ARHAI Scotland
Antimicrobial Resistance and Healthcare Associated Infection

National Surveillance of Healthcare Associated Infection in Intensive Care Units Protocol

November 2024
Version 2.0

Document Control

Version History

Version	Date	Summary of changes
V2.0	November 2024	Surveillance paused during COVID-19 pandemic and protocol redeveloped following stakeholder engagement. Changes include adapted pneumonia case definitions and microbiological criteria, and the use of Electronic Communication of Surveillance in Scotland (ECOSS) data linkage to capture blood stream infection (BSI) and antimicrobial resistance (AMR) data. See Key Updates for further details.

Contents

1. Key Updates

- Surveillance of bloodstream infections (BSI) will now be conducted via data linkage to the Electronic Communication of Surveillance in Scotland (ECOSS) system.
- Pneumonia infection case definitions have been adapted to widen the capture of these infections. There are two classes of pneumonia infection now being collected:
    - Signs and symptoms pneumonia infection: where patients meet signs and symptoms criteria.
    - Clinician defined pneumonia infections: where patients are highly suspected as having a pneumonia, but due to clinical intervention do not meet signs and symptoms criteria.
- Case definitions of microbiological cultures have been adapted to include the expected outputs from Scottish laboratories. There are three different outputs which can be recorded:
    - Quantitative
    - Semi-quantitative
    - Non-quantitative
- Antimicrobial resistance (AMR) information for pneumonia infections will be collated via linkage where microbiology laboratory specimen information are available and specimen details have been provided.

2. Introduction

Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland, part of National Services Scotland (NSS), works closely with the Scottish Intensive Care Society Audit Group (SICSAG).

Healthcare Associated Infection (HAI) surveillance in Scotland's Intensive Care Units (ICU) is a mandatory surveillance programme as set out in HAI DL (2015) 19. Following a pause of surveillance to support the pandemic response, surveillance was recommenced in May 2023 as communicated in HAI DL (2023) 11.

Surveillance of HAI in Scottish ICUs includes the mandatory surveillance of pneumonia infections and BSI and voluntary surveillance of central venous catheter related infections (CRI-CVC). Case definitions and methods are based upon those outlined by the European Centre for Disease Prevention and Control (ECDC), incorporating adapted criteria to align with the outputs of Scottish ICUs and laboratory reporting processes.

Data for surveillance are predominantly collected locally in NHS boards via WardWatcher™ (WW™) software. BSI data are collated by ARHAI Scotland via linkage of ICU activity data from WW™ to microbiological data in ECOSS. Pneumonia infections and non-bloodstream CRI-CVC infections are collected within WW™.

Further information on the audit of critical care settings can be found on the SICSAG website.

This protocol outlines the processes in place to collect, link and output data from ICUs in Scotland.

3. Aims and Objectives

The **aim** of this surveillance programme is to monitor and support strategies to reduce the incidence of HAI in ICU settings in NHSScotland hospitals and/or units.

The **objectives** of the ICU surveillance programme are:

- To provide robust epidemiological data analysis to monitor national trends of HAI in ICU.
- To provide robust epidemiological data to support local teams monitor trends of HAI in ICU.
- To provide expert epidemiological support to NHS boards where required or requested.
- To support partner organisations and clinical networks in the identification of quality improvement and reduction strategies.

Inclusion Criteria

4.1 Study Population

All patients, aged 16 and older, who have been in-patients in ICU for more than **two** calendar days should be included in HAI surveillance where:

date of discharge from the ICU – date of admission to the ICU + 1 > 2

4.2 HAI Surveillance

An infection is considered as ICU-acquired if it occurs in the ICU on, or after, the **third** calendar day of the patients ICU stay. Those patients who acquired an infection on day one or day two of their stay will be recorded as “no infection” for surveillance purposes. All infections with onset from day three onwards in the ICU should be reported. The day of admission to the ICU is counted as day one.

Data collection should be coordinated locally by a designated individual to ensure that these patients are identified and included in surveillance and that staff have the appropriate level of knowledge and training.

Information from clinical personnel, medical and nursing records, and positive microbiology cultures can be used to identify HAI.

The following HAI are included in surveillance:

- Bloodstream infection (BSI)
- Catheter related infection (CRI)
- All pneumonia including both ventilator-associated and non-ventilator associated pneumonia.

BSI are to be derived from data linkage to ECOSS by ARHAI Scotland and presented to ICUs in the form of a line list, accompanying SICSAG monthly reports.

