



National Audit of Hospital Mortality:
Impact Assessments

August 2020

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Glossary

Acronym	Description
AuROC	Area under Receiver Operating Characteristic
AvLOS	Average length of stay
CCI	Charlson Comorbidity Index
CCS	Clinical Classifications Software
COVID-19	coronavirus disease 2019
HIPE	Hospital In-Patient Enquiry
HIU	Health Intelligence Unit
HPO	Healthcare Pricing Office
HSE	Health Service Executive
HSPC	Health Protection Surveillance Centre
ICD-10-AM/ACHI/ACS	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification/Australian Classification of Health Interventions/Australian Coding Standards
NAHM	National Audit of Hospital Mortality
NOCA	National Office of Clinical Audit
NQAIS	National Quality Assurance Improvement System. A suite of audit and performance-monitoring tools developed by the HIU, HSE.
NQAIS NAHM	National Quality Assurance Improvement System National Audit of Hospital Mortality web-based tool
SMR	Standardised Mortality Ratio

1.1 Introduction

The National Office of Clinical Audit (NOCA) set up a short-life working group to look at the impact of COVID-19 on the National Audit of Hospital Mortality (NAHM). Analysis for this report was prepared by Version 1, and providing support for the working group, as outlined within this report, in order to facilitate an impact assessment.

National Quality Assurance Improvement System National Audit of Hospital Mortality (NQAIS NAHM) analyses and displays mortality patterns across 44 publicly funded acute hospitals. Hospital In-Patient Enquiry (HIPE) data is standardised to take into account factors known to affect the underlying risk of death in hospital, such as age, gender, existing co-morbidities, type of admission (emergency or elective), etc. The main objective of NQAIS NAHM is to analyse and display mortality patterns across the country's hospitals, in order to guide improvement measures.

A 3rd June 2020 paper by the Health Service Executive (HSE) Health Intelligence Unit (HIU) outlined a number of issues around whether, and how, to adapt COVID-19 into hospital mortality monitoring, including data coding, physiology and impact on the overall functioning of the health system. This report aims to gather data and metrics to support decisions on:

- how to interpret and communicate NAHM results in the short term, and
- planning for any changes needed in the longer term.

1.1 Scope of Review

The scope of this review covers three topics:

1. Impact of 10th edition ICD-10-AM/ACHI/ACS codes on NQAIS NAHM. This requirement is separate to the COVID-19 analysis and arose as a result of coding changes introduced in 2020.
2. Impact of COVID-19 on changing numbers of admissions and discharges on NQAIS NAHM mode. This aims to draw out changes in the overall functioning of the health system.
3. Impact of COVID-19 on specific Clinical Classifications Software (CCS) Codes e.g. respiratory. This will examine issues around data coding and the physiology of COVID-19.

Access to data was provided on 13th July 2020 and as at that date the following datasets were available:

- Risk models based on HIPE data to 30th April 2020 – these use the new ICD-10-AM/ACHI/ACS coding.
- Raw HIPE data to 31st May 2020
- Older models and older raw HIPE datasets (using prior ICD-10-AM/ACHI/ACS coding).

Appendix 2 of this report lists the datasets used for each section of this report, including extract criteria.

1.2 Summary Findings

Impact of 10th edition ICD-10-AM/ACHI/ACS codes on NQAIS NAHM

The introduction of the 10th edition of ICD-10-AM/ACHI/ACS coding raises no concerns. The changes to the mapping from ICD-10-AM/ACHI/ACS codes to CCS categories does not raise any material concerns, although it is worth noting that the increase in the number of “small / low-risk” CCS categories (those with fewer than 40 observed deaths since 2005, or in some cases no observed deaths) is not ideal for NQAIS NAHM since risk models are only fitted to CCS categories with observed deaths at 40 or more.

Impact of COVID-19

COVID-19 has had a significant impact on the functioning of the health system, as evidenced by changes in admission and discharge patterns and the case-mix of patients presenting to hospital.

Standardised Mortality Ratios (SMR)'s are significantly above 100 in March and April 2020 and will likely trigger alerts in NQAIS NAHM. Under normal circumstances such alerts would lead to an increase in audit activity. However in the short-term such signals and alerts should be treated with caution, as they are likely to simply reflect the strain caused by the pandemic on the entire system, rather than areas for improvement in individual hospitals.

CCS 122 (pneumonia - non TB/STD) is the CCS category most impacted by COVID-19. However a total of 75 CCS categories experienced one or more COVID-19 deaths in March/April 2020.

Variations in coding practices (in particular of the primary diagnosis Dx1) may exist across hospitals. A sample of 49 patients transferred between a model 4 hospital and a model 2 hospital found that, of 38 patients with COVID-19, 36 had different primary diagnoses recorded by the two hospitals.

In terms of geographic impact, the Dublin-based hospitals saw the greatest strain from COVID-19 patients, followed by wider Leinster hospitals.

The following factors might give weight to an argument to retain COVID-19 cases within their current CCS categories rather than creating a separate, new category for risk modelling purposes:

- The mortality risk on COVID-19 patients varies widely by CCS category (see **Table 13 COVID-19 cases: CCS category of primary diagnosis**)
- No single hospital is disproportionately disadvantaged by retaining COVID-19 discharges within their primary diagnosis group. Dublin hospitals have experienced a greater strain, but this can be borne in mind when interpreting the results. The next wave may impact other regions of the country.
- Actual mortality on COVID-19 patients, while much higher than would long-run mortality for each CCS category, tracks the expected risk distribution produced by the risk models reasonably well (see **Figure 36 Mortality by percentile of risk distribution, all CCS**)

For the moment, expected deaths on 2020 discharges are calibrated to 2019 mortality experience – the `hai_year 2019` parameter is locked in for 2020 discharges across all CCS categories. While actual mortality is compared to longer-run patterns, NQAIS NAHM will raise significant numbers of signals for 2020 discharges. Once the `hai_year 2020` parameter is “unlocked” the overall number of signals will be expected to reduce. For the moment, it would seem to make sense to retain the locked in 2019 parameter so that stakeholders can appreciate the impact of COVID-19. Once the parameter is released the change in signals will have to be carefully communicated.

2 Impact of 10th edition ICD-10-AM/ACHI/ACS codes on NQAIS NAHM

The primary data source for the NQAIS NAHM is HIPE, which is governed by the Healthcare Pricing Office (HPO). HIPE is a health information system designed to collect demographic, clinical and administrative information on discharges and deaths from acute hospitals nationally. Clinical information is coded using ICD-10-AM/ACHI/ACS, the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification/Australian Classification of Health Interventions/Australian Coding Standards. The CCS collapses the 19,000 ICD codes into a more manageable 260 clinically more meaningful codes. Separate risk models are run in NQAIS NAHM for each CCS category that has experienced more than 40 deaths since 2005.

2.1 Changes to coding systems

The 8th Edition of ICD10-AM was used to code all discharges from 1st January 2015 to 31st December 2019. Discharges from 1st January 2020 onwards are coded using the 10th Edition of ICD-10-AM/ACHI/ACS. The changes between 8th edition and 10th edition can be summarised as follows:

- 19,427 8th edition codes will continue in the 10th edition
- 169 codes in use in the 8th edition have been retired in the 10th edition
- 384 new codes have been introduced in the 10th edition.

In addition to the changes to the ICD-10-AM/ACHI/ACS coding, changes have been made to the mapping from the ICD-10-AM/ACHI/ACS code that represents the primary diagnosis to the CCS category. 1,774 codes (or 9% of 19,980 codes) have a different mapping from 1st January 2020, compared to 2019 and prior. This includes 582 ICD codes re-mapped to one of 27 newly-created CCS groups.

The combined effect of the above two changes is as follows:

Table 1 changes to ICD-10-AM/ACHI/ACS codes

Count of ICD-10-AM/ACHI/ACS codes	No change to CCS mapping	Change in CCS mapping		Total
		Pre-existing CCS	Newly created CCS	
8 th edition codes retired at 1 st January 2020	159	10	0	169
New codes introduced in the 10 th edition	0	384	0	384
8 th edition code continuing in 10 th edition	18,047	798	582	19,427
Total	18,206	1,192	582	19,980

In evaluating the impact of the changes on NQAIS NAHM focus is on the primary diagnosis, since this drives the CCS category and hence the risk model fitted.

2.2 Retired Codes

Of 169 retired codes, 51 had never been used as a primary diagnosis, and a further 66 had not been used as a primary diagnosis since 31st December 2014, leaving 52 codes which had been actively used as a primary diagnosis up to 31st December 2019. These are tabulated by CCS category below.

Table 2 Retired ICD-10-AM/ACHI/ACS Codes

CCS category	CCS category description	Discharges 2015-2019 on retired codes	Deaths 2015-2019 on retired codes	Mortality rate 2015-2019 on retired codes	ICD10-AM codes retired
197	Skin infection	26,086	310	1.2%	L0310,L0311
238	Surgical/medical complication	8,167	49	0.6%	I971,J951,J952,K910,K913,N990,O294,O298,T8141
181	Other complications of pregnancy	6,208	-	0.0%	O211,O218,O2682,O2683
56	Cystic fibrosis	5,138	36	0.7%	E840,E841,E848,E849
183	Hypertension complicating pregnancy; child birth and the puerperium	1,221	-	0.0%	O100,O101,O102,O103,O104,O109
195	Other complications of birth; puerperium affecting management of mother	834	-	0.0%	O220,O221,O222,O223,O225,O228,O742,O743,O745,O746,O754,O870,O871,O873,O878,O892,O894,O895,O898
2	Sepsis agent	707	9	1.3%	T8142
58	Nutrition, endo, metab other	405	~	*	E660,E668
81	CNS degenerative other	90	~	*	G903
187	Malposition; malpresentation	44	-	0.0%	O325
7	Viral infection	39	-	0.0%	A90,A91
259	Residual codes - unclassified	11	-	0.0%	R521
Total		48,950	408	0.8%	

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

It was not possible within the timescales of this study to determine what specific guidance has been given to HIPE coders in relation to 2020 coding of diagnoses that would previously been allocated to one of the retired codes. Instead the potential for a retired code to upset the risk profile of a CCS category was examined, through the removal of codes with a materially lower or materially higher mortality rate than the average mortality rate for that CCS category.

Observed and expected deaths on retired codes (2005-2019 discharges) were aggregated by CCS category. CCS categories with fewer than 40 total deaths were excluded since risk models are only fitted to CCS categories with over 40 deaths. CCS categories with fewer than 5 expected deaths on retired codes were also excluded since the impact will be immaterial.

Table 3 SMR on retired ICD-10-AM/ACHI/ACS codes

CCS category	CCS category description	Retired ICD codes	Observed deaths 2005-2019 on retired codes (1)	Expected deaths 2005-2019 on retired codes (2)	SMR on retired codes (3) = $100 \times (1)/(2)$	z-score associated with SMR (4)	% of total CCS discharges represented by retired codes (5)
197	Skin infection	L0310,L0311	560	552.6	101.3	0.30	55%
238	Surgical/medical complication	I971,J951,J952,K910,K913,N990,O294,O298,T8141	150	168.7	88.9	-1.41	29%
56	Cystic fibrosis	E840,E841,E848,E849	146	146.0	100.0	0.06	99%
2	Sepsis agent	T8142	47	130.4	36.0	-8.27	4%
81	CNS degenerative other	G903	7	8.5	82.4	-0.29	3%

Of the five CCS categories impacted, only CCS 2, sepsis, shows a significant difference in risk profile between the retired code and the CCS category as a whole. In this case, the mortality rate on retired code T8142 (sepsis following a procedure) represented 36% of the overall mortality rate of CCS 2 Sepsis. The code comprised only 4% of discharges over 2005-2019, however, and since sepsis-related ICD codes (excluding newborn sepsis) are all allocated to CCS category 2, the impact is likely to be absorbed by other ICD codes within that CCS category.

It is worth noting that all previously used ICD codes for cystic fibrosis (CCS 56) have been retired, and going forward only ICD code E84 (which had not previously been used) is available.

In summary, none of the retired ICD-10-AM/ACHI/ACS codes cause concern in relation to the NAHM risk models.

2.3 New in 10th edition

A total of 384 new ICD-10-AM/ACHI/ACS codes have been introduced in the 10th edition. Discharges between 1st January 2020 and 30th April 2020 have been used to assess for impact. Only 156 out of the 384 new codes have been used as a primary diagnosis in that period.

The potential for a new code to upset the risk profile of a CCS category has been examined, through the introduction of codes with a materially lower or materially higher mortality rate than the average mortality rate for that CCS category.

Observed and expected deaths on new codes (2020 discharges) were aggregated by CCS category. CCS categories on which risk models are not run were excluded. CCS categories with fewer than 5 expected deaths on new codes were also excluded since the sample size is not large enough. Only four CCS categories remained, these are shown in the table below.

