Improved Outcomes With Routine Respiratory Therapist Evaluation of Non-Intensive-Care-Unit Surgery Patients

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BACKGROUND: Respiratory therapist (RT) driven protocols decrease ventilator days and resource utilization in the intensive care unit (ICU). Protocols have been studied in non-ICU settings, but their effect on mortality has been incompletely studied. METHODS: In our neurosurgery step-down, trauma/surgery step-down, and trauma/surgery general units we initiated an RT-driven evaluate-and-treat protocol that included a standardized, quantitative, RT-driven patient-assessment scale and protocolized interventions. Before and after initiation of the protocol we collected data on non-ICU patients at risk for pulmonary complications. RESULTS: The patient groups before (n = 2,230) and after (n = 2,805) protocol initiation were well matched in age, sex, Charlson score, and admitting service. Most of the patients, whether assessed by a physician or an RT, were deemed to have low risk of pulmonary complications and did not require any respiratory treatments. The number of respiratory treatments increased after protocol initiation, but the patients who received respiratory treatments after protocol initiation had shorter ICU stay and hospital stay, and lower total hospital costs than those who received respiratory treatments before protocol initiation. There was a nonsignificant trend toward lower mortality after protocol initiation. CONCLUSIONS: Our RT-evaluate-and-treat protocol for non-ICU surgery patients was associated with more patients receiving respiratory treatments but decreased ICU and hospital stay and lower total hospital costs. Routine RT-driven assessment of non-ICU patients may reduce pulmonary complications in high-risk patients. *Key words: atelectasis, outcomes, respiratory care, pulmonary diseases, postoperative care, hypoxia*. [Respir Care 2009;54(7):861–867. © 2009 Daedalus Enterprises]

Introduction

Pulmonary therapy is important for patients at risk for atelectasis and pneumonia from immobility or inadequate mobilization of pulmonary secretions. Aggressive pulmonary care is particularly important for surgery patients, because postoperative incisional pain can decrease inspiratory effort, alter normal respiratory mechanics, and increase the potential for postoperative pulmonary complications. Many post-surgery patients require medications that can depress the respiratory drive and further interfere with pulmonary function. Atelectasis from inadequate inspiratory effort is a common complication following any operation that requires general anesthesia, and is a common cause of postoperative hypoxemia.[1] Post-surgery pulmonary complications consume substantial health-care resources, can produce substantial morbidity, and can even lead to death.

The rising interest in evidence-based medicine has resulted in efforts to standardize care through the development of clinical protocols. Protocols decrease the time required to wean patients from mechanical ventilation, reduce the risk of ventilator-associated pneumonia, and improve glucose control in the intensive care unit (ICU).[2-6]

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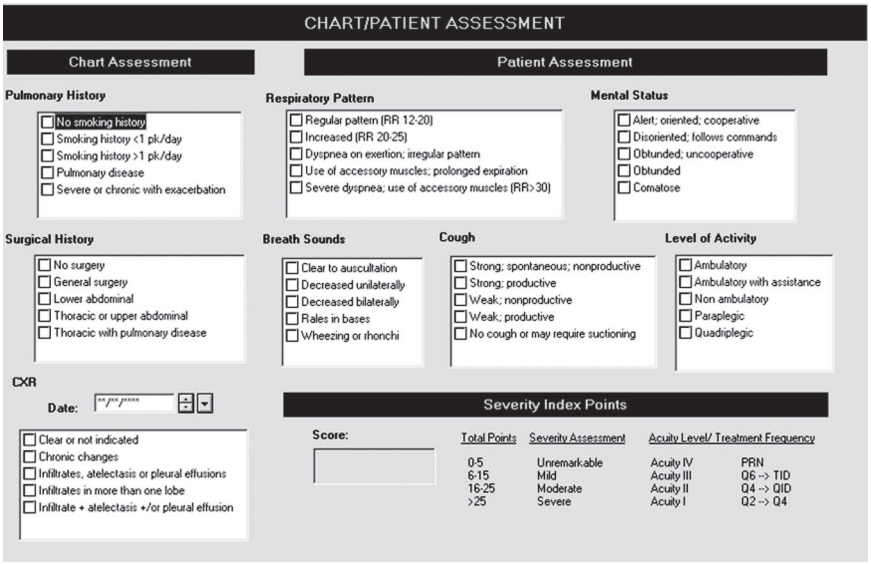

Fig. 1. Assessment form for our respiratory-therapist-driven evaluate-and-treat protocol. All categories are assessed by the respiratory therapist, and an objective score is generated. RR = respiratory rate. CXR = chest radiograph.

Protocolized care has also been studied outside the ICU.[7-15] Many of the studies on protocols in non-ICU settings evaluated protocol compliance or the number of respiratory treatments provided, whereas relatively few have rigorously analyzed the impact of protocols on patient-specific outcomes such as admission to the ICU or mortality.[7-15] Though it is clear that protocolized respiratory care can decrease inappropriate application of respiratory services and improve utilization,[16] the effect on patient mortality is difficult to measure.[7,12,15] We hypothesized that a respiratory therapist (RT) driven evaluate-and-treat protocol for non-ICU surgery patients would reduce respiratory complications and improve patient outcomes.

