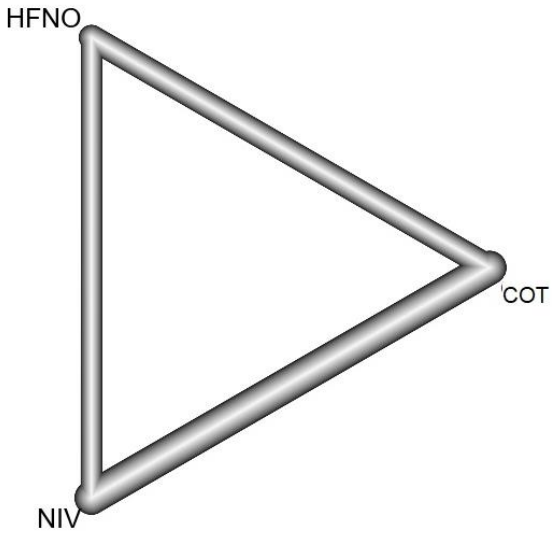
**SUPPLEMENTARY MATERIAL**

**Noninvasive respiratory support after extubation.**
**A systematic review and network meta-analysis**

**Supplementary figure 1. Network diagram for the primary outcome (reintubation).**




***Abbreviations:*** COT, conventional oxygen therapy; HFNO, high flow nasal oxygen; NIV, noninvasive ventilation.

**Supplementary table 1. PRISMA checklist.**

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a systematic review. | 1 |
| **ABSTRACT** | | | |
| Abstract | 2 | See the PRISMA 2020 for Abstracts checklist. | 3 |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. | 4 |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | 5 |
| **METHODS** | | | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | 6 |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | 6 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | 6, Figure 1, SM1-2 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | 7 |
| Data collection process | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | 7 |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | 7, SM 3 |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | 7 |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | 7-8, Figure 2, SM 4 |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | 8-9 |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | 8-9 |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary | 8-9 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | | statistics, or data conversions. | |
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | 8-9 |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | 8-9 |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). | 8-9 |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | 8-9 |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | 7-8, SM 4 |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | 7-9 |
| **RESULTS** | | | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | 9-10, Figure 1 |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | 9-10 |
| Study characteristics | 17 | Cite each included study and present its characteristics. | 9-10, SM 3 |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. | SM 4, Figure 2 |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | 10-12 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | 10-12 |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | Table 1, SM 5-7, Figure 3 |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. | Table 1, SM 5-7 |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | SM 5-7, Figure 4 |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | 10-12 |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | 10-12 |
| **DISCUSSION** | | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. | 12-14 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | 23b | Discuss any limitations of the evidence included in the review. | 14-15 |
| | 23c | Discuss any limitations of the review processes used. | 14-15 |
| | 23d | Discuss implications of the results for practice, policy, and future research. | 12-14 |
| **OTHER INFORMATION** | | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | 2 |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | - |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. | - |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | 2 |
| Competing interests | 26 | Declare any competing interests of review authors. | 1 |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | - |

***References:*** *[28-30]*

**Supplementary table 2. Electronic Search Strategies.**

A computerized **Pubmed/MEDLINE** search (from inception until June 20, 2022) was conducted using the following medical subjects headings:

1) positive pressure ventilation.mp.
2) positive pressure ventilation.tw.
3) bipap.mp.
4) bipap.tw.
5) face mask.mp.
6) face mask.tw.
7) helmet.tw.
8) helmet.mp.
9) nasal cannu*.mp.
10) nasal cannu*.tw.
11) 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
12) extubation.mp.
13) extubation.tw.
14) wean*.mp.
15) wean*.tw.
16) liberation.mp.
17) liberation.tw.
18) 12 or 13 or 14 or 15 or 16 or 17
19) 11 and 18

**Results: 1314**

In addition, we searched other 4 databases using the following keywords:

- **Embase** (see PubMed/MEDLINE)

**Results: 3611**

- **Cochrane CENTRAL**

(positive pressure ventilation) or (bipap) or (face mask) or (helmet) or (nasal cannu*) in All Text

AND (extubation) or (wean*) or (liberation) in All Text

**Results: 1728**

- **Scopus**

((positive AND pressure AND ventilation) OR (bipap) OR (face AND mask) OR (helmet) OR (nasal AND cannu*)) AND ((extubation) OR (wean*) OR (liberation))

**Results: 5465**

- **Web of Science**

((positive AND pressure AND ventilation) OR (bipap) OR (face AND mask) OR (helmet) OR (nasal AND cannu*)) AND ((extubation) OR (wean*) OR (liberation))

**Results: 2480**

The network analysis was prospectively registered on prospective register (ResearchRegistry, London, UK; reference: reviewregistry1435), and then on PROSPERO (CRD42022361671).

