Public Services Delivery
Scotland

NHS SCOTLAND

Transmission-based precautions definitions literature review

Considered Judgement Forms

Version 1.1

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Antimicrobial Resistance & Healthcare Associated Infection (ARHAI) Scotland
An NHS Scotland Assure Service, part of Public Services Delivery Scotland

Version history

This literature review will be updated in real time if any significant changes are found in the professional literature or from national guidance/policy.

Version	Date	Summary of changes
1.1	3 August 2026	Completion of Part B of the considered judgement forms. Removal of 'executive summary' section. Addition of subheadings, evidence conclusions and summary of evidence conclusions to section 1.2 of research question 4. Removal of reference provided in error within Research Question 4.[1] More detail (study descriptions) added to section 1.2 of research question 8.
1.0	19 August 2024	New document

Approvals

Version	Date Approved	Group/Individual
1.1	9 June 2026	Extraordinary Transmission-Based Precautions Definitions Working Group
1.0	27 April 2023	National Policies Guidance and Evidence Working Group Community Infection Prevention and Control Working Group

Contents

Research Question 1: What is the current definition of contact transmission?

A: Quality of Evidence

1.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4**)**

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Thirteen general infection prevention and control (IPC) guidance documents were included for this research question.[1-13] All guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence. Generally, primary evidence cited to support statements within included guidance was of low quality. No primary research studies were included to answer this research question.	13 x SIGN 50 level 4 – expert opinion

1.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how the judgement was formed as to the overall direction of the evidence.

Comments

Definitions of direct and indirect contact transmission were consistent across guidance.

- Direct contact transmission was defined as the physical transfer of infectious agents from an infected or colonised person to another susceptible individual, via touch[5-7, 9] or contact with blood or body fluids[10, 11] without a contaminated intermediate object or person.[3, 10, 12]
- Indirect contact transmission was defined as the transfer of an infectious agent to a susceptible host via a contaminated intermediate object.[3, 5, 6, 9, 10, 12]

Sources consistently provided examples of scenarios which would be characterised as contact transmission[1, 9-12] and nine sources provided examples of infectious agents considered to be spread via the contact route.[2, 4, 6-12]

Three sources provided citations to support their definition of contact transmission.[9, 10, 12] These citations were all low-quality studies; outbreak reports, environmental sampling studies, before-after studies or experimental inoculation studies.

1.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments

The included guidance documents are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings. Some guidance was specific to certain healthcare settings or groups of infectious agents, for example, care homes or acute respiratory infections. Where appropriate, findings in relation to these documents have been connected in text to their respective infectious agent or setting specific guidance sources.

1.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
No primary research studies were included therefore generalisability is not applicable.

1.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
A formal assessment of publication bias was not conducted.

B: Evidence to Decision

1.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
This research question aimed to outline how contact transmission is currently described within the literature. It therefore does not have any associated recommendation(s).	N/A

1.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
N/A

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
N/A

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
N/A

1.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
N/A

1.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
N/A

1.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
N/A

1.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/religious reasons.

Intentional vagueness
N/A

1.12 Exceptions

List situations or circumstances in which the Recommendation/ Good Practice Point should not be applied.

Exceptions
N/A

1.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
N/A

Research Question 2: What is the current definition of droplet transmission?

A: Quality of Evidence

2.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Fourteen general infection prevention and control (IPC) guidance documents were identified for this research question.[1-3, 5-15] All guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence. Generally, evidence cited to support statements within guidance was of low quality.	14 x SIGN 50 level 4 – expert opinion

2.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how the judgement was formed as to the overall direction of the evidence.

Comments
• Eight SIGN 50 level 4 expert opinion guidance documents are consistent in their definition of droplet transmission. They describe infectious respiratory

Comments

droplets travelling over 'short' distances (<1-2m), from the respiratory tract of an infectious individual directly through the air, to the susceptible mucosal surfaces (eyes, mouth and/or nose) of the recipient with droplets being generated when an infected individual coughs, sneezes, or talks.[1, 5-7, 9, 10, 12, 13]

- Five SIGN 50 level 4 expert opinion guidance documents describe the respiratory particles involved in droplet transmission being equal to or greater than 5µm in size, with almost all lacking supportive citations.[2, 3, 7, 10, 12] However, Canadian guidance[9] authors outline droplets as being greater than 10µm.
- Eight SIGN 50 level 4 expert opinion guidance documents outline the concept that due to gravitational forces, droplets do not remain suspended in the air for long (time unspecified)[1, 3, 5-10] and seven specify that they cannot traverse large distances (greater than 1-2m).[1, 6, 7, 9, 10, 12, 13]

Evidence cited in guidance to support the key characteristics of droplet transmission are of low quality.[16-24]

In expert opinion guidance the following infectious agents are considered as being transmitted via the droplet route; *Bordetella pertussis*,[2, 6, 7, 9-12] Adenovirus,[2, 5, 9, 12] Group A *streptococcus*,[2, 7, 11, 12] *Neisseria meningitides*,[2, 6, 10-12, 14] rubella[6, 7, 9, 11] and influenza.[2, 5-12, 14] Weak supportive evidence is only cited in one guidance source to support these infectious agent assignations.[12]

There is inconsistency across expert opinion guidance (SIGN 50 level 4) regarding the approximate droplet transmission 'at risk' area:

- 3ft around infected individual.[12]
- less than one metre[5]
- less than one to two metres[1, 9, 10]

There is inconsistency across expert opinion guidance (SIGN 50 level 4) regarding whether droplet transmission should be considered a form of contact transmission[12] and whether indirect contact transmission via droplet contaminated surfaces should be considered a form of droplet transmission.[3, 8-10]

2.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments
The included guidance documents are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings. Some guidance was specific to certain healthcare settings or groups of infectious agents for example care homes or acute respiratory infections. Where appropriate, findings in relation to these documents have been connected in text to their respective infectious agent or setting specific guidance sources.

2.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
No primary studies were included therefore generalisability is not relevant for this research question.

2.5. Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
Overall, no concerns identified. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

2.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
This research question aimed to outline how droplet transmission is currently described within the literature. It therefore does not have any associated recommendation(s).	N/A

2.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
N/A

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
N/A

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/ Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
N/A

2.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
N/A

2.9 Expert Opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
N/A

2.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
N/A

2.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/religious reasons.

Intentional vagueness
N/A

2.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
N/A

2.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
N/A

Research Question 3: What is the current definition of airborne transmission?

A: Quality of Evidence

3.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
• Fourteen general infection prevention and control (IPC) guidance documents were included for this research question.[1-3, 5-10, 12-15, 25] All guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence. No primary studies were included in the answer for this research question.	14 x SIGN 50 level 4 – expert opinion

3.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how a judgement was formed as to the overall direction of the evidence.

Comments

Extant guidance provided similar definitions for 'airborne transmission':

- inhalation of infectious, 'small' aerosol particles (<5μm)[1-3, 5-10, 12, 14, 15, 25] (or 'droplet nuclei') which have been generated by the respiratory activities of an infectious host
- particles involved in airborne transmission can be dispersed over undefined large distances [3, 5-7, 9, 10, 12, 13, 15] and remain infective in the air for prolonged periods (time unspecified),[1, 3, 5-10, 12, 14, 15, 25] meaning that close contact is not required for transmission to occur.
- small particles can be carried on air currents and via ventilation systems [7, 10, 12, 14, 15]

Extant guidance states that the following infectious agents are spread by the 'airborne' route:

- Measles virus [6-10, 12, 15]
- *Mycobacterium tuberculosis* [6-10, 12, 14, 15]
- Varicella zoster virus [6-9, 12, 15]

Supportive citations regarding the 'airborne transmission' status of the infectious agents above are only provided in two sources.[9, 12]

There was a lack of clarity in guidance regarding a defined airtime for small particles. English guidance simply outlines that aerosols "remain in the air for longer" than droplets[1] whilst New Zealand guidance specifies that particles "can stay suspended in the air for hours"[8] with the CDC outlining indefinite airborne suspension.[15]

3.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments

The included guidance documents are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings.

Comments
Some guidance was specific to certain healthcare settings or groups of infectious agents for example care homes or acute respiratory infections. Where appropriate, findings in relation to these documents have been connected, in text, to their respective infectious agent or setting specific guidance.

3.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
No primary studies were included.

3.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
Overall, no concerns identified. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

3.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
This research question aimed to outline how airborne transmission is currently described within the literature. It therefore does not have any associated recommendation(s).	N/A

3.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
N/A

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
N/A

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
N/A

3.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
N/A

3.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
N/A

3.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
N/A

3.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/religious reasons.

Intentional vagueness
N/A

3.12 Exceptions

List situations or circumstances in which the Recommendation/ Good Practice Point should not be applied.

Exceptions
N/A

3.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
N/A

Research Question 4: How are infectious agents released into the air of the health and care environment from the respiratory tract with consideration of particle size, distance and clearance/fallout time?

A: Quality of Evidence

4.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Sixty-nine evidence sources were included for this research question: • 64 observational air sampling studies, graded SIGN 50 level 3.[26-89] • Five guidance documents, graded SIGN 50 level 4 expert opinion.[5, 9, 12, 90, 91] All 64 air-sampling studies are considered low quality evidence as they involved observational particle and/or infectious agent detection and heterogeneous comparators for overall analysis. In 16 of 23 studies where air samples were taken at specified distances, sampling was performed in uncontrolled environments where confidence in maintenance of subject's distance to sampler was poor, precise activities of subjects were unclear and contribution to samples by others could not be ruled out.[27, 29, 35, 41, 42, 49, 50, 63, 66, 67, 72, 74, 79, 83, 86, 89] Consistent limitations are outlined in further detail in section 4.2	64 x SIGN 50 level 3 5 x SIGN 50 level 4

Comments	Evidence level
The five guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence. Experts including aerosol scientists agreed with the exclusion criteria for air sampling studies in this literature review including the decision to omit manikin and simulation studies as well as studies where particle dispersion or counts were assessed through smoke visualisation, fluorescent dyes or high-resolution camera imaging. Inclusion of manikin or simulation studies was not deemed appropriate when the aim was to assess how infectious agents and/ or respiratory particles are dispersed into the air by natural respiratory activities or medical procedures. When manikins and specialised equipment are used to generate aerosols, it cannot be assured that they replicate real-life respiratory particle production and behaviour.	

4.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results, indicate how a judgement was formed as to the overall direction of the evidence.

Comments
Size of respiratory particles Eight papers (SIGN 50 level 3) described the size of particles generated during respiratory activities with six of these assessing non-infected individuals[26, 34, 47, 53, 81, 82] and two assessing particle production of those with respiratory infections.[32, 88] Four studies showed that a significant proportion of particles produced at source when breathing are <5 micrometres (µm) in size, whether healthy,[81, 82] infected with influenza[88] or human rhinovirus.[32]

Comments

Five studies (all involving healthy individuals) showed that the majority of particles produced when singing, speaking, shouting or coughing were <5µm in size.[26, 34, 53, 81, 82] Three of these studies demonstrated that the mean diameter of particles produced near to source (5-20cm) was close to 1µm.[26, 34, 53]

SIGN 50 level 4 (expert opinion) guidance from the CDC, the Canadian PHA and ASHRAE states that during respiratory activities and medical procedures, people, regardless of infective status, release respiratory fluid particles in a range of sizes at close range.[9, 12, 90] The Public Health Agency of Canada specifically states that "research has demonstrated that both droplet and airborne-sized particles can be found in the air at close proximity (up to two metres) to a coughing/sneezing source".[9] This guidance references a single air sampling study and a mathematical modelling study to support this statement.

Conclusion 1: evidence (8 SIGN 50 level 3 studies and 3 SIGN 50 level 4 guidance) is consistent in demonstrating that the majority of particles (of total particle count) released in respiratory exhalations are of a respirable (<10µm) size.

Respiratory activity and particle production

Seven air sampling studies (SIGN 50 level 3) assessed the effects of differing respiratory activities (breathing, speaking, shouting, coughing) on the numbers of particles produced.[26, 40, 47, 59, 60, 81, 82]

Three studies supported the concept that speaking generates more particles than breathing[26, 60, 81] and four studies found that singing or shouting produces more particles than speaking.[47, 60, 81, 82]

In three studies coughing was associated with more particles than breathing,[53, 59, 60] and in one study more than speaking.[47]

In five studies, increased physical exertion and loudness of speech were associated with increased particle production.[26, 40, 47, 60, 81]

Two SIGN 50 level 4 guidance documents provide expert opinion on the impact of differing natural respiratory activities. ASHRAE state that "speaking loudly, singing, and deeper breathing associated with physical activity and the like increase the number and speed of droplets and aerosols discharged into the air".[90] Two narrative reviews and two air sampling studies are referenced by ASHRAE to support this. The UK Health Security Agency (UKHSA) state that "when someone with a respiratory viral infection breathes, speaks, coughs or sneezes, they release small particles (droplets and aerosols) that contain the virus which causes the infection […] The risk of airborne transmission is increased when occupants in an enclosed space are participating in energetic activity, such as exercising, or when they are shouting, singing or talking loudly".[91] There are no references provided by UKHSA to support this statement.

Comments

Conclusion 2: evidence (8 SIGN 50 level 3 studies and 2 SIGN 50 level 4 guidance) supports the concept that particle generation increases as the force of respiratory exhalations increase.

Medical procedures and particle production

Fifteen air sampling studies (SIGN 50 level 4) assessed particle production during specific medical and/or surgical procedures.[31, 34, 39, 43, 45, 46, 48, 51-55, 60, 65, 76] The presence of infectious agents was not assessed in any of these studies. The medical procedures assessed included:

- upper gastrointestinal (GI) endoscopy[46, 65]
- upper airway suctioning[52]
- face mask ventilation (associated with anaesthetic machine)[52, 53]
- tracheal intubation (anaesthetised)[52]
- tracheal extubation (anaesthetised)[52]
- lung function tests[43, 51]
- nasal endoscopy[39]
- dental procedures[45, 76]
- oxygen delivery[34, 55]
- high flow nasal oxygen[34, 48, 60]
- continuous positive airway pressure (CPAP)[48]
- bilevel positive airway pressure (BiPAP) [34, 55, 60]
- chest physiotherapy/induction of sputum[55]
- nebuliser therapy[55]
- supraglottic airway insertion[54]
- supraglottic airway removal[54]
- tonsillectomy with monopolar electrocautery[31] and
- myringotomy and tympanostomy tube insertion.[31]

Many of these studies had limitations which included small sample sizes and inappropriate comparative baseline measurements. In some studies where procedural particle measurements were compared with those pre-procedure, pre-procedure measurements were not accompanied by sufficient information on numbers of staff present and nature of activity. Without clear information on timing of particle count spikes, counts cannot confidently be interpreted to be solely of respiratory tract origin and may be from other sources such as lint or skin

Comments

squames. In addition, it is unclear whether particle counts correlate with viral, bacterial or fungal levels in the air and thus transmission risk. The number of studies providing findings on each specific procedure were small.

Medical procedure particle counts compared to respiratory activities

Coughing was used as a key comparator in 9 of 15 medical procedure studies when assessing aerosol generation.[34, 45, 46, 48, 51-53, 55, 60] This reflects the concept that coughing is a high particle producing natural respiratory activity. Comparing particle counts produced during medical procedures to those produced during coughing provides an indication as to whether certain medical procedures constitute a lesser, similar or greater exposure risk (in terms of aerosol generation) when compared to non-procedural care.

Procedural particle counts higher than forced coughing

Three studies demonstrated that for certain medical procedures, or certain aspects of medical procedures, particle counts recorded were significantly higher than those recorded during forced coughing.[45, 46, 55] This was demonstrated for:

- upper GI endoscopy (specifically in relation to procedurally induced coughing)[46]
- administration of nebulised saline[55]
- induction of sputum/chest physiotherapy[55]
- BiPAP with use of a vented mask[55]
- the following dental procedures: ultrasonic scaling, drilling (high speed/slow speed/surgical) and 3-in-1 use (with air) however, the authors did not report on statistical significance within this study.[45]

Procedural particle counts lower than forced coughing

One study demonstrated that particle counts recorded during tracheal intubation of unconscious subjects was not significantly different when compared to the low background particle counts of an ultraclean theatre.[52]

Seven studies demonstrated that for certain medical procedures particle counts were significantly lower, or not significantly different to, those recorded during breathing.[31, 34, 39, 46, 52, 54, 65] These procedures were as follows;

- supraglottic airway insertion[54]
- supraglottic airway removal[54]
- myringotomy with tympanostomy tube insertion[31]
- nasal endoscopy without debridement[39]
- upper GI endoscopy with continuous oral suctioning[65]

Comments

- upper GI endoscopy without coughing events[46]
- tracheal extubation (anaesthetised subjects)[52]
- oxygen delivery (up to 15L/min)[34]
- respiratory tract suctioning beyond the oropharynx[52]
- high flow nasal oxygen (HFNO) (≤50L/min)[34]
- BiPAP with a vented oronasal mask[34]

Four studies demonstrated that for certain medical procedures, particle counts recorded were significantly lower than those recorded during forced coughing. These procedures were as follows;

- facemask ventilation (associated with anaesthetic machine) (2 studies)[52, 53]
- spirometry (with filter) (1 study)[51]
- peak flow measurements (with filter) (1 study)[51]
- CPAP (with exhalation filter) (1 study)[48]

In three studies, procedures produced significantly more particles than breathing and although statistical significance was not assessed for coughing it can be inferred from additional study data that they likely produce fewer particles than coughing:

- HFNO at a flowrate of 60L/min (2 studies)[48, 60]
- BiPAP with use of an exhalation filter and non-vented mask (1 study)[60]

In one study, for the following procedures, mean particle counts recorded were not significantly different to those recorded during the comparison - a single session of participants performing a ‘series of coughs’ whilst wearing and not wearing a surgical mask;

- BiPAP with an exhalation filter and non-vented mask[55]
- oxygen delivery (up to 15L/min)[55]

Procedural particle counts – no comparison to forced coughing

In four studies, procedures produced particle counts which were significantly greater than those reported during breathing (a comparison was not made with coughing in these studies). These procedures included nasal endoscopy with debridement,[39] peak flow testing,[43] tonsillectomy with monopolar electrocautery[31] and ultrasonic scaling.[76]

There are procedures which feature on the current Scottish AGP list (as of September 2025) for which no studies of adequate quality were identified. They are as follows; bronchoscopy, tracheotomy or tracheostomy procedures (including

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insertion or removal), high frequency oscillatory ventilation (HFOV), manual facemask ventilation and high-speed cutting of the respiratory tract in surgery or post-mortem procedures. **Conclusion 3:** evidence (15 studies graded SIGN 50 level 3) is consistent in demonstrating that the aerosol exposure risk presented by medical procedures currently defined as AGPs is not equal and for some, the aerosol exposure risk may be lower, higher or similar to that created by a cough. **Intersubject variability in particle production** Eight air sampling studies (SIGN 50 level 3) demonstrated significant inter-subject variability in particle production during natural respiratory activities.[26, 32, 38, 47, 81, 82, 85, 88] Four of these studies included participants with respiratory infection (rhinovirus, influenza, SARS-CoV-2).[32, 38, 85, 88] Two studies demonstrated wide intersubject variability in particle counts for breathing.[32, 88] Mean particle counts during breathing ranged from 67 to 8,500/L of air for subjects in one study[88] and 0.2 to 7200/L in another.[32] Two studies demonstrated wide intersubject variability in particle counts for speaking. In one study, particles emitted per second ranged from 1 to 14[26] whilst in another, mean particle concentration ranged from 0.060-0.75 particles/cm³.[47] Two studies demonstrated wide intersubject variability in particle counts for singing.[81, 82] Particles emitted per second ranged from 753 to 6093 in one study and 141 to 1240 in another.[81, 82] Three studies demonstrated wide intersubject variability in particle counts for coughing. In one study particle counts per cough ranged from 0.9 to 217.4[85] and from 400 to 516,800 in another.[38] In a third study, which assessed particles <5µm, counts per cough ranged from 0.22 to 41 particles/cm³.[47] One guidance graded SIGN 50 level 4 expert opinion, published by ASHRAE outlines that particle number and speed will “vary widely by individual, type of respiratory activity and/or metabolic intensity, the volume of vocalization, and stage of disease if the person is infected”.[90] **Conclusion 4:** evidence is consistent (8 SIGN 50 level 3 studies, 1 SIGN 50 level 4 guidance) in demonstrating that there is wide intersubject variability in particle production. **Detection of infectious material** Of the 39 air sampling studies which involved detection of infectious agents in the air and/or in respiratory exhalations, 15 involved collection of samples at or close to source using apparatus with a mouthpiece, or cone shaped aperture.[33, 36, 37, 44, 56, 59, 64, 68-71, 77, 78, 85, 87] 23 studies involved detection of infectious agents at specified distances (up to 4.8 metres*) from infected persons.[27-30, 35, 41, 42, 49, 50, 57,

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[58, 61-63, 66, 67, 72, 74, 75, 79, 83, 86, 89] Studies were heterogeneous in terms of infectious agent studied (including specific variant), population characteristics, procedures reported and environmental parameters during sampling. Two SIGN 50 level 4 expert opinion guidance documents outline that distances travelled by respiratory emissions are contingent on a multitude of factors including velocity of the particles at release[5, 91] and airflow patterns.[5]

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

Conclusion 5: evidence is consistent in demonstrating that infectious agent material (RNA, DNA, or viable virus) can be detected at source (19 studies, SIGN 50 level 3)[33, 36, 37, 44, 56-59, 62, 64, 68-71, 77, 78, 84, 85, 87] and at distances of up to 5 metres (23 studies, SIGN 50 level 3)[27-30, 35, 41, 42, 49, 50, 57, 58, 61-63, 66, 67, 72, 74, 75, 79, 83, 86, 89] from infected subjects (both hospitalised and un-hospitalised).

