NHS
National
Services
Scotland

Hospital onset COVID-19 mortality in Scotland

7 March 2020 to 31 March 2021

26 May 2021

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Contents

Introduction

Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland, part of National Services Scotland, works closely with Public Health Scotland to deliver under the Health Protection Scotland (HPS) COVID-19 response. This third release provides data for COVID-19 hospital onset mortality in Scotland for the period 7 March 2020 to 31 March 2021. A report for period 1 July 2020 to 30 September 2020 was not published due to the small number of COVID-19 cases during this time.

Nosocomial transmission of SARS-CoV-2 contributes significantly to the overall burden of infection within these settings. Deaths occurring in patients with COVID-19 are an important measure of patient outcome. Therefore, monitoring COVID-19 mortality in hospital patients and publishing the data is critical in the development and monitoring of local and national improvement plans to improve patient outcomes, inform the development of infection prevention and control measures, shape policy and guide research. Further information on the epidemiology of COVID-19 in healthcare settings can be found on the Health Protection Scotland website.

A report on COVID-19 hospital onset cases is published weekly and is available from: https://beta.isdscotland.org/find-publications-and-data/population-health/covid-19/hospital-onset-covid-19-cases-in-scotland/

This report describes 28-day all-cause mortality in cases of COVID-19 that were identified during an inpatient stay in an NHS hospital in Scotland, including those cases which are thought to have developed the infection as a result of nosocomial transmission.

Main points

- Different methodologies are employed to measure mortality in cases of COVID-19. This report uses 28-day all-cause mortality in laboratory confirmed cases of COVID-19 rather than deaths where suspected or confirmed COVID-19 is listed on the death certificate. This is aligned with the daily reporting of deaths by Public Health Scotland.
- Overall more than a quarter of patients who were diagnosed with COVID-19 during an inpatient stay died within 28 days of their first positive test for SARS-CoV-2. Nearly a third of patients who developed probable or definite hospital onset COVID-19 died within 28 days.
- The difference in all-cause mortality between the onset categories can largely be explained by differences in the demographics of cases. Cases with probable or definite hospital onset COVID-19 are older than cases diagnosed in the first two days of admission to hospital and are likely to be sicker (co-morbidity data are not included in this report due to the lag in these data being available for the whole time period).
- After adjustment, patients who develop probable or definite hospital onset COVID-19 (day 8 of admission onwards) are at no greater risk of dying than inpatients who likely acquired SARS-CoV-2 prior to that admission and tested positive on day 1 or 2 of admission (non-hospital onset status).
- There is no evidence from these analyses that patients developing nosocomial COVID-19 are at an increased risk of death compared with other patients diagnosed with COVID-19 in hospital.
- After adjustment for the potential confounding effects of when the patient first tested positive during their admission (hospital onset status), age and sex, patients who were first diagnosed with COVID-19 in hospital had lower odds of death within 28 days in wave 2 compared with wave 1.
- Older hospitalised patients are likely to have longer lengths of stay in hospital, increasing their risk of healthcare associated infection including COVID-19. These patients are also more likely to die from other causes and these are not distinguished in all-cause mortality estimates.
- Asymptomatic testing for SARS-CoV-2 has increased since the beginning of the pandemic. This will have increased case ascertainment including those with mild or asymptomatic disease who may have a lower risk of dying from COVID-19. It was not possible to distinguish between symptomatic cases and asymptomatic cases identified by testing policies nor control for this during these analyses.
- Preventing transmission of SARS-CoV-2 is critical to reducing morbidity and mortality from COVID-19, particularly in older hospital patients. Infection prevention

and control precautions and early detection and management of cases is vital in efforts to reduce the spread of SARS-CoV-2 in hospital settings.

Results and commentary

COVID-19 deaths by hospital onset status

A total of 15,209 cases of COVID-19 were diagnosed during an inpatient stay in Scotland between the first case identified in hospitals on the 7 March 2020 and 31 March 2021 which includes 4,677 cases for the period January 2021 to March 2021. The total number of these patients who died within 28 days (all-cause) for the period 7 March 2020 to 31 March 2021 was 4,089 (26.9%) which includes 1,232 deaths in the period January 2021 to March 2021.

Cases of COVID-19 were categorised based on date of first positive SARS-CoV-2 PCR test following admission to a health board. Patients where the first positive sample was taken on day 1 or 2 of admission were considered most likely to have acquired SARS-CoV-2 in the community. For patients where the first positive sample was taken on days 3-7 (indeterminate hospital onset), it is not possible to determine where acquisition was likely to have taken place e.g. in the community or during their hospital stay. Patients where the first positive samples were taken on days 8-14 (probable hospital onset) and days 15+ (definite hospital onset) are likely to have acquired SARS-CoV-2 via nosocomial transmission within the health board.