**Supplementary table 3: Detailed characteristics of the 33 studies included in the qualitative analysis.**

| Author, year | Journal | Subgroups | Setting | Indication | Inclusion criteria | Main exclusion criteria | Treatments (*N*) | Principal outcomes | Overall population *(N)* | Age (mean) | M (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Al Jaaly 2013 [55] | J ThoracCardiovascSurg | Post-surgical | ICU | Prophylactic | Adult; first cardiopulmonary bypass | Emergency Surgery; renal impairment; hepatic or hematologic disease; poor left ventricular function; chronic infection | NIV (66); COT (63) | Discharge; atelectasis; ICU LOS; hospital LOS | 129 | 67.7 | |
| Cho 2020 [44] | J Korean Med Sci | High-risk* (Age > 65; APACHE II > 12; Obesity; Poor expectoration; Difficult or prolonged weaning; Multiple comorbidities) | ICU | Prophylactic | Adult; IMV > 12hrs; * | | HFNO (31); COT (29) | Reintubation; ICU/H LOS; mortality; time to reintubation | 60 | 77.9 | 63.3 |
| Corley 2015 [45] | Intensive Care Med | Post-surgical | ICU | Prophylactic | Adult; BMI > 30; elective cardiopulmonary bypass | IMV > 36hrs; extubation into NIV; tracheostomy; palliative cure | HFNO (81); COT (74) | Reintubation; respiratory complications; ICU LOS | 155 | 64 | 73.5 |
| Esteban 2004 [56] | N Engl J Med | Low-risk | ICU | Treatment | Adult; IMV > 48hrs; ARF post-extubation | Tracheostomy | NIV (114); COT (107) | Reintubation; H mortality; ICU LOS | 221 | 59.5 | 57.5 |
| Fernandez 2017 [46] | Ann Intensive Care | High-risk* (Age > 65; APACHE II > 12; Obesity; Poor expectoration; Difficult or prolonged weaning; Multiple comorbidities) | ICU | Prophylactic | Adult; IMV > 12hrs; * | Tracheostomy; do-Not-Reintubate order; hypercapnia during SBT | HFNO (78); COT (77) | ARF within 72hrs; reintubation; ICU/H LOS; mortality | 155 | 68.5 | 65.2 |
| Ferrer 2006 [57] | Am J Respir Crit Care Med | High-risk* (Age > 65; APACHE II > 12; cardiac failure as cause of intubation) | ICU | Prophylactic | Adult; IMV > 48hrs; * | Tracheostomy; facial/cranial trauma or surgery; recent gastric or esophageal surgery; active upper GI bleeding; excessive respiratory secretions; do-not-resuscitate order | NIV (79); COT (83) | Reintubation; ARF; H mortality; ICU LOS | 162 | 71 | 71 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ferrer 2009 [58] | Lancet | High-risk | ICU | Prophylactic | Adult; chronic respiratory disorders; IMV > 48hrs; hypercapnic respiratory failure on SBT | Tracheostomy; facial/cranial trauma or surgery; recent gastric or esophageal surgery; active upper GI bleeding; excessive respiratory secretions; do-not-resuscitate order | NIV (54); COT (52) | Reintubation; ARF; H mortality; ICU LOS | 106 | 68.5 | 75.5 |
| Hernandez 2016 (High) [50] | JAMA | High-risk* (Age > 65; APACHE II > 12; heart failure as primary indication for IMV; moderate-severe COPD; BMI > 30; airway patency concern) | ICU | Prophylactic | Adult; IMV > 12hrs; * | Tracheostomy; do-not-resuscitate orders; hypercapnia during the SBT; accidental extubation; self-extubation | HFNO (290); NIV (314) | Reintubation; ICU/H LOS; mortality; time to reintubation | 604 | 64.5 | 64.2 |
| Hernandez 2016 (Low) [47] | JAMA | Low-risk | ICU | Prophylactic | Adult; IMV > 12hrs; 'low risk' features (Age < 65 years; absence of heart failure as primary indication; APACHE II < 12; BMI < 30; no COPD; no airway patency concerns; managing secretions) | Tracheostomy; do-not-resuscitate orders; hypercapnia during the SBT; accidental extubation; self-extubation | HFNO (264); COT (263) | Reintubation; ICU/H LOS; mortality; time to reintubation | 527 | 51.4 | 60.2 |
| Hu 2020 [71] | Int J of Gerontology | High-risk* (age > 65 years, CHF, COPD, severe pulmonary pathology, CKD ect) | ICU | Prophylactic | Adult; IMV > 48hrs ; * | Tracheotomy, pregnancy, facial trauma, acute gastrointestinal bleeding. | HFNO (29); COT (27) | ARF within 72 hours; switch rescue devices; reintubation | 56 | 73.9 | 69.6 |
