

Intermediate respiratory intensive care units in Europe: a European perspective

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Historical background

In the early 1950s an outbreak of poliomyelitis in Scandinavia highlighted for the first time the need for hospital units specialised in treating episodes of acute respiratory failure. The first intensive care units (ICUs), at that time utilising non-invasive techniques such as tank ventilators, were therefore built in Northern Europe. Later on positive pressure ventilation via an endotracheal tube or a tracheotomy became common and the modalities of non-invasive ventilation were progressively abandoned.¹ Insertion of an endotracheal tube is usually performed after sedation and paralysis of the patient, and for this reason for many years mechanical ventilation was the exclusive field of anaesthetists so that in many European countries ICUs are still run mainly by anaesthetists rather than "organ specialists". This clinical and management background has also conditioned respiratory medicine in Europe, and only a few European countries include specific training in emergency medicine and mechanical ventilation as part of the programme of the specialisation in respiratory medicine.² This is not the case in North America where intensive care medicine has been closely linked to respiratory medicine for many years. In the middle of the 1960s, following the pioneering experience of Dr Petty,³ a growing number of specialised respiratory intensive care units (RICUs) started to spread all over the USA alongside, and not in competition with, "general" ICUs.⁴ The RICUs were designed to treat acute or acute-on-chronic respiratory failure due to any pulmonary disease with monitoring systems equal to those of the ICUs. These units necessitated a specialised environment and personnel, with increasing costs, so that in the 1980s a new class of "step down" or "intermediate" critical care units, the so-called non-invasive respiratory care units (NRCU) or high dependency units (HDU)⁵ were developed as a less costly option for patients receiving long term mechanical ventilation and for "basic" non-invasive monitoring and management of high risk, critically ill patients.⁶ The increasing amount of clinical and scientific data supporting the use of non-invasive mechanical ventilation as a "first line treatment" for acute respiratory failure⁷ has also increased the interest in HDUs and NRCUs.

Rationale behind opening a unit

The rationale for ICUs was formulated by the UK Working Party on Intensive Care in 1989 as "a service for patients with potentially recoverable disease who can benefit from more detailed observation and treatment that is not generally available in the standard ward and departments".⁸ The increasing number of admissions to ICUs and the relatively high costs have given rise to wide discussion about the utilisation of ICU resources, not only from a medical point of view but also from economic, ethical, and political viewpoints. For example, it has been estimated that in the USA at the end of the 1980s the costs of intensive care medicine comprised approximately 20% of hospital associated health costs.⁹ The institution of invasive mechanical ventilation seems to have been an expensive procedure and, indeed, Wagner has drawn attention to this problem stating "there is some level of cost of acute care that is beyond our society's economic capacity".¹⁰ On the other hand, it has been shown that about 40% of the patients admitted to ICUs, where the daily costs are very high, never receive active intensive care, including mechanical ventilation,¹¹⁻¹³ and therefore may be considered ideal candidates for specialised intermediate respiratory care units. In particular, two recent studies have shown that, of patients affected by acute respiratory failure due to pulmonary diseases and admitted to an ICU, only about 40% needed to be invasively ventilated.^{14 15}

The opening of intermediate respiratory care units providing non-invasive monitoring such as ECG and Sao_2 , non-invasive ventilation, not needing major expenditure on building a dedicated area, and with a better nurse/patient ratio than the general ward, allows a more efficient and cost effective approach to respiratory care without decreasing the quality of care or adversely affecting outcome.¹⁶ These units can also function as step down units for those patients who no longer require all the facilities of the ICU but do need more intensive monitoring and care than that available on a general ward, and for patients proving difficult to wean from mechanical ventilation.¹⁷ There is a subset of patients affected by pulmonary diseases whose stay in the ICU is very prolonged because of complications due to invasive ventilation or underlying chronic health conditions