A total of 1,661 patients with probable or definite hospital onset COVID-19 died within 28 days of their first positive sample (30.8%). Mortality was highest among patients with probable (31.3%) or definite hospital onset COVID-19 (30.5%) (Table 1).

Table 1: COVID-19 case all-cause mortality within 28 days by onset status and reporting period in Scotland overall: specimen dates up to 31 March 2021. [1,2,3]

Hospital onset status	Mar-Dec 2020 Mortality within 28 days (n)	Mar-Dec 2020 Mortality within 28 days (%)	Mar-Dec 2020 Total Cases	Jan-Mar 2021 Mortality within 28 days (n)	Jan-Mar 2021 Mortality within 28 days (%)	Jan-Mar 2021 Total Cases	Total Mortality within 28 days (n)	Total Mortality within 28 days (%)	Total Cases
Non-hospital onset (day 1 or 2 of admission)	1,597	25.1%	6,350	496	22.6%	2,194	2,093	24.5%	8,544
Indeterminate hospital onset (days 3-7)	215	27.1%	793	120	25.3%	475	335	26.4%	1,268
Probable hospital onset (days 8-14)	295	29.5%	1,000	229	34.1%	672	524	31.3%	1,672
Definite hospital onset (days 15+)	750	31.4%	2,389	387	29.0%	1,336	1,137	30.5%	3,725
Scotland	**2,857**	**27.1%**	**10,532**	**1,232**	**26.3%**	**4,677**	**4,089**	**26.9%**	**15,209**

1. Source of data is Electronic Communication of Surveillance in Scotland (ECOSS) data, the Rapid Admission Preliminary Inpatient Data (RAPID) data or local admission data, and National Records of Scotland (NRS).
2. The data used has not been adjusted for potential factors that may affect mortality e.g. severity of COVID-19 disease and patient comorbidities.
3. Cases diagnosed in the community (not during an inpatient stay) were excluded from these analyses.

A logistic regression model was developed to adjust for potential confounding between the onset categories (Appendix 3a). The model included all cases of COVID-19 identified during the hospital stay and the comparator group was selected as those cases thought most likely to have acquired the infection in the community (day 1 or 2 of admission). The pandemic wave was included as survival may have improved as knowledge of the course of the infection improved, or the severity of disease reduced over time. Cases and deaths included in each pandemic wave (wave 1: specimen date ≤26/07/2020; wave 2: specimen date >26/07/2020) are shown in Table 2. After adjustment for the confounding effects of age, sex and pandemic wave, there was no significant difference between all-cause mortality in cases of indeterminate, probable and definite hospital onset COVID-19 compared with patients diagnosed with COVID-19 during the first 2 days of their admission to the health board (where the inpatient most likely acquired the virus in the community). Age, sex and pandemic wave were all significantly associated with 28-day all-cause mortality. The model results are presented in Appendix 3a. All-cause mortality decreased from wave 1 to wave 2, after adjustment for case mix (age and sex) including the distribution of hospital onset cases. The reasons for this will be multifactorial and not intended to be explained by this model.

Table 2: COVID-19 case all-cause mortality within 28 days by onset status and pandemic wave in Scotland overall: specimen dates up to 31 March 2021. [1,2,3]

Hospital onset status	Wave 1 Mortality within 28 days (n)	Wave 1 Mortality within 28 days (%)	Wave 1 Total Cases	Wave 2 Mortality within 28 days (n)	Wave 2 Mortality within 28 days (%)	Wave 2 Total Cases	Total Mortality within 28 days (n)	Total Mortality within 28 days (%)	Total Cases
Non-hospital onset (day 1 or 2 of admission)	947	26.8%	3,536	1,146	22.9%	5,008	2,093	24.5%	8,544
Indeterminate hospital onset (days 3-7)	74	24.2%	306	261	27.1%	962	335	26.4%	1,268
Probable hospital onset (days 8-14)	99	35.7%	277	425	30.5%	1,395	524	31.3%	1,672
Definite hospital onset (days 15+)	342	31.7%	1,078	795	30.0%	2,647	1,137	30.5%	3,725
Scotland	**1,462**	**28.1%**	**5,197**	**2,627**	**26.2%**	**10,012**	**4,089**	**26.9%**	**15,209**

1. Source of data is Electronic Communication of Surveillance in Scotland (ECOSS) data, the Rapid Admission Preliminary Inpatient Data (RAPID) data or local admission data, and National Records of Scotland (NRS).
2. The data used has not been adjusted for potential factors that may affect mortality e.g. severity of COVID-19 disease and patient comorbidities.
3. Cases diagnosed in the community (not during an inpatient stay) were excluded from these analyses.