| Jaber 2016 [59] | JAMA | Post-surgical | ICU | Treatment | Adult; elective or nonelective abdominal surgery; ARF within 7 days | Palliative care, sleep apnea syndrome; immediate intubation; emergent surgery needed | NIV (150); COT (150) | Reintubation; infection rate; ventilator-free days; ICU LOS | 300 | 63.4 | 76.5 |
| Jing 2019 [54] | Res Nurs Health | High-risk | ICU | Prophylactic | Adult; COPD exacerbation and hypercapnia | Tracheostomy; severe dysfunction of other organs; hemodynamic instability; facial injury, burns or | NIV (22); HFNO (20) | ICU LOS; patient comfort; reintubation | 42 | 75.7 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | deformities; uncooperative; copious secretions; weak cough; rhinitis | | | | | |
| Keenan 2002 [60] | JAMA | High-risk | ICU | Treatment | Adult; IMV > 48hrs or history of CHF or chronic lung disease; ARF post-extubation | Do-Not-Resuscitate order; Prior obstructive sleep apnea; cervical spine injury; upper airway obstruction | NIV (39); COT (42) | Reintubation; ICU/H LOS; hospital mortality | 81 | 68.5 | |
| Khilnani 2011 [61] | Anaesth Intensive Care | High-risk | ICU | Prophylactic | Adult; IMV > 48 hrs; COPD exacerbation and hypercapnia | Tracheostomy; cardiopulmonary instability; copious secretions; prior reintubation during current admission | NIV (20); COT (20) | Reintubation; H LOS | 40 | 60.2 | |
| Kindgen-Milles 2005 [62] | Chest | Post-surgical | ICU | Prophylactic | Adult; elective thoraco-abdominal aortic surgery | Emphysema; glucocorticoid treatment; IMV > 48hrs | NIV (25); COT (25) | Respiratory complications; re-intubation; ICU/H LOS | 50 | 66.5 | 58 |
| Maggiore 2014 [26] | Am J Respir Crit Care Med | Hypoxemic | ICU | Prophylactic | Adult; IMV > 24hrs; $PaO_2/FiO_2$ < 300 | Pregnancy; Tracheostomy; do-Not-Intubate status; planned use of NIV after extubation | HFNO (53); COT (52) | Oxygenation; patient discomfort; reintubation | 105 | 64.5 | 64.8 |
| Maggiore 2022 [42] | American J of Respir and Crit Care Med | Hypoxemic | ICU | Prophylactic | Adult; IMV > 48hrs; $PaO_2/FiO_2$ < 300 | Tracheostomy; Pregnancy; planned use of NIV after extubation | HFNO (242); COT (250) | Reintubation; ICU/H LOS; ICU/H mortality; time to reintubation | 492 | 62.5 | 68 |
| Matsuda 2020 [24] | Respir Care | Hypoxemic | ICU | Treatment | Adult; IMV >24hrs; $PaO_2/FiO_2$ < 300 | Tracheostomy; do-not-intubate order; pregnancy; Pneumothorax | HFNO (30); COT (39) | Reintubation; ICU LOS | 69 | 71.4 | 71 |
| Mohamed 2013 [63] | Egypt J Chest Dis Tuberc | Low-risk | ICU | Prophylactic | Adult; IMV > 48hrs; | Tracheostomy; facial or cranial trauma or surgery; recent abdominal surgery; active upper | NIV (60); COT (60) | Reintubation | 120 | 66.5 | 60.8 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | gastrointestinal bleeding; excessive amount of respiratory secretions | | | | | |
| Nava 2005 [8] | Crit Care Med | High-risk* (chronic heart failure, hypercapnia, more than one comorbidity, weak cough, upper airway stridor) | ICU | Prophylactic | Adult; IMV > 48hrs; * | Inability to protect airway; swallowing difficulty; cervical spine injury; neuromuscular disease; agitated/uncooperative; anatomical abnormalities; BMI > 30 | NIV (48); COT (49) | Reintubation; H mortality; ICU/H LOS | 97 | 54.6 | 62.9 |
| Ornico 2013 [64] | Crit Care | Low-risk | ICU | Prophylactic | Adult; IMV > 72hrs | Pregnancy | NIV (20); COT (20) | Reintubation; mortality; ICU LOS | 40 | 49.9 | 68.4 |
| Sahin 2018 [70] | Canadian Respiratory Journal | Post-surgical | ICU | Prophylactic | Adult; BMI > 30 cardiopulmonary bypass | Hemodynamic instability, tracheostomy, obstructive sleep apnea, active pulmonary disease, low cardiac output, emergency surgery | HFNO (50); COT (50) | Reintubation, ICU/H LOS; respiratory complications; extrapulmonary complications; mortality | 100 | 61 | 36 |
