UK Health Security Agency

Mandatory healthcare associated infection surveillance: data quality statement for April 2019 to March 2020

June 2022

Contents

Introduction

History of surveillance of Gram-negative and *Staphylococcus aureus* bacteraemia and CDI mandatory surveillance

The UK Health Security Agency (UKHSA) and predecessors, the Health Protection Agency (HPA) and Public Health England (PHE), have managed the mandatory surveillance of *Staphylococcus aureus* bacteraemia since April 2001.

As part of reforms to the UK's public health system, PHE transferred its health protection functions to UKHSA on 1 October 2021. Although the mandatory surveillance now falls under the remit of the UKHSA, the nature and implementation of the mandatory surveillance of Gram-negative and Staphylococcus aureus bacteraemia and CDI mandatory surveillance did not change as result of the transition.

Mandatory surveillance began in response to increasing rates of MRSA bacteraemia across the English NHS and has subsequently been rolled out for other HCAIs where there was a perceived issue.

It has been mandatory for NHS acute trusts to report all cases of Meticillin-resistant *Staphylococcus aureus* (MRSA) bacteraemia since April 2004. In October 2005, the surveillance scheme was enhanced to include patient-level data. Enhanced surveillance involves collecting patient details such as NHS number, hospital number, date of birth and sex, as well as information concerning the patient's location, date of admission, consultant specialty, and associated care details. All information is collected by acute trusts and reported to UKHSA via a real-time web-based surveillance system (Healthcare Associated Infection Data Capture System (HCAI DCS)). In January 2011, this scheme was extended to include surveillance of Meticillin-sensitive Staphylococcus aureus (MSSA) bacteraemia.

Between April 2013 and April 2018, all NHS organisations reporting positive cases of MRSA bacteraemia were required to complete a Post Infection Review (PIR). This process was introduced to support the delivery of zero tolerance on MRSA bacteraemia, as set out by NHS England Planning Guidance. A PIR was undertaken on all reported MRSA bacteraemias with the purpose of identifying how a case occurred and to identify actions which would prevent reoccurrences. It also enabled identification of the organisation best placed to ensure necessary improvements are made. From April 2018, only trusts with MRSA rates in the top 15% of trusts were required to undertake PIRs for any MRSA cases. In addition, trusts which breach the threshold in the course of a year will be expected to commence the PIR process for the

remainder of the year. From this point, PIR became a local process and was not reported to UKHSA[1].

Surveillance of *Clostridioides difficile* (previously identified as *Clostridium difficile*) infection (CDI) was originally introduced in 2004 for patients aged 65 years and over. This was then extended to include all cases in patients aged 2 years and over in April 2007. Reports are submitted using the same HCAI DCS.

Escherichia coli (*E. coli*) bacteraemia surveillance was introduced in June 2011 following observed year-on-year increases via UKHSA voluntary surveillance and a recommendation from the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection (APRHAI). In April 2017, *Klebsiella* spp. and *Pseudomonas aeruginosa* bacteraemia were added to the mandatory surveillance scheme alongside *E. coli bacteraemia* surveillance these additional requirements are to support progress against the Government's ambition to reduce the number of Gram-negative bloodstream infections by 50% by the end of financial year (FY) 2023 to 2024.

Relevant Chief Medical Officer and Chief Nursing Officer letters detailing the introduction of the various mandatory surveillance schemes can be found below:

- Implementation of mandatory HCAI surveillance
- MRSA bacteraemia mandatory surveillance
- NHS Improvement guidance on PIR
- CDI surveillance (patients aged 65 and over)
- CDI surveillance (patients aged 2 and over)
- MSSA bacteraemia
- *E. coli* bacteraemia

The ambition to halve healthcare associated Gram-negative bloodstream infections by 2023 to 2024 is outlined in the 'UK 5-year action plan for antimicrobial resistance 2019 to 2024' policy document.

Purpose of the mandatory surveillance scheme

Mandatory HCAI surveillance outputs are used to monitor progress on controlling major healthcare associated infections and for providing epidemiological evidence to inform action to reduce them.

Data is unavailable from any other source and provide unique case level information.

[1] Guidance on the reporting and monitoring arrangements and post infection review process for MRSA bloodstream infections from April 2014 (version 2)

Data is used to support the NHS objective of improving the quality and safety of health services and promoting patient choice by providing access to information on NHS performance.
Data is used nationally for benchmarking purposes and for the performance management of MRSA bacteraemia and CDI objectives set by NHS Improvement.

Data and outputs are also routinely used to answer relevant Parliamentary Questions.

This data is also used to inform patient choice via the NHS Choices website.

NHS acute trusts and CCGs use this data to monitor progress against these objectives and to help inform action to reduce these infections locally. Mandatory surveillance outputs are routinely used to appraise local and regional NHS management of infection levels within their area.

The *Klebsiella* spp. and *P. aeruginosa* bacteraemia surveillance outputs will are an integral part of NHS Improvement's strategy for the 50% reduction in Gram-negative bacteraemia by the end of the financial year 2023 to 2024.

Relevance of the mandatory surveillance scheme

Users' needs

Data and outputs from the mandatory surveillance of bacteraemia and CDI are used for a variety of purposes, by a range of organisations across the health service. Details of key stakeholders and associated data users are outlined below.

National users

UKHSA data and outputs are used to:

- undertake epidemiological analyses at national, regional or local level to provide, on request, relevant response to Parliamentary Questions

Department of Health and Social Care (DHSC) data and outputs are used to:

- routinely brief ministers on national and regional incidence of MRSA, MSSA, *E. coli*, *Klebsiella* spp. and *P. aeruginosa* bacteraemia and CDI.
- inform and identify national level targets for interventions and reduction strategies

NHS England and NHS Improvement data and outputs are used to:

- identify and establish performance management and improvement methodologies
- set national and local level performance management targets and objectives
- assess performance against target or objective

Regional or local users

Sustainability Transformation Partnerships (STP) data and outputs are used to:

- assess NHS trust and CCG performance against targets or objectives at a local level

UKHSA Field Epidemiology Service and UKHSA Regions data and outputs used to:

- assist in outbreak investigation as or when necessary
- inform public health initiatives and reports at a local level

NHS acute trusts data and outputs are used to:

- inform trust boards of the current organisational position in terms of key HCAIs (MRSA, MSSA and *E. coli* bacteraemia and CDI)
- monitor progress against performance management objectives and targets

Clinical commissioning groups data and outputs are used to:

- monitor progress against performance management objectives and targets
- assist in the commissioning of services from relevant acute level providers

User satisfaction

A routine Stakeholder Engagement Forum is held every 3 months. This meeting includes representation from a wide range of national and local level stakeholders as such as CCGs and acute trusts.

Standing items on the meeting's agenda include:

- recent publications
- experiences
- improvements
- future developments and updates

Following the meeting a summary of the discussion and outcomes is produced and is available on the HCAI DCS website. This summary covers:

- currently known uses of data and outputs
- user experiences (including changes, updates and improvements)
- stakeholder opinion of proposed and upcoming changes

Meeting feedback is used to improve and enhance ongoing engagement. It is also used to inform future development and to ensure that data users remain central or integral to the process.

Timeliness and punctuality

Timeliness

Mandatory HCAI surveillance data is published in as timely a manner as possible. Data is signed off by acute trusts' chief executives 15 days after the end of each month (that is, sign off for each month is required by the 15th of the following month). Data is published on a monthly, quarterly and annual basis according to a pre-announced publication schedule published on GOV.UK.

The UKHSA official statistics publication calendar is available online. This includes mandatory HCAI surveillance specific announcements.

Monthly data tables

Monthly data is processed and analysed before being published on the first Wednesday of the following month. This occurs between 2 and 6 weeks following the end of a given month (depending on how the month falls). For example, January 2017 data was signed off on 15 February 2017 and then published on 1 March 2017. This is 2 weeks from sign off to publication.