Table 4 SMR on new ICD-10-AM/ACHI/ACS codes

CCS category	CCS category description	New ICD codes	Discharges on new ICD codes	Observed deaths 2020 on new codes (1)	Expected deaths 2020 on new codes (2)	SMR on new codes (3) = $100 \times (1)/(2)$	z-score associated with SMR (4)	% of total CCS discharges 2020 represented by new codes (5)
197	Skin infection	L0240,L0241,L0242,L0243,L0312,L0313,L0314,L0319	1307	21	13.6	154.4	1.78	62%
199	Skin chronic ulcer	L8910,L8915,L8922,L8924,L8925,L8926,L8927,L8929,L8930,L8931,L8933,L8934,L8935,L8936,L8937,L8938,L8939,L8947,L8949,L970,L978,L979	228	~	7.6	78.5	-0.36	100%
237	Complication implant, graft	T8251,T8252,T8253,T8259,T8271,T8273,T8274,T8275,T8276,T8277,T8279,T8281,T8282,T8284,T8286,T8289,T8381,T8383,T8384,T8385,T8389,T8481,T8483,T8489,T8563,T8564,T8569,T8573,T8575,T8576,T8577,T8582,T8583,T8585,T8586,T865,T8685,T8686	308	11	6.1	179.1	1.66	28%
238	Surgical / medical complication	G9711,G9719,G9731,H5913,H5982,I9783,I9789,I9501,I9502,I9503,I9504,I9509,I9564,I9584,I9585,I9589,K9141,K9142,K9143,K9149,K9163,K9181,K9182,K9183,K9184,K9189,N9951,N9952,N9953,N9959,N9963,N9983,N9989,T8182,T8183,T8184,T8189,T8852	469	~	5.4	55.9	-0.79	33%

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

None of the absolute value of the z-scores in the table above exceed 1.96 and so all SMRs are within a 95% confidence interval of 100. It is noted that the new codes under CCS 197 (skin infection) and 238 (surgical/medical complication) may replace retired codes in those CCS categories, although there is not specific HIPE coder guidance that would confirm this.

In summary, none of the new ICD-10-AM/ACHI/ACS codes cause concern in relation to the NQAIS NAHM risk models.

2.4 8th edition codes continuing in 10th edition – changed CCS mapping

Of the 19,427 ICD-10-AM/ACHI/ACS codes that have continued from the 8th edition into the 10th edition, 1,380 have been subject to changes in the mapping from ICD10 to CCS categories. The CCS mapping changes were made for NQAIS Clinical based on clinical review of the previous mapping file and input from Clinical programmes.

Of the 1,380 mapping changes, 798 ICD-10-AM/ACHI/ACS codes have been mapped to pre-existing CCS categories and 582 ICD-10-AM/ACHI/ACS codes have been mapped to newly created CCS categories.

Codes mapped to pre-existing CCS categories

Using ICD-10-AM/ACHI/ACS codes, the sum of expected deaths using the old CCS and new CCS mappings was compared. CCS categories on which risk models are not run were excluded. The table below illustrates results for ICD-10-AM/ACHI/ACS codes with over 5 deaths observed (2005-2017) and a difference of 10 or more expected deaths between the old and new risk models.

(Note: discharges in 2018 and 2019 were not included since there were some difficulties in matching risk model record identifiers between the latest and prior risk models, however the patterns evident from 2005 to 2017 should be sufficient in terms of sample size).

Table 5 CCS mapping change: pre-existing CCS

ICD-10 code	ICD-10 label	Observed deaths	Old CCS	Old CCS label	New CCS	New CCS label	Risk - old CCS	Risk - new CCS	Change in Risk	z-score
B371	Pulmonary candidiasis	37	4	Mycoses	122	Pneumonia - non TB/STD	17.8	30.3	12.5	2.63
D469	Myelodysplastic syndrome unspecified	124	39	Leukemias	44	Neoplasm unspecified nature	231.8	89.6	-142.3	-10.54
I739	Peripheral vascular disease unspecified	8	117	Other circulatory disease	114	Periph/visceral atherosclerosis	7.5	41.9	34.4	8.42
S7203	Fracture of subcapital section of femur	242	230	Fracture of lower limb	226	Fracture neck of femur	244.3	286.7	42.3	2.61
S722	Subtrochanteric fracture	95	230	Fracture of lower limb	226	Fracture neck of femur	72.1	86.5	14.4	1.61
Total		506					573.6	535.0	-38.6	

The most significant change in risk is on D469 myelodysplastic syndrome unspecified. The expected deaths under the new CCS (89.6 expected deaths) are closer to observed deaths (124 observed deaths) than the expected deaths under the old CCS mapping (231.8 expected deaths) so the change in mapping raises no concerns.

Variances on other ICD-10-AM/ACHI/ACS codes above are smaller in size.

Codes mapped to newly-created CCS categories

Again comparison of the sum of expected deaths by ICD-10-AM/ACHI/ACS code, using the old CCS and new CCS mappings was carried out. CCS categories on which risk models are not run were excluded. The table below illustrates results for ICD-10-AM/ACHI/ACS codes with over 5 deaths observed (2005-2017) and a difference of 10 or more expected deaths between the old and new risk models.

Table 6 CCS mapping change: new CCS

ICD-10 code	ICD-10 label	Observed deaths	Old CCS	Old CCS label	New CCS	New CCS label	Risk - old CCS	Risk - new CCS	Change in Risk	z-score
I609	Subarachnoid haemorrhage unspecified	854	267	Acute cerebrovascular disease	625	Subarachnoid haemorrhage	800.8	785.6	-15.2	0.52
Total		854					800.8	785.6	-15.2	

The change in risk is moderate and so raises no concerns.

2.5 Overall review of new CCS categories

There were 27 new CCS categories created and 6 CCS categories are no longer used, leading to an increase of 21 in the overall count of CCS categories.

The number of CCS categories on which a risk model is not fitted (due to fewer than 40 observed deaths 2005 to date) has increased from 96 to 111. This would be a concern if it led to an increase in the percentage of deaths not monitored by a risk model, however this has remained steady at 0.6%.

Table 7 CCS categories on which risk models fitted

Status	Old CCS mapping			New CCS mapping (including newly created CCS)		
	Count CCS categories	% of Total Cases	% of Total Deaths	Count CCS categories	% of Total Cases	% of Total Deaths
Risk model fitted	166	75.6%	99.4%	172	75.8%	99.4%
Crude mortality rate applied	96	24.4%	0.6%	111	24.2%	0.6%
Total	262	100.0%	100.0%	283	100.0%	100.0%

The number of CCS groups on which a risk model is not fitted and the observed death count is zero has increased from 18 to 30. There is therefore a small understatement of risk on these CCS groups, since the predicted risk (using crude observed deaths/discharges) is zero but the actual risk will be non-zero.

The Area under Receiver Operating Characteristic (AuROC) metric is used to evaluate the goodness of fit of individual risk models. The weighted average AuROC across all risk models (weighted by observed deaths) was 82.63% before the new CCS categories were introduced and has remained steady at 82.58%.

3 Impact of COVID-19 on changing numbers of admissions and discharges on NQAIS NAHM model

3.1 Background

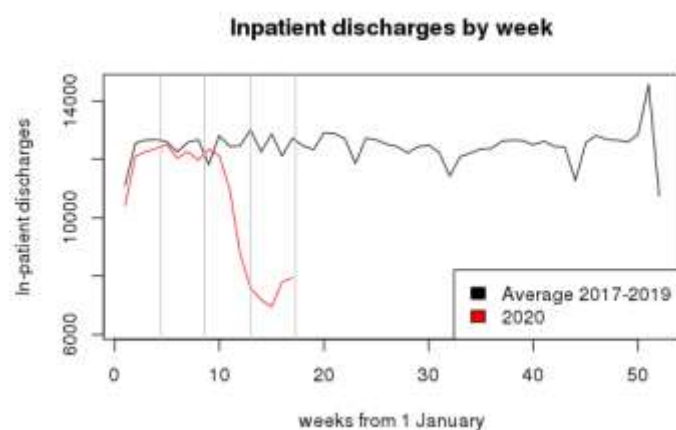
Preliminary observations (dated 3rd June 2020) from the HIU noted the impact of COVID-19 on the functioning of the health service, including cancellation of elective admissions, reduced hospital capacity, lower numbers of presentations at hospitals and closure of some nursing homes to new admissions. It was agreed to explore the following areas to investigate the impact on in-patient activity:

- Discharges by week compared to same period in prior years, including destination of discharges (home, transfer to other acute, nursing home etc.)
- Length of stay vs same period prior years.
- Admissions by week compared to same period in prior years (prior years filtered for discharged by 30th April for comparison).
- Profile case-mix 2020 vs same period prior years, including Charlson comorbidity index (CCI) and CCS profile.
- Elective vs emergency 2020 vs prior years.
- All hospitals combined, and any outlier hospitals.
- Differences by geographical region and/or Model 2, 3 or 4 hospital.

3.2 Discharges by week 2020 compared to same period in prior years

Preparations for COVID-19 began in January 2020, with the Department of Health establishing a National Public Health Emergency Team on 27 January 2020. Individual hospital preparations included discharging patients that could safely be discharged, in particular from ICU wards.

The chart below compares counts of discharges by week across all inpatient cases (including maternity and newborn).

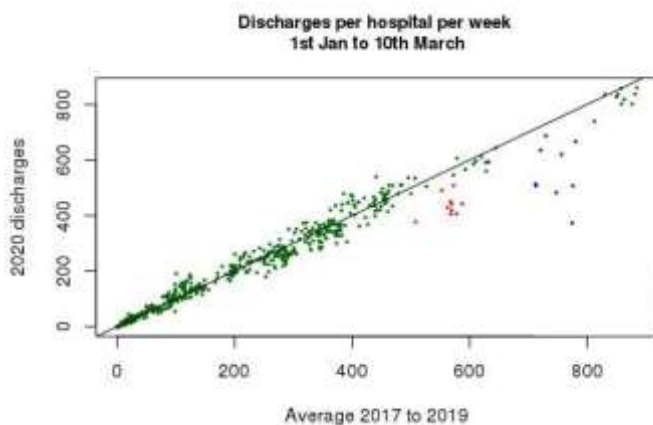


In-patient discharge counts by week, 2020 vs average across 2017-2019.

Months January to April delineated by vertical grey lines.

Figure 1 Discharges by week

Preparation phase: In comparing the volumes of discharges in the early part of 2020 with the same period in prior years, a higher volume of discharges in weeks 1-10 of 2020 (period to 10th March 2020) might have been expected. At a total level across all hospitals the volume of discharges was slightly lower in the first 10 weeks of 2020 compared to average discharges 2017-2019 across the same weeks. By hospital, most hospitals showed reasonably similar levels of discharges per week over the first 10 weeks of 2020 compared to prior years. Two Model 4 hospitals showed lower discharge counts in 2020, compared to prior years. This may be in part due to delays in coding of HIPE records.



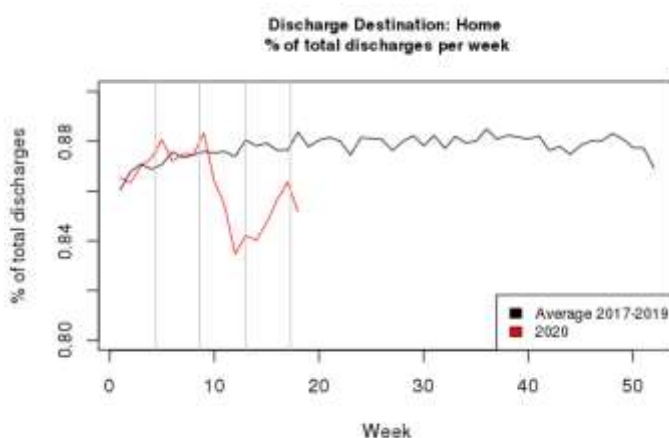
Scatterplot of discharges per week per hospital, weeks 1-10 2020 vs same period prior years. Points below the diagonal line indicate that discharge volumes are lower in 2020 compared to average across 2017 to 2019.

Figure 2 Discharges by hospital by week

Response phase: Discharges show a sharp decrease from mid-March to early April (due primarily to lower admissions), with a small uptick in late April.

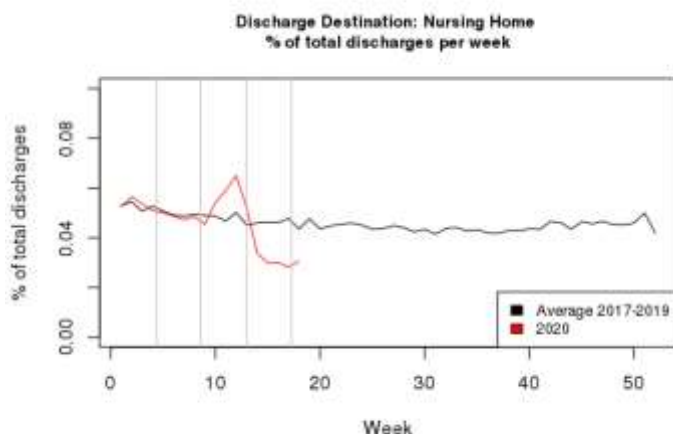
3.3 Discharges by destination of discharge

Discharges by destination, 2020 vs prior years, are shown below as percentages of total discharges per week. Note that the scale of the vertical axis varies across the plots that follow. There was a marked reduction in the percentage of patients discharged to home in March and April 2020. Discharges to nursing homes increased in March 2020 but fell in April 2020. Transfers to acute hospitals increased steadily in March/April 2020.



Discharges to home: DISC_CODE 01.
2017-2019 average: 87.8%.
2020: Dropped below 84% in March, increasing in April.

Figure 3 Discharged to home as % of total discharges



Discharges to nursing home: DISC_CODE 02.

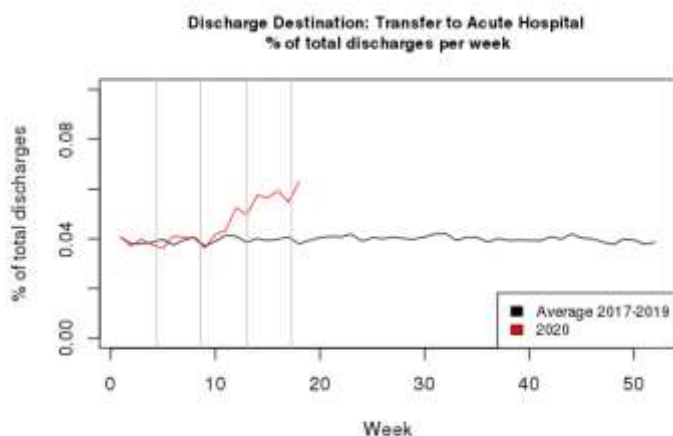
2017-2019 average: 4.6%.

