Impact of Taiwan's Integrated Prospective Payment Program on Prolonged Mechanical Ventilation: A 6-Year Nationwide Study

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OBJECTIVE: The integrated prospective payment program (IPP), which encourages the integrated care of mechanically ventilated patients in order to reduce the heavy utilization of high-cost ICUs, has been implemented by Taiwan's Bureau of National Health Insurance since July 2000. The aim of this study was to assess the impact of this program on weaning, hospital stay, mortality, and cost for patients requiring prolonged mechanical ventilation (PMV). METHODS: A data set of 1,000,000 randomly selected insurance holders from the National Health Research Insurance Database, Taiwan, was retrospectively analyzed. We enrolled 7,967 adult patients (age ≥ 17 y) who required PMV (duration ≥ 21 d) over a 6 year period. RESULTS: There were 3,275 patients on PMV before (1997–1999) and 4,692 patients on PMV after (2001–2003) the IPP implementation. After IPP implementation, PMV was found to be required in patients with a significantly higher age, lower urbanization level, higher income status, and a higher prevalence of neuromuscular disease ($P < .001$). In-hospital mortality was similar between the 2 periods (17.2% before vs 16.2% after, $P = .26$), but the weaning rate was significantly lower in the latter period (68.1% vs 64.2%, $P < .001$). Total hospital stay (75.3 d vs 95.1 d, $P < .001$) and duration of mechanical ventilation usage (55.8 d vs 71.6 d, $P < .001$) were both significantly higher after the IPP implementation. Total hospitalization cost in the PMV patients was significantly lower after IPP implementation. CONCLUSIONS: Implementation of the IPP program reduced the total hospitalization cost, increased the duration of mechanical ventilation usage and stay, and reduced the weaning rate in PMV patients. *Key words: integrated prospective payment; prolonged mechanical ventilation; health insurance; weaning.* [Respir Care 2013;58(4):676–682. © 2013 Daedalus Enterprises]

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Introduction

The rapid increase in the number of patients requiring prolonged mechanical ventilation (PMV) has attracted much attention in the healthcare system, because this population is a very resource-intensive in-patient subgroup.[1,2] Due to the aging population, increased acuity and severity of disease, and advances in disease management, the shortage of ICU beds at hospitals has emerged as a critical issue.[2,3] Efforts have been made to move patients who need ventilator support beyond the acute stage but who are less critically ill into settings other than ICUs, including specialized respiratory care units and intermediate- and long-term care facilities.[4,5]

A PMV was defined as 21 consecutive days of invasive mechanical ventilation with over 6 hours per day in the United States[1]; the same criterion applies in Taiwan. Experiences in the United States reveal that in 23 long-term care hospitals, more than half of post-ICU ventilator-dependent patients were successfully weaned from PMV.[6] Studies have found that transferring patients from the ICU to a regional weaning center or chronic ventilator-dependent unit improves survival after discharge[4] and reduces costs.[7,8] However, these studies of cost analysis are often conducted in a single care center or unit, limiting the ability to generalize the results across all centers. Furthermore, cost and resource utilization in healthcare are strongly associated with patient characteristics and comorbidity. For patients with PMV, cost estimations that take these factors into consideration are rare.

In March 1995, Taiwan implemented its universal National Health Insurance (NHI) program, which provided coverage to 99% of the population by 2007.[9] In July 2000, to manage the shortage of ICU beds and to control the use of medical resources, the Bureau of NHI implemented an Integrated Prospective Payment (IPP) program for patients who need PMV. This payment program is an attempt to encourage large-scale hospitals, medical centers, and regional hospitals to establish respiratory care centers (RCCs) that provide programs for the aggressive weaning of ventilator support for hemodynamically stable patients who are receiving PMV. This integrated payment plan covers 4 types of mechanical ventilator care: fee-for-service ICU care (for up to 21 d), per-diem RCC (for up to $\leq$ 42 d), capitation respiratory care ward (RCW), and per-month home ventilation service.[10]

However, studies focusing on the impact of the IPP program on patients requiring PMV are limited. This study aimed to determine if the IPP program has beneficial effects on PMV patients in the NHI research data set in Taiwan. The major end points of analysis included hospitalization costs, hospital stay, weaning rate, and mortality rate both before and after IPP implementation. Before the program, many PMV patients occupied ICU beds. After the program these PMV patients had a route to transfer to RCCs for intensive ventilator weaning, so the ICU had more beds for other acute and severe patients.

