Modelling Uncertainty in the Risk of Intensive Care Unit Readmission I: Data Extraction and Modelling

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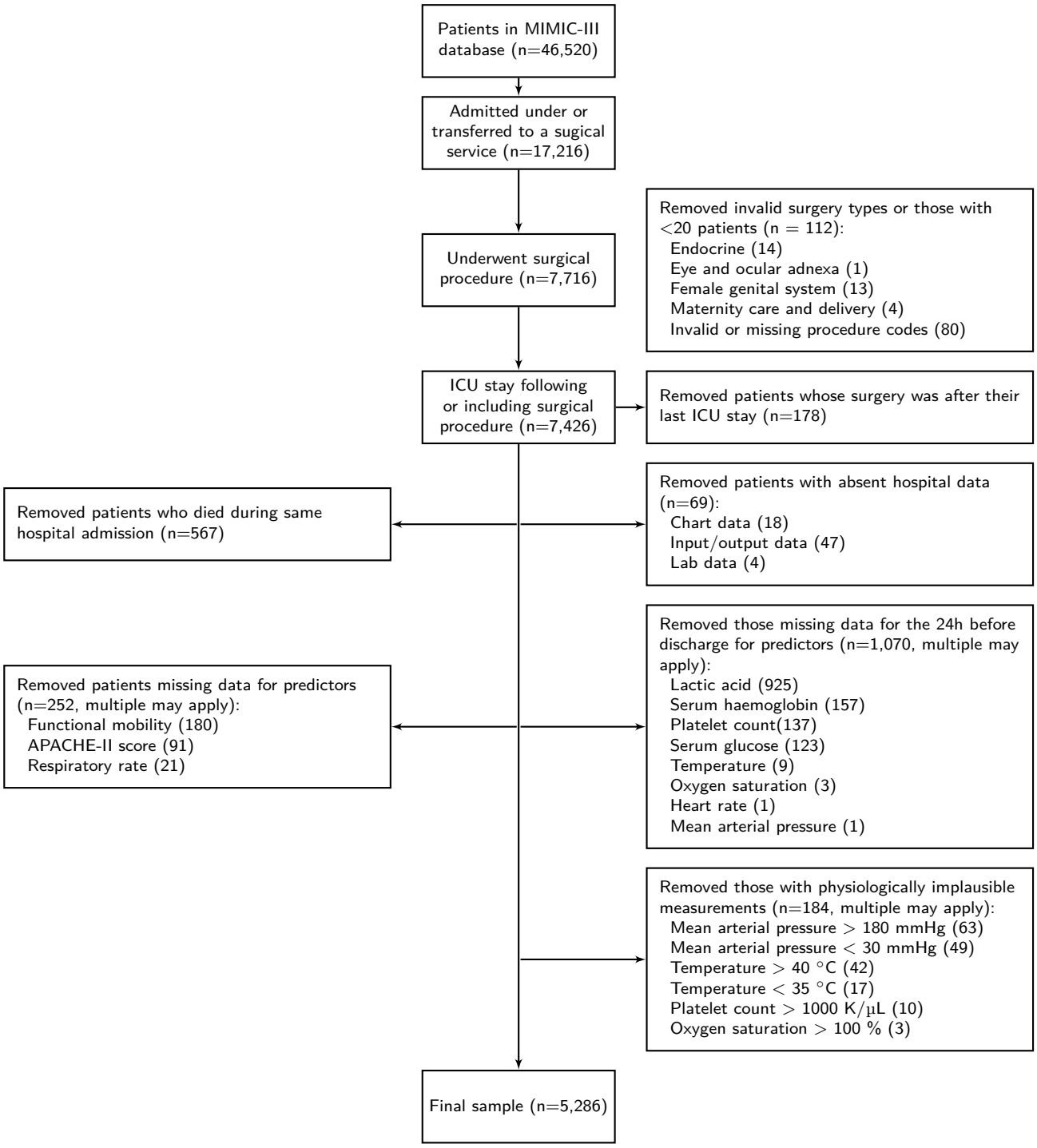
1 Scope and Aims

This document provides a written overview of the first phase of the project. The aims of this phase were twofold:

1. To extract a dataset from the MIMIC-III database of surgical ICU patients, consisting of a clearly defined outcome measure (ICU readmission), and a range of predictors.
2. To compare the performance of a range of published models for the prediction of ICU readmission risk and identify the best model to take forward. This will form the prediction model at the core of a system for quantifying uncertainty and dealing with missing data.