During the second wave, there was a second surge in cases at the end of December that continued into January and February. During this time, variant of concern VOC-20DEC-01 (also known as B.1.1.7) became the dominant strain circulating in Scotland. There are some early indications of increased disease severity in people infected with this variant of concern compared to people with non-VOC virus variants.[1] This change in the dominant strain, and in any future shifts in dominant strains with changes to severity of disease, has implications for mortality outcome analyses and should be considered. To account for the possible effects of the changing epidemiology starting in late December including a change in the dominant strain, the time period for wave 2 was split in a second logistic regression model at week ending 27th December (Appendix 3b). The inclusion of the two time periods for wave 2 did not change the results from the comparison of all-cause mortality in the hospital onset categories. In addition, there was no significant difference between all-cause mortality in the two wave 2 time periods. Consideration for the effects of changing dominant strains may be required in future mortality analyses.

The distribution of 28-day all-cause mortality by age and sex for each of the hospital onset categories is described in Table 3. The highest all-cause mortality was reported in male patients and in older age groups, where risk of death increased with increasing age. This is in line with the outputs from the logistic regression model. These data are unadjusted for underlying co-morbidity and other risk factors and therefore should be interpreted with due caution. The median age of patients who died following a probable or definite hospital onset COVID-19 diagnosis (79 years) was significantly higher than those patients with likely community acquisition (day 1 or 2 of admission) (71 years, unadjusted $p<0.001$).

There are some limitations and caveats to these modelling analyses that must be considered in the interpretation. Age, sex and pandemic wave are currently the only risk factors with comprehensive data available and further modelling to adjust for other risk factors such as underlying co-morbidities will be undertaken in future analyses. Cases who are in the probable and definite hospital onset category have a longer length of stay prior to developing COVID-19. This is indicative of underlying medical conditions which will be a risk factor for mortality and some of these patients may have died irrespective of COVID-19. Similarly, it is not known if some of the patients in the non-hospital onset category (day 1 or 2 of admission) were emergency admissions due to a severe COVID-19 infection which has implications for the comparison with the probable and definite hospital onset mortality. This group may also include patients who were readmitted following a prior stay in hospital where acquisition could have occurred rather than in the community. Further characterisation of this group is underway to describe patients readmitted to hospital after a recent discharge. Additionally, asymptomatic testing for SARS-CoV-2 has increased since the beginning of the pandemic. This will have increased case ascertainment including those with mild or asymptomatic disease who may have a lower risk of dying from COVID-19. This may affect comparisons in all-cause mortality across all onset groups and in particular the day 1 or 2 onset cases due to increased admission testing (though serial asymptomatic testing has been in place in some areas). It was not possible to distinguish between symptomatic cases and asymptomatic cases identified by testing policies and control for this during these analyses.

Table 3: COVID-19 case all-cause mortality within 28 days, by onset status, age group and sex: specimen dates up to 31 March 2021. [1,2,3,4]

Age Group / Hospital onset status	Female mortality (n)	Female cases (n)	Female mortality (%)	Male mortality (n)	Male cases (n)	Male mortality (%)	Total mortality (n)	Total cases (n)	Total mortality (%)
0-24	**3**	**224**	**1.3%**	**0**	**196**	**0.0%**	**3**	**420**	**0.7%**
Non-Hospital Onset	3	183	**1.6%**	0	163	**0.0%**	3	346	**0.9%**
Indeterminate Hospital Onset	0	15	**0.0%**	0	12	**0.0%**	0	27	**0.0%**
Probable Hospital Onset	0	4	**0.0%**	0	4	**0.0%**	0	8	**0.0%**
Definite Hospital Onset	0	22	**0.0%**	0	17	**0.0%**	0	39	**0.0%**
25-44	**12**	**451**	**2.7%**	**18**	**448**	**4.0%**	**30**	**899**	**3.3%**
Non-Hospital Onset	7	346	**2.0%**	11	352	**3.1%**	18	698	**2.6%**
Indeterminate Hospital Onset	1	40	**2.5%**	3	33	**9.1%**	4	73	**5.5%**
Probable Hospital Onset	1	24	**4.2%**	2	18	**11.1%**	3	42	**7.1%**
Definite Hospital Onset	3	41	**7.3%**	2	45	**4.4%**	5	86	**5.8%**
45-64	**176**	**1,385**	**12.7%**	**261**	**1,761**	**14.8%**	**437**	**3,146**	**13.9%**
Non-Hospital Onset	103	960	**10.7%**	170	1,249	**13.6%**	273	2,209	**12.4%**
Indeterminate Hospital Onset	18	106	**17.0%**	14	120	**11.7%**	32	226	**14.2%**
Probable Hospital Onset	20	96	**20.8%**	28	142	**19.7%**	48	238	**20.2%**
Definite Hospital Onset	35	223	**15.7%**	49	250	**19.6%**	84	473	**17.8%**
65-74	**313**	**1,330**	**23.5%**	**507**	**1,764**	**28.7%**	**820**	**3,094**	**26.5%**
Non-Hospital Onset	180	756	**23.8%**	306	1,043	**29.3%**	486	1,799	**27.0%**
Indeterminate Hospital Onset	19	102	**18.6%**	35	148	**23.6%**	54	250	**21.6%**
Probable Hospital Onset	31	150	**20.7%**	54	170	**31.8%**	85	320	**26.6%**
Definite Hospital Onset	83	322	**25.8%**	112	403	**27.8%**	195	725	**26.9%**
75-84	**597**	**2,084**	**28.6%**	**881**	**2,200**	**40.0%**	**1,478**	**4,284**	**34.5%**
Non-Hospital Onset	294	1,001	**29.4%**	457	1,143	**40.0%**	751	2,144	**35.0%**
Indeterminate Hospital Onset	47	177	**26.6%**	68	197	**34.5%**	115	374	**30.7%**
Probable Hospital Onset	77	273	**28.2%**	111	274	**40.5%**	188	547	**34.4%**
Definite Hospital Onset	179	633	**28.3%**	245	586	**41.8%**	424	1,219	**34.8%**
85+	**650**	**1,961**	**33.1%**	**671**	**1,404**	**47.8%**	**1,321**	**3,365**	**39.3%**
Non-Hospital Onset	273	751	**36.4%**	289	596	**48.5%**	562	1,347	**41.7%**
Indeterminate Hospital Onset	71	191	**37.2%**	59	127	**46.5%**	130	318	**40.9%**
Probable Hospital Onset	103	312	**33.0%**	97	205	**47.3%**	200	517	**38.7%**
Definite Hospital Onset	203	707	**28.7%**	226	476	**47.5%**	429	1,183	**36.3%**
Grand Total	**1,751**	**7,435**	**23.6%**	**2,338**	**7,773**	**30.1%**	**4,089**	**15,208**	**26.9%**

