www.brn.cat

PERMANYER

BRN Rev. 2022;8(3):140-9

BRN Reviews

REVIEW

# Types of Respiratory Intermediate Care Units

Raffaele Scala, MD, FCCP[1] and João C. Winck, MD, PhD[2]

*[1]Pulmonology and Respiratory Intermedial Care Unit, S. Donato Hospital, Cardio-toraco-neurologic Department, Usl Toscana Sudest, Arezzo, Italy; [2]Faculdade de Medicina da Universidade do Porto, Centro de Reabilitação do Norte (Centro Hospitalar de Vila Nova de Gaia-Espinho), Vila Nova de Gaia, Portugal*

## ABSTRACT

Respiratory intermediate care units (RICU) may be divided into three types, depending on staffing, monitoring levels and patients' severity. In this chapter, we clearly define the different typologies of RICU, including the change and expansion due to the COVID-19 pandemic. There is a heterogeneity of RICU in terms of number, structure and model which largely vary in the different countries and locally within different hospitals. According to the European Respiratory Society (ERS) task force there are three main RICU levels: respiratory intensive care unit, respiratory intermediate care unit and respiratory monitoring units. To define the levels of the RICU, the expertise of the team, the nurse workload, and the capability of providing invasive as well non-invasive respiratory support are the crucial factors. RICU allow for a more efficient and cost-effective approach to respiratory care without decreasing the quality of care or adversely affecting the outcome. Respiratory medicine units should make strong efforts to lead and include such facilities under their own space.

**Keywords:** Acute-on chronic respiratory failure. Non-invasive respiratory support. Respiratory intermediate care units.

**Correspondence to:**
*João C. Winck*
*E-mail: jcwinck@mail.telepac.pt*

*Received in original form: 03-11-2022*
*Accepted in final form: 11-11-2022*
DOI: 10.23866/BRNRev:2022-M0078
www.brnreviews.com

## INTRODUCTION

Acute respiratory failure (ARF) represents one of the greatest epidemiological challenges in terms of burden for the modern health systems[1]. Intensive care units (ICU) are an integral but expensive component of healthcare in developed countries. Ideally, ICU admission should be reserved for patients with the greatest severity of critical illness who are likely to get the highest probability of benefit from ICU care[2]. The increasing numbers of admissions to ICUs and the relatively high costs have given rise to wide discussion about the utilization of ICU resources, not only from a medical point of view but also from economic, ethical, and political viewpoints. For that reason, for the management of less severe patients, one possible solution has been the development of "intermediate care units", which provide more intensive monitoring and patient management with higher nurse/patient ratios than the general ward but less than is offered in the ICU[3-8]. Some centers have created general "intermediate care units", whereas others have intermediate care units for specific patient groups, such as cardiac (coronary care units) or neurological (stroke units) or respiratory patients (respiratory intermediate care units [RICU]). According to published data, less than one-third of hospitals belonging to 75 countries had an intermediate care unit[9]. Based on this strong rationale, the implementation of an intermediate care unit in a hospital is likely to improve ICU utilization[7]. However, local considerations, including demand, ICU and ward case mix, ICU volume, available staffing, physical and financial resources, and the quality of clinical care on the ward are usually the main factors taken into account when making the decisions of structuring an intermediate care unit amongst centers and countries[3,4].

The imbalance between the increasing prevalence of patients with acute and acute-on-chronic decompensated respiratory diseases and the shortage of ICU beds has stimulated the growth of RICUs. This is especially true for end-stage lung disease, fragile, immunosuppressed patients admitted to hospital for ARF who are usually refused by overcrowded ICUs[10.] Differently from North America, where RICUs provide all levels of intensity of care for the management of respiratory acute critically ill patients within Departments of Pulmonology and Critical Care Medicine, in Europe there is a gap between ICU and RICU models, the former managed by anesthesiologists and intensivists, the latter managed mainly by pulmonologists[11]. The concomitant expansion of non-invasive respiratory tools to support patients at earlier stages of ARF and the increased skills and expertise of non-ICU clinicians in respiratory critical care medicine has favored the development of RICU taken over by pulmonologists[5]. It must be pointed out that the heterogeneity of RICU in terms of number, structure and model largely varies in different countries and locally within different hospitals.

