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I-MOVE- COVID-19 hospital surveillance system

Multidisciplinary European network for research, prevention and control of the COVID-19 pandemic

D3.8: Surveillance monitoring and evaluation report

March 2022

Authors of report: Johanna Young, Heather Mutch, Josie Evans

Contents

List of abbreviations

COVID-19	Coronavirus disease 2019
E-SARI-NET	European SARI surveillance network
EEA	European Economic Area
ECDC	European Centre for Disease Prevention and Control
ESCAIDE	European Scientific Conference on Applied Infectious Disease Epidemiology
EU	European Union
HCW	Healthcare worker
HDU	High dependency unit
HPS	Health Protection Scotland
ICU	Intensive care unit
I-MOVE	Influenza – Monitoring Vaccine Effectiveness in Europe
PCR	Real-Time Polymerase Chain Reaction
SARI	Severe Acute Respiratory Infection
SARS-CoV-2	Severe Acute Respiratory Syndrome – Coronavirus 2
VEBIS	Vaccine effectiveness, burden and impact studies of COVID-19 and influenza
WP	Work Package

1. Aim of the evaluation

The overarching purpose of this evaluation is to assess the development of a hospital surveillance system for COVID-19 during a pandemic, identify any weaknesses of such a system and make recommendations on how to address them for future scenarios.

The following objectives were identified to support the evaluation of the COVID-19 hospital surveillance network:

1.1 General evaluation objectives

The evaluation report would indicate to all stakeholders:

- Whether the I-MOVE-COVID-19 hospital surveillance system has objectives relevant to public health action;
- Whether the I-MOVE-COVID-19 hospital surveillance system is meeting its objectives and adding value;
- Where and how any shortcomings may be improved;
- Whether the I-MOVE-COVID-19 hospital surveillance system is sustainable and should be continued if funding was available;
- Whether there are more efficient and effective alternatives to routine surveillance for achieving the I-MOVE-COVID-19 hospital surveillance objectives (e.g. ad hoc or regular surveys or epidemiological studies).

1.2 Specific I-MOVE COVID-19 hospital surveillance evaluation objectives

The specific objective of the I-MOVE COVID-19 hospital surveillance system evaluation will be to

- To describe:
  - the system (i.e. public health importance, different uses of the surveillance data, objectives of the surveillance system, case definition, population under surveillance, type of system and key variables collected)
  - the system's processes at coordination level (i.e. those for data collection, validation, analysis, reporting, and feedback to key actors in the surveillance system)
  - the system's outputs.
- To evaluate:
  - Whether surveillance objectives are being met
  - Usefulness and efficiency of the system
  - Data quality (completeness, comparability and validity)

2. European I-MOVE hospital surveillance background

The aims of the I-MOVE-COVID-19 consortium (multidisciplinary European network for research, prevention and control of COVID-19) are to obtain epidemiological and clinical information on patients with COVID-19 as well as virological information on severe acute respiratory syndrome

coronavirus 2 (SARS-CoV-2). The third work package (WP3), relating to hospital surveillance for COVID-19, has been co-ordinated by Public Health Scotland (PHS) – previously Health Protection Scotland (HPS) - with support from Epiconcept, a consultancy company providing expertise in epidemiology and IT for public health programmes. The aim of WP3 is to provide a flexible surveillance platform (adaptable to the epidemiological situation) through hospital surveillance, to contribute to the knowledge base, guide patient management and inform the public health response. This was implemented through adaptation and expansion of the existing I-MOVE influenza vaccine effectiveness network to include COVID-19.

The I-MOVE-COVID-19 hospital network comprises 11 participating hospital surveillance sites in nine European countries that are part of the I-MOVE COVID-19 Network. The laboratory component of the network includes regional and national reference centres from the participating countries. The surveillance is either population-based (for sites where the catchment area of each participating hospital is known and well-defined) or sentinel surveillance (for sites where the catchment area may not be known). At European level and for the purposes of WP3, the surveillance is multicentre population-based surveillance that pools data over several countries/regions. While each of the surveillance sites can analyse their data separately, pooling provides a larger sample size to generate hypotheses and to answer study questions with more precision.

WP3 consisted of several deliverables. An overview of current practice at the hospital level was submitted on 15 April 2020 as part of deliverable 3.1.: “Report describing current COVID-19 hospital surveillance practices and recommendations on how to strengthen preparedness and surveillance of severe disease.”

Under the deliverable 3.3. a protocol for I-MOVE-COVID-19 hospital phased surveillance was submitted on 15 June 2020. This protocol was adapted from the I-MOVE influenza generic surveillance protocol. The surveillance monitoring and evaluation protocol under the deliverable 3.4 was submitted on 15 July 2020 and was later updated prior to the start of the evaluation. The first I-MOVE COVID-19 hospital surveillance bulletin under deliverable 3.5 was published on 15 September 2020 and the final bulletin number six will be published in March 2022.

2.1 Objectives for the I-MOVE-COVID-19 hospital surveillance system

2.1.1 Primary objective

The primary objective was to describe, for nine European countries, clinical and epidemiological characteristics of Severe Acute Respiratory Infection (SARI) patients hospitalised with COVID-19 and virological characteristics of Severe Acute Respiratory Syndrome – Coronavirus 2 (SARS-CoV-2) in hospitalised patients, to contribute to the knowledge base, guide patient management, and inform the public health response.

2.1.2 Secondary objectives

Secondary objectives were:

- To strengthen preparedness to respond to COVID-19 through hospital surveillance

- To describe COVID-19 suspected, probable and confirmed cases with severe disease by sex, age group, and other potential risk or protective factors
- To describe deaths from COVID-19 in hospital by country and pooled across the network
- To measure the incidence of hospitalised COVID-19 patients, by participating region/country (where appropriate), to measure the impact of/inform decisions on mitigation measures, and to identify at-risk groups for severe disease.

3 Methods

The process of the evaluation followed the steps outlined below in Figure 1.

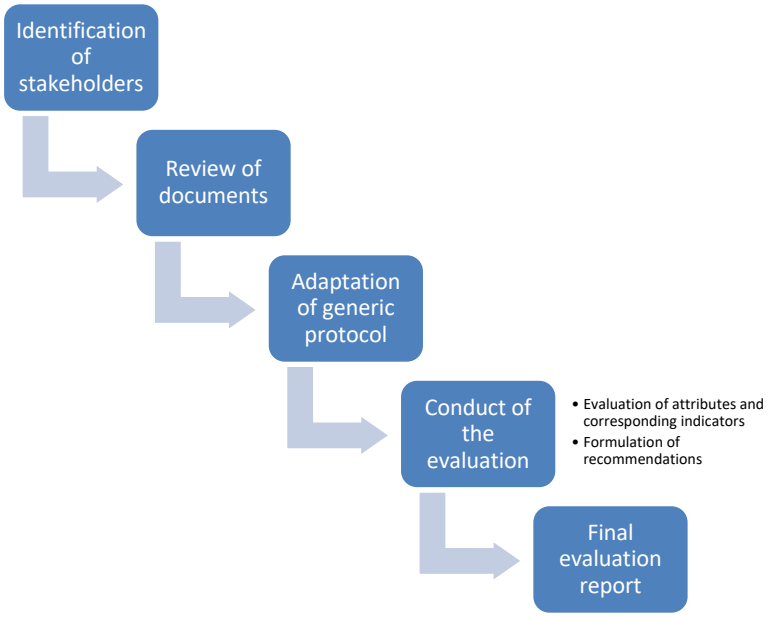

Figure 1. Process of the I-MOVE COVID-19 hospital surveillance evaluation.

3.1 Identification of stakeholders

Stakeholders in the I-MOVE-COVID-19 hospital surveillance include:

<u>Partners directly involved:</u>

- Participating sites (e.g. public health professionals, project managers, data analysts)
- Epiconcept
- European Commission (EC)

<u>Partners indirectly involved:</u>

- Sub-national/regional public health bodies
- Participating hospitals and ICU/HDU (Intensive Care Unit/High Dependency Unit) wards (including clinicians collecting data, staff entering data into the surveillance system)
- European Centre for Disease Prevention and Control (ECDC)
- World Health Organization (WHO)

3.2 Review of documents

In this step, all documents relevant to describe the system and measure the surveillance indicators of the COVID-19 hospital surveillance evaluation were identified. All stakeholders were asked to list any documentation that could support the evaluation and PHS identified all key publications from the scientific and grey literature which used data from the surveillance system.

3.3 Adaptation of the surveillance monitoring and evaluation protocol

The surveillance monitoring and evaluation protocol under the deliverable 3.4 submitted on 15 July 2020 was updated prior to the start of the evaluation in consultation with Epiconcept.

3.4 Conduct of the evaluation

3.4.1 Data analysis and data collection methods

3.4.1.1 Type of data collected

- Quantitative analysis
    - Analysis of data from Member States evaluation questionnaires (frequencies, proportions)
- Qualitative analysis
    - Whether the surveillance system objectives were relevant and whether other objectives were required
    - Whether the surveillance system was sensitive, effective, flexible and sustainable
    - Summary of the strength – weakness – opportunity – threat (SWOT) analysis

3.4.1.2 Data collection methods

The data collection methods used for the evaluation and information extracted were:

- Document review
- Analysis of pooled datasets (combined dataset including data from all participating sites after each data collection)
- Anonymised online questionnaire
- Semi -structured interview or group discussion

The questions of the online questionnaire were developed on the basis of the indicators of each of the attributes under surveillance and relevant questions were formulated. Limesurvey was used to conduct the evaluation questionnaire. The survey did not intentionally collect personal data. A Rapid Data Protection Impact Assessment was approved to outline any related risks and mitigations. Whilst participants were prompted not to include disclosive information in free text boxes, any identifiable information that was provided here, was immediately redacted. The questionnaire was piloted internally in PHS and with selected members within the network prior to the start of the data collection. Thirty minutes were expected to be needed to complete the questionnaire. The questionnaire was sent to all the participating sites. Quantitative data were analysed using Microsoft Excel.

