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# Transmission of Acute Respiratory Infections During Aerosol Generating Medical Procedures

Update of 2011 CADTH Systematic Review

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In 2011, the Canadian Agency for Drugs and Technologies in Health (CADTH) completed a systematic review on aerosol-generating procedures (AGMPs) and associated risk of transmission of acute respiratory infections (ARIs).[1] There have been no known recent systematic reviews conducted on this topic since 2011. Considering the COVID-19 pandemic, updated evidence is required on transmission of ARIs to health care workers (HCW) due to aerosolized particles. This brief review presents an overview of the 2011 CADTH report, followed by results of an update of this systematic review.

# 1 Synthesis of CADTH Report Findings

The 2011 CADTH report[1] included ten non-randomized studies, all of which examined transmission of severe acute respiratory syndrome (SARS) to HCWs during the 2002-2003 SARS outbreaks. Studies included in the CADTH report were conducted in Toronto, Guangzhou, Beijing, Tianjin, Singapore, and Hong Kong.[1]

Procedures significantly associated with risk of SARS transmission to HCWs included (Table 1): tracheal intubation, non-invasive ventilation, tracheotomy, and manual ventilation before intubation.[1] Procedures not significantly associated with risk of SARS transmission to HCWs were: suction before intubation, suction after intubation, manual ventilation after intubation, bronchoscopy, nebulizer treatment, manipulation of oxygen mask, manipulation of biphasic positive airway pressure (BiPAP) mask, defibrillation, chest compressions, insertion of nasogastric tube, collection of sputum samples, high-frequency oscillatory ventilation, high-flow oxygen, endotracheal aspiration, suction of body fluid, administration of oxygen, chest physiotherapy, and mechanical ventilation.[1] In the 2011 CADTH report[1], all studies were assessed using Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) criteria, and deemed very low quality.

Table 1. Summary of findings, 2011 CADTH Report[1]

| | Procedure | Literature | Estimate |
|---|---|---|---|
| Significantly associated with risk of SARS transmission to HCWs, odds ratios > 1 | Tracheal intubation | Four cohort studies, four case control studies | Cohort studies: OR 6.6; 95% CI 2.3 to 18.9; Case-control studies: OR 6.6; 95% CI 4.1 to 10.6) |
| | Non-invasive ventilation | Two cohort studies | OR 3.1; 95% CI 1.4 to 6.8) |
| | Tracheotomy | One case-control study | OR 4.2; 95% CI 1.5 to 11.5 |
| | Manual ventilation before ventilation | One cohort study | OR 2.8; 95% CI 1.3 to 6.4 |
| Not significantly associated with risk of SARS transmission to HCWs | Suction before intubation | Two cohort studies | OR 3.5; 95% CI 0.5 to 24.6 |
| | Suction after intubation | Two cohort studies | OR 1.3; 95% CI 0.5 to 3.4 |
| | Manual ventilation after intubation | One cohort study | OR 1.3; 95% CI 0.5 to 3.2 |
| | Bronchoscopy | Two cohort studies | OR 1.9; 95% CI 0.2 to 14.2 |
| | Nebulizer treatment | Two cohort studies | OR 1.9; 95% CI 0.2 to 14.2 |
| | Manipulation of oxygen mask | Two cohort studies | OR 4.6; 95% CI 0.6 to 32.5 |
| | Manipulation of BiPAP mask | One cohort study | OR 4.2; 95% CI 0.6 to 27.4 |
| | Defibrillation | Two cohort studies | OR 2.5; 95% CI 0.1 to 43.9 |
| | Chest compressions | Two cohort studies | OR 1.4; 95% CI 0.2 to 11.2 |
| | Insertion of nasogastric tube | Two cohort studies | OR 1.2; 95% CI 0.4 to 4.0 |
| | Collection of sputum | One cohort study | OR 2.7; 95% CI 0.9 to 8.2 |
| | High-frequency oscillatory ventilation | One cohort study | OR 0.7; 95% CI 0.1 to 5.5 |
| | High-flow oxygen | One cohort study | OR 0.7; 95% CI 0.1 to 1.7 |
| | Endotracheal aspiration | One cohort study | OR 1.0; 95% CI 0.2 to 5.2 |
| | Suction of bodily fluid | One case-control study | OR 1.0; 95% CI 0.4 to 2.8 |
| | Administration of oxygen | One case-control study | OR 1.0; 95% CI 0.3 to 2.8 |
| | Chest physiotherapy | Two cohort studies | OR 0.8; 95% CI 0.2 to 3.2 |
| | Mechanical ventilation | One cohort study | OR 0.9; 95% CI 0.4 to 2.0 |

# 2 Systematic Review Update

## 2.1 Methods

### *2.1.1 Literature Search*

The CADTH search strategy was updated by a research librarian to capture studies published from 2011-current. MEDLINE, EMBASE, Cochrane SR, Cochrane Central, and CINAHL were searched from 2011 until March 31st, 2020. Terms aimed to capture the aerosol-generating procedures, such as "ventilation" and "intubation" were combined with disease terms, such as "coronavirus," "SARS," or "acute respiratory infection," using the Boolean Operator "and."