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that are exacerbated by a critical illness. These chronic patients have recovered from the most acute phase of critical illness but still require intensive nursing or physiotherapy for several weeks before they can be weaned from the ventilator or discharged.^{18 19} In one study these “chronically critically ill” patients, representing only 3% of the total number of patients admitted to the ICUs, used almost 40% of the total patient days of care.¹⁹ Elpern and co-workers¹⁶ demonstrated a decrease in the daily costs of almost US\$2000 associated with the transfer of ventilated patients from the general ICU to the NRCU. From another angle, Byrick *et al*²⁰ examined the impact on critical care utilisation of the closure of an intermediate care unit and found that the number of non-emergency ICU admissions increased from 18% to 27% after the closure, and that the severity score of the patients, measured by the APACHE II, decreased significantly. In other words, this study demonstrated that less severely ill patients were treated at a higher cost after the NRCU was no longer available.

The principal financial savings of intermediate respiratory care units are due to the diminished nursing staff requirements, reduced ancillary services (laboratory tests, radiography), and decreased overheads because of simpler monitoring equipment and ventilators. Other savings may be related to the decreased number of complications occurring as a consequence of invasive monitoring, although the efficacy and cost effectiveness of non-invasive approaches has not been clearly proven. These reductions in costs do not apparently influence the quality of care. The rationale for opening intermediate respiratory care units is not based on economic factors alone; these units act as a “protected” environment in which the patients have greater privacy, there is less light and noise, and visitor access is easier than on many ICUs. There is evidence that the comprehensive staff intervention in intermediate respiratory care units seems to have enhanced weaning success from prolonged mechanical ventilation and recovery from episodes of acute respiratory failure.^{18 21} Since “single organ” intensive care units may be an expensive luxury

Table 1 Proposed admission criteria in ICUs, and NRCUs or HDUs

Patients to be admitted to an ICU:
(1) patients who require, or may soon require, endotracheal intubation
(2) patients needing invasive monitoring
(3) more than one organ/system failure
(4) haemodynamic instability
Respiratory patients to be admitted to an NRCU or HDU:
(1) patients with life threatening respiratory illness but not likely to need endotracheal intubation in the near future
(2) patients requiring non-invasive ventilation acutely
(3) patients requiring mask CPAP for respiratory failure
(4) patients with a tracheostomy (except when longstanding)
(5) patients discharged from intensive care unit

in some European countries, an acceptable way forward in general hospitals would be to provide an HDU to take acute respiratory patients as well as other medical emergencies such as cases of ketoacidosis, gastrointestinal bleeding, drug overdoses etc, in addition to the traditional ICU and coronary care units.

Admission criteria

The criteria for admission to respiratory care units are strictly linked to the definition of the latter. Units dealing with acute respiratory care may be divided into: (1) ICUs—usually general, occasionally specialised (e.g. RICU); (2) NRCUs or HDUs—usually general, occasionally single organ (in larger centres these would also take on difficult weaning problems, chronically critically ill patients, etc.); and (3) general or respiratory medicine wards.

The RICUs in Europe are usually in large specialist cardiothoracic centres and are similar to general ICUs in monitoring, technical expertise, and ancillary support. In NRCUs or HDUs intensive but non-invasive monitoring is available; the physicians should be familiar with cardiopulmonary resuscitation and management of artificial ventilation, primarily using non-invasive modalities. There are no specific guidelines about the admission criteria and the suggestions in table 1 are based on data extrapolated from the few papers published on the subject.^{3-6 16}

A particular subset of NRCUs would function as specialist weaning units, taking patients who may require longer term ventilatory support. Figure 1 illustrates the ideal route through the hospital of a patient with acute respiratory failure.