In this chapter, we aim at reporting the state of the art on the types of RICU all over Europe, detailing the differences in definition, structural and functional organizations, human and instrumental resources, skills and capabilities of managing different levels of complexity of ARF. Integration with ICU, Pulmonology Department and other hospital facilities will also be discussed, together with the role of RICUs as long-term/weaning units

within rehabilitative post-acute settings. Finally, the RICU changes induced by COVID-19 pandemics will be described.

## RATIONALE OF THE RESPIRATORY INTERMEDIATE CARE UNIT

RICUs provide a specialized quality of care for patients recovering from ARF, acute on chronic respiratory failure (ACRF), with health resources optimization (e.g., lower nurse-to-patient ratio). RICUs are intermediate-level respiratory care settings designed to manage ARF patients without severe non-pulmonary dysfunction and to avoid the risk of inadequate intensity of care in a lower-level care environment (e.g, ward) and the potentially wasteful provision of unnecessarily higher-level care in an ICU[5,8,12-15,16].

According to a recent Italian Thoracic Society (AIPO/ITS) position paper[16], RICUs are defined as *"a pulmonary monitoring and treatment area for patients with acute respiratory failure and with acute on chronic respiratory failure in whom non-invasive monitoring and respiratory support (NRS) (e.g., non-invasive ventilation [NIV], high flow oxygen therapy [HFOT]) techniques are mainly used. Difficult to wean tracheostomized patients are also admitted from general ICUs. The discharge planning of ventilator-dependent patients is part of the activities. Interventional procedures, such as bronchoscopy and pleural drainage, chest ultrasound and analgo-sedation are usually performed in these units to facilitate the management of ventilated patients".*

It has been shown that about 40% of the patients admitted to ICUs never receive active intensive care, including mechanical ventilation, and therefore may be considered ideal candidates for specialized intermediate respiratory care units[17]. The opening of RICUs, providing non-invasive monitoring and non-invasive respiratory support, not needing major expenditure on building a dedicated area, and with a better nurse/patient ratio than the general ward, allows for a more efficient and cost-effective approach to respiratory care without decreasing the quality of care or adversely affecting the outcome.

A recent Italian experience has shown that the opening of an RICU reduces in-hospital mortality, the need for ICU admission, and the hospital stay of patients with acute exacerbation of chronic obstructive pulmonary disease (COPD), community-acquired pneumonia and adult respiratory distress syndrome (ARDS) as compared to general internal ward and emergency department setting[15]. This may be explained by better use of care resources (i.e., physiotherapist care, systemic steroids, timing of antibiotics and NIV) for patient management in the RICU[15]. In a Spanish large multicenter study, Masa et al.[17] clearly demonstrated that NIV could be successfully applied in RICUs to treat acute cardiogenic pulmonary edema, COPD and obesity hypoventilation syndrome patients showing a severe degree of hypercapnic respiratory acidosis (pH ≤ 7.25) that usually does not recommend ventilatory management outside ICU[17].

Depending on the patient's previous level of care, an RICU can provide: step-up care when admitting a patient transferred from a general ward, needing specific treatments, such as NIV or invasive mechanical ventilation (IMV) and/or close monitoring; for an ARF episode

that developed during the hospital admission; or step-down care when a patient no longer requires all the facilities of an ICU but is not ready to be transferred to a general medical ward because of specific care needs, managing difficulties in weaning from prolonged mechanical ventilation and decannulation, as well as for planning home discharge of patients requiring full or partial home ventilatory support[12-14,18,19].

In Europe, there has been a rapid increase in the number of RICUs, and the types of RICUs differ among the European countries[12]. This growth mirrored the expanding popularity of NIV and, more recently HFOT, to prevent and treat ARF.

## CLASSIFICATION OF TYPE OF RICUs

RICUs could be classified according to four main tracks: 1) level of intensity/resources care; 2) structural model for the acute care hospital depending on the integration within pulmonologists and non-pulmonologists' structures; 3) functional role as weaning/long-term ventilated patient units in rehabilitative post-acute setting; 4) changes induced by the COVID-19 pandemic.