2020: Increased to 6.5% in mid-March, then dropped to 3%-3.5% in April.

27% of patients discharged to nursing homes 1st-13th March 2020 had been admitted from nursing homes.

Figure 4 Discharged to nursing home as % of total discharges

11.9% of patients discharged to nursing homes between 1st and 13th March 2020 were subsequently readmitted (and discharged again by 30th April). There may be further readmissions not yet discharged.



Discharges to Acute Hospital: DISC_CODE 03, 04.

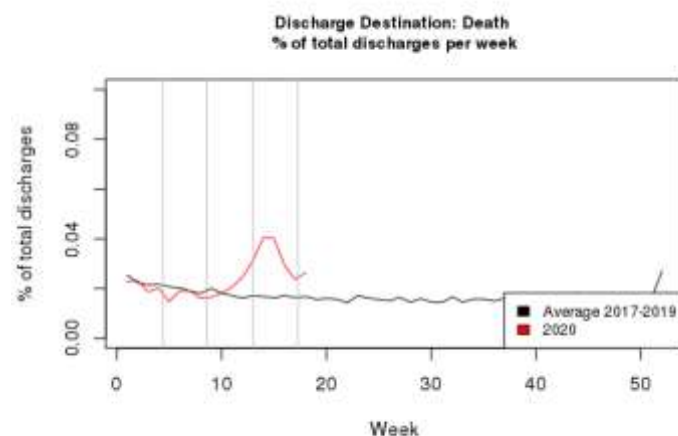
2017-2019 average: 4.0%.

2020: Increased to 5%-6% in March/April.

March/April 2020 transfer volumes:

- Smaller hospital to larger: 1,424 (8.6% COVID-19-positive)
- Larger hospital to smaller: 2,400 (6.7% COVID-positive)

Figure 5 Transfer to acute hospital as % of total discharges



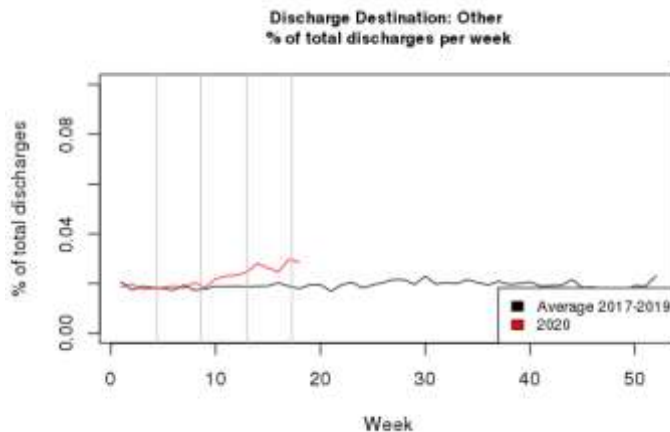
Died in hospital: DISC_CODE 06, 07.

2017-2019 average: 1.7%. (Note – includes maternity).

2020: Increased to 4% in early April.

Increase in mortality rate can be attributed to COVID-19 and to increased complexity of non-COVID-19 case-mix.

Figure 6 Died in hospital as % of total discharges



Discharges to other destination:
DISC_CODE 00, 05, 08-15.

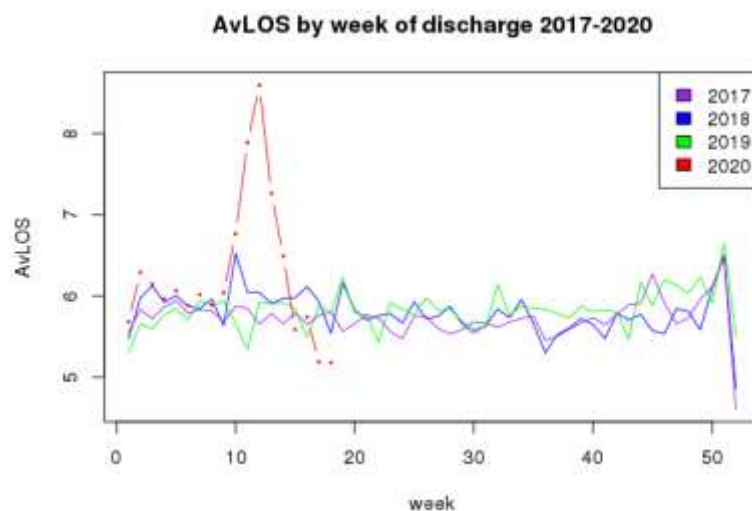
2017-2019 average: 1.9%

2020: Increased to 2.5%-3% in
March/April.

Figure 7 Discharged to other destination as % of total discharges

3.4 Length of Stay by week of discharge

Average length of stay (AvLOS) across discharges has tended to remain steady over time (2019 & prior), with some variations typically seen around holiday periods.



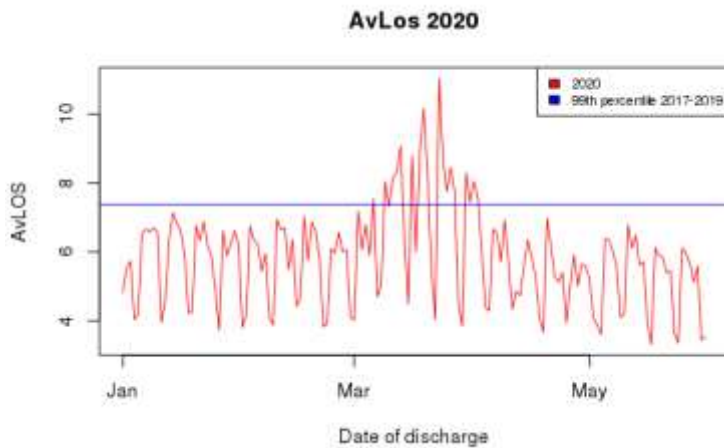
In this plot, the length of stay (in days) is attributed to the date of discharge. AvLOS by week is then calculated as sum of LOS by week divided by number of patients discharged by week.

Figure 8 AvLOS by week of discharge

AvLOS on in-patient discharges showed a significant increase (relative to same periods 2017-2019) during March 2020.

The 99th percentile of average length of stay per day prior to 2020 was 7.38 days.

Between Friday 6th March 2020 and Thursday 2nd April 2020, the AvLOS on discharges exceeded 7.38 days on 18 days out of 28.



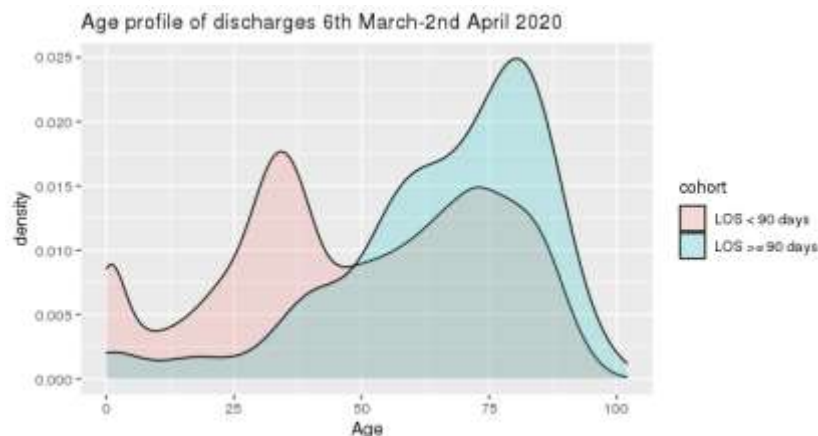
In this plot, the length of stay (in days) is attributed to the date of discharge. AvLOS by day is then calculated as sum of LOS by day divided by number of patients discharged by day.

Figure 9 AvLOS by day 2020 discharges

The increase in AvLOS can be attributed to higher volumes of discharges of patients with length of stay of 90 days or more. Patients with lengths of stay of 90 days and above accounted for 18% of bed days used ** between 6th March 2020 and 2nd April 2020, compared to an average of 10% of bed days used in the same period 2017 to 2019.

** bed days used on a given date of discharge = sum of lengths of stay of all patients discharged on that date.

Those discharged having completed long lengths of stay are typically older patients (mean age 66 years for LOS ≥ 90 days, 50 years for LOS < 90 days).



Age profile of in-patient discharges (including maternity) 6th March-2nd April 2020.

Those with lengths of stay of 90 days and over show an older age profile.

Figure 10 Age profile of discharges by LOS

The long length of stay discharges between 6th March and 2nd April 2020 were discharged primarily to nursing homes or to the patient's home. Of the 45 that were transferred to another facility, 39 were transferred to another HIPE-coded hospital, 1 to a non-HIPE coded hospital and 5 to a (non-HIPE) rehabilitation facility.

Table 8 Discharges of patients with LOS \geq 90 days

Discharges of patients with LOS \geq 90 days, between 6th March and 2nd April of each year

Discharge Year	Home	Nursing Home	Transfer	Death	Other	Total
2017	71	67	20	~	*	181
2018	61	69	29	~	*	182
2019	79	72	25	~	*	195
2020	107	123	45	~	*	300

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

3.5 Admissions by week 2020 compared to same period in prior years

Volumes of admissions were not significantly different in the early weeks of 2020 compared to the average of 2017 to 2019, but admissions dropped sharply in March and April 2020.

To ensure that 2017 to 2019 counts are on a like for like basis with 2020, only admissions that were discharged by May of each prior year were included. As noted earlier in this report, 2020 counts may still be understated due to HIPE coding delays. The dotted red line in the charts below represents a crude estimate of 2020 admissions adjusted for reporting delays.

The chart below shows counts of admissions by week, 2020 vs average of prior years, across all admission types: emergency, elective and maternity.

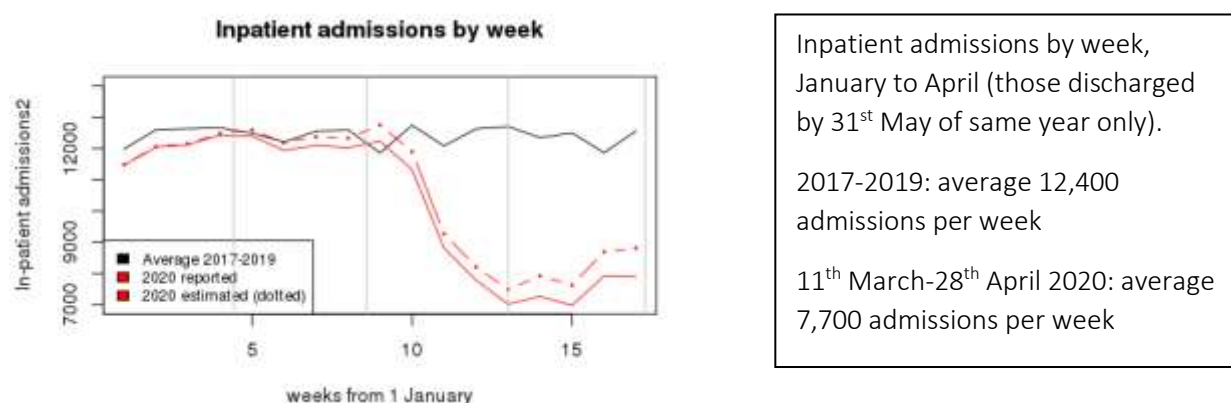
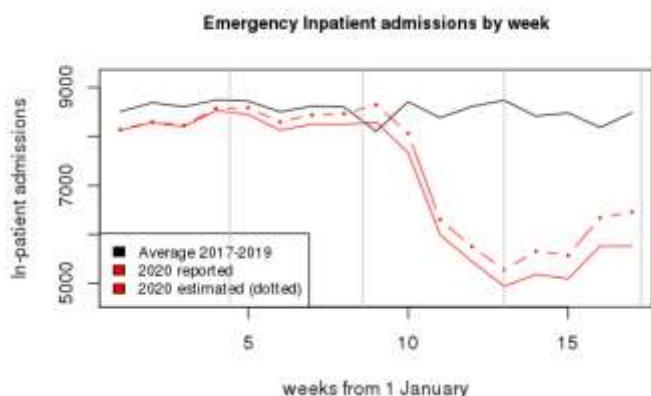


Figure 11 Admissions by week

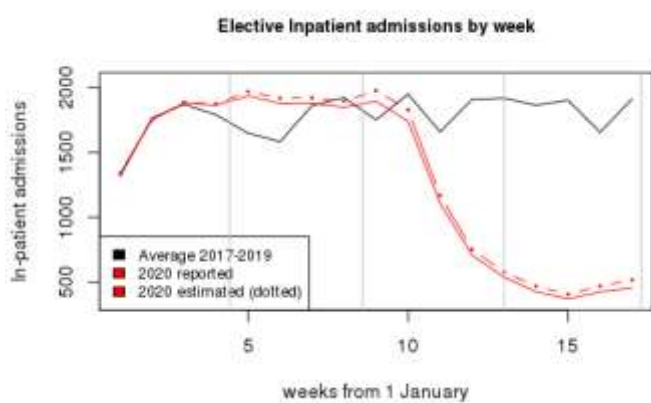
The charts below split admissions by type of admission. Newborn emergency admissions are included with emergency admissions below.



Inpatient emergency admissions by week, January to April (those discharged by 31st May of same year only).