These terms were searched as text words in titles and abstracts and as MeSH subject headings, when applicable. The search excluded case reports, animal studies, conference abstracts, editorials, and letters. The full search strategy is reported in Appendix I.

### *2.1.2 Literature Selection*

Abstracts identified through database searching were screened in duplicate; all abstracts included at this stage by either reviewer proceeded to full-text review. Full-text publications were screened in duplicate. Any discrepancies between reviewers' inclusions were resolved through discussion between reviewers. Publications were included if they met all inclusion criteria in Table 2 and failed to meet exclusion criteria.

Table 2. *A priori* Systematic Review Inclusion and Exclusion Criteria

| **Inclusion Criteria** | **Exclusion Criteria** |
|---|---|
| • Randomized controlled trials, and non-randomized comparative studies<br>• HCWs caring for patients with acute respiratory infections (ARIs), including but not limited to Covid-19, SARS, MERS, influenza<br>• Intervention is the provision of care to patients undergoing aerosol-generating procedures (exposed to the procedures)<br>• Comparator is the provision of care to patients not undergoing aerosol-generating procedures (unexposed to the procedures)<br>• Outcome of interest is the risk of transmission of ARIs from patients to HCWs<br>• English or French language | • Study published in language other than English or French<br>• Does not include a comparator<br>• Does not report risk of transmission of ARIs from patients to HCWs |

Abbreviations: ARI: acute respiratory infection; HCW: healthcare worker; MERS: Middle East respiratory syndrome; SARS: severe acute respiratory syndrome

### *2.1.3 Data Extraction*

For all included studies, year of publication, country, study design, population, aerosolizing procedure, period of evaluation, assessment of training and protective equipment, and number of

exposed and non-exposed cases were extracted in duplicate using standardized data extraction forms. Discrepancies between reviewers during data extraction were resolved through consensus.

#### *2.1.4 Data Analysis*

Due to limitations in the data of included studies, it was not possible to add the new included studies to the meta-analysis completed by CADTH. Results of these studies have been narratively synthesized, alongside results from the 2011 CADTH report.[1]

### 2.2 Results

Searches of electronic databases yielded 7,299 records. Following removal of duplicates, title and abstract of 5,284 records were screened. The full-texts of 59 records were screened, of which 2 records met inclusion/exclusion criteria (

Figure 1). The most common three reasons for exclusion at the full-text screening state were: intervention not of interest (n=21), outcome not of interest (n=13), and comparator not of interest (n=10) (Table of excluded studies, Appendix II).

Two prospective cohort studies were identified meeting inclusion criteria (

Table 3). One was conducted during the 2009 influenza A (H1N1) pandemic in Toronto, Canada at multiple acute care hospitals[2]; and, the other was conducted during a similar period in emergency departments and respiratory wards in nine hospitals in Beijing, China.[3]