## TYPES OF RICUs ACCORDING TO THE LEVELS OF COMPLEXITY OF CARE

According to the European Respiratory Society (ERS)[12], three different levels of care (respiratory intensive care unit, respiratory intermediate care unit, respiratory monitoring units) are defined and stratified according to human and instrumental resources as well as the intensity of care, by considering the following characteristics: nurse-patient ratio, availability of medical doctor on call, the presence of multifunctional monitors and life support ventilators, and the possibility of applying both IMV and NIV in patients with respiratory failure or more than one organ failure, provision of facilities such as bronchoscopy and arterial blood gas (ABG) analyzer.

In the last update of AIPO-ITS on RICU, expertise of the team has been highlighted as a crucial ingredient to define the level of the units; nurse workload and capability of providing invasive as well non-invasive respiratory support have been considered too[16,20].

The panel of the Italian Position Paper has questioned the real meaning of the lower RICU level –"Respiratory Monitoring Units"– that do not sound to fit the modern concept of RICU for several reasons: 1) this setting is much more similar to a ward than to an intermediate care unit in terms of intensity and complexity of intervention; for example NIV and HFOT may be safely provided also in a respiratory ward to treat selected patients with less severe ARF by an expert team[21-23]; 2) the term is misleading as the activity of RICUs is not limited to a simple "monitoring" activity but provides "active" respiratory support; 3) currently, in Italy, like in other European countries, there are two levels of care for critically ill patients defined as intensive and intermediate care units according to the types and complexity of the interventions available. For these reasons, the Panel agreed to consider two levels of units based on: 1) the nurse/patient ratio; 2) interventions performed

to update the instruments; 3) admission criteria (see table 1 for details).

According to the AIPO/ITS Position Paper, RICUs are classified according to only two levels of care: 1) the first or lower level, defined as Pulmonary Intermediate Care Unit (PIMCU), corresponds to the RICU" of the ERS Task Force[12]; it was characterised by a nurse/patient ratio of at least 1:4, the routine use of non-invasive monitoring, NRS and the application of IMV when necessary.

The second or higher level defined as the Pulmonary Intensive Care Unit (PICU), corresponds to the RICU of ERS Task Force[12]; it was characterised by a nurse/patient ratio > 1: 3, with the possibility of managing ARF of any level of severity with invasive and non-invasive ventilation but not ARF with multiple organ failure requiring multiple organ support, cardiogenic shock requiring aortic counterpulsation and severe refractory hypoxaemia requiring extracorporeal membrane oxygenation (ECMO) treatment. These conditions necessarily require treatment in general ICUs. Additional criteria were introduced regarding renal ultrafiltration and interventional lung assist for extracorporeal $CO_2$-removal. In recent years, reports from some PICUs have shown their capability to support patients presenting with both ARF and acute renal failure by means of ventilation and renal support (i.e., haemofiltration or dialysis) with the backup of intensivists and nephrologists. Finally, some centres have successfully applied extracorporeal carbon dioxide removal ($ECCO_2R$) to reduce the risk of NIV failure in severe COPD exacerbations and other chronic lung diseases[24-26]. Moreover RICUs could also serve to monitor patients' unstable clinical situation such as massive pulmonary embolism (PE) or life-threatening hemoptysis.

**Table 1.** Admission criteria to RICU

| |
|---|
| COPD with ARF requiring mechanical ventilation, mainly non-invasive, and/or monitoring of vital parameters. |
| Chronic restrictive diseases (neuromuscular and chest wall diseases and diffuse infiltrative lung diseases) with ARF requiring mechanical ventilation, mainly non-invasive, and/or monitoring of vital parameters. |
| Patients with central hypoventilation or sleep apnoea syndrome requiring hospitalization for ARF |
| Patients undergoing mechanical ventilation in an ICU, to complete weaning from the ventilator and/or to restore functional recovery before discharge to the hospital ward or home. |
| Weaned tracheostomized patients to attempt decannulation. |
| Patients requiring mechanical ventilation, mainly non-invasive, and/or monitoring of vital parameters due to respiratory complications after surgery. |
| Patients requiring mechanical ventilation and/or monitoring of vital parameters for hypoxaemic ARF following pulmonary parenchyma diseases, with $PaO_2/FiO_2$ ratio < 300 and > 100. |
| Patients requiring mechanical ventilation and/or monitoring of vital parameters for acute asthma exacerbation. |
| Patients needing interventional procedures (e.g., bronchoscopy, digestive endoscopy, PEG positioning, and trans-oesophageal echocardiography) with ARF during conventional oxygen therapy, HFOT, or NIV. |