1. Source of data is Electronic Communication of Surveillance in Scotland (ECOSS) data, the Rapid Admission Preliminary Inpatient Data (RAPID) data or local admission data, and National Records of Scotland (NRS).
2. The data used has not been adjusted for potential factors that may affect mortality e.g. severity of COVID-19 disease and patient comorbidities.
3. Cases diagnosed in the community (not during an inpatient stay) were excluded from these analyses.
4. One Non-Hospital onset case excluded due to unknown age.

Comparison with other mortality data in Scotland

Nearly a third of cases of hospital onset COVID-19 (probable and definite) died within 28 days of the first positive specimen (30.8%). Cases who are in the probable and definite category have, by the design of the case definition, a longer length of stay prior to developing COVID-19. This is indicative of underlying medical condition which will also be a risk factor for mortality and some of these patients may have died irrespective of COVID-19. It is not possible to quantify this with the data currently available and comparison with other published mortality data is difficult due to the different ways in which the deaths are defined and the populations in which they are reported.

All-cause mortality data is available for other infection types commonly associated with nosocomial infection. In 2018, nearly a fifth of cases (18.2%) of *Staphylococcus aureus* bacteraemia; 10.9% of *Clostridioides difficile* cases aged 15 years and older; and 13.7% of cases of *Escherichia coli* bacteraemia had died within 30 days of their diagnosis.[2] These mortality estimates are not directly comparable as the population of cases will include hospitalised and non-hospitalised cases and the duration of follow up differs (i.e. 28-day vs 30-day all-cause mortality).

The COVID-19 analyses are restricted to hospitalised patients and it would be anticipated that these patients are sicker and require hospital care. Crude mortality rates in Scotland, used in the calculation of hospital standardised mortality ratios, for January to December 2020 indicate that 4.6% and 10.4% of patients aged 60-79 years and 80+ years, respectively die within 30 days of an admission to hospital.[3] A UK study of mortality in nosocomial COVID-19 in older people reported that 27.0% of cases of nosocomial COVID-19 (diagnosed 15 or more days after admission) had died within seven days.[4] After adjustment, nosocomial mortality was reduced compared with community acquired COVID-19 in hospitalised patients.

Any comparisons between differing mortality measures must be treated with caution. All-cause mortality includes deaths where COVID-19 may not have been either the underlying or contributory cause of death. In addition, deaths due to COVID-19 infection of long duration will be underestimated in 28-day all-cause mortality e.g. cases who have died more than 28 days after their first positive sample would not be included using 28-day all-cause mortality. All-cause mortality is not subject to the same biases as death certification that are introduced as a result of subjectivity or changes in the way deaths were registered during the early stages of the pandemic. In addition, death certification includes cases of presumed COVID-19 without a positive SARS-CoV-2 test and these are not included in 28-day all-cause mortality measure.

Implications for improved outcomes and infection prevention

As SARS-CoV-2 is a new and emerging pathogen, new international evidence around effective treatments, diagnostics, and prevention and control are being published at a rapid pace. Within Scotland and across the UK there are a number of organisations reviewing the evidence, contributing to the research and ensuring that key measures are reflected in the COVID-19 national response guidance.