The semi-structured interviews and group discussions were held using MS Teams. The evaluation team defined groups for the group discussions and sent invites with proposed times by e-mail. Semi-structured interviews and group discussions were chosen to allow a blend of closed- and open-ended questions, accompanied by follow-up how or why questions to facilitate discussion. These questions were prepared in advance on the basis of the indicators and attributes under surveillance and the key discussion points were shared with the interviewees in advance of the meeting. The interviews and group discussions were all scheduled for one hour.

3.4.2 Timeline of the I-MOVE COVID-19 hospital surveillance evaluation

The evaluation protocol was finalised in August 2021. The document review took place between September and December 2021. The pooled datasets were analysed between October and December, and datasets containing data up to October 2021 were used for this. The online survey was prepared and piloted between October and November 2021, and the link to the survey was shared early December. The results of the survey were extracted on 22 December 2021. The participating sites and Epiconcept were all contacted in early December 2021 and invitations to the groups discussions or interviews were shared. These sessions were all scheduled in December 2021 and January 2022.

3.5 Evaluation of attributes of each hospital surveillance objective and corresponding indicators

The evaluation team identified the key attributes needed to assess if the system met the surveillance objectives. The selected attributes are listed below including the set of key indicators to measure each attribute (Table 1).Table 1. Methods to evaluate the surveillance system attributes and its set key indicators. Prior to the evaluation of each of these attributes the development and implementation of the COVID-19 hospital surveillance system is described.

The attributes evaluated as part of this evaluation included the following[1]:

- **Attribute 1:** Whether surveillance objectives have been met

  Definition: The extent to which the surveillance system met its objectives.

- **Attribute 2:** Usefulness

  Definition: Usefulness is the ability of the surveillance system to provide data relevant for its intended use, e.g. to lead to public health action at country-level or European level.

- **Attribute 3:** Timeliness

[1] Adapted from the generic EPHESUS protocol available from https://sites.google.com/a/epiconcept.fr/ephesus/generic-protocol

Definition: Timeliness measures the time interval linking any of the discrete steps of the data flow in a surveillance system (e.g. the time between the diagnosis of a definite case and the registration of this case at European level, or between data collation and action taken).

- **Attribute 4:** Data quality

  Definition: Data quality reflects the completeness and validity of the data recorded in the public health surveillance system

- **Attribute 5:** Simplicity

  Definition: The simplicity of a surveillance system refers to both its structure and ease of operation. Surveillance systems should be as simple as possible while still meeting their objectives.

- **Attribute 6:** Sustainability

  Definition: The sustainability of a surveillance system is defined by the ability to provide an efficient and effective surveillance system in the long-term. Integrated systems to reduce inefficient silos, stable funding, and workforce development is necessary to ensure a sustainable public health infrastructure [2].

[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3733763/

Table 1. Methods to evaluate the surveillance system attributes and its set key indicators.

Attribute	Indicator	Type of data	Data collection method(s)	Data source(s)
Attribute 1: Whether surveillance objectives have been met	***Written objectives*** Number, percentage of participating site representatives who think written objectives have been met by the system	Quantitative and qualitative	Web questionnaire, interviews/group discussions, document review	Epiconcept, participating site representatives and PHS
Attribute 2: Usefulness	***Inputs*** Number and list of variables reported which are required but considered not useful at the European level	Quantitative and qualitative	Interviews/group discussion, questionnaire	Written objectives, PHS, and Epiconcept, data dictionary, surveillance data, datasets
	Number and list of additional variables not being collected but which would be useful to be collected at European level			
	Outputs Number of published scientific articles, reports, bulletins, press releases, presentations, rapid risk assessments, etc. using surveillance data	Quantitative and qualitative	Interviews/group discussion, questionnaire, document review, web search	Google, “grey literature” surveillance protocols, quarterly I-MOVE Bulletins, Quarterly Network Meetings Agenda’s and meeting minutes, Epiconcept, participating site representatives and PHS

Attribute	Indicator	Type of data	Data collection method(s)	Data source(s)
	Information for action Use of European level data for decision making or to improve surveillance (e.g. has this European level data been used to guide policy at national level).	Qualitative	Interviews/group discussion, questionnaire	Epiconcept, participating site representatives and PHS
	Added value European level surveillance Usefulness of standardised EU case definitions, SOPs and the generic protocols	Quantitative and qualitative	Interviews/group discussion, questionnaire, document review, review collected data, metadata sets	Surveillance protocols, quarterly I-MOVE Bulletins, Quarterly Network Meetings Agendas and meeting minutes, Epiconcept, participating site representatives and PHS
	Usefulness of being part of European COVID-19 hospital surveillance network (e.g. added value of European network, networking meetings and surveillance bulletins)	Qualitative	Interviews/ group discussion	National representatives, Epiconcept and PHS
Attribute 3: Timeliness	**Number of days between key steps** Time between date final dataset is received for analysis and date publication of surveillance bulletin	Quantitative	Document review, review collected data	Quarterly datasets, Quarterly timelines PHS/Epiconcept

Attribute	Indicator	Type of data	Data collection method(s)	Data source(s)
	Time between mean date of hospital admission and date of publication of surveillance bulletins			
	Median reporting delay in days of data reporting from participating site to I-MOVE coordination team.			
	Balance between timeliness and information needed Whether system reporting (data dissemination) is both timely and frequent enough to meet objectives.	Qualitative	Interviews/group discussion and questionnaire	Participating site representatives, Epiconcept and PHS
Attribute 4: Data quality	Variable completion of participating sites	Quantitative	Data analysis	Cleaned quarterly datasets
	Proportion of reported cases that fit the case definition among all laboratory cases			
	Opinion on data quality (whether they feel it is sufficient to meet objectives)	Qualitative	Interviews/group discussion and questionnaire	Participating site representatives, Epiconcept and PHS
	Data efficiency Number and percentage of unused variables at coordination level.	Quantitative	Examination of data dictionary from received datasets and data (recorded in report tables,	Surveillance system data dictionary from received datasets (or reporting

Attribute	Indicator	Type of data	Data collection method(s)	Data source(s)
	Comparison of total number of fields in data reports produced with total number of fields in data received		graphs, maps and text) included in bulletin/presentations.	protocol), quarterly I-MOVE Bulletins/ presentation slides
Attribute 5: Simplicity	Opinion on simplicity of the surveillance system (e.g. was any assistance from Epiconcept or the network required to collect the data, ease of submission to Epiconcept, any part of the surveillance system unnecessarily complicated or any changes that could have facilitated the implementation while still achieving its purpose?)	Qualitative	Interviews/group discussions	Participating site representatives, Epiconcept and PHS
	Feasibility of reporting deadlines for data collection	Qualitative	Interviews/group discussion	Participating site representatives, Epiconcept and PHS
	Person-days for data preparation – need of additional resources (on top of usual workload) done by routine services.	Qualitative & quantitative	Interviews/group discussion, questionnaire	Epiconcept and PHS
Attribute 6: Sustainability	Plans for continuation of data collection and/or expansion	Qualitative	Interviews/group discussions	Participating site representatives, Epiconcept and PHS

4. Results

4.1 Description of the I-MOVE COVID-19 hospital surveillance system

Participating sites submit surveillance data securely to Epiconcept every quarter, where data are checked to ensure all cases are suitable for analysis; the data are then cleaned and pooled. The anonymised, pooled dataset is then analysed and reported by PHS (Figure 2).

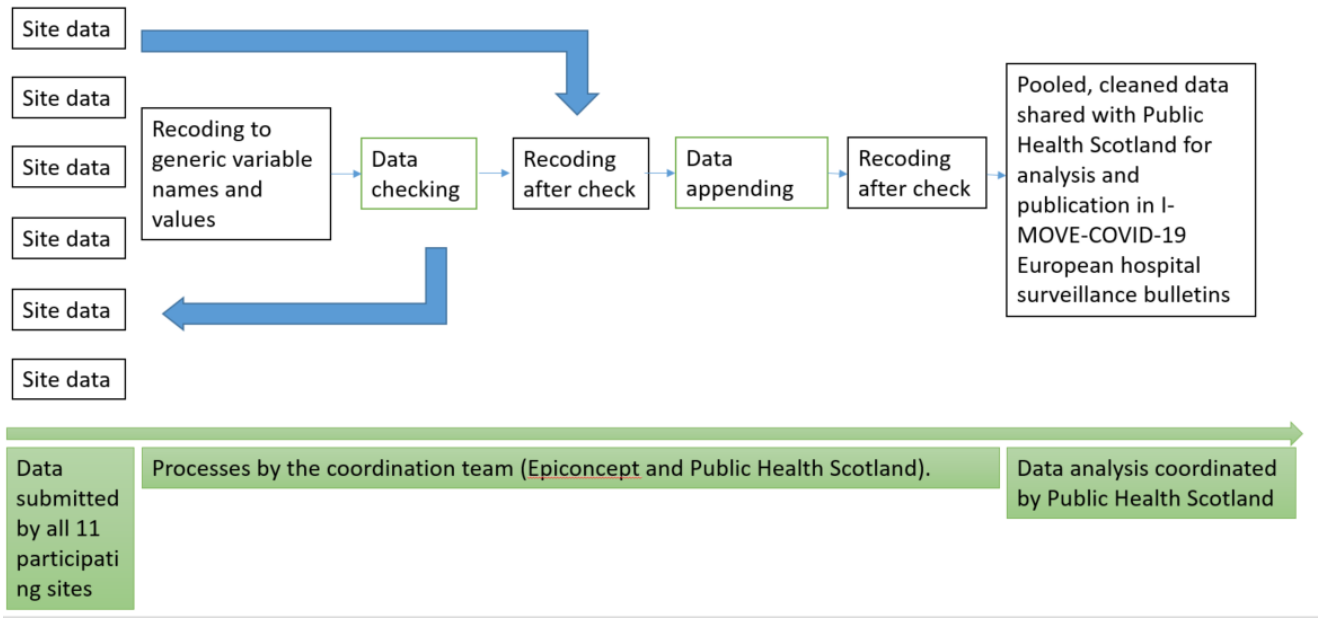

Figure 2. Dataflow of the I-MOVE COVID-19 hospital surveillance system

Table 2 provides an overview of the participating sites, the type of surveillance system in place within the sites and the number of hospitals contributing to the surveillance. Most sites generate their data using surveillance forms implemented at a small number of sentinel hospitals; however, the surveillance data provided by England and Scotland are collected at a larger number of hospitals and are obtained through mixed methods using linkages of routinely collected data and therefore represent the greatest proportions of the European pooled dataset.