All pneumonia infections are collected via the WW^{TM} surveillance system. CRI1-CVC and CRI2-CVC infections may also be collected in WW^{TM} in the interest of local surveillance and quality improvement initiatives.

The **date of onset** is the date of onset of symptoms or, if unknown, the date that treatment was started, or the first diagnostic examination was done.

Surveillance of HAI ends when a patient is discharged, transferred from the ICU or dies.

4. Denominator Data

Denominator data are calculated using data that are collected in WW^{TM} and include clinical information from all patients with an in-patient stay of more than **two** calendar days, as defined under the study population.

- **Patient days**: Total of all days in ICU, inclusive of ICU admission date and ICU discharge date. Calculated as *ICU Discharge date - ICU Admission date + 1,* from the admission date data collected in WW^{TM}.
- **CVC days:** Total of all days where a CVC was present. Calculated from the augmented care period (ACP) data collected in WW^{TM}.
- **Intubation days:** Total of all days where the patient was intubated. Calculated from the ACP data.

5. HAI Case Definitions

HAI case definitions are based on the definitions and methods set out in the ECDC protocol for Surveillance of HAI in ICU. These definitions have been adapted to fulfil Scottish surveillance requirements while also maintaining the ability to make international comparisons using the standardised ECDC definitions. These are epidemiological case definitions for the purpose of surveillance and are not intended for clinical decision making.

6.1 Definition of Pneumonia

Including both ventilator-associated and non-ventilator associated pneumonia.

Pneumonia definitions are applied based on criteria of:

A. Radiology (6.1.1).
B. Signs and Symptoms of Pneumonia (6.1.2).
C. Microbiology Definitions (6.1.3).

6.1.1 Radiology

Pneumonia infections are categorised depending on patients' radiological history and invasive respiratory device history**.** Pneumonia infections require **either:**

Chest X-ray or Computed Tomography (CT)-scan evidence (PN1-PN5 diagnosis codes):

- Patients with no underlying cardiac or pulmonary disease **one** definitive chest X-ray or CT-scan with suggestive image of pneumonia is sufficient.
- Patients with underlying cardiac or pulmonary disease require:
    - **Two** or more serial chest X-rays or CT-scans with a suggestive image of pneumonia
    - Where previous chest X-rays or CT-scans are available, **one** definitive chest X-ray or CT-scan during the current ICU stay may be sufficient.

–OR –

Recent invasive respiratory device (PNX diagnosis codes):

- An invasive respiratory device must have been present (even intermittently) in the **two** calendar days preceding the onset of infection and **no** chest X-ray or CT-scan evidence are available.

Notes

Pneumonia infections will be categorised as ventilator-associated pneumonia (VAP) if an invasive respiratory device was present (even intermittently) within the **two** calendar days preceding the onset of infection.

These definitions exclude cases where intubation was used for the treatment of pneumonia.

6.1.2 Signs & Symptoms of Pneumonia

Pneumonia infections must meet **signs and symptoms** criteria or be **clinician diagnosed.**

Signs and Symptoms

At least **one** of:

- fever > 38 °C with no other cause
- leukopenia (< 4 000 WBC/mm3) or leucocytosis (≥ 12 000 WBC/mm3)

and at least **one** (or at least **two**, if diagnosis meets PN4/PN4C, PN5/PN5C or any PNX) of:

- new onset of purulent sputum, or change in character of sputum (colour, odour, quantity, consistency)
- cough or dyspnoea or tachypnoea
- suggestive auscultation (rales or bronchial breath sounds), rhonchi, wheezing
- Worsening gas exchange or increased respiratory support needed e.g. O_2 desaturation or increased O_2 requirements or increased ventilation demand

Clinician Diagnosed Pneumonia Infections

If patients are highly suspected as having a pneumonia infection but due to clinical intervention do not meet the signs and symptoms criteria, these may still be recorded as clinician diagnosed pneumonia. Some examples would be:

- treatment to reduce their temperature such as cooling or receiving paracetamol
- being intubated which would prevent the patient presenting with a cough or any other chest aspirations.

6.1.3 Microbiology Definitions

All pneumonia definitions are categorised according to the following microbiological criteria:

PN1A (signs and symptoms) and PN1C (clinician diagnosed):

Positive **quantitative/semi-quantitative** culture from **minimally contaminated** lower respiratory tract specimen:

- broncho-alveolar lavage (BAL) with a threshold of > 10^4 colony forming units (CFU)/ml or ≥5 % of BAL obtained cells contain intracellular bacteria on direct microscopic exam or heavy growth (classified on the diagnostic category BAL)
- distal protected aspirate (DPA) with a threshold of > 10^3 CFU/ml.