As 28-day all-cause mortality is no different in patients admitted to hospital with likely community acquisition to those who develop nosocomial COVID-19 (probable or definite hospital onset), preventing transmission of SARS-CoV-2 in all settings is critical to reducing morbidity and mortality from COVID-19. Further work relating to the specialty or setting where these cases are being cared for will be included in future analyses These will be essential for developing local and national focused improvement plans.

A continued focus on the broader public health interventions along with the application of infection prevention and control precautions in line with current guidance will reduce the risk of transmission. In healthcare settings, early detection and appropriate management through testing of symptomatic patients and screening of asymptomatic patients with early identification of any contacts, particularly when there is an unexpected case or outbreak, is vital in efforts to reduce the spread of SARS-CoV-2 in these settings.

References

(1) NERVTAG update. 2021 [cited 2021 Feb 17];Available from: URL: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/961042/S1095_NERVTAG_update_note_on_B.1.1.7_severity_20210211.pdf

(2) Antimicrobial Resistance and Healthcare Associated Infection Scotland. Healthcare Associated Infections. 2019 Annual report. ARHAI Scotland 2020 [cited 2021 Feb 9];Available from: URL: https://www.hps.scot.nhs.uk/web-resources-container/healthcare-associated-infection-annual-report-2019/

(3) Public Health Scotland. Hospital Standardised Mortality Ratios. PHS 2021 February 9 [cited 2021 Feb 9];Available from: URL: https://beta.isdscotland.org/find-publications-and-data/health-services/hospital-care/hospital-standardised-mortality-ratios/

(4) Carter B, Collins JT, Barlow-Pay F, Rickard F, Bruce E, Verduri A, et al. Nosocomial COVID-19 infection: examining the risk of mortality. The COPE-Nosocomial Study (COVID in Older PEople). J Hosp Infect 2020 Oct;106(2):376-84.

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Further information

Further Information can be found on the HPS website.

For more information on types of infections included in this report, please see the COVID-19 pages on the HPS website.

The next release of this publication will be subject to additional cases in the intervening period.

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Appendices

Appendix 1 – Publication metadata

Metadata indicator	Description
Publication title	Hospital onset COVID-19 mortality in Scotland
Description	This release provides information on hospital onset COVID-19 mortality, there is a need for consistent reporting using standardised case definitions.
Theme	Infections in Scotland
Topic	COVID-19
Format	Word document
Data source(s)	**COVID-19 Cases:** **Case data source:** Electronic Communication of Surveillance in Scotland (ECOSS) **Admissions data Source:** Rapid Admission Preliminary Inpatient Data (RAPID) or Local Patient Admissions Systems **Mortality data source:** National Records of Scotland (NRS)
Date that data are acquired	29 April 2021
Release date	26 May 2021
Frequency	Quarterly (subject to additional cases in the intervening period).
Timeframe of data and timeliness	Timeframe of this publication was decided by first positive sample in Scotland which fell into anyone of the hospital onset categories (i.e. 7 March 2020) The latest iteration of data is 31 March 2021, therefore the data are 7 or 8 weeks in arrears. No report was produced in November 2020 to allow sufficient data to accumulate for information governance needs and analysis to be done since the period of the last published report (March-June 2020).
Continuity of data	Subject to additional cases in the intervening period.
Revisions statement	These data are not subject to planned major revisions. However, ARHAI Scotland aims to continually improve the interpretation of the data and therefore analysis methods are regularly reviewed and may be updated in the future.

<table>
<tr>
<td>Revisions relevant to this publication</td>
<td>Hospital onset data are continually validated by NHS boards, NRS and within the ECOSS laboratory database. Any changes to cases taken within hospital settings, which are validated by NHS boards, are tracked by ARHAI Scotland. Changes to retrospective mortality data for the hospital onset groups are outlined in the table below if applicable.
<table>
<tr><th>Hospital onset mortality as previously reported (24 February 2021)</th><th>Hospital onset mortality as currently reported</th><th>Reason</th></tr>
<tr><td>1,556 non-hospital onset, 211 indeterminate hospital onset, 285 probable hospital onset, and 730 definite hospital onset with mortality identified for time period March-December 2020</td><td>1,597 non-hospital onset, 215 indeterminate hospital onset, 295 probable hospital onset, and 750 definite hospital onset with mortality identified for time period March-December 2020</td><td>Changes to the hospital onset status of COVID-19 cases (see revisions included in the weekly Hospital Onset COVID-19 report for full details), impacts whether cases, and therefore any deaths associated with these cases, are included in this report. In addition, on March 3, 2021, PHS adopted an improved method for linking daily confirmed COVID-19 cases with deaths reported through the National Records of Scotland.</td></tr>
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<tr>
<td>Concepts and definitions</td>
<td>The transmission of COVID-19 is thought to occur mainly through respiratory droplets and through contact with contaminated surfaces. Further information on the epidemiology of COVID-19 in healthcare settings can be found on the Health Protection Scotland website. As sustained community transmission has occurred as the pandemic has progressed, it has become more challenging to identify true cases of hospital transmission.