Quarterly epidemiological commentary (QEC)

The QEC is published approximately 2 months following sign-off of the last full month of data for inclusion.

For the April 2019 to March 2020 publications, this was increased to 4 months. The increase is to allow for the inclusion of the most recent hospital admissions data which would otherwise be unavailable at the time of the QEC's production. This change is relevant due to the lower than usual levels of hospital admissions in April 2019 to March 2020 due to the coronavirus (COVID-19) pandemic.

Publication of this report occurs on the first Thursday of the fourth month after the quarter covered in the reported. For example, data up to and including December 2021 was signed off on 15 January 2022 and was published on 7 April 2022.

Annual data tables and annual epidemiological commentary (AEC)

Annual data tables and the accompanying AEC was usually published in early July each year. For the April 2019 to March 2020 publication, this was delayed to September. This delay was to allow for the inclusion of the most recent hospital admissions data which would otherwise be unavailable at the time of the AEC's production. Similarly, this change due to the lower than usual levels of hospital admissions in April 2019 to March 2020 due to the COVID-19 pandemic.

The annual data tables include counts and rates for both acute trusts and CCGs. The AEC represents the most substantial HCAI mandatory surveillance output produced or published each FY. The lead time necessary for analysis and compilation of data cannot be underestimated. Decreasing the amount of time between sign off and publication of these reports has been considered. However, doing so would not allow enough time to undertake relevant data quality checks on either the data used for preparing the report or the report itself. Hence the benefit of using the current publication schedule far outweighs any minor benefit that might be achieved in reducing the lead time for the QEC publication.

Furthermore, the changes to the publication schedule for 2020 to 2021 was due to those periods having atypical levels of hospital admission, necessitating the need wait and use published admission data.

Punctuality

All published data outputs are published at 9:30am on the pre-announced publication date. To date there have been 2 occasions where publication was delayed. On 10 July 2014 publication of the annual data and accompanying Annual Epidemiological Commentary (AEC) was delayed by approximately 30 minutes as a result of unforeseen delays in the process used by Online Services for uploading statistics to the external website. Further information about this delay is available on the UKHSA website.

Routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data (SGSS)

The Second Generation Surveillance System (SGSS) is a voluntary surveillance data capture system used by laboratories to report cases of microbial infection from various samples, for example, blood, urine and faeces and so on. Information on antibiotic and antifungal susceptibility is also submitted where relevant. Although primarily an internal system used by healthcare professionals, the data reported via this system is routinely compared to the mandatory data collected via the mandatory surveillance database - HCAI DCS. This routine comparison between surveillance systems provides a data quality check of the ascertainment of cases reported to the HCAI DCS.

Note that testing for *C. difficile* is a 2-stage process, the second stage identifies *C. difficile* toxin. Only *C. difficile* toxin-positive cases are reportable to the mandatory surveillance system. It is not currently possible to differentiate reported *C. difficile* cases which have tested positive for *C. difficile* toxins from those which have not, with an acceptable degree of accuracy from SGSS. This is due to data quality and reporting issues in SGSS. Therefore, it is not currently possible to include *C. difficile* data in the routine HCAI DCS/SGSS comparison as information on *C. difficile* cases is not comparable.

The following summary provides the results of this comparison for financial year April 2019 to March 2020.

Figure 1 compares the overall trends of MRSA and MSSA bacteraemia reported to the mandatory (HCAI DCS) and voluntary (SGSS) surveillance schemes between financial year April 2011 to March 2012 and financial year April 2019 to March 2020. Figure 2 shows the same comparison for *E. coli*, *Klebsiella* spp. and *P. aeruginosa* bacteraemia.

Figure 1. Number of MRSA and MSSA bacteraemia cases reported via the mandatory surveillance and voluntary surveillance schemes: April 2011 to March 2020

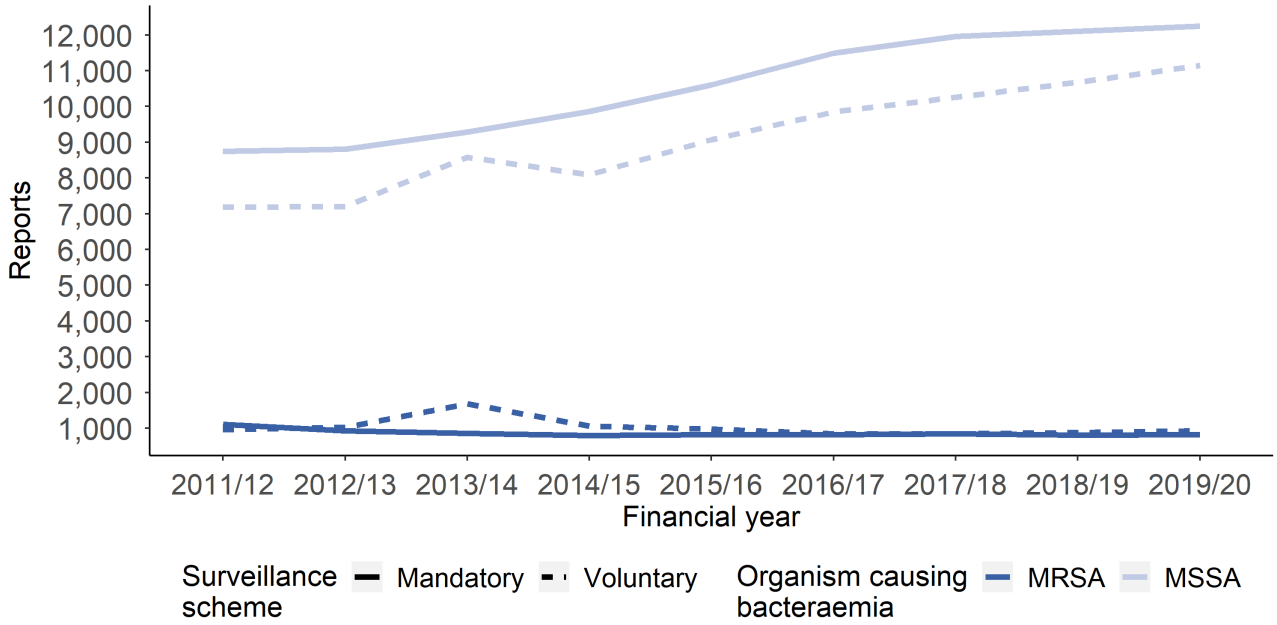
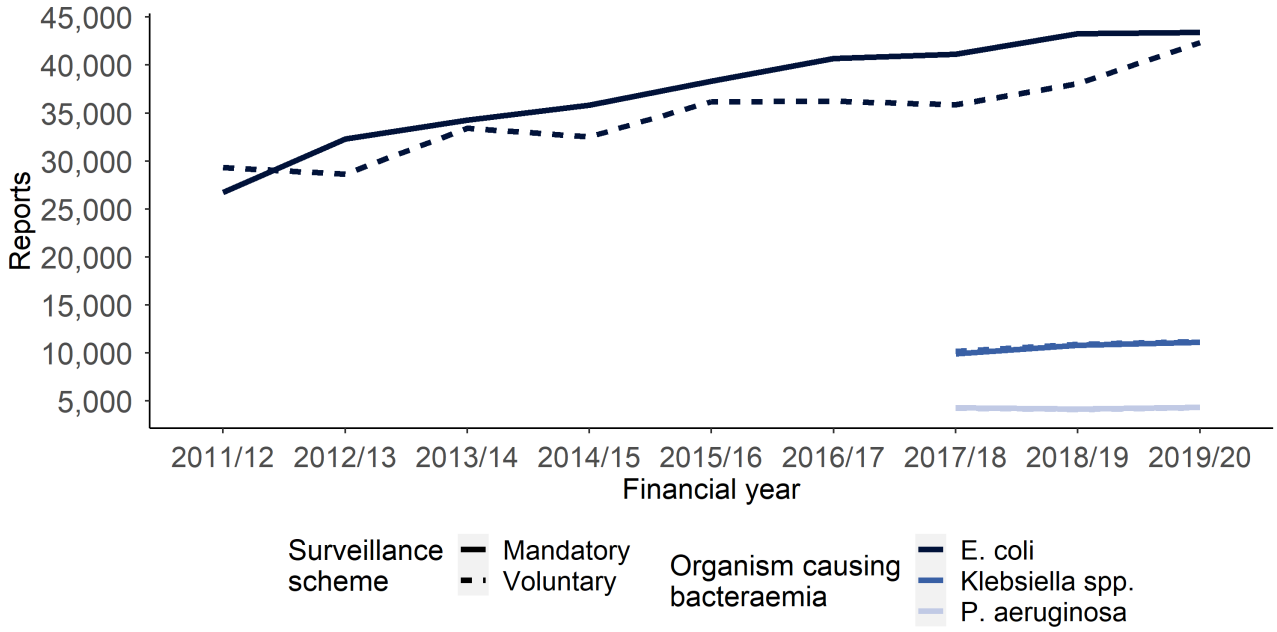