| Song 2017 [48] | Clinics (São Paulo) | Low-risk | ICU | Prophylactic | Adult; IMV > 48hrs | Pregnancy; poor cooperation; tracheostomy | HFNO (30); COT (30) | ARF within 24hrs; patient discomfort; reintubation | 60 | 68.5 | 56.7 |
| Su 2012 [65] | Respir Care | Low-risk | ICU | Prophylactic | Adult; IMV > 48hrs | Tracheostomy | NIV (202); COT (204) | Reintubation; ICU mortality | 406 | 63.9 | 60.8 |
| Tan 2020 [51] | Crit Care | High-risk | ICU | Prophylactic | Adult (< 85 years); COPD exacerbation with hyoercapnia; broncho-pulmonary infection | Contraindications to NIV; palliative care; heart, brain, liver, or kidney failure; tracheostomy; weak cough | HFNO (48); NIV (48) | ARF; reintubation; mortality; ICU/H LOS | 96 | 69.9 | 58.1 |
| Thanthitaweewat 2018 [66] | Indian J Crit Care Med | Low-risk | ICU | Prophylactic | Adult; IMV > 48hrs; | Tracheostomy; previous intubation in the current admission; | NIV (29); COT (29) | Reintubation; respiratory | 58 | 63.1 | 67.2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | COPD exacerbation or CHF | | complications; ICU/H LOS | | | |
| Theerawit 2020 [52] | J Crit Care | High-risk* (2nd or more SBT; ineffective cough; chronic heart failure; APACHE II > 12; upper airway obstruction) | ICU | Prophylactic | Adult; IMV > 48hrs; * | Coma; inability to protect the airway; cervical spine injury; neuromuscular diseases; anatomical abnormalities affecting mask fit; planned use of NIV | HFNO (71); CPAP (69) *(included in NIV group)* | Reintubation; mortality; patient comfort; time to reintubation | 140 | 69.7 | 45 |
| Theologou 2021 [49] | J. Clin. Med. | Post-surgical/Hypoxiemic | ICU | Prophylactic | Adult; cardiac surgery; $PaO_2/FiO_2$ < 200 | OSAS; exacerbation of COPD; tracheostomy; do-not-resuscitate; GCS < 13; language visual and hearing impairment | HFNO (33); COT (33) | ARF within 48h; reintubation; ICU/H LOS ICU or in-hospital mortality; patient discomfort | 66 | 67.2 | 68.2 |
| Thille 2019 [33] *(excluded from quantitative analysis)* | JAMA | High-risk* (>65 years; underlying chronic cardiac or lung disease) | ICU | - | Adult; IMV > 24hrs; * | Long-term treatment with NIV or CPAP at home; contraindication to NIV; chronic neuromuscular disease; unplanned extubation | HFNO (306); HFNO + NIV (342) | Reintubation; reintubation; ICU/H LOS; mortality | 648 | 69.5 | 66.3 |
| Tongyoo 2021 [53] | Ann Intensive Care | Low-risk | ICU | Prophylactic | Adult; IMV > 48hrs; Sepsis-3 criteria for sepsis/septic shock | Tracheostomy; do-not-intubate order; unplanned extubation | HFNO (112); NIV (110) | Reintubation; ICU/H LOS; mortality; time to reintubation | 222 | 62.8 | 54.5 |
| Vargas 2017 [67] | Intensive Care Med | High-risk | ICU | Prophylactic | Adult; IMV > 48hrs and known or suspected chronic respiratory disorders | Tracheostomy; facial/cranial trauma or surgery; recent gastric or esophageal surgery; active upper GI bleeding; excessive respiratory secretions; lack of cooperation; do-not-resuscitate order | NIV (72); COT (72) | ARF within 48hrs; reintubation; ICU LOS; 90-day mortality | 144 | 64.8 | 63.6 |
| Yang 2016 [68] | J CardiovascVascAnesth | Post-surgical | ICU | Treatment | Adult; type A aortic dissection; | Severe cardiac dysfunction; high risk of aspiration; COPD; face/neck trauma or | NIV (25); COT (25) | Reintubation; hospital mortality; ICU LOS | 50 | 54.6 | 60 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ARF after-extubation | obstruction; septic shock | | | | | |
| Yu 2017 [69] | Canadian Respiratory Journal | Post-surgical | ICU | Prophylactic | Adult; elective thoracoscopic surgery | Immunocompromised; pregnant; converted to an open thoracotomy age >80 years | HFNO (56); COT (54) | Respiratory complications; reintubation; pneumonia; ICU LOS; mortality | 110 | 56 | 52 |