ARF: acute respiratory failure; COPD: chronic obstructive pulmonary disease; HFOT: high-flow oxygen therapy; NIV: non-invasive ventilation; $PaO_2/FiO^2$: partial oxygen pressure/fraction of inspired O2; PEG: percutaneous endoscopic gastrostomy. *Adapted from Renda et al., 2021[16].*

## TYPES OF RICUs ACCORDING TO THE ACUTE HOSPITAL STRUCTURAL MODELS

RICU beds can be specific stand-alone units, adjacent to but physically distinct from an ICU or general ward, or designated beds co-located within ICUs or general wards. RICUs co-located in ICUs or wards can be structured as separate beds reserved for only intermediate care or "flexible" beds that change designation based on patient needs.

There are no guidelines or standards on the best location and design of RICUs within the

hospital[12]. Local considerations, including demand, ICU and ward case mix, ICU volume, available staffing, physical and financial resources represent the key factors for the allocation of the RICU in real practice. Several models for the location of these units in a hospital have been proposed: **independent location** (free-standing unit), **parallel model** (adjacent to the ICU or co-located), **integrated model** (within the ICU or in a Pulmonology Unit, functionally and ideally integrated with a sleep disorder laboratory)[27-30].

In Italy, RICUs are mainly located inside the pulmonology ward and work following a step-up/step-down flexibility according to changes in clinical status; this location facilitates the discharge at home of ventilator-dependent patients to home mechanical ventilation programs typically run by pulmonologists[31].

Moreover, locating RICUs in a Pulmonology Unit and Sleep Disorder Laboratory facilitates the integration of respiratory support, the monitoring of breathing resources and the availability of an experienced team for both acute conditions and chronically ill patients needing titration of home mechanical ventilation (invasive and non-invasive ventilation). The integrated model in a Pulmonology Unit, adjusting treatment to the patient's needs in the same area, may ensure optimum continuity of treatment; furthermore, the costs of basic equipment per bed and personnel management (nurse to patient ratio) are lower than the integration model in an ICU.

There is no definitive scientific evidence on the recommended number of beds or size of RICUs. These units should be based on a model of 4-8 beds in the Thoracic or Cardiothoracic Department or elsewhere, depending on the organisational level of the various local situations. The optimal number of beds reported is as follows: a) 4-6 for hospitals with more than 500 beds; b) 8 beds for hospitals with more than 1,000 beds, or 1-2 beds per 100,000 inhabitants[32].

## RICUs AS WEANING UNITS

In Italy and several EU countries, the implementation of pulmonology centers working as step-down units for the management of patients discharged from ICUs as a result of difficult or prolonged weaning from IMV largely coincides with the birth and growth of RICUs[13,14,33-37]. The mission of RICUs that function as weaning centers[38] is crucial in the context of clinical governance of ARF/ACRF because they work as a strategic node for (1) the quick discharge of critically ill patients from the ICU, where they failed repeated attempts of disconnections from the ventilator, to these units dedicated to weaning with an optimization of the limited health resources; (2) the achievement of a greater rate of success in totally or partially liberating ventilator-dependent patients from IMV through protocol-driven, multidisciplinary, intensive rehabilitative interventions; and (3) the delicate transitional process at the home of chronically critical patients (e.g., with COPD, end-stage heart failure, advanced neuromyopathy, pluri-comorbidities, postsurgical sequelae), thanks to the activation of integrated pathways between hospital and territory.

Among European countries, the Italian experience represents one of the most developed models.

Germany is the European country that has the most comprehensive specialized weaning centers network established by the German Respiratory Society (DGP) and included in a national registry called the WeanNet initiative, starting in March 2008. It includes 85 facilities across Germany with a very well-structured accreditation program[39]. With the same typology of units, the last report (analyzing 11,424 patients from 2011 to 2015) showed these units were able to successfully wean patients in 64.3% of cases, with the rate of successful weaning growing from 60% to 66.2% during the study period, and simultaneously the time required for weaning reducing from 22 days to 18 days[39].