Size of respiratory particles carrying infectious material

Twenty-six studies (graded SIGN 50 level 3) presented data on the sizes of respiratory particles found to contain or carry viral or bacterial material (DNA, RNA, viable infectious agent):

Evidence from 26 air sampling studies was consistent in demonstrating that infectious agent can be detected in varying particle sizes that range from <1µm->10µm.[27-30, 33, 37, 41, 42, 44, 49, 50, 56, 57, 59, 61, 62, 64, 66, 68, 71, 77, 83, 85-87, 89]

Seven studies demonstrated that the majority of total exhaled infectious material (influenza viral RNA,[37, 87] SARS-CoV-2 RNA,[68] viable *P. aeruginosa*,[59, 61] and viable *M. tuberculosis*[33, 71]) was found in small size fractionated samples (<5µm) close to source (<1m). A single study demonstrated this for *P. aeruginosa* at 2 metres.[61]

Conclusion 6: evidence (26 studies graded SIGN 50 level 3) is consistent in demonstrating the presence of infectious material in particle sizes of <1µm->10µm including those in the respirable range (<10µm).

Conclusion 7: there is an insufficient scope of evidence (seven studies graded SIGN 50 level 3 assessing 4 different infectious agents) and therefore it is not possible to conclude from the evidence whether there is a correlation between particle size and proportion of total infectious material present.

Reported symptoms and detection of infectious agent

Contradictory findings were identified in association with SARS-CoV-2 RNA positivity rates of exhalations and reported symptoms.

Two studies reported a correlation between report of coughing symptoms and SARS-CoV-2 RNA aerosol positivity.[64, 84]

Comments
One study found that clinical symptoms (sore throat, rhinorrhoea, anosmia, fever, cough, dyspnoea) were not significantly different between participants with and without detectable SARS-CoV-2 RNA in respiratory exhalations.[68] **Conclusion 8:** There is an insufficient scope of evidence (3 studies assessing detection of only one infectious agent (SARS-CoV-2 RNA)) therefore it is not possible to establish any conclusions from the evidence regarding the influence of reported symptoms on detection of infectious agent in exhalations. **Respiratory activity and detection of infectious agent** Contradictory findings were identified regarding nature of respiratory activity assessed and detection of infectious agent. Three studies assessed the correlation between respiratory activity performed and detection of infectious agent.[36, 56, 64] In one study there was no significant difference regarding frequency of viral RNA detection (parainfluenza or rhinovirus) in samples from breathing or samples from coughing.[56] In another study, a higher fraction of SARS-CoV-2 RNA positive aerosol samples were obtained from either singing or talking samples, compared to breathing samples.[64] In a third study, there was no significant difference in rates of viable influenza A positive air samples between forced coughing and forced deep exhalations.[36] One study assessed the nature of respiratory activity performed and quantity of infectious agent. In this one study there was a 42.5-fold increase in mean CFU counts of *P. aeruginosa* when frequent strong coughing for 5 minutes was compared to 5 minutes of quiet breathing.[59] **Conclusion 9:** there is an insufficient scope of evidence (3 studies, SIGN 50 level 3 assessing four infectious agents) and therefore it is not possible to establish from the evidence if a correlation exists between the type of respiratory activity performed and detection of infectious agent in exhalations. **Conclusion 10:** there is an insufficient scope of evidence (1 study, SIGN 50 level 3 assessing one infectious agent) and therefore it is not possible to establish from the evidence if a correlation exists between the type of respiratory activity performed and quantity of infectious agent released in exhalations. **Viability** Twenty-three studies demonstrated the presence of viable infectious agents in the air/ respiratory exhalations for the following: SARS-CoV-2 (3 studies),[35, 41, 77] influenza (4 studies), [36, 37, 44, 87] *Pseudomonas aeruginosa* (4 studies),[57-59, 61]

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Mycobacterium tuberculosis (4 studies),[33, 69, 71, 78] *Staphylococcus aureus* (2 studies),[30, 62] coagulase negative *staphylococci* (1 study),[28] respiratory syncytial virus (1 study),[50] *Burkholderia cenocepacia* (1 study),[59] *Stenotrophomonas maltophilia* (1 study),[61] MERS-CoV (1 study)[79] and *Aspergillus fumigatus* (1 study).[70] Thirteen studies provided a measure of the size of positive particles (in size range <1µm to >7µm).[28, 30, 33, 36, 37, 41, 44, 50, 57, 59, 61, 71, 87] Detection of viable exhaled infectious agents at specified distances (>1m-4.8m*) was assessed in seven studies.[35, 50, 57, 58, 61, 62, 79] Two SIGN 50 level 4 expert opinion guidance documents outline that distances travelled by respiratory emissions are contingent on a multitude of factors including velocity of the particles at release[5, 91] and airflow patterns.[5]

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

Viable SARS-CoV-2 virus was detected in three studies, at source (no particle size assessment, n=2 subjects),[77] approximately 1m away (<1µm, n=3 subjects)[41] and 4.8m away (no particle size assessment, n=1 subject).[35]

In four studies, viable influenza was detected at close range (<1m) from infected subjects[36, 37, 44, 87] with positive samples found in small particle size fractions (<5µm).[44, 87]

Four studies detected viable *P. aeruginosa* in the coughing exhalations of colonised persons (with cystic fibrosis and/ or COPD/bronchiectasis), in particles <5µm diameter, both at source and at 2m,[57, 59, 61] at source in particles >7µm[59] and at 4m from source,[57, 58] with positive samples in particles <3.3µm and >7µm.[57]

Four studies reported detection of viable *Mycobacterium tuberculosis* at source[33, 69, 71, 78] with two studies demonstrating positive samples in particle size fractions <1.1µm and >7µm.[33, 71]

In two studies viable *Staphylococcus aureus* was detected in particles less than and greater than 5µm at approximately 2m,[62] and 3m[30] from source with one of these studies also demonstrating detection at 4m (particle size unknown).[62]

Single studies assessed the presence of the following infectious agents in the air and/or respiratory exhalations; viable coagulase negative *staphylococci* (<5µm and >5µm at 3m),[28] viable respiratory syncytial virus (<1.1µm and >7µm at 1 metre),[50] viable *B. cenocepacia* (at source, unclear particle size),[59] viable *S. maltophilia* (at source, no measurement of size),[61] viable MERS-CoV (at 4 metres, no measurement of size) [79] and viable *A. fumigatus* (at source, no measurement of size).[70]

Conclusion 11: evidence (23 studies graded SIGN 50 level 3) is consistent in demonstrating that viable (as per laboratory methods) infectious agents can be

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present at source and up to distances of 4.8 metres* in particle sizes of <1µm to >7µm. The correlation between detection of viable infectious agent and transmission risk is unknown.

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

Infectious agent clearance time

Limited evidence was identified regarding the length of time an infectious agent can remain detectable or viable in the air post-release from a source.

Three experimental studies (SIGN 50 level 3) demonstrated the presence of viable *S. aureus*, *P. aeruginosa*, and gram-negative bacteria (specifically *S. maltophilia*, *Burkholderia* spp., *Achromobacter* spp.) when sampled from a rotating drum apparatus post-release from coughing patients.[57, 58, 62]

One air sampling study (SIGN 50 level 3) involving three RSV-infected infants (SIGN 50 level 3) demonstrated the presence of viable RSV in the air two hours after the infectious patient had departed the space.[50]

It is unclear from this evidence base the influence of room ventilation, air humidity and temperature on the detectability of viable infectious agents post-release.

Conclusion 12: there is insufficient evidence (4 studies, SIGN 50 level 3) regarding the length of time viable infectious agent can remain detectable post-release from a source, therefore no conclusions can be made at this time.

Summary of conclusions

Conclusion 1: evidence (8 SIGN 50 level 3 studies and 3 SIGN 50 level 4 guidance) is consistent in demonstrating that the majority of particles (of total particle count) released in respiratory exhalations are of a respirable (<10µm) size.

Conclusion 2: evidence (8 SIGN 50 level 3 studies and 2 SIGN 50 level 4 guidance) supports the concept that particle generation increases as the force of respiratory exhalations increase.

Conclusion 3: evidence (15 studies graded SIGN 50 level 3) is consistent in demonstrating that the aerosol exposure risk presented by medical procedures currently defined as AGPs is not equal and for some, the aerosol exposure risk may be lower, higher or similar to that created by a cough.

Conclusion 4: evidence is consistent (8 SIGN 50 level 3 studies and 1 SIGN 50 level 4 guidance) in demonstrating that there is wide intersubject variability in particle production.

Conclusion 5: evidence is consistent in demonstrating that infectious agent material (RNA, DNA, or viable virus) can be detected at source (19 studies, SIGN

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50 level 3) and at distances of up to 4.8 metres* (23 studies, SIGN 50 level 3) from infected subjects (both hospitalised and un-hospitalised). *Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies. Conclusion 6: evidence (26 studies graded SIGN 50 level 3) is consistent in demonstrating the presence of infectious material in particle sizes of <1µm->10µm including those in the respirable range (<10µm). Conclusion 7: there is an insufficient scope of evidence (7 studies graded SIGN 50 level 3 assessing 4 different infectious agents) and therefore it is not possible to conclude from the evidence whether there is a correlation between particle size and proportion of total infectious material present. Conclusion 8: There is an insufficient scope of evidence (3 studies assessing detection of only one infectious agent (SARS-CoV-2 RNA)) therefore it is not possible to establish any conclusions from the evidence regarding the influence of reported symptoms on detection of infectious agent in exhalations. Conclusion 9: there is an insufficient scope of evidence (3 studies, SIGN 50 level 3 assessing four infectious agents) and therefore it is not possible to establish from the evidence if a correlation exists between nature of respiratory activity performed and detection of infectious agent in exhalations. Conclusion 10: there is an insufficient scope of evidence (1 study, SIGN 50 level 3 assessing one infectious agent) and therefore it is not possible to establish from the evidence if a correlation exists between nature of respiratory activity performed and quantity of infectious agent released in exhalations. Conclusion 11: evidence (23 studies graded SIGN 50 level 3) is consistent in demonstrating that viable (as per laboratory methods) infectious agents can be present at source and up to distances of 4.8 metres* in particle sizes of <1µm to >7µm. The correlation between detection of viable infectious agent and transmission risk is unknown. *Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies. Conclusion 12: there is insufficient evidence (4 studies, SIGN 50 level 3) regarding the length of time viable infectious agent can remain detectable post-release from a source, therefore no conclusions can be made at this time.

4.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments
Of the 64 research studies, 20 were from the U.S.A,[26-44, 87] 12 were from the U.K,[45-55, 89] six were from Australia,[56, 58-62] three each from Germany,[73, 81, 82] France,[67, 72, 74] and Singapore,[66, 68, 83] two each from Canada,[77, 86] Hong Kong,[65, 88] Uganda,[71, 78] South Korea,[79, 80] and Sweden[64, 85] and one from each of the following countries; Italy,[76] Turkey,[63] Norway,[75] South Africa,[69] Japan,[84] and the Netherlands.[70] Clinical procedures performed may utilise differing equipment or techniques depending on country specific practices and there was a lack of detail in the evidence base to confirm whether this was the case or not. The five included guidance documents (SIGN 50 level 4 expert opinion) are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings. Three of the included guidance documents (SIGN 50 level 4 expert opinion) were generic healthcare infection prevention and control documents without a focus on a specific infectious agent or health and care setting.[9, 12, 90] Two guidance documents (SIGN 50 level 4 expert opinion) focused on respiratory infections[5, 91] with one specific to SARS CoV-2.[91]

4.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
Most included primary studies had highly specific cohorts, environmental conditions, procedures and/or infections (including associated circulating strain) therefore findings may not be generalisable. In terms of study populations, in 13 studies where SARS-CoV-2 was identified in air samples, 6 had sole involvement of hospitalised patients.[27, 35, 41, 66, 83, 84] Of 8

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studies where influenza was identified in air samples, 4 had sole involvement of young, otherwise healthy cohorts (~19-21yo).[36, 37, 44, 87] The heterogeneity in study design and methodology may limit generalisability beyond the specifics of the study setting. All study conclusions should be interpreted with an awareness that differing infectious agents, air flow patterns, air change rates, symptoms of participants, humidity conditions, and room temperatures could produce different results.

4.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
There may be a tendency towards publication of studies where infectious agents were identified in air samples as opposed to studies where they were not. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

4.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) does the Working Group agree are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Please note that the recommendations and good practice points detailed below are high-level and outline principles on which practical, implementable guidance will be based.

Recommendation(s)	Grading
R4.1 The evidence base demonstrates that the current definitions of 'droplet' and 'airborne' transmission are not sufficiently supported and should be discontinued.	Recommendation
R4.2 Evidence-based definitions should be developed to replace the historical 'droplet' and 'airborne' descriptors – these are outlined in GPP5.1.	Recommendation
GPP4.1 Coughing (both natural and procedurally induced on awake patients) should be considered as presenting a higher-risk exposure compared to most other natural respiratory activities; risk of exposure increases with proximity.	Good Practice Point

Recommendation(s)	Grading
GPP4.2 Use of high-speed devices on tissues within the respiratory tract (and extra-pulmonary TB sites) in surgery/ post-mortem and dentistry, should be considered as presenting a high-risk exposure; risk of exposure increases with proximity.	Good Practice Point
GPP4.3 Respiratory exposure risk increases with proximity and should be considered greatest when within 1 metre (~3 feet) of an individual's airway when delivering care.	Good Practice Point

4.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
R 4.1 and R 4.2: • Definitions will more accurately reflect the current evidence base and the significant quantity of research conducted during and since the COVID-19 pandemic (61% of all studies included in the answer to RQ4 were published between 2019 and 2022). An approach which better reflects the evolving evidence base aims to improve patient and healthcare worker safety and facilitate future pandemic response. • Anticipated alignment with other international healthcare organisations who have recently assessed the droplet/airborne dichotomy. GPP4.1 *[Coughing (both natural and procedurally induced on awake patients) should be considered as presenting a higher-risk exposure compared to most other natural respiratory activities; risk of exposure increases with proximity.]* – the benefits of considering coughing as a higher-risk exposure are:

Benefits

- that it may allow a HCW to identify potentially infectious patients and allow the HCW to consider the potential mitigations (if the patient has presented with suspected or confirmed respiratory infection and visible symptoms and/or the need for a specific procedure which induces coughing)
- using coughing as an indicator, rather than all natural respiratory activities (for example, breathing, talking) identifies patients that are releasing particles in high-expulsive outputs, which presents a risk when at close range when delivering care. This would allow a HCW to consider mitigations when delivering care at close range.
- another potential benefit is the ability to communicate this risk (and the subsequent mitigations) to the patient. This links in with the respiratory hygiene/ cough etiquette practices already in place in health and care settings.

GPP4.2 *[Use of high-speed devices on tissues within the respiratory tract, (and extra-pulmonary TB sites) in surgery/ post-mortem and dentistry should be considered as presenting a high-risk exposure].*

The benefits include:

- that it may allow a HCW to consider and target mitigations when they are performing these procedures on patients with suspected/ confirmed transmissible respiratory infection. It may be possible to predict or anticipate when these procedures are likely to be performed, which will allow a HCW to consider the need for targeted mitigations.

GPP4.3 [Respiratory exposure risk should be considered greatest when within 1 metre (~3 feet) of an individual's airway when delivering care].

The intended benefit of considering exposure risk greatest when within 1 metre (~3 feet) of an individual's airway when delivering care, is that this will provide a pragmatic and tangible point on which healthcare workers can base a risk assessment and may consider use of RPE as a personal choice for R1 pathogens, recognising the lack of understanding around increased transmission risk associated with greater exposure at proximity.

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms

R4.1 and R4.2:

- If definitions do not align with other devolved nations or international organisations, it could cause confusion and miscommunication and a lack of trust in national guidance.

GPP4.1

- infectious patients that are not coughing, or are coughing infrequently or intermittently, will be overlooked. However, there are other indicators (in addition to coughing) to be evaluated as part of clinical assessment that support determination of mitigations (for example other symptoms, the suspected/confirmed infectious agent, patient history, knowledge of infectious agents circulating in the community). Consideration of these other indicators can help to further mitigate exposure risk. This GPP is a general principle and it would not over-ride existing pathogen-specific guidance that is currently in place, for example high consequence infectious disease (HCID) guidance.
- patients who are coughing due to a non-infectious condition, for example chronic obstructive pulmonary disease (COPD), may initially be identified as presenting a high-risk exposure could have unnecessary TBP mitigations applied. However, there are other indicators (in addition to coughing) that would rule out the suspicion of infection (for example other symptoms and patient history). Consideration of these other indicators can help to further mitigate this risk.

GPP4.1, GPP4.2:

- focusing on high-risk exposures could disproportionately focus attention (and possibly mitigations) onto these exposures, at the risk of lower-risk exposure events/scenarios being overlooked.

There is a risk that care delivery which does not involve high-risk exposures could present a comparable transmission risk to a high-risk exposure due to the duration of time spent with the infectious patient both at proximity and at further distances within the care area. This may be influenced by pathogen-specific factors such as viability/survival post-emission and infectious dose.

GPP4.3:

There is a risk that focusing on a specific distance could disproportionately focus attention (and possibly mitigations) onto exposures within this distance, at the risk of exposures at greater distances being overlooked.

There is a risk that care/ task delivery which does not occur at 1 metre proximity could present a comparable exposure risk (and by proxy transmission risk) due to the duration of time spent with the infectious patient at further distances within the

Risks/Harms
care area. This may be influenced by pathogen-specific factors such as viability/ survival post-emission and infectious dose.

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/ staff/ visitor perspective, the societal perspective, or both. Recommendations/ Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
R4.1 and R4.2 It is expected that benefits will outweigh harms if supported by a comprehensive implementation plan for suggested changes to terminology and practice. Further, the new definitions proposed in GPP5.1 are in alignment with the World Health Organization’s Global technical consultation report on proposed terminology for pathogens that transmit through the air, published in April 2024, which demonstrates that the risk of misalignment is minimal. GPP4.1, GPP4.2 The working group agreed that the anticipated benefits will outweigh the harms if consideration is given to additional indicators (such as patient symptoms, the suspected/confirmed infectious agent, patient history, knowledge of infectious agents circulating in the community) that can support determination of the infection risk the patient presents and the mitigations required. There is a risk that lower-risk exposures (of durations which create a comparable risk to that of a high-risk exposure) will be overlooked if the focus is on exposure events considered high-risk. However, the anticipated benefit of mitigating against a recognisable and predictable high-risk exposure will outweigh the risk if proportionate and appropriate mitigations are implemented against the lower-risk exposures. GPP4.3 The working group agreed that the anticipated benefits will outweigh the harms if consideration is given to additional indicators laid out in GPP7.2 (such as patient symptoms, the suspected/confirmed infectious agent, patient history, knowledge of infectious agents circulating in the community, environmental conditions) that can support determination of a greater exposure risk and the mitigations required. Regarding the risk that exposures at distances greater than 1 metre will be overlooked, the working group agreed that the anticipated benefit will outweigh the risk if proportionate and appropriate mitigations are implemented against the exposures occurring at distances beyond 1 metre. For example, see GPP7.3.