Figure 1. Flow Chart of Included Studies

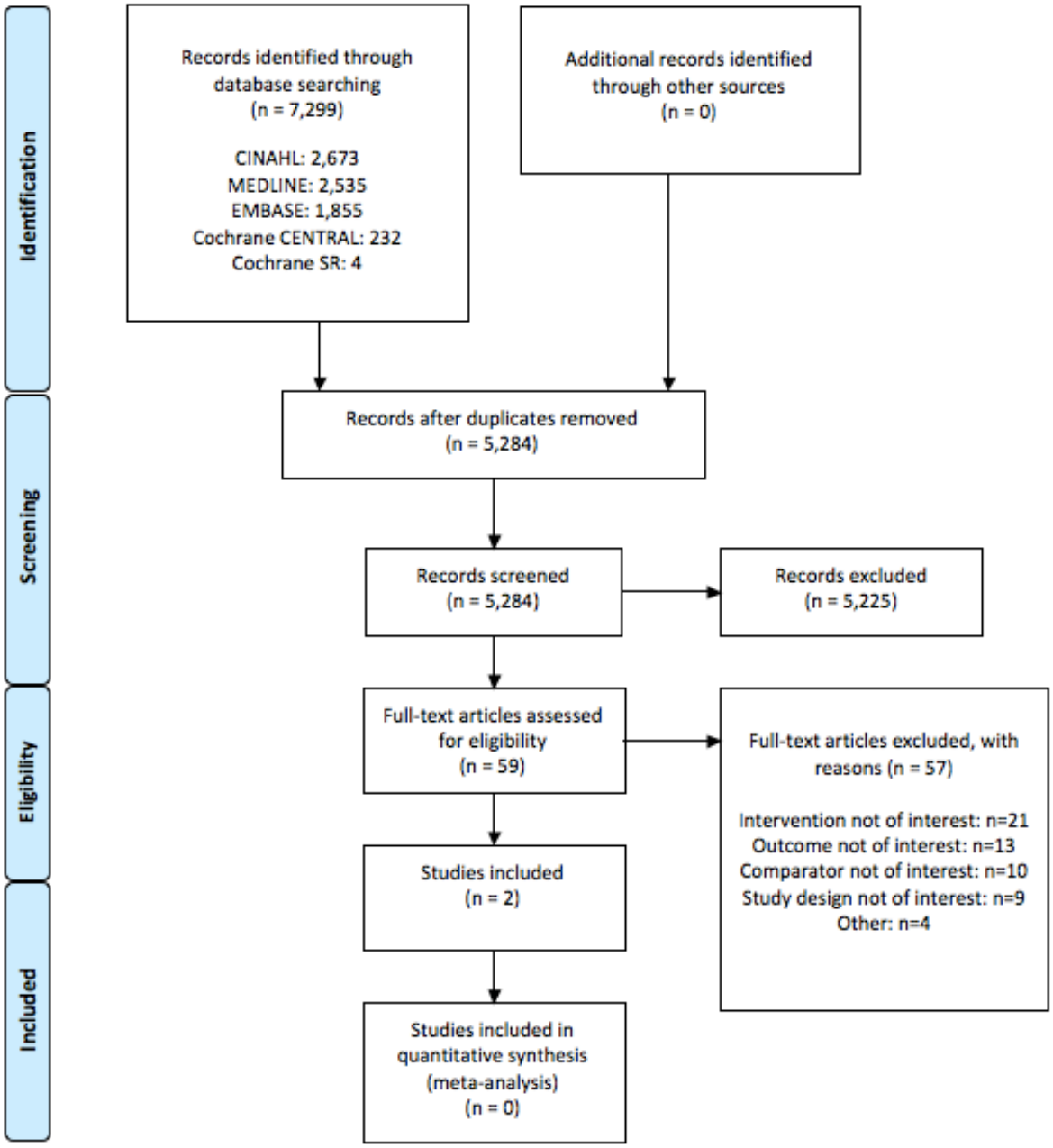

Table 3. Characteristics of studies included in update

| Study; Country | Design and Setting | Period of Evaluation | Population | Assessment of Training and Protection Equipment? | Laboratory Tests |
|---|---|---|---|---|---|
| Kuster et al.[2] 2013 | Prospective Cohort<br><br>Acute Care Hospitals | 2009 H1N1 pandemic in Toronto, Canada | 563 HCW 169 non-HCW | Adherence to hand hygiene and facial protection based on recommendations | Hemagglutination-inhibition assay to determine antibody titers against the A(H1N1)pdm09 strain (A/California/07/2009-like) and the 2008-09 seasonal A(H1N1) strain (A/Brisbane/59/07 |
| MacIntyre et al.,[3] 2014 | Prospective Cohort<br><br>Emergency and respiratory wards from nine hospitals | 1 December 2008 to 15 January 2009 in Beijing, China | 481 HCW | Hand washing, use of surgical masks or cloth masks (RR not reported), influenza vaccination | Viruses: *adenoviruses*, *human metapneumovirus*, *coronavirus* 229E/NL63 and OC43/HKU1, *parainfluenza virus* 1,2, and 3, *influenza virus* A and B, *respiratory syncytial virus* A and B, and *rhinovirus* A/B<br>Bacteria: *Streptococcus pneumoniae*, *Mycoplasma pneumoniae*, *B. pertussis*, *Legionella* spp, *Chlamydophilia* and *Haemophilus influenza*e type B |

The study conducted in Toronto defined aerosol-generating medical procedures as any one of the following: administration of nebulized therapy or humidified oxygen at >40% use of bag-valve mask, manual ventilation, non-invasive ventilation, open airway suctioning, bronchoscopy or other upper airway endoscopy, tracheostomy, endotracheal intubation, cardiopulmonary resuscitation, oscillatory ventilation, or any procedure that involved manipulation of open ventilatory tubing in a mechanically ventilated patient, or sputum induction or other deliberate induction of coughing.[2] In multivariate analysis adjusted for receipt of vaccine and dynamics of pandemic waves, Kuster et al. (2013)[2] found that performance or assistance with AGMP during the previous week was significantly associated with symptomatic influenza (adjusted OR: 2.29, 95% CI: 1.3 to 4.2).[2]

In the second study, conducted in Beijing China, AGMPs were defined as: provision of nebulizer medications, suctioning, intubation, aerosol-generating procedures, and chest physiotherapy.[3] MacIntyre et al. (2014)[3] measured transmission of clinical respiratory infections defined as: presence of two or more respiratory symptoms; or, one respiratory symptom and one or more systemic symptoms. Laboratory-confirmation of viruses included: adenoviruses, human metapneumoviruses, coronaviruses 229E/NL63 and OC43/HKU1, parainfluenza viruses 1, 2 and influenza viruses A and B, *respiratory syncytial virus* A and B, *rhinovirus* A/B; and, laboratory-confirmed bacteria, includesd *Streptococcus pneumoniae, Mycoplasma pneumonia, Bordatella pertussis, Legionalla* spp, *Chlamydophilia* and *Haemophilus influenzae* type B). Using Poisson regression, MacIntyre et al. (2014)[3] found that performance of AGMP was significantly associated with clinical respiratory infections ($p<0.01$), laboratory-confirmed virus or bacteria ($p=0.01$), and laboratory-confirmed virus ($p=0.05$).