QUICK LOOK

Current knowledge

The rapid increase in the number of patients requiring prolonged mechanical ventilation (PMV) has attracted attention because of the related high costs. To manage the shortage of ICU beds and to control the use of medical resources, Taiwan's Bureau of National Health Insurance implemented an Integrated Prospective Payment program that established respiratory care centers for aggressive ventilator weaning.

What this paper contributes to our knowledge

The program redistributed medical resources, reduced hospital costs, and improved the weaning rate, but increased the duration of mechanical ventilation and stay.

Methods

Data Source and Subjects

This study used a data subset of the research database established by the National Health Research Institute. The data set contains all claims data for 1,000,000 subjects randomly selected from the entire population of 23,000,000 insured citizens. To protect subjects' privacy, personal identification was encrypted before the release of the database for our use. With National Health Research Institute approval, this research data set was used to select study subjects and to obtain healthcare information, including demographic (eg, sex, birth date, residential district or township, income, and occupation); in-patient care utilization (eg, dates of admission and discharge, diagnoses, medical expenses, and discharge disposition); and hospital information (eg, accreditation level and location).

Integrated Prospective Payment Program

Due to limited resources, and after discussions with the physician and patient's family, patients from Taiwan were routinely transferred to respiratory care units. In 2000, the NHI initiated the IPP, also called Integrative Delivery Services, which guarantees ICU care resources for the first 21 days, followed by transfer to a RCC for 42 days of specialized care plus weaning training, followed by transfer to a RCW and/or home care services. As a result, lower-level specialized-care facilities have been developed

to manage PMV patients at a reduced cost, thus making many ICU wards available for other acute care services.[11] The IPP system was the first integrated, near-total insurance coverage, gradual respiratory care reduction system established in the world. The purpose of the RCCs and RCWs is to manage patients who require specialized respiratory care but who no longer need ICU monitoring, thereby improving the implementation of specialized care and reducing wastage of medical resources. The difference between an RCC and an RCW is that the RCC is a ventilator weaning center and the RCW is a ventilator-dependent patient ward for long-term care.

Criteria for Identifying New PMV Patients

Some PMV patients used mechanical machines intermittently and had multiple PMV episodes. Our research focused on patients who had PMV episodes between 1997 and 2003 and were in remission for at least 1 year (no mechanical ventilation for 365 days; ie, admissions linked with use of code 57001B, 57002B, or 57023B, including patients who both did and did not satisfy PMV diagnostic criteria). The sample selection reflects the project's focus on conditions and outcomes among PMV patients whose earlier health was good enough for them to remain free from mechanical ventilation (MV) for at least 1 year before requiring PMV. We suggest that findings from such an investigation can provide more reference information for physicians and policy makers for making decisions related to clinical practice and healthcare resource allocation, compared to that provided by examination of PMV patients who have been using MV services continuously or intermittently for months or even years. Few of our subjects who met this criterion had more than 1 PMV episode. To simplify analysis without losing generalizability, our analysis only included each subject's first PMV episode in this period. On the 21st day after a PMV episode we defined the subject as a new PMV patient for that year, including that day. No subject was included in both periods.