The latest data depicting an Italian "snapshot" of pulmonologists' activity on difficult/prolonged weaning may be extrapolated from the last national survey on the RICUs conducted by the AIPO at the end of 2007[14,36]. Compared with the first census performed in 1997, the second survey showed that, over the past ten years, there has been an increase not only in the number of RICUs but also in their efficiency, as the admissions for monitoring have been reduced only in favour of those for active interventions (i.e., mechanical ventilation, weaning and decannulation). The weaning activity of the Italian RICU has more than doubled in the past decade as the admissions for problems of weaning have increased from 8 to 19%[14,36]. These data refer to patients who were transferred from ICUs after failing one or more attempts at disconnection from the ventilator for at least seven days; these patients belong to the categories of "difficult" and "prolonged" weaning, which are correlated with greater rate of mortality and higher health costs compared with those belonging to the "simple" weaning category[40].

In Italy, there are two main organizational patterns for the management of patients with prolonged weaning within the pulmonologist's rehabilitative critical area. The first clinical pathway involves the transfer of ventilator-dependent patients into the eight RICUs with "rehabilitative attitude" where long-term (> 30 days) multidisciplinary interventions may be applied. The role played by these units is oriented first to recovering as much as possible of the patient's functional autonomy, from ventilation to neuromotor activities, and then, to activate home-care programs for patients who remain partly or totally dependent on mechanical ventilation[5,18,19]. The weakness of this model is due to the small number of these rehabilitative RICUs scattered throughout the national territory and their location in institutions lacking ICU facilities. The latter may have negative implications for safety in case of multiorgan deterioration of the patient during the weaning process.

The second clinical option is based on the transfer of patients with difficult/prolonged weaning into the 36 RICUs located inside acute care hospitals, where the strategy followed to achieve the maximum ventilatory autonomy could be applied for a shorter period of time (< 30 days)[5,14]. In case of failure of further weaning attempts in these acute RICUs, patients could be transferred, if one is available in their regional area, to a rehabilitative RICU. Otherwise, the length of stay in the acute RICU is likely to be extended with the consequence of a reduced turnover of beds available for the admission of new ARF/ACRF patients. The integrated sequential activity of an RICU located in an acute care hospital with that of a weaning center implemented in a close rehabilitative center was the subject of

a pilot experience in Tuscany. In a sample of 49 tracheostomized ventilator-dependent patients who were transferred from the ICU to the acute RICU of the same hospital, the passage from the second to the third step of care improved the success rate of weaning from 67.3 to 79.6 % with a positive economic impact[19].

The number of RICUs surveyed nationwide being, unfortunately, still insufficient, a third clinical option involves a prolonged stay of yet un-weaned patients in the ICU with negative consequences in terms of efficiency of the resource management system.

The importance of allocating enough human resources in a weaning center is highlighted by the finding of a very high nursing workload required to manage patients with weaning problems during the first two days of admission into an Italian rehabilitative RICU[41]. Unfortunately, the "snapshot" of the Italian RICUs has clearly pointed out that, in the last decade, there has been a contraction in the amount of human resources, in terms of doctor- and nurse-to-patient ratio, albeit without a significant variation in the instrumental resources for monitoring and mechanical ventilation[14,36]. Moreover, despite the important role of respiratory physiotherapy in critically ill patients, surprisingly, the physiotherapist-to-patient ratio in the RICUs surveyed in 2007 was less than 1:11 for all levels of care units, a value that is lower than the ratio of 1:6 recommended by the AIPO-ITS document[34]. Similar results emerged from a retrospective multicenter study conducted in five rehabilitative RICUs[18]. According to this analysis, the reduced doctor-to-patient ratio observed from 1990 to 2005 was associated with a prolonged length of stay, a lower rate of weaning success, and fewer patients dischargeable to home.

## RICU TYPES ACCORDING TO COVID-19-INDUCED REORGANIZATION

Unfortunately, the network of RICUs is not developed enough to address the ARF–related epidemiological burden in the majority of European countries. This gap has been furthermore elicited by the COVID-19 pandemic which caused a quick saturation of ICU beds with non-intubated patients who did not find allocation in other protected specialized environments such as the RICU.