PN1B (signs and symptoms) and PN1D (clinician diagnosed):

Positive **non-quantitative** culture from **minimally contaminated** lower respiratory tract specimen:

- broncho-alveolar lavage (BAL)
- distal protected aspirate (DPA)/mini-BAL.

PN2A (signs and symptoms) and PN2C (clinician diagnosed):

Positive **quantitative/semi-quantitative** culture from **possibly contaminated** lower respiratory tract (LRT) specimen:

- culture of LRT specimen (e.g., endotracheal aspirate) with a threshold of 10^6 CFU/ml or heavy growth.

PN2B (signs and symptoms) and PN2D (clinician diagnosed):

Positive **non-quantitative** culture from **possibly contaminated** LRT specimen:

- positive culture of LRT specimen (e.g., endotracheal aspirate).

PN3 (signs and symptoms) and PN3C (clinician diagnosed):

Alternative microbiological method:

- positive blood culture not related to another source of infection
- positive growth in culture of pleural fluid
- pleural or pulmonary abscess with positive needle aspiration
- histologic pulmonary examination shows evidence of pneumonia
- positive examination for pneumonia with virus or particular microorganisms (e.g., *Legionella, Aspergillus, mycobacteria, mycoplasma, Pneumocystis jiroveci* [previously P*. carinii*]):
    - positive detection of viral antigen or antibody from respiratory secretions (e.g., EIA, FAMA, shell vial assay, PCR)
    - positive direct exam or positive culture from bronchial secretions or tissue
    - seroconversion (example: influenza viruses, *Legionella, Chlamydia*)
    - detection of antigens in urine (*Legionella*).

PN4 (signs and symptoms) and PN4C (clinician diagnosed):

Positive **sputum culture** or **other non-quantitative** LRT specimen culture and does not meet the criteria to be recorded as PN1-3.

PN5 (signs and symptoms) and PN5C (clinician diagnosed):

No positive microbiology:

- examination not done
- results not available
- micro-organism not identified

- sterile examination (e.g. negative culture).

Notes

- Definitions PN1A, PN2A, PN3, PN4 and PN5 correspond to the ECDC's definitions PN1-PN5.
- Where the above definitions have **no X-ray or CT-scan** evidence, but the patient has had an invasive respiratory device in-situ within the 48 hours preceding infection, the PNX labelling is used, e.g. PNX1A, PNX2A etc.
- PNX case definitions require positive microbiology therefore a PNX5 cannot be reported.
- See the pneumonia infection algorithm in Appendix 1 for further details.

6.2 Definition of a Central Venous Catheter Related Infection (CRI-CVC)

6.2.1 CRI1-CVC: local CVC-related infection (no positive blood culture)

Quantitative CVC culture ≥ 10^3 CFU/ml or semi-quantitative CVC culture > 15 CFU **and** pus/inflammation at the insertion site or tunnel.

6.2.2 CRI2-CVC: general CVC-related infection (no positive blood culture)

Quantitative CVC culture ≥ 10^3 CFU/ml or semi-quantitative CVC culture > 15 CFU **and** clinical signs improve within 48 hours after catheter removal.

Notes

- The inclusion of CRIs is optional in the surveillance of HAI in ICUs. When CRIs are included, both types of CRI-CVC should be reported.
- CVC colonisation should not be reported.

6.3 Definition of a Bloodstream Infection (BSI)

Microbiologically Confirmed BSI

A case of BSI is a patient from whom an organism has been isolated from the patient's blood, and who has not previously had the same organism isolated from blood within the same 14-day period (i.e. 14 days from date last positive sample obtained).

Inclusion and Exclusion Criteria

Common skin contaminants* are included as microbiologically confirmed BSI if **two** separate blood specimens containing the same organism are identified within **three** calendar days.

*Skin contaminants = coagulase-negative *staphylococci, Bacillus* species, *Corynebacterium* species*, Cutibacterium acnes*, *Dermabacter* species, *Dermacoccus* species, *Propionibacterium acnes* and *Micrococcus* species)

The following blood specimens are excluded from the surveillance:

- Post-mortem blood/pathology reports
- Clotted blood
- Plasma
- Serum
- Ascitic fluid

6. WardWatcher™ Data Collection

Patient and HAI data are to be collected by trained staff in ICUs. A visual step by step guide for entering HAI data can be found in the WW™ HAI Manual.