A system for monitoring COVID-19 is critical to tracking nosocomial transmission in healthcare settings to inform infection, prevention and control measures.

Deaths occurring in patients with COVID-19 are an important measure of patient outcome. Therefore, monitoring COVID-19 mortality in hospital patients and publishing the data is critical to improve care of patients, inform the development of infection prevention and control measures, shape policy and guide research.

The data provided are national data for Scotland representing the 14 NHS boards and one NHS special health board.

The agreed nosocomial case definition for the UK is based on the number of days since admission to an NHS health board to the date of specimen sampling for a positive SARS-CoV-2 RT-PCR test. Time since admission to specimen sampling is categorised as:
community onset (first positive specimen taken in the community)
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- non-hospital onset (first positive specimen on day 1 or 2 of admission to NHS board);
- indeterminate (first positive specimen on days 3 to 7 of admission to NHS board);
- probable (first positive specimen on days 8 to 14 of admission to NHS board); and
- definite hospital onset (first positive specimen date was 15 or more days after admission to NHS board).

Note that for the purposes of this report, cases diagnosed in the community (not during an inpatient stay) were excluded from these analyses to restrict the comparisons within the hospitalised patient population.

These definitions are necessary due to the maximum incubation period of 14 days for COVID-19 (see table below):

Day of sampling post admission	Nosocomial categorisation
Before admission	Community onset COVID-19 (not included in this report)
Day 1 of admission/on **admission to NHS board**	Non-hospital onset COVID-19
Day 2 of admission	Non-hospital onset COVID-19
Day 3 of admission	Indeterminate hospital onset COVID-19
Day 4 of admission	Indeterminate hospital onset COVID-19
Day 5 of admission	Indeterminate hospital onset COVID-19
Day 6 of admission	Indeterminate hospital onset COVID-19
Day 7 of admission	Indeterminate hospital onset COVID-19
Day 8 of admission	Probable hospital onset COVID-19
Day 9 of admission	Probable hospital onset COVID-19
Day 10 of admission	Probable hospital onset COVID-19
Day 11 of admission	Probable hospital onset COVID-19
Day 12 of admission	Probable hospital onset COVID-19
Day 13 of admission	Probable hospital onset COVID-19
Day 14 of admission	Probable hospital onset COVID-19
Day 15 of admission and onwards to discharge	Definite hospital onset COVID-19
Post discharge	Community onset COVID-19 (not included in this report)

The hospital onset cases in this report represent cases presenting in hospital and do not include COVID-19 associated with hospital care that present on readmission to hospital or post-discharge.

Start point of duration

Admission to health board was agreed as the appropriate point to start counting the duration of hospital stay to first positive specimen date, rather than the date of admission to a single hospital, since patients can be transferred between hospitals which would lead to restarting the clock to 'day 1' each time and therefore underestimating the number of nosocomial infections.

Any discharges and re-admissions which occur within the same calendar day will be classed as a continuous stay; the clock will not be restarted in these instances, only when a readmission occurs on the second day or more after any discharge.

For definite, probable, indeterminate and non-hospital onset (day 1 or 2 of in-patient stay), the NHS board reported is where the first sample was taken, established either using Rapid Admission Preliminary Inpatient Data (RAPID) data and validated by the boards, or using individual NHS board's internal admissions systems. Since the definition of hospital-onset COVID-19 was determined using date of admission to NHS board, the board assigned may not represent the board of attribution of hospital-onset COVID-19 infection (Table above).

Minimum data required for hospital onset COVID-19 cases to be validated:

- CHI number
- Date of positive SARS-CoV-2 RT-PCR test
- Date of admission to health board when patient tested positive for COVID-19
- NHS board where first positive test undertaken

Mortality definition

In this report, all-cause mortality within 28 days of the COVID-19 diagnosis (laboratory specimen date) is used. Therefore, the data includes deaths where COVID-19 may not have been either the underlying or contributory cause of death. All-cause mortality depends solely on the number of deaths identified, and is not subject to bias that may be introduced as a result of inaccuracies in completion of the death certificate or coding of the cause of death. Using 28-days as the time period makes the assumption that most deaths related to COVID-19 will occur within this timeframe. Deaths occurring after this time period are more difficult to assess as being specifically related to COVID-19, though they are known to occur. Therefore, care should be taken when interpreting this data and when comparing published data on COVID-19 mortality that use different definitions.