Figure 1: Flowchart of participants' progress through the phases of the trial



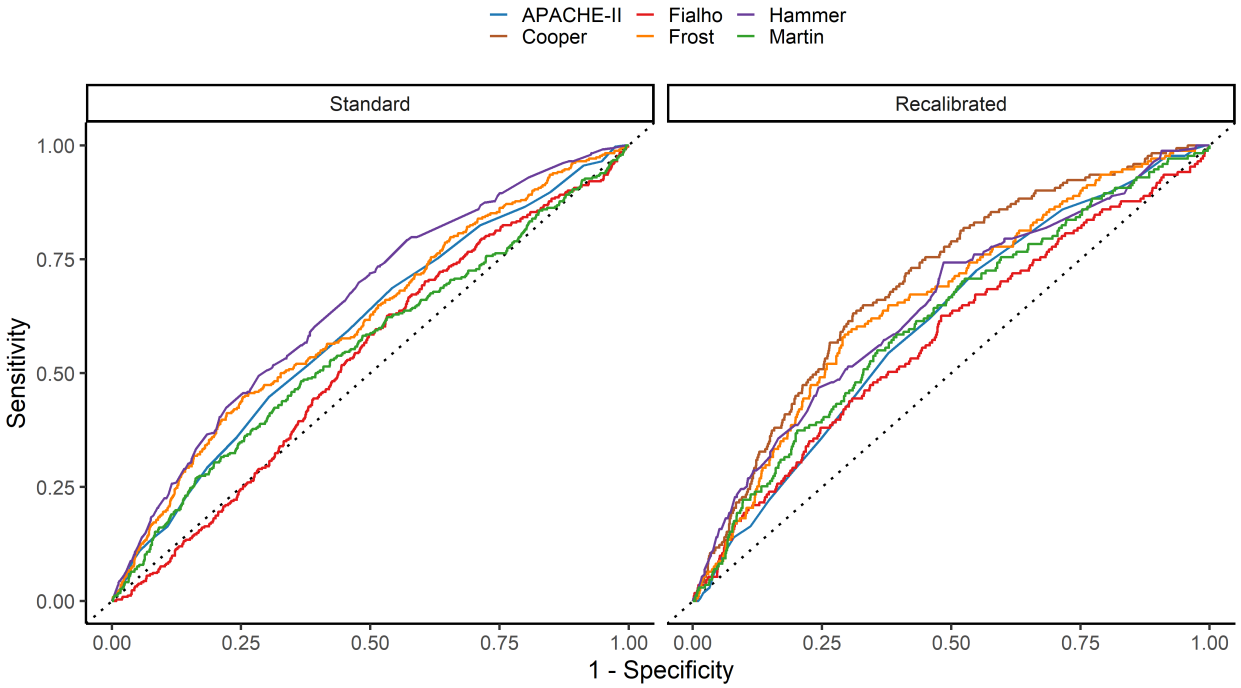

APACHE-II
Cooper
Fialho
Frost
Hammer
Martin
Standard
Recalibrated
Sensitivity
1 - Specificity
0.00
0.25
0.50
0.75
1.00