The following data items are utilised by ARHAI Scotland for surveillance:

WW Page	WW Data Item Name	Data Definition	WW Field Values
Patient	ID No.	A unique code which identifies an individual unit (anonymous numerical code)	Automatically generated numeric ID number for ICU unit
Patient	Surname	Surname of patient	Free text
Patient	First name	Forename of patient	Free text
Patient	Hospital No.	Numeric Code for each patient, unique within hospital, anonymous. Provides unique numeric id number for each patient	Numeric
Patient	DOB	Age of the patient on the date of admission to the ICU (in years)	Numeric
Patient	Sex	Sex of patient	M = Male; F = Female; O = Other; UNK = Unknown
Patient	CHI No.	Community Health Index Number. Unique numeric identifier for each patient within NHS	10-digit number- consisting of DOB in first 6 digits
Admission	Hospital admission date	Date patient was admitted to hospital	Date field (DD MMM YYYY)
Admission	Unit admission date	Date of admission in the ICU	Date field (DD MMM YYYY)
Admission	Previously housed within	Origin of the patient at the time he/she was admitted at the ICU	This hospital site; Another hospital in this Health Board; Another hospital in another Health Board; Non-NHS facility
ACP	Respiratory support	Patient on a ventilator in this unit at some point today; Reintubated at some	Y = Yes; N = No

WW Page	WW Data Item Name	Data Definition	WW Field Values
		point today; Intubation/reintubation considered; High flow nasal oxygen administered	
ACP	Cardiovascular support	Multiple IV vasoactive drugs and/or IV antiarrhythmics; Single IV vasoactive drugs and/or IV antiarrhythmics; Cardiac output monitoring; Circulatory instability due to hypovolaemia; Central venous catheter (including dialysis catheter); Arterial line	Y = Yes; N = No
HAI	Date	Date of onset of symptoms or, if unknown, date treatment was started or date first diagnostic examination was done	Date field (DD MMM YYYY)
HAI	Infection type	Type of infection	CVC related infection (NOT bloodstream); Pneumonia
HAI (CRI-CVC)	Culture	Quantitative CVC culture >= 10^3 CFU/ml OR semi- Quantitative CVC culture > 15 CFU	Y = Yes; N = No
HAI (CRI-CVC)	Signs and Symptoms	Pus/inflammation at the insertion site or tunnel	Y = Yes; N = No
HAI (CRI-CVC)	Signs and Symptoms	Clinical signs improve within 48 hours after catheter removal	Y = Yes; N = No
HAI (pneumonia)	Invasive respiratory device	Invasive respiratory device present (even intermittently) in last 2 days	Y = Yes; N = No

WW Page	WW Data Item Name	Data Definition	WW Field Values
HAI (pneumonia)	Radiology	Chest X-ray/CT scan with suggestive image of pneumonia - no underlying cardiac or pulmonary disease; One definitive chest X-ray/CT scan with suggestive image of pneumonia where previous radiology have not suggested pneumonia; 2 or more serial chest X-rays/CT scans with a suggestive image of pneumonia	Y = Yes; N = No
HAI (pneumonia)	Signs and Symptoms	Temperature more than 38 C with no other cause; New onset of purulent sputum or change in character or sputum; Suggestive auscultation (rales or bronchial sounds), rhonchi, wheezing; WBC less than 4.0 (10^9/L) or more than 12.0 (10^9/L); Cough, dyspnoea, tachypnoea; Worsening gas exchange or increased respiratory support needed	Y = Yes; N = No
HAI (pneumonia)	Clinician diagnosed pneumonia?	Where Signs and Symptoms criteria are not met but may be masked by treatment e.g. antipyretics	Y = Yes; N = No
HAI (pneumonia)	Microbiology (i)	Quantitative or semi-quantitative culture available?	Y = Yes; N = No

WW Page	WW Data Item Name	Data Definition	WW Field Values
HAI (pneumonia)	Microbiology (ii)	If “Yes” to Microbiology (i)	Positive culture from LRT e.g., BAL, DPA/mini-BAL; Alternative microbiology (not related to another source, from other sites, histological examination, positive examination for pneumonia with virus or particular microorganisms); LRT specimen culture (e.g. endotracheal aspirate) with a threshold of 10^6 CFU/ml
HAI (pneumonia)	Microbiology (iii)	If “No” to Microbiology (i)	Positive culture from minimally contaminated LRT e.g., BAL, DPA/mini-BAL; Alternative microbiology (not related to another source, from other sites, histological examination, positive examination for pneumonia with virus or particular microorganisms); Positive culture from possibly contaminated LRT e.g. endotracheal aspirate; Sputum culture or other non-quantitative LRT specimen culture; No positive micro
HAI	Organisms	Whether causative organism information has been identified	Identified/Not Identified
HAI	Organisms	List organisms under primary/secondary/tertiary organisms	Name of organism [dropdown list]
HAI	Date specimen collected	Date specimen was collected from patient.	Date field