***Abbreviations:*** APACHE, acute physiologic assessment and chronic health evaluation; ARF, acute respiratory failure; BMI, body mass index; CHF, chronic heart failure; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; COT, conventional oxygen therapy; CPAP, continuous positive airway pressure; GI, gastrointestinal bleeding; HFNO, high-flow nasal oxygen; H, hospital; ICU, intensive care unit; IMV, invasive mechanical ventilation; K, number of studies providing direct evidence; LOS, length of stay; MD, mean difference; NIV, noninvasive ventilation; $PaO_2/FiO_2$, arterial partial pressure of oxygen/inspiratory oxygen concentration; SBT, spontaneous breathing trial; VAP, ventilator-associated pneumonia.

**Supplementary table 4. Risk of bias of each study.**

| Author (Year) | Risk of bias arising from the randomization process | Risk of bias due to deviations from the intended interventions | Risk of bias due to missing outcome data | Risk of bias in measurement of the outcome | Risk of bias in selection of the reported results | Overall |
|---|---|---|---|---|---|---|
| Al Jaaly (2013) | Some Concerns | Some Concerns | Low | Low | Some Concerns | Some Concerns |
| Cho (2020) | Low | Some Concerns | Some Concerns | Low | Low | Some Concerns |
| Corley (2015) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Esteban (2004) | Low | Some Concerns | Some Concerns | Some Concerns | Some concerns | High |
| Fernandez (2017) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Ferrer (2006) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Ferrer (2009) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Hernandez (High) 2016 | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Hernandez (Low) 2016 | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Hu (2020) | Some concern | Some Concerns | Low | Some Concerns | Low | Some Concerns |
| Jaber (2016) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Jing (2018) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Keenan (2002) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Khilnani (2011) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Kindgen-Milles (2005) | Low | Some Concerns | Low | Low | Low | Some Concerns |

| | | | | | | |
|---|---|---|---|---|---|---|
| Maggiore (2014) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Maggiore (2022) | Low | Some Concerns | Low | Low | Low | some concerns |
| Matsuda (2020) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Mohamed (2013) | High | Some Concerns | Low | Some Concerns | Some Concerns | High |
| Nava (2005) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Ornico (2013) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Sahin (2018) | Some concerns | Some Concerns | Low | Some Concerns | Low | Some concerns |
| Song (2017) | Some Concerns | Some Concerns | Low | Some Concerns | Low | Some Concerns |
| Su (2012) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Tan (2020) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Thanthitaweewat (2018) | High | Some Concerns | Low | Some Concerns | Low | High |
| Theerawit (2020) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Theologou (2021) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Tongyoo (2021) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Vargas (2017) | Low | Some Concerns | Low | Low | Low | Some Concerns |
| Yang (2016) | Low | Some Concerns | Low | Some Concerns | Low | Some Concerns |
| Yu (2017) | High | Some Concerns | Low | Some Concerns | Low | High |