ADMTYPE 4, 5, 7

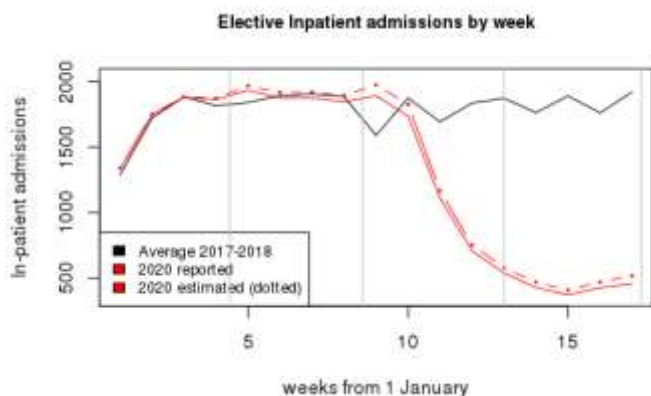
Figure 12 Emergency admissions by week



Inpatient elective admissions by week, January to April (those discharged by 31st May of same year only).

ADMTYPE 1, 2.

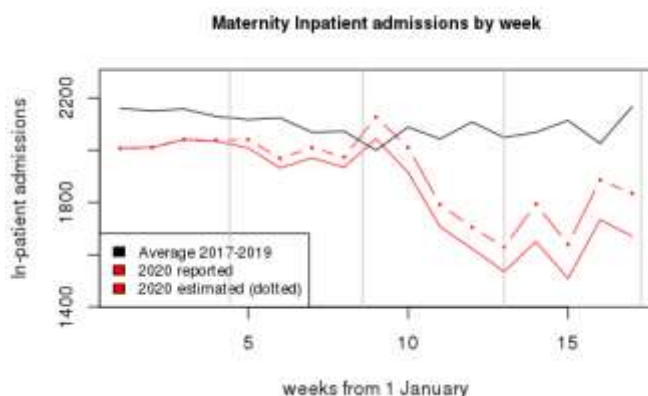
Figure 13 Elective admissions by week



Elective admissions in early 2019 were lower than usual because of Irish Nurses and Midwives Organisation strike action. This plot compares 2020 elective to the average of 2017-2018.

Figure 14 Elective admissions by week excluding 2019

Note that some transfers between acute hospitals are coded as elective, even when the primary diagnosis suggests that the nature of the original admission may have been unscheduled (e.g. pneumonia, heart failure). The chart above does not strip out transfers from the elective counts, hence there may be a slight overstatement of admissions.



Inpatient maternity admissions by week, January to April (those discharged by 31st May of same year only).

ADMTYPE 6.

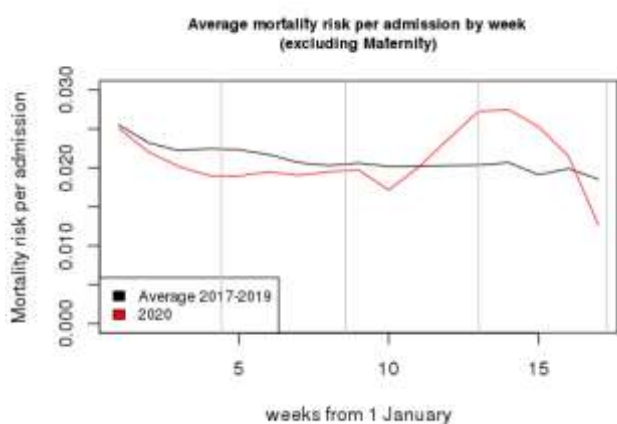
Figure 15 Maternity admissions by week

3.6 Casemix 2020 vs same period prior years, including CCI and CCS profile

Volumes of patients presenting to hospitals were lower in March/April 2020 as many may have been conscious of the risk of contracting COVID-19 in a hospital setting. The patients who did present were most likely to be those with more severe disease.

For a given primary diagnosis, a number of factors, including age, CCI, type of admission, source of admission, palliative care requirement and others are included in the fitted risk model. The combined view of the complexity of an individual admission can be summarised using the predicted risk of death that is output by the fitted model.

The chart below shows the average risk per admission (per week) in 2020, compared to the same period 2017-2019. A clear increase in average risk per admission can be seen as admission volumes fell in 2020. The date range during which average risk per admission spiked was 7th March 2020 to 19th April 2020 inclusive.



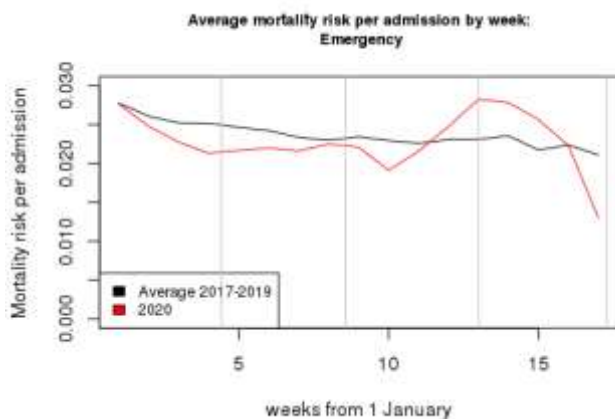
Average mortality risk as measured by NQAIS NAHM risk models.

Admissions 7th March to 19th April 2020: mean risk **2.34%**.

Same period 2017-19: mean risk **2.0%**

Figure 16 Average mortality risk per admission

The charts that follow show the increase in average risk per admission for each of emergency and elective admissions. The increase in average risk appears more severe for elective, compared to emergency, reflecting the cancellation of non-essential elective admissions.

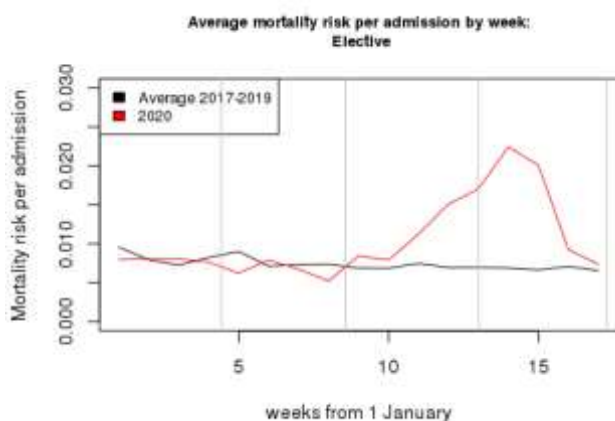


Average mortality risk on emergency admissions.

Emergency admissions 7th March to 19th April 2020: mean risk **2.45%**.

Same period 2017-19: mean risk **2.27%**.

Figure 17 Average mortality risk: emergency



Average mortality risk on elective admissions.

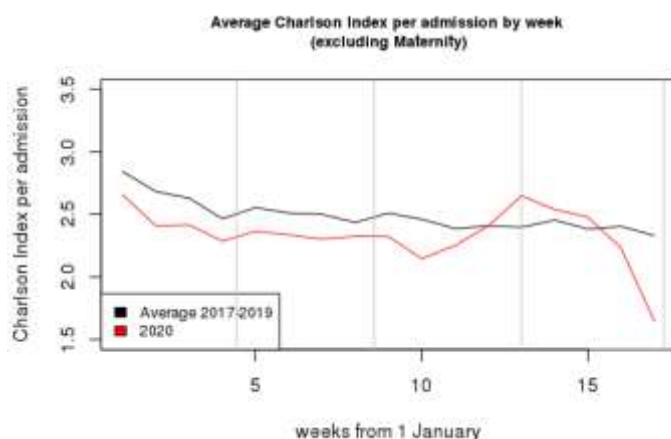
Elective admissions 7th March to 19th April 2020: mean risk **0.69%**.

Same period 2017-19: mean risk **1.40%**.

Figure 18 Average mortality risk: elective

Charlson comorbidity index

The CCI is a score that indicates the presence of one or more comorbid conditions such as heart disease or cancer in an admitted patient. Each condition is assigned a score of 1, 2, 3, or 6, depending on the risk of dying associated with each one. Scores are summed to provide a total score which can help to explain mortality patterns. During the period mid-March to mid-April 2020 the average CCI increased, although not as sharply as the overall predicted risk from the fitted models.

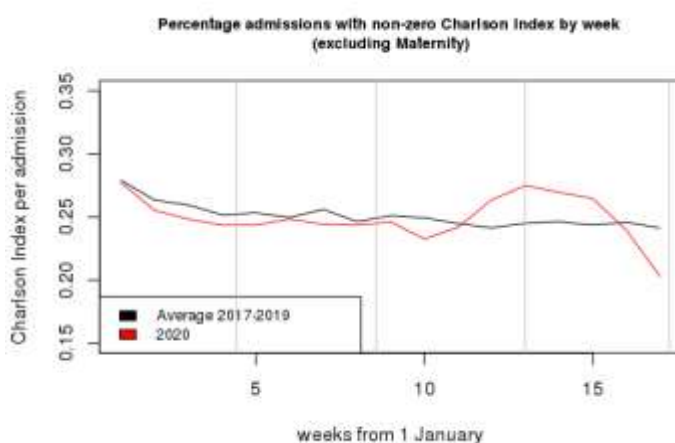


Average CCI per admission

2017-2019 average: 2.49

2020: increased to 2.65 in late March.

Figure 19 Average CCI



Percentage of admissions with one or more co-morbidities (CCI >0)

2017-2019 average: 25%

2020: increased to 27% in late March.

Figure 20 Percentage admissions with non-zero CCI

CCS profile

In order to understand which CCS categories most contributed to the increase in average risk per admission, the average risk per admission and percentage share of all admissions were tabulated for each CCS. The contribution to the 'spike' by CCS is then the difference between {2017-2019 risk x share} and {2020 risk x share}.

The table below shows the top CCS groups contributing to an increase in average risk per admission from 2.0% in 2017-2019 to 2.34% in 2020. The reference dates are 7th March to 19th April of each year, since these are the dates between which the highest average risk on admission were recorded in 2020.

The main causes of the increase are respiratory codes (pneumonia, respiratory failure and lower respiratory disease other). On these CCS groups, the average risk (as estimated by the risk model, which does not allow for presence or absence of COVID-19) is similar in 2020 to prior years, however the share of admissions is over twice what would normally be seen. These are high risk CCS groups and so any increase in volume will drive an increase in overall risk.

The cardiovascular CCS groups (stroke codes 261 and 625) saw the usual volumes but slightly higher risk per admission.

Finally, a number of CCS groups contributed to a reduction in overall risk, including sepsis and aspiration pneumonitis, where the average risk per admission was slightly lower in 2020 than in prior years.

All Admissions excluding Maternity:

CCS	CCS Name	Group Name	Mortality risk per admission 2017-2019	Mortality risk per admission 2020	Percent of admissions 2017-2019	Percent of admissions 2020	Contribution to change in average risk	Share of overall change
122	Pneumonia - non TB/STD	Respiratory	10.77%	10.02%	2.6%	5.6%	0.28%	82.10%
131	Respiratory failure	Respiratory	22.07%	20.38%	0.1%	0.4%	0.04%	12.62%
133	Lower respiratory disease other	Respiratory	2.20%	2.18%	1.0%	2.4%	0.03%	9.28%
261	Stroke haemorrhagic	Cardiovascular	28.89%	30.08%	0.2%	0.2%	0.03%	8.02%
625	Subarachnoid haemorrhage	Cardiovascular	15.34%	20.00%	0.1%	0.1%	0.01%	4.05%
2	Sepsis agent	Infection	13.39%	11.22%	0.6%	0.6%	-0.02%	-5.71%
129	Aspiration pneumonitis	Respiratory	22.52%	17.09%	0.4%	0.4%	-0.02%	-7.18%
Other	All other CCS groups		1.51%	1.58%	95.0%	90.3%	-0.01%	-3.18%
Total			2.00%	2.34%	100.0%	100.0%	0.34%	100.00%

Table 9 Increase in average risk by CCS category

Looking at emergency admissions only, the increase in average risk during the period 7th March to 19th April can again be attributed primarily to respiratory diagnoses.

Emergency

CCS	CCS Name	Group Name	Mortality risk per admission 2017-2019	Mortality risk per admission 2020	Percent of admissions 2017-2019	Percent of admissions 2020	Contribution to change in average risk	Share of overall change
122	Pneumonia - non TB/STD	Respiratory	10.76%	9.84%	3.1%	6.1%	0.26%	146.27%
131	Respiratory failure	Respiratory	22.50%	20.50%	0.1%	0.4%	0.05%	25.44%
133	Lower respiratory disease other	Respiratory	2.24%	2.11%	1.1%	2.6%	0.03%	17.24%
261	Stroke haemorrhagic	Cardiovascular	29.05%	30.33%	0.2%	0.3%	0.03%	14.68%
127	COPD & bronchiectasis	Respiratory	3.70%	3.15%	3.5%	3.6%	-0.02%	-8.68%
159	Urinary tract infection	Renal/urogenita	2.36%	1.89%	3.0%	2.9%	-0.02%	-9.89%
108	Congestive heart failure	Cardiovascular	6.78%	6.43%	1.5%	1.3%	-0.02%	-10.24%
2	Sepsis agent	Infection	13.49%	11.24%	0.7%	0.6%	-0.03%	-16.46%
129	Aspiration pneumonitis	Respiratory	22.51%	16.82%	0.5%	0.4%	-0.04%	-20.76%
Other	All other CCS groups		1.52%	1.52%	86.2%	81.8%	-0.07%	-37.60%
Total			2.27%	2.45%	100.0%	100.0%	0.18%	100.00%

Table 10 Increase in average emergency risk by CCS category

The top contributors to the spike in average risk per admission on elective admissions includes diagnoses that would appear to be unscheduled in nature (e.g. pneumonia). The figures in the table below include acute hospital transfers which have been coded as elective admissions.