The outbreak of COVID-19 in Italy has shown the inadequacy of the health system to counterbalance a massive request of ICU care[42]. One-fourth of > 1500 COVID-19 patients died after admission in Lombardy ICUs; in only 11% of them NIV and/or HFOT were attempted early to prevent respiratory deterioration and IMV[42]. Subsequent published data reported that non-invasive respiratory support delivered by mean either HFOT and/or continuous positive airway pressure (CPAP) and NIV shows average success of 60%, 55% and 59%, respectively, in COVID-19-related ARF with relatively low risk of infection rate in health professionals[43].

The delayed admission in Lombardy's overcrowded ICUs of severely hypoxemic COVID-19 patients meeting criteria for IMV without being offered an HFOT/NIV trial must have played a crucial role. The "gap" between the Italian RICU network and pre-COVID-19 respiratory needs might largely explain the ICU network

failure in Lombardy[44]. A national survey performed at the beginning and one month after the COVID-19 outbreak demonstrated an increase rate (94% versus 12%) of RICU accounting for extra beds involved in the fight against COVID-19 as compared to pre-COVID-19 eras. This was associated with the "up-grading" of 84% wards towards RICUs, most of them dedicated to provide NIV/HFOT which avoided intubation/death in 40% of cases[45]. The expanded RICU and pulmonologist network together with national more restrictive measures against virus dissemination are the proof of the concept that may explain the mitigation of the COVID-19 impact on mortality after the initial tremendous effects of the outbreak in Lombardy[44].

In this new pandemic scenario, hospital models based on the safe separation of COVID- 19 from non-COVID-19 patients within pulmonologist-driven RICU areas strictly correlated with lower-intensity ordinary beds for non-invasive management of ARF patients are likely to keep free a higher number of ICU beds which are reserved only to treat severe acute respiratory critically intubated COVID + and COVID – subjects. These models may facilitate the escalation and de-escalation of respiratory support both within RICU areas and between ICU and RICU with the optimization of the costs.

Ideally confirmed or suspected COVID-19 patients should be treated in negative pressure isolation rooms. In some countries, in order to increase the capacity, extra negative pressure isolation rooms were constructed, or some rooms were converted to negative pressure[46]. In some occasions, when high numbers of severe patients are admitted, to reach the necessary level of management, an increase of staff-to-patient ratios (doctor, nurse, or respiratory physiotherapist) may be needed[47].

As COVID-19 is a complex and heterogeneous disease, some centres have repurposed their RICU, and a good example is the Milan 41-bed COVID-19 High Dependency Unit where a multidisciplinary approach is proposed[48].

## CONCLUSIONS

Respiratory medicine units of the 21st century should include an intermediate care unit under their own space. The typology depends on the structural model of the hospital but, whatever the model, it is likely to improve ICU utilization and costs.

## REFERENCES


1. Scala R, Heunks L. Highlights in acute respiratory failure. Eur Respir Rev. 2018;27:180008.
2. Ohbe H, Sasabuchi Y, Yamana H, Matsui H, Yasunaga H. Intensive care unit versus high-dependency care unit for mechanically ventilated patients with pneumonia: a nationwide comparative effectiveness study. Lancet Reg Health West Pac. 2021;13:100185.
3. Vincent JL, Rubenfeld GD. Does intermediate care improve patient outcomes or reduce costs? Crit Care. 2015;19:89.
4. Prin M, Wunsch H. The role of stepdown beds in hospital care. Am J Respir Crit Care Med. 2014;190:1210-6.
5. Scala R. Respiratory High-Dependency Care Units for the burden of acute respiratory failure. Eur J Intern Med. 2012;23:302-8.
6. Capuzzo M, Volta C, Tassinati T et al. Hospital mortality of adults admitted to Intensive Care Units in hospitals with and without Intermediate Care Units: a multicentre European cohort study. Crit Care. 2014;18:551.
7. Solberg BC, Dirksen CD, Nieman FH et al. Introducing an integrated intermediate care unit improves ICU utilization: a prospective intervention study. BMC Anesthesiol. 2014;14:76.
8. Bertolini G, Confalonieri M, Rossi C et al. Costs of the COPD. Differences between intensive care unit and respiratory intermediate care unit. Respir Med. 2005;99:894-900.
9. Sakr Y, Moreira CL, Rhodes A et al. The impact of hospital and ICU organizational factors on outcome in critically ill patients: results from the Extended Prevalence of Infection in Intensive Care study. Crit Care Med. 2015;43:519-26.
10. Iapichino G, Corbella D, Minelli C et al. Reasons for refusal of admission to intensive care and impact on mortality. Intensive Care Med. 2010;36:1772-9.
11. Evans T, Elliott MW, Ranieri M et al. Pulmonary medicine and (adult) critical care medicine in Europe. Eur Respir J. 2002;19:1202-6.