We identified patients with a history of hospitalization for respiratory failure (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] code 518.81), who were treated with daily mechanical ventilator support. To evaluate the influence of the IPP program on subject outcomes, subjects with a first hospitalization with PMV (index hospitalization) during the 3-year periods before (1997–1999) and after (2001–2003) IPP program implementation were selected. Data analysis was confined to the same length of time for the 2 study periods, to reduce incomparability due to variation in long-term patient ventilation management. Patients < 17 years old were excluded. Taiwan's NHI defined a PMV as 21 consecutive days of invasive mechanical ventilation over 6 hours per day: the same criteria applied in the United States.[1]

Subjects' residential areas were grouped into low, moderate, and high levels of urbanization, on the basis of the population density (persons/km^2) of each township and district in which a hospital was located in Taiwan.[12] In multiple liner regression models, the urbanization levels of hospitals was used a covariate instead of subjects. Urbanization was classified as low if the results were in the third quartile of population density, and high if the results were in the fourth quartile of population density. To account for the influence of comorbidities on subject outcome, we calculated the Charlson comorbidity index (see the supplementary materials at http://www.rcjournal.com),[13] resulting in a total score encompassing a range of comorbid conditions weighted by mortality risk.

Costs, Hospital Stay, and Survival

Hospital stay was defined as the time between admission and discharge. The daily cost of hospitalization was calculated using the total medical costs for an entire admission, divided by stay (1 United States dollar = 32 New Taiwan dollars). Using the NHI definition, weaning success was considered as termination of MV for at least 5 days before the last day of follow-up. The follow-up period started during the index hospitalization, from the date of initial mechanical ventilator usage until the date of cancellation of NHI or December 31, 2008, whichever came first.

Statistical Analysis

From 1997 to 2003, patients on PMV for the first time and admitted to an ICU, RCC, or RCW were identified. The sociodemographic characteristics, the hospitals accreditation levels, and the Charlson comorbidity index score (a total score encompassing a range of comorbid conditions weighted based on mortality risk[13]) were compared between subjects receiving PMV in 1997–1999 and in 2001–2003. The Charlson Comorbidity Index contains 19 categories of comorbidity, which are primarily defined using ICD-9-CM diagnoses codes. Each category has an associated weight, which is based on the adjusted risk of 1-year mortality. The overall comorbidity score reflects the cumulative increased likelihood of 1-year mortality; the higher the score, the more severe the burden of comorbidity.[14] Urbanization level of the hospitals was grouped into low, moderate, and high levels, on the basis of the population density (persons/km^2) of each township and district in which a hospital was located in Taiwan.[12] Urbanization was classified as low if the population density was in the third quartile of its distribution; high if the population density was in the fourth quartile.

Outcomes, including mean days on MV, mean stay, cost of hospitalization, discharge disposition, and rate of wean-

ing success, was compared between the 2 study periods. Differences were examined using the chi-square test (Fisher exact test for small sample size) for categorical variables, and the Student *t* test (Mann-Whitney U test for skewed distribution) for continuous variables. Multiple linear regression models were applied to determine whether hospitalizations with PMV during 2001–2003, compared to that during 1997–1999, were associated with reduction in cost and stay. The variables included for adjustment were age, sex, level of urbanization, occupation, insured income, accreditation level of hospitals, Charlson comorbidity index score, and discharge disposition, which may be associated with cost and stay for hospitalization. All analyses were done using statistics software (SAS 9.1, SAS Institute, Cary, North Carolina). All statistical tests were 2-tailed. A P value of $< .05$ was considered significant.

Results

In 1997, the number of total beneficiaries was 20,492,317, including 11,674,073 primary policy holders and 8,818,244 dependents. Male patients accounted for 10,313,824 (50.3%), and female patients for 10,178,493 (49.7%). The mean age of the patients was 32.7 years, and patients > 60 years old accounted for 12.49% of the total study population. In 2003, the number of total beneficiaries was 21,984,415, including 12,878,979 primary policyholders and 9,105,436 dependents. Male patients accounted for 10,938,048 (49.8%), and female patients for 11,046,367 (50.2%). The mean age of the patients was 34.5 years, and patients > 60 years old accounted for 13.01% of the total study population.

