THV”
2. TAVI procedures (set 2) removed:
If \texttt{X3.31.Native.Aortic.valve.other.path} contains “TRANSF” “TRANSA” AND

3. TAVI procedures (set 3) removed for King’s College Hospital only:
If both \texttt{X3.51.Aortic.implant.prosthesis.name} == “PENDB” AND \texttt{X3.52.Aortic.implant.prosthesis.model} missing,
OR IF \texttt{X3.31.Native.Aortic.valve.other.path} == “TAVI”

**Census Data Conflicts**

1. ONS records mapped to NACSA data:
Pre-cleaned ONS data is deterministically mapped to patient records by common ParentUNID fields

1. ONS mismatched records removed:
If \texttt{LS.Date} precedes \texttt{X3.02.Procedure.Date} and \texttt{LS.Status} is “Dead”

2. \texttt{LS.Date} and \texttt{LS.Status} set as missing:
If \texttt{LS.Date} precedes \texttt{X3.02.Procedure.Date}

**Summary**

1. Date Conflicts: 577 records removed
2. Age Filter: 553 records removed
3. Non-Cardiac Procedures: 96 records removed
4. Duplicate Records: 5308 records removed
   respectively: 5205, 72, 31
5. TAVI Procedures: 208 records removed
   respectively: 142, 21, 45
6. Census Data Conflicts: 46 records removed
**TOTAL**: 6788
7 Generated Indicator Fields

7.1 Flags

New fields were created to provide evidence of a risk factor or patient status when multiple fields are related yet some have missing data or are in conflict with one another.

LVEFC.flag
This is an indicator of left ventricular ejection fraction category that resolves two fields:
X2.27.Ejection.Fraction and X2.28.LV.Ejection.Fraction.Category

Set LVEFC.flag equal to X2.28.LV.Ejection.Fraction.Category if recorded
If X2.28.LV.Ejection.Fraction.Category missing or “9. Not measured”:
Set as “3. Poor (LVEF < 30%)” if X2.27.Ejection.Fraction < 30
Set as “2. Fair (LVEF 30-50%)” if X2.27.Ejection.Fraction > 30 and <= 50
Set as “1. Good (LVEF >50%)” if X2.27.Ejection.Fraction > 50

Dead.flag
This is an indicator of in-hospital mortality status that resolves two fields:

Set as TRUE if X4.04.Discharge.Destination is “4. Not applicable - patient deceased” AND
X4.05.Status.at.Discharge missing or “1. Dead”
Set as TRUE if X4.05.Status.at.Discharge is “1. Dead” AND X4.04.Discharge.Destination missing
X4.05.Status.at.Discharge missing or “0. Alive”
Set as FALSE if X4.05.Status.at.Discharge is “0. Alive” AND X4.04.Discharge.Destination missing

Dead.flag2
This is an indicator of in-hospital mortality status that extends the first Dead.flag field by using ONS census data to backfill missing records.

Set Dead.Flag2 equal to Dead.flag if recorded
If Dead.flag missing:
Set as TRUE if LS.Status is “Dead” AND LS.Date equals X4.06.Discharge.Date
Set as FALSE if LS.Status is “Alive” AND LS.Date more recent than X4.06.Discharge.Date
NB: Still 200 conflicting records

Single Episode Flag
This is an indicator of whether the record corresponds to i) the only cardiac procedure for the admission spell, or ii) the first cardiac procedure during the admission spell (i.e. where a patient had >1 cardiac procedures).

The algorithm proceeds as follows:

- The flag is initialised as TRUE for all records
- The records are ordered according to Artemis, Hospital, X3.02.Procedure.Date, X3.02.Procedure.Time, X3.01.Admission.Date, then X4.06.Discharge.Date.
- If sequential records have the same Artemis number and Hospital, set as FALSE if:
  - X3.02.Procedure.Date match within 2 days
  - both X3.01.Admission.Date and X4.06.Discharge.Date match within 1 day
  - either X3.01.Admission.Date or X4.06.Discharge.Date match within 1 day AND the other field cannot be evaluated due to missing data for either record
7.1 Flags