Figure 2. Number of *E. coli*, *Klebsiella* spp. and *P. aeruginosa* bacteraemia cases reported via the mandatory surveillance and voluntary surveillance schemes: April 2012 to March 2020 (Note that mandatory reporting of *E. coli* bacteraemia began in June 2011 while mandatory reporting of *Klebsiella* spp. and *P. aeruginosa* began in April 2017)



In general, these show that more cases are captured via mandatory surveillance than via voluntary surveillance however, the overall trends of cases reported to both surveillance schemes remain the same. Interpretation of the comparisons in case numbers for MRSA and MSSA bacteraemia should be done with care. Meticillin resistance in the mandatory surveillance is reported by NHS acute trusts after susceptibility testing.

However, for this report, meticillin resistance in the voluntary system was determined by selecting the most severe susceptibility results from patients' blood cultures within a 14-day period. This difference is a contributory factor to the apparent over-ascertainment of the voluntary MRSA reports in some financial years.

HCAI DCS and SGSS matching process

Not all SGSS cases are eligible for reporting in the mandatory HCAI DCS. Therefore, for data sets to be comparable, eligible SGSS cases have been defined as:

MRSA bacteraemia – The earliest *S. aureus* blood isolate per patient within a 14-day period, with a susceptibile (resistant or indeterminate) result to meticillin, oxacillin, cefoxitin or flucloxacillin result within the 14-day period.

MSSA bacteraemia – The earliest *S. aureus* blood isolate per patient within a 14-day period, with no susceptibile (resistant or indeterminate) result to meticillin, oxacillin, cefoxitin or flucloxacillin result within the 14-day period.

E. coli bacteraemia – The earliest *E. coli* blood isolate per patient within a 14-day period.

Klebsiella spp. bacteraemia – The earliest *Klebsiella* spp. (including *Enterobacter aerogenes*) blood isolate per patient within a 14-day period.

P. aeruginosa bacteraemia – The earliest *P. aeruginosa* blood isolate per patient within a 14-day period

Matched cases between surveillance systems were identified using a number of ordered matching criteria (see Appendix 2 for details) and a 14-day window between cases from both surveillance schemes.

Table 1. Total number of cases reported to the mandatory and voluntary surveillance schemes, April 2019 to March 2020

Organism causing bacteraemia	Voluntary	Mandatory	Ascertainment (%)
S. aureus	12,999	-	-
MRSA	932	814	114
MSSA	11,134	12,206	91
Unknown methicillin susceptibility	933	-	-
E. coli	42,322	43,281	98
Klebsiella spp.	11,046	11,076	100
P. aeruginosa	4,297	4,326	99
Total	**57,665**	**58,683**	**98**

Number of cases from voluntary surveillance (SGSS) found in the mandatory surveillance scheme (HCAI DCS)

Reports have been matched this way to demonstrate the effectiveness of the HCAI DCS in capturing all cases of Gram-negative and *Staphylococcus aureus* bacteraemia which are eligible for mandatory reporting. Figure 3 and Table 3 shows the number of cases reported via voluntary surveillance (SGSS) that were also captured via mandatory surveillance (HCAI DCS).

Overall 67,933 (96%) eligible cases reported via SGSS were identified in the HCAI DCS. The number of MRSA, MSSA, *E. coli*, *Klebsiella* spp. and *P. aeruginosa* bacteraemia cases reported to the voluntary surveillance scheme which were identified in the mandatory surveillance scheme were 728 (78%), 10,673 (96%), 41,202 (97%), 10,368 (94%) and 4,072 (95%) cases respectively.

Figure 3. Ascertainment of cases reported the voluntary surveillance scheme which were identified in the mandatory surveillance scheme

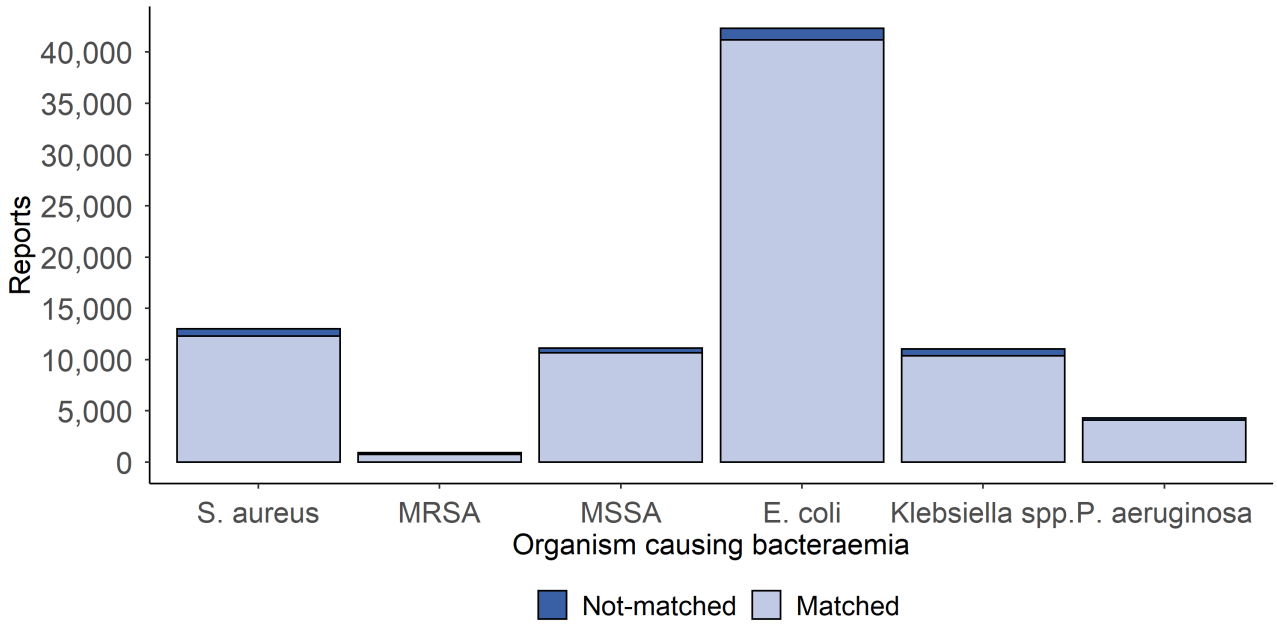


Table 2. Ascertainment of cases reported to the voluntary surveillance scheme which were identified in the mandatory surveillance scheme

Organism causing bacteraemia	Matched (%)	Not matched (%)	Total (%)
S. aureus	12,291 (95%)	708 (5%)	12,999 (100%)
MRSA	728 (78%)	204 (22%)	932 (100%)
MSSA	10,673 (96%)	461 (4%)	11,134 (100%)
Unknown methicillin susceptibility	0 (0%)	933 (100%)	933 (100%)

Organism causing bacteraemia	Matched (%)	Not matched (%)	Total (%)
E. coli	41,202 (97%)	1,120 (3%)	42,322 (100%)
Klebsiella spp.	10,368 (94%)	678 (6%)	11,046 (100%)
P. aeruginosa	4,072 (95%)	225 (5%)	4,297 (100%)
Total	67,933 (96%)	2,731 (4%)	70,664 (100%)

The apparent under-ascertainment of MRSA and MSSA cases compared to other data collections is an artefact of how meticillin susceptibility is determined in the mandatory and voluntary surveillance schemes. When comparing *S. aureus* cases as a whole regardless of meticillin susceptibility, only 708 (5%) *S. aureus* cases were not identified in the HCAI DCS.