12. Corrado A, Roussos C, Ambrosino N et al. Respiratory intermediate care units: a European survey. Eur Respir J. 2002;20:1343-50.
13. Confalonieri M, Gorini M, Ambrosino N, Mollica C, Corrado A, Scientific Group on Respiratory Intensive Care of the Italian Association of Hospital P. Respiratory intensive care units in Italy: a national census and prospective cohort study. Thorax. 2001;56:373-8.
14. Scala R, Corrado A, Confalonieri M, Marchese S, Ambrosino N, Scientific Group on Respiratory Intensive Care of the Italian Association of Hospital P. Increased number and expertise of Italian respiratory high-dependency care units: the second national survey. Respir Care. 2011;56:1100-7.
15. Confalonieri M, Trevisan R, Demsar M et al. Opening of a respiratory intermediate care unit in a general hospital: impact on mortality and other outcomes. Respiration. 2015;90:235-42.
16. Renda T, Scala R, Corrado A, Ambrosino N, Vaghi A, Scientific Group on Respiratory Intensive Care of the Italian Thoracic S. Adult Pulmonary Intensive and Intermediate Care Units: The Italian Thoracic Society (ITS-AIPO) Position Paper. Respiration. 2021;100:1027-37.
17. Masa JF, Utrabo I, Gomez de Terreros J et al. Noninvasive ventilation for severely acidotic patients in respiratory intermediate care units: Precision medicine in intermediate care units. BMC Pulm Med. 2016;16:97.
18. Polverino E, Nava S, Ferrer M et al. Patients' characterization, hospital course and clinical outcomes in five Italian respiratory intensive care units. Intensive Care Med. 2010;36:137-42.
19. Carpene N, Vagheggini G, Panait E, Gabbrielli L, Ambrosino N. A proposal of a new model for long-term weaning: respiratory intensive care unit and weaning center. Respir Med. 2010;104:1505-11.
20. Renda T, Arcaro G, Baglioni S et al. Respiratory Intensive Care Unit: update 2018. Rass Pat App Respir 2018;33:306-32.
21. Koyauchi T, Hasegawa H, Kanata K et al. Efficacy and Tolerability of High-Flow Nasal Cannula Oxygen Therapy for Hypoxemic Respiratory Failure in Patients with Interstitial Lung Disease with Do-Not-Intubate Orders: A Retrospective Single-Center Study. Respiration. 2018;96:323-9.
22. Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. Lancet. 2000; 355:1931-5.
23. Dave C, Turner A, Thomas A et al. Utility of respiratory ward-based NIV in acidotic hypercapnic respiratory failure. Respirology. 2014;19:1241-47.
24. Maggiorelli C, Ciarleglio G, Granese V et al. Integrated therapeutic strategy during noninvasive ventilation in a patient with end-stage respiratory disease. Respir Care. 2015;60:e80-5.
25. Arcaro G, Vianello A. The successful management of a patient with exacerbation of non-cystic fibrosis bronchiectasis and bilateral fibrothorax using a venovenous extracorporeal carbon dioxide removal system. Respir Care. 2014;59:e197-200.
26. Del Sorbo L, Pisani L, Filippini C et al. Extracorporeal Co2 removal in hypercapnic patients at risk of noninvasive ventilation failure: a matched cohort study with historical control. Crit Care Med. 2015;43:120-7.
27. Guia M, Ciobanu LD, Sreedharan JK et al. The role of non-invasive ventilation in weaning and decannulating critically ill patients with tracheostomy: A narrative review of the literature. Pulmonology. 2021;27:43-51.
28. Torres A, Ferrer M, Blanquer JB et al. [Intermediate respiratory intensive care units: definitions and characteristics]. Arch Bronconeumol. 2005;41(9): 505-512.