Elective

CCS	CCS Name	Group Name	Mortality risk per admission 2017-2019	Mortality risk per admission 2020	Percent of admissions 2017-2019	Percent of admissions 2020	Contribution to change in average risk	Share of overall change
122	Pneumonia - non TB/STD	Respiratory	10.92%	15.63%	0.3%	1.8%	0.25%	34.45%
125	Lwr respiratory infection other	Respiratory	2.94%	6.94%	0.4%	1.0%	0.06%	7.81%
257	Other aftercare	Other	1.75%	1.84%	3.6%	6.4%	0.05%	7.60%
108	Congestive heart failure	Cardiovascular	6.29%	11.86%	0.3%	0.6%	0.05%	7.04%
133	Lower respiratory disease other	Respiratory	1.63%	4.03%	0.4%	0.9%	0.03%	3.99%
159	Urinary tract infection	Renal/urogenita	2.41%	3.13%	0.4%	1.2%	0.03%	3.74%
19	Cancer bronchus	Cancer	3.14%	3.88%	1.0%	1.4%	0.02%	3.13%
Other	All other CCS groups		0.56%	0.86%	93.6%	86.9%	0.23%	32.24%
Total			0.69%	1.40%	100.0%	100.0%	0.71%	100.00%

Table 11 Increase in average elective risk by CCS category

If elective admissions by source of admission is further split, the top three CCS categories contributing to the increase in average risk in March/April 2020 are as follows:

Elective admissions by source of admission	CCS categories contributing to increase in risk March/April 2020
Admsource 1 = Home	CCS 122 (pneumonia - non TB/STD); CCS 19 (cancer bronchus); CCS 83 (epilepsy)
Admsource 2 = Transfer from nursing home/convalescent home or other long stay accommodation	CCS 125 (Lower respiratory infection other); CCS 42 (secondary malignancy); CCS 16 (cancer liver & bile duct)
Admsource 3 = Transfer of admitted patient from acute hospital	CCS 122 (pneumonia - non TB/STD); CCS 108 (congestive heart failure); CCS 125 (lower respiratory infection other)
Other = Transfer from non-acute hospital, hospice, psychiatric hospital/unit, other.	CCS 150 (liver disease alcohol related); CCS 97 (carditis/myopathy - non TB/STD); CCS 100 (acute myocardial infarction)

3.7 Differences by geographical region and/or Model 2, 3 or 4 hospital

SMR plots by hospital were run. Dublin hospitals experienced the greatest share of risk on COVID-19 patients, followed by Leinster hospitals.

The hospitals with the highest overall SMRs across COVID-19 and non-COVID-19 discharges, are again the Dublin hospitals.

Figure 5 Transfer to acute hospital as % of total discharges showed a higher than usual rate of transfer between acute hospitals during March and April. March/April 2020 patients (COVID-19 + non-COVID-19) discharged to another acute hospital included 1,424 transfers from a smaller hospital to a large hospital, and 2,400 transfers from a large hospital to a smaller hospital. Some patients were transferred more than once during the period.

A sample of 49 patients discharged from a Model 4 hospital to a Model 2 hospital, showed the following patient pathways:

Pathway	Count	Of which COVID-19 positive
Home-> Model 4 hospital -> Model 2 hospital -> Home	24	24
Home -> Model 2 hospital -> Model 4 hospital -> Home	9	2
Home -> 3 hospital stays -> Home	8	7
Nursing home -> Model 4 hospital -> Model 2 hospital -> Nursing home	~	~
Patients still in hospital (last discharge to acute hospital)	*	*
Total	49	38

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

4 Impact of COVID-19 on specific CCS Codes e.g. respiratory

4.1 Background

The HPO issued guidance on the coding of discharges for patients according to the degree of COVID-19 symptoms, exposure, laboratory testing and other factors. An extract from the HPO guidance is included within **Appendix 1: HPO guidance**. Within NQAIS systems, a new flag has been created which identifies patients with COVID-19 as follows:

- Diagnosis includes either U07.1 or U07.2: COVID-19
- Diagnosis does not include U07.1 or U07.2: Not COVID-19.

There were 527 deaths recorded during March and April on patients with either U07.1 or U07.2 as an additional diagnosis. The Health Protection Surveillance Centre (HSPC) reported 1,050 deaths (all locations) on confirmed cases by 30th April 2020. Later HSPC reporting showed more detail in terms of deaths amongst probably/possible COVID-19 cases and % of deaths occurring in hospital, from which it can be estimated the HSPS 30th April cumulative deaths in hospital as 516.

Within NQAIS NAHM, discharges are grouped according to primary diagnosis for risk modelling purposes. Since U07.1 and U07.2 will be coded as additional diagnoses, COVID-19 cases are likely to appear across a range of primary diagnoses. Preliminary observations (dated 3rd June 2020) from the HIU noted that “While early phases of the illness due to COVID-19 may preferentially affect the respiratory system, later phases are shown to involve multiple body systems. It is problematic, therefore, to limit COVID-19 to a CCS that reflects only a narrow interpretation of its multi-system potential for harm.”

It was agreed to explore the following areas to investigate the impact on specific CCS codes:

- Primary diagnosis and CCS across all COVID-19 activity.
- Review coding of U07.1, U07.2 and U06.0.
- Review HADx coding, particularly on patients admitted prior to March.
- Profile COVID-19 case mix against normal case-mix (age, gender, co-morbidities).
- Profile case-mix on non-COVID-19 cases against normal case mix.
- Observed and expected deaths per week: COVID-19 vs non-COVID-19.
- CCS codes most impacted.

4.2 Primary diagnosis and CCS across all COVID-19 activity

The table below shows the CCS group associated with the primary diagnosis on COVID-19 patients discharged in March and April 2020. Of these cases 66% presented with a primary diagnosis of a respiratory nature.

Table 12 COVID-19 cases: CCS group of primary diagnosis

CCS Group	Discharges	Deaths	Mortality rate	% of total COVID-19 discharges	HADx COVID discharges	HADx % of total discharges
Respiratory	1,943	376	19%	66.0%	40	2.1%
Other	295	15	5%	10.0%	32	10.8%
Cardiovascular	167	23	14%	5.7%	48	28.7%
All other	541	113	21%	18.4%	175	32.3%
Total	2,946	527	18%	100.0%	295	10.0%

The table below further splits discharges by individual CCS category. CCS 122 (pneumonia – non TB/STD) accounts for 31.2% of COVID-19 cases and experienced a mortality rate of 29% on COVID-19 discharges over March/April 2020.

Table 13 COVID-19 cases: CCS category of primary diagnosis

CCS Group	CCS	CCS Name	Discharges	Deaths	Mortality rate	% of total COVID-19 discharges	HADx COVID discharges	HADx % of total discharges
Respiratory	122	Pneumonia - non TB/STD	919	267	29%	31.2%	12	1.3%
Respiratory	133	Lower respiratory disease other	296	6	2%	10.0%	~	*
Respiratory	125	Lwr respiratory infection other	252	28	11%	8.6%	9	3.6%
Other	246	Fever unknown origin	197	7	4%	6.7%	~	*
Respiratory	134	Upper respiratory disease other	166	~	*	5.6%	~	*
Respiratory	131	Respiratory failure	75	33	44%	2.5%	~	*
Respiratory	127	COPD & bronchiectasis	72	25	35%	2.4%	9	12.5%
Respiratory	126	Upr respiratory infection other	52	-	0%	1.8%	0	0.0%
Respiratory	123	Influenza	51	6	12%	1.7%	~	*
Cardiovascular	102	Chest pain nons	46	-	0%	1.6%	0	0.0%
Renal/urogenital	159	Urinary tract infection	37	10	27%	1.3%	13	35.1%
Musculoskeletal	211	Connective tissue other	35	~	*	1.2%	6	17.1%
Gastrointestinal	135	Intestinal infection	32	~	*	1.1%	~	*
Various		All Other	716	136	19%	24.3%	236	33.0%
Total			2946	527	18%	100.0%	295	10.0%

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

4.3 Coding of U07.1, U07.2 and U06.0

Three new codes were introduced in 2020 to facilitate COVID-19 coding:

- **U07.1** Laboratory confirmed cases: Tested Positive.
- **U07.2** Clinically diagnosed or probable cases. Testing is inconclusive, unavailable or not specified
- **U06.0** Ruled out cases. Tested negative.

HIPE records were checked for the presence of one or more of U07.1, U07.2 or U06.0. No records were found to have more than one of the above codes. Records that did not include any of U07.1, U07.2 or U06.0 are described as “not tested” in the commentary below. It may be the case that some of these patients were tested for COVID-19 but the result was not recorded in HIPE.

Rates of COVID-19 testing increased over the early weeks of March 2020, but the proportion of non-tested patients remained high at approximately 70% into April 2020.

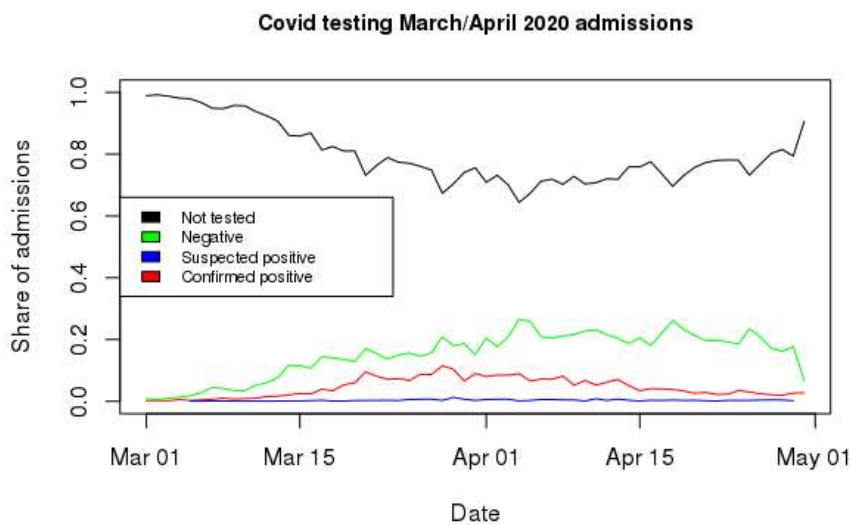


Figure 21 COVID-19 testing rates

The following factors appear to increase the likelihood of a COVID-19 code (U07.1, U07.2 or U06.0) being recorded:

- Age >18
- Longer length of stay
- Died in hospital
- CCS group Respiratory or Infection
- Source of admission: Nursing Home
- Admitted later in the March/April period (since testing rates increased over time)

Where the source of admission is transfer from acute hospital, the rate of testing is slightly lower (compared to source of admission home). It may be that some of these cases had been tested in the source hospital, but the result not recorded in the receiving hospital. Across a sample of 49 patients transferred between a Model 4 hospital and a Model 2 hospital (in either direction), 5 patients were confirmed negative (U06.0) in the issuing hospital but only 2 of these patients had the negative result recorded in the receiving hospital.

A rough profile of expected test counts (any of U07.1, U07.2 or U06.0) was prepared using the above explanatory factors, and the ratio of actual test counts to expected is plotted below as a standardised ratio.

A few hospitals appear to have tested a greater than average proportion of admissions and a number of hospitals appear to have tested a lower than average proportion of admissions:

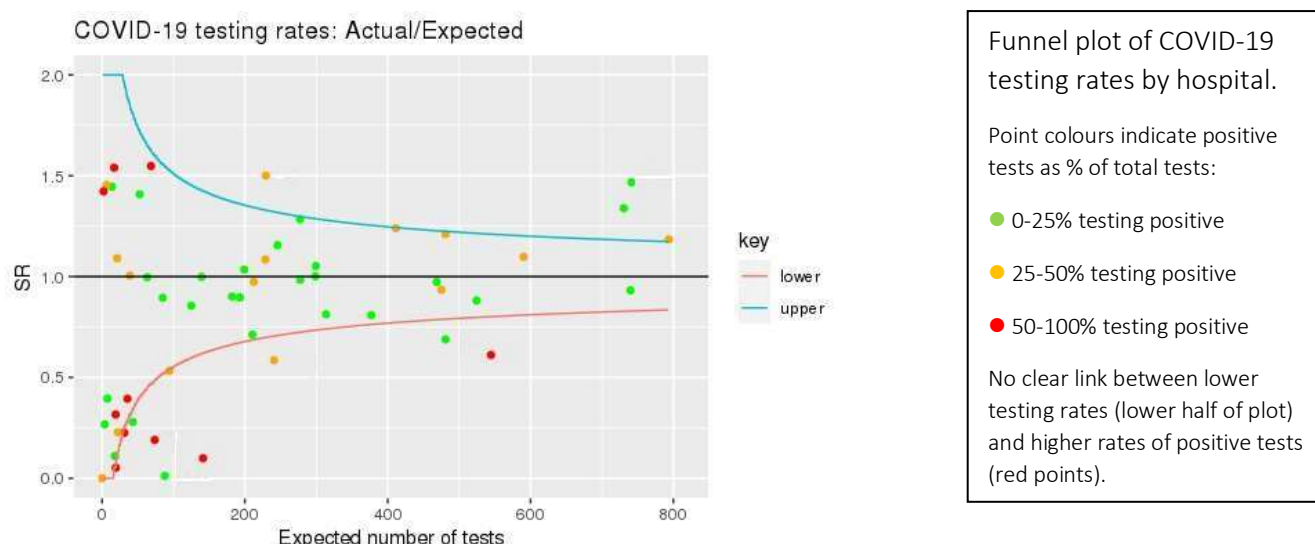


Figure 22 COVID-19 testing rates by hospital

4.4 HADx coding, particularly on patients admitted prior to March 2020

HPO guidance notes that, where COVID-19 is acquired during an episode of care the codes U071 and U072 can be assigned as additional diagnosis with the HADx flag(s) assigned as appropriate.