- both X3.01.Admission.Date and X4.06.Discharge.Date cannot be evaluated due to missing data for either record AND X3.02.Procedure.Date is less than or equal to the preceding record X4.06.Discharge.Date
- both X3.01.Admission.Date and X4.06.Discharge.Date cannot be evaluated due to missing data for either record AND X3.02.Procedure.Date is within 14 days of the preceding X3.02.Procedure.Date (NB. The choice of 14 is slightly arbitrary but is retained for consistency with previous versions)

• The above procedure is then repeated with the Apollo numbers

Previous Operation Flag
This is an indicator of whether a patient has previously undergone cardiac surgery.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are TRUE:

- single.ep.flag is FALSE
- X2.36.N.Previous.Heart.Operations > 0
- The above is repeated for Mitral, Tricuspid and Pulmonary valves, using variables:
- X2.08.Date.Last.Cardiac.Operation is not missing and X3.02.Procedure.Date is more recent than X2.08.Date.Last.Cardiac.Operation
- Duplicated Artemis numbers
- Duplicated Apollo numbers

First Time Cardiac Procedure
This is an indicator of whether the record corresponds to the patient’s first-ever cardiac operation. It is set as the opposite of previous.op.flag.

CABG Flag
This is an indicator of whether there is any evidence to suggest a CABG procedure took place.
NB. X3.11.1.CABG is the primary indicator used by researchers but is occasionally in conflict with CABG specific data.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are TRUE:

- X3.11.1.CABG is recorded as “1. Yes”
- X3.14.NGrafts > 0
- X3.15.Graft.site is not missing
- X3.16.Graft.conduit is not missing
- X3.17.Graft.Anastomoses is not missing
7.1 Flags

Aortic Valve Flag
This is an indicator of whether there is any evidence of an aortic valve procedure occurring.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are non-missing:
X3.51.Aortic.implant.prosthesis.name, X3.52.Aortic.implant.prosthesis.model, OR X3.54.Aortic.valve.or.ring.size


Mitral Valve Flag
This is an indicator of whether there is any evidence of an mitral valve procedure occurring.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are non-missing:
X3.55.Mitral.implant.prosthesis.name, X3.56.Mitral.implant.prosthesis.model, OR X3.58.Mitral.valve.or.ring.size

Tricuspid Valve Flag
This is an indicator of whether there is any evidence of an tricuspid valve procedure occurring.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are non-missing:
X3.49.Tricuspid.Valve.Implant.Type, X3.59.Tricuspid.implant.prosthesis.name,
X3.60.Tricuspid.implant.prosthesis.model, OR X3.62.Tricuspid.valve.or.ring.size

Pulmonary Valve Flag
This is an indicator of whether there is any evidence of an pulmonary valve procedure occurring.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are non-missing:
X3.50.Pulmonary.Valve.Implant.Type, X3.63.Pulmonary.implant.prosthesis.name,
X3.64.Pulmonary.implant.prosthesis.model, OR X3.66.Pulmonary.valve.or.ring.size


Valve Flag
This is an indicator of whether there is any evidence to suggest a valve procedure took place.
NB. X3.11.2.Valve is the primary indicator used by researchers but is occasionally in conflict with valve specific data.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are TRUE:

- X3.11.2.Valve is recorded as “1. Yes”
- Aortic.valve.flag is TRUE
7.1 Flags

- Mitral.valve.flag is TRUE
- Tricuspid.valve.flag is TRUE
- Pulmonary.valve.flag is TRUE

**Aortic Flag**
This is an indicator of whether there is any evidence to suggest a major aortic procedure took place.
NB. X3.11.3.Major.aortic is the primary indicator used by researchers but is occasionally in conflict with aortic specific data.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are TRUE:

- X3.11.3.Major.aortic is recorded as “1. Yes”
- X3.67.N.Aortic.Segments.operated.on > 0
- X3.68.1.Ao.path.Root.Segment.Code.1 is not missing
- X3.70.1.Ao.path.Ascending.Segment.Code.2 is not missing
- X3.72.1.Ao.path.Arch.Segment.Code.3 is not missing
- X3.74.1.Ao.path.Descending.Segment.Code.4 is not missing
- X3.76.1.Ao.path.Abdominal.Segment.Code.5 is not missing
- X3.69.1.Ao.proc.Root.Segment.Code.1 is not missing
- X3.71.1.Ao.proc.Ascending.Segment.Code.2 is not missing
- X3.73.1.Ao.proc.Arch.Segment.Code.3 is not missing
- X3.75.1.Ao.proc.Descending.Segment.Code.4 is not missing
- X3.77.1.Ao.proc.Abdominal.Segment.Code.5 is not missing

**Other Flag**
X3.11.4.Cardiac.Procedures.Other and X3.12.Other.Cardiac.Procedures This is an indicator of whether there is any evidence to suggest any other cardiac procedure took place.
NB. X3.11.4.Cardiac.Procedures.Other is the primary indicator used by researchers but is occasionally in conflict with other cardiac procedure data fields.

The flag is initialised as FALSE for all records, but set as TRUE if any of the following are TRUE:

- X3.11.4.Cardiac.Procedures.Other is recorded as “1. Yes”
- X3.12.Other.Cardiac.Procedures is neither missing nor “0. No other cardiac procedure performed”

**Previous MI Flag**
This is an indicator of whether there is any evidence of a previous MI for the patient using fields X2.03.N.Previous.MIs and X2.04.Interval.between.Surgery.and.last.MI

Set as TRUE if:

- X2.03.N.Previous.MIs is “1. One” or “2. Two or more” AND X2.04.Interval.between.Surgery.and.last.MI is NOT “0. No previous MI”
- X2.03.N.Previous.MIs is missing or “9. Unknown” AND X2.04.Interval.between.Surgery.and.last.MI is neither “0. No previous MI” nor missing

Set as FALSE if:

- X2.03.N.Previous.MIs is “0. None” AND X2.04.Interval.between.Surgery.and.last.MI is “0. No previous MI” or missing
- X2.03.N.Previous.MIs is missing or “9. Unknown” AND X2.04.Interval.between.Surgery.and.last.MI is “0. No previous MI”

Set as “Conflict: type 1” if:
7.2 Shortcuts

As part of analysing the NACSA database certain routine fields are often required. A number of common variables have been generated and appended to the database after cleaning.

Country
Each hospital is mapped to one of the following: England, Wales, Scotland, Northern Ireland and Republic of Ireland.

Geographical region
Each hospital is mapped to one of the following: The South West, South East, South Central, London, East England, West Midlands, East Midlands, North West, Yorkshire & Humber, North East, Scotland, Northern Ireland, Republic of Ireland, Wales.

Financial year
The date of the procedure is mapped to the financial year. For example, procedure dates between 2000-04-01 to 2001-03-31 would be mapped to 2000.

Post-operative length of stay (PLOS)
The post-operative length of stay associated with each record is calculated as the difference in days between X3.02.Procedure.Date and X4.06.Discharge.Date

Once evaluated it is set as missing if following conditions are TRUE:

- plos < 0
- plos < 3 AND Dead.flag2 is FALSE AND either CABG.flag, Valve.flag, or Aortic.flag are TRUE

Survival data
Survival time-to-follow-up and event indicators were calculated as follows:

1. time set as difference between LS.Date and X3.02.Procedure.Date
2. event set as 1 if LS.Status is “Dead” and 2 if “Alive”.
3. time and event corrections if time, event, plos and Dead.flag2 all not missing:
   Set time as plos, if Dead.flag2 TRUE, LS.Status “Dead”, time <plos
   OR if Dead.flag2 TRUE and LS.Status “Alive” set as plos
   OR if Dead.flag2 FALSE and time >plos set as plos
   Set event as 1, if Dead.flag2 TRUE
4. time2 initially set as time
   Mapped from plos if time missing and Dead.flag2 not missing
5. event2 initially set as event
   Mapped from Dead.flag2 if event missing and plos not missing
7.2 Shortcuts

Isolated CABG
Set as TRUE if:

- \( \text{CABG.flag} = \text{TRUE} \) & \( \text{Valve.flag} = \text{FALSE} \) & \( \text{Aortic.flag} = \text{FALSE} \) & \( \text{Other.flag} = \text{FALSE} \)