29. Ferrer M, Torres A. Intermediate respiratory care units. In: JL V, ed. Intensive care medicine. yearbook of intensive care and emergency medicine. Vol 41. Berlin: Springer Berlin Heidelberg; 2007:505-12.
30. Marchioni A, Tonelli R, Sdanganelli A et al. Prevalence and development of chronic critical illness in acute patients admitted to a respiratory intensive care setting. Pulmonology. 2020;26:151-8.
31. Lloyd-Owen SJ, Donaldson GC, Ambrosino N et al. Patterns of home mechanical ventilation use in Europe: results from the Eurovent survey. Eur Respir J. 2005;25:1025-31.
32. Corrado A, Ambrosino N, Cavalli A, Gorini M, Navalesi P, Confalonieri M. Respiratory intensive care unit: an update. Rassegna di Patologia dell'Apparato Respiratorio. 2004;19:18-34.
33. Corrado A, Ambrosino N, Rossi A, Gruppo di Studio AIPO "Riabilitazione e Terapia Intensiva Respiratoria". Unità di Terapia Intensiva Respiratoria. Rass Patol App Respir. 1994;9:115-23.
34. Corrado A, Ambrosino N, Cavalli A. Unità di terapia Intensiva Respiratoria:update. Rass Patol App Respir. 2004;19:18-34.
35. Confalonieri M, Mollica C, Nava S. Censimento delle Unità di Terapia Intensiva Respiratoria in Italia. Rass Patol App Respir. 1998;13:186-92.
36. Scala R, Confalonieri M, Corrado A. Il secondo censimento AIPO delle UTIR in Italia tra "certezze scientifici che e criticità organizzative". Rass Patol App Respir. 2011;26:242-9.
37. Marchese S, Corrado A, Scala R, Corrao S, Ambrosino N, Intensive Care Study Group IAoHP. Tracheostomy in patients with long-term mechanical ventilation: a survey. Respir Med. 2010;104:749-53.
38. MacIntyre NR, Epstein SK, Carson S et al. Management of patients requiring prolonged mechanical ventilation: report of a NAMDRC consensus conference. Chest. 2005;128:3937-54.
39. Windisch W, Dellweg D, Geiseler J et al. Prolonged Weaning from Mechanical Ventilation. Dtsch Arztebl Int. 2020;117:197-204.
40. Boles JM, Bion J, Connors A et al. Weaning from mechanical ventilation. Eur Respir J. 2007;29:1033-56.
41. Vitacca M, Clini E, Porta R, Ambrosino N. Preliminary results on nursing workload in a dedicated weaning center. Intensive Care Med. 2000;26:796-9.
42. Grasselli G, Zangrillo A, Zanella A et al. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. JAMA. 2020;323:1574-81.
43. Winck JC, Ambrosino N. COVID-19 pandemic and non invasive respiratory management: Every Goliath needs a David. An evidence-based evaluation of problems. Pulmonology. 2020;26:213-20.
44. Scala R, Renda T, Corrado A, Vaghi A. Italian pulmonologist units and COVID-19 outbreak: "mind the gap"! Crit Care. 2020;24:381.
45. AIPO. Il 94% delle Pneumologie è in prima linea nella lotta contro l'infezione da COVID-19. 2020; Available at http://www.aiponet.it/news/speciale-covid-19/2463-il-2494-delle-pneumologie-e-in-prima-linea-nella-lotta-contro-l-infezione-da-covid-2419.html.
46. Kim SC, Kong SY, Park GJ et al. Effectiveness of negative pressure isolation stretcher and rooms for SARS-CoV-2 nosocomial infection control and maintenance of South Korean emergency department capacity. Am J Emerg Med. 2021;45:483-9.
47. Grigonis AM, Mathews KS, Benka-Coker WO, Dawson AM, Hammerman SI. Long-Term Acute Care Hospitals Extend ICU Capacity for COVID-19 Response and Recovery. Chest. 2020;159:1894-1901.
48. Aliberti S, Amati F, Pappalettera M et al. COVID-19 multidisciplinary high dependency unit: the Milan model. Respir Res. 2020;21:260.