During the 1997–1999 and 2001–2003 periods there were 3,275 and 4,692 in-patients requiring PMV, respectively (Table 1). Compared to the subjects identified in first period (1997–1999), the subjects requiring PMV during the second period (2001–2003) were older (mean age 67.8 y vs 66.0 y, $P < .001$), more likely to reside in low-urbanized areas, to be blue-collar workers, and to have lower monthly income. Relative to the first period, the second period had more subjects receiving PMV admitted to regional hospitals rather than to medical centers (see Table 1).

Subjects on PMV in the second period had higher mean Charlson comorbidity indices (1.28 vs 1.67, $P < .001$). They were more likely to be diagnosed with more comorbidities, including cerebrovascular and cardiovascular diseases, dementia, chronic pulmonary disease, peptic ulcer disease, liver disease, diabetes, hemiplegia or paraplegia, and renal disease (Table 2). Subjects in the second period had a significantly higher incidence of neuromuscular disease, including cerebrovascular disease (16.6% vs 24.5%), dementia (2.5% vs 5.2%), and hemiplegia or paraplegia (3.4% vs 6.3%). Malignancy was the leading comorbidity in 1997–1999, whereas diabetes mellitus was the most common in the latter period.

Table 1. Demographics of Subjects Before and After the Integrated Prospective Payment Program

	1997–1999 (n = 3,275)	2001–2003 (n = 4,692)	
Sex			.34
Female	1,182 (36.1)	1,743 (37.2)	
Male	2,093 (63.9)	2,949 (62.9)	
Age range, y			< .001
< 60	949 (29.0)	1,237 (26.4)	
60–69	703 (21.5)	878 (18.7)	
70–79	1,044 (31.9)	1,523 (32.5)	
≥ 80	579 (17.7)	1,054 (22.5)	
Mean ± SD	66.0 ± 16.0	67.8 ± 15.9	< .001
Urbanization*			.040
Low	612 (18.7)	960 (20.5)	
Moderate	711 (21.7)	1,068 (22.8)	
High	1,952 (59.6)	2,664 (56.8)	
Occupation category			< .001
White collar	1,074 (32.8)	1,515 (32.3)	
Blue collar	1,240 (37.9)	2,005 (42.7)	
Other	961 (29.3)	1,172 (25.0)	
Income†			< .001
≥ $468.75	2,091 (63.9)	2,510 (53.5)	
< $468.75	1,184 (36.2)	2,182 (46.5)	
Hospital level			< .001
Medical center	1,533 (46.8)	2,037 (43.4)	
Regional hospital	1,071 (32.7)	1,784 (38.0)	
Other	671 (20.5)	871 (18.6)	

Values are number and percent unless otherwise indicated.
* Urbanization: low = first and second quartile of population density; moderate = third quartile of population density; high = fourth quartile of population density.
† United States dollars.

Compared to the first period, the second period had significantly higher average MV days and stay (75.3 d vs 95.1 d, $P < .001$, Table 3). As expected, the mean number of ICU days decreased from 55.7 ± 92.8 days in 1997–1999 to 21.4 ± 12.7 days in 2001–2003 The average cost per admission was reduced by US $500 ($8,532 in the first period vs $8,031 in the second, $P < .001$). In-hospital mortality of subjects on PMV was not significantly different between the 2 periods: 17.2% in 1997–1999 and 16.2% in 2001–2003 ($P = .26$). However, the rate of weaning success decreased from 68.1% in the first study period to 64.2% in the second study period ($P < .001$).

In the multiple linear regression analysis, in-patients receiving PMV in 2001–2003 had lower hospitalization costs ($545.7, $P < .001$) and longer stay (21.1 d, $P < .001$) (Table 4).

