ORIGINAL ARTICLE

An intermediate respiratory care unit for spinal cord-injured patients. A retrospective study

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Objectives: Patients with cervical spinal cord injury (SCI) may need prolonged mechanical ventilation (MV) and a long stay in the Intensive Care Unit. An intermediate respiratory care unit (IRCU) can shorten that stay, optimizing hospital resources. The aim of our work has been to evaluate the activity of such a unit in our hospital.

Methods: This is a descriptive retrospective study based on the data of patients with SCI and respiratory failure discharged from our IRCU between 1 July 2010 and 28 February 2013.

Results: We have analysed data from 146 patients with SCI, adding up to 228 admissions (68 first admissions and 160 readmissions due to complications or scheduled review visits). Sixty-three out of the 68 newly admitted patients survived their first admission (92.6%). Length of hospitalization was 195.6 ± 110.4 days, 22 were admitted to monitor their respiratory status and 46 were on MV on admission. Of these, 26 (38.2%) were admitted to attempt weaning from the respirator and 20 (29.4%) to enter a programme of permanent respiratory support. Weaning was successful in 23 out of 26 patients (88.4%), the process taking 47.2 ± 49.3 days. Forty of them (58.8%) were discharged to their home.

Conclusions: An IRCU can manage a substantial number of severe SCI patients who need MV, and an important number of them can be weaned from the respirator. It may also achieve a good success rate in the integration of MV-dependent patients within family and society.

Spinal Cord (2015) **53**, 552–556; doi:10.1038/sc.2015.10; published online 17 March 2015

INTRODUCTION

Respiratory failure due to paralysis of the respiratory muscles is the most frequent cause of morbidity and mortality in patients with spinal cord injury (SCI),^{1–2} often requiring respiratory support with mechanical ventilation (MV) (especially in cervical injuries).³ A substantial number of them will recover spontaneous ventilation after following an adequate protocol of weaning from the respirator. However, if spinal cord damage is above diaphragmatic nucleus (C3–C5), weaning attempts may repeatedly fail and the need of MV may become prolonged or permanent.¹ That fact may entail a long stay at the Intensive Care Unit (ICU), even in otherwise stable patients, to achieve a delayed weaning or planning domiciliary MV. One of the consequences is an increase in costs.^{4,5}

In this context, an intermediate respiratory care unit (IRCU) may have a useful role, providing high-level intensity care with less consumption of resources compared with the ICU and bridging the gap between the ICU and the standard ward of rehabilitation. Patients will also enjoy a higher level of intimacy and privacy than at the ICU.^{6,7} These kind of units have demonstrated good results in other diseases⁸ in terms of utilization of resources, mortality, successful weaning rates and reintegration into the community, as well as saving costs. Some experiences in SCI patients have shown promising results.^{9–12}

With this study, we have tried to evaluate the outcome of the IRCU of our hospital during 2.5 years, with the goal of establishing its

efficacy in the treatment and follow-up of patients with respiratory failure due to SCI.

PATIENTS AND METHODS

Setting

Our hospital is devoted to patients with SCI and attempts to provide a comprehensive program of rehabilitation. The IRCU has been designed to provide a multidisciplinary approach with a thorough respiratory evaluation plus medical, nursing, physiotherapeutic and psychosocial treatment. This unit is equipped with 10 beds, all of them with monitoring facilities such as pulse oximetry and heart rate control, as well as continuous electrocardiography and capnography if needed, and it has resources for non-invasive and invasive MV (with portable volume-controlled ventilators). The unit also carries out the phrenic nerve pacing (PNP) programme. During their hospitalization, patients also perform all the activities of a comprehensive rehabilitation program. Medical staff is composed of three specialists (pneumology, internal medicine and rehabilitation). It offers round-the-clock medical care with support from the ICU medical staff. The ratio nurse/bed is 1:4 during the day and 1:6 during the night, with two respiratory physiotherapists in two shifts.