The COVID-19 hospital surveillance is part of WP3 of the I-MOVE COVID-19 consortium. While data collected through this WP is specific to the hospital surveillance, the grant agreement between Epiconcept and the European Union (EU) outlined that the pooled surveillance data from WP2 and WP3 will be provided to the leader of WP4 (Epiconcept) to conduct pooled analyses to respond to the relevant priority questions (following the WP4 protocols). Therefore, data collected through WP3 may contain variables that are not directly analysed and presented in reports from WP3, as they are used to inform WP4. The data fields included in the analysis below, particularly in relation to the

assessment of data quality and timeliness, are all variables that were included in the WP3 surveillance protocols and data dictionaries.

Table 2. Overview of the participating sites, their type of surveillance and number of hospitals involved

Country	Type of surveillance	Number of participating (sentinel) hospitals
Albania	Questionnaire-based surveillance	Two hospitals
Belgium	Questionnaire-based surveillance	One hospital
England	Nationwide	Randomly selected from 53 sentinel hospitals
France		
FR-R (REIVAC)	Questionnaire-based surveillance	Five hospitals
FR-V (ViVI)	Questionnaire-based surveillance	Two hospitals
Lithuania	Questionnaire-based surveillance	Two hospitals
Portugal	Questionnaire-based surveillance	Three hospitals
Romania	Questionnaire-based surveillance	Two hospitals
Scotland	Nationwide	All hospitals
Spain		
Spain (regions of Granada and Aragon)	Questionnaire-based surveillance	Two hospitals
Spain – Navarra (Navarra region, Spain)	Questionnaire-based surveillance	Six hospitals

4.2 Document review

Public Health Scotland identified surveillance bulletins, posters and protocols related to the I-MOVE-COVID-19 surveillance system (Appendix 1 – Document review).

There were six I-MOVE-COVID-19 Surveillance Bulletins available, two poster presentations presented at the ESCAIDE conference and the I-MOVE-COVID-19 Surveillance Protocol.

As part of the grant agreement a report describing current COVID-19 hospital surveillance practices and recommendations on how to strengthen preparedness and surveillance of severe

disease (deliverable 3.1), a protocol for I-MOVE-COVID-19 hospital phased surveillance (deliverable 3.3), the surveillance monitoring and evaluation protocol (deliverable 3.4) and three surveillance bulletins (deliverable 3.5-3.7) were prepared and submitted.

Six pooled datasets including data from the participating sites submitted at the six different data collection moments were identified.

Network meeting agendas and meeting minutes were identified and included for this document review.

4.3 Surveillance evaluation questionnaire and interviews/ group discussions: Response rates

4.3.1 Evaluation questionnaires

The link to the online questionnaire was sent to all contacts from the participating sites. Questionnaires were received from 23 respondents, of which 10 were completed. There was a wide mix of responsibilities amongst the 10 respondents of the survey; coordinators (n=3), data managers (n=2), laboratory experts (n=1), hospital based participants (n=2), university based participants (n=2) and regional and national public health institute based participants (n=3).

4.3.2 Interviews and group discussions

A total of six interview and individual group discussions were organised by the evaluation team to represent the following categories: i) participating sites and ii) Epiconcept as the coordination site. The interviews and group discussions included representatives of one or two sites at the same time. Four group discussions were held with representatives of two countries, one interview was held with a representative of one country and a final interview was conducted with Epiconcept.

4.4 Evaluation of system attributes

This section summarises the analysis of attributes relevant to the I-MOVE-COVID-19 hospital surveillance system. For the questionnaires, percentages are given with the 10 completed questionnaires as denominator, unless otherwise stated.

4.4.1 Development and implementation of COVID-19 hospital surveillance

In this section the interviewees were asked about the development and implementation process of the I-MOVE-COVID-19 hospital surveillance. Many interviewees indicated that they had previously been part of the I-MOVE network (Influenza – Monitoring Vaccine Effectiveness in Europe) which aims to measure influenza vaccine effectiveness (VE) in Europe[3] or the I-MOVE+ consortium (Integrated Monitoring of Vaccines in Europe)[4] that facilitated the development and implementation for COVID-19 hospital surveillance. Protocols from these networks were used and adapted for the collection of COVID-19 data, so staff were familiar with the surveillance activities and existing information governance procedures could be further expanded. Several interviewees

[3] https://www.imoveflu.org/
[4] http://www.i-moveplus.eu/

who were also part of the European SARI surveillance network (E-SARI-NET), recently established by Epiconcept in collaboration with ECDC which aims to collect SARI data, highlighted that this network also supported the implementation of the COVID-19 hospital data collection.

For most interviewees the surveillance was based on questionnaires completed by clinical staff in hospitals. The majority of the challenges relating to the development and implementation of the surveillance system were linked to the data collection. The limited human resources available to support the data collection, the collection of whole genome sequence data, and logistical issues such as the shipping of the samples were a few of the challenges highlighted by the interviewees. Ensuring that information governance regulations were met was mentioned as a challenge during this process; setting-up all the ethical requirements was time-consuming and resulted in delays to data collection. Interviewees from three sites indicated that informed consent was required for each interviewed patient which was particularly challenging as patients with severe disease were not able to sign forms and visitors were not allowed to enter hospitals. However, other interviewees reported that they managed to add the collection of COVID-19 data to existing informed consent practices or were exempted due to this being a public health emergency.

4.4.2 Whether surveillance objectives have been met

Number, percentage of participating site representatives who believe written objectives have been met by the system

Respondents were requested to react to each of the six objectives below. Overall, the respondents reacted very positively about the surveillance system meeting its objectives. A total of 60 responses were collected for each of the six objectives by 10 respondents. Two of the respondents failed to answer and therefore the completion rate for this was 80% (48/60). When the responses for all objectives with an answer were considered, 88% (42/48) of all respondents were in agreement (or strong agreement) that the surveillance system met its objectives. Five responses of a possible 48 were neutral (10%), and only 2% (1/48) disagreed that the surveillance system met all of its objectives.

More specifically, the results from the respondents for each of the surveillance objectives are as follows:

1) *To describe the clinical and epidemiological characteristics of SARI patients hospitalised with COVID-19 in the eleven hospital sites across nine European countries.*

Eight out of 10 respondents agreed or strongly agreed that the surveillance system had met this objective. Two respondents did not answer this question.

2) *To describe the virological characteristics of SARS-CoV-2 in hospitalised patients with COVID-19 in the eleven hospital sites across nine European countries.*

Five out of ten respondents agreed that the surveillance system had met this objective. Two respondents were neutral and one respondent disagreed that this was met (due to no sequencing information being available). The remaining two respondents did not answer this question.

3) *To contribute to the knowledge base, guide patient management, and inform the public health response.*

Six out of ten respondents agreed that the surveillance system had met this objective and two were neutral. The remaining two respondents did not answer this question.

4) *To strengthen preparedness to respond to COVID-19 through hospital surveillance.*

Seven out of ten respondents agreed that the surveillance system had met this objective and one respondent was neutral. Two respondents did not answer this question.

5) *To describe COVID-19 suspected, probable and confirmed cases with severe disease by sex, age group, and other potential risks or protective factors*

Eight out of ten respondents agreed that the surveillance system had met this objective. The remaining two respondents did not answer this question.

6) *To describe deaths from COVID-19 in hospital by country and pooled across the network*

Eight of ten respondents agreed that the surveillance system had met this objective. The remaining two respondents did not answer this question.

4.4.3 Usefulness

Number and list of variables reported which are required but considered not useful at European level

The participating sites were asked whether there were any variables required for reporting to Epiconcept that they considered not necessary to meet the surveillance objectives at European level.

Forty-two percent (61/145) of the required variables collected for surveillance purpose were selected by at least one respondent as unnecessary for surveillance purposes (see Table 3). There was a clear emphasis from interviewees and respondents that if timely data collection is desired then only essential variables should be collected. Several respondents emphasised that the collection of the patient's postcode was unnecessary and could be in violation of data protection regulations as the patient could be identified in combination with other variables such as admission date, country, age and sex. While postcode was initially agreed to be included in order to provide an overview of representativeness of the data collection across Europe, it was later agreed to report on a wider geographical area instead if this was possible. This variable was never included in the final dataset and thus not part of any of the analysis. Several respondents indicated that clinical characteristics such as presenting symptoms were deemed unnecessary as these did not align with typical epidemiological surveillance questions. The hospital ward and patient test or scan results were also found to be unnecessary, especially when these are free text fields which are not easily compared between patients. While these variables were included in the data dictionary as part of this surveillance, they may have only been used for WP4. It was also suggested by the interviewees that the number of variables should be determined based on the variable completeness which can be obtained by each of the sites, alluding to a minimum dataset.