WW Page	WW Data Item Name	Data Definition	WW Field Values
HAI	Lab specimen number	Unique laboratory number assigned to specimen collected.	Free text
HAI	Specimen site	Site where specimen was collected	Sputum; BAL; Pleural fluid; Blood culture; DPA; Endotracheal aspirate; Pleural or pulmonary abscess; Bronchial secretions or tissue; Urine; Other, please specify: If Other specimen site, please specify: [free text]
HAI	Resistance	Antibiotics identified as resistant via laboratory susceptibility testing.	Name of antibiotic or combination [dropdown list]
Discharge	Unit Outcome	Patient status at discharge from the ICU or at end of follow-up in the ICU.	Improved; No change; Worse; Died
Discharge	Actual discharge date	Date the patient was discharged from the ICU or date of in-ICU death or date of last follow-up in the ICU.	Date field

7. Roles and Responsibilities

8.1 ARHAI Scotland Responsibilities

ARHAI Scotland is responsible for:

- Developing and updating the surveillance of HAI in Scottish ICUs protocol.
- Providing epidemiological support to SICSAG and ICUs in the application of the surveillance of HAI in Scottish ICUs protocol, including training.
- Monthly linkage of WW^{TM} ICU patient episode data to ECOSS blood culture results to produce cases of unvalidated ICU-acquired BSI.
- Returning a monthly line list of unvalidated ICU-acquired BSI to SICSAG.
- Annual linkage of WW^{TM} reported pneumonia infections to ECOSS to determine AMR profiles of causative organisms.
- Annual quality assurance and analysis of ICU HAI data to contribute to content for both SICSAG and ARHAI Scotland annual reports.

ARHAI Scotland is **not** responsible for:

- Interpretation/analysis of monthly outputs. Alerting ICUs of data exceedances, outbreaks and incidents.

8.2 SICSAG Responsibilities

SICSAG is responsible for:

- Providing ARHAI Scotland with WW^{TM} data to link to ECOSS as required.
- Producing and disseminating monthly reports along with accompanying line lists of linked BSI data provided by ARHAI Scotland.
- Co-ordinating communication between ARHAI Scotland and ICUs regarding the surveillance of HAI in Scottish ICUs.

8.3 NHS Boards Responsibilities

ICUs are responsible for:

- Recording ICU patient data in WW^{TM} as per SICSAG requirements.
- Reporting pneumonia infections via WW^{TM} as per the Surveillance of HAI in Scottish ICUs protocol.
- Liaising with their local Infection Prevention and Control Team to identify and act on any HAI data exceedances, outbreaks and incidents as per Chapter 3 of the National Infection Prevention and Control Manual (NIPCM).

8. Data Extraction

9.1 BSI Data Extraction

Case definitions of BSI are defined in section 6.3 Definition of a BSI. Line lists of BSI data are deduplicated using a 14-day episode definition; an ICU specimen arising at least 14 days from any previous ICU specimen is considered a new episode of infection. BSI data are extracted by ARHAI Scotland from ECOSS monthly. The extract line-list will provide the organism and resistance profile on all laboratory recorded BSI in Scotland for the time-period specified.

Reporting of BSI infections is constrained to data which is available within ECOSS (as reported by NHSScotland diagnostic and reference laboratories) and reliant on local ICU teams ensuring patient identifiers are correctly coded in WW^{TM}. Since ECOSS and WW^{TM} are live databases, BSI case numbers may be subject to change over time from monthly to annual reporting as further data becomes available.

9.2 Pneumonia AMR Data Extraction

For pneumonia infections recorded by local teams in WW^{TM}, ARHAI Scotland will extract corresponding respiratory specimen laboratory data from ECOSS annually. This linked dataset will provide the detail as provided to ECOSS, including organism and antimicrobial resistance profile on all laboratory recorded respiratory specimens.

Reporting of AMR in pneumonia infections is constrained to data which is available within ECOSS (as reported by NHSScotland diagnostic and reference laboratories), and reliant on local ICU teams ensuring patient identifiers and pneumonia infections are correctly recorded in WW^{TM}.