Patients

All newly admitted patients come from the ICU of our hospital or from ICUs of other hospitals, during the acute phase of SCI with respiratory failure. The readmitted patients come from the community (home, long-term care facilities) or from other acute care hospitals when they suffer any complication. They have been classified into three groups according to the main reason for their admission: (i) new admissions with recent SCI; (ii) admitted for scheduled follow-up visit; and (iii) readmitted because of complications. The reasons for

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Received 2 June 2014; revised 5 January 2015; accepted 8 January 2015; published online 17 March 2015

admission into the IRCU were as follows: (i) to attempt weaning from MV; (ii) to adapt permanent respiratory support, either MV or PNP; and (iii) to monitor their respiratory status because of high risk of recurrence of respiratory failure (unstable respiratory situation). To be admitted into the IRCU patients must be able to cooperate with the treatment, be haemodynamically stable without the need of vasopressor drugs, be free of signs or symptoms of sepsis and, in the case of needing MV, have undergone an open tracheostomy.

Data collection

We have retrospectively collected the data of all patients discharged from the IRCU between 1 July 2010 and 28 February 2013, taken from their medical records. We have analysed demographic, clinical and outcome variables. The level and neurological severity of injury were assessed with the American Spinal Injury Association (ASIA) Impairment Scale¹³ and evaluation of their performance at the IRCU with SAPS II (Simplified Acute Physiology Score II), a score to evaluate severity of illness widespread used for critically ill patients.¹⁴ Mortality after hospital discharge was evaluated at the first scheduled admission, 6 months after discharge.

Statistical analysis

Categorical data are shown as the distribution of frequencies and percentages and quantitative data with the mean $\pm$ standard deviation and median and interquartile range 25–75% when they have high standard deviation.

The statistical treatment for the comparison of variables has been performed using Fisher's exact test for the association of categorical data and Pearson's χ^2 method to compare quantitative variables. To compare several groups in quantitative variables (when they have a high degree of dispersion), we have used an analysis of variance (one-way analysis of variance). Data were analysed with the use of SPSS version 15.0 for Windows software. In contrast, we have rejected the null-hypothesis for an alpha-error less than 0.05 ($P < 0.05$).

RESULTS

We have retrospectively evaluated data of 146 patients admitted to the IRCU because of respiratory failure, adding up to 228 admissions. Of these, 68 were newly admitted patients with recent (less than 3 months) SCI and came from our ICU. The other 78 patients were readmissions, who had already been discharged after their initial programme of rehabilitation; overall, they have meant 160 admissions: 115 hospitalization episodes for scheduled follow-up visit and 45 hospitalization episodes due to complications that took place after their hospital discharge (Figure 1, flow diagram).

Clinical and demographic characteristics of the 68 patients in their first admission are shown at Table 1, and the summary of the IRCU activity can be seen at the flow diagram. Weaning from the respirator was attempted in 26 patients. It was successful (six consecutive days

CRF: chronic respiratory failure; PU: Pressure Ulcer; MV: Mechanical ventilation; PNP: Phrenic nerve pacing

Figure 1 Outcome according to reason for admission CRF, chronic respiratory failure; PU, pressure ulcer.

without MV support) in 23/26 patients (88.4% success rate, 11.6% failure rate). The weaning process took 47.3 ± 49.3 days. Two patients were weaned from the ventilator after the implantation of a PNP.

Tracheostomy closure was possible in 13 patients out of the 22 who had been admitted for monitoring (59.1%), once respiratory function became stable and an effective cough was demonstrated. There is an association between the need of MV and destiny after discharge: patients with MV are admitted to another hospital or long-term care facility with higher frequency (RR = 1.98; $P = 0.014$ with odds ratio 4.86 (confidence interval 1.46–16.24)) compared with patients that do not need MV. Regarding the survival outcome in our series, five patients (7.5%) died during their first admission: one on MV, another already weaned and the remaining three belonged to the group admitted just for monitoring. The causes of death were sepsis and septic shock in three patients, massive pulmonary embolism in one

and an acute coronary event in the fifth patient. Seven patients died after hospital discharge, at an average of 66.7 days (median 36, range 2–293 days); three of them were on MV. Three died at home, three in a chronic care facility and one in an acute care hospital.

Length of hospitalization at the IRCU and factors that may bear an influence on it are shown at Table 2. Multivariate analysis demonstrates that the only independent variables related to a longer hospital stay are the type of SCI (traumatic versus non-traumatic, $P = 0.049$) and the goal of the hospitalization (withdrawal or maintenance of MV versus admission just for monitoring, $P = 0.012$).