Table 3. List of variables reported as unnecessary by the respondents of the survey.

Patient characteristics	Underlying chronic conditions	Hospital/ward information	Case/severity definitions				Risk factors		
			Severity indicators	*COVID or not*	*SARI signs/ symptoms at admission continued; onset date*		*Exam/labs results on admission or during hospital stay*	*Close contact setting*	*In hospital medications/ interventions*
Postcode	Weight	Hospitalward_oth	Vent_sp	lab_covtesttype_sp	Abdopain	Dizzy	Examoth_sp	Closecont_sp	Study_gm_csf
Postpartum	tuberc	Icudisdate	Vent_type		Ageusia	Fever	Ct_us_ecg	Close cont	Prone
	height	Los_icu	Venttype_sp		Anosmia	General_deter	Abo	Closecont_type	Study_convpl
		multiple_hosp			Chest	Headache	Ct_res		Nebu
		Discharge date			Chills	Malaise	Cxr		Trialdrugs
		Prevhosp			Confusion	Myalgia	Ecg_qt		Study_oth_sp
		Hospitalward			Conjuct	Palp	Ct_res_sp		Study_oth
		Los_hosp			Coryza	Sob	Oxsat		
		Multiple_episode			Cough	Suddenonset	Cxroth_sp		
					Dermato	Tach	Ox_nasal		
					Diarr	Vomit			

The majority of the interviewees also reported that there were too many required variables, particularly with the data submissions of the different I-MOVE COVID-19 WP's being combined. As a result of the large amount of data required for submission and because the majority of the participating sites had questionnaire-based surveillance in place, the questionnaires were lengthy. Some interviewees therefore reported high levels of missing data. This could have been avoided if the size of the questionnaire was reduced. It was also suggested by several interviewees that there needed to be a balance between essential data and additional data of interest, and a minimum dataset was proposed as a possible solution to this. It was also mentioned that a reduction in the number of variables would contribute to the sustainability of the surveillance system.

Several interviewees questioned the rationale for the collection of clinical data, such as blood group, oxygen saturation and chest x-ray findings as this data was not used in any of the analysis of WP3. The collection of this clinical data was particularly challenging as it was a time-consuming process for clinical staff who were already stretched during the COVID-19 pandemic. Interviewees suggested that efforts should be made to analyse the pooled clinical data at a later stage when more time is available to ensure that this data collection was not purposeless. These analyses have been done by Epiconcept and will be presented in due course.

Though many respondents and interviewees suggested limiting the number of variables to be collected, the alternative view was that this surveillance system was implemented in light of a new infection and therefore the drive to collect as much information as possible in order to be able to characterise the disease was very important.

Number and list of additional variables not being collected but which would be useful to be collected at European level

Several respondents indicated that additional variables could be collected and would be useful for further analysis at European level. These include patient ethnicity, whether the patient was alcohol dependent, whether the patient was susceptible to infection and whether the patient had a "do not resuscitate" order in place. While patient's ethnicity was mentioned in the survey as a potential useful variable, it was decided at the start of the surveillance that this would be challenging to pool as not all sites routinely collect this information and it is recorded differently per country.

Interviewees did not suggest any additional variables to be collected through this surveillance system.

Number of published scientific articles, reports, bulletins, press releases, presentations, rapid risk assessments, etc. using surveillance data

To date five surveillance bulletins have been published on the I-MOVE COVID-19 website[5] which describe the COVID-19 hospital surveillance data collected on a European level. These bulletins describe the patients who were hospitalised with severe SARS-CoV-2 by gender, age group and additional risk factors and were published in September 2020, and January, March, July and October 2021.Two scientific posters that were presented at ESCAIDE are also published on this website.

[5] https://www.imoveflu.org/i-move-covid-19/i-move-covid-19-publications/

Use of European level data for decision making or to improve surveillance (e.g. has this European level data been used to guide policy at national level?).

Only one respondent indicated that the data collected through the I-MOVE COVID-19 hospital surveillance contributed to their national surveillance of COVID-19 and was therefore used to guide governmental decision making at a national level. Most respondents indicated that as their hospital surveillance, as part of the I-MOVE hospital surveillance, only represented one or few hospitals and did not include national level data, they did not think or were unaware that this surveillance directly impacted any decision making regarding COVID-19 at a national level. One respondent indicated that they did not send their hospital data to their national health institute as their country already had a national surveillance system in place that was being used to develop guidance and drive policies. Respondents also raised the lack of timeliness during data collection due to the number of variables as an explanation for not being able to use the collected data for decision-making purposes.

The majority of the respondents indicated that the publication of the surveillance data supported the improvement of the surveillance. Respondents suggested that the surveillance data allowed the sites to raise awareness of the importance of this surveillance, supported the implementation of the surveillance system within their site and allowed them to further develop national SARI surveillance. They also indicated that they were able to provide information to clinicians and healthcare workers who had been collecting the surveillance data, and presented the data at national conferences. One respondent also highlighted that being part of this surveillance network allowed automation of data flow processes which not only improved the surveillance at site level, but also at national level as the automation encouraged the national public health institute to improve their data transfer tool. Finally, some respondents suggested that a wider range of analysis (e.g. distributions between key dates including date of onset and admission, more in-depth analysis on age/sex distribution and outcome) may have been useful to improve COVID-19 hospital surveillance.

Usefulness of standardised EU case definitions, SOPs and the generic protocols

Overall, the majority of respondents indicated that the EU case definitions, SOPs and generic protocols were positively received. The EU case definitions were found to be useful or very useful by six out of ten respondents, one respondent chose a neutral response and the remaining three did not answer the question. The standard operating procedures were found useful by four out of ten respondents, two chose a neutral response whilst the remaining four did not answer the question. The generic protocols were found useful or very useful by five out of ten respondents, two chose a neutral response and three did answer the question.

Usefulness of being part of European COVID-19 hospital surveillance network (e.g. added value of European network, networking meetings and surveillance bulletins)

The majority of the interviewees indicated that being part of the network was beneficial and interesting. It helped them understand the developments across the different sites, which consequently supported the improvement of their own national surveillance. Being part of the network also helped to strengthen the relationship with other actors within the participating sites, including for example clinical staff in the hospitals. Several interviewees also mentioned that participation in the network supported advocating for national surveillance and helped them receive more funding from regional or national sponsors.

The network meetings were generally perceived positively. Some interviewees indicated that they did not have enough time to join all the meetings due to time constraints and balancing priorities during the pandemic. It was suggested by a few interviewees that the meetings could be recorded and shared with the network so that people who could not attend could listen to the discussions in their own time. One of the interviewees suggested asking participating sites to prepare and present a presentation during the network meetings to increase the interaction. Several interviewees indicated that it was a shame that no in-person meetings could be organised due to the restrictions in the pandemic, as it is often the networking element of the European surveillance systems that is very valuable to the participating sites.

The majority of respondents to the questionnaire indicated that the surveillance bulletins supported the improvement of COVID-19 hospital surveillance within their site. The bulletins raised awareness of the importance of this surveillance and in some sites were able to form a basis of their national SARI surveillance and help to transform national surveillance methods.

The interviewees generally indicated that the bulletins provided a clear epidemiological overview of the pooled dataset. However, several interviewees reported that the bulletins were not timely enough to contribute to public health action. One suggestion was to decrease the size of the bulletins in order to have them published more frequently, although it was acknowledged that this would have consequences for the number of data collection rounds. The use of a surveillance dashboard was also suggested by one of the interviewees. A small number of interviewees encouraged publication of the findings from the surveillance bulletins in scientific papers to reach a larger audience. One of the interviewees suggested that alerts could be set-up when new surveillance bulletins were added to the I-MOVE COVID-19 website.

4.4.4 Timeliness

Timeliness of the surveillance system was measured to ensure that the surveillance system and the bulletins being produced were able to provide useful information to guide the public health response across Europe. The timeliness of the surveillance system was measured using several indicators which calculated the number of days between key steps in the surveillance process and the balance between timeliness and the need for timely data analysis reporting.

Time between date final dataset is received for analysis and date publication of surveillance bulletin

The time between the date the cleaned, pooled dataset was received for analysis and the date of publication of the surveillance bulletins is a useful indicator of timeliness as it gives insight into the time allocated for data exploration, analysis and the overall quality of the bulletin which is produced.

The time between the final dataset being received by PHS and the date of publication ranged from 15 days to 63 days, with an average number of 42 days. The first bulletin had the shortest preparation time of 15 days. This was a short turnaround time which could impact the quality of the data analysis, however, it is known that a dummy dataset was provided to the PHS analysis team to allow preliminary analysis to be carried out. From the second data collection onwards, there was an average of 49 days between the pooled dataset being received and the publication of the bulletin. This allowed for more detailed data analysis and investigations into any spurious

findings to be completed. A balance is needed to ensure that there is enough time to analyse the data thoroughly, but also to ensure that the data is received promptly enough to support public health action.

Time between mean date of hospital admission and date of publication of surveillance bulletins

The time between the mean date of admission and the date of publication of the surveillance bulletins is another indicator utilised to monitor the timeliness of the surveillance system and to assess the likelihood that the bulletins are able to positively influence public health within the different participating sites.