4.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility

R4.1 and R4.2:

There will be resource implications related to staff education and training (inclusive of acknowledging human factors/ergonomics) as a result of a change in definitions.

Material and financial implications in relation to staff education and training (replacement of educational materials and associated waste).

Resource implications in relation to change of terminologies and wording throughout existing guidance and resources.

GPP4.1 *[Coughing (both natural and procedurally induced on awake patients) should be considered as presenting a higher-risk exposure compared to most other natural respiratory activities; risk of exposure increases with proximity.]*

Feasibility issues include:

- staff time and resource is required to assess a patient
- staff education will be required to support implementation of this good practice point in practice
- the requirement for the HCW to know which procedures are likely to induce coughing

The working group discussed whether provision of a formal comprehensive list of procedures was required:

if a list is not provided, healthcare workers may base their decision-making on pre-existing beliefs, preferences and experience rather than application of the criteria of proximity and induced coughing. This could result in significant variation in practice in terms of the mitigations applied during patient care. Inappropriate decisions by individuals could influence others and potentially create a risk if appropriate mitigations are not applied. The working group expressed concern that, by moving completely away from an ‘AGP list’, the importance of adhering to IPC guidance could be lessened.

The working group reported that an exemplary list could be used as a supportive educational tool to provide greater clarity on procedural elements that increase risk.

Feasibility
The working group reported that healthcare workers are familiar with a list, and such a list could support situations where deviation from good practice is identified. However, retaining a list in any form may result in stakeholders assuming that tasks or procedures which do not feature on the list are low-risk exposures. In light of the above considerations, the working group agreed that an exemplary, non-exhaustive list of procedures considered to be capable of inducing a cough will be provided in guidance (rationale for the items on this list is provided in section 4.9 Expert Opinion). Presentation of guiding principles alongside such a list would support clinicians' decision making and negate the need for a finite list of procedures that would be under constant debate and review. GPP4.2: *[Use of high-speed devices on tissues within the respiratory tract (and extra-pulmonary TB sites) in surgery/ post-mortem and dentistry, should be considered as presenting a high-risk exposure; risk of exposure increases with proximity]* Clinicians will need to consider which procedures will involve use of high-speed devices on respiratory tract tissue (including dental tissues and extra-pulmonary TB sites) GPP4.3 *[Respiratory exposure risk increases with proximity and should be considered greatest when within 1 metre (~3 feet) of an individual's airway when delivering care]:* Healthcare workers will need to anticipate which care activities are likely to require proximity within 1 metre, and which are likely to occur at distances greater than 1 metre. Feasibility issues associated with mitigations (for example PPE choice) that might be determined based on the 1 metre distance will feature within the respective PPE literature reviews (for example RPE and FRSM).

4.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state "none". Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
R4.1 *[The evidence base demonstrates that the current definitions of 'droplet' and 'airborne' transmission are not sufficiently supported and should be discontinued]*

Expert opinion

and **R4.2** *[Evidence-based definitions should be developed to replace the historical 'droplet' and 'airborne' descriptors – these are outlined in GPP5.1].*

Although the number of studies for specific infectious agents are small, the findings regarding infectious agent detection in the air and specific particle sizes, as part of a general respiratory infection picture, are clear:

- **Evidence conclusion 1** (see section 4.2): evidence (8 SIGN 50 level 3 studies and 3 SIGN 50 level 4 guidance) is consistent in demonstrating that the majority of particles (of total particle count) released in respiratory exhalations are of a respirable (<10µm) size.
- **Evidence conclusion 6**: evidence (26 studies graded SIGN 50 level 3) is consistent in demonstrating the presence of infectious material in particle sizes of <1µm->10µm including those in the respirable range (<10µm).
- **Evidence conclusion 11:** evidence (23 studies graded SIGN 50 level 3) is consistent in demonstrating that viable (as per laboratory methods) infectious agents can be present at source and up to distances of 4.8 metres* in particle sizes of <1µm to >7µm. The correlation between detection of viable infectious agent and transmission risk is unknown.

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

- The working group have ascertained that the evidence base is limited but stronger than the evidence on which the current definitions (droplet and airborne) are based. The evidence is considered sufficient to support these recommendations. The working group agreed that these evidence conclusions support that the historical definitions of 'droplet' and 'airborne' transmission should be discontinued.

GPP4.1 – *[Coughing (both natural and procedurally induced on awake patients) should be considered as presenting a higher-risk exposure compared to most other natural respiratory activities; risk of exposure increases with proximity.].*

It is emphasised by the working group that the 'exposure' outlined in the above good practice point pertains to the risk of transmission via the air. It is acknowledged that these and other care interactions will also present risk of transmission via other routes such as via direct or indirect contact to varying degrees.

The natural coughing element of this GPP is informed by the following:

- This good practice point is informed by **evidence conclusion 2** (see section 4.2): 'evidence (8 SIGN 50 level 3 studies and 2 SIGN 50 level 4 guidance) supports the concept that particle generation increases as the force of respiratory exhalations increase'. It is logical to deduce that the exposure risk

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from a coughing person, in terms of the quantity and velocity of respiratory particles produced, will usually be greater than the exposure risk from a patient that is breathing normally.

- Although **evidence conclusion 4** states that 'evidence is consistent (8 SIGN 50 level 3 studies and 1 SIGN 50 level 4 guidance) in demonstrating that there is wide intersubject variability in particle production', for any particular individual, a cough will still generate more particles (of all sizes) than breathing.
- In summary, the working group agreed that exposure risk to respiratory particles (regardless of whether there is any infectious agent present in those particles) will usually increase if the force of respiratory exhalations increase.
- As per **evidence conclusion 11**: 'evidence (23 studies graded SIGN 50 level 3) is consistent in demonstrating that viable (as per laboratory methods) infectious agents can be present at source and up to distances of 4.8 metres* in particle sizes of <1µm to >7µm. The correlation between detection of viable infectious agent and transmission risk is unknown', the evidence is unable to determine the actual **transmission risk** that exposures present to the healthcare worker, from a suspected/confirmed infectious patient. The difference/distinction between exposure risk and transmission risk is important. A healthcare worker may be able to assess the exposure risk (which is required for all patients, regardless of infection status), but in most cases will be unable to assess the transmission risk.

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

- Exposure risk can be determined by observing actual exposure events or anticipating exposure events (for example, the likelihood of being exposed to blood and body fluids whether that be via direct/ indirect contact or via the air).
- Transmission risk from a suspected or confirmed infectious person is difficult to assess because it depends on many unknown and 'invisible' factors such as how much infectious agent is present in the blood/ body fluids, the ability of the infectious agent to survive outside of the body when emitted, the amount of infectious agent that the exposure event generates, and how much infectious agent is required to result in infection (infectious dose).
- The working group acknowledged that transmission can occur without requiring coughing symptoms and will depend on factors specific to the infectious agent (for example its ability to transmit without symptoms – which this evidence review has not looked at specifically) and factors specific to the

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infected person (how many respiratory particles that person typically produces as their baseline). **Evidence conclusion 4** highlights the variation between people regarding baseline particle production: evidence is consistent (8 SIGN 50 level 3 studies and 1 SIGN 50 level 4 guidance) in demonstrating that there is wide intersubject variability in particle production.

- In 7 studies, the impact of symptoms or the type of respiratory activity performed (for example coughing) on detection or quantity of infectious agent in exhalations was considered. However, how this evidence translates to transmission risk remains unknown. This is highlighted in the following three evidence conclusions:
    - **evidence conclusion 8**: there is an insufficient scope of evidence (3 studies, SIGN 50 level 3, assessing detection of only one infectious agent - SARS-CoV-2 RNA) and therefore it is not possible to establish any conclusions from the evidence regarding the influence of reported symptoms on detection of infectious agent in exhalations
    - **evidence conclusion 9**: there is an insufficient scope of evidence (3 studies, SIGN 50 level 3 assessing four infectious agents) and therefore it is not possible to establish from the evidence if a correlation exists between the type of respiratory activity performed and detection of infectious agent in exhalations
    - **evidence conclusion 10:** there is an insufficient scope of evidence (1 study, SIGN 50 level 3 assessing one infectious agent) and therefore it is not possible to establish from the evidence if a correlation exists between the type of respiratory activity performed and quantity of infectious agent released in exhalations.
- With the above limitations acknowledged (the knowledge gaps regarding transmission risk according to specific symptoms), the working group agreed that a patient coughing with respiratory infection generally presents a higher risk exposure compared to a patient with respiratory infection who is not coughing. When considering patients with a suspected/ confirmed infection, symptoms such as coughing can be identified by a healthcare worker.
- With regards to inclusion of induced coughing in GPP4.1, the working group discussed whether there is a difference in exposure risk presented by a natural cough versus an induced cough from a patient with suspected/ confirmed infection. Upon discussion with aerosol scientists, it was agreed that it is generally the force of the exhalation that is the biggest determinant of aerosol production, and therefore exposure risk; a natural cough on a fully conscious individual will present a greater exposure risk compared to a (weaker) induced cough on a partially sedated patient. Experts highlighted that there is not currently sufficient evidence to distinguish between the force or aerosol production from an adult's cough versus a child's or neonates. The

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working group agreed that, whilst there may be differences in exposure risk, both a natural and an induced cough present a greater risk than most other natural respiratory activities.

The procedurally induced coughing element of the GPP is informed by the following:

- This good practice point is informed by **evidence conclusion 3**: 'evidence (15 studies graded SIGN 50 level 3) is consistent in demonstrating that the aerosol exposure risk presented by medical procedures currently defined as AGPs is not equal, and for some, the aerosol exposure risk may be lower, higher or similar to that created by a cough'.
- This good practice point is informed by **evidence conclusion 2**: 'evidence (8 SIGN 50 level 3 studies and 2 SIGN 50 level 4 guidance) supports the concept that particle generation increases as the force of respiratory exhalations increase'.
- As per section 4.2, coughing was used as a key comparator in 9 of 15 medical procedure studies when assessing aerosol generation. This reflects the concept that coughing is a high particle producing natural respiratory activity. Comparing particle counts produced during medical procedures to those produced during coughing provides an indication as to whether certain medical procedures constitute a lesser, similar or greater exposure risk (in terms of aerosol generation) when compared to non-procedural care.
- The working group acknowledged that using particle count as a proxy for exposure risk (and in turn exposure risk as a proxy for transmission risk) is a limitation, as some of the particles produced may not be of a respiratory origin and particle count alone is not the only determinant for infectious dose/ total exposure and presumably transmission risk. Further, this literature review did not include studies which assessed transmission events or infection rates associated with specific medical procedures, only particle counts, particle sizes and distances from source of infectious agent detection.
- Expert opinion was obtained from clinicians and aerosol scientists regarding the elements of medical procedures that may present a high exposure risk, and the evidence regarding aerosol production associated with these procedures. From this, the working group agreed the following:
    - Exposure risk is increased if the procedure induces coughing. Ability to cough is determined by the service user's state of consciousness; a fully anaesthetised or unconscious patient cannot cough, a partially anaesthetised patient may produce a weaker cough, a fully awake patient will be most capable of coughing with the greatest force.
    - Exposure risk includes exposure to splashing and spraying of respiratory fluids as well as respirable particles.

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- All procedures require a degree of proximity however risk is reduced if the patient is wearing a close-fitting mask associated with the procedure which covers the nose and mouth (such as those used to provide ventilation) and if duration of proximity is short (for example seconds or minutes).
- Certain procedural elements or equipment may reduce dissemination of respiratory particles for example, suctioning, dental dam application, equipment exhalation filters and non-vented masks.

Expert opinion regarding specific procedures is presented below:

Continuous medical procedures (BiPAP, CPAP, HFNO, HFOV, oxygen delivery, facemask ventilation):

BiPAP

- Three studies assessed BiPAP with mixed results.
- In one study, particle counts recorded during administration of BiPAP (pressure setting of 20/5 cm H_2O) with use of an exhalation filter and a non-vented mask were not significantly different to those recorded during coughing,[55] however in a second study (BiPAP 5/5-25/10), counts were significantly more than breathing but likely less than coughing.[60] This latter result was also observed without use of an exhalation filter.
- Conflicting results were observed across two studies where a vented mask was used; in one study particle counts were significantly greater than those recorded during coughing (20/5)[55] and in the second study counts were not significantly different to breathing (12/5 and 20/10).[34]
- BiPAP does not feature on the English AGP list (published April 2022).
- Expert opinion from clinicians/ aerosol scientists: BiPAP does not induce coughing, there may be loosening of secretions but the patient is wearing a mask which is connected to a closed system. Whilst it does require proximity to set up and reposition, the risk of exposure is reduced when the patient's mask is placed which will impede release of emission to a degree. An exhalation filter is important to have as a mitigation.
- Considering the evidence of aerosol generation, which is not greater than forced coughing, combined with expert opinion that this procedure does not induce coughing, the working group agreed that BiPAP with use of an exhalation filter and non-vented mask should not be considered a high-risk exposure.

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CPAP

- A single study[48] demonstrated that continuous positive airway pressure (CPAP) with use of an exhalation filter and non-vented mask was associated with lower aerosol production compared to a forced cough.
- CPAP does not feature on the English AGP list (published April 2022).
- Expert opinion from clinicians/ aerosol scientists: As with BiPAP, CPAP doesn't typically induce a cough but may loosen secretions. Whilst it does require proximity to set up and reposition, the risk of exposure is reduced once the patient's mask is placed as it will impede release of emission to a degree and be connected to a closed system. An exhalation filter is important to have as a mitigation.
- Considering the evidence of lower aerosol generation than that produced during forced coughing combined with expert opinion that this procedure does not induce coughing, the working group agreed that CPAP with use of an exhalation filter and non-vented mask should not be considered a high-risk exposure.

HFNO

- Two studies[34, 60] demonstrate that high flow nasal oxygen (at a flow rate of 60L/min) is associated with lower aerosol production when compared to forced coughing.
- HNFO does not feature on the English AGP list (published April 2022).
- Expert opinion from clinicians/ aerosol scientists: HFNO does not induce coughing. If the oxygen isn't humidified, it could induce a cough associated with a dry airway, however it should never be administered without humidification. Proximity is required only when setting up and is well tolerated by the patient so there is unlikely to be much need to reposition. Aerosol scientists stated that evidence suggests that aerosol sampled in studies was exhaled without having been through the respiratory tract. Experts felt strongly that HFNO should not be considered a high-risk procedure.
- Considering the evidence of lower aerosol generation than that produced during forced coughing combined with expert opinion that this procedure does not induce coughing, the working group agreed it should not be considered a high-risk exposure.

HFOV

- Although no studies were included within the evidence review, high frequency oscillatory ventilation (HFOV) is not anticipated to induce coughing.

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- HFOV currently features on the Scottish AGP list (at the time of writing); it does not feature on the English AGP list (published April 2022).
- Expert opinion from clinicians/ aerosol scientists: experts reported that HFOV is now used very rarely in adults, and that there is a general move away from it. Where it is used, it is typically on paralysed patients so they will not be coughing. It does not induce coughing and should not be considered a high-risk exposure.

Oxygen delivery up to 15L/min

- Two studies were included that assessed oxygen delivery via facemask (up to 15L/min).[34, 55] In one study, particle counts produced during delivery were not significantly different to those recorded during breathing.[34] In the second study, counts during delivery were not significantly different to those recorded during breathing combined with a series of coughs whilst wearing and not wearing a mask.[55]
- During oxygen delivery, a mask is fitted to the patients face. The procedure is unlikely to induce coughing and the mask is anticipated to impede release of respiratory emissions to a degree.
- It is the expert opinion of the working group that oxygen delivery should not be considered a high-risk exposure.

Facemask ventilation (anaesthetic machine associated)

- Two studies demonstrate that face mask ventilation is associated with lower aerosol generation than that produced during forced coughing.[52, 53]
- Expert opinion from clinicians/ aerosol scientists: this procedure is not expected to induce coughing as the patient is typically not awake. The mask creates a seal with the patient's face and therefore any aerosols are contained within the closed breathing circuit. Evidence suggests that even with a simulated leak, median aerosol counts are lower than those associated with breathing and peak counts are lower than those associated with coughing.
- The working group agreed that this procedure should not be considered a high-risk exposure.

Non-continuous procedures:

Chest compressions

- No studies of sufficient quality which assessed chest compressions were identified as part of this literature review.
- The working group agreed that it is not logical to consider chest compressions in isolation. Chest compressions are performed as part of CPR and not in

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isolation, CPR also includes other procedures such as manual ventilation and intubation.

- It is the expert opinion of the working group that chest compressions are not expected to induce coughing as the patient will be unconscious and aerosol production will be minimal, therefore the procedure should not be considered a high-risk exposure.
- In some cases, the perceived higher transmission risk associated with this procedure can be related to the unknown patient history/ infectious status at the point of CPR.

Manual facemask ventilation

- No evidence available.
- Expert opinion from clinicians/ aerosol scientists: patients won't be awake and therefore very unlikely to cough. With bag-mask the exhaled air comes out of the rear of the bag and if a filter is not fitted, there could be a degree of exposure, therefore experts recommend use of a filter.
- The working group agreed that this procedure should not be considered a high-risk exposure.

Oral cavity suctioning

- Evidence regarding aerosol production associated with oral cavity suctioning is limited with only one study included; this study demonstrated a reduction in aerosol levels with use of oral cavity suctioning during upper GI endoscopy.[65]
- No studies were included that specifically assessed aerosols during oral cavity suctioning during dentistry.
- Expert opinion from clinicians/aerosol scientists: there is a misconception that aerosols may escape from the finger hole on the suction device, however this was considered highly unlikely and supported by their in-house unpublished experiments. A gag may be induced but not a cough. Oral suctioning may be carried out in ENT, trauma and stroke patients in addition to dental. Suctioning may act as a mitigation; the use of suctioning can remove aerosols produced and this has been demonstrated in clinical study.
- High volume suctioning in dentistry is recognised as an AGP mitigation by the Scottish Dental Clinical Effective Programme (SDCEP), a conclusion which is supported by the limited evidence included in this review.[65]
- It is the opinion of the Working Group that oral cavity suctioning should not be considered a high-risk exposure. Scottish dental representatives support this view.

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Respiratory tract suctioning beyond the oral cavity

- 'Respiratory tract suctioning 'beyond the oropharynx' currently features on the Scottish AGP list (as of September 2025). Evidence is limited; in the single study included, respiratory tract suctioning (beyond the oropharynx) was associated with lower aerosol generation than that produced during forced coughing.[52]
- The terms 'oral cavity suctioning' and 'respiratory tract suctioning beyond the oropharynx' were not deemed by the working group to adequately account for all three anatomical spaces involved in respiratory tract suctioning (the oral cavity, the oropharynx and beyond the oropharynx). Therefore, terms to be used going forward are 'oral cavity suctioning' and 'respiratory tract suctioning beyond the oral cavity'.
- Expert opinion from clinicians/ aerosol scientists: tracheal suctioning almost always generates gagging on awake patients. In rare circumstances it is used to generate coughing to get the secretions to be brought up. It is also used on anaesthetised patients when waking them up and the cough in this case may be directed into the ventilation tube; this coughing was anticipated to be weaker in force due to partial sedation. The use of suctioning can remove aerosols produced and this has been demonstrated in clinical study.[65]
- It is the opinion of the working group that suctioning beyond the oral cavity which is performed manually (not as part of a closed ventilation system) and anticipated to induce coughing should be considered a high-risk procedure.

Upper GI endoscopy

- Upper GI endoscopy is currently featured on the Scottish AGP list (as of September 2025), but only within the context of it being performed with respiratory tract suctioning (beyond the oropharynx). It features on the English AGP list.
- Two studies were included. One study demonstrated that procedurally induced coughs, when compared to forced coughs, generated significantly more small particles (<10µm).[46] In the same study, upper GI endoscopy without coughing events produced particle counts that were not significantly different to those recorded during breathing.[46]
- One study demonstrated that upper GI endoscopy with continuous oral suctioning[65] produced particle counts that were significantly lower than those recorded during breathing.
- It is the expert opinion of the working group that there may be coughing or gagging induced during upper GI endoscopy when the scope is inserted. Most patients will be sedated and anaesthetic spray applied to the throat,

however some patients may opt for no sedation to avoid a recovery period; these patients are likely to gag/ cough the most. Coughing was reported to be caused when anaesthetic spray is applied to the throat. Suctioning during the procedure is in itself a mitigation for any aerosol production. Consequently, upper GI endoscopy on awake service users should be considered a high-risk exposure.