9. Reporting Process and Schedule

ARHAI Scotland continue to encourage regular local reporting of surveillance data by NHS Boards to aid local quality improvement.

SICSAG generate **monthly** reports of HAI data for individual units to monitor their data locally. Line lists of BSI will accompany the dissemination of these monthly reports.

Annual epidemiological data are produced by ARHAI Scotland and included within the ARHAI Scotland and SICSAG reports published annually. These reports can be found here.

The subcategories of infection definitions for pneumonia allows for international comparisons between ICUs and surveillance networks using the standardised ECDC definitions.

Appendix 1 – Pneumonia Infection Algorithm

Pneumonia Algorithm

Patients must meet at least one criteria on each row to diagnose pneumonia, if the criteria are not met on every row, then diagnosis should not be pneumonia

Radiology

Chest X-ray or CT scan with suggestive image of pneumonia for patients with no underlying cardiac or pulmonary disease
OR
Two or more serial chest X-rays or CT scans with suggestive image of pneumonia for patients with underlying cardiac or pulmonary disease
OR
One definitive chest X-ray or CT scan with suggestive image of pneumonia where previous chest X-Rays or CT scan have not suggested pneumonia
OR
None of the above criteria met but an invasive respiratory device was present (even intermittently) in the 2 days preceding the onset of infection **[PNX]**

AND

Signs and symptoms

At least <u>one</u> of the following:
fever OR white cell count of <4 or >=12x10⁶
AND
At least <u>one</u> of the following (or <u>two</u> for PN4,PN5, PNX):
- new onset of purulent sputum, or change in character of sputum
- cough or dyspnea or tachypnea
- suggestive auscultation
- worsening gas exchange

OR

Clinician diagnosis of pneumonia

(PN1-5C / PN1-2D)

AND

Micro-biology

Quantitative or semi-quantitative culture available		Where no quantitative or semi-quantitative culture available		Alternative microbiology (other related sites, histological examination, positive examination for virus or particular microorganisms) **	Sputum culture or other non-quantitative LRT specimen culture	No positive micro	Quantitative or semi-quantitative culture available		Where no quantitative or semi-quantitative culture available		Alternative microbiology (other related sites, histological examination, positive examination for virus or particular microorganisms) **	Sputum culture or other non-quantitative LRT specimen culture	No positive micro
Positive culture from lower respiratory tract (LRT) e.g., Broncho-alveolar lavage (BAL), distal protected aspirate (DPA)*	LRT specimen culture (e.g. endotracheal aspirate) with a threshold of 10⁶ CFU/ml	Positive culture from minimally contaminated LRT e.g.: BAL, DPA/mini-BAL	Positive culture from possibly contaminated LRT e.g., endotracheal aspirate (ETA)				Positive culture from lower respiratory tract* e.g.: BAL, DPA*	LRT specimen culture (e.g. endotracheal aspirate) with a threshold of 10⁶ CFU/ml	Positive culture from minimally contaminated lower respiratory tract e.g.: Broncho-alveolar lavage (BAL), Distal protected aspirate (DPA)/mini-BAL	Positive culture from possibly contaminated LRT e.g., endotracheal aspirate			
PN1A [PNX1A]	PN2A [PNX2A]	PN1B [PNX1B]	PN2B [PNX2B]	PN3 [PNX3]	PN4 [PNX4]	PN5 ***	PN1C [PNX1C]	PN2C [PNX2C]	PN1D [PNX1D]	PN2D [PNX2D]	PN3C [PNX3C]	PN4C [PNX4C]	PN5C ***

Pneumonia diagnosis

*(PN1) Broncho-alveolar lavage (BAL) with a threshold of ≥ 10^4 colony forming units (CFU)/ml or ≥ 5% of BAL obtained cells contain intracellular bacteria on direct microscopic exam (classified on the diagnostic category BAL) OR distal protected aspirate (DPA) with a threshold of ≥ 10^3 CFU/ml.
** (PN3) Alternative microbiology methods: positive blood culture not related to another source of infection OR positive growth in culture of pleural fluid OR pleural or pulmonary abscess with positive needle aspiration OR histologic pulmonary exam shows evidence of pneumonia OR positive exams for pneumonia with virus or particular organisms (e.g. *Legionella, Aspergillus, mycobacteria, mycoplasma, Pneumocystis jiroveci*).
***(PN5 and PN5C) Where no positive microbiology is available, radiological evidence is required to define a pneumonia infection, an invasive respiratory device is not sufficient.