Number of cases from the mandatory surveillance scheme (HCAI DCS) found in the voluntary laboratory surveillance scheme (SGSS)

Reports were matched on a case by case basis in order to identify the proportion of individual cases that are captured via the mandatory surveillance scheme (HCAI DCS) but are not reported via the voluntary laboratory surveillance scheme (SGSS).

Table 2 shows the percentage of cases reported via the HCAI DCS that were also identified in SGSS. Overall 68,429 (95%) cases reported to the HCAI DCS were also reported in SGSS. The number of MRSA, MSSA, *E. coli*, *Klebsiella* spp. and *P. aeruginosa* cases identified in SGSS were 732 (90%), 10,829 (89%), 41,346 (96%), 10,502 (95%) and 4,108 (95%) respectively. This suggests that only about 5% of infection currently captured by the mandatory surveillance could not be found in voluntary surveillance. This demonstrates the importance of both the mandatory surveillance scheme and of the system used for data collection (HCAI DCS). Further benefits are outlined in Strengths and weaknesses.

Table 3. Ascertainment of cases reported to the mandatory surveillance scheme which were identified in the voluntary surveillance scheme FY April 2019 to March 2020

Organism causing bacteraemia	Matched (%)	Not matched (%)	Total (%)
S. aureus	12,473 (96%)	547 (4%)	13,020 (100%)
MRSA	732 (90%)	82 (10%)	814 (100%)
MSSA	10,829 (89%)	1,377 (11%)	12,206 (100%)
E. coli	41,346 (96%)	1,935 (4%)	43,281 (100%)
Klebsiella spp.	10,502 (95%)	574 (5%)	11,076 (100%)
P. aeruginosa	4,108 (95%)	218 (5%)	4,326 (100%)
Total	68,429 (95%)	3,274 (5%)	71,703 (100%)

Resolution of unmatched cases from the voluntary surveillance scheme

As part of the routine laboratory data checks, laboratories with cases reported to the voluntary surveillance scheme but not identified in the HCAI DCS (mandatory scheme) are contacted for feedback on the discrepancy. The cases are closed if:

1. The unmatched case is subsequently identified in the HCAI DCS.
2. The unmatched case is added to the HCAI DCS as a new record.
3. There is a legitimate reason for it not being reported to the HCAI DCS (for example, post-mortem blood cultures).

Table 4 shows the result of this follow up process for April 2019 to March 2020.

Table 4. Follow-up for unmatched cases

Organism causing bacteraemia	Number of cases unmatched	Number of cases resolved (%)
S. aureus	1,598	53 (3%)
MRSA	204	3 (1%)
MSSA	461	27 (6%)
Unknown meticillin susceptibility	933	23 (2%)
E. coli	1,120	42 (4%)
Klebsiella spp.	678	28 (4%)
P. aeruginosa	225	5 (2%)
Total	3,621	128 (4%)

Expected number of reports not captured by the mandatory surveillance scheme

Assuming all currently open cases remain open, an expected number of cases eligible for mandatory reporting which haven't been captured by the HCAI DCS can be estimated. For example, the results of this routine laboratory data check show that overall 95% (n = 68,429) (Table 2) of cases reported to the HCAI DCS are captured in SGSS. It can be assumed that the total number of open cases from SGSS (n = 3,493) is also 95% of an expected number of unmatched cases which should be reported to the HCAI DCS. Therefore, we could expect up to 3,660 reports, across all organisms, which are not included in the mandatory surveillance scheme. Using this, an ascertainment of cases reported to the mandatory surveillance system compared to total number of cases eligible for mandatory reporting can be calculated as follows:

$$\left(\frac{\text{Total number of cases on the HCAI DCS}}{\text{Total number of cases on the HCAI DCS + expected number of unmatched cases from SGSS}}\right) \times 100$$

$$\left(\frac{71{,}703}{71{,}703 + 3{,}660}\right) \times 100 = 95$$

Using this method, the ascertainment of S. aureus, *E. coli*, *Klebsiella* spp. and *P. aeruginosa* bacteraemia cases reported to the mandatory surveillance system compared to the estimated total number of cases of these bacteraemia eligible for mandatory reporting are 89%, 97%, 94% and 95% respectively. This demonstrates that the HCAI DCS has an extremely high level of coverage.

Summary

Identifying cases from the mandatory surveillance scheme (HCAI DCS) which were also reported to the voluntary surveillance scheme (SGSS) demonstrates the percentage of Gram-negative, MRSA and MSSA bacteraemia which are not captured by SGSS (see Table 2):

1. Overall, 95% (n= 68,429) of all cases reported to the HCAI DCS can be accounted for in SGSS.
2. Of the 5% (n= 3,274) of cases not captured by SGSS, 15.9% (n=1,120) are *E. coli* bacteraemia, 9.6% (n=678) are *Klebsiella* spp. bacteraemia, 6.5% (n=461) are MSSA bacteraemia, 3.2% (n=225) are *P. aeruginosa* bacteraemia and 2.9% (n=204) are MRSA bacteraemia.
3. This demonstrates the necessity of the mandatory surveillance scheme. Relying on voluntary surveillance alone would mean that an estimated 5% of the total burden of infection across the organisms currently subject to mandatory surveillance would be missed.

Identifying cases from SGSS which were also reported to the HCAI DCS demonstrates the effectiveness of the HCAI DCS as a surveillance system responsible for capturing Gram-negative, MRSA and MSSA bacteraemia eligible for mandatory surveillance (see Table 3):

1. Overall, 96% (n= 67,933) of all cases reported to SGSS are also accounted for in the HCAI DCS.
2. The highest ascertainment of SGSS cases found in the HCAI DCS, was observed in *E. coli* (95.5%, n= 41,346) and *P. aeruginosa* (95.0%, n= 4,108).
3. The seemingly lower ascertainment of MRSA (89.9%, n= 732) and MSSA (88.7%, n= 10,829) is due to a difference in how meticillin susceptibility is determined in the mandatory and voluntary surveillance systems. The ascertainment of *S. aureus* cases as a whole regardless of meticillin susceptibility is 95% (n= 12,291).

Taking into account the open cases identified in the voluntary surveillance scheme, the HCAI DCS is capturing an estimated 89%, 97%, 94% and 95% of S. aureus, *E. coli*, *Klebsiella* spp. and *P. aeruginosa* bacteraemia cases, respectively, which are eligible for mandatory reporting.

In conclusion, the vast majority of data reported via UKHSA's voluntary surveillance system (SGSS) can be found in data reported to mandatory surveillance (HCAI DCS). This suggests that the HCAI DCS can indeed be seen to provide an accurate national picture of the overall burden of infection across the 3 bacteraemia under mandatory surveillance in England.