Bronchoscopy

- Bronchoscopy currently features on the Scottish AGP list (as of September 2025). No studies which assessed bronchoscopy were included in this review.
- Expert opinion from clinicians/ aerosol scientists: akin to awake tracheal intubation, coughing will likely be induced while doing the procedure (related to taking biopsies and sampling the airways) if the patient is awake. Most patients are awake. Suctioning may induce coughing but also acts as a mitigation. Bronchoscopy is generally a controlled procedure as it is predominantly elective and diagnostic.
- The working group agreed that bronchoscopy performed on awake patients may induce coughing; if this is anticipated to occur, it should be considered a high-risk exposure.

Upper ENT procedures

- Upper ENT airway procedures currently feature on the Scottish AGP list (as of September 2025) but only in the context of associated respiratory tract suctioning (beyond the oropharynx).
- Two studies assessed various ENT procedures. Particle counts produced during myringotomy with tympanostomy tube insertion[31] and during nasal endoscopy without debridement[39] were not significantly different to those recorded during breathing. For nasal endoscopy with debridement,[39] and for tonsillectomy with monopolar electrocautery[31] particle counts were significantly greater than breathing; a comparison was not made to coughing.
- It is the expert opinion of the working group that upper ENT procedures should be considered a high-risk exposure if they induce coughing or involve the use of high-speed devices on respiratory tissues.

Tracheal intubation and extubation

- Tracheal intubation and extubation currently feature on the Scottish AGP list (as of September 2025). “Awake tracheal intubation, excluding anaesthetised patients with secured airway” features on the English AGP list. Tracheal extubation (on anaesthetised patients) was removed from the English AGP

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list in June 2022. Awake tracheal extubation does not feature on the England AGP list.

- The evidence for these procedures was inconclusive. One study demonstrated that particle concentrations during tracheal intubation of unconscious patients were not significantly different to background levels (p=>0.99) of an ultraclean ventilation theatre. In the same study, particle concentrations produced during tracheal extubation of unconscious patients were not significantly different to awake tidal breathing (p=0.1).[52] Coughing was only induced for one participant upon extubation and mean rather than peak particle counts were compared.
- Expert opinion from clinicians/aerosol scientists:
    - Tracheal intubation is akin to bronchoscopy in that it may induce coughing if the patient is awake. If the patient is appropriately anesthetised, they will be unable to generate a cough. Experts felt that anaesthetists are capable of performing intubation without inducing a cough. The patient will have been given a sedative and muscle relaxant so even in the rare situation where a cough is produced, it is likely to be less forceful than a 'normal' cough. Most intubations are performed in controlled environments with air handling and strict standards of cleanliness. It does require proximity. This is a very common procedure and the majority of the population may require intubation at some point in their life. There is no difference between intubation via the nose versus the mouth and the same risk assessment considerations apply. Aerosol scientists discussed that, from their clinical studies, no aerosol generation was detected during intubation on anaesthetised patients, it was 3 or 4 orders of magnitude lower than that measured during a cough; they felt confident this finding would be observed in future studies. In addition, they felt that the risk related to intubating a patient has been confused with the risk presented by the patient (where the patient is infectious with, for example, TB, and may require intubation as part of their care). In contrast, awake intubation is typically performed when the clinician is anticipating challenges with the airway (e.g. tumours affecting the upper airways). Clinical experts estimated that awake intubation accounts for less than 1% of all intubations; the key difference is the patient can cough and will frequently cough during the procedure.
    - For extubation, coughing can occur during and after but is not a feature of all extubations. A patient may be extubated when asleep to prevent coughing in scenarios of increased cranial pressure, however most patients are extubated when waking up from anaesthesia. A facemask is usually clamped to the face as soon as the tube is pulled out, which

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is connected to a closed circuit. Extubation typically takes1-5 minutes and requires proximity. The figure of 1 coughing patient out of 20 on elective patients in the Shrimpton et al study (2022) is representative of extubation following surgery. Experts reported that the documented cough in this study produced less aerosol than volitional coughs from the same patient – this is because at the point at which they are coughing, they are still recovering from the sedation and so cannot generate a strong cough. Clinicians will generally know more about the patient's history at extubation compared to intubation. Experts felt that extubation is higher risk than intubation (on anaesthetised patients), but not higher risk than coughing in an awake patient, and there is a higher perceived risk from a naturally coughing preoperative patient (compared to a patient being extubated).

- It is the expert opinion of the working group that tracheal intubation of anaesthetised patients (or unconscious patients without protective airway reflexes) should not be considered a high-risk exposure. In contrast, tracheal intubation of awake patients should be considered a high-risk exposure because coughing may be induced (similar to bronchoscopy). Tracheal extubation is not considered a high-risk exposure as in most cases coughing is anticipated to be minimal/weak and a facemask is fitted to the patients face immediately upon tube removal. Extubation in most cases is anticipated to be a short and controlled procedure.

Tracheotomy or tracheostomy including insertion and removal

- 'Tracheotomy or tracheostomy procedures (insertion or removal)' currently features on the Scottish AGP list (as of September 2025). No studies were included that assessed aerosol production associated with tracheotomy or tracheostomy procedures including insertion and removal.
- Expert opinion from clinicians/aerosol scientists: during insertion, the patient may cough if awake although most are inserted when patients are anaesthetised, paralysed and/or unconscious. It can be a tricky procedure, inserting percutaneously or surgically, there is shared airway between the surgeon and anaesthetist, and the airway can be in jeopardy. In this regard, it should be considered high risk because of the proximity and uncontrolled nature. Experts reported that there can be spraying of secretions (mostly larger size particles), but stated that aerosol generation was unlikely and the patient will not be coughing if they are paralysed/ sedated.
- For care of a tracheostomy site, suctioning will induce coughing if the patient is awake (although suctioning is outlined to be a mitigation measure and likely to reduce aerosol exposure). If suctioning is conducted whilst the patient is ventilated in ICU with a closed circuit, emissions from a coughing patient will

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be contained as the circuit doesn't have to be broken to do the suctioning; if the cuff is up on a closed circuit then anything coughed up will not reach the mouth.

- It is the expert opinion of the working group that care of a tracheotomy site where there is suctioning of an awake patient that may induce coughing should be considered a high-risk exposure. Insertion should not be considered a high-risk exposure when the patient is sedated/ unconscious.

Administration of nebulised saline or medication (not associated with sputum induction)

- Although one study indicated that aerosol counts were higher during administration of nebulised saline when compared to forced coughing,[55] the origin of these particles was not assessed.
- Based on the expert opinion of the Working Group, the nebuliser itself is likely the main contributor to raised particle counts, and this procedure is not likely to induce coughing.
- Consequently, administration of nebulised saline (not associated with sputum induction) should not be considered a high-risk exposure.

Induction of sputum/chest physiotherapy

- 'Induction of sputum using nebulised saline' currently features on the Scottish AGP list (as of September 2025) and features as 'induction of sputum' on the English AGP list.
- One study was included that assessed induction of sputum, it demonstrated that particle counts recorded were significantly higher than those recorded during "a series of spontaneous coughs both without and with a surgical mask".[55]
- Induction of sputum involves inducing the service user to cough forcefully with or without the administration of nebulised saline. In line with a consideration of risk associated with induced coughing, it is the expert opinion of the Working Group that this procedure is considered a high-risk exposure whether nebulised saline is administered or not.

Lung function tests

- Lung function tests, such as spirometry and peak flow measurements, are not currently included on the Scottish AGP list (as of September 2025).
- Two studies were included that assessed lung function tests. One study was included that assessed spirometry (with filter). It demonstrated that particle counts produced during spirometry were significantly lower than those recorded during forced coughing.[51] The same study found that particle counts

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recorded during peak flow measurements (with filter) were significantly lower than those recorded during forced coughing.[51]

- A second study assessed peak flow measurements (filter presence unknown) and reported particle counts to be significantly higher than those recorded during tidal breathing.[43] There was no comparison to coughing in this study.
- It is the expert opinion of the working group that spirometry can induce coughing and should be considered a high-risk exposure.

Supraglottic airway insertion and removal

- Supraglottic airway insertion and removal is not currently included on the Scottish AGP list (as of September 2025).
- One study was included; particle counts produced during insertion and removal were not significantly different to those recorded during breathing.[54]
- Expert opinion from clinicians/ aerosol scientists: the patient is unconscious during insertion and often conscious during removal. A filter is likely to be used through which any air/gases would pass. The patient may retch during removal. Experts considered supraglottic airway insertion and removal to be a lower risk exposure compared to intubation and extubation, and unlikely to generate aerosols.
- It is the expert opinion of the working group that supraglottic airway insertion and removal should not be considered a high-risk exposure.

Based on the above evidence and expert opinion, the working group agreed that the following procedures, **performed on awake service users***, should be considered as presenting a high-risk exposure. This is a non-exhaustive list and represents examples only. Tasks and procedures not featured on this list should be assessed and, if induced coughing on awake service users is anticipated and proximity is required, should also be considered as presenting a high-risk exposure.

- Bronchoscopy
- Awake tracheal intubation (ATI)
- Upper GI endoscopy
- Induction of sputum
- Care of tracheostomy site
- Suctioning beyond the oral cavity which is performed manually (not as part of a closed ventilation system)

*Awake includes patients that have received sedation but can still control/protect their own airway and therefore generate a forceful cough.

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GPP4.2 *[Use of high-speed devices on tissues within the respiratory tract, (and extra-pulmonary TB sites) in surgery/ post-mortem and dentistry, should be considered as presenting a high-risk exposure].*

High-speed cutting in surgery/post-mortem

- High-speed cutting in surgery/post-mortem procedures currently features on the Scottish AGP list (as of September 2025). “Surgery or post-mortem procedures (like high-speed cutting/drilling) likely to produce aerosol from the respiratory tract (upper or lower) or sinuses” features on the English AGP list.
- Although no studies which assessed high-speed cutting of respiratory tract tissues were included in this review, there is a clear mechanistic aerosol generating process associated with high-speed cutting. Although this review focused on the potential risk associated with cutting respiratory tissues, there may be an air transmission risk associated with high-speed cutting of extra pulmonary TB sites.
- It is the expert opinion of the Working Group that high-speed cutting of respiratory tract tissues and extra-pulmonary TB sites in surgery/post-mortem procedures be considered high-risk exposures.

Dental procedures using high speed devices, for example, high-speed drilling, and ultrasonic scaling

- ‘Dental procedures using high speed devices’ currently features on the Scottish AGP list (as of September 2025).
- One study demonstrated that ultrasonic scaling, drilling (high speed/slow speed/surgical) and 3-in-1 use (with air) was associated with higher particle counts than those produced during forced coughing, however, the authors did not report on statistical significance within this study.[45] A second study found that particle production during ultrasonic scaling was significantly higher than that recorded during tidal breathing.[76] There was no comparison to coughing in this study.
- Although induction of coughing is not anticipated, there is a clear mechanistic aerosol generating process with procedures that vibrate or drill respiratory tissues and fluids at high-speed. The origin of the particles generated, however, is unknown. Proximity is required throughout use of dental high-speed devices and instruments.
- The drill used in ‘slow-speed’ dental drilling has a lower ‘revolutions per minute’ (rpm) rate than that of high-speed drilling and does not involve water or air being blasted onto the tissues. It was agreed by dental members of the working group that both aspects reflect a likely reduced potential for dispersion of the patient's respiratory particles. Dental members of the

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working group agree that 'slow-speed' dental drilling should not be considered a high-risk exposure.

- The drill used in dental surgical drilling has a lower rpm rate than that of high-speed drilling and does not involve air being blasted onto the tissues. It was agreed by dental members of the working group that both aspects reflect a likely reduced potential for dispersion of the patient's respiratory particles. Dental members of the working group agree that surgical dental drilling should not be considered a high-risk exposure.
- Consideration was given to the use of the 3-in-1 with air, with water or with air and water together. Of the three, it was surmised, based on the expert opinion of dental members of the working group, that use of the 3-in-1 with air and water together, generates the greatest risk for dispersion of the patient's respiratory particles. It was surmised, however, that the 3-in-1 is used for such a small period of time that it does not present a comparable risk to prolonged use of a high-speed drill and should not be considered a high-risk exposure when used briefly.
- Ultrasonic scaling involves high frequency vibrations and water spray. It was agreed by dental members of the working group that ultrasonic scaling should be considered a high-risk exposure due to its potential to aerosolise and disperse patients' respiratory particles
- Dental members of the working group postulated that generally, dentistry should be considered a lower risk environment due to the ability to employ pre-appointment screening questions, reschedule non-urgent appointments and due to the mitigation measures available such as high-volume suctioning and dental dam.
- It is the expert opinion of the Working Group that dental procedures using high speed devices such as high-speed drills or ultrasonic scaling should be considered high-risk exposures.

GPP4.3 *[Respiratory exposure risk increases with proximity and should be considered greatest when within 1 metre (~3 feet) of an individual's airway when delivering care].*

- There is currently insufficient evidence to determine a specific distance from an infectious source at which respiratory transmission risk increases or decreases. Logically, level of risk exists across a gradient; exposure risk increases with proximity to the source.
- As per part A, evidence conclusion 11 ("evidence (23 studies graded SIGN 50 level 3) is consistent in demonstrating that viable (as per laboratory methods) infectious agents can be present at source and up to distances of 4.8 metres*

in particle sizes of <1µm to >7µm. The correlation between detection of viable infectious agent and transmission risk is unknown)") has determined the presence of viable infectious agents at distances beyond 1 metre. However, viability of infectious agents at distance from an infectious source is one of many factors that influence transmission risk. The exact influence of this factor on transmission risk – and in relation to the other factors - remains unknown.

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

- To support risk assessment for guidance development, there is a requirement to determine a distance at which exposure risk is greatest.
    - The working group agreed that a distance of 1 metre (3 feet) is pragmatic and applicable to care scenarios. This is specific to delivery of care, where a healthcare worker is engaged in an activity that requires presence at proximity to an infectious individual's airway for any length of time.
    - The working group considered the option of applying a distance greater than 1 metre, as a precautionary measure to account for evidence conclusion 11 where viable infectious agents have been detected at up to 4.8 metres* from an infectious source.
    - A social distance of 2 metres was applied during the COVID-19 pandemic however this was specific to social interactions, which the working group agreed present a lower risk compared to healthcare interactions (where an individual is more likely to present as infectious).
    - However, as per GPP4.1 and GPP4.2, the exposure risk presented by high-risk exposures is greatest at proximity and more typical of direct care provision rather than of social interactions.

*Please note that the 4.8 metres presented does not represent the maximum distance of infectious agent particle travel but simply the furthest distance at which air samples were taken in included studies.

Fallow-time considerations:

- The concept of leaving a room vacant following exit of an infectious individual has mainly been in relation to AGPs (post-AGP fallow time). The need for AGPs (and hence a fallow time) arose during the emergence of SARS-CoV which was a novel infectious agent with severe clinical outcomes. After this

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time, it was then applied to all respiratory infectious agents following AGPs regardless of novel nature or severity of clinical outcome.

- The need for a fallow time post AGP is theorised to be due to respiratory particles remaining both airborne and viable for an extended time post-release from the respiratory tract such that they still present an exposure risk to a person entering after the infectious person has vacated the space. Infectious agents with a low infectious dose are likely to pose the greatest risk. Not all infectious agents will remain viable in sufficient quantities post-release or have a low enough infectious dose to pose an exposure risk in this way.
    - As per **Evidence conclusion 12**, there is insufficient evidence (4 studies, SIGN 50 level 3) regarding the length of time viable infectious agents can remain detectable post-release from a source, therefore no conclusions can be made at this time.
- The current post-AGP fallow time refers to the period of time that is deemed to be required, following aerosol generation, for aerosols still circulating in the air to be removed and/or diluted from the space. For example, a fallow time would be applied before entering a room in which an AGP was performed on an infectious patient but would not be applied if no AGP had been performed in that room.
- As per Evidence conclusion 3, evidence (15 studies graded SIGN 50 level 3) is consistent in demonstrating that the aerosol exposure risk presented by medical procedures currently defined as AGPs is not equal and for some, the aerosol exposure risk may be lower, higher or similar to that created by a cough). Hence, some medical procedures may generate aerosol counts comparable to that of a cough.
- It is therefore necessary to consider whether it is inappropriate to disproportionately focus mitigations (in this case a 'fallow time') on patients having medical procedures and not on patients having non-procedural care.
- Assessment of this presents the following options:
    - Option 1 – retain the status quo and only apply a 'fallow time' in relation to certain medical procedures, effectively a 'post-medical procedure fallow time'.
    - Option 2 – apply a 'fallow time' to GPP4.1, and GPP4.2 (in effect, any infectious patients that are coughing, have induced cough, or are undergoing a procedure with high-speed device use on respiratory tract tissues or extra-pulmonary TB sites)
    - Option 3 – use severity of infection instead of aerosol exposure risk as an indication for a 'fallow time'. This presents additional options for consideration:

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- Option 3A - A 'fallow time' would be applied for infectious agents that cause severe disease and for which there is usually no effective prophylaxis or treatment available. This constitutes R3 infections agents as per GPP7.4. Current practice with HCIDs involves extensive post-discharge environmental decontamination which typically takes many hours. Consequently, there has not been a need to recommend a prescribed fallow-time period in extant HCID guidance, as the time period is implied with the time to decontaminate.
- Option 3B – A fallow time would be applied for both R3 and R2 infectious agents (those that may cause severe disease but there is usually effective prophylaxis or treatment, as per GPP7.4). R2 infectious agents include: *Mycobacterium tuberculosis,* measles, chickenpox and a number of infectious agents that are currently categorised as HCIDs in the UK (*Yersinia pestis* (pneumonic plague), MERS, SARS).

- Option 4 – apply no fallow time. This is reflective of current practice in that a fallow time is not currently applied after an individual with a respiratory infection has vacated a room (unless an AGP was undertaken).

- The working group discussed current practice around post-AGP fallow times for these infectious agents. A summary of discussions is as follows:
  - Post-AGP fallow times were not routinely applied pre-pandemic. The main application was within theatres, ICUs, HDUs, treatment rooms and ENT and only ever in acute healthcare settings.
  - Post-AGP fallow times were given more attention during the pandemic because the risk of severe illness associated with contracting COVID-19 was perceived to be higher (compared to non-pandemic infectious agents that required a fallow time).
  - Mathematical modelling was used to develop guidance for fallow times based on the ventilation within the room and the length of the AGP. This resulted in long fallow times, some as high as 5.5 hours significantly impacting the flow of patients and delivery of clinical care.
  - Current modelled (post-AGP) fallow times are based on worst case scenarios which assume that suspended particles remain viable and infectious right up to the point at which they are removed from the room by ventilation.
  - It is not possible to accurately calculate a fallow time if the ventilation provision is unknown and if the AGP is a continuous event. However, it

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is easy for a non-specialist to refer to the post-AGP fallow time calculations in Appendix 16 (current at the time of writing) of the NIPCM when attempting to implement a post-AGP fallow time.

- Implementation of fallow times during the pandemic (once modelling had created the fallow time guidance) was felt to be unachievable due to the old hospital estate which has poor ventilation which would have necessitated very long fallow times. This would have made those areas unusable and prevented clinical practice.
- Post-AGP fallow times are currently mainly implemented following AGPs for the following infectious agents: MERS (and other similar pathogens), TB, measles, RSV, pertussis, chickenpox.
- Only emergency AGP appointments (for example in dentistry) necessitated a post-AGP fallow time on an infectious patient.