This was assessed by identifying the mean date of admission from each data collection and subtracting this from the date of publication of the bulletin. The cumulative nature of the data collection methodology meant that calculating the mean date of admission required the removal of duplicates from the previous bulletin. These duplicates were removed based on 10 key variables: the country ID, patient sex, patient age, date of admission, date of discharge, ICU status, ICU admission date, ICU discharge date, onset date and swab date. Once the duplicated records were removed, the mean date of admission was calculated for each data submission. While limitations of the measurement of this indicator exist, it provides an indication of the timeliness of the surveillance system.

The mean date of admission and the publication date increased over time. The number of days between the publication date and the mean date of admission steadily increased from 152 days at the publication of the first surveillance bulletin to 322 days after the most recent bulletin was published. This suggests that the time between data collection and publication of the surveillance bulletins is too long to support necessary public health interventions within the participating sites. There are a number of reasons for this increase in time between admission and publication date, including retrospective changes to any records, or the addition of entirely new records from the previous quarter. This suggests that sites may not have had enough time to complete every record (either data collection/recording/submission) within a given quarter and caught up with these records over the following quarter for the next data submission.

Median reporting delay in days of data reporting from participating site to I-MOVE coordination team

This indicator monitors whether participating sites were able to submit the data to Epiconcept by the given deadline and provides insight into the ease of data submission and suggests whether the sites experienced any pressure compiling all of the data records into one coherent dataset. Typically, around two weeks were provided to each site in order to collate all data submissions.

The median date by which data was received by Epiconcept was generally close to the deadline date for submission agreed between all sites and the coordinators. For the first bulletin the date of submission was not exactly specified, but throughout the project the deadlines for later submissions were more specifically clarified. During most data collection periods, numerous sites sent several updated data submissions to Epiconcept for the same reporting period after adding new records or carrying out additional cleaning. Each updated data submission underwent data cleaning by Epiconcept adding additional strain on the data management team at Epiconcept and

delayed the analysis efforts from the team at PHS. This could have resulted in delays between receiving pooled datasets and publishing surveillance bulletins.

Whether system reporting (data dissemination) is both timely and frequent enough to meet objectives

Most respondents considered the timeliness of the data calls to be sufficient. However, while some respondents indicated that they were not timely enough to inform public health decisions and that more timely submissions would be preferable, it was also acknowledged that this could be challenging due to resourcing issues, the number of variables being collected and data management activities.

The majority of the respondents thought the frequency of the publications was sufficient to meet the surveillance system objectives but some respondents thought that there should be shorter rapid communications on a more regular basis with lengthier in-depth surveillance bulletins distributed less frequently.

The respondents were split on the timeliness of the publication of the bulletin. Some thought that these were not timely enough to meet the surveillance system objectives and instead there should have been more rapid publications which would have added to the overall knowledge base. It was acknowledged that more frequent publications consequently require more frequent data collections and this is only possible with a condensed surveillance dataset. This is in line with what was perceived as the added value of the network by the participants described in the usefulness section above.

4.4.5 Data quality

Data quality is a critical attribute which measures the effectiveness of the surveillance system. The inclusion of high quality data is crucial to ensure that accurate information is being provided to those working in public health and members of the public. The data must be high quality in order to inform decision making and guide public behaviour. The data quality of the surveillance system is tested by observing the number and range of the different variables being used in the surveillance system, as well as the overall completion and the completion by each site.

There were 105 separate variables requested within the I-MOVE-COVID-19 surveillance study, covering patient demographics (sex, age, type of residence), hospital records (admission date, discharge date, hospital ward), severity indexes (ICU/HDU admission and length of stay, ventilation status, outcome), risk factors (healthcare worker, smoking status, pregnancy, underlying chronic conditions), SARS-CoV-2 presenting symptoms, laboratory test results as well as clinical information regarding measurements carried out within the hospital (see Appendix 2). The number of variables increased to 257 for the sites which also participated in the risk factor analysis as part of WP4.

Variable completion of participating sites

An important indicator of data quality is the percentage completion of each variable included within the dataset. This gives insight into the ease of collecting each variable, which may be impacted by ethics and information governance, data collection methodology and/or each

patient's willingness to provide the information being asked for. When variable completion is poor the variables are often excluded from analysis. This indicator measures the percentage completion of a range of variables specified Table 4 within the surveillance dataset overall and for each participating site, and observe how this changed between each data submission.

Table 4. Variables assessed to measure the data completeness

Patient demographics	Risk factors	Chronic conditions	SARS-CoV-2 presenting symptoms	
Age	healthcare worker status	Anaemia	abdominal pain	malaise
Sex	smoking status	Asplenia	ageusia	myalgia
type of residence,	pregnancy status	Asthma	anosmia	nausea
Hospital stay information		Cancer	chest pain	nausea and vomiting
hospital admission date		Dementia	chills	palpitations
hospital discharge dates		Diabetes	confusion	shortness of breath
Laboratory confirmation		heart disease	conjunctivitis	sudden onset of any symptoms
swab date		hypertension	coryza	tachypnoea
Severity indexes		immunodeficiency (through medicine or disease)	cough	vomiting
ICU/HDU status		liver disease	dermatological complaints	onset date of symptoms
ICU admission date		lung disease	diarrhoea	
ICU discharge date		neuromuscular disease	dizziness	
ventilation status		obesity	dysgeusia	
outcome		renal disease	fever	

Patient demographics	Risk factors	Chronic conditions	SARS-CoV-2 presenting symptoms	
date of death		rheumatologic disease	feverishness	
cause of death		Stroke	general deterioration	
		tuberculosis	headache	

The completion of each variable was calculated by removing any null responses: including blank, NA, unknown, 8 or any other response which constituted a non-answer. The percentage of given responses was then calculated by taking the total number of responses minus the null responses and dividing this by the total number of responses.

Analysis indicates that age, sex, hospital stay dates and the severity indexes were generally well-completed by all sites, with completion of greater than 70% in all bulletins. These variables are important for surveillance reporting so it is clear that either effort is put into collecting these to a high standard, or they are routinely recorded already and therefore are straightforward to collect.

The patient's type of residence, healthcare worker status, symptom onset date and most chronic conditions (excluding anaemia, stroke and tuberculosis) were all reasonably well collected with between 30% and 69% completion for most of the surveillance bulletins. The patient's smoking status, pregnancy status, three of the chronic conditions (anaemia, stroke and tuberculosis), and all symptoms were poorly completed in all surveillance bulletins, with less than 25% completion for any of the variables. In-hospital measurements and interventions were frequently too low to be included in the analysis as are sequencing results and the genetic group of the variables. The poorer completion of these variables could be the result of difficulty sending this data due to ethical concerns, or the sensitive nature of the pregnancy or smoking status could result in patients' unwillingness to disclose these. They may also be affected by a lack of routine collection; symptoms data is not always regularly collected within hospital settings. In addition to this, some issues may stem from the clinicians being overwhelmed by the pressures of the pandemic.

The completion rate of variables has decreased over time. This is likely a result of the increased number of missing variables of sites that have national surveillance instead of sentinel surveillance in place with a consequence that the absolute numbers of these sites are higher and therefore any variables that are not completed lead to overall lower completion rates. When reporting rates of specific variables fall in such sites this will be reflected in the overall completion rate of the variable. This indicates that it is crucial to not only observe the overall completion of the variables but the completion of the variables within the participating sites also.

When comparing the individual sites, some striking similarities between some of the sites were observed. In general, sites utilising a sentinel questionnaire based approach were able to achieve higher levels of completion of certain variables compared to those that utilised linkage to collect national data. However, significantly more cases were accrued by the sites using data linkage approaches, therefore, there are both pros and cons for each of the two methods.

Proportion of reported cases that fit the case definition among all laboratory cases

This indicator examines the number of reported cases initially sent to Epiconcept for cleaning and those that were excluded by Epiconcept prior to pooling and analysis. Epiconcept carry out a variety of checks on the dataset ensuring that no duplicated records are present, cases are not admitted before a chosen date and to ensure that all cases meet the case definition of a COVID-19 patient. This indicator assesses the number of excluded cases and sheds light on the efficiency of each participating site which in turn will determine how robust the case definition is and whether this requires more clarity.

Cases were excluded for a number of different reasons: patients did not have COVID-19, patients were admitted prior to the first recorded case within their country; the patient's admission date, symptom onset date, swab date, sex or age was missing; or incoherent dates or results. The proportion of cases which were excluded during cleaning carried out by Epiconcept was 30% in the first data collection, this followed an overall decrease to 5% in the fourth data collection but a slight increase to 16% in the fifth data collection. This suggests that the sites improved the quality of the data over time before submitting it to Epiconcept.

Opinion on data quality (whether they feel it is sufficient to meet the surveillance objectives)

Generally, the interviewees reported performing regular data management activities to ensure good quality data. These activities included recoding of variables, de-duplication procedures, addressing of missing variables, cross-validation and translation of variables to English. Several interviewees indicated that they carried out thorough data performance checks by preparing data quality reports and having data liaisons in place to support the data collection and overall data improvement. However, these were very time-consuming tasks and are unlikely to be sustainable. Some interviewees indicated that the feedback from Epiconcept as part of the data validation process was very useful and supported the participating sites to improve the quality of the submitted data. It was also highlighted that the quality of the data generally improved over time. One of the interviewees pointed out that automation of the data collection would have facilitated improving the data quality and completeness as it would have allowed conditions and rules to be applied to the submitted data. It was also repeatedly mentioned that the participating sites would have liked to include more patients to increase the sample size and therefore be able to improve the data quality if they had more resources and funding available.