Accuracy and reliability

Under mandatory surveillance guidelines all laboratory confirmed cases should be reported. Data should not be subject to sampling error, as the data collection is a census of all infections rather than a sample (that is, all laboratory-confirmed cases of these infections in England are mandated to be reported to UKHSA). However, there is the potential for non-sampling error.

Coverage error

Infection cases are reported by NHS acute trusts. As part of the verification process, the CEO of the acute trust signs off infection data reported each month by the 15th of the following month (as outlined in the Timeliness section of this document). This sign-off process provides formal assurance that the data are accurate and complete. Published statistics therefore include details of all cases for the reported time period.

On occasion, however, a notification is received that an amendment is required (undertaken via the update process outlined in 'Practice area 2: Communication with data supply partners'). This may occur when sign off is required prior to full laboratory results being available. This may result in additional cases being added following laboratory confirmation. Alternatively, deletions may be required. An acute trust may have entered case information for what they thought was an MSSA bacteraemia, but further laboratory information may confirm the case to actually be an MRSA bacteraemia. In this situation, a CEO must request the deletion of the MSSA bacteraemia episode and the addition of an MRSA episode (for the same time period).

NHS acute trusts or external agencies (for example the Care Quality Commission) may also perform audits of local infection data. This can result in requests to add infection episodes that had not previously been entered. Finally, an NHS trust may ask to delete a case, if it is found to be a duplicate of a case reported from another trust (please see the Mandatory HCAI Surveillance Protocol, section 9.2 for further detail on what constitutes a duplicate).

NHS acute trusts may request to alter their data in order to improve the CCG attribution of a given infection record. The algorithm for CCG attribution is as described in the associated Mandatory HCAI Surveillance Protocol (section 13.6, Appendix 6). This process is undertaken via an 'unlock' of the HCAI DCS. Further detail of the unlock process can be found in the 'Data-specific policy for revisions or amendments to MRSA bacteraemia, MSSA bacteraemia, *E. coli* bacteraemia and *Clostridioides difficile* infection mandatory surveillance data'. Note that this policy will be updated to include *Klebsiella* spp. and *P. aeruginosa* over coming months.

A total of 86 (62%) acute trusts requested an unlock of at least 1 case across all organisms affecting data in financial year 2019 to 2020. This equated to 673 cases that were unlocked. 32.8% of these unlocks were to add additional cases to a locked period (n=221), 5.5% were amendments (n=37) and 61.7% (n=415) were to delete records (Table 5). Compared to the

previous financial year (2018 to 2019) there has been no percentage change in the number of trusts that requested unlocks to change their data. However, there has been a 12.5% decrease in the total number of unlocks. A decrease in number of unlocks to delete and add cases has also been seen, 36% decrease in deletions and 46% to add (n=413 to n=221). The number of unlock requests to amend cases increased from 298 to 415 requests. The number of deleted cases decreased from 58 to 37 requests.

Table 5. Number of unlocked cases by data collection and unlock reason, for financial year April 2019 to March 2020

Reason for unlock request	Date collection						
	CDI	MRSA	MSSA	*E. coli*	*Klebsiella* spp.	*P. aeruginosa*	Total
Add	33	10	33	68	70	7	221
Amend	24	4	3	5	0	1	37
Delete	162	4	57	135	57	0	415
Total	219	18	93	208	127	8	673

The HCAI DCS includes facilities to assist NHS acute trusts to identify duplicate infection episodes within their organisation. A pop-up for potential duplicates at case entry is available in order to determine that no duplicates have been entered for a designated time period. Following sign off, as the CEO of an acute trust has verified their data as being accurate, data used for statistical publications are not altered by the UKHSA mandatory HCAI surveillance team to remove potential duplicate records. This may result in multiple listings of the same infection episode in the data set.

As the mandatory surveillance of healthcare associated infections data set is a national-level data collection, there is no over coverage. However, there is a possibility that some cases may not be reported to the HCAI DCS, resulting in under coverage. In order to ascertain the level and to rectify this, a consistency study is performed comparing voluntary reported laboratory information for England with the mandatory surveillance scheme data set.

See routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data for more information.

Data changes between releases are highlighted in each publication, so that users are made aware of any changes to historical data between publications. Further information on this process is available on the caveats page of each routine publication.

Measurement error

All mandatory HCAI surveillance data is collected via the HCAI DCS. The appendices of the mandatory HCAI surveillance protocol detail definitions and guidance on each field in the data collection. Therefore, there should be little concern over the interpretation of the questions by different users, although it should be noted that some questions are subjective in nature, asking the clinical opinion of the treating physicians.

Non-response error

Item non-response

The bulk of data used to produce the mandatory HCAI surveillance outputs are from mandatory questions in the data capture system. This means that a response is required in order to save the infection episode. Therefore, there will be only a marginal effect of non-response error in the statistical outputs. The exceptions are the data collected on risk factors for bacteraemias presented in the Annual Epidemiological Commentary (AEC), because the risk factor or source of bacteraemia questions are not mandatory fields. However, there are accompanying statements in the relevant sections of the AEC on the level of response for these data, as well as, mention in the discussion of potential bias caused by missing data.

Unit non-response

While item non-response is extremely low, unit non-response (that is, individual NHS acute trusts who have not entered data and/or signed off data) is present. All trust-level outputs highlight such non-responders. Consistent non-responders are furthermore referred to NHS England for follow up or resolution.

Processing error

Data entry

Processing errors may occur during the data entry stage. The data collected via the HCAI DCS is either entered by hand or partially uploaded (the main questions required to save an infection episode) using the healthcare associated infections data capture system upload wizard. Data entry errors may occur, either because the source data at the acute trust is incorrect or missing, or in the transcription process.

While it is not possible to provide a level or direction of bias through processing errors for the entire data collection, it is possible to estimate the collective level of processing errors for 2 important variables (date of birth and NHS number), which can be used as an indicator for the full data collection. Section 13.6 (Appendix 6) of the associated Mandatory HCAI Surveillance Protocol details the process of CCG attribution. This is done through the use of both NHS

number and date of birth entered into the healthcare associated infections data capture system. If either the date of birth or NHS number is incorrect or missing, a match will not be made and we will not receive necessary patient data from the NHS Spine. Assessing the percentage of all cases which could not be attributed via a match with the NHS Spine provides an indication of data entry errors.

For financial year April 2019 to March 2020, less than XX% of all cases are not attributed to a CCG through a match with the Spine, where neither NHS number nor date of birth are missing. Thus, we are confident in the data entered onto the healthcare associated infections data capture system. Data entry errors may occur, either because the source data at the acute trust is incorrect or missing, or in the transcription process.

Data processing

As mentioned in Timeliness and punctuality, the accuracy of the data submitted to the mandatory surveillance of healthcare associated infections scheme is assured by the CEO of all of the reporting acute trusts via the monthly sign off process. Data is not amended after data entry. Data is, however, processed in order to produce the statistics. All statistical processing is performed independently by 2 scientists and then is cross-checked to verify that the data are correct. In addition, when rates are calculated for our quarterly commentaries and annual data tables and commentary, we also independently process the data used for denominators (occupied overnight bed days (KH03 return) from NHS England and population data from the Office of National Statistics).

Mandatory HCAI surveillance data in NHS performance management

NHS Improvement sets annual objectives for the continued improvement of CDI in England and there has been a zero-tolerance policy for MRSA since April 2013. Organisations which exceed their objectives are liable for financial penalties (up to and including 31 March 2014 for CCGs and to date for acute trusts).

Additionally, the secretary of state for health set an ambition to reduce Gram-negative bloodstream infections by 50% by 2023 to 2024.

While UKHSA are not responsible for either the setting of these objectives, or the imposition of financial sanctions, data collected, produced and published (as National Statistics) by UKHSA are used by NHS England to set objectives for, and the performance management of, Gram-negative bloodstream infection, CDI and MRSA bacteraemia incidence rates.