Figure 2

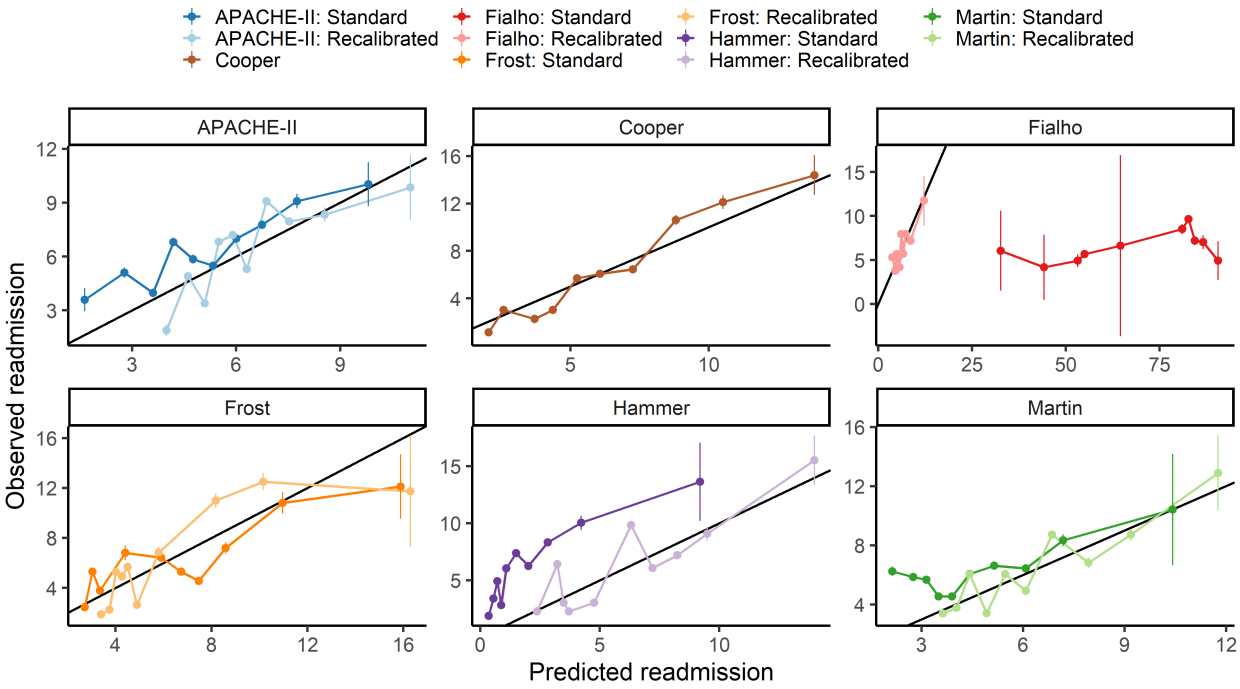


Figure 3

Table 1

Variable	No Readmission	Readmitted to ICU
N	4944 (93.5%)	342 (6.5%)
Sex		
Male	3121 (63.1%)	207 (60.5%)
Female	1823 (36.9%)	135 (39.5%)
General surgery	1167 (23.6%)	136 (39.8%)
Cardiac surgery	2423 (49%)	93 (27.2%)
Hyperglycaemia	475 (9.6%)	35 (10.2%)
Severe anaemia	35 (0.7%)	1 (0.3%)
APACHE-II > 20	2397 (48.5%)	164 (48%)
Positive fluid balance >5L	768 (15.5%)	95 (27.8%)
No ambulation	3882 (78.5%)	298 (87.1%)
ICU stay >5 days	1244 (25.2%)	124 (36.3%)

Table 2

Variable	No Readmission	Readmitted to ICU
N	4944 (93.5%)	342 (6.5%)
Age	64.2 ± 14.5	63.5 ± 14.5
Sex		
Male	3121 (63.1%)	207 (60.5%)
Female	1823 (36.9%)	135 (39.5%)
Elective admission	1980 (40%)	104 (30.4%)
Admission source		
Operating theatre	2246 (45.4%)	120 (35.1%)
Emergency room	769 (15.6%)	91 (26.6%)
Other hospital	976 (19.7%)	69 (20.2%)
Ward	953 (19.3%)	62 (18.1%)
APACHE-II score	10.4 ± 4.70	12.0 ± 4.87
ICU stay >7 days	864 (17.5%)	98 (28.7%)
Discharged after hours	2874 (58.1%)	223 (65.2%)
Acute renal failure	788 (15.9%)	125 (36.5%)

Table 3

Variable	No Readmission	Readmitted to ICU
N	4944 (93.5%)	342 (6.5%)
Age	64.2 ± 14.5	63.5 ± 14.5
Respiratory rate	18.4 ± 3.89	19.2 ± 3.91
Blood urea nitrogen	22.8 ± 16.3	27.8 ± 20.9
Serum glucose	129 ± 29.0	126 ± 29.2
Serum chloride	105 ± 4.4	105 ± 4.7
Hx atrial fibrillation	1565 (31.7%)	129 (37.7%)
Hx renal insufficiency	261 (5.3%)	31 (9.1%)

Table 4

Variable	No Readmission	Readmitted to ICU
N	4944 (93.5%)	342 (6.5%)
Heart rate	83.9 ± 12.2	84.8 ± 13.4
Temperature	36.8 ± 0.51	36.8 ± 0.55
Oxygen saturation	96.8 ± 1.64	96.8 ± 1.69
Mean arterial pressure	81.2 ± 14.6	85.0 ± 16.0
Platelets	221 ± 131	241 ± 154
Lactic acid	1.68 ± 0.82	1.58 ± 0.82

Table 5

Model	AUC	χ^2	AUC_{rc}	χ^2_{rc}
APACHE-II	0.60	296.8	0.61	**6.29**
Cooper	—	—	0.70	**6.17**
Fialho	0.53	19010.1	0.58	**6.70**
Frost	0.61	402.3	0.66	17.48
Hammer	0.65	130	0.65	**7.57**
Martin	0.56	273.7	0.61	**6.06**