Only a few sites indicated that no additional data management activities at a national level were carried out prior to data submission, though these activities were then generally conducted by the involved hospitals. A few interviewees indicated that the identification of the patients was challenging at a national level as the data was collected at the hospitals and personal identifiable information was not sent across which prohibited the national public health institute to do further data linkages and data checks.

Number and percentage of unused variables at coordination level

The number and percentage of unused variables at coordination level indicates the difference between the number of variables requested by the I-MOVE-COVID-19 project, the number of variables collected within each data submission and the number of variables which were analysed

within the bulletin. This indicator informs any planned minimum dataset and how readily these could be collected, thereby allowing the number of variables to be reduced if necessary.

For the five data submission periods, between 80% and 97% of the requested surveillance variables (listed in Appendix 2) were included in the pooled dataset post data submission to Epiconcept. Notable missing variables included the patient postcode and a variety of measurements completed on the patient whilst they were in hospital. Postcode is routinely missing from all of the data submissions, potentially as the result of information governance restrictions, and is therefore also removed from the final dataset and not further analysed. The surveillance bulletins have utilised between 43% and 63% of the variables requested for the surveillance study. The number of variables included within the surveillance bulletins have increased throughout the duration of the study as more time for analysis has been available. The proportion of the number of variables included in the surveillance bulletins from the total number of variables collected is still fairly low therefore the minimum dataset of key variables could potentially be reduced.

Comparison of total number of fields in data reports produced with total number of fields in data received

Comparing the total number of variables within the surveillance bulletin with the total number of surveillance variables included within each pooled dataset allows the efficiency of the overall surveillance system to be explored. When a variable is used in the data analysis, there is stronger rationale for collection of that variable.

This was monitored by calculating the number of surveillance variables collected within the pooled dataset and comparing these to the number of variables included within the surveillance bulletins, allowing a percentage to be calculated. The number of surveillance variables contained within each data submission showed a general decrease from 102 in the first data submission to 84 in the most recent data submission. Conversely, the number of variables included in the bulletin increased from 45 to 66. This led to an overall increase in the percentage of variables used from 44% to 79% in the first and fifth surveillance bulletins respectively. This increase suggests that as more time was given to consider analyses, a broader range of data analyses could be carried out. The variables missing from the data analysis of the surveillance bulletins should be considered to determine why these have not been included.

4.4.6 Simplicity

Opinion on simplicity of the surveillance system

Most respondents indicated that they experienced some challenges with data collection ranging from obtaining ethical permissions from data protection bodies and patients to collect and provide the data; using manual approaches for surveillance and trying to automate them, and finally the burden of data collection on clinical and public health colleagues during a pandemic. Respondents suggested more frequent update of the surveillance protocols and the enabling of training options for those entering the surveillance project at a larger stage.

Overall, respondents indicated that the data collation was found to be straightforward, although some respondents did mention challenges due to the lack of automation, a high workload and the large number of required clinical variables.

All respondents reported that the data submission process to Epiconcept was very easy. Some respondents reported that they did experience some issues with information governance surrounding person identifiable information during the submission phase which led to late data submissions.

This was in line with the results of the group discussions where the majority of the interviewees reported that the surveillance system was easy to use. Epiconcept were very helpful in supporting all parts of the surveillance system. Generally, the participating sites did not report any issues in submitting the data to Epiconcept. Some interviewees indicated that the data collection was a manual process which was time-consuming and an automated data collection system would have been preferred. A few interviewees asked for a simpler protocol, as well as further guidance on case identification as this was not always understood by clinicians.

Feasibility of reporting deadlines for data collection

Several interviewees reported that the data submission deadlines were sometimes perceived as challenging. Data reporting deadlines were not always met which was often linked to a lack of human resources, or delayed data collection in the hospitals which was similarly associated to resourcing issues. Some of the interviewees also indicated that they were experiencing many competing deadlines, perhaps impacting the timing for data submission to Epiconcept.

A few interviewees suggested a clear data reporting schedule at the start of a year or season rather than more *ad-hoc* e-mail reminders.

Person-days for data preparation – need of additional resources (on top of usual workload) done by routine services.

Respondents indicated that the time required to prepare the datasets for submission to Epiconcept ranged between 2-30 days with an average of 11.5 days. The majority of the respondents felt that additional human resources were required to deal with the heavy workload that they were experiencing, to help with coordination between public health institutes and hospitals and to carry out analysis. Through funding from the I-MOVE consortium some participating sites were able to employ additional human resources. It was suggested that having increased capacity from a more robust workforce would have allowed the data to be timelier and helped guide decision making.

The need for additional resources was also mentioned during the interviews, where the majority of the interviewees indicated that additional resources were required to collect the data for the I-MOVE-COVID-19 hospital surveillance. To help manage the workload, some interviewees reported collecting data on restricted number of days in the week rather than including all patients.

4.4.7 Sustainability

Plans for continuation of data collection and/or expansion

Interviewees responded variously with regards to the continuation of the surveillance system. For those participating sites where the data collection for I-MOVE-COVID-19 hospital surveillance is

part of their national COVID-19 hospitalisation data, the surveillance will likely continue and further plans will depend on the development of the pandemic. Several interviewees indicated that the expectation is that the data collection will reduce and likely become similar to the seasonal influenza reporting.

Those interviewees that were also part of E-SARI-NET reported continuing to collect SARI data and had plans to expand this surveillance to other hospitals, although for some this might depend on funding and recruitment of further resources. A new European vaccine effectiveness project VEBIS (Vaccine Effectiveness, Burden and Impact Studies for COVID-19 and Influenza) is currently being implemented and this may be a route for the participating sites of this surveillance system to ensure the sustainability of COVID-19 hospital surveillance data.

4.5 SWOT analysis

SWOT is an acronym for strengths, weaknesses, opportunities and threats and is a framework for identifying and analysing the internal and external factors that can have an impact on the viability of, for example, a surveillance system. Strengths and weaknesses are considered internal factors, opportunities and threats are considered external.

From the questionnaires, a description of major strengths, weaknesses, opportunities and threats was compiled (Table 5). The major **strengths** identified were the strong collaboration of the European network and its added value to regional and national surveillance, the excellent leadership and support provided by Epiconcept as the coordinator of the surveillance network, the opportunity of shared learning and experiences for future surveillance systems and the gained knowledge about SARS-CoV-2. Lack of timeliness of data reporting to inform public health action, the limited human resources and data quality and completeness issues were the main **weaknesses** reported for this surveillance system. **Opportunities** described by the participating sites include the opportunity to develop and implement wider SARI surveillance (as part of the European SARI surveillance network through ECDC), lessons learned for new surveillance systems, and the opportunity for interaction with the scientific community. Several **threats** were reported by the respondents, including the sustainability of continuation of the surveillance as this is often dependent on external funding, the challenges around complying with information governance regulations and poor data completeness.

Table 5. Strengths, Weaknesses, Opportunities and Threats of the I-MOVE COVID-19 hospital surveillance system (N=6)

Strengths	Weaknesses
– Strong collaboration with European network and its added value (4x) – Excellent leadership, communication and support provided by Epiconcept (4x) – Shared learning and experiences for future surveillance systems (3x) – Great gained knowledge about SARS-CoV-2 (2x)	– Lack of timeliness of reporting of data to inform public health action (3x) – Limited human resources/too high workload (2x) – Data quality and completeness (2x) – Lack of uniformity between surveillance systems and standardisation in approach (2x)

– Large pooled dataset to carry out analysis, overview and comparison (2x) – Supportive network during the development and implementation of the surveillance system in a pandemic (2x) – Uniformity of variables (1x)	– Not a sufficient number of scientific publications (1x) – Delays in data collection (1x) – Number of required variables (1x) – No sufficient opportunities to provide or receive feedback after data submission (1x) – I-MOVE project narrowed to limited number of hospitals per participating site and cannot be carried out on a national level (1x)
Opportunities	**Threats**
– Supported the development and implementation of wider SARI surveillance (as part of the European SARI surveillance network through ECDC) (3x) – Lessons learned for new surveillance systems (3x) – Publications and scientific interaction (1x)	– Sustainability of the surveillance is dependent on external funding (2x) – Ethical approval (1x) – Poor data completeness for some variables (1x) – No insight into other sites data quality (1x) – Very difficult to integrate all results (sequencing especially) (1x) – Other COVID-19 surveillance systems have prevented the use of I-MOVE-COVID-19 surveillance for public health interventions (1x) – The importance of specific variables may vary over time due to the nature of the disease (consequently making some data irrelevant over time) (1x) – Length of I-MOVE-COVID-19 hospital surveillance project not long enough (1x)

5. Discussion

5.1 Summary of findings

Development and implementation of the surveillance

- Sites who were previously part of the I-MOVE influenza or I-MOVE+ network and those that are currently part of the recently established SARI surveillance network E-SARI-NET indicated that this membership facilitated the development and implementation of the COVID-19 hospital surveillance within their site.
- The main challenges in this process were linked to the collection of the data, limited available human resources and compliance to information governance.

Whether surveillance objectives have been met

- Overall, the respondents were in agreement (or strong agreement) that the surveillance system met the objectives of the surveillance system (88%, 42/48).

Usefulness

- Just less than half of the required variables collected for surveillance purpose were selected by at least one respondent as unnecessary for surveillance purposes, including for example postcode, clinical characteristics, hospital ward and patient test/scan result.
- There was a clear emphasis that if timely data collection is desired then only essential variables should be collected. There was a consensus that this would minimise missing data and contribute towards the sustainability of the surveillance system.
- A few additional variables were suggested that could be useful for the surveillance, including, ethnicity, alcohol dependency and “do not resuscitate” status.
- Only a few respondents indicated that the data collected through the surveillance contributed to their national surveillance of COVID-19 and therefore was used to guide governmental decision making at a national level.
- However, the majority of the respondents indicated that the surveillance data supported the improvement of the surveillance by raising awareness, supporting the implementation and further development of national SARI surveillance.
- The majority of the interviewees indicated that being part of the network was beneficial and supportive. The network meetings were generally perceived positively, and the surveillance bulletins were perceived as informative although not timely enough to contribute to public health action.