As such, there is the potential for the introduction of bias into the statistics, as one of the organisation types who are subject to targets (acute trusts) are responsible for reporting

infection numbers to UKHSA. Therefore, there could be a potential conflict between the use of statistics for both epidemiology and public health and for performance management.

Speculation of potential 'gaming' in NHS acute trusts, through the empirical treatment of suspected cases of CDI or MRSA bacteraemia without seeking microbiological confirmation of the diagnosis (whereby cases are only reportable to the surveillance scheme if they are laboratory confirmed) led UKHSA to investigate whether there was any evidence to corroborate such concerns.

A separate data set, (the Quarterly Mandatory Laboratory Returns) which includes the numbers of *C. difficile* toxin tests performed by laboratories in England between 2008 and 2013, was queried to ascertain if there were any changes in the testing of *C. difficile* toxin over a 6 year period in England. In brief, while there has been an overall decline in the count and rate of *C. difficile* toxin testing in England over this time period, there has been a much greater decline in the count and rate of CDI, with a much higher ratio of toxin tests performed per case of CDI identified in 2013 than in 2008, leading to the conclusion that there is little evidence of large-scale changes in testing practices over time and that 'gaming' by NHS acute trusts to avoid exceeding CDI objectives and incurring financial penalties, has not been a major factor in the reduction of CDI in England.

Furthermore, the number of deaths involving CDI or MRSA in England, where MRSA or CDI were mentioned on death certification – a data source not related to the mandatory surveillance scheme – have decreased in recent years, providing further confidence in the trends reported in HCAI Official Statistics as they are borne-out in other data sources.

Finally, data provided in 'Routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data', comparing the mandatory NHS acute trust reported data with voluntary laboratory reported data indicates that the mandatory surveillance scheme, from which official statistics are produced, is capturing cases in a similar order of magnitude to the voluntary scheme and overarching trends overtime between the 2 data sets are conserved.

Together, these alternative data sources provide us with confidence in the reliability of the data.

Strengths and weaknesses

The mandatory surveillance scheme has several strengths. The surveillance is at patient-level and in real-time, including both risk factor data and information on both date of positive specimen and date of inpatient admissions which allow for timing of detection to be ascertained. These enhanced data provide a platform to identify potential interventions, which could not be garnered from other surveillance schemes in place in England.

In addition, the surveillance scheme is a census of all microbiologically confirmed episodes of bacteraemias and CDI, which provides up to 2%[2] greater ascertainment than comparative voluntary surveillance schemes (see 'Routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data'). Such rich surveillance is unrivalled across much of the world. The structured nature of the incurring financial penalties, has not been a major factor in the reduction of CDI in England[3].

Together, these alternative data sources provide us with confidence in the reliability of the data.

Well-completed patient identifiers allow for the utilisation of other data sources through direct linkage, allowing for a fuller dataset without duplication of effort in the resource-restricted NHS. For example, data can be linked from the mandatory surveillance scheme with data from the voluntary laboratory reports to access antimicrobial susceptibility information, or to Hospital Episode Statistics for comorbidity information or prior healthcare interactions.

Live reporting from the HCAI DCS, for registered users, is available, covering the statistics and other tabulations or graphical representations of these data as well. While regular pre-defined statistical publications provide the timely reporting of data, with extensive stratification of the data by organisation type and time periods on a website accessible to both healthcare professionals and the general public.

However, even with the ability to link the mandatory surveillance data with other datasets, the completion of the data return takes time and in the resource-restricted NHS, this leads to variable field completion for the non-mandatory fields, which in turn restricts what the data can be used for. In addition, there is the potential conflict between the use of these data for epidemiological purposes by UKHSA and performance management or audit by others. While the effect on data validity is not currently of great concern, as discussed in Mandatory HCAI Surveillance Data in NHS performance management, the emphasis on performance management surrounding reductions in MRSA bacteraemia and CDI could lead to an emphasis on the infection prevention and control of these infections over others and, as we know, that interventions developed to tackle MRSA bacteraemia and CDI have not had a similarly reductive impact on other healthcare associated infections.

Comparison with devolved administrations

There are several differences between the English mandatory HCAI surveillance scheme and the surveillance undertaken by other devolved administrations. These include case definitions and protocols for diagnosing the infections, definitions regarding inpatient episode versus trust

[2] Excluding CDI cases, due to issues with voluntary surveillance described in Routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data.
[3] Gerver and others. 'Clostridium difficile toxin testing by NHS acute Trusts in England: 2008 to 2013'. Clinical Microbiology and Infection 2015: volume 21, issue 9, page 850

apportioned or assigned episodes, age groups included in the surveillance schemes and the way in which data are presented (that is, time periods provided).

Ignoring differences in the case definitions used for the surveillance schemes, the population sizes of the other devolved administrations are quite different to England. Therefore, crude counts of infections cannot be compared between countries in the United Kingdom. Furthermore, as the population demographics between the devolved administrations differ, as do the denominators used to calculate any infection rates, these are also not directly comparable.

Therefore, the data provided in the published reports from Public Health Agency Northern Ireland, Public Health Wales and Health Protection Scotland is not directly comparable with the data published by PHE. Data on healthcare associated infections from the devolved administrations is available online:

- Wales
- Northern Ireland
- Scotland

Comparability over time

MRSA bacteraemia

Although data is comparable over time, and can be displayed as a time series there have been 2 recent changes to the published MRSA bacteraemia outputs.

NHS England adopted a ‘zero tolerance’ approach to MRSA bacteraemias in April 2013. In parallel all organisations reporting an MRSA bacteraemia were required to undertake a Post Infection Review (PIR) (outlined in the PIR toolkit and History of surveillance of Gram-negative and *Staphylococcus aureus* bacteraemia and CDI mandatory surveillance). This resulted in MRSA cases being categorised on the basis of which organisation was best placed to ensure that any lessons learned are actioned.

Following a PIR cases were either categorised as ‘Trust-assigned’ or ‘CCG-assigned’. A ‘Third-party assigned’ category was introduced in April 2014 to reflect cases where neither the acute trust or CCG was the best place organisation to actions the lessons learnt from the PIR process. In April 2018, the PIR process was further amended and ceased to be part of the national surveillance as performed by UKHSA. Instead, the PIR process is performed locally and only among trusts with the highest rates of MRSA infection.

In 2019, responding to improved understanding of the phylogeny of *S. aureus*, the surveillance was updated to include *S. aureus*, *S. schweizeri* and *S. argenteus*.

CDI

A change in the guidance on the laboratory testing algorithm for *C. difficile* detection in 2012 may have had an effect on the CDI time series. Based upon an NHS Centre for Evidence Based Purchasing report in 2009.

The DHSC commissioned a study to review the effectiveness of many test kits available to detect *C. difficile* toxin in order to identify the combination of tests which produced the most reliable results. Based on these results, a 2-stage testing algorithm has been recommended. The DHSC has estimated, that if all acute trusts had adopted the new testing algorithm compared to the single test algorithm between October 2010 and September 2011, then a 17% reduction in the total number of CDI episodes would have been expected.

Therefore, it is likely that a small proportion of the reduction in CDI seen in England between 2010 and 2012 may be due to the gradual change in laboratory testing from the former testing algorithm to the more accurate 2-stage algorithm. However, it is worth noting that any potential reduction caused by this change in testing, will have only occurred once (that is, at a single time point) for each reporting.

Data collection and associated quality assurance

The administrative data source used for collection of the data included in all the mandatory HCAI surveillance outputs is the HCAI DCS. This is a real-time web-enabled system that facilitates the collection of all mandatory HCAI surveillance data from NHS acute trusts. The HCAI DCS is managed by the Healthcare Associated Infection and Antimicrobial Resistance (HCAI and AMR) division at UKHSA. The HCAI and AMR division are also responsible for the production of the mandatory surveillance outputs.