### 2.3 Conclusions

Two studies were identified in this update of the 2011 CADTH systematic review. In the additional evidence identified, AGMPs were grouped. Hence, risk could not be attributed to individual procedures as it was in the 2011 CADTH report. Both additional studies concluded that the performance of AGMPs significantly increased risk of ARI transmission to HCWs. Analysis by Kuster et al. (2013)[2] suggests that the provision of assistance for AGMPs also carries risk of transmission.

The 2011 CADTH report appears to find no pattern to the procedures that are significantly associated with risk of transmission to healthcare workers.[1] Interpretation of these findings is complicated by variation across jurisdictions in: clinical care; availability of PPE; type of PPE; materials used for PPE; and individual use and fit of PPE for each procedure. In addition to these sources of variation, validity of estimates from meta-analysis in the 2011 CADTH report is threatened by the very low quality of evidence available.

Like the 2011 CADTH report, this update finds the presence of a significant research gap. Moreover, the generalizability of these findings to the current COVID-19 outbreak is unclear.

Further evidence is needed regarding the probability and types of infections following exposure, by type of procedure and PPE. This would enhance the transferability of lessons learnt from aerosol-generating medical procedures, whether from SARS, H1N1 or COVID-19.

## 2.4 References

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## Appendix I

## MEDLINE Final March 31 2020

1. exp Positive-Pressure Respiration/
2. exp High-Frequency Ventilation/
3. exp Ventilators, Mechanical/
4. Ventilation/
5. exp Intubation, Intratracheal/
6. Suction/
7. Tracheostomy/
8. Bronchoscopy/
9. Thoracostomy/
10. exp "Nebulizers and Vaporizers"/
11. Sputum/
12. Oxygen Inhalation Therapy/
13. Autopsy/
14. exp Respiratory Function Tests/
15. exp Spirometry/
16. exp Cardiopulmonary Resuscitation/
17. exp Respiration, Artificial/
18. exp Breathing Exercises/
19. Physical Therapy Modalities/ and Thorax/
20. (ventilation or ventilator or ventilating or ventilatory).ti,ab.
21. (respirator or respirators or respirat* support or respirat* care).ti,ab.
22. (intubation or intubated or extubation or extubated).ti,ab.
23. ((respiratory or airway or air way or open) adj3 suction*).ti,ab.
24. (nebulize* or nebulise* or aerosolize* or aerosolise*).ti,ab.
25. heat moisture exchange*.ti,ab.
26. (bronchoscopy or tracheostomy or thoracostomy).ti,ab.
27. (chest adj3 physiotherapy).ti,ab.
28. (sputum adj3 (induction or inducing)).ti,ab.

29. oxygen therap*.ti,ab.

30. (lung function test* or pulmonary function test*).ti,ab.

31. ((continuous or bilevel) adj2 (positive airway or positive pressure)).ti,ab.

32. (cardiopulmonary resuscitation or artificial resuscitation or artificial respiration).ti,ab.

33. (autopsy adj3 lung tissue*).ti,ab.

34. (bag adj1 mask*).ti,ab.

35. (ambu bag* or bag valve* or bvm).ti,ab.

36. (manual resuscitator* or self-inflating bag*).ti,ab.

37. ((nasopharyn* or nasal or nose or np or oropharyn* or OP) adj3 (culture* or smear* or specimen* or swab*)).ti,ab.

38. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37

39. Infectious Disease Transmission, Patient-to-Professional/

40. 38 and 39

41. exp Health Personnel/

42. (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*).ti,ab.

43. 41 or 42

44. Infectious Disease Transmission, Patient-to-Professional/

45. Occupational Exposure/

46. Air Microbiology/

47. Disease Transmission, Infectious/

48. infection control/ or infection control, dental/

49. exp Cross Infection/

50. Disease Outbreaks/

51. Aerosols/

52. ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc*or creat* or respirable range* or dispers* or transmission or

transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab.

53. cross-infection*.ti,ab.

54. 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53

55. 38 and 43 and 54

56. (aerosol* adj2 generat* adj2 procedure*).ti,ab.

57. 40 or 55 or 56

58. Influenza, Human/

59. exp Influenza A virus/

60. SARS Virus/

61. Severe Acute Respiratory Syndrome/

62. exp Coronavirus/

63. Coronavirus Infections/

64. exp Tuberculosis/

65. exp Pneumonia/

66. Coronaviridae Infections/

67. (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*).ti,ab.

68. (2019-nCoV* or 2019nCov* or coronavirus* or coronavirus 2 or coronavirus2* or corona or covid or covid-19 or covid19* or HCoV-19 or novel coronavirus* or ncov or SARS2 or SARS-COV-2* or SARS-COV2* or SARSCov or SARSCoV-2* or SARSCoV2* or Wuhan pneumonia or Wuhan virus).ti,ab,kf.