Appendix 2 – Microorganism List for Causative Organisms

Bacteria Group	Microorganism Name
Anaerobes	Anaerobes, not specified
Anaerobes	*Bacteroides fragilis*
Anaerobes	*Bacteroides other*
Anaerobes	*Bacteroides spp.,* not specified
Anaerobes	*Clostridioides difficile*
Anaerobes	*Clostridioides other*
Anaerobes	Other anaerobes
Anaerobes	*Prevotella* spp.
Anaerobes	*Propionibacterium* spp.
Enterobacteriaceae	*Citrobacter koseri (*e.g. *diversus)*
Enterobacteriaceae	*Citrobacter* spp., not specified
Enterobacteriaceae	*Citrobacter* spp., other
Enterobacteriaceae	*Enterobacter aerogenes*
Enterobacteriaceae	*Enterobacter agglomerans*
Enterobacteriaceae	*Enterobacter cloacae*
Enterobacteriaceae	*Enterobacter gergoviae*
Enterobacteriaceae	*Enterobacter sakazakii*
Enterobacteriaceae	*Enterobacter* spp., not specified
Enterobacteriaceae	*Enterobacter* spp., other
Enterobacteriaceae	*Enterobacteriaceae Citrobacter freundii*
Enterobacteriaceae	*Enterobacteriaceae*, not specified
Enterobacteriaceae	*Escherichia coli*
Enterobacteriaceae	*Hafnia* spp.
Enterobacteriaceae	*Klebsiella oxytoca*
Enterobacteriaceae	*Klebsiella pneumoniae*
Enterobacteriaceae	*Klebsiella* spp., not specified
Enterobacteriaceae	*Klebsiella* spp., other
Enterobacteriaceae	*Morganella* spp.
Enterobacteriaceae	Other Enterobacteriaceae
Enterobacteriaceae	*Proteus mirabilis*
Enterobacteriaceae	*Proteus* spp., not specified
Enterobacteriaceae	*Proteus* spp., other
Enterobacteriaceae	*Proteus vulgaris*
Enterobacteriaceae	*Providencia* spp.
Enterobacteriaceae	*Salmonella Enteritidis*
Enterobacteriaceae	*Salmonella* spp., not specified
Enterobacteriaceae	*Salmonella* spp., other

Enterobacteriaceae	*Salmonella Typhi or Paratyphi*
Enterobacteriaceae	*Salmonella Typhimurium*
Enterobacteriaceae	*Serratia liquefaciens*
Enterobacteriaceae	*Serratia marcescens*
Enterobacteriaceae	*Serratia* spp., not specified
Enterobacteriaceae	*Serratia* spp., other
Enterobacteriaceae	*Shigella* spp.
Enterobacteriaceae	*Yersinia* spp.
Fungi	*Aspergillus fumigatus*
Fungi	*Aspergillus niger*
Fungi	*Aspergillus* spp., not specified
Fungi	*Aspergillus* spp., other
Fungi	*Candida albicans*
Fungi	*Candida auris*
Fungi	*Candida glabrata*
Fungi	*Candida krusei*
Fungi	*Candida parapsilosis*
Fungi	*Candida* spp., not specified
Fungi	*Candida* spp., other
Fungi	*Candida tropicalis*
Fungi	Filaments other
Fungi	Fungi other
Fungi	Fungi, not specified
Fungi	Other parasites
Fungi	Other yeasts
Gram-negative bacilli	*Achromobacter* spp.
Gram-negative bacilli	*Acinetobacter baumannii*
Gram-negative bacilli	*Acinetobacter calcoaceticus*
Gram-negative bacilli	*Acinetobacter haemolyticus*
Gram-negative bacilli	*Acinetobacter lwoffii*
Gram-negative bacilli	*Acinetobacter* spp., not specified
Gram-negative bacilli	*Acinetobacter* spp., other
Gram-negative bacilli	*Aeromonas* spp.
Gram-negative bacilli	*Agrobacterium* spp.
Gram-negative bacilli	*Alcaligenes* spp.
Gram-negative bacilli	*Burkholderia cepacia*
Gram-negative bacilli	*Campylobacter* spp.
Gram-negative bacilli	*Flavobacterium* spp.
Gram-negative bacilli	*Gardnerella* spp.
Gram-negative bacilli	Gram-negative bacilli, not specified
Gram-negative bacilli	*Haemophilus influenzae*
Gram-negative bacilli	*Haemophilus parainfluenzae*
Gram-negative bacilli	*Haemophilus* spp., not specified