- The working group initially agreed that a fallow time should be applied as per option 3B, which in practice would involve leaving a room vacant for a specified time after the room has been vacated by an individual with an R2 or R3 (suspected or confirmed) infection, unless the person entering the room is wearing RPE.
  - Aside from the HCID R2 and R3 infectious agents (which would be managed in HCID treatment centres and not in the general healthcare setting), the fallow time consideration would primarily apply in practice to individuals with measles, chickenpox and pulmonary *Mycobacterium tuberculosis.*
  - The working group initially proposed a fallow time duration of 60 minutes, with the rationale being that the 60 minutes ensures that even a room with low ventilation provision (1 air change per hour (ACH)) will have had the room air volume replaced once within the 60 minutes.
  - Feedback from primary care and dental groups was that option 3B incorporating the 60 minute fallow time (which is not current practice) would result in significant disruption to care delivery, as it would delay commencement of care for the subsequent patient entering the room. The harm caused by waiting 60 minutes between patients is considered to be greater than the perceived benefit that a 60 minute fallow time would provide.
  - Further, it is noted that for some individuals, including those who are immunocompromised or pregnant, exposure to any respiratory infectious agent (not just R2 and R3) could result in severe clinical outcomes. The working group discussed the requirement to protect specific patient groups such as haemato-oncology patients where they

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are entering rooms known to have been occupied by a patient infected with any transmissible respiratory infection.

- Consequently, the working group agreed against option 3B and also against having a set fallow-time advised in guidance.
- Whilst the majority of the working group did not object to completely removing fallow-times from guidance (as per option 4), some cited concerns of the exposure risk within a room that was previously occupied by a patient with respiratory infection. Concern in particular was noted for measles.
    - To address this, a decision was made to consider new content for the patient placement section of the NIPCM to note good practice options for reducing exposure to any remaining respiratory particles. This would include potentially allowing the room to remain vacant for a period after a respiratory patient has exited, dependent on the vulnerability of the incoming patient and the risk posed by the respiratory pathogen involved. The stage of infection, and whether the vacating occupant still presents a transmission risk, should be considered by the clinical team.
    - Whilst it is acknowledged that higher ventilation rates will result in faster clearance of any airborne respiratory particles in the vacated room, it is not possible to quantify a specific ventilation rate due to the many unknown variables, as is noted in GPP7.3.
- In conclusion no recommendations or good practice points were made regarding fallow times.
- The working group also noted the need to maintain the 10-minute wait time for the largest suspended particles to settle prior to terminal decontamination, which is a historic precautionary practice. Other mitigations such as hand hygiene provide additional precautions against indirect transmission of respiratory infectious agents from respiratory particles that may have settled out onto surfaces after 10 minutes.

4.10 Value Judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value Judgements
R4.1 – none to note. R4.2 – none to note. GPP4.1 – none to note. GPP4.2 – none to note. GPP4.3 – none to note.

4.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/religious reasons.

Intentional vagueness
R4.1, R4.2 – None to note. GPP4.1 *[Coughing (both natural and procedurally induced on awake patients) should be considered as presenting a higher-risk exposure compared to most other natural respiratory activities; risk of exposure increases with proximity]:* A definition of what constitutes a cough - in the context of a person with transmissible respiratory infection - has not been provided. This is intentional as the working group agreed there may be significant variation in presentation which will require local assessment of the individual. Within the benefit-harms assessment it is noted that there are other indicators (for example test results, patient history) in addition to a cough that will support determination of exposure risk in the patient. Specifics regarding test results and patient histories have not been noted as there will be wide variation depending on the infectious agent. A list of procedures has not been detailed in the GPPs. This is intentional to reinforce the concept that although a non-exhaustive, exemplary list will be presented in final guidance, clinicians should use their professional expertise to determine whether the procedure they perform should be considered a high-risk exposure based on its requirement for proximity and propensity to induce coughing.

Intentional vagueness
GPP4.2 A list of procedures has not been detailed in the GPP. This is intentional to reinforce the concept that although a list (non-exhaustive and exemplary) will be presented in final guidance, clinicians should use their professional expertise to determine whether the procedure they perform involves use of a high-speed device on the tissues within the respiratory tract or on extra-pulmonary TB sites. GPP4.3 – None to note.

4.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
R4.1 – None to note. R4.2 – None to note. GPP4.1 - None to note. GPP4.2 – None to note. GPP4.3 – None to note.

4.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
Establishing a distance from infectious source at which exposure is significantly reduced, and thus also transmission risk, is dependent on knowing how the presence and quantity of infectious agents in the air changes with distance from an infectious source. Air sampling at differing distances from source with consideration of infection stage, symptoms, infectious agent and air currents would be valuable. Analysis of any correlation between quantity of infectious agent emitted by infected individuals and stage of infection or presence of symptoms would be beneficial. Findings from this research would support guidance development on whether precautions can or should be applied in line with certain symptoms or stages of infection. Assessment of emission of viable infectious agents through air sampling, in association with both reporting of general symptoms and active presence of specific symptoms or respiratory activities, would be useful. Further research is needed on the relationship between bacterial or viral counts in clinical samples (for

Recommendations for research

example nasopharyngeal (NP) swabs) and exhalation samples, to support assessment of whether NP swab results can effectively indicate infectivity and thus risk of onward transmission.

Comparison between quantity of infectious agent emission during natural versus procedurally induced coughing, established through air sampling, is an area which requires further research. A larger body of research would support thorough assessment of the risk associated with certain procedures when compared to routine care of infected service users.

Correlation between quantity of infectious agent emitted by infected individuals and particle count would be highly valuable as many existing studies provide data on particle count emission, however, whether there is a linear positive relationship between particle count and infectious agent quantity remains unknown.

Greater knowledge on the microbial content of fluids disseminated into the air by nebulisers or through the conduct of high-speed drilling or vibration of respiratory tract tissues (including teeth) is needed. Establishing the proportion of dispersed fluids which are derived from the respiratory tract of the service user, as opposed to fluids generated by the equipment (such as irrigant), is imperative to understanding the potential infection risk associated with these procedures.

Determination of suitable wait times before entering rooms that infectious patients have vacated, is dependent on knowledge regarding the fall out, removal and loss of viability for emitted infectious particles. Further research is needed to ascertain the average length of time it takes for infectious agents, which are released by an infected individual, to fall out onto surfaces, be removed from the air via ventilation and/or lose infectivity. Observational studies with repeated air sampling over time, following departure of an infected host, would likely be valuable in this regard. Conduct of this process under differing environmental conditions with different respiratory pathogens would also be valuable as ventilation rates, type of infectious agent, air current patterns, temperatures, humidity etc. will affect fall out time, speed of air dilution and the period for which infectious agents remain viable in the air.

Evaluation of contact tracing exercises and outbreak reports may provide useful information regarding the transmission risk associated with infectious particles which remain suspended in the air of rooms that infectious patients have vacated.

Research Question 5: Can person-to-person transmission of infection be described/defined beyond the current categories of contact/droplet and/or airborne?

A: Quality of Evidence

5.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Six general infection prevention and control (IPC) guidance documents were included for this research question.[5, 9, 12, 90, 92, 93] All guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence. No primary research studies were included.	6 x SIGN 50 level 4 – expert opinion

5.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how the judgement was formed as to the overall direction of the evidence.

Comments
Little to no consistency was observed regarding descriptions of transmission beyond the framework of contact, droplet and airborne. Two organisations used alternatives for the term 'airborne' with the CDC (2016) suggesting use of the terms 'inhalation' and 'close range inhalation'[92] and the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) (2022) using the phrase 'inhalation of aerosols' with no associated distance descriptors.[90] Some guidance outlines that infectious agents are not exclusively transmitted via one route and that routes of transmission have differing likelihoods attributed to them based on the infectious agent and encounter circumstances. For example, the Canadian Government Pathogen Risk Assessment includes terms which indicate likelihood of transmission via a specific route "none; low, unlikely; moderate, possible; high, preferred route; unknown".[93]

5.3 Are the studies applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments
The included guidance documents are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings. Some guidance is specific to certain healthcare settings or groups of infectious agents for example care homes or acute respiratory infections. Where appropriate, findings in relation to these documents have been connected, in text, to their respective setting or infectious agent specific guidance.

5.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
No primary studies were included therefore generalisability is not relevant for this research question.

5.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
Overall, no concerns identified. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

5.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
GPP5.1 Person-to-person transmission of infectious agents should be defined by one, or a combination of, the following transmission routes: Air transmission: transmission of infectious agents from one person to another (without touching) via body fluids that travel from the infected person through the air. Infectious agents can be transmitted by splashing or spraying of body fluid particles onto the mucosa and/or inhaling body fluid aerosols. Contact transmission: transmission of infectious agents from one person to another by direct physical contact (direct contact transmission) or indirectly through contact with a contaminated object or surface (indirect contact transmission).	Good Practice Point

5.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
GPP5.1 - Using the term air-transmission in place of the droplet/airborne dichotomy acknowledges the presence of small (<5µm) potentially infectious particles being encountered both at less than and more than 2m from source. This allows the development of guidance that takes account of these potential exposures. GPP5.1 - Using the term air transmission in place of the droplet/airborne dichotomy removes evaluation of transmissibility based solely on particle size using arbitrary cut off values of 5µm/10µm. This allows the development of guidance that is based on additional factors beyond particle size alone.

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
GPP5.1 - A change in transmission terminology could create confusion and uncertainty for healthcare staff. GPP5.1 - If transmission definitions do not align with other UK devolved nations or international organisations it could cause confusion and miscommunication. GPP5.1 - Introduction of new transmission terminology may cause stakeholders, service users and the public to question guidance provided during the COVID-19 pandemic that was based on extant terminology, which could compromise trust and confidence in ARHAI Scotland and infection prevention and control teams.

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/ Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
GPP5.1 Benefits deemed to outweigh harms if new terminology is introduced with appropriate supportive material and stakeholder collaboration.

5.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
GPP5.1 - There will be resource implications related to staff education and training (inclusive of acknowledging human factors/ergonomics) as a result of this change in definitions. GPP5.1 - Material and financial implications in relation to staff education and training (replacement of educational materials and associated waste). GPP5.1 - Resource implications in relation to change of terminologies and wording throughout existing guidance and resources.

5.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
GPP5.1 –The evidence for this research question consists of six SIGN 50 level 4 expert opinion guidance documents; this evidence is considered insufficient for the development of a recommendation. A good practice point has been developed with the Working Group which provides a new definition for person-to-person transmission. The 'air transmission' definition replaces the previous 'droplet' and 'airborne' transmission modes to reflect the fact that emitted particles exist in a spectrum of sizes and may travel beyond 2 metres upon expulsion as outlined in section 4.2. This definition is inclusive of non-respiratory sources of body fluids, for example those generated from splashing and spraying of blood, urine, faeces, breast milk, vomit, semen, and cerebrospinal fluids. The working group discussed replacing 'transmitted' with 'spread' however transmission describes the transfer from one to another, spread does not. The working group also discussed the use of the word 'breathing' instead of 'inhaling' but agreed that inhaling better describes the process of breathing in, 'breathing' does not. Addition of the word 'aerosols' led to discussion of whether this was accurately defined in the NIPCM glossary (entry as at March 2026: "Very small particles (of respirable size) that may contain infectious agents") and that other transmission definitions in the glossary will need updated. Use of the word 'mucosa' was agreed to replace 'body' as it more accurately describes the location of deposition. The working group agreed that no major changes were required to the 'contact' transmission definition. Consideration was given to adding an example for indirect transmission ('another person's contaminated skin (for example the hands)' however the working group agreed not to add this because it could be misinterpreted as being direct contact.

5.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state "none". Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
GPP5.1 None to note.

5.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/religious reasons.

Intentional vagueness
GPP5.1 None to note.

5.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
GPP5.1 The ‘air transmission’ definition does not currently encompass transmission of non-human (environmental) sources of infectious agents.

5.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
None to note.

Research Question 6: What are Transmission Based Precautions (TBPs)?

A: Quality of Evidence

6.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Nineteen general infection prevention and control (IPC) guidance documents were included for this research question.[1-7, 9-12, 14, 25, 94-99] All guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence.	19 x SIGN 50 level 4 – expert opinion

6.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how a judgement was formed as to the overall direction of the evidence.

Comments
There was consistency regarding the overall definition of transmission-based precautions (TBPs) which was as follows:

Comments

Transmission Based Precautions (TBPs) are additional measures that should be implemented with standard infection control precautions (SICPs) to prevent the onward transmission of a suspected or confirmed infectious agent.

Some sources referred to TBPs as 'additional precautions';[5, 9] these were considered equivalent to TBPs in the context of this review.

Certain types of contact, droplet and airborne precautions were consistently outlined under each bundled heading across the evidence base.

Inconsistency within and amongst guidance documents arose through deviation from the initially outlined framework of contact/ droplet/ airborne precautions for those infected with contact/ droplet/ airborne transmitted infections. These deviations involved TBP recommendations which were based on or specific to:

- individual infectious agents[9, 11, 12]
- patients' presenting symptoms[1, 9, 12]
- certain health and care settings (long-term care facilities, home care)[9]
- the performance of certain clinical procedures (those that induce coughing)[2, 9]
- certain patient factors (cognitive impairment)[9]
- local outbreak information[9]

6.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments

The included guidance documents are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings. Some guidance was specific to certain infectious agents or healthcare settings for example multi-drug-resistant organisms, acute respiratory infections or care homes. Where appropriate, findings in relation to these documents have been connected, in text, to their respective infectious agent or setting specific guidance.

6.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
No primary studies were included therefore generalisability is not relevant for this research question.

6.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
Overall, no concerns identified. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

6.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
This research question aimed to outline how transmission-based precautions are currently described within the literature. It therefore does not have any associated recommendation(s).	N/A

6.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
N/A

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
N/A

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/ staff/ visitor perspective, the societal perspective, or both. Recommendations/ Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
N/A

6.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
N/A

6.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
N/A

6.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
N/A

6.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/ religious reasons.

Intentional vagueness
N/A

6.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
N/A

6.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
N/A

Research Question 7: When should TBPs be applied?

A: Quality of Evidence

7.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
The following evidence was included: • Twenty guidance documents graded SIGN 50 level 4 - expert opinion[1-6, 9-14, 25, 94-100] • One interrupted time series study graded SIGN 50 level 3[101] • One retrospective cohort study graded SIGN 50 level 3[102] Overall, the primary evidence for this question is limited in quantity and quality. The two SIGN 50 level 3 studies were graded as such due to their observational nature, lack of randomisation and other limitations associated with study design. The interrupted time series study findings may have specifically been affected by temporal variation of MRSA rates, lack of blinding and enhanced adherence to protocols which may not reflect true practice. The cohort study is retrospective in nature with findings based on modelling (network analysis), which in turn is defined by assumptions made by the authors and relies heavily on the accuracy of medical records and consistent adherence to contact precautions, which were not monitored. The guidance documents were published by national organisations and were graded SIGN 50 level 4 expert	20 x SIGN 50 level 4 – expert opinion 2 x SIGN 50 level 3

Comments	Evidence level
opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence.	

7.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how a judgement was formed as to the overall direction of the evidence.

Comments
Indications for TBPs • Guidance (n=10) published by public health organisations in England, Northern Ireland, Canada, Australia, and the USA, was consistent in advising the use of TBPs for patients and/or residents who are confirmed or suspected to be infected or colonised with an infectious agent spread via the contact, droplet or airborne route.[1-3, 9-12, 95, 97, 98] • Guidance (n=9) published by public health organisations in England, Northern Ireland, Canada, Australia, and the USA, also consistently outline that TBPs are required for infectious agents where standard precautions alone are deemed insufficient for the prevention of nosocomial transmission.[1, 3, 9-13, 95, 97] Evidence of sufficient quality was not cited within these guidance to support this position. • Two guidance documents (published by the WHO and the Public Health Agency of Canada (PHAC)) outline a higher risk associated with 'aerosol generating procedures' and the increased volume of smaller infectious particles which they are anticipated to generate and disperse. Different AGP lists are presented across three guidance documents (published by WHO, PHE, and PHAC) with weak supportive evidence.[1, 5, 9] There is a lack of consistency between guidance documents regarding the specific factors which should influence the decision on when to apply TBPs. Factors outlined by more than one SIGN 50 level 4 guidance source included: • TBPs for novel, targeted, or 'epidemiologically important' MDROs.[9, 100]

Comments

- TBPs for 'epidemiologically significant' infectious agents (examples given include *C. difficile*, antibiotic-resistant microorganisms, viral gastroenteritis and emerging respiratory infections).[6, 9]
- consideration of severity of illness caused by infection with the presenting infectious agent.[9, 13]
- PHAC advise a need for the organisation to determine the severity of illness caused by the microorganism, and the consequences of transmission on individuals, organisations and the community.[9]
- consideration of TBP application within the context of local outbreak data.[5, 9, 10, 12, 97, 98]
- application of TBPs when a clinical procedure or task is deemed to increase the risk of transmission of a specific infectious agent.[5, 9, 13]
- consideration of patient's presenting symptoms.[9, 12, 13]
- consideration of patient's ability to perform hand hygiene.[9, 98]
- consideration of the specific health and care setting, with a suggested need for variation between acute care, long term care, ambulatory care, pre-hospital care and home care settings.[9, 13, 98]
- performance of a patient care risk assessment to inform use of TBPs.[9, 13]

Recommendations which were unique to one guidance source included:

- consideration of an infectious agent's infective dose.[9]
- consideration of TBP use when "the clinical situation prevent[ed] consistent application of routine practices (for example, care of the young child, incontinent adult or cognitively impaired individual".[9]
- consideration of environmental factors, specifically areas where ventilation is poor[13]

Effectiveness of transmission-based precautions:

Two SIGN 50 level 3 graded studies presented results that demonstrated effectiveness of precautions, specifically the use of contact precautions to prevent nosocomial MRSA transmission in ICU settings (one a neonatal ICU).[101, 102]

No evidence was included that assessed the effectiveness of 'droplet' or 'airborne' precautions.

7.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments
The included guidance documents are produced by internationally recognised national healthcare associations and are generally relevant to Scottish health and care settings. Some guidance was specific to certain groups of infectious agents or healthcare settings for example multi-drug resistant organisms, acute respiratory infections or care homes. Where appropriate, findings in relation to these documents have been connected, in text, to their specific, named infectious agent or setting specific guidance. The two included studies which assessed contact precaution bundle effectiveness both assessed nosocomial acquisition of MRSA in ICU settings (one was a neonatal ICU).[101, 102] The studies were conducted 10-12 years ago, one in Australia,[101] the other in the U.S.A.[102] Specificity was enhanced in the Australian study through plastic aprons being used for the care of all patients in the before period, not just for those with MRSA.[101] These studies are generally applicable to Scottish settings however some country-specific aspects of care delivery may differ.

7.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
The two included studies which assessed the effectiveness of contact precaution bundles both assessed nosocomial acquisition of MRSA in ICU settings (one was a neonatal ICU).[101, 102] These may not be generalisable to other patient groups.

7.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
There is a widely acknowledged publication bias for studies with statistically significant results, however, when screening and appraising evidence in relation to this research question, there were many studies (that were subsequently excluded) which reported both on changes and an absence of change to infection rates following introduction or discontinuation of contact precautions. It is therefore not expected in this case for publication bias to have significantly hindered the identification of an evidence base to support an effect (or absence of effect) of contact precaution use. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

7.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
GPP 7.1 Transmission Based Precautions (TBPs) should be implemented in addition to SICPs when an individual is suspected or confirmed to be infected or colonised with an infectious agent.	Good Practice Point
GPP 7.2 In addition to the transmission route of the suspected or confirmed infectious agent, the following factors should be considered when deciding which TBPs should be applied: • Infectious agent (transmissibility, severity of illness, consequences of onward transmission, novel nature). • Place (environmental factors) • Local epidemiology/outbreak data • Presence of other vulnerable service users • Procedure	Good Practice Point

Recommendation(s)	Grading
• Service user factors (symptoms, behaviour, ability to comply with IPC). • Occupational health related risk	
GPP7.3 Room ventilation provision which is insufficient to dilute the infectious particles in the air, taking account of the size and maximum capacity of the room, should be considered higher risk for far-field exposure to transmissible respiratory infectious agents.	Good Practice Point
GPP7.4 For the purposes of transmission-based precautions, respiratory infectious agents should be categorised according to the hazard they pose into the following categories: • R1 = respiratory infectious agents that can cause human disease and may be a hazard to employees; they are unlikely to spread to the community and there is usually effective prophylaxis or treatment available. • R2 = respiratory infectious agents that can cause severe human disease and may be a serious hazard to employees; they may spread to the community but there is usually effective prophylaxis or treatment available. • R3 = respiratory infectious agents that cause severe human disease and are a serious hazard to employees if exposed; they are likely to spread to the community and there is usually no effective prophylaxis or treatment available.	