NHS acute trusts are required to report all episodes of MRSA bacteraemia, MSSA bacteraemia, *E. coli* bacteraemia, *Klebsiella* spp. bacteraemia, *P. aeruginosa* bacteraemia and CDI to the HCAI DCS. Associated case definitions and further organism specific requirements for the submission of cases can be found in the Mandatory HCAI Surveillance Protocol.

Quality assurance of the HCAI data capture system

The HCAI DCS has been assessed in line with the risk and profile matrix included in the UKHSA Administrative Data Quality Assurance Toolkit and has been judged as follows:

- high risk of data quality concerns due to complex data collection processes that are hard to independently verify
- high public interest profile as the data represents an important public health issue that has historically received substantial media coverage

Such an assessment or judgement demands assurances across a variety of practice areas. The assurances currently in place are believed to ensure that the quality of information held on the HCAI DCS is sufficient for the production of the Official Statistic outputs relating to mandatory HCAI surveillance.

Practice area 1: operational context and administrative data collection

The following assurances are in place across this practice area:

As outlined above there is a protocol in place for the organisms covered by Mandatory HCAI Surveillance. This protocol spells out in detail the exact processes and requirements for data suppliers (NHS acute trusts) in terms of data provision and transfer from NHS acute trusts to UKHSA (HCAI DCS).

The mandatory HCAI surveillance protocol provides background on both the surveillance processes and the mechanism employed for data collection (HCAI DCS). Details of exactly what should be reported (surveillance inclusion criteria, core data set and so on) are also provided for each organism under surveillance. Information on monthly reporting deadlines (as outlined in Timeliness) is also provided.

The HCAI DCS is also supplemented by a complete and comprehensive set of user guides. These guides provide system users with detailed information on all aspects of the system.

All infection episodes are entered into the HCAI DCS by the NHS acute trust responsible for testing the specimen. Acute trust CEOs are required to sign off the infection data across all 6 infections collected via the HCAI DCS on the 15th of each month (see monthly data tables for further detail). CEO sign off constitutes formal agreement and assurance that a given month of data is complete and correct. CEO sign-off for acute trusts is mandated by the Chief Medical Officer (CMO) June 2005. NHS acute trusts that have failed to sign off their data for 3 or more months in a row are highlighted in all published data tables. The public reporting of organisations that repeatedly fail to sign off serves the dual purpose of increasing awareness of potential data quality issues and of highlighting those organisations that are failing to adhere to their mandatory responsibilities.

Further information on this process is provided in the relevant data tables and their associated caveats. The links to the tables are in the 'Monthly counts of cases' section.

Routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data details the routine comparisons that are undertaken between data collected on the HCAI DCS and that collected via the voluntary surveillance system (Second Generation Surveillance System). This routine audit not only enables us to assess the completeness of the mandatory datasets but also enables us to identify or investigate any differences that may exist in terms of the collection and recording of data by region or geography, age, sex and so on.

Accuracy and reliability provides a detailed investigation or assessment of the accuracy and quality of surveillance data reported via the HCAI DCS. This section includes assessment of potential sources of bias and error as well as discussion on the impact that NHS performance management may have on reported data.

Practice area 2: Communication with data supply partners

The following assurances have been implemented across this practice area: There are established and maintained collaborative relationships in place between UKHSA and NHS acute trusts (data suppliers). These are maintained via regional UKHSA colleagues.

UKHSA also routinely gauge the extent of interest from NHS colleagues in attending the quarterly Mandatory HCAI Surveillance National Stakeholder Engagement Forum (outlined in User satisfaction). If there is found to be significant interest in attending such a forum an event specifically for NHS colleagues will be convened.

The HCAI DCS includes a facility for direct communication with system users. This enables news items and other announcements or areas of interest to be communicated to system users on an ad-hoc basis as and when required.

The UKHSA mandatory surveillance team routinely uses Granicus (formerly GovDelivery) to deliver relevant communications to targeted user and stakeholder groups. Use of this methodology ensures the timely dissemination of information whenever required.

As outlined above there is a protocol in place for the organisms covered by Mandatory HCAI Surveillance. This protocol spells out in detail the roles and responsibilities of NHS acute trusts as data suppliers. It also includes detail on the process of data supply and transfer from reporting NHS organisations to the UKHSA-managed HCAI DCS as well as associated sign off requirements. The underlying requirements are as mandated by the CMO. More detailed information on the various CMO mandates for undertaking mandatory HCAI surveillance can be found in History of surveillance of Gram-negative and *Staphylococcus aureus* bacteraemia and CDI mandatory surveillance.

UKHSA has a published Official Statistics Corrections and Revisions Policy.

This is supplemented by a Data Specific Revisions and Corrections Policy which provides additional information relating specifically to mandatory HCAI surveillance.

This additional guidance accounts for the nuances of the real time surveillance undertaken by the HCAI DCS. It also provides information and signposts for how data suppliers can request or undertake an update to reported information.

The HCAI DCS adheres to UKHSA requirements for security and confidentiality. These arrangements are documented in detail in Confidentiality and disclosure control.

Note that the UKHSA mandatory surveillance team is responsible for both the administration of the HCAI DCS and for the publication of the various outputs. This means that there is significant overlap between the quality assurance (QA) steps and assurances undertaken taken in terms of both the administrative source (HCAI DCS) and the published outputs.

Practice area 3: QA principles, standards and checks applied by data suppliers

The following assurances are in place across this practice area:

The Mandatory HCAI Surveillance Protocol provides information on data collected via the HCAI DCS. This is the definitive data entry guide for data providers (NHS acute trusts) and helps to ensure that all organisations are adhering to a well-defined and exhaustive set of definitions.

Furthermore, certain fields and options are only triggered when a certain response to a previous question is given. By linking questions in this manner data quality is ensured – it is not possible for reporting organisations to input or save inconsistent information. Further information on all data items collected and the linkage or triggering of subsequent questions can be found in Appendix 1 of the Mandatory HCAI Surveillance Protocol.

Mandatory HCAI Surveillance Data in NHS performance management provides discussion on the potential impact that the application of these data for performance management purposes may have on reporting.

'Routine comparison and quality assurance of HCAI DCS data with voluntary laboratory surveillance data' outlines the routine comparisons undertaken between HCAI DCS data and data collected via the voluntary surveillance system (SGSS) for the financial year ending 2019. This routine audit enables assessment of the completeness of the mandatory data sets.

Practice area 4: Producer's QA investigations and documentation

The following assurances are in place across this practice area: Routine comparisons between HCAI DCS data and data collected via the voluntary laboratory surveillance system (SGSS) are undertaken. This has previously been outlined and discussed under practice area 3, above. Further detail can be found in 'Routine comparison or quality assurance of HCAI DCS data with voluntary laboratory surveillance data'.

Assessment on the impact of the use of these data for performance management purposes may have on reporting has been undertaken (previously outlined under practice area 3). Further detail can be found in Mandatory HCAI Surveillance Data in NHS performance management. The 'Strengths and weaknesses' section provides an overview of the major strengths and weaknesses of the data and of the associated administrative data source (HCAI DCS). This includes detail on the issues inherent in the use of the data for published statistics and data outputs.

Cost and burden

Cost

All mandatory HCAI Surveillance Outputs are produced from data collected via the HCAI DCS. Data collected via this system are primarily for epidemiological purposes.

The Official Statistics outputs are by-products of this process and as such incur very little in the way of additional cost. In terms of the overall data collection process, UKHSA historically submits the information on the burden of assessment to the NHS Digital Challenging Burden Service (CBS). The CBS assesses burden and provides associated recommendations to minimise burden.

Burden

The HCAI DCS was relaunched in October 2015. Several changes and improvements have been incorporated to reduce the burden placed upon data suppliers (NHS acute trusts).