The first confirmed case of COVID-19 in Ireland was reported on 29th February 2020. Patients admitted to hospital in February 2020 or earlier and subsequently testing positive might therefore be assumed to have acquired COVID-19 during their episode of care. This is confirmed by the data (except for very small numbers of admissions February 2020 and prior not marked as hospital acquired).

The rate of coding positive cases as hospital acquired was 13% for patients admitted in March 2020 and reduced to 7% for patients admitted in April 2020.

Table 14 Hospital-acquired COVID-19

Hospital acquired positive cases by admission period (all hospitals, admitted patients only)

Codes U071 and U072	2018	2019	Jan-20	Feb-20	Mar-20	Apr-20	Total
Positive cases	~	*	37	85	1529	2074	3758
Positive cases, hospital acquired	~	*	35	80	200	148	494
HADx as % of total	100%	94%	95%	94%	13%	7%	13%

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

The patterns are similar across confirmed cases (U071) and suspected cases (U072) as seen in the tables below.

Table 15 - Hospital acquired, U071

Hospital acquired confirmed positive cases by admission period (all hospitals, admitted patients only)

Code U071 (confirmed)	2018	2019	Jan-20	Feb-20	Mar-20	Apr-20	Total
Positive cases	~	~	36	83	1463	1942	3555
Positive cases, hospital acquired	~	~	34	78	195	134	470
HADx as % of total	100%	93%	94%	94%	13%	7%	13%

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

Table 16 Hospital acquired, U072

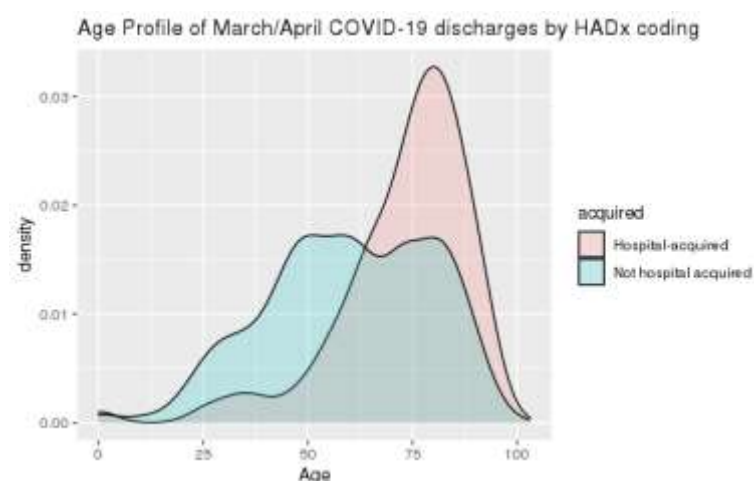
Hospital acquired suspected positive cases by admission period (all hospitals, admitted patients only)

Code U072 (suspected)	2018	2019	Jan-20	Feb-20	Mar-20	Apr-20	Total
Positive cases	0	~	~	~	66	132	203
Positive cases, hospital acquired	0	~	~	~	~	14	24
HADx as % of total	n/a	100%	100%	100%	8%	11%	12%

~ denotes 5 or fewer patients

* denotes further suppression is necessary to ensure that cells with 5 or fewer cases are not disclosed

The age profile of hospital-acquired COVID-19 cases is older than that of non-hospital acquired cases. Mortality rates were significantly higher on hospital-acquired cases (35% mortality rate) vs non-hospital acquired (16% mortality rate) but this may be a function of the older age profile.



Age Profile HADx vs non-HADx:

Positive cases discharged
March/April 2020.

Mean age HADx cases: 72.8 years

Mean age non-HADx cases: 59.9
years

Figure 23 Age profile of hospital acquired COVID-19

4.5 Profile COVID-19 case mix against normal case-mix (age, gender, co-morbidities)

In-patient discharges (excluding Maternity) on COVID-19 cases across March and April 2020 were profiled against March/April discharges in 2017 to 2019.

Age profile

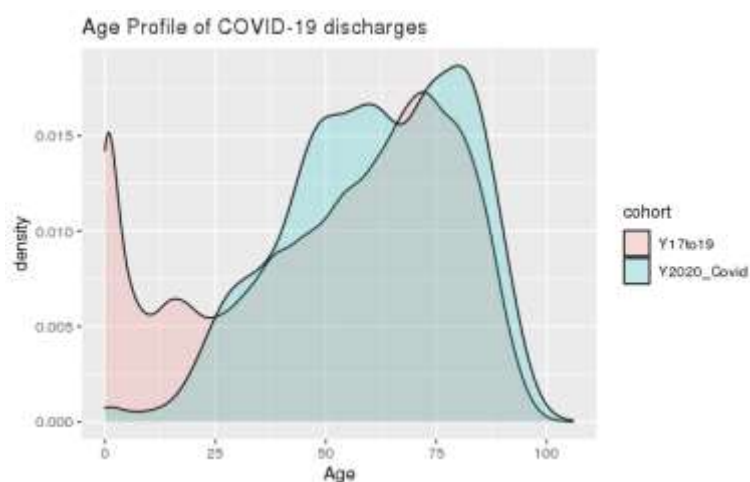


Figure 24 COVID-19 Age profile

Age Profile:

COVID-19 profile shows fewer patients aged <25 years and higher proportions aged 40-65 and 75+.

Mean age 61.2 years March/April 2020 vs 51.1 years March/April 2017-2019.

Gender profile

Discharges in the reference period (March/April 2017-2019) were 50.5% male, 49.5% female. In contrast, COVID-19 cases were 58.0% male, 42.0% female. This represents a significant difference in proportions (p-value on two-sample test of proportions < 0.001).

Charlson comorbidity index profile

The profile of CCI typically shows the majority (76%) of discharges having no recorded co-morbidities, and those with co-morbidities (24%) having CCI scores ranging from 1 to 50 and above. For the purpose of the chart below, values over 10 have been capped at 10.

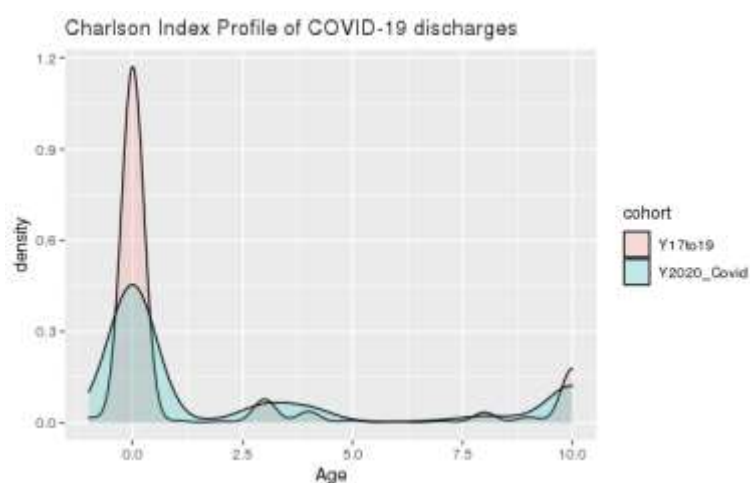


Figure 25 COVID-19 CCI profile

Charlson Comorbidity Index:

Mean score COVID-19 cases: 3.6

Mean score 2017-2019: 2.5

Proportion of discharges with CCI greater than zero (at least one co-morbidity) is 36.1% for COVID-19 cases compared to 23.8% across March/April 2017-2019.

4.6 Profile case-mix on non-COVID-19 cases against normal case mix

Discharges on non-COVID-19 cases across March and April 2020 were profiled against March/April discharges in 2017 to 2019.

Age profile

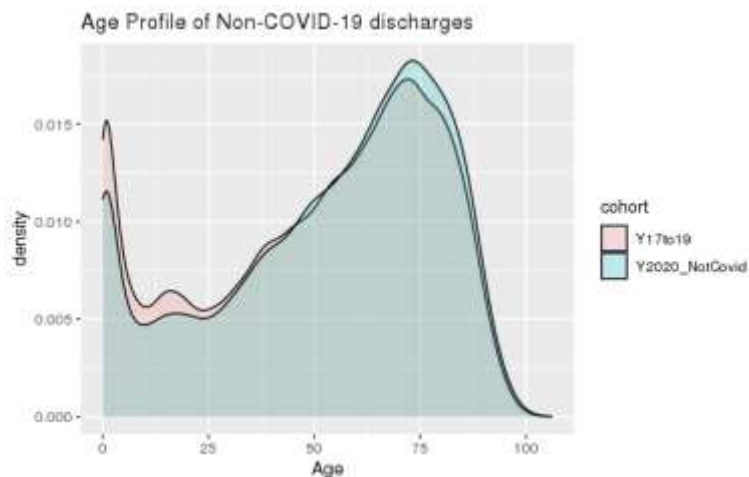


Figure 26 Non-COVID-19 age profile

Age Profile:

March-April 2020 non-COVID-19 discharges show slightly older age profile compared to same months 2017-2019.

Mean age 53.4 years March/April 2020 vs 51.1 years March/April 2017-2019.

Gender profile

Discharges in the reference period (March/April 2017-2019) were 50.5% male, 49.5% female. In contrast, non-COVID-19 cases during March/April 2020 were 51.8% male, 48.2% female. This represents a significant difference in proportions (p-value on two-sample test of proportions < 0.001).

Charlson comorbidity index profile

For the purpose of the chart below, CCI values over 10 have again been capped at 10.

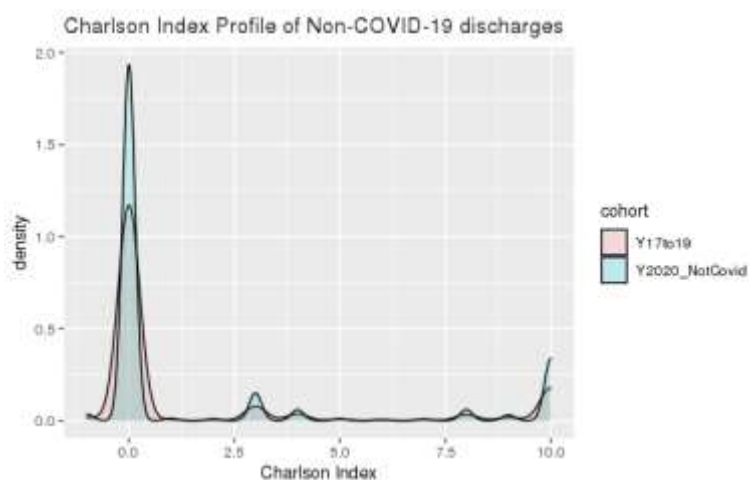


Figure 27 Non-COVID-19 CCI profile

Charlson Comorbidity Index:

Mean score March/April 2020 non COVID-19 cases: 2.7

Mean score 2017-2019: 2.5

Proportion of discharges with CCI greater than zero (at least one comorbidity) is 25.8% for 2020 non-COVID-19 cases compared to 23.8% across March/April 2017-2019.

4.7 Observed and Expected deaths per week: COVID-19 vs non-COVID-19

In earlier sections of this report it is noted that the case-mix of patients discharged during March and April 2020 exhibited a higher mortality risk than the normal case-mix, due to their age profile, co-morbidities and other factors considered by the NQAIS NAHM risk models. In this section the observed deaths are examined, relative to the expected number of deaths that would be predicted by the risk models. It is noted that the risk models are calibrated to 2019 mortality rates, with no adjustment for the pandemic experienced in March/April 2020.

Counts of Actual Deaths and Expected Deaths

The charts below track the 7-day moving average count of deaths per day against the expected number of deaths, separately for COVID-19 and non-COVID-19 patients.

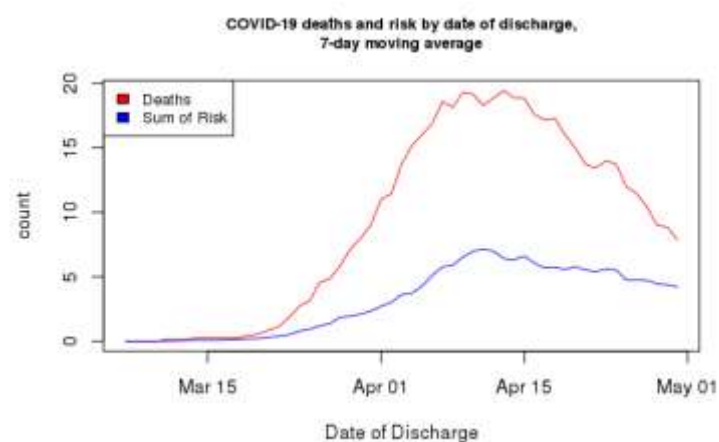


Figure 28 7-day moving average COVID-19 deaths

COVID-19 discharges March/April 2020

Observed mortality was significantly higher than the number of deaths that would be expected for the relevant primary diagnoses.

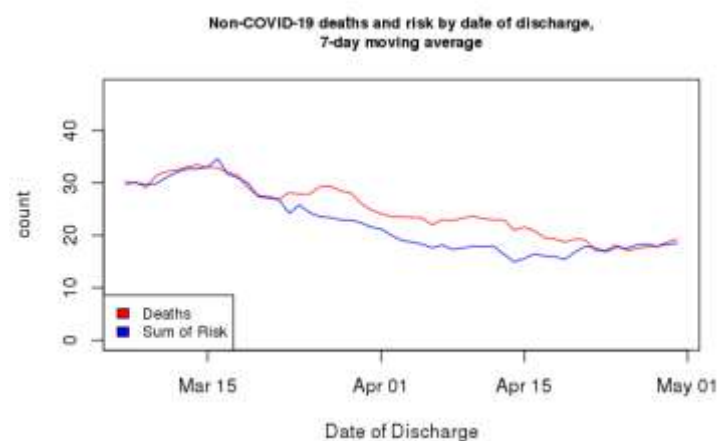


Figure 29 7-day moving average non-COVID-19 deaths

Non COVID-19 discharges March/April 2020

Observed mortality was slightly higher than that expected by NQAIS NAHM risk models.