Readmissions were due to either severe complications that occurred in the community or periodic scheduled follow-up. The 34 patients readmitted because of complications amount 45 hospitalizations (26 caused by worsening of their chronic respiratory failure and 19 by other infectious conditions: 13 cases of sepsis from the urinary tract, 3 cases of acute cholecystitis and 3 with bacteraemia from a pressure sore). Their mean length of hospitalization was 53 ± 56.3 days, and their SAPS II score on admission was 23.3 ± 9.1 . Nine patients were admitted with respiratory support (MV) after a recurrent episode of respiratory failure. Six of them could be weaned again (66.6%), taking 17.2 ± 19.3 days. One patient died of septic shock during the weaning process and it failed in two cases, these patients entering the programme of permanent MV.

Sixty-one patients were admitted because of scheduled follow-up programme (adding up to 115 hospitalizations), having a mean length of hospitalization of 13.8 ± 17.1 days. One of them died because of a pulmonary embolism. Their SAPS II score on admission was 17.6 ± 6.8 , smaller than the previous group ($P < 0.001$). In 71 hospitalization episodes (61.7%), respiratory support was needed as a continuum of care from the community (16 admissions of patients with PNP). Most of these patients (94.8%) went back to their previous place of residence on being discharged; two patients died during their hospitalization and four of them (3.48%), who were previously at their

Table 1 Characteristics of newly admitted patients (first admission)

Number of patients	68
Sex: Male	49 (72.1%)
Female	19 (27.9%)
Age in years (mean $\pm$ s.d.)	53.8 ± 16.6
<i>Aetiology of the SCI</i>	
Traumatic	40 (58.8%)
Non-traumatic	20 (29.4%)
Post-degenerative spinal surgery	8 (11.8%)
<i>Level of SCI</i>	
Cervical C1-C4	44 (64.7%)
Cervical C5-C8	11 (16.2%)
Thoracic	13 (19.1%)
<i>ASIA score</i>	
A	42 (61.8%)
B	13 (19.1%)
C	10 (14.7%)
D	3 (4.4%)
Mean stay at the ICU in days	55.3 ± 27.2
Median (IQR) stay at the ICU in days	54 (15–219)
Mean stay at the IRCU in days	171.4 ± 121.1
Median (IQR) stay at the IRCU in days	164.5 (66–254)
SAPS II score on admission at the IRCU	25.1 ± 7.8
<i>Reason for admission at the IRCU</i>	
Monitoring	22 (32.4%)
Weaning from the respirator	26 (38.2%)
Adaptation of permanent respiratory support	20 (29.4%)
<i>Outcome after first admission (n = 68)</i>	
Discharged home	47 (69.1%)
Discharged to extended-care facilities	13 (19.1%)
Transferred to another acute care hospital	3 (4.4%)
Deceased	5 (7.4%)
<i>Respiratory situation on discharge (n = 63)</i>	
Spontaneous breathing	43 (68.2%)
With MV	18 (28.6%)
With PNP	2 (3.2%)

Abbreviations: ASIA, American Spinal Injury Association; ICU, intensive care unit; IRCU, intermediate respiratory care unit; IQR, interquartile range 25–75%; MV, mechanical ventilation; PNP, phrenic nerve pacing; SAPS II, Simplified Acute Physiology Score II; SCI, spinal cord injury.

Table 2 Length of stay at the IRCU in days by ANOVA one-way analysis

	Median (IQR)	P
<i>According to the degree of SCI</i>		
ASIA A or B	200 (121.5–272)	0.007
ASIA C or D	27 (1–120)	
<i>According to aetiology, first admission</i>		
Traumatic SCI	170 (81–275)	0.52
Non-traumatic SCI	169.5 (37–232)	
Postsurgical SCI	161 (55–190)	
<i>According to main goal of the admission</i>		
For monitoring	53.5 (2–144)	0.018
For permanent MV	167 (101–274)	
For weaning	213 (170–270)	
<i>According to their origin</i>		
First admission	164.5 (66–254)	<0.001
Readmission because of complications	33 (7–97)	
Readmission because of scheduled follow-up, without complications:	9 (6–16)	

Abbreviations: ANOVA, analysis of variance; ASIA, American Spinal Injury Association; IQR, interquartile range 25–75%; IRCU, intermediate respiratory care unit; MV, mechanical ventilation; SCI, spinal cord injury. Length of stay at the IRCU in days expressed as median and 25–75% IQR.

home, could not return because of worsening of their functional capabilities or failure of social support. They were discharged to a chronic care health facility.