69. 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68

70. 43 and 54 and 69

71. 57 or 70

72. limit 71 to (english or french)

73. limit 72 to yr="2011 -Current"

74. animals/ not humans/

75. 73 not 74

76. limit 75 to (editorial or letter)

77. 75 not 76

78. limit 77 to "review articles"

79. 77 not 78

80. limit 77 to "systematic review"

81. limit 77 to meta analysis

82. ((systematic or critical) adj1 (review* or overview* or synthesis)).ti,ab.

83. 77 and 82

84. 79 or 80 or 81 or 83

85. limit 84 to case reports

86. 84 not 85

87. limit 86 to comment

88. 86 not 87

**EMBASE Final March 31 2020**

1. positive end expiratory pressure/

2. exp High-Frequency Ventilation/

3. intermittent positive pressure ventilation/

4. endotracheal intubation/

5. endotracheal intubation/

6. Suction/

7. Tracheostomy/ or tracheobronchial toilet/

8. Bronchoscopy/

9. thorax drainage/

10. nebulization/ or exp nebulizer/

11. Sputum/ or sputum analysis/ or sputum examination/

12. Oxygen Therapy/

13. Autopsy/

14. exp lung function test/

15. exp lung function test/

16. resuscitation/

17. artificial ventilation/

18. exp Breathing Exercise/
19. (ventilation or ventilator or ventilating or ventilatory).ti,ab.
20. (respirator or respirators or respirat* support or respirat* care).ti,ab.
21. (intubation or intubated or extubation or extubated).ti,ab.
22. ((respiratory or airway or air way or open) adj3 suction*).ti,ab.
23. (nebulize* or nebulise* or aerosolize* or aerosolise*).ti,ab.
24. heat moisture exchange*.ti,ab.
25. (bronchoscopy or tracheostomy or thoracostomy).ti,ab.
26. (chest adj3 physiotherapy).ti,ab.
27. (sputum adj3 (induction or inducing)).ti,ab.
28. oxygen therap*.ti,ab.
29. (lung function test* or pulmonary function test*).ti,ab.
30. ((continuous or bilevel) adj2 (positive airway or positive pressure)).ti,ab.
31. (cardiopulmonary resuscitation or artificial resuscitation or artificial respiration).ti,ab.
32. (autopsy adj3 lung tissue*).ti,ab.
33. (bag adj1 mask*).ti,ab.
34. (ambu bag* or bag valve* or bvm).ti,ab.
35. (manual resuscitator* or self-inflating bag*).ti,ab.
36. ((nasopharyn* or nasal or nose or np or oropharyn* or OP) adj3 (culture* or smear* or specimen* or swab*)).ti,ab.
37. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36
38. exp Health Care Personnel/
39. (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*).ti,ab.
40. 38 or 39
41. *Occupational Exposure/
42. *airborne infection/ or *hospital infection/

43. *virus transmission/ or *bacterial transmission/

44. *infection control/

45. exp *Cross Infection/

46. *Disease transmission/

47. Aerosol/

48. ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc*or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab.

49. cross-infection*.ti,ab.

50. 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49

51. 37 and 40 and 50

52. (aerosol* adj2 generat* adj2 procedure*).ti,ab.

53. 51 or 52

54. *Influenza/ or *influenza virus/

55. *Parainfluenza virus infection/

56. *Severe Acute Respiratory Syndrome/

57. *tuberculosis/ or *lung tuberculosis/ or *drug resistant tuberculosis/

58. *streptococcus pneumoniae/ or *pneumonia/ or *Respiratory syncytial pneumovirus/

59. exp *coronavirus infection/ or exp *coronavirinae/

60. (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*).ti,ab.

61. (2019-nCoV* or 2019nCov* or coronavirus* or coronavirus 2 or coronavirus2* or corona or covid or covid-19 or covid19* or HCoV-19 or novel coronavirus* or ncov or SARS2 or SARS-COV-2* or SARS-COV2* or SARSCov or SARSCoV-2* or SARSCoV2* or Wuhan pneumonia or Wuhan virus).ti,ab,kw.

62. 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61

63. 40 and 50 and 62

64. 53 or 63

65. limit 64 to (english or french)

66. limit 65 to yr="2011 -Current"

67. animals/ not human/

68. 66 not 67

69. limit 68 to conference abstract

70. 68 not 69

71. limit 70 to "review"

72. 70 not 71

73. limit 70 to (meta analysis or "systematic review")

74. ((systematic or crtical) adj1 (review* or overview* or synthesis)).tw.

75. 70 and 74

76. 72 or 73 or 75

77. case report/

78. 76 not 77

79. limit 78 to embase

**EBM Cochrane Database of Systematic Reviews March 31 2020**

1. (ventilation or ventilator or ventilating or ventilatory).ti,ab.