7.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
GPP 7.1- TBPs have historically been recommended to generate a number of benefits: • increased safety for staff, service users and visitors • Contributes to prevention of nosocomial transmission and antimicrobial resistance. • Reduced length of service user stay if service user remains free from healthcare associated infection. • Reduction in costs if service user remains free from healthcare associated infection. It is anticipated that continued recommendation of TBPs should sustain these outcomes. GPP 7.2 This GPP acknowledges that more than one factor (not just the transmission route) can facilitate transmission and may require consideration. GPP7.3 If it was currently possible to know which rooms have insufficient room ventilation provision for the dilution of infectious particles in the air, it might be possible to label these areas as unsuitable for the placement of patients with transmissible respiratory infection and apply additional mitigations (for example PPE) when such a patient was placed in the room. This could reduce the risk of far-field exposure to transmissible respiratory infectious agents when working within these rooms. The working group acknowledged that it is not currently possible to define sufficient (or insufficient) dilution for the purposes of infection control; current technical guidance SHTM 03-01 Part A refers to dilution of airborne contaminants in general, not dilution of infectious airborne contaminants. For more information, see section 7.9 (expert opinion) for GPP7.3. Therefore, the aforementioned benefits cannot currently be realised in practice. As RPE use is advised at all times, regardless of environmental conditions, for the most hazardous respiratory infectious agents (R2 and R3), the risk of far-field transmission is already mitigated against. The working group do not currently support routine use of RPE for protection against far-field exposure to R1 respiratory infectious agents (see RPE literature review).

Benefits
GPP7.4 Categorising respiratory infectious agents according to the hazard they pose is intended to be used as an indicator to support risk assessment when determining which TBPs to apply in the heath and care setting.

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/ Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
GPP 7.1- The risks and harms associated with specific TBPs such as mask use and service user isolation are considered within their associated literature reviews. GPP7.2: There is a risk that some care interactions will be inadequately risk assessed with underuse or overuse of resources for example, PPE. Conducting risk assessments may result in varied practices across boards and/ or services when presented with comparable scenarios. This is a high-level good practice point to inform TBP application, it is not intended to be implemented as a point-by-point risk assessment in practice. There is a risk that applying these factors to guidance development could result in unclear guidance which could lead to confusion. GPP7.3 If it was currently possible to know which rooms have insufficient room ventilation provision for the dilution of infectious particles in the air, it might be possible to label these areas as unsuitable for the placement of patients with transmissible respiratory infection and apply additional mitigations when such a patient was placed in the room. There would be no risks or harms associated with identifying such rooms. The working group acknowledged that it is not currently possible to define sufficient (or insufficient) dilution for the purposes of infection control; current technical guidance SHTM 03-01 Part A refers to dilution of airborne contaminants in general, not dilution of infectious airborne contaminants. GPP7.4 There is a risk that the R1-R3 categorisations may be confusing to stakeholders as whilst the definitions are aligned to the ACDP Approved List of Biological Agents groups, the numbering is not.

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
GPP 7.1 If implemented/ applied correctly, it is anticipated that benefits will outweigh harms. GPP 7.2 The working group agreed that the need to consider these factors when developing TBP guidance outweighs the potential risks. GPP7.3 N/A (the good practice point is not being implemented in practice). GPP7.4 The benefits are anticipated to outweigh the harms if guidance is clear and supported by education and implementation resources.

7.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
GPP7.1 The following feasibility issues have historically been associated with the implementation of TBPs: • financial implications related to increased use of materials (for example PPE), staffing resource, facility requirements and time • sustainability and waste management implications in relation to increased resource use • staffing resource • clinical judgement is required to assess the need for TBPs for certain colonisations where TBPs may not be warranted. Staff resource/ time was highlighted by the Working Group as being a potential harm for this good practice point. However, it has not been added as a harm because harms are those that would occur as a result of the good practice point being

Feasibility
implemented as intended, whereas feasibility relates to the actions that are required to implement the good practice point. GPP 7.2: This good practice point is a high-level statement and not intended to be implemented in practice as written. Feasibility issues are related to the translation of this good practice point into TBP guidance and include but are not limited to development of NIPCM content that is implementable in practice, educational materials, and implementation processes. GPP7.3: It is not currently feasible to implement this good practice point in practice because it is not currently possible to advise healthcare organisations as to which areas have insufficient dilution for the purposes of infection control. GPP7.4: There will be a requirement to continuously review the categorisations and make amendments if for example treatments or prophylaxis become available or if a new pathogen emerges. This may require consultation with ACDP.

7.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
GPP7.1: • Ten SIGN 50 level 4 guidance documents published by public health organisations in England, Northern Ireland, Canada, Australia, and the USA advise the use of TBPs for patients and/ or residents who are confirmed or suspected to be infected or colonised with an infectious agent spread via the contact, droplet or airborne route.[1-3, 9-12, 95, 97, 98] • SIGN 50 level 4 guidance (n=9) published by public health organisations in England, Northern Ireland, Canada, Australia, and the USA, also consistently outlined that TBPs are required for infectious agents where standard precautions alone are deemed insufficient for the prevention of

Expert opinion

nosocomial transmission.[1, 3, 9-13, 95, 97] Evidence of sufficient quality was not cited within these guidance to support this position.

- Only two studies (SIGN 50 level 3) presented results to support the use of precautions, specifically the use of contact precautions to prevent nosocomial MRSA transmission.[101, 102] No evidence was available that assessed the effectiveness of 'droplet' or 'airborne' precautions.

This combined evidence was insufficient to support development of a recommendation. A good practice point was supported by the Working Group that reflects the international expert opinion on this topic.

The working group discussed the fact that not all colonisations warrant TBPs and sought for this to be recognised in the GPP. Consideration was given to amending the GPP to read "TBPs should be implemented in addition to SICPs when an individual is suspected or confirmed to be infected with an infectious agent or colonised with a clinically significant infectious agent". However, the Working Group reflected that there is sufficient local expertise in place to manage this therefore no change was made to the GPP.

GPP 7.2:

SIGN 50 level 4 graded international and devolved/UK nation guidance is consistent in advising that factors, beyond the transmission route of a suspected or confirmed infectious agent, should be considered when implementing TBPs. This evidence was considered insufficient for the development of a recommendation.

The suggested list of factors within the good practice point is based on extant SIGN 50 level 4 guidance (severity of illness, place, procedures, symptoms, ability to comply with IPC, novel nature, consequence of onward transmission for example with MDROs) and expert opinion of the Working Group (environmental factors, occupational health risk, local epidemiology, presence of other vulnerable service users).

The working group discussed addition of 'burden of infection' to the list of factors. Burden of infection can be interpreted in a number of ways for example the impact of cohorting infectious patients which could impact transmission risk, or the burden of infection related to patient outcomes. 'Place (environmental factors)' covers the former, and 'infectious agent (transmissibility, severity of illness, consequences of onward transmission, novel nature)' can encompass the latter, therefore 'burden of infection' as a standalone factor was not included in the list.

The working group discussed the option of adding 'duration of exposure' as a factor in GPP7.2, to acknowledge that – logically - transmission risk increases with duration of exposure to an infectious source. The working group agreed not to add duration of exposure to GPP7.2 because it is not possible to predict how long you may spend with an infectious patient (individual exposures or cumulative). In

Expert opinion

comparison, there will be some prior information available regarding the other factors within GPP7.2. It is also not possible to apply a pragmatic duration due to the vast variation in types and durations of care tasks across different areas of clinical practice.

GPP7.3 [Room ventilation provision which is insufficient to dilute the volume of infectious particles in the air, taking account of the size and maximum capacity of the room, should be considered higher risk for far-field exposure to transmissible respiratory infectious agents].

The working group discussed the influence of environmental factors, specifically the impact of ventilation and room occupancy on far-field transmission risk.

The rationale for considering the size and maximum patient capacity of a room when assessing whether ventilation is sufficient to achieve adequate dilution, is based on the fact that as the number of occupants in a room increases, the amount of fresh air per person decreases on the basis that the ventilation rate remains constant/ fixed, which may lead to a build-up of contaminants.

An environmental risk assessment was added to Appendix 17 (Hierarchy of Controls) of the NIPCM during the COVID-19 pandemic that advised assessment of overcrowding (insufficient bed/ chair spacing) and 'poor ventilation' (deemed as < 6 ACH) as markers of increased transmission risk. However, many NHS boards reported an inability to implement this risk assessment in practice for many of the reasons noted below.

With regards to ventilation:

Only one included evidence source (SIGN 50 level 4) discusses consideration of environment factors as indicators for TBPs, specifically 'areas where ventilation is poor' however no specifics are provided as to what constitutes 'poor'.[13]

SHTM 03-01 Part A "The concept, design, specification, installation and acceptance testing of healthcare ventilation systems" details the ventilation requirements for health and care settings. Specified air change rates "have been found to give enough dilution of airborne contaminants, provided the mixing of room air is reasonably uniform". The guidance advises 6 ACH for general areas requiring mechanical ventilation within health and care settings (single rooms, general wards). However, other ventilation features (air flow direction, air pressure), in addition to air change rate, are also important determinants in achieving sufficient dilution in a space. Multiple design modes can be used to achieve dilution, including natural ventilation, mechanical ventilation and mixed modes. Consequently, specifying the deficiency of a single design feature (for example below specification ACH) as an indicator of poor ventilation (insufficient dilution) would be inappropriate.

Expert opinion

Current technical guidance is unable to provide any evidence-based specifications for ventilation provision to provide sufficient dilution of infectious airborne contaminants for the purposes of infection control. Further work is required in this area.

The working group agreed that it is not currently possible for healthcare organisations to determine whether their ventilation provision is providing sufficient dilution to reduce the risk of far-field transmission of respiratory infectious agents. This is an area that requires further research and development. This means that currently, it is not possible to explicitly place any reliable environmental indicators in IPC guidance.

Application of the precautionary principle to account for this risk, for example use of RPE at all times when caring for respiratory patients, is not supported by the working group (see the RPE CJF). Whilst RPE provides mitigation against far-field exposure to R2 and R3 infectious agents (regardless of the environmental conditions), the main indicator for RPE use is severity of infection associated with R2 and R3 infectious agents. RPE is also advised for care of R1 infectious agents by health and care workers when indicated by a personal GP, medical practitioner or occupational health where there is a risk of severe health outcomes should the staff member become infected. However, routinely R1 infectious agents do not currently require RPE use and hence mitigation (for both close and far-field exposure) is provided by FRSM.

GPP7.4:

With discontinuation of the 'droplet' and 'airborne' transmission descriptors (as recommended by **R4.1**), there is a need to replace the current 'droplet' and 'airborne' TBPs which are based solely on transmission mode.

As per **GPP7.2**, factors related to the infectious agent (transmissibility, severity of illness, consequences of onward transmission, novel nature) are noted as requiring consideration when determining which TBPs to apply. It is the expert opinion of the working group that it is not the responsibility of a healthcare worker to determine the severity of infection and consequences of onward transmission to others associated with an infectious agent nor would a healthcare worker necessarily have knowledge of this (or the transmissibility of an infectious agent) at the point of care. This aligns with COSHH legislation which mandates the responsibility of the employer to undertake a risk assessment to determine hazards and the risk they pose.[103] Consequently, the working group agreed that there is a need for guidance to have this assessment built in, to support determination of TBPs at the point of care. This is supported by one SIGN 50 level 4 guidance, published by the Public Health Agency of Canada (PHAC)[9] that advises that application of TBPs should be informed by determination (by the organisation) of the severity of illness caused by the microorganism, and the consequences of transmission on individuals,

Expert opinion

organisations and the community. This is intended to support application of the hierarchy of controls, which includes TBPs at various levels.

In determining how to provide categorisation of infectious agents based on severity of infection, transmissibility, and consequences of onwards transmission to individuals and the community, the working group have assessed the UK Advisory Committee on Dangerous Pathogens (ACDP) approved list of biological agents (ALBA):[104]

The ALBA was first published in 2000 (updated most recently in 2023) and categorises infectious agents in four groups according to the hazard they pose to human health. ACDP has made the relevant classification of biological agents having considered evidence as to the likelihood that they will cause disease by infection or toxicity in humans, how likely it is that the infection would spread to the community, and the availability of any prophylaxis or treatment.[104]

The ability of a pathogen to spread to the community takes into consideration those biological agents that are already endemic in a population. There is a lower risk of an onward outbreak in a community if that biological agent is already circulating in the general population.

The UK Health and Safety Executive (HSE) have approved the ALBA categorisations for reference within the Control of Substances Hazardous to Health (COSHH) legislation, where use of the list supports compliance with COSHH.[104] COSHH requires employees and any other person working with biological agents in ACDP Hazard Groups 2, 3 and 4 to assess the risk of exposure to those biological agents.[103]

Currently the ACDP ALBA is mainly used as part of risk assessment by those who work with biological agents, especially those “in research, development, teaching or diagnostic laboratories and industrial processes”, however ACDP state that it is also intended for use by “people working with humans who are, or who are suspected of being, infected with such an agent”.[104] It is therefore the expert opinion of the working group that use of the list as a foundation for assessing application of TBPs, is applicable to all staff working in health and care settings.

For respiratory infectious agents that are transmissible by the air and may transmit within health and care settings, the following ‘respiratory transmission-based precautions’ categories are informed by the ACDP ALBA:

R1 = respiratory infectious agents that can cause human disease and may be a hazard to employees; they are unlikely to spread to the community and there is usually effective prophylaxis or treatment available.

R2 = respiratory infectious agents that can cause severe human disease and may be a serious hazard to employees; they may spread to the community but there is usually effective prophylaxis or treatment available.

Expert opinion

R3 = respiratory infectious agents that cause severe human disease and are a serious hazard to employees; they are likely to spread to the community and there is usually no effective prophylaxis or treatment available.

The R1 category corresponds to the ACDP Group 2 definition, R2 corresponds to the ACDP Group 3 definition, and R3 to the ACDP Group 4 definition. Although there are four ADCP categories, the working group agreed that starting the 'R' Categories at R2 (instead of R1), to align with ACDP Group 2, would result in confusion and queries as to what the R1 category was.

These R1-R3 categories are intended to provide a foundation for TBP guidance for the prevention and control of respiratory infection, particularly RPE and PPE, patient placement, and fallow times. The categories are not intended to provide a single factor on which to base TBPs but rather to provide a foundation on which additional factors laid out in GPP7.2 can be considered when determining TBPs. The UK Health and Safety Executive (HSE) Biohazards Team are supportive of the ACDP-informed R1-R3 categorisation system and the hazard-based approach to respiratory transmission-based precautions.

Allocation of specific respiratory infectious agents into R1, R2, R3, is outlined in the table below.

R1	R2	R3
Bordetella pertussis mumps rubella endemic influenza RSV rhinovirus SARS-CoV-2	Mycobacterium tuberculosis (pulmonary) Measles Chickenpox MERS* SARS* Yersinia pestis* avian influenza*	Nipah*

* These infectious agents are currently categorised as high consequence infectious diseases (HCID) in the UK and therefore have IPC guidance that is separate from TBPs.

The working group considered the categorisation of measles and chickenpox, which are both ACDP ALBA Hazard Group 2 biological agents, and whether categorisation into R2 (which would correspond to ACDP ALBA Hazard Group 3) is warranted.

Expert opinion

This would be an ‘upgrade’ of hazard in acknowledgement by the working group that these infectious agents have historically been regarded as greater hazards than for example rhinovirus (R1/ACDP ALBA Group 2), with historical mitigations reflecting this (isolation room and RPE advised for patients with chickenpox and measles).

Expert opinion sought from an international consultant virologist supports the ‘upgrade’ of measles based on transmission potential, risk of transmission to vulnerable groups, the need for interventions, and risk of severe disease. Measles has no specific antiviral treatment, severity of infection can be significant (pneumonitis, encephalitis), and there is a risk of subacute sclerosing panencephalitis (SSPE) emerging in later life (rare but almost always fatal) following infection. As of 26 January 2026, the UK lost its WHO measles elimination certification after the disease circulated continuously for more than a year. The Working Group agreed to categorise measles as an R2 infectious agent.

A chickenpox vaccination was introduced in Scotland on 1 January 2026, whereby children will be offered two doses of the vaccine combined with the MMR vaccine as part of the routine schedule. This is expected to increase the population herd immunity and therefore reduce the number of hospitalisations/ healthcare presentations and subsequent risk of exposure to chickenpox within healthcare settings. However, this impact will not be realised immediately. Regarding chickenpox, the virologist opinion is for chickenpox to be categorised as R1 (which aligns with the current ACDP ALBA Group 2 categorisation); this is due to chickenpox having both an effective vaccine and antiviral treatment, a low risk of reinfection, and currently greater herd immunity (compared to measles).

Further expert opinion from the international virologist is that there is a fundamental difference between respiratory viruses and measles/ chickenpox - though all can spread via the air. In the case of measles/ chickenpox, there is only one serotype, and infection and vaccination give mostly life-long immunity to that serotype. Spread in the community is limited by high herd immunity, which is generally long-lasting. The reason why measles is spreading in the UK is mainly due to lack of immunity (not being vaccinated) rather than waning immunity. But eventually those naturally infected (who have not been vaccinated) will eventually increase herd immunity to a level where the outbreaks will naturally cease - unless a high proportion of newborns are also not consistently vaccinated into the future (as this replenishes the susceptible population). With respiratory viruses, there are some with multiple serotypes (for example rhinovirus and adenoviruses) as well as multiple species that all have only temporary immunity lasting just a few months, so reinfection is common each year - and new infections in those infected in previous seasons is the norm. Hence their rapid spread in the community as this herd immunity is temporary.

Expert opinion
There was mixed opinion within the Working Group with regards to the categorisation of chickenpox and therefore a precautionary approach was taken to categorise chickenpox as an R2 infectious agent.

7.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
GPP7.1 None to note.
GPP7.2 Note to note.
GPP7.3 None to note.
GPP7.4 None to note.

7.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/ religious reasons.

Intentional vagueness
GPP7.1 - None to note.
GPP 7.2 - A list of factors to consider has been given but the specifics within these are not detailed as there will be variation across different settings which will require local assessment.

Intentional vagueness
GPP7.3 The term ‘insufficient dilution’ has not been defined in the good practice point because there is currently insufficient extant technical guidance to support determination of what sufficient dilution is for the purposes of infection control. GPP7.4 The R1-R3 categories have been defined but the infectious agents within each category have not been specified within the good practice point – there will be a need to provide this in guidance.

7.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
GPP7.1 There may be instances where specific TBPs cannot be applied based on individual patient risk assessment, for example, patient safety considerations. GPP 7.2 None to note. GPP7.3 N/A. GPP7.4 None to note.

7.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
Further studies which examine the effectiveness of transmission-based precautions, through randomised controlled trials where possible, would be valuable. It is acknowledged that these may need to involve assessment of bundled interventions and require consideration of a significant number of confounding variables such as compliance with precautions and non-healthcare setting acquired infection. Studies which examine the efficacy of contact precautions for multi-drug-resistant organisms is specifically an area which requires further study. Specific to GPP7.3, there is a need for more robust evidence to support technical guidance for the provision of ventilation in health and care settings. There is a lack of evidence to support current ventilation specifications for the purpose of infection control. Future work is required to identify the parameters on which environmental risk can be assessed (for the purposes of infection control), as well as the

Recommendations for research
development of a framework for assessing and recording the ventilation specification across the NHS Scotland estate.

Research Question 8: Are there reported occurrences of person-to-person infectious agent transmission which do not align with their currently assigned transmission mode(s)?

A: Quality of Evidence

8.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Three outbreak reports were included for this research question.[105-107] They were graded SIGN 50 level 3 evidence. The reports are limited by retrospective data analysis and are at risk of recall bias. Limited information was provided regarding movement of HCWs or sharing of equipment, and active air sampling was not conducted.	3 x SIGN 50 level 3

8.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how a judgement was formed as to the overall direction of the evidence.

Comments
• One report presents evidence for hypothesised air transmission of *Acinetobacter baumannii* (*A. baumannii*); it is widely accepted that transmission most likely occurs via contact. Presence of *A. baumannii* in the air was demonstrated in the study but whether this contributed to transmission in the outbreak is unclear.[105] It was not possible to assess consistency due to an insufficient number of studies. • Two outbreak reports (published in 2021) describe potential long-range air transmission of SARS-CoV-2, which challenges the concept that close contact is required for transmission to occur between individuals (historically associated with 'droplet' transmission).[106, 107] In light of Good Practice Point 5.1 (GPP5.1) (introduction of the 'air transmission' terminology to replace the droplet-airborne dichotomy), the argument of droplet versus airborne transmission becomes obsolete.