Isolated AVR
Set as TRUE if:

- \( \text{CABG.flag} = \text{FALSE} \) & \( \text{Valve.flag} = \text{TRUE} \) & \( \text{Aortic.flag} = \text{FALSE} \) & \( \text{Other.flag} = \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} = \text{TRUE} \) & \( \text{Mitral.valve.flag} = \text{FALSE} \) & \( \text{Tricuspid.valve.flag} = \text{FALSE} \) & \( \text{Pulmonary.valve.flag} = \text{FALSE} \)
- AND \( \text{X3.43.Aortic.Valve.Procedure} \) is “1. Replacement” or missing

Isolated AVR + CABG
Set as TRUE if:

- \( \text{CABG.flag} = \text{TRUE} \) & \( \text{Valve.flag} = \text{TRUE} \) & \( \text{Aortic.flag} = \text{FALSE} \) & \( \text{Other.flag} = \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} = \text{TRUE} \) & \( \text{Mitral.valve.flag} = \text{FALSE} \) & \( \text{Tricuspid.valve.flag} = \text{FALSE} \) & \( \text{Pulmonary.valve.flag} = \text{FALSE} \)
- AND \( \text{X3.43.Aortic.Valve.Procedure} \) is “1. Replacement” or missing

Isolated MV surgery
Set as TRUE if:

- \( \text{CABG.flag} = \text{FALSE} \) & \( \text{Valve.flag} = \text{TRUE} \) & \( \text{Aortic.flag} = \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} = \text{TRUE} \) & \( \text{Mitral.valve.flag} = \text{FALSE} \) & \( \text{Pulmonary.valve.flag} = \text{FALSE} \)
- AND \( \text{X3.12.Other.Cardiac.Procedures} \) is “0. No other cardiac procedure performed”, “19. Other procedure not listed above”, “13. AF Ablation surgery”, or missing

Isolated MV surgery + CABG
Set as TRUE if:

- \( \text{CABG.flag} = \text{TRUE} \) & \( \text{Valve.flag} = \text{TRUE} \) & \( \text{Aortic.flag} = \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} = \text{TRUE} \) & \( \text{Mitral.valve.flag} = \text{FALSE} \) & \( \text{Pulmonary.valve.flag} = \text{FALSE} \)
- AND \( \text{X3.12.Other.Cardiac.Procedures} \) is “0. No other cardiac procedure performed”, “19. Other procedure not listed above”, “13. AF Ablation surgery”, or missing

Isolated MV repair
Set as TRUE if:

- \( \text{CABG.flag} = \text{FALSE} \) & \( \text{Valve.flag} = \text{TRUE} \) & \( \text{Aortic.flag} = \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} = \text{TRUE} \) & \( \text{Mitral.valve.flag} = \text{FALSE} \) & \( \text{Pulmonary.valve.flag} = \text{FALSE} \)
- AND \( \text{X3.12.Other.Cardiac.Procedures} \) is “0. No other cardiac procedure performed”, “19. Other procedure not listed above”, “13. AF Ablation surgery”, or missing

Isolated MV repair + CABG
Set as TRUE if:

- \( \text{CABG.flag} = \text{TRUE} \) & \( \text{Valve.flag} = \text{TRUE} \) & \( \text{Aortic.flag} = \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} = \text{TRUE} \) & \( \text{Mitral.valve.flag} = \text{FALSE} \) & \( \text{Pulmonary.valve.flag} = \text{FALSE} \)
- AND \( \text{X3.12.Other.Cardiac.Procedures} \) is “0. No other cardiac procedure performed”, “19. Other procedure not listed above”, “13. AF Ablation surgery”, or missing
7.2 Shortcuts

**Isolated MVR**

Set as TRUE if:

- \( \text{CABG.flag} == \text{FALSE} \) \& \( \text{Valve.flag} == \text{TRUE} \) \& \( \text{Aortic.flag} == \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} == \text{TRUE} \) \& \( \text{Mitral.valve.flag} == \text{FALSE} \) \& \( \text{Pulmonary.valve.flag} == \text{FALSE} \)
- AND \( \text{X3.12.Other.Cardiac.Procedures} \) is “0. No other cardiac procedure performed”, “19. Other procedure not listed above”, “13. AF Ablation surgery”, or missing
- \( \text{X3.44.Mitral.Valve.Procedure} \) is “1. Replacement”

**Isolated MVR + CABG**

Set as TRUE if:

- \( \text{CABG.flag} == \text{TRUE} \) \& \( \text{Valve.flag} == \text{TRUE} \) \& \( \text{Aortic.flag} == \text{FALSE} \)
- AND \( \text{Aortic.valve.flag} == \text{TRUE} \) \& \( \text{Mitral.valve.flag} == \text{FALSE} \) \& \( \text{Pulmonary.valve.flag} == \text{FALSE} \)
- AND \( \text{X3.12.Other.Cardiac.Procedures} \) is “0. No other cardiac procedure performed”, “19. Other procedure not listed above”, “13. AF Ablation surgery”, or missing
- \( \text{X3.44.Mitral.Valve.Procedure} \) is “1. Replacement”
8 Model Variables

8.1 EuroSCORE

**Age** (integer)
Set as 1 if \( \text{Age.at.operation} < 60 \)
Set as \( (\text{Age.at.operation} - 58) \) if \( \text{Age.at.operation} > 59 \)

**Sex** (logical)
Set as 1 if \( X1.07.\text{Gender} = "2. Female" \)
Set as 0 if \( X1.07.\text{Gender} = "1. Male" \)

**Chronic pulmonary disease** (logical)
Set as 1 if \( X2.13.\text{Hx.of.Pulmonary.Disease} = "1. COAD/emphysema or Asthma" \)
Set as 0 if \( X2.13.\text{Hx.of.Pulmonary.Disease} = "0. No pulmonary disease" \)

**Extracardiac arteriopathy** (logical)
Set as 1 if \( X2.17.\text{Extracardiac.arteriopathy} = "1. Yes" \)
Set as 0 if \( X2.17.\text{Extracardiac.arteriopathy} = "0. No" \)

**Neurological dysfunction disease** (logical)
Set as 1 if \( X2.14.\text{Hx.of.Neurological.Disease} \) contains \( "3. CVA with residual deficit" \)
OR if \( X2.16.\text{Hx.of.Neurological.Dysfunction} = "1. Yes" \)
Set as 0 if \( X2.14.\text{Hx.of.Neurological.Disease} \) does NOT contain \( "3. CVA with residual deficit" \)
AND if \( X2.16.\text{Hx.of.Neurological.Dysfunction} = "0. No" \)

**Previous cardiac surgery** (logical)
Set as 1 if \( \text{previous.op.flag} \) is TRUE
Set as 0 if \( \text{previous.op.flag} \) is FALSE

**Serum creatinine** (factor)
Set as 1 if \( X2.12.0.\text{Actual.Creatinine.at.time.of.Surgery} > 200 \)
Set as 0 if \( X2.12.0.\text{Actual.Creatinine.at.time.of.Surgery} \leq 200 \)

**Active endocarditis** (logical)
Set as 1 if any of the following are TRUE:
- \( X3.27.\text{Native.Aortic.Valve.Path} = "3. Active infective endocarditis" \)
- \( X3.28.\text{Native.Mitral.Valve.Path} = "3. Active infective endocarditis" \)
- \( X3.29.\text{Native.Tricuspid.Valve.Path} = "3. Active infective endocarditis" \)
- \( X3.30.\text{Native.Pulmonary.Valve.Path} = "3. Active infective endocarditis" \)
- \( X3.35.\text{Reason.Repeat.aortic.valve.replacement} = "4. Infection" \)
- \( X3.36.\text{Reason.Repeat.Mitral.valve.replacement} = "4. Infection" \)
- \( X3.37.\text{Reason.Repeat.Tricuspid.valve.replacement} = "4. Infection" \)
- \( X3.38.\text{Reason.Repeat.Pulmonary.valve.replacement} = "4. Infection" \)
Set as NA if \( X3.11.2.\text{Valve} = "1. Yes" \) and all the above are FALSE.
Set as 0 otherwise
Critical preoperative state (logical)
Set as 1 if any of the following are TRUE:
- X2.12.1.Renal.Function.Dialysis is “3. No dialysis but pre-operative acute renal failure (anuria or oliguria > 10ml/hour)”
- X2.18.Heart.technique is “3. Ventricular fibrillation or ventricular tachycardia”
- X2.30.Heart.technique is “1. Yes”
- X2.31.Heart.technique is “1. Yes”
- X2.32.Heart.technique is “1. Yes”
- X2.33.0.Intra.aortic.balloon.pump.used is “1. Pre-operation”
- X2.33.1.Impeller.device.used is “1. Pre-operation”
- X2.33.2.Ventricular.assist.device.used is “1. Pre-operation”
- X2.33.3.Other.Support.device.used is “1. Pre-operation”
- X2.35.Operative.Urgency is “4. Salvage”