Timeliness

- The time between the final dataset being received by PHS for analysis and the date of publication ranged from 15 days to 63 days, with an average number of 42 days.
- The time between the mean date of admission and the publication date increased over time suggesting that the timeliness of the surveillance system and the ability to influence public health action in a timely fashion reduced over the study period.

- The median date which data was received by Epiconcept was generally close to the deadline date for submission agreed between all sites and the coordinators, suggesting that there were no major issues with data submission.
- Respondents generally felt that the publication of the bulletins were not timely enough to meet the surveillance objectives although it was also acknowledged that more frequent publications would have burdened sites with additional data collection and submissions.

Data quality

- Patient demographics such as age, sex, hospital stay dates and the severity indexes were generally well-completed by all sites, with completion of greater than 70% in all surveillance bulletins.
- More specific patient characteristics including smoking status, pregnancy status, chronic conditions (anaemia, stroke and tuberculosis) and symptom data were less complete across the surveillance bulletins, with less than 25% completion for any of these variables. Other variables that had lower level of completeness and were therefore excluded from the analysis included in-hospital measurements and interventions, sequencing results and the genetic group. This may be a result of this information not being routinely collected across all the sites.
- The proportion of cases which were excluded during data validation decreased over time and the number of variables included in the surveillance bulletins increased, suggesting a data quality improvement over time.
- Generally, the analysis suggests that those sites utilising a sentinel questionnaire-based approach were able to achieve higher levels of completion of certain variables compared to those who utilised linkages of national routinely collected data. However, more cases were accrued by the sites using data linkage approaches, therefore, there are both pros and cons for each of the two methods.

Simplicity

- The majority of the respondents indicated that they experienced some challenges with data collection ranging from obtaining ethical permissions from data protection bodies and patients to collect and provide the data; using manual approaches for surveillance and trying to automate them, and finally the burden of data collection on clinical and public health colleagues during a pandemic.
- Overall, respondents indicated that the data collation was found to be straightforward, though challenges included a lack of data automation, a high workload and the large number of required clinical variables.
- Respondents indicated that on average the preparation of the datasets for submission required on average 11.5 days. The majority of the respondents suggested that additional human resources were required to deal with the heavy workload that they were experiencing, support with coordination between hospitals and public health institutes and assistance with data analysis.
- All respondents reported that the data submission process to Epiconcept was very easy.

- Meeting the data submission deadlines was sometimes perceived as challenging. When deadlines were not met, this was often related to a lack of human resources or a delayed data collection in the hospitals.

Sustainability

- Sites which collect data for the I-MOVE-COVID-19 network that also contribute to national surveillance indicated that they would continue the COVID-19 hospital surveillance as it stands, albeit in a reduced form depending on the situation of the pandemic.
- Other sites that are involved in other European surveillance networks such as VEBIS and E-SARI-NET will use the existing data collection tools, protocols and resources to continue the COVID-19 hospital surveillance as part of the new networks.

Limitations

This evaluation has several limitations. The COVID-19 hospital surveillance network consists of eleven participating sites that either have a population-based or sentinel surveillance in place. It is important to note that the responses to certain questions may reflect the respondent's perception of the current system within their sentinel site or specific area of work and may not necessarily provide a general view of the overall participating site.

The evaluation of the surveillance system was further limited by the wide heterogeneity of the surveillance systems across the different regions and countries. The variance of the different type of surveillance systems (sentinel vs. national surveillance) in place in the participating countries, as well as the variance in datasets, number of variables collected and completion rates makes comparisons challenging.

The self-reporting nature of the survey makes data subject to subjective interpretation by those collecting the information. Interpretation of the feedback from some of the questionnaires was sometimes challenging, especially where it was free text. Possible variance in inter-reporter understanding of the survey terms was to some degree reduced by piloting the questionnaire. The response rate of the survey was low, even though reminder e-mails were sent to the network in attempts to improve the response rate. Group discussions were arranged with representatives of most participating sites. Due to staffing and resources issues as a consequence of the pandemic it was not possible to arrange one-to-one interviews with all representatives of the participating sites separately, which may have provided a completer and more representative picture.

The COVID-19 pandemic has put unprecedented pressure on people working in healthcare and establishing a new surveillance system during such time has proven to be challenging.

5.2 Conclusions and recommendations

Being part of a European surveillance network was regarded as one of the key strengths of this surveillance system. Participating in a European network is extremely valuable and assisted the individual sites to strengthen the surveillance system at national level and supported building relationships with different national and international stakeholders. It was particularly beneficial to highlight the importance of the data collection and advocate for national surveillance. The network has supported the continuation of this data collection at different sites either through existing or new routes. The surveillance system was generally perceived as uncomplicated and easy to use;

support was available when needed and the data submission process was considered straightforward. The quality of the data was perceived positively mainly due to the different data validation processes at local, national and European level.

A common challenge mentioned throughout the questionnaires and interviews was the collection of the data. It was challenging to collect the large number of required variables, particularly when the pressure in the hospitals and on clinical staff were already high with data completeness issues as a result. It was suggested that reducing the number of required variables would further improve the data quality and support the sustainability of the surveillance system. Further challenges that were frequently highlighted included the compliance of privacy and data protection regulations and the high pressure on staff resources to ensure timely data collection.

The following recommendations are made as a result of this evaluation:

- Further harmonise the substantial inter- and intra-country differences in surveillance methods to ensure heterogeneity of the scope, focus, objectives, methodology, resources and reporting across the different regions and countries.

- Reduce the minimum mandatory dataset in collaboration with participating sites to enable increased data completeness and improve data quality.

- Workload issues need to be monitored to ensure the sustainability of the surveillance.

- Consider introducing a uniform template for data submission to harmonise the order and coding of variables to minimise the extent of the data management carried out by Epiconcept post data submission.

- Increase the timeliness of reporting of data to further ensure to achieve the objectives set out by the surveillance system and support public health action in a timely fashion.

- Explore options of merging data submission with other existing networks (such as E-SARI-NET or VEBIS) or moving the data collection to those networks in order to ensure sustainability of the surveillance whilst still achieving the surveillance objectives set out through the COVID-19 hospital surveillance network.

- Continue further data analysis with the available data collected through the surveillance and share results with the network and scientific community.

- Set and communicate fixed data reporting deadlines well in advance.

- Encourage participating sites to contribute to the network meetings by preparing short presentations in advance.

- Regularly review the different processes of the surveillance system to assess whether they are still fit for purpose at relevant stages of the development/implementation of the

surveillance (e.g. review data collection moments, suitable meeting frequency, and assess list of variables at different stages of the pandemic).

- Continue efforts to facilitate data collection in participating sites (e.g. automation of systems, updates review of variables)

Appendices

Appendix 1 – Document review

The following documents have been identified related to the COVID-19 hospital surveillance:

Table 6. Grey literature related to the COVID-19 hospital surveillance.

Document category	Document	Date of publication	HTML/link
I-MOVE COVID-19 Surveillance Protocol	COVID-19 European hospital surveillance: Draft generic protocol	June 2020	https://www.imoveflu.org/wp-content/uploads/2021/03/14jun2020_draft_generic_protocol-I-MOVE-COVID-19_hosp_survl_v8.1.pdf
I-MOVE COVID-19 Surveillance Bulletins	COVID-19 European hospital surveillance: First surveillance bulletin including data from all sentinel sites	15 September 2020	https://www.imoveflu.org/wp-content/uploads/2020/10/D3.5-First-Surveillance-bulletin-I-MOVE-COVID-19_WP3.pdf
	COVID-19 European hospital surveillance: Second bulletin	19 January 2021	https://www.imoveflu.org/wp-content/uploads/2021/01/19jan2021_Second_Surveillance_bulletin_I-MOVE-COVID-

Document category	Document	Date of publication	HTML/link
			19_WP3_hosp_surv_final_revised.pdf
	COVID-19 European hospital surveillance: Third Bulletin	15 March 2021	https://www.imoveflu.org/wp-content/uploads/2021/03/IMove-Bulletin-Feb-2021_FINAL-13.03.21.pdf
	COVID-19 European hospital surveillance: Fourth Bulletin	12 July 2021	https://www.imoveflu.org/wp-content/uploads/2021/07/I-MOVE-COVID19-WP3-Fourth-bulletin_FINAL_09072021.pdf
	COVID-19 European hospital surveillance: Fifth Bulletin	11 October 2021	https://www.imoveflu.org/wp-content/uploads/2021/10/I-MOVE-bulletin_5th_bulletin_05_10_2021_FINAL.pdf
	COVID-19 European hospital surveillance: Sixth Bulletin	Expected date of publication March 2022	

Table 7. Scientific literature on the I-MOVE COVID-19 hospital surveillance.

Lead author	Title	Date
Georgia Ladbury et al.	Establishing a novel European hospital surveillance platform in response to a newly emerging infection lessons from the I-MOVE-COVID-19 hospital network (ESCAIDE conference)	16 November 2021 (presented at ESCAIDE)
Damilola Mokogwu et al.	Enhanced surveillance of COVID-19 in secondary care in Europe: a tale of two waves	16 November 2021 (presented at ESCAIDE)

Table 8. Deliverable documents as part of WP3.