8.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments
The *A. baumannii* outbreak investigation was undertaken within a UK burns intensive care unit, making it directly applicable to these settings in Scotland.[105] Of two COVID-19 outbreak investigations, one was undertaken in a haematological ward in South Korea[106] and the other in a general paediatric ward in Israel.[107] Findings from these studies may not be directly applicable to these types of wards in the UK.

8.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments
No primary research studies were included.

8.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
No concerns regarding publication bias specifically, however, it is noted that there may be many transmission events which have occurred in health and care settings which have not been published in the literature. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

8.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
This research question aimed to identify and describe any reported occurrences of person-to-person infectious agent transmission which do not align with their currently assigned transmission mode(s). There are no associated recommendations or good practice points.	N/A

8.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
N/A

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
N/A

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
N/A

8.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
N/A

8.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion
N/A

8.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
N/A

8.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/religious reasons.

Intentional vagueness
N/A

8.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
N/A

8.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
Reports of infectious agents being transmitted by modes beyond the widely accepted or cited route within health and care settings are rare. The included outbreak reports represent low-quality evidence sources. Further research and improvements in reporting would be beneficial.

Research Question 9: What factors should be considered when determining whether to discontinue TBPs?

A: Quality of Evidence

9.1 How reliable is the body of evidence?

(see SIGN 50, section 5.3.1, 5.3.4)

Comment here on the quantity of evidence available on this topic and its methodological quality. Please include citations and evidence levels.

If there is no available evidence to answer the key question, go to section B.

Comments	Evidence level
Nineteen pieces of evidence were included for this research question: • One systematic review (SIGN 50 level 1+),[108] • Three cohort studies (SIGN 50 level 3)[109-111] • Five observational studies (SIGN 50 level 3)[89, 112-115] • Ten guidance documents (SIGN 50 level 4 – expert opinion).[1, 4, 5, 9, 10, 12, 98, 116-118] The five SIGN 50 level 3 observational studies and three SIGN 50 level 3 cohort studies are graded as such due to their observational nature and study design limitations which include lack of controls, convenience sampling and reliance on accuracy of historical patient records. These studies rely on proxy measures of infectivity such as positive clinical swab results. The guidance documents were published by national organisations and were graded SIGN 50 level 4 expert opinion. Expert opinion guidance has potential bias given little detail is provided regarding how recommendations	1 x SIGN 50 level 1+ 8 x SIGN 50 level 3 10 x SIGN 50 level 4 – expert opinion

Comments	Evidence level
were formulated, and it is not always clear where expert opinion has taken precedence over scientific evidence.	

9.2 Is the evidence consistent in its conclusions?

(see SIGN 50, section 5.3.2)

Comment here on the degree of consistency demonstrated by the evidence. Where there are conflicting results/conclusions, indicate how a judgement was formed as to the overall direction of the evidence.

Comments

There was consistency in reporting that the following factors should be used as considerations for discontinuation of TBPs:

- The type of infectious agent
- Period of infectivity, estimated based on testing results or pathogen related evidence
- The estimated end of the infectious period, which was linked to specific indicators such as:
  - testing results or pathogen clearance times
  - resolution of symptoms
  - a set period of time having elapsed following symptom resolution
  - a set period of time having elapsed following treatment end
  - the possibility of prolonged carriage
  - the possibility of infection reoccurrence

Guidance was consistent in outlining that estimating period of infectivity can be challenging as it can vary depending on patient age, immune status, and presence of co-infection.[1, 5, 9, 12, 108, 116]

Guidance was consistent in indicating that estimating the end of the infectious period was associated with symptom resolution,[1, 4, 9, 10, 12, 116-118] completion of a specific treatment[9, 116-118] and/ or testing results.[1, 9, 12, 98, 110, 116]

Limited evidence demonstrated the potential for carriage or recurrence of multi-drug resistant organisms[109, 111, 115] and persons with COVID-19 infection remaining PCR positive for extended periods of time.[108, 110]

Comments
The CDC and WHO outline recommendations which do not align with considerations presented in other guidance sources. The CDC state that enhanced barrier precautions which are to be used for those “known to be colonized or infected with a MDRO as well as those at increased risk of MDRO acquisition (for example, residents with wounds or indwelling medical devices)” should remain in place for the duration of a patient’s stay or until wounds heal or indwelling devices are removed, although this is specific to care home service users.[4] The WHO do not recommend using testing as a trigger for discontinuation of precautions implemented in association with acute respiratory infection.[5] Both of these recommendations are in direct contradiction with considerations presented by other identified evidence.[1, 9, 10, 12, 116-118]

9.3 Is the evidence applicable to Scottish health and care settings?

(see SIGN 50, section 5.3.3)

For example, do the studies include interventions, comparators or outcomes that are common to Scottish health and care settings?

Comments
Of the included evidence, three pieces were undertaken in or written for UK health and care settings.[1, 89, 117] The findings from these would be directly applicable to NHS Scotland. There are a further two pieces of evidence that were written for international or unspecified audiences (1 systematic review,[108] 1 WHO expert opinion[5]). The remaining 13 pieces of evidence were undertaken in or written for North American health and care settings (12 United States,[4, 12, 98, 109-116, 118] 1 Canada[9]), with one additional piece of expert opinion being written for Australian Settings.[10]

9.4 Are the studies generalisable to the target population?

Comment here on sample size and methods of sample selection. Is the sample representative of the specific population/group of interest? Generalisability is only relevant to primary research studies.

Comments

Findings from included primary research may not be generalisable to all infectious agents as evidence was specific to SARS-CoV-2,[108, 110, 114] MRSA,[111, 112, 115] Carbapenemase-Producing *Enterobacteriaceae* (CPE),[109] *Clostridioides difficile*,[113] and influenza H1N1.[89]

Within studies, testing was undertaking in a variety of ways both directly from patients[108-112, 114, 115] and using staff skin or environmental contamination as a proxy indicator for carriage of infectious agents.[89, 113] These testing and analysis methods will all have differing levels of efficacy and applicability.

Of three included studies which involved SARS-CoV-2 infected patients, two included adult patients who were tested upon admission to hospital [110, 114] with one of these specific to solid organ transplant patients.[114] The third SARS-CoV-2 study included both paediatric (<18 years of age) and adult patients, however, it was unclear if patients were assessed within a hospital setting.[108]

Of the three studies which included MRSA patients, all were undertaken in hospital settings.[111, 112, 115] Two of these studies presented information on the age of included subjects with the median age of participants reported as 51 and 53 years of age respectively.[111, 112] Due to this, findings from these studies may not be generalisable to paediatric populations.

The single study which addressed removal of transmission-based precautions for patients colonised with CPE included only adult patients admitted to ICU facilities across four hospitals.[109] A number of comorbidities were reported for the included patient cohort, however none of these were found to be significantly associated with CPE carriage.[109]

The single study which included *C. difficile* patients did not report on ages of participants and was undertaken in general hospital wards.[113] The findings of this paper are difficult to generalise given the lack of information provided.

A single study addressed removal of precautions for patients infected with influenza (H1N1). This study included adult and paediatric subjects both in the community and admitted to hospital.[89]

9.5 Are there concerns about publication bias?

(see SIGN 50, section 5.3.5)

Comment here on whether there is a risk in the evidence base that studies have been selectively published based on their results (and thus a risk that results from published studies are systematically different from unpublished evidence).

Comments
Overall, no concerns identified. A formal assessment of publication bias was not conducted.

B: Evidence to Decision

9.6 Recommendation(s)

What Recommendation(s) or Good Practice Point(s) are appropriate based on this evidence?

Note the following terminology:

- **"must"** implies that the health and care setting must implement the recommended approach and is used where a recommendation has been directly lifted from legislation or mandatory guidance.
- **"should"** implies that the health and care setting "should" implement the recommended approach unless a clear and compelling rationale for an alternative approach is present.
- **"should consider"** implies that the health and care setting should consider implementing the recommended approach.

Recommendation(s)	Grading
GPP9.1 Transmission Based Precautions (TBPs) should be discontinued when the service user is considered to be no longer infectious.	Good Practice Point
GPP 9.2 The following factors may inform assessment of service user infectivity: • infectious agent characteristics including the likelihood of prolonged carriage and/or recurrence • time since specific sign(s) and symptom(s) onset or resolution • time since known exposure • clinical test results • evidence of effective treatment • immune status and/or age of infected person	Good Practice Point

Recommendation(s)	Grading
GPP 9.3 When deciding when to discontinue TBPs, the vulnerability of service users in the vicinity should be considered.	Good Practice Point
GPP 9.4 The need for continued application of TBPs should be reassessed regularly.	Good Practice Point

9.7 Balancing benefits and harms

Comment here on the potential impact of the Recommendation/Good Practice Point on service users, visitors and staff. Benefits and harms include considerations beyond IPC.

Benefits

List the favourable changes in outcome that would likely occur if the Recommendation/Good Practice Point were followed correctly. Be explicit, clear about pros.

Benefits
GPP9.1/GPP 9.2 – Appropriate and timely discontinuation of TBPs has historically been recommended to generate a number of benefits: • reduction in use of resources associated with TBPs • reduction of restrictive measures (for example isolation and PPE) which can have negative impacts on service users for example, communication issues, psychological impact GPP9.3 - Considering the vulnerability of service users in the vicinity ensures the welfare of these patients is being considered and may reduce the risk of negative outcomes. GPP9.4 - Regularly assessing the continued application of TBPs will reduce the risk of unnecessary application beyond what is required.

Risks and Harms

List the adverse events or other unfavourable outcomes that may occur if the Recommendation/ Good Practice Point were followed correctly. Be explicit, clear about cons.

Risks/Harms
GPP9.1, GPP9.2, GPP9.3, GPP9.4 - No harms identified for any of the GPPs but it is acknowledged that they may occur if TBPs are prematurely discontinued (for example onwards transmission) or continued longer than necessary (for example prolonged patient isolation, unnecessary use of resources).

Benefit-Harm assessment

Classify as “benefit outweighs harm” (or vice versa) or a “balance of benefit and harm.” Description of this balance can be from the individual service user/staff/visitor perspective, the societal perspective, or both. Recommendations/Good Practice Points are possible when clear benefit is not offset by important harms, costs or adverse events (or vice versa).

Benefit-Harm assessment
GPP9.1, GPP9.2, GPP9.3, GPP9.4 If applied correctly, benefits are anticipated to outweigh harms.

9.8 Feasibility

Is the Recommendation/Good Practice Point implementable in the Scottish context?

Describe (if applicable) financial implications, opportunity costs, material or human resource requirements, facility needs, sustainability issues etc., that may be associated with following a Recommendation/Good Practice Point. State clearly if information on resource use is lacking.

Feasibility
GPP9.1, GPP 9.2, GPP9.4 • Additional demands on staff resource to conduct comprehensive assessment of infectivity/the need for TBPs.

Feasibility

- There are not always reliable, measurable indicators of reduced infectivity therefore clinical judgement/risk assessment will be required.

GPP9.3: Staff resource is required to assess the vulnerability of surrounding service users.

9.9 Expert opinion

Summarise the expert opinion used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves expert opinion where evidence is insufficient. Clearly outlining expert opinion helps users understand its influence on interpreting objective evidence. Expert opinion may also be required where there is no evidence available.

Expert opinion

GPP9.1 - Although not explicitly stated in the evidence base, discontinuation of TBPs when the individual is no longer infectious is logical, reflects current practice and is supported by the expert opinion of the Working Group.

GPP9.2 – This good practice point is informed by:

- one systematic review (SIGN 50 level 1+) which demonstrated that, regarding COVID-19 infection, immune status and age may be factors which influence length of infectivity.[108]
- three cohort studies (SIGN 50 level 3) which demonstrated that for certain organisms, colonisation may recur and that wide intersubject variation in clearance times is possible.[109-111]
- five observational studies (SIGN 50 level 3) which demonstrate that transplant patients may test PCR positive for COVID-19 for prolonged periods post infection and post resolution of symptoms, that swabbing results for MDROs can be invalidated by a multitude of factors, that PCR testing detects environmental influenza virus shedding for longer than culture based sampling and that policies for cessation of TBPs can be too conservative with a need, in some cases, for a greater number of negative sample results or a longer period post treatment completion.[89, 112-115]
- ten guidance documents (SIGN 50 level 4) which outline the listed factors to be prudent considerations when assessing whether an individual can be considered no longer infectious and/ or transmission-based precautions can be ceased.[1, 4, 5, 9, 10, 12, 98, 116-118]

Expert opinion
The factors listed in GPP9.2 are supported by the expert opinion of the Working Group. Time since known exposure may be a useful consideration in certain circumstances for example, when infected persons are asymptomatic. Inclusion of time since known exposure is not mentioned in the evidence base but reflects current practice and is supported by the expert opinion of the Working Group. GPP9.3 - Consideration of vulnerability of other service users in the vicinity is based on an acknowledgement that the onward transmission of infection may result in severe outcomes for those service users. Therefore, the Working Group advise a precautionary approach to discontinuation of TBPs, particularly where there is uncertainty regarding resolution of infectivity. GPP9.4 - The need to regularly assess the continued application of TBPs is logical, reflects current practice, and is based on the expert opinion of the Working Group.

9.10 Value judgements

Summarise value judgements used in creating the Recommendation/Good Practice Point; if none were involved, state “none”. Translating evidence into action often involves value judgements, which include guiding principles, ethical considerations, or other beliefs and priorities. Clearly outlining value judgements helps users understand their influence on interpreting objective evidence.

Value judgements
GPP9.1, GPP9.2, GPP9.3, GPP9.4 – None to note.

9.11 Intentional vagueness

State reasons for any intentional vagueness in the Recommendation/Good Practice Point; if none was intended, state “none”. Recommendations/Good Practice Points should be clear and specific, but if a decision to be vague is made, acknowledging the reasoning clearly promotes transparency. Reasons for vagueness may include inadequate evidence; inability to achieve consensus regarding evidence quality, anticipated benefits/harms, or interpretation of evidence; legal considerations; economic reasons; ethical/ religious reasons.

Intentional vagueness
GPP9.1 – None to note.

Intentional vagueness
GPP9.2 - The list of factors to be considered when determining infectivity is high level as it is anticipated that there will be variation in application depending on the specific factors that are unique to each infectious agent. It is not intended that all factors or conditions must be met and/ or considered for all infectious agents. GPP9.3 – None to note. GPP9.4 - The frequency of reassessment of TBP implementation has not been specified as this may depend on a number of factors including the infectious agent, local parameters and expertise.

9.12 Exceptions

List situations or circumstances in which the Recommendation/Good Practice Point should not be applied.

Exceptions
GPP9.1, GPP9.2, GPP9.3, GPP9.4 – None to note.

9.13 Recommendations for research

List any aspects of the question that require further research.

Recommendations for research
There is a lack of evidence on the effectiveness of clinical tests for determining when precautions should be discontinued – further research in this area is essential, acknowledging the wide scope for multiple infectious agents. It is noted that research involving paediatric, neonatal, immunocompromised or asymptomatic cohorts is lacking.

References

1. Public Health England. Infection control precautions to minimise transmission of acute respiratory tract infections in healthcare settings, (2016, accessed 21 September 2022).
2. Association of periOperative Registered Nurses (AORN). Guideline Quick View: Transmission-Based Precautions. AORN journal 2019; 109(4): 529-536.
3. Australian Commission on Safety and Quality in Healthcare. Standard and transmission-based precaution posters, (2022, accessed 7 September 2022).
4. Centers for Disease Control and Prevention. Frequently Asked Questions (FAQs) about Enhanced Barrier Precautions in Nursing Homes, (2022, accessed 26 August 2022).
5. World Health Organization. Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care, (2014, accessed 7 November 2022).
6. World Health Organization. Transmission-based precautions for the prevention and control of infections: aide-memoire, (2022, accessed 11 October 2022).
7. Department of Health of Hong Kong. Guidelines on Infection Control Practice in the Clinic Settings of Department of Health, (2019, accessed 14 March 2023).
8. MANATU HAUORA (Ministry of Health) New Zealand. How infectious diseases spread, Available online at (2021, accessed 15 September 2022).
9. Public Health Agency of Canada. Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Healthcare Settings, (2017, accessed 1 November 2022).
10. Australian Government and National Health and Medical Research Council. Australian Guidelines for the Prevention and Control of Infection in Healthcare, (2019, accessed 7 October 2022).

11. Public Health Agency (Northern Ireland). Transmission Based Precautions: The Northern Ireland Regional Infection Prevention and Control Manual., (accessed 6 September 2022).

12. Siegel JD, Rhinehart E, Jackson M, et al. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings, (2007 (updated 2022), accessed 6 September 2022).

13. Department of Health & Social Care. Infection prevention and control: resource for adult social care, (2022, accessed 5 October 2022).

14. Lemass H MN, O'Connor N, Rochford S. Infection Prevention and Control for Primary Care in Ireland: a Guide for General Practice, (2013, accessed 7 October 2022).

15. Sehulster L and Chinn R. Guidelines for Environmental Infection Control in Health-Care Facilities, (2003, accessed 30 September 2022).

16. Duguid JP. The size and the duration of air-carriage of respiratory droplets and droplet-nuclei. The Journal of hygiene 1946; 44: 471-479. 1946/09/01. DOI: 10.1017/s0022172400019288.

17. Wells WF. ON AIR-BORNE INFECTION*: STUDY II. DROPLETS AND DROPLET NUCLEI. American Journal of Epidemiology 1934; 20: 611-618. DOI: 10.1093/oxfordjournals.aje.a118097 %J American Journal of Epidemiology.

18. Xie X, Li Y, Chwang ATY, et al. How far droplets can move in indoor environments--revisiting the Wells evaporation-falling curve. Indoor air 2007; 17: 211-225. DOI: 10.1111/j.1600-0668.2007.00469.x.

19. Feigin RD, Baker CJ, Herwaldt LA, et al. Epidemic meningococcal disease in an elementary-school classroom. The New England journal of medicine 1982; 307: 1255-1257. 1982/11/11. DOI: 10.1056/nejm198211113072007.

20. Dick EC, Jennings LC, Mink KA, et al. Aerosol transmission of rhinovirus colds. The Journal of infectious diseases 1987; 156: 442-448. 1987/09/01. DOI: 10.1093/infdis/156.3.442.

21. Bassinet L, Matrat M, Njamkepo E, et al. Nosocomial Pertussis Outbreak Among Adult Patients and Healthcare Workers. Infection Control & Hospital Epidemiology 2004; 25: 995-997. 2015/01/02. DOI: 10.1086/502332.

22. Wong TW, Lee CK, Tam W, et al. Cluster of SARS among medical students exposed to single patient, Hong Kong. Emerg Infect Dis 2004; 10: 269-276. 2004/03/20. DOI: 10.3201/eid1002.030452.

23. Pachucki CT, Pappas SA, Fuller GF, et al. Influenza A among hospital personnel and patients. Implications for recognition, prevention, and control. Archives of internal medicine 1989; 149: 77-80. DOI: 10.1001/archinte.1989.00390010091010.

24. Papineni RS and Rosenthal FS. The size distribution of droplets in the exhaled breath of healthy human subjects. Journal of aerosol medicine : the official journal of the International Society for Aerosols in Medicine 1997; 10: 105-116. 1997/07/01. DOI: 10.1089/jam.1997.10.105.

25. MANATU HAUORA (Ministry of Health) New Zealand. Infection prevention and control, (2022, Accessed 12 October 2022).

26. Asadi S, Wexler AS, Cappa CD, et al. Aerosol emission and superemission during human speech increase with voice loudness. Scientific reports 2019; 9(1): 2348.

27. Binder RA, Alarja NA, Robie ER, et al. Environmental and Aerosolized Severe Acute Respiratory Syndrome Coronavirus 2 among Hospitalized Coronavirus Disease 2019 Patients. Journal of Infectious Diseases 2020; 222(11): 1798-1806.

28. Bischoff WE, Bassetti S, Bassetti-Wyss BA, et al. Airborne dispersal as a novel transmission route of coagulase-negative staphylococci: interaction between coagulase-negative staphylococci and rhinovirus infection. Infection Control & Hospital Epidemiology 2004; 25: 504-511. Research Support, U.S. Gov't, P.H.S.