Table 2. Charlson Comorbidity Index Scores

	1997–1999	2001–2003	*P*
Myocardial infarction	131 (4.0)	244 (5.2)	.01
Congestive heart failure	314 (9.6)	493 (10.5)	.18
Peripheral vascular disease	70 (2.1)	170 (3.6)	< .001
Cerebrovascular disease	544 (16.6)	1,147 (24.5)	< .001
Dementia	82 (2.5)	242 (5.2)	< .001
Chronic pulmonary disease	557 (17.0)	1,065 (22.7)	< .001
Rheumatologic disease	24 (0.7)	41 (0.9)	.49
Peptic ulcer disease	355 (10.8)	601 (12.8)	.008
Mild liver disease	183 (5.6)	379 (8.1)	< .001
Diabetes mellitus	627 (19.2)	1,210 (25.8)	< .001
Hemiplegia or paraplegia	111 (3.4)	297 (6.3)	< .001
Renal disease	239 (7.3)	496 (10.6)	< .001
Any malignancy	643 (19.6)	928 (19.8)	.87
Moderate or severe liver disease	54 (1.7)	127 (2.7)	.002
Metastatic solid tumor	262 (8.0)	412 (8.8)	.22
Acquired immune deficiency syndrome	0 (0)	3 (0.1)	.27
No. of comorbidities (mean ± SD)	1.28 ± 1.24	1.67 ± 1.47	< .001

Values are number and percent, unless otherwise indicated.

Discussion

This was the first study to assess the effect of the NHI program on patients requiring PMV in Taiwan. A nationwide representative database was used to compare the changes in clinical outcome and medical resource utilization before and after the two 3-year periods. After the IPP implementation, both the total stay from the first to the second period (75.3 d vs 95.1 d, $P < .001$) and the duration of MV usage (55.8 d vs 71.6 d, $P < .001$) significantly increased. However, total hospitalization cost was significantly lower after the IPP implementation.

According to the official report of the NHI, the average MV days per patient, ICU stay (36.8 d in 1997 vs 33.3 d in 2005), and RCC mortality rate (27% in 1997 vs 9.4% in 2005) decreased, whereas the RCC (30.8% in 1997 vs 44.7% in 2005) and RCW (5% in 1997 vs 12.8% in 2005) weaning rates increased after the IPP implementation.[15] However, these data focused only on certain stages of PMV patients. The current study provides a complete view of this process, showing the decreased total cost and increased number of MV days, stay, and survival months of the PMV patients.

There are some limitations to this study. First, one of the important limitations for the before-and-after comparison study is the potential bias due to temporal trends in some factors, such as mortality and changes in the reimbursement system, which may explain the observed differences between the study periods. However, during this period the NHI of Taiwan had not made changes in the reimbursement system. Second, clinically important differences were observed between the subjects on PMV in the 2 periods. Although we have adjusted for demographic characteristics and comorbid medical conditions in regression analysis for cost and stay, residual confounding due to unmeasured factors may explain a certain degree of the observed effect. For example, the claims data of the NHI do not contain information on disease severity such as the Acute Physiology and Chronic Health Evaluation score, which is an accurate indicator of the case severity in the ICU population.[16] Thus, we were unable to take into account the influence of disease severity. Last, the intervention made by the national health system is specific to Taiwan, which limits the generalizability for other healthcare systems.

Table 3. Mechanical Ventilation Days, Stay, Costs, Mortality, and Weaning Success

	1997–1999 (n = 3,275)			2001–2003 (n = 4,692)			
	No.	Mean ± SD	Median	No.	Mean ± SD	Median	*P*
Mechanical ventilation days							
All	3,275	55.8 ± 93.1	37.0	4,692	71.6 ± 153.0	37.0	< .001
ICU	3,275	55.7 ± 92.8	37.0	4,692	21.4 ± 12.7	19.0	< .001*
Respiratory care center	1	22.0 ± 0	22.0	293	47.5 ± 68.0	29.0	
Respiratory care ward	4	10.3 ± 7.5	9.5	165	68.6 ± 150.0	35.0	
Stay	3,275	75.3 ± 159.7	42.0	4,692	95.1 ± 207.9	43.0	< .001
Cost, United States dollars	3,275	8,532 ± 6,713	7,070	4,692	8,031 ± 6,541	6,761	< .001
Mortality at discharge, no. (%)	562 (17.2)			760 (16.2)			.26
Weaning success, no. (%)	2,231 (68.1)			3,013 (64.2)			< .001

* Via Mann-Whitney *U* test.