2. (respirator or respirators or respirat* support or respirat* care).ti,ab.

3. (intubation or intubated or extubation or extubated).ti,ab.

4. ((respiratory or airway or air way or open) adj3 suction*).ti,ab.

5. (nebulize* or nebulise* or aerosolize* or aerosolise*).ti,ab.

6. heat moisture exchange*.ti,ab.

7. (bronchoscopy or tracheostomy or thoracostomy).ti,ab.

8. (chest adj3 physiotherapy).ti,ab.

9. (sputum adj3 (induction or inducing)).ti,ab.

10. oxygen therap*.ti,ab.

11. (lung function test* or pulmonary function test*).ti,ab.

12. ((continuous or bilevel) adj2 (positive airway or positive pressure)).ti,ab.

13. (cardiopulmonary resuscitation or artificial resuscitation or artificial respiration).ti,ab.

14. (autopsy adj3 lung tissue*).ti,ab.

15. (bag adj1 mask*).ti,ab.

16. (ambu bag* or bag valve* or bvm).ti,ab.
17. (manual resuscitator* or self-inflating bag*).ti,ab.
18. ((nasopharyn* or nasal or nose or np or oropharyn* or OP) adj3 (culture* or smear* or specimen* or swab*)).ti,ab.
19. (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*).ti,ab.
20. ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc*or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab.
21. cross-infection*.ti,ab.
22. (aerosol* adj2 generat* adj2 procedure*).ti,ab.
23. (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*).ti,ab.
24. (2019-nCoV* or 2019nCov* or coronavirus* or coronavirus 2 or coronavirus2* or corona or covid or covid-19 or covid19* or HCoV-19 or novel coronavirus* or ncov or SARS2 or SARS-COV-2* or SARS-COV2* or SARSCov or SARSCoV-2* or SARSCoV2* or Wuhan pneumonia or Wuhan virus).ti,ab.
25. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
26. 20 or 21
27. 19 and 25 and 26
28. 22 or 27
29. 23 or 24
30. 19 and 26 and 29
31. 28 or 30

**EBM Cochrane CENTRAL Register March 31 2020**

1. exp Positive-Pressure Respiration/

2. exp High-Frequency Ventilation/
3. exp Ventilators, Mechanical/
4. Ventilation/
5. exp Intubation, Intratracheal/
6. Suction/
7. Tracheostomy/
8. Bronchoscopy/
9. Thoracostomy/
10. exp "Nebulizers and Vaporizers"/
11. Sputum/
12. Oxygen Inhalation Therapy/
13. Autopsy/
14. exp Respiratory Function Tests/
15. exp Spirometry/
16. exp Cardiopulmonary Resuscitation/
17. exp Respiration, Artificial/
18. exp Breathing Exercises/
19. Physical Therapy Modalities/ and Thorax/
20. (ventilation or ventilator or ventilating or ventilatory).ti,ab.
21. (respirator or respirators or respirat* support or respirat* care).ti,ab.
22. (intubation or intubated or extubation or extubated).ti,ab.
23. ((respiratory or airway or air way or open) adj3 suction*).ti,ab.
24. (nebulize* or nebulise* or aerosolize* or aerosolise*).ti,ab.
25. heat moisture exchange*.ti,ab.
26. (bronchoscopy or tracheostomy or thoracostomy).ti,ab.
27. (chest adj3 physiotherapy).ti,ab.
28. (sputum adj3 (induction or inducing)).ti,ab.
29. oxygen therap*.ti,ab.
30. (lung function test* or pulmonary function test*).ti,ab.
31. ((continuous or bilevel) adj2 (positive airway or positive pressure)).ti,ab.
32. (cardiopulmonary resuscitation or artificial resuscitation or artificial respiration).ti,ab.

33. (autopsy adj3 lung tissue*).ti,ab.

34. (bag adj1 mask*).ti,ab.

35. (ambu bag* or bag valve* or bvm).ti,ab.

36. (manual resuscitator* or self-inflating bag*).ti,ab.

37. ((nasopharyn* or nasal or nose or np or oropharyn* or OP) adj3 (culture* or smear* or specimen* or swab*)).ti,ab.

38. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37

39. Infectious Disease Transmission, Patient-to-Professional/

40. 38 and 39

41. exp Health Personnel/

42. (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*).ti,ab.

43. 41 or 42

44. Infectious Disease Transmission, Patient-to-Professional/

45. Occupational Exposure/

46. Air Microbiology/

47. Disease Transmission, Infectious/

48. infection control/ or infection control, dental/

49. exp Cross Infection/

50. Disease Outbreaks/

51. Aerosols/

52. ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc*or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab.

53. cross-infection*.ti,ab.