Wave 1 / Wave 2 definition

The 26th of July was chosen as an arbitrary cut-off signifying the end of Wave 1 in Scotland, since cases of Hospital onset COVID-19 were at their lowest point over the course of the pandemic. Data from the 27th July onwards are considered Wave 2. Wave 2 was further split into wave 2a and wave 2b at the point when there was a second surge in cases in the second wave. These are (>26/07/20 & ≤27/12/20) and (>27/12/20) respectively.

Relevance and key uses of the statistics	Surveillance data are essential for monitoring trends and assisting in outbreak investigations and to understand the extent of ongoing transmission within the hospital setting. HPS offers support to NHS boards across Scotland to aid their local COVID-19 prevention strategies.
Accuracy	It is acknowledged that patients can be transferred between NHS health boards and if transferred into a different health board during the same hospital stay, then the clock would be restarted to 'day 1' which could lead to an underestimation of cases. However, the decision to restrict start date to admission to a single NHS health board represents the requirement to report at the health board-level. Any discharges and re-admissions which occur within the same calendar day will be overlooked - the clock will not be restarted in these instances, only when a readmission occurs on the second or more day after any discharge. COVID-19 cases identified after discharge from hospital but within 14 days may be associated with the hospital. These cases, including those identified on readmission to hospital, are not included as hospital onset. This may result in under-reporting of COVID-19 cases associated with hospital care. All-cause mortality depends solely on the number of deaths identified, and is not subject to bias that may be introduced as a result of inaccuracies in completion of the death certificate or coding of the cause of death.
Completeness	Surveillance data are collected using the ECOSS system that allows data collectors in NHS boards to validate ECOSS records as well as identifying additional cases that may not be included in the Electronic Communications of Surveillance in Scotland (ECOSS) system. This therefore means that completeness is near to 100%. For mortality data, sufficient time is allowed for all cases to be followed up for 28 days. Some delays in reporting of death may occur but this will be minimal and completeness is near to 100%.
Comparability	The agreed nosocomial case definition for the UK has been adopted to allow comparison across the four nations. However, geographical differences for example NHS board versus NHS Trust have to be considered. The case numbers presented here are only for those COVID-19 cases who are positive as inpatients with an admission to an NHS hospital, i.e. community cases are excluded. Additionally, the end dates are different to that of the weekly report (i.e. week end 4th April 2021 vs. 31st March 2021). The data are therefore not wholly comparable with the weekly reporting of hospital onset cases. https://beta.isdscotland.org/find-publications-and-data/population-health/covid-19/hospital-onset-covid-19-cases-in-scotland/ Deaths within this report are taken from the same data source used by Public Health Scotland (PHS) in their daily reported deaths, therefore comparisons are possible between these two sources. However, it should be noted that this report includes data until 31st March 2021 using COVID-19 specimen date, with deaths followed-up until 28th April (28 days later), whereas Publish Health Scotland report using date of death. Therefore, comparisons between each surveillance system should be treated with caution.
Accessibility	It is the policy of HPS to make its web sites and products accessible according to published guidelines.
Coherence and clarity	Tables and charts are accessible via the HPS website at: **https://www.hps.scot.nhs.uk/a-to-z-of-topics/covid-19/hospital-onset-covid-19-cases-in-scotland/**

Value type and unit of measurement	At national level, the number and proportion of COVID-19 cases who died within 28-days (all-cause) of a COVID-19 diagnosis are classed as definite hospital onset, probable hospital onset, indeterminate hospital onset, and non-hospital onset. The data are further broken down by age group and sex. For adjusting the data to account for confounding, pandemic wave is also included in combination with age group, sex and hospital onset status.
Disclosure	The HPS protocol on Statistical Disclosure Control Protocol is followed.
Official Statistics designation	Management Information
UK Statistics Authority Assessment	Not assessed
Last published	24 February 2021
Next published	Subject to additional cases in the intervening period
Date of first publication	26 August 2020
Help email	**nss.hpshaiic@nhs.scot**
Date form completed	26 May 2021

Appendix 2 – Early access details

Pre-Release Access

Under terms of the "Pre-Release Access to Official Statistics (Scotland) Order 2008", ARHAI Scotland is obliged to publish information on those receiving Pre-Release Access ("Pre-Release Access" refers to statistics in their final form prior to publication). The standard maximum Pre-Release Access is five working days. Shown below are details of those receiving standard Pre-Release Access.

Standard Pre-Release Access:

Scottish Government Health Department

NHS board Chief Executives

NHS board Communication leads

Appendix 3a – Model results for adjusted hospital onset COVID-19 mortality (all-cause at 28 days) – wave 1 (≤26/07/2020) and wave 2 (>26/07/2020).