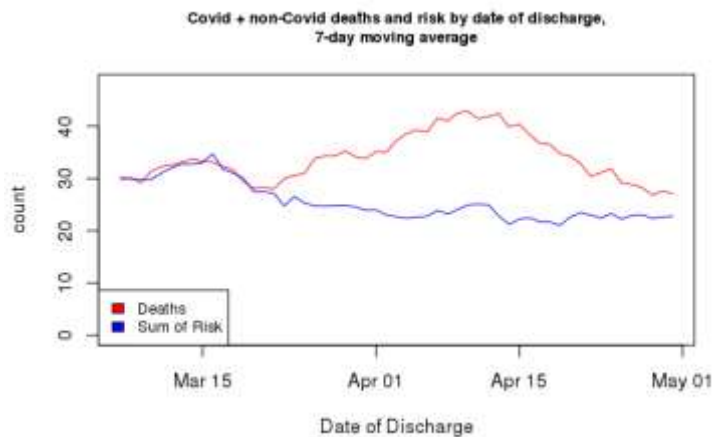


Figure 30 7-day moving average deaths COVID+non-COVID-19

Standardised Mortality Ratio

The Standardised Mortality Ratio (SMR) in a given time period is defined as: $SMR = 100 \times \frac{\text{Observed Deaths}}{\text{Expected Deaths}}$

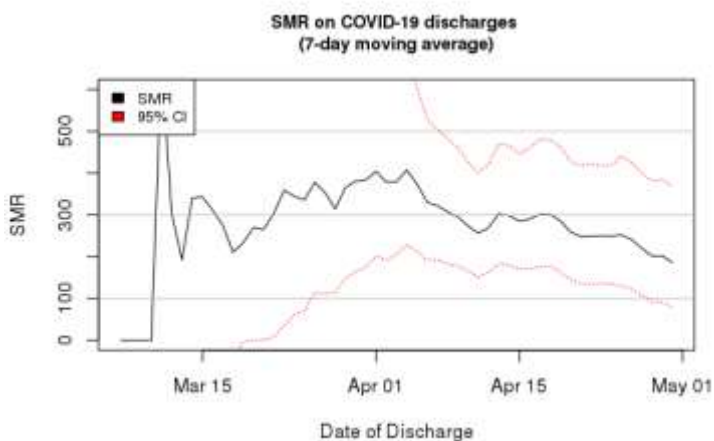


Figure 31 SMR COVID-19 discharges

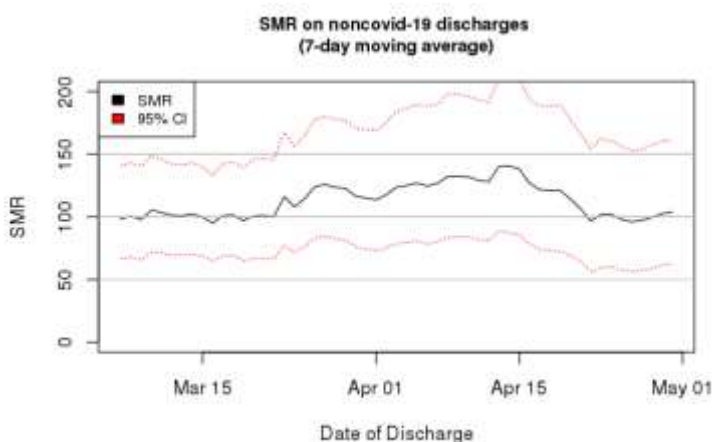


Figure 32 SMR Non-COVID-19 discharges

All discharges

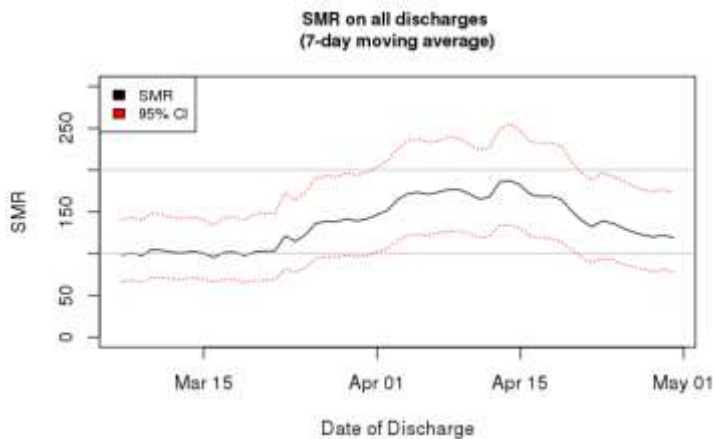
Total observed mortality is significantly higher than expected, the excess driven primarily by the COVID-19 deaths.

COVID-19 SMR March/April 2020

The SMR is above 300 in March and 200-300 in April. The confidence interval is wide in March due to the low number of discharges

Non-COVID-19 SMR March/April 2020

The non-COVID-19 SMR increased to 140 in early April but returned to normal levels in late April.



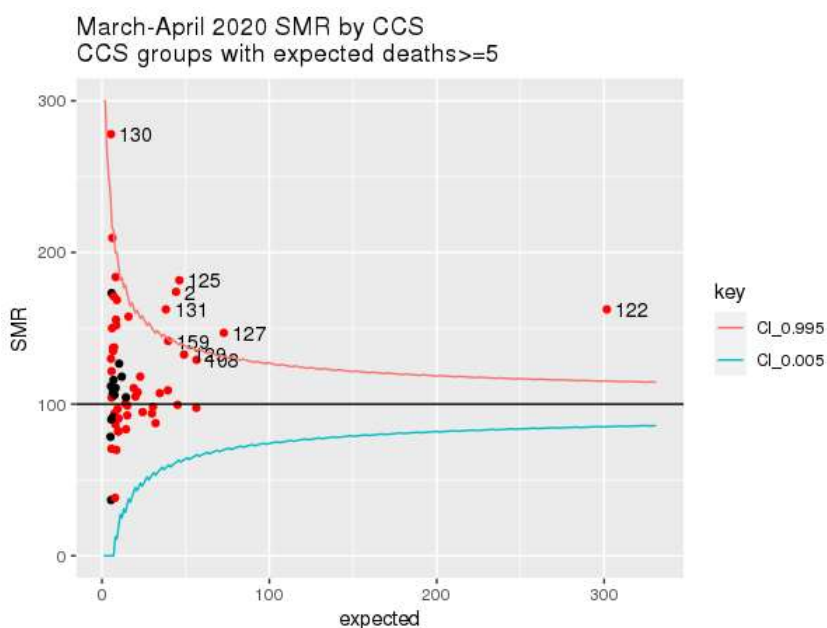
SMR on all discharges March/April 2020

The overall SMR is significantly impacted by COVID-19 deaths across late March and most of April 2020.

Figure 33 SMR All discharges March/April 2020

4.8 CCS codes most impacted

CCS 122 (pneumonia - non TB/STD) is impacted by COVID-19 to a greater extent than other CCS codes. As shown in Table 13, 31% of COVID-19 cases had CCS 122 as the primary diagnosis. The long-run expected mortality risk for patients with pneumonia is high at circa 10%. The SMR on CCS 122 across March/April 2020 was over 150%, and the mortality rate on COVID-19 patients with pneumonia was 29%.



Funnel plot of SMR March/April 2020 by CCS

Point colours indicate whether CCS category experienced COVID-19 deaths

● No COVID-19 deaths in CCS

● One or more COVID-19 deaths

Plot is dominated by CCS 122 (SMR 162) due to high volumes of discharges and high-risk nature of CCS 122, even in normal times.

Figure 34 SMR by CCS

In the plot below, CCS 122 is excluded so that the impact on other CCS categories can be seen. The following CCS categories have experienced very high SMRs across March and April 2020:

- Respiratory codes 125, 127, 129, 130, 131
- Non-respiratory codes 2 (infection: sepsis), 108 (cardiovascular: heart failure), 159 (renal: urinary tract infection).

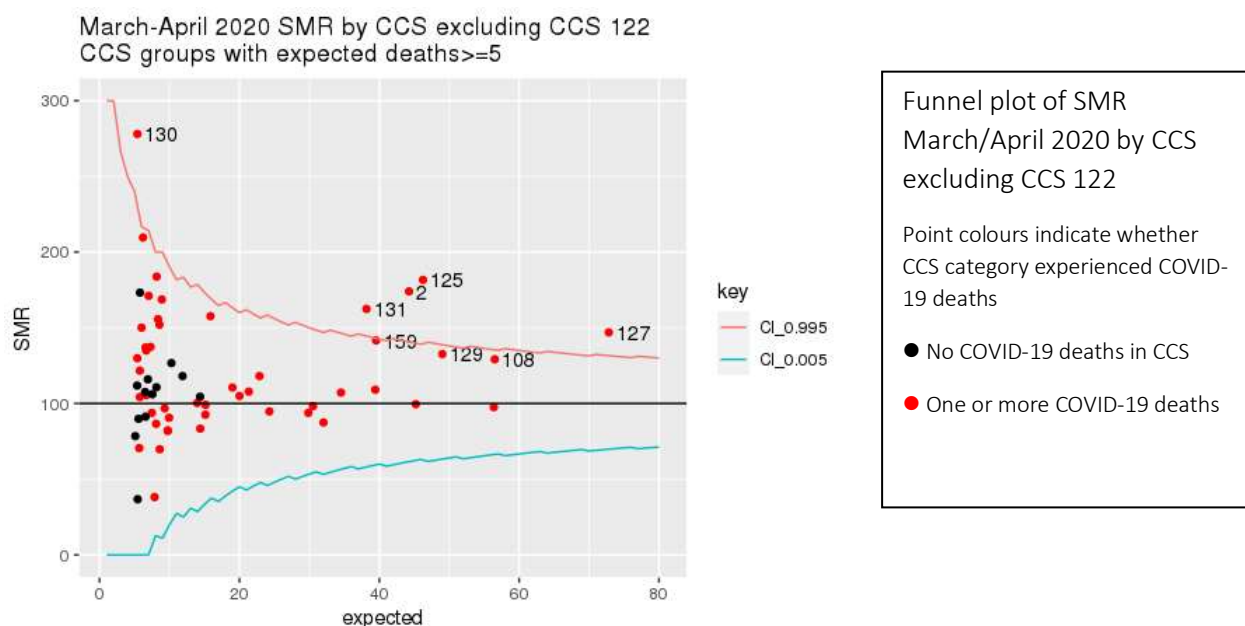


Figure 35 SMR by CCS excluding CCS 122

Performance of NQAIS NAHM risk models on COVID-19 patients

As noted earlier in this report, the risk models remain calibrated to 2019 mortality rates to predict mortality risk on 2020 discharges. This will result in very high SMRs being reported on a number of CCS categories across almost all hospitals. However, in comparing the actual mortality rate on COVID-19 patients against that predicted by the risk models, it is reassuring to note that the pattern of observed mortality increases uniformly by percentile of the expected risk distribution. This indicates that the risk models are still correctly discriminating between lower risk and higher risk admissions, albeit with an underestimation of risk across the entire distribution.

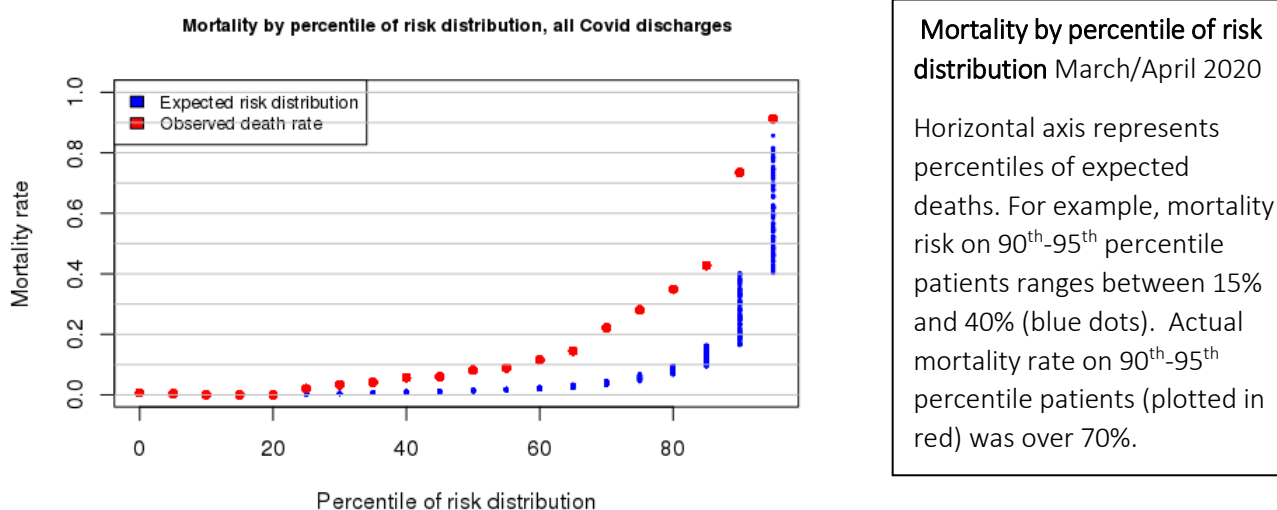


Figure 36 Mortality by percentile of risk distribution, all CCS

The chart below illustrates the pattern of actual deaths, relative to expected, for COVID-19 patients with primary diagnosis CCS 122 (pneumonia - non TB/STD). Other than a slight discrepancy between the 70th and 80th percentiles, the actual mortality rate is broadly increasing by percentile of the expected risk distribution.