54. 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53

55. 38 and 43 and 54
56. (aerosol* adj2 generat* adj2 procedure*).ti,ab.
57. 40 or 55 or 56
58. Influenza, Human/
59. exp Influenza A virus/
60. SARS Virus/
61. Severe Acute Respiratory Syndrome/
62. exp Coronavirus/
63. Coronavirus Infections/
64. exp Tuberculosis/
65. exp Pneumonia/
66. Coronaviridae Infections/
67. (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*).ti,ab.
68. (2019-nCoV* or 2019nCov* or coronavirus* or coronavirus 2 or coronavirus2* or corona or covid or covid-19 or covid19* or HCoV-19 or novel coronavirus* or ncov or SARS2 or SARS-COV-2* or SARS-COV2* or SARSCov or SARSCoV-2* or SARSCoV2* or Wuhan pneumonia or Wuhan virus).ti,ab.
69. 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68
70. 43 and 54 and 69
71. 57 or 70
72. limit 71 to (english or french)
73. limit 72 to yr="2011 -Current"
74. animals/ not humans/
75. 73 not 74

**CINAHL Search March 31 2020**

1. ((MH "Positive Pressure Ventilation") OR (MH "Intermittent Positive Pressure Ventilation") OR (MH "Continuous Positive Airway Pressure") OR (MH "Ventilation, High Frequency") OR (MH "Ventilators, Mechanical") OR (MH "Ventilation, Mechanical, Differentiated") OR

(MH "Ventilation") OR (MH "Suction") OR (MH "Tracheostomy") OR (MH "Bronchoscopy") OR (MH "Thoracostomy") OR (MH "Nebulizers and Vaporizers") OR (MH "Sputum") OR (MH "Oxygen Therapy") OR (MH "Autopsy") OR (MH "Respiratory Function Tests+") OR (MH "Spirometry") OR (MH "Resuscitation, Cardiopulmonary") OR (MH "Respiration, Artificial") OR (MH "Breath Tests") OR (MH "Breathing Exercises") ) OR TI ( Ventilat* or respirat* or intubat* or extubat* or nebulize* or nebulise* or aerosolize* or aerosolise* or heat moisture exchange* or bronchoscopy or tracheostomy or thoracostomy or oxygen therap* or lung function test* or pulmonary function test* or cardiopulmonary resuscitation or artificial resuscitation or artificial respiration or ambu bag* or bag valve* or bvm or manual resuscitator* or self-inflating bag* ) OR AB ( Ventilat* or respirat* or intubat* or extubat* or nebulize* or nebulise* or aerosolize* or aerosolise* or heat moisture exchange* or bronchoscopy or tracheostomy or thoracostomy or oxygen therap* or lung function test* or pulmonary function test* or cardiopulmonary resuscitation or artificial resuscitation or artificial respiration or ambu bag* or bag valve* or bvm or manual resuscitator* or self-inflating bag* )

2. TI ( (nasopharyn* or nasal or nose or np or oropharyn* or OP) N3 (culture* or smear* or specimen* or swab*) ) OR AB ( (nasopharyn* or nasal or nose or np or oropharyn* or OP) N3 (culture* or smear* or specimen* or swab*) )
3. TI ( (respiratory or airway or air way or open) N3 suction* ) OR AB ( (respiratory or airway or air way or op
5. TI chest N3 physiotherapy OR AB chest N3 physiotherapy
6. TI ( sputum N3 (induction or inducing) ) OR AB ( sputum N3 (induction or inducing) )
7. TI ( (continuous or bilevel) N2 (positive airway or positive pressure) ) OR AB ( (continuous or bilevel) N2 (positive airway or positive pressure) )
8. TI autopsy N3 lung tissue* OR AB autopsy N3 lung tissue*
9. TI bag n1 mask* OR AB bag n1 mask*
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. (MH "Disease Transmission, Patient-to-Professional")
12. 10 and 11
13. MH "Health Personnel+") OR TI ( (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital

worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*) ) OR AB ( (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*) )

14. (MH "Occupational Exposure") OR (MH "Air Microbiology") OR (MH "Disease Transmission, Patient-to-Professional") OR (MH "Infection Control") OR (MH "Disease Transmission") OR (MH "Cross Infection") OR (MH "Disease Outbreaks") ) OR TI ( ((aerosol* or cough* or droplet* or infection* or infectious or disease*) N3 (generat* or induc* or stimulat* or produc*or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)) ) OR AB ( ((aerosol* or cough* or droplet* or infection* or infectious or disease*) N3 (generat* or induc* or stimulat* or produc*or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)) ) OR TI cross-infection* OR AB cross-infection*
15. 10 and 13 and 14
16. 12 or 15
17. TI aerosol* N2 generat* N2 procedure* OR AB aerosol* N2 generat* N2 procedure*
18. 16 or 17
19. (MH "Influenza, Human") OR (MH "Influenza A H5N1") OR (MH "Influenza A Virus") OR (MH "Influenza, Pandemic (H1N1) 2009") OR (MH "Influenza, Seasonal") OR (MH "SARS Virus") OR (MH "Influenza A Virus, H1N1 Subtype") OR (MH "Influenza A Virus, H5N1 Subtype") OR (MH "Severe Acute Respiratory Syndrome") OR (MH "Respiratory Distress Syndrome, Acute") OR (MH "Respiratory Distress Syndrome") OR (MH "Coronavirus") OR (MH "Coronavirus Infections") OR (MH "Tuberculosis") OR (MH "Pneumonia+") OR (MH "Coronaviridae Infections") ) OR TI ( (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*) ) OR AB ( (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*) ) OR TI ( (2019-nCoV*