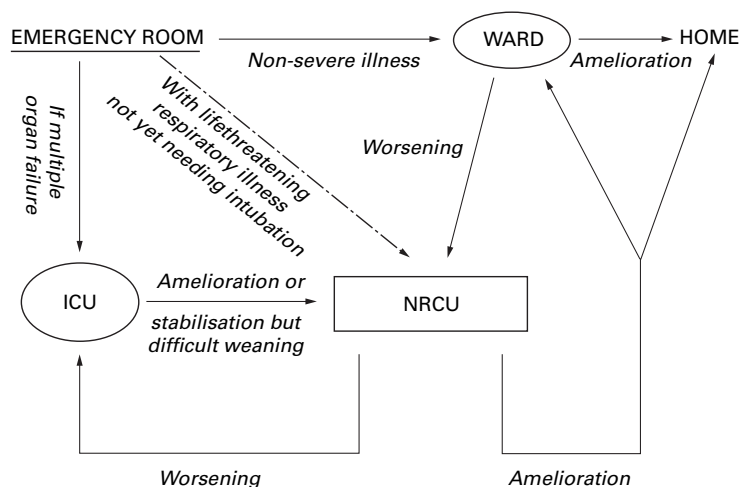


Figure 1 Flow of patients with acute respiratory failure due to a pulmonary cause.

Standards

STAFF

Nurses

In the classical ICU the nurse-to-patient ratio is 1:1. One of the most important cost savings in the intermediate respiratory care units is due to the reduced number of nurses. Elpern *et al*¹⁶ calculated that the standards for the NRCU, where the patients are ventilated non-invasively, are slightly lower (1:3 or 1:4 for the day shift and 1:4 or 1:5 in the evening and night shifts).

Respiratory physiotherapists

Although very few countries in Europe have adopted the North American idea of respiratory therapist (with the role of direct care and

management of ventilators and ventilated patients), this role is often taken by physiotherapists who are extremely important not only in “classical” rehabilitation procedures such as postural drainage and passive or active training of limb and respiratory muscles, but also in the weaning process and in the administration of non-invasive ventilation.^{22–23} The optimal therapist-to-patient ratio is 1:6, but only during the day since in most countries their shifts do not cover the whole 24 hours.

Medical doctors

The standard ratio for medical doctors has been formulated as 1:6.5 patients for each shift.²⁴ There is no mention in any peer reviewed paper about the characteristics and the competence of this category of professional. The Italian position paper on intermediate respiratory care units²⁵ stated that the medical doctors in charge of these units should have “a speciality in respiratory disease with clinical and theoretical experience in emergency medicine, with particular emphasis on mechanical ventilation and cardiopulmonary resuscitation”. Nurses, therapists and medical doctors working in an intermediate respiratory care unit should in any case be trained in this particular field and highly skilled in the use of the various invasive or non-invasive monitors and in the art of ventilator management, especially using non-invasive techniques.

Location

There are no guidelines on where an intermediate respiratory care unit should be located. Theoretically it should be within a respiratory department because, like a coronary unit, it should allow immediate admission of the patients located in the ward in case of acute deterioration. The NRCU allowing only non-invasive monitoring should be linked geographically and functionally with the ICU and therefore located nearby.²⁶ The total floor area is recommended to be roughly 2.5–3 times that of the specific patients’ area. However, this may not be available and people skills and equipment are more important than the floor area. The open setting is usually preferred to the closed setting for these units since in this environment one nurse can care for more patients. Indeed, the open setting, whilst maintaining controlled access and a high level of infection prevention, allows some access to the patients by relatives who may be directly involved in the care programme. Isolation should be necessary only for those patients suffering from communicable or infectious diseases; the use of single rooms is constrained by economic factors since isolation requires almost 100% more personnel per bed than an open ward. There are also other issues in the design of the ward that need to be considered. A higher level of monitoring and the use of non-invasive ventilators requires access to more power sockets than would be normal on a general ward. There should be sockets and service outlets on both sides of the bed, and they should not impede nursing care. Adequate access to the bedhead should also be possible for emergency manoeuvres. A central

nursing station that allows administrative work and at the same time direct patient surveillance,²⁷ together with monitoring systems for medical gases, patient communication devices, etc, is ideal. Storage space for consumable items, particularly those needed for non-invasive ventilation, should be as close as possible. All compressed medical gases should be supplied at the same pressure to prevent cross-leakage in gas mixers; vacuum, oxygen and compressed air pressures should be centrally monitored with visual and audible alarm systems.