Set as NA if critical.preop == 0 AND two or more of the following are missing: X2.12.1.Renal.Function.Dialysis, X2.18.Heart.technique, X2.30.Heart.technique, X2.31.Heart.technique, X2.32.Heart.technique, X2.33.0.Intra.aortic.balloon.pump.used, or X2.35.Operative.Urgency

Set as 0 otherwise

Unstable angina (logical)

Set as NA if X2.01.Angina.Status.Pre.Surgery is missing or “4. Symptoms at rest or minimal activity” AND X2.29.IV.Nitrates is missing AND X2.35.Operative.Urgency is missing or “2. Urgent” “3. Emergency” “4. Salvage”

Set as 0 otherwise

LV dysfunction (logical)
LV.dysfun1:
- Set as 1 if LVEFC.flag is “2. Fair (LVEF 30-50%)”
- Set as 0 if LVEFC.flag is “1. Good (LVEF > 50%)”, or “3. Poor (LVEF < 30%)”

LV.dysfun2:
- Set as 1 if LVEFC.flag is “3. Poor (LVEF < 30%)”
- Set as 0 if LVEFC.flag is “1. Good (LVEF > 50%)”, or “2. Fair (LVEF 30-50%)”

Recent myocardial infarct (logical)
Set as 1 if X2.04.Interval.between.Surgery.and.last.MI is “1. MI < 6 hours”, “2. MI 6-24 hours”, “3. MI 1-30 days”, or “4. MI 31-90 days”

Set as 0 if X2.04.Interval.between.Surgery.and.last.MI is “0. No previous MI”, or “5. MI > 90 days”

Pulmonary hypertension (logical)
Set as 1 if X2.23.PA.Systolic > 60
Set as 0 if X2.23.PA.Systolic <= 60

Emergency (logical)
Set as 1 if X2.35.Operative.Urgency is “3. Emergency”, or “4. Salvage”
Set as 0 if X2.35.Operative.Urgency is “1. Elective”, or “2. Urgent”

Other than isolated CABG (logical)
Set as 1 if isoCABG is FALSE
Set as 0 if isoCABG is TRUE
8.1 EuroSCORE

8 MODEL VARIABLES

**Surgery on thoracic aorta (logical)**
Set as 1 if Aortic.flag is TRUE
Set as 0 if Aortic.flag is FALSE

**Post infarct septal rupture (logical)**
Set as 1 if X3.12.Other.Cardiac.Procedures is “2. Acquired VSD”
   AND X2.04.Interval.between.Surgery.and.last.MI is “1. MI < 6 hours”, “2. MI 6-24 hours”,
   “3. MI 1-30 days”, “4. MI 31-90 days”, or “5. MI > 90 days”
Set as NA if X3.12.Other.Cardiac.Procedures is “2. Acquired VSD”
   AND X2.04.Interval.between.Surgery.and.last.MI is missing
Set as NA if X3.12.Other.Cardiac.Procedures is missing
   AND X2.04.Interval.between.Surgery.and.last.MI is NOT “0. No previous MI”
   AND X2.04.Interval.between.Surgery.and.last.MI is TRUE
Otherwise set as 0