Recent improvements and developments include:

1. The addition of a data upload wizard which enables data providers to batch upload infection data. Historically, information had to be manually entered on a case-by-case basis. Further details on the data upload process is available in the associated user guide.
2. The inclusion of easily accessible organisation specific summary information via the dashboards functionality. This enables HCAI DCS system users to see their summary position at a glance. Historically it was only possible to glean this information via multiple different reports.

Further information on the various dashboards is available in the associated user guides:

- Summary dashboard
- Benchmarking dashboard
- Data completeness dashboard

Data flows have been updated to enable more fluid and intuitive data entry. By ensuring that relevant questions are only triggered as or when required by a previous response, ambiguity in data entry is mitigated. This ensures that data entry is streamlined wherever possible.

Confidentiality and disclosure control

Confidentiality and disclosure control underpins all statistical and data driven work undertaken by UKHSA and is governed by organisational level guidance and policies. Local policies and procedures supplement this guidance as or when necessary.

Organisational level policies and procedures

UKHSA has a range of organisational policies and procedures in place to ensure statistical confidentiality and to avoid the unauthorised disclosure of data or individuals. UKHSA has a Personal Information Charter which sets out the standards UKHSA staff are required to comply with when handling personal information.

UKHSA also has well defined organisation level 'Caldicott Policy' which sets out the framework through which UKHSA implements the recommendations of the Caldicott Report on the Protection and Use of Patient Information (1997). There is also an Information Risk Management Policy.

Both these documents are available to staff via the UKHSA intranet.

UKHSA follows the Anonymisation Standard devised by the NHS Digital and approved by the Information Standards Board, which provides a standard approach and a set of tools to anonymise information to ensure that, as far as it is reasonably practicable, information published does not identify individuals. This standard is a statutory requirement for all public bodies publishing health and social care data.

UKHSA has adopted an internal Standard Operating Procedure for disclosure control which is consistent with the GSS disclosure control policy.

All UKHSA staff, including temporary and contract staff, with access to personal or confidential information are required to complete mandatory, information governance training upon recruitment and then every year thereafter. This training gives guidance to staff on how to protect and share information safely and appropriately.

UKHSA terms and conditions of employment include confidentiality clauses which apply to those staff employed on UKHSA terms and conditions. Similar clauses are included in the contracts of those staff employed on NHS contracts.

Mandatory HCAI surveillance output level policies and processes

As well as the previously outlined organisational level policies and procedures. There are a number of processes undertaken at the output level to ensure confidentiality and disclosure control. All mandatory HCAI Surveillance data is collected and processed in accordance with the Data Protection Act (1998). Patient level data is not published.

Disclosure control methods are always adhered to, published statistics are tabular outputs, which are always at an aggregate level (that is, tabulation by acute trust or clinical commissioning groups or larger geographies) meaning that the risk of disclosure is extremely low.

All published outputs take into account the need to protect patient confidentiality whilst At the same time ensuring that there is public access to official data and that it meets requirements to assist the Secretary of State to undertake their function in relation to the health service in accordance with the Statistics and Registration Service Act 2007 s42.

HCAI DCS system specific policies and controls

The HCAI DCS applies a strong password policy to user passwords as well as ensuring that users of the system only have access to information relevant to their roles. All UKHSA computers are connected to a local area network that is protected by firewalls operating to accepted NHS standards, and are protected by UKHSA standard anti-virus software. Unauthorised access to the HCAI DCS server will be prevented as the access to the networked drive and data on the UKHSA server, is controlled through a centralised directory at organisational level. Access to the database is controlled through username and passwords issued to identified and authorised users.

Passwords are encrypted and follow the guidelines for using and handling passwords as set out in the Centre for Protection of National Infrastructure (CPNI) Password Guidance. The user is required to configure 3 security questions as part of the registration process.

1. Access to patient level data within the application, with or without Patient Identifiable Information (PII), is restricted based on the organisational hierarchy.
2. National users have access to patient level data for all cases entered on the system (full or pseudo-anonymised depending on organisation).
3. Sub-national users (CCGS, NHS Local Offices, UKHSA Centres and so on) have patient level access for cases mapped to their organisation.
4. NHS acute trusts only have patient level access to the specific records that they entered.
5. System administrators have access to PII for routine administrative work.
6. Access to these PII is granted on a need to know basis as identified by the System Owner and would include NHS number, forename, initials, Soundex and date of birth.

Further information on roles and permissions can be found in the 'Overview of Roles and Permissions' user guide. No PII is transmitted beyond UKHSA secure networks by UKHSA staff. Standard Operating Procedures are in place regarding dissemination of data from the system to ensure data are aggregate only with all PII removed prior to transmission beyond UKHSA. Exceptions must be signed off by the director of the centre or division to which the data transfer applies and, where necessary, the director will be responsible for ensuring appropriate legal advice and guidance is sought.

External support colleagues will have access to anonymised data only, contained in a separate support environment. HCAI DCS backups are held in secure offline locations to which access is restricted. Backups are never held on the live system and are encrypted. HCAI DCS data is stored in a secure GIS approved location. All data is suitably encrypted using appropriate algorithms. When the database is no longer required the storage is released back to the ICT

Storage Team for reuse within the storage system. All physical IT infrastructure is disposed of in line with agreed UKHSA procedures. Backup tapes are disposed of by the Storage and Networking and Security teams in line with their procedures.

Appendix 1. Current mandatory HCAI surveillance outputs

Monthly counts of cases

Monthly counts by NHS acute trust and clinical commissioning group, published as .ods and .xlsx documents on a monthly basis.

Monthly data tables include data for a rolling 13-month period and provide counts of MRSA bacteraemia, CDI, MSSA bacteraemia and *E. coli* bacteraemia, *Klebsiella* spp. bacteraemia and *P. aeruginosa* bacteraemia counts by both acute trust and clinical commissioning group, each by onset status and prior trust exposure.

- MRSA
- MSSA
- *E. coli*
- *Klebsiella* spp.
- *P. aeruginosa*
- CDI

Quarterly epidemiological commentary

Provides national aggregated counts and rates of cases by financial year quarter for MRSA, MSSA, *E. coli*, *Klebsiella* spp., *P. aeruginosa* and CDI.

- PHE MRSA, MSSA, Gram-negative bacteraemia and CDI: quarterly report

Annual outputs

Annual counts and rates of cases are reported by acute trust and CCG. These are accompanied by an epidemiological commentary detailing trends in rates, by age, sex and region as well as infographics.

- MRSA, MSSA and Gram-negative bacteraemia and CDI: annual report

Appendix 2. Record linkage algorithm

Matching cases from the voluntary surveillance scheme (via SGSS) and the mandatory surveillance scheme (via HCAI DCS) were identified through the following ordered multi-step linkage criteria:

1. NHS number, Date of Birth (DoB)
2. NHS number
3. Hospital number, DoB, Soundex
4. Hospital number
5. Specimen number, Laboratory Code, DoB, Soundex, sex, forename initial
6. Specimen number, Laboratory Code, sex and (forname initial OR Soundex)
7. Specimen number, DoB
8. Specimen number and (Fuzzy DoB AND (forename initial OR Soundex))

Note that the fuzzy matching of DOB is an NHS Digital accepted method of matching records to account for subtle differences in the records that would originate from a data entry error. It assumes that the records belong to the same patient if only one component (that is, day, month or year) of the date of birth is different, while all other parts of the DOB and the NHS no. are the same.

Subsequently, matching episodes were identified where an episode from the same patient was identified in both SGSS and HCAI DCS. Specimen dates plus or minus 14 days were used as an episode of bacteraemia is defined as 14 days.

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation heath secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

Prepared by: Healthcare-associated Infections Mandatory Surveillance Team
For queries relating to this document, please contact: mandatory.surveillane@phe.gov.uk

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