Ventilators and monitoring systems

Despite the fact that it has been recently shown that most of the so called “home ventilators” performed “in vitro” as well or even better than traditional ICU ventilators,^{28–29} they actually do not allow direct “on line” monitoring of pressure, volume and flow. These are important features, especially during the first period of ventilation when it is important to assess the patient-ventilator interaction,³⁰ respiratory mechanics,³¹ and, during non-invasive modalities, the expired tidal volume. Indeed, portable ventilators do not have a gas blender so the operator does not know exactly what concentration of oxygen the patient is receiving. For all the above mentioned reasons the possibility of using some ICU ventilators, together with those designed for home use, is highly recommended also in the NRCU. Indeed, a new category of “intermediate” ventilators (both in price and in technical characteristics) has recently emerged and this may be the ideal choice for an intermediate respiratory care unit.

Accurate monitoring may be the most important feature of the intermediate respiratory care unit. The “French model”³² is based on the division of these units into different levels according to the facilities for monitoring (the more invasive and more sophisticated they are, the higher the level is), but this classification is not common in the rest of Europe. Monitoring is equally imperative in acute and post-critical respiratory patients, since they have a high risk of acute and unexpected deterioration. Invasive monitoring should be limited to the ICU while non-invasive monitoring should be a characteristic of the NRCU. Basic physiological non-invasive parameters include heart rate and rhythm, blood pressure, oxygen saturation, end tidal CO₂, respiratory rate and breathing pattern, neuromuscular drive (P_{0,1}), maximal inspiratory pressure, dynamic lung volumes and peak flow.^{16–33} This does not necessarily mean that all these non-invasive parameters should be measured in all the patients, but their availability may be useful. More sophisticated and expensive, but not necessarily more important, parameters are probably only needed in more specialist centres. These include measurement of transdiaphragmatic pressure (P_{di}), electrical or magnetic phrenic nerve stimulation, indirect calorimetry, colour-Doppler echocardiography, respiratory inductive plethysmography, and electromyography of the diaphragm or other respiratory muscles. The severity of neurological dysfunction in critically ill respiratory patients is best assessed using the Kelly score, specifically designed for

Table 2 Situation regarding respiratory intensive care units (RICUs) in some European countries

Country	No. of RICUs	No. of RICU beds	Monitoring systems	Patients	RT service	Nurse: patient ratio	Location	Government acknowledgement
Spain	1 + several NRCU	8	Invasive and non-invasive	All	No	1:2	Inside pn.	Yes
Slovenia	2	12	Invasive and non-invasive	All	?	1:2	Inside pn.	Yes
Greece	2	15	Non-invasive	ACRF	?	1:3	Inside pn.	Yes
Switzerland	4*	20	Invasive and non-invasive	All	?	1:2	Outside pn.	No
Turkey	8	53	Non-invasive	ACRF	Some	1:2-1:3	Inside pn.	Yes
Denmark	2†	10-15	Non-invasive	ACRF	Yes	—	Inside pn.	—
UK	10†	>50	Non-invasive	ACRF	Some	—	Inside pn.	—
Italy	22†	143	Non-invasive	ACRF	14 units	1:3-1:4	Inside pn.	Only 2
France	16 + several NRCU	170	Mainly invasive	All	Yes	1:2	Mainly inside pn.	Yes
Germany	15	70	Non-invasive or invasive (2 units)	ACRF and all in 2 units	Some	1:3-1:4	Inside or outside pn.	No
Holland	6§	50	Invasive	All	Some	1:2	Inside or outside pn.	—

All = including respiratory patients to be admitted to ICU (table 1); ACRF = including patients to be admitted to NRCU or HDU only (table 1); RT = autonomous respiratory therapist service; inside pn = inside a Pneumology division; outside pn = outside the Pneumology division; * in some university hospitals the ICUs are divided "unofficially" into general and respiratory units; †including "multiorgan" high dependency units; §two of six run by pneumologists only.