DISCUSSION

The main goal of rehabilitation after a SCI is to achieve the highest possible level of functional capability. In patients with respiratory support, this entails an attempt of weaning from MV but, if complete weaning is impossible, returning home with part or full time—usually nocturnal—ventilation is a possibility. This process requires the retraining and strengthening of undamaged respiratory muscles, as well as training in the clearing of respiratory secretions and the training of the future caregivers; hence, the weaning process may involve a long stay in the ICU.^{4,5,12} The aim of an IRCU is to facilitate this process to shorten the period in the ICU and therefore lessen the costs; and if weaning becomes impossible to plan an adequate programme of home ventilation.^{5,15} In some selected patients, another option is the placing of a PNP, improving survival and quality of life.¹

Length of hospitalization during first admission in our series may seem very prolonged, but it has to be taken into account that patients complete the whole rehabilitation programme in hospital, because this is a national hospital and most people live far from it. Furthermore, hospitalization is longer in the cases of SCI of traumatic origin instead of non-traumatic, possibly because they need longer periods of physiotherapy. In the case of patients admitted for weaning or adaptation of permanent MV, who also have longer length of hospitalization (versus patients admitted just for monitoring), they also possibly need longer respiratory physiotherapy and caretakers have to be trained before discharge. Length of hospitalization is shorter in patients who have been readmitted because of complications, although it may increase if a new weaning process is needed. Obviously, duration is even shorter in patients admitted for scheduled follow-up; in their case, mortality is very low (as could be expected), and most of them return uneventfully to their previous place of residence.

Although it is difficult to establish comparisons between our patients and other series with scarce number of SCI patients, we think that the rate of successful weaning is substantial: 34.9% (29 out of 83 patients, a higher figure than reported in other series of unselected mechanically ventilated patients, 22%).¹¹ Furthermore, the success rate is even better if we eliminate from this figure the patients in whom weaning is impossible because of the degree of severity of SCI (29 out of 35, 82.8%). The weaning process in our patients is slow because of the need of retraining and strengthening of the undamaged respiratory muscles (in our series, average was 47.3 days, median 25, versus 29 days of average in patients with neuromuscular diseases¹⁰ or 12.5–15 days in unselected patients),^{16,17} and it is similar to other series of SCI patients (26.6–56 days).^{5,12}

Regarding destiny on discharge, home discharge in the case of SCI patients with the need of respiratory support is always difficult, as they need relatively sophisticated equipment and the clinical situation must be stable to be looked after by the caretaker(s). They have to need a low fraction of inspired oxygen, certain possibility of communication, adequate nutritional supply and psychological support. In our experience, we have observed a higher percentage of patients admitted to other health-care facilities (other acute care hospitals or chronic care facilities) in the case of patients discharged with respirator versus discharged on spontaneous respiration ($P=0.031$). Home discharge is easier if respiratory support is supplied through PNP instead of MV.¹ Our percentage of home discharge (69.1%) is similar to other published series of post-traumatic SCI patients (29–75%),^{10,18} but

greater than in the case of other unselected MV-dependent patients, between 20¹⁹ and 55%.²⁰

Although in our study, we have not performed an economic evaluation, other authors⁸ have demonstrated that the cost of stay in the case of chronically ventilated patients is remarkably reduced in units with lower level of care than the ICU.

As we have reported a descriptive study performed at a single hospital, we are aware of some of its limitations. First, it evaluates the situation of SCI patients in Spain, a country with a system of care for these patients, which can be qualified as intermediate, and affected by regional differences; it is therefore difficult to establish comparisons with different settings. Second, a cost-efficiency analysis has not been performed: we deemed it very difficult given the heterogeneity of our population (patients are admitted from diverse hospitals and in different stages of their evolution, and hence data collected at the beginning of the respiratory failure and initial treatment are almost impossible to compare). Also for this reason (patients being admitted from different regions of our country), it is very difficult to control selection bias.

CONCLUSIONS

An IRCU in a hospital of neurorehabilitation for SCI patients has demonstrated its usefulness: we have managed a substantial number of patients who need MV outside the ICU, and we have been able to reintegrate a high percentage of these patients with permanent respiratory support into the community. We have achieved a substantial rate of weaning from the respirator in cases of long-standing MV, the weaning process taking place while patients are following their rehabilitation programme. The fact that our mortality rate has been low could be expected, as patients are admitted after the period with higher mortality in SCI (the first 3 months).

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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