Univariable and multivariable logistic regression results on 28-day all-cause mortality outcome of COVID-19 cases.[1,2]

Variable		Alive within 28 days (%)	Mortality within 28 days (%)	OR[3] (univariable)	OR[3] (multivariable)
Sex	F	5684 (76.4)	1751 (23.6)	-	-
	M	5435 (69.9)	2338 (30.1)	1.40 (1.30-1.50, p<0.001)	1.55 (1.44-1.67, p<0.001)
Age group (years)	0-49	1680 (95.8)	73 (4.2)	-	-
	50-59	1441 (87.9)	199 (12.1)	3.18 (2.42-4.22, p<0.001)	3.06 (2.33-4.06, p<0.001)
	60-69	1805 (78.6)	490 (21.4)	6.25 (4.87-8.12, p<0.001)	6.01 (4.68-7.81, p<0.001)
	70-79	2717 (69.8)	1174 (30.2)	9.94 (7.85-12.80, p<0.001)	9.82 (7.74-12.64, p<0.001)
	80+	3476 (61.8)	2153 (38.2)	14.25 (11.29-18.28, p<0.001)	14.68 (11.61-18.86, p<0.001)
Hospital onset status	Non-hospital onset	6450 (75.5)	2093 (24.5)	-	-
	Indeterminate hospital onset	933 (73.6)	335 (26.4)	1.11 (0.97-1.26, p=0.139)	0.95 (0.83-1.09, p=0.482)
	Probable hospital onset	1148 (68.7)	524 (31.3)	1.41 (1.25-1.58, p<0.001)	1.08 (0.96-1.22, p=0.186)
	Definite hospital onset	2588 (69.5)	1137 (30.5)	1.35 (1.24-1.47, p<0.001)	1.02 (0.93-1.12, p=0.686)
Pandemic wave	Wave 1 (≤26/07/20)	3735 (71.9)	1462 (28.1)	-	-
	Wave 2 (>26/07/20)	7384 (73.8)	2627 (26.2)	0.91 (0.84-0.98, p=0.013)	0.86 (0.80-0.93, p<0.001)

[1] Note that for the purposes of this report, cases diagnosed in the community (not during an inpatient stay) were excluded from these analyses to restrict the comparisons within the hospitalised patient population.

[2] One Non-Hospital onset case excluded due to unknown age.

[3] OR = Odds ratio.

Appendix 3b – Model results for adjusted hospital onset COVID-19 mortality (all-cause at 28 days) – wave 1 (≤26/07/2020), wave 2a (>26/07/2020 & ≤27/12/2020) and wave 2b (>27/12/2020).

Univariable and multivariable logistic regression results on 28-day all-cause mortality outcome of COVID-19 cases.[1,2]

Variable		Alive within 28 days (%)	Mortality within 28 days (%)	OR[3] (univariable)	OR[3] (multivariable)
Sex	F	5684 (76.4)	1751 (23.6)	-	-
	M	5435 (69.9)	2338 (30.1)	1.40 (1.30-1.50, p<0.001)	1.56 (1.44-1.68, p<0.001)
Age group (years)	0-49	1680 (95.8)	73 (4.2)	-	-
	50-59	1441 (87.9)	199 (12.1)	3.18 (2.42-4.22, p<0.001)	3.06 (2.33-4.07, p<0.001)
	60-69	1805 (78.6)	490 (21.4)	6.25 (4.87-8.12, p<0.001)	6.02 (4.69-7.82, p<0.001)
	70-79	2717 (69.8)	1174 (30.2)	9.94 (7.85-12.80, p<0.001)	9.84 (7.76-12.68, p<0.001)
	80+	3476 (61.8)	2153 (38.2)	14.25 (11.29-18.28, p<0.001)	14.72 (11.64-18.91, p<0.001)
Hospital onset status	Non-hospital onset	6450 (75.5)	2093 (24.5)	-	-
	Indeterminate hospital onset	933 (73.6)	335 (26.4)	1.11 (0.97-1.26, p=0.139)	0.95 (0.82-1.09, p=0.463)
	Probable hospital onset	1148 (68.7)	524 (31.3)	1.41 (1.25-1.58, p<0.001)	1.08 (0.96-1.22, p=0.199)
	Definite hospital onset	2588 (69.5)	1137 (30.5)	1.35 (1.24-1.47, p<0.001)	1.02 (0.93-1.11, p=0.731)
Pandemic wave	Wave 2b (>27/12/20)	3660 (73.7)	1308 (26.3)	-	-
	Wave 2a (>26/07/20 & ≤27/12/20)	3724 (73.8)	1319 (26.2)	0.99 (0.91-1.08, p=0.844)	0.94 (0.86-1.03, p=0.190)
	Wave 1 (≤26/07/20)	3735 (71.9)	1462 (28.1)	1.10 (1.00-1.20, p=0.041)	1.12 (1.02-1.23, p=0.015)

[1] Note that for the purposes of this report, cases diagnosed in the community (not during an inpatient stay) were excluded from these analyses to restrict the comparisons within the hospitalised patient population.

[2] One Non-Hospital onset case excluded due to unknown age.

[3] OR = Odds ratio.