**Supplementary table 5. Surface under the cumulative ranking curve (SUCRA) for the interventions (primary, secondary outcomes and subgroups).**

| Intervention | SUCRA |
|---|---|
| **REINTUBATION – OVERALL POPULATION** | |
| HFNO | 0.769 |
| NIV | 0.730 |
| COT | 0.001 |
| **VAP – OVERALL POPULATION** | |
| HFNO | 0.915 |
| NIV | 0.584 |
| COT | 0.001 |
| **DISCOMFORT – OVERALL POPULATION** | |
| HFNO | 0.528 |
| NIV | 0.001 |
| COT | 0.970 |
| **ICU MORTALITY – OVERALL POPULATION** | |
| HFNO | 0.504 |
| NIV | 0.854 |

| | |
|---|---|
| COT | 0.141 |
| **H MORTALITY – OVERALL POPULATION** | |
| HFNO | 0.431 |
| NIV | 0.981 |
| COT | 0.087 |
| **ICU LOS – OVERALL POPULATION** | |
| HFNO | 0.366 |
| NIV | 0.936 |
| COT | 0.198 |
| **H LOS – OVERALL POPULATION** | |
| HFNO | 0.264 |
| NIV | 0.999 |
| COT | 0.236 |
| **TIME TO REINTUBATION – OVERALL POPULATION** | |
| HFNO | 0.564 |
| NIV | 0.105 |
| COT | 0.839 |
| **OVERALL PROPHYLATIC NRS – REINTUBATION** | |

| | |
|---|---|
| HFNO | 0.699 |
| NIV | 0.800 |
| COT | 0.001 |
| **PROPHYLATIC NRS – HIGH-RISK PATIENTS (REINTUBATION)** | |
| HFNO | 0.528 |
| NIV | 0.957 |
| COT | 0.310 |
| **PROPHYLATIC NRS – LOW-RISK PATIENTS (REINTUBATION)** | |
| HFNO | 0.818 |
| NIV | 0.652 |
| COT | 0.029 |
| **PROPHYLATIC NRS – POST-SURGICAL PATIENTS (REINTUBATION)** | |
| HFNO | 0.872 |
| NIV | 0.586 |
| COT | 0.041 |
| **PROPHYLATIC NRS – HYPOXIEMIC PATIENTS (REINTUBATION)** | |
| HFNO | 0.731 |
| NIV | - |

| | |
|---|---|
| COT | 0.269 |
| **OVERALL RESCUE NRS – REINTUBATION** | |
| HFNO | 0.388 |
| NIV | 0.784 |
| COT | 0.326 |

The surface under the cumulative ranking curve (SUCRA) represents the overall ranking of each treatment for the specified outcome and ranges from 0 (minimum) to 1 (maximum).

***Abbreviations:*** COT, conventional oxygen therapy; ICU, intensive care unit; HFNO, high-flow nasal oxygen; LOS, length of stay; NIV, noninvasive ventilation; SUCRA, surface under the cumulative ranking curve; VAP, ventilator-associated pneumonia.

**Supplementary table 6. Direct and indirect evidence on the impact of the interventions on primary, secondary outcomes and subgroups.**

| **REINTUBATION – OVERALL POPULATION** | | | | | |
|---|---|---|---|---|---|
| **Treatments** | **K** | **Prop** | **Direct (OR, 95% CI)** | **Indirect (OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 11 | 0.66 | 0.59 (0.39; 0.89) | 0.63 (0.35; 1.13) | 0.844 |
| NIV vs. COT | 15 | 0.61 | 0.62 (0.45; 0.85) | 0.58 (0.30; 1.10) | |
| HFNO vs. NIV | 5 | 0.53 | 1.02 (0.62; 1.66) | 0.95 (0.56; 1.59) | |
| **VAP – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct (OR, 95% CI)** | **Indirect (OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 3 | 0.38 | 0.34 (0.11; 1.00) | 0.38 (0.16; 0.89) | 0.855 |
| NIV vs. COT | 7 | 0.49 | 0.50 (0.33; 0.75) | 0.44 (0.12; 1.65) | |

| | | | | | |
|---|---|---|---|---|---|
| HFNO vs. NIV | 1 | 0.71 | 0.76<br>(0.36; 1.61) | 0.67<br>(0.21; 2.15) | |
| **DISCOMFORT – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 1 | 0.48 | 9.03<br>(1.61; 50.62) | 0.82<br>(0.16; 4.32) | 0.050 |
| NIV vs. COT | 7 | 0.87 | 9.72<br>(4.16; 22.70) | 106.70<br>(11.39; 999.78) | |
| HFNO vs. NIV | 1 | 0.64 | 0.08<br>(0.02; 0.35) | 0.93<br>(0.14; 6.34) | |
| **ICU mortality – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 5 | 0.76 | 0.84<br>(0.42; 1.68) | 0.72<br>(0.21; 2.47) | 0.834 |
| NIV vs. COT | 8 | 0.86 | 0.63<br>(0.37; 1.07) | 0.73<br>(0.20; 2.71) | |