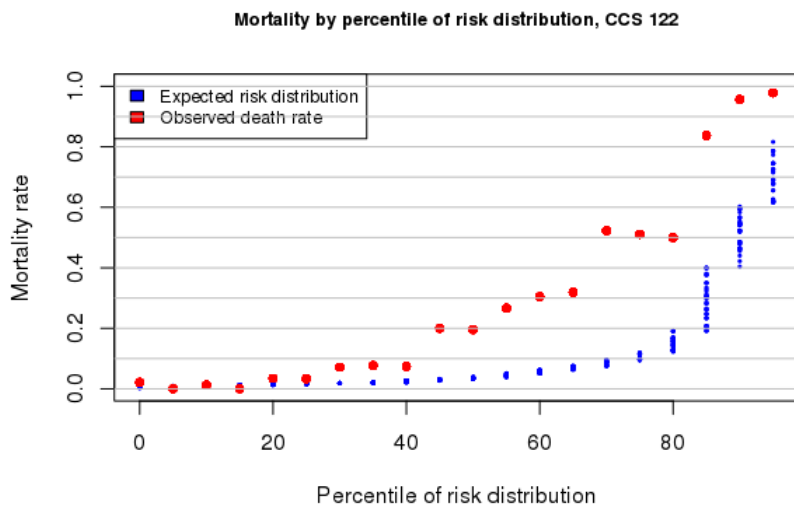


Figure 37 Mortality by percentile of risk distribution, COVID-19: CCS 122

Conclusion

COVID-19 has had a significant impact on in-hospital mortality across March and April 2020, both in terms of the impact of COVID-19 patients and the overall impact on higher SMRs, decreased admissions, more complex case-mix on non-COVID-19 patients.

In terms of the validity of NQAIS NAHM risk models, it is important to note that the models continue to discriminate reasonably well between lower-risk and higher-risk patients, even on COVID-19 patients.

The risk models will generate many more signals than normal on March and April 2020 discharges. In the short-term such signals and alerts should be treated with caution, as they are likely to simply reflect the strain caused by the pandemic on the entire system, rather than areas for improvement in individual hospitals.

5 Appendix 1: HPO guidance

5.1 ICS 22X2: Novel Coronavirus (COVID-19) – Effective from 1st April 2020

Supplementary guidelines for classifying COVID-19 scenarios in admitted patient care* (V1.1)
27.03.20

Presentation scenarios	Laboratory confirmed cases ¹ Tested positive	Clinically diagnosed or probable cases ² Testing is inconclusive, unavailable or not specified	Ruled out cases ³ Tested negative
Patient exhibiting symptoms (Symptoms) = Yes Exposure to confirmed case (Exposure ⁴) = Yes	Principal diagnosis: Symptom(s) or condition(s) Additional diagnoses: B97.2 Coronavirus as the cause of diseases classified to other chapters U07.1 Emergency use of U07.1 [COVID-19, virus identified] ¹	Principal diagnosis: Symptom(s) or condition(s) Additional diagnoses: B97.2 Coronavirus as the cause of diseases classified to other chapters U07.2 Emergency use of U07.2 [COVID-19, virus not identified] ²	Principal diagnosis: Symptom(s) or condition(s) Additional diagnoses: Z20.8 Contact with and exposure to other communicable diseases Z03.8 Observation for other suspected diseases and conditions ⁵ - Or Z03.71 Observation of newborn for suspected infectious condition for neonates U06.0 Emergency use of U06.0 [COVID-19, ruled out] ³
Symptoms = Yes Exposure ⁴ = No	Principal diagnosis: Symptom(s) or condition(s) Additional diagnoses: B97.2 Coronavirus as the cause of diseases classified to other chapters U07.1 Emergency use of U07.1 [COVID-19, virus identified] ¹	Principal diagnosis: Symptom(s) or condition(s) Additional diagnoses: B97.2 Coronavirus as the cause of diseases classified to other chapters U07.2 Emergency use of U07.2 [COVID-19, virus not identified] ²	Principal diagnosis: Symptom(s) or condition(s) Additional diagnoses: Z03.8 Observation for other suspected diseases and conditions ⁵ U06.0 Emergency use of U06.0 [COVID-19, ruled out] ³
Symptoms = No Exposure ⁴ = Yes	Principal diagnosis: B34.2 Coronavirus infection, unspecified site Additional diagnoses: U07.1 Emergency use of U07.1 [COVID-19, virus identified] ¹	Principal diagnosis: B34.2 Coronavirus infection, unspecified site Additional diagnoses: U07.2 Emergency use of U07.2 [COVID-19, virus not identified] ²	Principal diagnosis: Z20.8 Contact with and exposure to other communicable diseases Additional diagnoses: U06.0 Emergency use of U06.0 [COVID-19, ruled out] ³
Pregnancy complicated by COVID-19 / other condition (as per ACS 1521 Conditions and injuries in pregnancy)	Code first: O98.5 Other viral diseases complicating pregnancy, childbirth and the puerperium Additional diagnoses: As per advice above	Code first: O98.5 Other viral diseases complicating pregnancy, childbirth and the puerperium Additional diagnoses: As per advice above	Code first: O98.5 Other viral diseases complicating pregnancy, childbirth and the puerperium Additional diagnoses: As per advice above

6 Appendix 2: Data Extracts

Data sources and extract criteria for the tables and charts in this report

6.1 Tables in report

Table	Data sources	Extract Criteria
Table 1 changes to ICD-10-AM/ACHI/ACS codes	<ul style="list-style-type: none"> ICD 10 AM 10th edition CCS mapping 8th ed changes 20052020.xlsx ccs_mapping_changes.xls 	All ICD-10-AM/ACHI/ACS codes
Table 2 Retired ICD-10-AM/ACHI/ACS Codes	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020)	In-patient discharges 2019 and prior where Dx1 ICD-10-AM/ACHI/ACS code was retired 1 st January 2020.
Table 3 SMR on retired ICD-10-AM/ACHI/ACS codes	Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient discharges 2019 and prior where Dx1 ICD-10-AM code was retired 1 st January 2020.
Table 4 SMR on new ICD-10-AM/ACHI/ACS codes	Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient discharges 2020 where Dx1 ICD-10-AM/ACHI/ACS code is new from 1 st January 2020.
Table 5 CCS mapping change: pre-existing CCS	<ul style="list-style-type: none"> Risk model 30th April 2020 (nahm_risksout_20200619_apr2020) Risk model 31st March 2020 (nahm_risksout_20200527_mar2020) 	In-patient discharges 2017 and prior where mapping from Dx1 ICD-10-AM/ACHI/ACS code has changed to a different but pre-existing CCS category.
Table 6 CCS mapping change: new CCS	<ul style="list-style-type: none"> Risk model 30th April 2020 (nahm_risksout_20200619_apr2020) Risk model 31st March 2020 (nahm_risksout_20200527_mar2020) 	In-patient discharges 2017 and prior where mapping from Dx1 ICD-10-AM/ACHI/ACS code has changed to a newly created CCS category.
Table 7 CCS categories on which risk models fitted	<ul style="list-style-type: none"> Risk model status 30th April 2020 (nahm_statuslist_20200619_apr2020) Risk model status 31st March 2020 (nahm_statuslist_20200527_mar2020) 	All CCS categories.

Table	Data sources	Extract Criteria
Table 8 Discharges of patients with LOS>=90 days	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges with LOS>=90 days between 6 th March and 2 nd April inclusive of each of 2017-2020.
Table 9 Increase in average risk by CCS category	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient admissions, excluding Maternity, admitted 7 th March to 19 th April 2020, vs admissions between 7 th March and 19 th April in prior years.
Table 10 Increase in average emergency risk by CCS category	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient emergency admissions, excluding Maternity, admitted 7 th March to 19 th April 2020, vs admissions between 7 th March and 19 th April in prior years. ADMTYPE 4, 5, 7.
Table 11 Increase in average elective risk by CCS category	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient elective admissions, excluding Maternity, admitted 7 th March to 19 th April 2020, vs admissions between 7 th March and 19 th April in prior years. ADMTYPE 1, 2.
Table 12 COVID-19 cases: CCS group of primary diagnosis	HIPE data at 31 st May 2020 (hipe_casemix_enc)	March/April 2020 in-patient discharges excluding Maternity. Dx2-30 includes either U07.1 or U07.2.
Table 13 COVID-19 cases: CCS category of primary diagnosis	HIPE data at 31 st May 2020 (hipe_casemix_enc)	March/April 2020 in-patient discharges excluding Maternity. Dx2-30 includes either U07.1 or U07.2.
Table 14 Hospital-acquired COVID-19	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to 31 st May 2020. Dx2-30 includes either U07.1 or U07.2.
Table 15 - Hospital acquired, U071	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to 31 st May 2020. Dx2-30 includes U07.1
Table 16 Hospital acquired, U072	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to 31 st May 2020. Dx2-30 includes U07.2

6.2 Charts in report

Chart item	Data sources	Extract Criteria
Figure 1 Discharges by week	HIPE data at 31 st May 2020 (hipe_casemix_enc)	All in-patient discharges 1 st January 2017 to 30 th April 2020. Discharges are grouped by “week” which is calculated as (number of days since 1 st January of relevant year)/7.
Figure 2 Discharges by hospital by week	HIPE data at 31 st May 2020 (hipe_casemix_enc)	All in-patient discharges January to April of each of 2017, 2018, 2019, 2020, by hospital and week.
Figure 3 Discharged to home as % of total discharges	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to home: DISC_CODE 01. Discharges 1 st January 2017 to 30 th April 2020.
Figure 4 Discharged to nursing home as % of total discharges	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to nursing home: DISC_CODE 02. Discharges 1 st January 2017 to 30 th April 2020.
Figure 5 Transfer to acute hospital as % of total discharges	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to acute hospital: DISC_CODE 03, 04. Discharges 1 st January 2017 to 30 th April 2020.
Figure 6 Died in hospital as % of total discharges	HIPE data at 31 st May 2020 (hipe_casemix_enc)	Died in hospital: DISC_CODE 06, 07. Discharges 1 st January 2017 to 30 th April 2020.
Figure 7 Discharged to other destination as % of total discharges	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges to other destination: DISC_CODE 00,05, 08-15. Discharges 1 st January 2017 to 30 th April 2020.
Figure 8 AvLOS by week of discharge	HIPE data at 31 st May 2020 (hipe_casemix_enc)	All in-patient discharges 1 st January 2017 to 30 th April 2020. Discharges are grouped by “week” which is calculated as (number of days since 1 st January of relevant year)/7.
Figure 9 AvLOS by day 2020 discharges	HIPE data at 31 st May 2020 (hipe_casemix_enc)	All in-patient discharges 1 st January 2020 to 30 th April 2020.
Figure 10 Age profile of discharges by LOS	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges between 6 th March 2020 and 2 nd April 2020 inclusive.
Figure 11 Admissions by week	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions admitted January to April and discharged January to May of same year.
Figure 12 Emergency admissions by week	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions with ADMTYPE 4,5,7 admitted January to April and discharged January to May of same year..

Chart item	Data sources	Extract Criteria
Figure 13 Elective admissions by week	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions with ADMTYPE 1,2 admitted January to April and discharged January to May of same year.
Figure 14 Elective admissions by week excluding 2019	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions with ADMTYPE 1,2 admitted January to April and discharged January to May of same year, excluding 2019.
Figure 15 Maternity admissions by week	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions with ADMTYPE 6 admitted January to April and discharged January to May of same year.
Figure 16 Average mortality risk per admission	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient admissions excluding Maternity admitted January to April and discharged January to May of same year. ADMTYPE 1,2, 4, 5, 7.
Figure 17 Average mortality risk: emergency	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient emergency admissions admitted January to April and discharged January to May of same year. ADMTYPE 4, 5, 7.
Figure 18 Average mortality risk: elective	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient emergency admissions admitted January to April and discharged January to May of same year. ADMTYPE 1, 2.
Figure 19 Average	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020)	In-patient admissions excluding Maternity admitted January to April and discharged January to May of same year. ADMTYPE 1,2, 4, 5, 7.
Figure 20 Percentage admissions with non-zero CCI	HIPE data at 30 th April 2020 (hipe_casemix_enc_apr2020)	In-patient admissions excluding Maternity admitted January to April and discharged January to May of same year. ADMTYPE 1,2, 4, 5, 7.
Figure 21 COVID-19 testing rates	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions from 1 st March 2020, discharged on or before 30 th April 2020.
Figure 22 COVID-19 testing rates by hospital	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient admissions from 1 st March 2020, discharged on or before 30 th April 2020.
Figure 23 Age profile of hospital acquired COVID-19	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges March/April 2020 excluding Maternity.

Chart item	Data sources	Extract Criteria
Figure 24 COVID-19 Age profile, Figure 25 COVID-19 CCI profile, Figure 26 Non-COVID-19 age profile, Figure 27 Non-COVID-19 CCI profile	HIPE data at 31 st May 2020 (hipe_casemix_enc)	In-patient discharges March/April 2020 and March/April prior years excluding Maternity.
Figure 28, Figure 29, Figure 30, Figure 31, Figure 32, Figure 33, Figure 34, Figure 35, Figure 36, Figure 37, Error! Reference source not found., Error! Reference source not found.	HIPE data at 31 st May 2020 (hipe_casemix_enc) Risk model 30 th April 2020 (nahm_risksout_20200619_apr2020)	In-patient discharges March and April 2020 excluding Maternity.

National Audit of Hospital Mortality: COVID-19 Impact Assessments

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