or 2019nCov* or coronavirus* or coronavirus 2 or coronavirus2* or corona or covid or covid-19 or covid19* or HCoV-19 or novel coronavirus* or ncov or SARS2 or SARS-COV-2* or SARS-COV2* or SARSCov or SARSCoV-2* or SARSCoV2* or Wuhan pneumonia or Wuhan virus) ) OR AB ( (2019-nCoV* or 2019nCov* or coronavirus* or coronavirus 2 or coronavirus2* or corona or covid or covid-19 or covid19* or HCoV-19 or novel coronavirus* or ncov or SARS2 or SARS-COV-2* or SARS-COV2* or SARSCov or SARSCoV-2* or SARSCoV2* or Wuhan pneumonia or Wuhan virus) )

20. 13 and 18 and 19
21. 18 or 20
22. **Limiters** - Published Date: 20110101-20201231; Scholarly (Peer Reviewed) Journals
23. **Narrow by Language:** - English

## Appendix II

| Author (Year) | Reason for Exclusion |
|---|---|
| Anonymous (2011)[4] | Other |
| Baig et al. (2015)[5] | Study design not of interest |
| Bhadelia et al. (2013)[6] | Study design not of interest |
| Bien et al. (2016)[7] | Study design not of interest |
| Bischoff et al. (2013)[8] | Intervention not of interest |
| Chan et al. (2018)[9] | Comparator not of interest |
| Chin et al. (2014)[10] | Outcome not of interest |
| Chughtai et al. (2016)[11] | Outcome not of interest |
| Chung et al. (2015)[12] | Outcome not of interest |
| Cummings et al. (2014)[13] | Study design not of interest |
| De Perio et al. (2014)[14] | Intervention not of interest |
| De Vries et al. (2017)[15] | Intervention not of interest |
| Du et al. (2012)[16] | Intervention not of interest |
| Hui et al. (2013)[17] | Comparator not of interest |
| Hui et al. (2014)[18] | Intervention not of interest |
| Ito et al. (2016)[19] | Intervention not of interest |
| Jones et al. (2018)[20] | Intervention not of interest |
| Kim et al. (2016)[21] | Comparator not of interest |
| Kim et al. (2015)[22] | Outcome not of interest |
| Kim et al. (2015)[23] | Outcome not of interest |
| Kim et al. (2013)[24] | Intervention not of interest |
| King et al. (2015)[25] | Intervention not of interest |
| Kulkarni et al. (2016)[26] | Other |
| Lee et al. (2015)[27] | Study design not of interest |
| MacIntyre et al. (2017)[28] | Intervention not of interest |
| MacIntyre et al. (2014)[29] | Study design not of interest |
| Memish et al. (2018)[30] | Intervention not of interest |
| Mitchell et al. (2012)[31] | Outcome not of interest |
| Moon et al. (2019)[32] | Comparator not of interest |
| Morilla et al. (2018)[33] | Comparator not of interest |
| Na et al. (2016)[34] | Outcome not of interest |
| Nam et al. (2017)[35] | Comparator not of interest |
| O'Neil et al. (2017)[36] | Other |
| Offeddu et al. (2017)[37] | Intervention not of interest |
| Pedrosa et al. (2011)[38] | Intervention not of interest |
| Ricard et al. (2011)[39] | Comparator not of interest |
| Rule et al. (2018)[40] | Outcome not of interest |
| Sayed et al. (2011)[41] | Intervention not of interest |
| Schmidt et al. (2018)[42] | Intervention not of interest |
| Schubert et al. (2019)[43] | Intervention not of interest |
| Schwarz et al. (2019)[44] | Intervention not of interest |
| Seto (2015)[45] | Study design not of interest |

| | |
|---|---|
| Seto et al. (2013)[46] | Study design not of interest |
| Seto et al. (2011)[47] | Intervention not of interest |
| Shin et al. (2017)[48] | Outcome not of interest |
| Shiu et al. (2020)[49] | Intervention not of interest |
| Suen et al. (2017)[50] | Outcome not of interest |
| Thompson et al. (2013)[51] | Outcome not of interest |
| Tran et al. (2013)[52] | Other |
| Tran et al. (2012)[53] | Other |
| Tsai et al. (2015)[54] | Outcome not of interest |
| Tudor et al. (2014)[55] | Intervention not of interest |
| Uden et al. (2017)[56] | Intervention not of interest |
| Weber et al. (2019)[57] | Outcome not of interest |
| Zietsman et al. (2019)[58] | Comparator not of interest |
| Zumla et al. (2014)[59] | Comparator not of interest |
| Zuo et al. (2020)[60] | Comparator not of interest |