| | | | | | |
|---|---|---|---|---|---|
| HFNO vs. NIV | 1 | 0.38 | 1.15<br>(0.38; 3.50) | 1.34<br>(0.56; 3.22) | |
| **H mortality – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 5 | 0.66 | 1.00<br>(0.67; 1.47) | 0.64<br>(0.37; 1.10) | 0.194 |
| NIV vs. COT | 11 | 0.70 | 0.56<br>(0.38; 0.81) | 0.87<br>(0.50; 1.53) | |
| HFNO vs. NIV | 4 | 0.64 | 1.15<br>(0.77; 1.72) | 1.79<br>(1.05; 3.07) | |
| **ICU LOS – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(MD, 95% CI)** | **Indirect<br>(MD, 95% CI)** | ***p**** |
| HFNO vs. COT | 9 | 0.85 | 0.21<br>(-0.58; 1.01) | -2.02<br>(-3.91; -0.14) | 0.032 |
| NIV vs. COT | 14 | 0.86 | -1.05<br>(-1.82; -0.27) | 1.19<br>(-0.70; 3.08) | |

| | | | | | |
|---|---|---|---|---|---|
| HFNO vs. NIV | 4 | 0.29 | -0.98<br>(-2.69; 0.74) | 1.26<br>(0.15; 2.37) | |
| **H LOS – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(MD, 95% CI)** | **Indirect<br>(MD, 95% CI)** | ***p**** |
| HFNO vs. COT | 8 | 0.81 | 0.35<br>(-1.01; 1.71) | -1.74<br>(-4.54; 1.07) | 0.189 |
| NIV vs. COT | 10 | 0.77 | -2.86<br>(-4.36;-1.37) | -0.77<br>(-3.41; 1.96) | |
| HFNO vs. NIV | 3 | 0.42 | 1.13<br>(-1.25; 3.50) | 3.22<br>(1.20; 5.24) | |
| **TIME TO REINTUBATION – OVERALL POPULATION** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(MD, 95% CI)** | **Indirect<br>(MD, 95% CI)** | ***p**** |
| HFNO vs. COT | 3 | 0.74 | 0.01<br>(-12.88; 12.89) | 11.62<br>(-10.32; 33.56) | 0.371 |
| NIV vs. COT | 4 | 0.80 | 11.52<br>(0.06; 22.98) | -0.09<br>(-22.81; 22.62) | |

| | | | | | |
|---|---|---|---|---|---|
| HFNO vs. NIV | 1 | 0.46 | 0.10<br>(-18.61; 18.81) | -11.52<br>(-28.76; 5.73) | |

## *SUBGROUP ANALYSIS*

**PROPHYLACTIC NRS - OVERALL POPULATION (REINTUBATION)**

| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
|---|---|---|---|---|---|
| HFNO vs. COT | 10 | 0.69 | 0.55<br>(0.34; 0.86) | 0.50<br>(0.25; 0.98) | 0.820 |
| NIV vs. COT | 11 | 0.74 | 0.49<br>(0.32; 0.75) | 0.54<br>(0.27; 1.09) | |
| HFNO vs. NIV | 5 | 0.58 | 1.01<br>(0.60; 1.72) | 1.11<br>(0.60; 2.08) | |

**PROPHYLACTIC NRS – HIGH-RISK PATIENTS (REINTUBATION)**

| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
|---|---|---|---|---|---|
| HFNO vs. COT | 2 | 0.32 | 0.90<br>(0.39; 2.07) | 0.53<br>(0.30; 0.94) | 0.310 |

| | | | | | |
|---|---|---|---|---|---|
| NIV vs. COT | 5 | 0.80 | 0.45<br>(0.28; 0.71) | 0.76<br>(0.31; 1.88) | |
| HFNO vs. NIV | 4 | 0.88 | 1.18<br>(0.83; 1.68) | 2.00<br>(0.77; 5.20) | |
| **PROPHYLACTIC NRS – LOW-RISK PATIENTS (REINTUBATION)** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 2 | 0.64 | 0.39<br>(0.12; 1.29) | 0.41<br>(0.08; 2.02) | 0.954 |
| NIV vs. COT | 5 | 0.83 | 0.49<br>(0.22; 1.11) | 0.47<br>(0.07; 2.90) | |
| HFNO vs. NIV | 1 | 0.53 | 0.83<br>(0.21; 3.27) | 0.78<br>(0.18; 3.34) | |
| **PROPHYLACTIC NRS – POST-SURGICAL PATIENTS (REINTUBATION)** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 3 | 1.00 | 0.13<br>(0.04; 0.45) | - | - |