Gram-negative bacilli	*Haemophilus* spp., other
Gram-negative bacilli	*Helicobacter pylori*
Gram-negative bacilli	*Legionella* spp.
Gram-negative bacilli	Other Gram-negative bacilli, non Enterobacteriaceae
Gram-negative bacilli	*Pasteurella* spp.
Gram-negative bacilli	*Pseudomonadaceae* family, not specified
Gram-negative bacilli	*Pseudomonadaceae* family, other
Gram-negative bacilli	*Pseudomonas aeruginosa*
Gram-negative bacilli	*Stenotrophomonas maltophilia*
Gram-negative cocci	Gram-negative cocci, not specified
Gram-negative cocci	*Moraxella catarrhalis*
Gram-negative cocci	*Moraxella* spp., not specified
Gram-negative cocci	*Moraxella* spp., other
Gram-negative cocci	*Neisseria meningitidis*
Gram-negative cocci	*Neisseria* spp., not specified
Gram-negative cocci	*Neisseria* spp., other
Gram-negative cocci	Other Gram-negative cocci
Gram-positive bacilli	*Bacillus* spp.
Gram-positive bacilli	*Corynebacterium* spp.
Gram-positive bacilli	Gram-positive bacilli, not specified
Gram-positive bacilli	*Lactobacillus* spp.
Gram-positive bacilli	*Listeria monocytogenes*
Gram-positive bacilli	Other Gram-positive bacilli
Gram-positive cocci	Coag-neg. staphylococci, not specified
Gram-positive cocci	*Enterococcus faecalis*
Gram-positive cocci	*Enterococcus faecium*
Gram-positive cocci	*Enterococcus* spp., not specified
Gram-positive cocci	*Enterococcus* spp., other
Gram-positive cocci	Gram-positive cocci, not specified
Gram-positive cocci	Other coagulase-negative staphylococci (CNS)
Gram-positive cocci	Other Gram-positive cocci
Gram-positive cocci	Other haemol. Streptococcae (C, G)
Gram-positive cocci	*Staphylococcus aureus*
Gram-positive cocci	*Staphylococcus epidermidis*
Gram-positive cocci	*Staphylococcus haemolyticus*
Gram-positive cocci	*Staphylococcus* spp., not specified
Gram-positive cocci	*Streptococcus agalactiae* (B)
Gram-positive cocci	*Streptococcus pneumoniae*
Gram-positive cocci	*Streptococcus pyogenes* (A)
Gram-positive cocci	*Streptococcus* spp., not specified
Gram-positive cocci	*Streptococcus* spp., other

Other bacteria	*Actinomyces* spp.
Other bacteria	*Chlamydia* spp.
Other bacteria	*Mycobacterium tuberculosis* complex
Other bacteria	Mycobacterium, atypical
Other bacteria	*Mycoplasma* spp.
Other bacteria	*Nocardia* spp.
Other bacteria	Other bacteria
Other bacteria	Other bacteria, not specified
Viruses	Adenovirus
Viruses	Cytomegalovirus (CMV)
Viruses	Enterovirus (polio, coxsackie, echo)
Viruses	Hepatitis A virus
Viruses	Hepatitis B virus
Viruses	Hepatitis C virus
Viruses	Herpes simplex virus
Viruses	Human immunodeficiency virus (HIV)
Viruses	Influenza A virus
Viruses	Influenza B virus
Viruses	Influenza C virus
Viruses	Norovirus
Viruses	Other virus
Viruses	Parainfluenza virus
Viruses	Respiratory syncytial virus (RSV)
Viruses	Rhinovirus
Viruses	Rotavirus
Viruses	SARS virus
Viruses	SARS-CoV-2
Viruses	Varicella-zoster virus
Viruses	Virus, not specified

Appendix 3 - Acronyms

Acronym	Description
ACP	Augmented care period
ARHAI	Antimicrobial Resistance and Hospital Acquired Infection
BAL	Broncho-alveolar lavage
CFU	Colony forming units
CRI	Catheter related infections
CVC	Central venous catheter
DPA	Distal protected aspirate
ECDC	European Centre for Disease Prevention and Control
EIA	Enzyme immunoassay
FAMA	Fluorescent-antibody-to-membrane-antigen
HAI	Healthcare associated infection
ICU	Intensive care unit
NHS	National health service
PCR	Polymerase chain reaction
SICSAG	Scottish intensive care society audit group
VAP	Ventilator-associated pneumonia

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