these patients.³⁴ Clinical scores such as a therapeutic intervention scoring system,³⁵ simplified acute physiology score,³⁶ and acute physiology and chronic health evaluation³⁷ may be useful in evaluating the degree of illness and the likelihood of recovery. Severity of illness scores, together with the diagnosis, may also be a guide to selecting patients to admit to the ICU or NRCU.^{38, 39} Patients who require indwelling arterial or pulmonary artery catheters or monitoring of passive respiratory mechanics needing muscle paralysis should be cared for on the RICU. Despite the recent technological advances, there is still no substitute for properly trained observers providing direct patient care. Clinical examination can still give a great deal of information regarding the status of the patient and may be an early indicator of respiratory muscle fatigue, neurological deterioration, or the development of complications. However, there are very few data about the effectiveness of such units, particularly with regard to outcome, duration of stay, etc, and it is hoped that these will be fields of future research.

The European situation

The situation of respiratory medicine in Europe is very confused. The data in the present survey are based on personal communications given by recognised authorities in some countries. Unfortunately for various reasons it was not possible to obtain information about all the European countries. Table 2 summarises the European situation on intermediate respiratory care units. Italy is the country with the largest number of respiratory units. In France these units are numerous and widely spread geographically, but the organisation and division by level (according to the monitoring system available) is the most advanced. Respiratory units are officially recognised in only a very few countries (France, Greece, Italy, Spain, Slovenia, Turkey) while, in most, official recognition has not yet been given. Indeed, the number of respiratory care units actually functioning is very small. Apparently there are about 10 RICUs, although "step down" or "intermediate" units seem to be more numerous and have been increasing in the last few years. It has been suggested that the ideal number of beds per head of population for a respiratory care unit would be 1/100 000.⁴⁰ A

calculation of the actual bed availability in Europe is impossible at the moment but, based on the data collected, we can estimate roughly that this ratio is about 1/1 000 000 in the countries considered in table 2. France is again the country where this ratio most closely approaches the ideal. Since the French Government is probably no more enlightened than most others, we believe that the responsibility for the lag in respiratory medicine compared, for example, with cardiology (how many coronary units!) is due to "political mistakes" of our local societies, academic system, and medical corporations. Despite the fact that acute respiratory failure due to COPD is the fifth commonest cause of death in the Western World, most of the speciality schools of respiratory medicine in Europe are still focused on the study of parenchymal diseases such as tuberculosis, pneumonia, and sarcoidosis while the physiopathological features and the treatment of severe failure of the lung and thoracic pump are not considered to be so important. Indeed, other diseases such as asthma or pulmonary complications of immunodeficiency states such as AIDS seem to be more "advertised and sponsored" by the media and our local societies because of the emotional and economic impact they have on the population.

Conclusions

Even though there have only been a few studies of the cost/benefits of respiratory care units, mainly done in North America, it seems reasonable to conclude that these units offer a considerable opportunity to improve the care of an often underestimated population of patients.⁴¹ The opening of intermediate respiratory care units is also likely to increase bed availability in the traditional ICUs where some patients do not actually need active intensive care. In Europe the number of respiratory units is still small, but it is rapidly increasing with major differences between countries. In this era of "evaluation of costs and decisional responsibility"⁴² development of the intermediate respiratory care unit is a bet that European pulmonologists must not lose. The process of cultural and technological conversion of some traditional divisions into respiratory care units must not be over hasty or "solved" by the acquisition of sophisticated ventilators or monitoring systems,

but by the gradual cultural and managerial training of "new" medical and paramedical personnel with an approach similar to that used by the cardiologists concerning their "single organ" (or coronary) intensive care units. It is also mandatory that this process should be sponsored by the national and European Respiratory Societies. Comparative analysis should also help to achieve uniform standards and provide a basis for future research on the effects of these units on morbidity and mortality.

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