Deliverable	Name of document	Date
D3.1	Report describing current COVID-19 hospital surveillance practices	15 April 2020
D3.3	Hospital Phased surveillance protocol	15 June 2020
D3.2	Hospital Capacity strengthening plan	This deliverable was cancelled
D3.4	Surveillance monitoring and evaluation protocol	15 July 2020
D3.5	First surveillance bulletin	15 September 2020
D3.6	Second surveillance bulletin	15 March 2021

Deliverable	Name of document	Date
D3.7	Third surveillance bulletin	Expected 15 March 2022
D3.8	Surveillance evaluation report	Expected 15 March 2022

Appendix 2 – List of variables and definitions of the I-MOVE COVID-19 hospital-based surveillance dataset

Table 9. List of variables and definitions of the I-MOVE COVID-19 hospital-based surveillance dataset.

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
Study identifiers	idcountry	Identifier uniquely identifying the country	N	N
	id	Unique number for each patient	N	Y
	hospitalcode	Unique number for each hospital	N	N
	hosp_id2	Hospital-created unique ID for patient	Y	N
	consent	Agreement of patient to participate (where appropriate, i.e. in countries/sites where consent required for surveillance)	Y	N
Hospital/ward information	prevhosp	Prior admission to hospital (at least once in previous 12 months)	Y	Y
	admitdate	The hospital admission date of each patient	Y	Y
	hospitalward	First ward of referral	Y	Y
	hospitalward_oth		Y	Y
	dischargedate	Date of hospital discharge	Y	Y
	icu	Admission to intensive care unit (ICU) or high-dependency unit (HDU)	Y	Y
	icuadmitdate	Date first admitted ICU/HDU	Y	Y
	icudisdate	Date last discharged from ICU/HDU	Y	Y
	los_hosp	Length of stay (days) in hospital	Y	N
	los_icu	Length of stay in ICU/HDU (if no dates for ICU/HDU admission/discharge)	Y	Y
	swabdate	Respiratory specimen collection date	Y	Y

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
	multiple_hosp	Whether patient had >1 hospital admission for SARI or suspected COVID-19 as part of this current episode (> 14 days from onset)	Y	Y
	multiple_hosp	Number of re-admissions (where 2 = Re-admission 2 known)	N	N
	multiple_episode	How many re-admissions have they had >14 days from initial onset? (Indicate which re-admission number this record represents)	Y	Y
	hospitalward	First ward of referral	N	N
	hospitalward_sp	Specify other first ward of referral	N	N
Prior healthcare contact	healthcare_contact		Y	Y
Patient characteristics	sex	Sex of patient	Y	Y
	dob	Date of birth (only if no age; once age calculated from dob this will be dropped)	N	N
	age_y	Age of patient (if unable to provide dob) in years for those aged 2 years and older	Y	N
	age_m	Age of patient (if unable to provide dob) in years for those aged 2 years and older	Y	N
	residence	Patient residence at time of SARI onset. Whether patient was living at home or was institutionalised, or had pre-hospital dependence on home support/care	Y	Y
	postcode	Postcode of residence (where possible)	Y	N
	smoking	Never, former (stopped smoking at least 1 year before inclusion in the study), current smoker	Y	Y
	pregnant	Whether patient is pregnant	Y	Y

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
	trimester	Trimester of pregnancy	Y	Y
	postpartum	Whether patient is within the first 6 weeks post partum	Y	Y
	hcw	Whether the patient is a healthcare worker	Y	Y
Case/severity definitions (COVID or not)	lab_covtest	Tested for SARS-CoV-2	Y	Y
	lab_covtesttype	Type of lab test used	Y	N
	lab_covtesttype_sp	Specify other type of lab test	Y	Y
	lab_covid	Laboratory result: virus type SARS-CoV-2	Y	Y
Case/severity definitions (SARI signs/ symptoms at admission)	feverishness	Sub-febrility (37–38°C) (to construct SARI case definition)	Y	Y
	fever	History of fever (to construct SARI case definition)	Y	Y
	malaise	Malaise (to construct SARI case definition)	Y	Y
	headache	Headache (to construct SARI case definition)	Y	Y
	myalgia	Myalgia (to construct SARI case definition)	Y	Y
	sorethroat	Sore throat (to construct SARI case definition)	Y	Y
	cough	Cough (to construct SARI case definition)	Y	Y
	suddenonset	Sudden onset	Y	Y
	sob	Shortness of breath (to construct SARI case definition)	Y	Y
	general_deter	Deterioration of general condition (asthenia or loss of weight or anorexia or confusion or dizziness) (to construct SARI case definition)	Y	Y
	vomit	Vomiting	Y	N
	diarr	Diarrhoea	Y	Y
	abdopain	Abdominal pain	Y	Y
	ageusia	Loss of sense of taste	Y	Y

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
	anosmia	Loss of sense of smell	Y	Y
	dysgeusia		N	Y
	onsetdate	Date of onset of symptoms	Y	Y
Case/severity definitions (severity indicators)	outcome	Indicate the outcome of the patient known at the time of data collection (note: this may be updated later)	Y	Y
	deathdate	Date of death	Y	Y
	deathcause	Cause of death	Y	Y
	vent	Patient's level of mechanical ventilation. Note that option 1 is for respiratory support level ECMO, option 2 includes any high-flow (6L/min or higher, including OptiFlow), and option 3 includes any noninvasive, positive pressure ventilator.	Y	Y
	vent_sp	Specify other mechanical ventilation	Y	N
	vent_type	Type of invasive ventilation: positive endexpiratory pressure (PEEP), bilevel positive airway pressure (BiPAP), continuous positive airway pressure (CPAP) or othe	Y	N
	venttype_sp	Specify other invasive ventilation type	Y	N
Risk factors (close contact setting)	closecont	Close contact setting with a person who is a probable or confirmed case in the 14 days prior to symptom onset	Y	Y
	closecont_sp	Specify other close contact setting	Y	N
	closecont_type	Close contact setting with a person who is a probable or confirmed case	Y	Y

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
Risk factors (exam/labs results on admission or during hospital stay)	ct_us_ecg	Indicate whether patient had CT, ultrasound, Chest X-ray, ECG, or none of these (note: several selections may be made, e.g. if patient had CT and u/sound)	Y	N
	ct_res	CT, u/sound and CXR results. Ground-glass opacification defined as hazy increased lung attenuation with preservation of bronchial and vascular margins. Consolidation defined as opacification with obscuration of margins of vessels and airway walls	Y	N
	ct_res_sp	Specify other significant finding on CT/ultrasound/CXR	Y	N
	cxr_sp		N	N
	examoth_sp	List any other in-hospital examinations and their most significant findings	Y	Y
	ecg_qt	Specify presence/absence of long QTc on ECG findings	Y	N
	oxsat	Patient's oxygen saturation on admission to hospital (on air), %	Y	N
	seq	Whether patient sample was sequenced/sent for sequencing	Y	Y
	genetic_group	Laboratory result: genetic group	Y	Y
	abo	ABO blood grouping	Y	
	cxr	Chest X-ray findings	Y	N
	cxroth_sp	Specify other CXR result, if relevant	Y	N
	trialdrugs	Have any trial drugs been administered to the patient?	Y	Y
	study_convpl	Convalescent plasma	Y	Y
	study_gm_csf	GM-CSF	Y	Y
	study_oth	Other new/study/trial drugs	Y	Y
	study_oth_sp	Specify any other study or trial medications	Y	N

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
Underlying chronic conditions	anaemia	Anaemia/chronic haematologic disease	Y	Y
	asplenia	Asplenia (absence of/damage to spleen)	Y	Y
	asthma	Asthma	Y	Y
	cancer	Cancer (any)	Y	Y
	dement	Dementia	Y	Y
	diabetes	Diabetes	Y	Y
	heartdis	Heart / cardiac disease (excluding hypertension)	Y	Y
	hypert	Hypertension	Y	N
	immuno	HIV (including other immunodeficiency, organ transplantation)	Y	Y
	liverdis	Chronic liver disease (excluding cancer)	Y	Y
	lungdis	Lung disease (excluding asthma)	Y	Y
	neuromusc	Neuromuscular disorder	Y	Y
	height	Height of patient in metres	Y	N
	weight	Weight of patient in kg	Y	N
	bmi	BMI of patient (only if available in place of missing wt/ht)	Y	N
	obese	Obesity (only if height, weight and BMI not collected; can be calculated)	Y	Y
	rendis	Renal disease (excluding cancer and acute renal failure)	Y	Y
	rheumat	Rheumatologic disease	Y	Y
	Stroke	Stroke	Y	Y
	tuberc	Tuberculosis	Y	Y
Risk factors (inhospital medications/ interventions)	ox_nasal	Nasal oxygen (not high-flow)	Y	Y
	prone	Whether patient was placed in prone 1 = Yes position for ventilation	Y	Y
	nebu	Nebuliser treatment	Y	Y
Symptoms at admission	chills	“Chills”, shivering	Y	Y

Variable category	Variable	Definition	Variables in data dictionary to be completed for data submission (N=105)	Variables included final surveillance dataset (N=85)
	tach	Tachypnoea or signs of low oxygen saturation	Y	Y
	coryza	Coryza	Y	Y
	confusion	Confusion	Y	Y
	dizzy	Dizziness	Y	Y
	chest	Chest pain	Y	Y
	palp	Palpitations	Y	Y
	nausea	Nausea	Y	Y
	nausea_vomit		N	Y
	conjunct	Conjunctivitis	Y	Y
	dermato	Rash or other dermatological manifestations of COVID-19	Y	Y
Laboratory results	pcr2	Whether a second PCR was done (if first PCR was negative)	N	Y
	lab_covidpcr2	Second PCR result for virus type SARS-CoV-2	N	Y