Table 4. Multiple Linear Regression Analysis

	Cost (United States dollars)			Stay (days)		
	Coefficient	Standard Error	*P*	Coefficient	Standard Error	*P*
2001–2003 (vs 1997–1999)	–545.7	152.4	< .001	21.1	4.35	< .001
Age	–2.33	5.07	.65	–0.13	0.14	.38
Sex (male vs female)	–115.9	155.4	.46	–13.0	4.43	.003
Urbanization (vs low)						
Moderate	72.7	231.0	.75	–0.005	6.59	> .99
High	189.7	209.7	.36	–6.46	5.99	.28
Occupation category (vs other)						
White collar	263.8	207.8	.20	5.65	5.93	.34
Blue collar	94.6	246.1	.70	10.1	7.03	.15
Income (≥ $468.75 vs < $468.75)*	536.7	207.3	.01	–16.4	5.92	.006
Hospital level (vs other)						
Medical center	1,761.2	206.4	< .001	–14.1	5.89	.02
Regional hospital	1,027.1	209.9	< .001	–8.09	5.99	.18
Charlson Comorbidity Index	27.8	55.7	.62	1.06	1.59	.51
Deceased at discharge (vs alive)	1,297.6	205.5	< .001	74.3	5.87	< .001

* United States dollars.

Previous studies reported that transferring PMV patients from the ICU to a long-term care facility is more cost-effective.[8,17,18] MV is required for acute or chronic respiratory failure patients,[19,20] with an approximately 41% weaning rate in COPD patients.[21] ICU patients were reported to have a 31% mortality rate[19] and 5%–25% PMV rate.[1] Thus, patients requiring MV are increasing annually. The NHI encouraged transferring care to hospital-affiliated RCCs to solve the shortage of ICU beds and aggressively withdraw mechanical ventilation in patients in relatively stable condition, thereby encouraging a step-down to RCWs or home care in PMV patients. After implementing the IPP program, more ICU beds became available.[17] Fortunately, the PMV rate did not increase; it was 28–34% before the IPP implementation and 29–34% after. Nonetheless, the PMV rate was higher and the mortality rate was lower than those reported in other countries.[1]

Univariate analyses in this study showed that the characteristics of subjects were different between 1997–1999 and 2001–2003. The PMV subjects in 2001–2003 were older and more likely to be from low-urbanized areas, to be blue-collar workers, and to have lower monthly incomes, compared with the PMV subjects in 1997–1999. This difference may be associated with the increase in RCCs and RCWs in the countryside, where greater numbers of older people reside, and patients and their families have a relatively lower socioeconomic status. Consistently, the results of this study revealed that PMV patients after the IPP implementation are more commonly admitted to regional hospitals, rather than to medical centers.

We found that cardiovascular disease (myocardial infarction and peripheral vascular disease), cerebrovascular disease, peptic ulcer, liver disease, diabetes mellitus, hemiplegia or paraplegia, and renal disease increased significantly in the second period. This prevalence may be related to the family's attitude toward the patients. In addition, subjects on PMV in the second period were older; this could be another possible explanation for the higher prevalence of comorbidity and severity of illness in this period. Although the prevalence of some comorbidities changed (subjects on PMV in the second period were older), in both study periods the most common comorbidities in subjects requiring PMV were infectious diseases, cardiovascular and heart-related diseases, and diabetes mellitus. This observation is consistent with the findings of previous reports.[6]

Conclusions

In conclusion, the Taiwanese IPP program for PMV patients may redistribute medical resources and reduce hospitalization costs and weaning rate. However, this program increases the duration of MV use and stay.

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