| | | | | | |
|---|---|---|---|---|---|
| NIV vs. COT | 1 | 1.00 | 0.27<br>(0.04; 1.69) | - | |
| HFNO vs. NIV | 0 | - | - | 0.47<br>(0.05; 4.33) | |
| **THERAPEUTIC NRS – OVERALL POPULATION (REINTUBATION)** | | | | | |
| **Treatments** | **K** | **Prop** | **Direct<br>(OR, 95% CI)** | **Indirect<br>(OR, 95% CI)** | ***p**** |
| HFNO vs. COT | 1 | 1.00 | 1.09<br>(0.30; 3.98) | - | - |
| NIV vs. COT | 4 | 1.00 | 0.81<br>(0.60; 1.11) | - | |
| HFNO vs. NIV | 0 | 0.00 | - | 1.34<br>(0.36; 5.08) | |

***Abbreviations:*** CI, confidence interval; CPAP, continuous positive airway pressure; ICU, intensive care unit; GRADE, grading of recommendations assessment, development, and evaluation; HFNO, high-flow nasal oxygen; LOS, length of stay; MD, mean difference; NIV, noninvasive ventilation; OR, Odds ratio; Prop, direct evidence proportion; VAP, ventilator-associated pneumonia; vs. : versus. *: p-value for network incoherence.

**Supplementary table 7. Network estimates evaluating the impact of the interventions on subgroups.**

| Comparison | MD or OR (95% CI) | p-value | $I^2$ | $Tau^2$ | K |
|---|---|---|---|---|---|
| **PROPHYLACTIC NRS – OVERALL POPULATION (REINTUBATION)** | | | | | |
| HFNO vs. COT | 0.53 (0.36; 0.77) | **0.001** | 39% | 0.398 | 10 |
| NIV vs. COT | 0.50 (0.35; 0.72) | **<0.001** | | | 11 |
| NIV vs. HFNO | 1.05 (0.70; 1.58) | 0.820 | | | 5 |
| **PROPHYLACTIC NRS – HIGH-RISK PATIENTS (REINTUBATION)** | | | | | |
| HFNO vs. COT | 0.63 (0.39; 1.01) | 0.055 | 0% | 0 | 2 |
| NIV vs. COT | 0.50 (0.33; 0.75) | **<0.001** | | | 5 |
| NIV vs. HFNO | 1.26 (0.91; 1.75) | 0.310 | | | 4 |
| **PROPHYLACTIC NRS – LOW-RISK PATIENTS (REINTUBATION)** | | | | | |
| HFNO vs. COT | 0.39 (0.15; 1.03) | 0.057 | 61% | 0.414 | 2 |
| NIV vs. COT | 0.49 (0.23; 1.03) | 0.059 | | | 5 |
| NIV vs. HFNO | 0.80 (0.30; 2.19) | 0.954 | | | 1 |
| **PROPHYLACTIC NRS – POST-SURGICAL PATIENTS (REINTUBATION)** | | | | | |
| HFNO vs. COT | 0.13 (0.04; 0.45) | **0.001** | 0% | 0 | 3 |
| NIV vs. COT | 0.27 (0.04; 1.69) | 0.162 | | | 1 |
| NIV vs. HFNO | - | - | | | 0 |

| | | | | | |
|---|---|---|---|---|---|
| **PROPHYLACTIC NRS – HYPOXEMIC PATIENTS (REINTUBATION)** | | | | | |
| HFNO vs. COT | 0.72 (0.26; 2.04) | 0.538 | 69% | 0.542 | 3 |
| NIV vs. COT | - | - | | | 0 |
| NIV vs. HFNO | - | - | | | 0 |
| **THERAPEUTIC NRS – OVERALL POPULATION (REINTUBATION)** | | | | | |
| HFNO vs. COT | 1.09 (0.30; 3.99) | 0.891 | 0% | 0 | 1 |
| NIV vs. COT | 0.81 (0.60; 1.11) | 0.196 | | | 4 |
| NIV vs. HFNO | - | - | | | 0 |

***Abbreviations:*** CI, confidence interval; COT, conventional oxygen therapy; ICU, intensive care unit; GRADE, grading of recommendations assessment, development, and evaluation; HFNO, high-flow nasal oxygen; K, number of studies providing direct evidence; NIV, noninvasive ventilation; OR, Odds ratio; Prop, direct evidence proportion; $Tau^2$ and $I^2$, loop heterogeneity; VAP, ventilator-associated pneumonia; vs., versus.