29. Bischoff WE, McNall RJ, Blevins MW, et al. Detection of Measles Virus RNA in Air and Surface Specimens in a Hospital Setting. Journal of Infectious Diseases 2016; 213: 600-603. DOI: 10.1093/infdis/jiv465.

30. Bischoff WE, Wallis ML, Tucker BK, et al. "Gesundheit!" sneezing, common colds, allergies, and Staphylococcus aureus dispersion. Journal of Infectious Diseases 2006; 194(8): 1119-1126.

31. Campiti VJ, Ye MJ, Sharma D, et al. Aerosol Generation During Myringotomy With Tympanostomy Tube Insertion: Implications for Otolaryngology in the COVID-19 Era. Otolaryngology - Head and Neck Surgery (United States) 2021; 165(4): 532-535.

32. Fabian P, Brain J, Houseman EA, et al. Origin of exhaled breath particles from healthy and human rhinovirus-infected subjects. Journal of Aerosol Medicine and Pulmonary Drug Delivery 2011; 24(3): 137-147.

33. Fennelly KP, Martyny JW, Fulton KE, et al. Cough-generated Aerosols of Mycobacterium tuberculosis: A New Method to Study Infectiousness. American journal of respiratory and critical care medicine 2004; 169(5): 604-609.

34. Gaeckle NT, Lee J, Park Y, et al. Aerosol generation from the respiratory tract with various modes of oxygen delivery. American journal of respiratory and critical care medicine 2020; 208(8): 1115-1124.

35. Lednicky JA, Lauzard M, Fan ZH, et al. Viable SARS-CoV-2 in the air of a hospital room with COVID-19 patients. International Journal of Infectious Diseases 2020; 100: 476-482.

36. Lindsley WG, Blachere FM, Beezhold DH, et al. Viable influenza A virus in airborne particles expelled during coughs versus exhalations. Influenza and other Respiratory Viruses 2016. In Press.

37. Lindsley WG, Blachere FM, Thewlis RE, et al. Measurements of airborne influenza virus in aerosol particles from human coughs. PLoS ONE 2010; 5(11).

38. Lindsley WG, Pearce TA, Hudnall JB, et al. Quantity and size distribution of cough-generated aerosol particles produced by influenza patients during and after illness. Journal of Occupational and Environmental Hygiene 2012; 9(7): 443-449.

39. Murr AT, Lenze NR, Gelpi MW, et al. Quantification of Aerosol Concentrations During Endonasal Instrumentation in the Clinic Setting. Laryngoscope 2021; 131(5): E1415-E1421.

40. Sajgalik P, Garzona-Navas A, Csécs I, et al. Characterization of Aerosol Generation During Various Intensities of Exercise. CHEST 2021; 160: 1377-1387. DOI: 10.1016/j.chest.2021.04.041.

41. Santarpia JL, Herrera VL, Rivera DN, et al. The size and culturability of patient-generated SARS-CoV-2 aerosol. Journal of exposure science & environmental epidemiology 2021; 18.

42. Shankar NS, Witanachchi CT, Morea AF, et al. SARS-CoV-2 in residential rooms of two self-isolating persons with COVID-19. Journal of Aerosol Science 2022; 159.

43. Subat YW, Guntupalli SK, Sajgalik P, et al. Aerosol generation during peak flow testing: Clinical implications for COVID-19. Respiratory Care 2021; 66(8): 1291-1298.

44. Yan J, Grantham M, Pantelic J, et al. Infectious virus in exhaled breath of symptomatic seasonal influenza cases from a college community. Proceedings of the National Academy of Sciences - PNAS 2018; 115: 1081-1086. DOI: 10.1073/pnas.1716561115.

45. Dudding T, Sheikh S, Gregson F, et al. A clinical observational analysis of aerosol emissions from dental procedures. PLoS ONE 2022; 17(3 March).

46. Gregson FKA, Shrimpton AJ, Hamilton F, et al. Identification of the source events for aerosol generation during oesophago-gastro-duodenoscopy. *Gut* 2022; 71(5): 871-878.

47. Gregson FKA, Watson NA, Orton CM, et al. Comparing aerosol concentrations and particle size distributions generated by singing, speaking and breathing. Aerosol Science and Technology 2021; 55(6): 681-691.

48. Hamilton FW, Gregson FKA, Arnold DT, et al. Aerosol emission from the respiratory tract: an analysis of aerosol generation from oxygen delivery systems. Thorax 2022; 77(3): 276-282.

49. Killingley B, Greatorex J, Digard P, et al. The environmental deposition of influenza virus from patients infected with influenza A(H1N1)pdm09: Implications for infection prevention and control. Journal of Infection and Public Health 2016; 9(3): 278-288.

50. Kulkarni H, Smith CM, Lee Ddo H, et al. Evidence of Respiratory Syncytial Virus Spread by Aerosol. Time to Revisit Infection Control Strategies? American Journal of Respiratory & Critical Care Medicine 2016; 194: 308-316. Research Support, Non-U.S. Gov't.

51. Sheikh S, Hamilton FW, Nava GW, et al. Are aerosols generated during lung function testing in patients and healthy volunteers? Results from the AERATOR study. Thorax 2022; 77(3): 292-294.

52. Shrimpton AJ, Brown JM, Cook TM, et al. Quantitative evaluation of aerosol generation from upper airway suctioning assessed during tracheal intubation and extubation sequences in anaesthetized patients. Journal of Hospital Infection 2022; 124: 13-21.

53. Shrimpton AJ, Brown JM, Gregson FKA, et al. Quantitative evaluation of aerosol generation during manual facemask ventilation. Anaesthesia 2022; 77: 22-27. DOI: 10.1111/anae.15599.

54. Shrimpton AJ, Gregson FKA, Brown JM, et al. A quantitative evaluation of aerosol generation during supraglottic airway insertion and removal. Anaesthesia 2021; 76: 1577-1584. Observational Study

55. Simonds AK, Hanak A, Chatwin M, et al. Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections. Health technology assessment (Winchester, England) 2010; 14(46): 131-172.

56. Gralton J, Tovey ER, McLaws ML, et al. Respiratory virus RNA is detectable in airborne and droplet particles. Journal of Medical Virology 2013; 85(12): 2151-2159.

57. Knibbs LD, Johnson GR, Kidd TJ, et al. Viability of Pseudomonas aeruginosa in cough aerosols generated by persons with cystic fibrosis. Thorax 2014; 69(8): 740-745.

58. Stockwell RE, Chin M, Johnson GR, et al. Transmission of bacteria in bronchiectasis and chronic obstructive pulmonary disease: Low burden of cough aerosols. Respirology 2019; 24(10): 980-987.

59. Wainwright CE, France MW, O'Rourke P, et al. Cough-generated aerosols of Pseudomonas aeruginosa and other Gram-negative bacteria from patients with cystic fibrosis. Thorax 2009; 64: 926-931. DOI: 10.1136/thx.2008.112466.

60. Wilson NM, Marks GB, Eckhardt A, et al. The effect of respiratory activity, non-invasive respiratory support and facemasks on aerosol generation and its relevance to COVID-19. Anaesthesia 2021; 76(11): 1465-1474.

61. Wood ME, Stockwell RE, Johnson GR, et al. Face masks and cough etiquette reduce the cough aerosol concentration of pseudomonas aeruginosa in people with cystic fibrosis. American journal of respiratory and critical care medicine 2018; 197(3): 348-355.

62. Wood ME, Stockwell RE, Johnson GR, et al. Cystic fibrosis pathogens survive for extended periods within cough-generated droplet nuclei. Thorax 2019; 74(1): 87-90.

63. Akin H, Karabay O, Toptan H, et al. Investigation of the Presence of SARS-CoV-2 in Aerosol After Dental Treatment. International dental journal 2022; 72(2): 211-215.

64. Alsved M, Nygren D, Thuresson S, et al. SARS-CoV-2 in exhaled aerosol particles from covid-19 cases and its association to household transmission. Clinical infectious diseases: an official publication of the Infectious Diseases Society of America 2022; 10.

65. Chan SM, Ma TW, Chong MKC, et al. A Proof of Concept Study: Esophagogastroduodenoscopy Is an Aerosol-Generating Procedure and Continuous Oral Suction During the Procedure Reduces the Amount of

Aerosol Generated. Gastroenterology 2020; 159(5): 1949-1951.e1944. Short Survey.

66. Chia PY, Coleman KK, Tan YK, et al. Detection of air and surface contamination by SARS-CoV-2 in hospital rooms of infected patients. Nature communications 2020; 11: 2800-2807. DOI: 10.1038/s41467-020-16670-2.

67. Choukri F, Menotti J, Sarfati C, et al. Quantification and Spread of Pneumocystis jirovecii in the Surrounding Air of Patients with Pneumocystis Pneumonia. Clinical infectious diseases 2010; 51: 259-265. DOI: 10.1086/653933.

68. Coleman KK, Tay DJW, Sen Tan K, et al. Viral Load of SARS-CoV-2 in Respiratory Aerosols Emitted by COVID-19 Patients while Breathing, Talking, and Singing. Clinical infectious diseases: an official publication of the Infectious Diseases Society of America 2021; 06.

69. Dinkele R, Gessner S, McKerry A, et al. Aerosolization of Mycobacterium tuberculosis by Tidal Breathing. American journal of respiratory and critical care medicine 2022; 206: 206-216. 2022/05/19. DOI: 10.1164/rccm.202110-2378OC.

70. Engel TGP, Erren E, Vanden Driessche KSJ, et al. Aerosol transmission of Aspergillus fumigatus in cystic fibrosis patients in the Netherlands. Emerging Infectious Diseases 2019; 25(4): 797-799.

71. Fennelly KP, Jones-Lopez EC, Ayakaka I, et al. Variability of Infectious Aerosols Produced during Coughing by Patients with Pulmonary Tuberculosis. American journal of respiratory and critical care medicine 2012; 186(5): 450-457.

72. Ferroni A, Werkhauser-Bertrand A, Le Bourgeois M, et al. Bacterial contamination in the environment of hospitalised children with cystic fibrosis. Journal of Cystic Fibrosis 2008; 7: 477-482.

73. Fleischer M, Schumann L, Hartmann A, et al. Pre-Adolescent children exhibit lower aerosol particle volume emissions than adults for breathing, speaking, singing and shouting. Journal of the Royal Society Interface 2022; 19(187).

74. Frealle E, Valade S, Guigue N, et al. Diffusion of Pneumocystis jirovecii in the surrounding air of patients with Pneumocystis colonization: frequency and putative risk factors. Medical Mycology 2017; 55: 568-572.

75. Gohli J, Anderson AM, Brantsaeter AB, et al. Dispersion of SARS-CoV-2 in air surrounding COVID-19-infected individuals with mild symptoms. Indoor air 2022; 32(2): e13001.

76. Graziani F, Izzetti R, Lardani L, et al. Experimental evaluation of aerosol production after dental ultrasonic instrumentation: An analysis on fine particulate matter perturbation. International Journal of Environmental Research and Public Health 2021; 18(7) (no pagination).

77. Johnson TJ, Nishida RT, Sonpar AP, et al. Viral load of SARS-CoV-2 in droplets and bioaerosols directly captured during breathing, speaking and coughing. Scientific reports 2022; 12(1): 3484.

78. Jones-Lopez EC, Namugga O, Mumbowa F, et al. Cough aerosols of Mycobacterium tuberculosis predict new infection: A household contact study. American journal of respiratory and critical care medicine 2013; 187(9): 1007-1015.

79. Kim SH, Chang SY, Sung M, et al. Extensive Viable Middle East Respiratory Syndrome (MERS) Coronavirus Contamination in Air and Surrounding Environment in MERS Isolation Wards. Clinical Infectious Diseases 2016; 63(3): 363-369.

80. Kim UJ, Lee SY, Lee JY, et al. Air and Environmental Contamination Caused by COVID-19 Patients: a Multi-Center Study. Journal of Korean medical science 2020; 35(37): e332.

81. Murbe D, Kriegel M, Lange J, et al. Aerosol emission in professional singing of classical music. Scientific reports 2021; 11(1): 14861.

82. Murbe D, Kriegel M, Lange J, et al. Aerosol emission of adolescents voices during speaking, singing and shouting. PLoS ONE 2021; 16(2 February).

83. Ong SWX, Tan YK, Coleman KK, et al. Lack of viable severe acute respiratory coronavirus virus 2 (SARS-CoV-2) among PCR-positive air

samples from hospital rooms and community isolation facilities. Infection Control and Hospital Epidemiology 2021; 42(11): 1327-1332.

84. Sawano M, Takeshita K, Ohno H, et al. RT-PCR diagnosis of COVID-19 from exhaled breath condensate: a clinical study. Journal of Breath Research, 2021; 15: 10. Clinical Study.

85. Viklund E, Kokelj S, Larsson P, et al. Severe acute respiratory syndrome coronavirus 2 can be detected in exhaled aerosol sampled during a few minutes of breathing or coughing. Influenza and other Respiratory Viruses 2022; 16(3): 402-410.

86. Yip L, Finn M, Granados A, et al. Influenza virus RNA recovered from droplets and droplet nuclei emitted by adults in an acute care setting. Journal of Occupational and Environmental Hygiene 2019; 16: 341-348. DOI: 10.1080/15459624.2019.1591626.

87. Milton DK, Fabian MP, Cowling BJ, et al. Influenza Virus Aerosols in Human Exhaled Breath: Particle Size, Culturability, and Effect of Surgical Masks. PLOS Pathogens 2013; 9: e1003205. DOI: 10.1371/journal.ppat.1003205.

88. Fabian P, McDevitt JJ, DeHaan WH, et al. Influenza virus in human exhaled breath: an observational study. PLoS ONE [Electronic Resource] 2008; 3: e2691.

89. Killingley B, Greatorex J, Cauchemez S, et al. Virus shedding and environmental deposition of novel A (H1N1) pandemic influenza virus: interim findings. Health technology assessment (Winchester, England) 2010; 14(46): 237-354.

90. ASHRAE. ASHRAE Positions on Infectious Aerosols, Available online at (2022, accessed 15 September 2022).

91. UK Health Security Agency. Ventilation to reduce the spread of respiratory infections, including COVID-19, (2021, accessed 7 October 2022).

92. Centers for Disease Control and Prevention. How Infections Spread, (2016, accessed 11 April 2022).

93. Government of Canada. Pathogen Risk Assessment, (2021, accessed 3 October 2022).

94. Centers for Disease Control and Prevention. Enhanced Barrier Precautions, (accessed 6 September 2022).

95. Centers for Disease Control and Prevention. Transmission-Based Precautions, (2016, accessed 24 August 2022).

96. Centers for Disease Control and Prevention. Consideration for Use of Enhanced Barrier Precautions in Skilled Nursing Facilities, (2021, accessed 26 August 2022).

97. Centers for Disease Control and Prevention. Implementation of Personal Protective Equipment (PPE) Use in Nursing Homes toPrevent Spread of Multidrug-resistant Organisms (MDROs), (2022, accessed 7 November 2022).

98. Siegel JD, Rhinehart E, Jackson M, et al. Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006, (2006, accessed 5 October 2022).

99. World Health Organization. Strengthening infection prevention and control in primary care, (2021, accessed 7 September 2022).

100. Centers for Disease Control and Prevention. Preventing Infections in Healthcare, (2020, accessed 6 September 2022).

101. Marshall C, Richards M and McBryde E. Do Active Surveillance and Contact Precautions Reduce MRSA Acquisition? A Prospective Interrupted Time Series. PLoS ONE 2013; 8(3).

102. Geva A, Wright SB, Baldini LM, et al. Spread of methicillin-resistant Staphylococcus aureus in a large tertiary NICU: Network analysis. Pediatrics 2011; 128(5): e1173-e1180.

103. UK Government. The Control of Substances Hazardous to Health Regulations 2002. 2002.

104. UK Advisory Committee on Dangerous Pathogens - Health and Safety Executive. The Approved List of biological agents. 24 March 2026 2026.

105. Teare L, Martin N, Elamin W, et al. Acinetobacter - the trojan horse of infection control? Journal of Hospital Infection 2019; 102(1): 45-53.

106. Jung J, Lee J, Jo S, et al. Nosocomial outbreak of COVID-19 in a hematologic ward. Infection and Chemotherapy 2021; 53(2): 332-341.

107. Goldberg L, Levinsky Y, Marcus N, et al. SARS-CoV-2 Infection among Health Care Workers despite the Use of Surgical Masks and Physical Distancing-the Role of Airborne Transmission. Open Forum Infectious Diseases 2021; 8(3).

108. Morone G, Palomba A, Iosa M, et al. Incidence and Persistence of Viral Shedding in COVID-19 Post-acute Patients With Negativized Pharyngeal Swab: A Systematic Review. Frontiers in Medicine 2020; 7.

109. Jimenez A, Fennie K, Munoz-Price LS, et al. Duration of carbapenemase-producing Enterobacteriales carriage among ICU patients in Miami, FL: A retrospective cohort study. American Journal of Infection Control 2021; 49(10): 1281-1286.

110. Jiwani RA, Mao Y, Pona A, et al. Discontinuation of Transmission Precautions for COVID-19 Patients: Polymerase Chain Reaction Diagnostics, Patient Delays, and Cycle Threshold Values. Infectious Diseases in Clinical Practice 2021; 29(5): E287-E293.

111. Richey LE, Oh Y, Tchamba DM, et al. When should contact precautions be discontinued for patients with methicillin-resistant Staphylococcus aureus? American Journal of Infection Control 2017; 45(1): 75-76.

112. Richards V and Tremblay E. Assessment of current methicillin-resistant Staphylococcus aureus screening protocols and outcomes at an academic medical center. American Journal of Infection Control 2019; 47(8): 906-910.

113. Shrestha SK, Sunkesula VCK, Kundrapu S, et al. Acquisition of clostridium difficile on hands of healthcare personnel caring for patients with Resolved C. difficile Infection. Infection Control and Hospital Epidemiology 2016; 37(4): 475-477.

114. Theodore DA, Greendyke WG, Miko B, et al. Cycle Thresholds Among Solid Organ Transplant Recipients Testing Positive for SARS-CoV-2. Transplantation 2021; 105(7): 1445-1448.

115. Vikram HR, Dumigan DG, Kohan C, et al. Discontinuation of contact precautions for patients no longer colonized with methicillin-resistant Staphylococcus aureus. Infection Control and Hospital Epidemiology 2010; 31(5): 541-543.

116. Banach DB, Bearman G, Barnden M, et al. Duration of Contact Precautions for Acute-Care Settings. Infection control and hospital epidemiology 2018; 39: 1-144. DOI: 10.1017/ice.2017.245.

117. Department of Health and Social Care and England. PH. Prevention and control of infection in care homes - an information resource, (2013, accessed 14 March 2023).

118. Woodside J RT, Williams C, Woodin J. APIC: Guide to Infection Prevention in Emergency Medical Services. Association for Professionals in Infection Control and Epidemiology 2013.

Appendix 1 – Definitions

Term used	Description	Evidence
Recommendation	In general, 'Recommendations' should be supported by high- to moderate-quality evidence. In some circumstances, however, 'Recommendations' may be made based on lower quality evidence when high-quality evidence is impossible to obtain, and the anticipated benefits strongly outweigh the harms or when the Recommendation is required by Legislation or Mandatory Guidance.	Sufficient evidence (SIGN 50 level 1++, 1+, 2++, 2+, 3, 4* AGREE II Recommend AGREE II Recommend (with Modifications)) Legislation, or mandatory guidance
Good Practice Point	Insufficient evidence or a lack of evidence to make a recommendation but identified best practice based on the clinical/technical experience (expert opinion) of the Working Group, with a clear balance between benefits and harms.	Insufficient evidence + Working Group expert opinion OR No evidence + Working Group expert opinion
No Recommendation	Both a lack of pertinent evidence and an unclear balance between benefits and harms.	No evidence

* A Recommendation cannot be developed when there is only SIGN 50 level 4 evidence available.

The considered judgement form and recommendation system are adapted from the following three sources.

- Update to the Centers for Disease Control and Prevention and the Healthcare Infection Control Practices Advisory Committee Recommendation Categorization Scheme for Infection Control and Prevention Guideline Recommendations. (2019)
- Scottish Intercollegiate Guidelines Network (SIGN). A guideline developer's handbook. (2019)
- Grading of Recommendations, Assessment, Development and Evaluation (GRADE) Handbook. (2013)