Methods

This investigation was approved by the University of Pittsburgh Medical Center-Presbyterian quality-improvement committee as a performance-improvement project, and was exempt from the University of Pittsburgh institutional review board.

We implemented the protocol in July 2003. The protocol focused on early identification of patients at risk for pulmonary complications and early provision of pulmonary therapy and bronchodilator, if needed, to high-risk patients, to decrease pulmonary complications and ICU admissions. The protocol was implemented as a trial in the neurosurgery step-down unit, the trauma/surgery step-down unit, and the trauma/surgery general ward, where non-ICU patients at greatest risk for pulmonary complications are concentrated. The control group consisted of the patients admitted to those units during the 8 months prior to the initiation of the protocol (November 2002 through June 2003). The treatment group consisted of the patients admitted to those units during the 8 months after the initiation of the protocol (July 2003 through February 2004).

Prior to the initiation of the protocol, respiratory treatments were performed as directed by physician order, based on the physician's assessment of the patient's risk of pulmonary complications and need for specific respiratory treatments. RTs could recommend treatments, but only treatments with specific physician orders were implemented.

The protocol involved RT evaluation (without the need for a physician order) of every patient admitted to the neurosurgery step-down, trauma/surgery step-down, and trauma/surgery general units. The RT used a standardized patient-assessment tool to quantify the severity of pulmonary risk factors and guide the frequency of intervention (Fig. 1).[9,16] The patient assessment included pulmonary history, surgical history, chest radiograph, respiratory pattern, breath sounds, cough, mental status, activity level, laboratory data, and pulse-oximetry readings. In each assessment category the RT assigned a score from zero (normal) to 4 (marked abnormality). Based on the patient-assessment cumulative score the RT selected one of the protocol treatment groups (Fig. 2) and developed and implemented an individualized care plan that specified the respiratory treatments and the frequency of the treatments. Treatments that could be implemented by RTs included positive expiratory pressure (PEP), oscillatory PEP, incentive spirometry, chest percussion, bi-level positive airway pressure, airway suctioning, intermittent positive-pressure breathing, and aerosol bronchodilator (via metered-dose

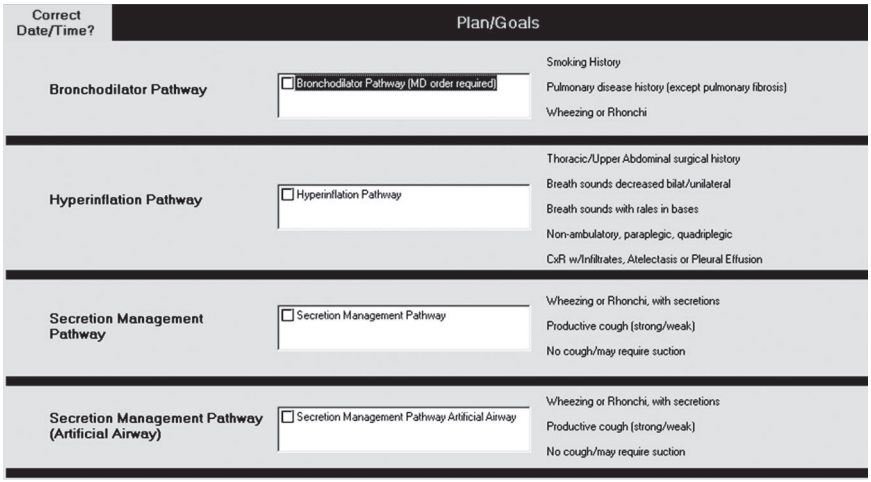

Fig. 2. Protocol care plan tool.

inhaler or nebulizer). The RT evaluated the effectiveness of the first treatment, and subsequent treatments, if needed, were performed by the "house" RT, who provided respiratory care in several units. The house RT could modify the care plan as necessary, per the protocol, the patient's response to therapy, and the patient's general status, and the physician reviewed important changes to the care plan and patient status. Respiratory treatments were stopped when deemed no longer beneficial. The RT met daily with the unit charge nurse to discuss patient needs and communicate assessment findings and the care plan. The physician could write orders for respiratory care, but such orders were not required prior to RT evaluation and implementation of the care plan. If medications were indicated, the relevant information was conveyed to the treating physician and a physician order was obtained.

We collected data on demographics, admitting service, number and type of respiratory treatments, stay, and in-hospital mortality. We tracked ICU admissions from the neurosurgery step-down, trauma/surgery step-down, and trauma/surgery general units and cross-checked that data with a database maintained by the institution's rapid-response team. From the medical records we recorded the primary indication for ICU admission, in a manner blinded to the presence or absence of the RT-evaluate-and-treat protocol. We assessed medical comorbidities with the Charlson index.[17] We obtained total hospital charges from the hospital's financial database, and calculated hospital costs as previously described.[18] We tabulated charge codes to determine the number and type of respiratory treatments delivered. Data are presented as mean ± SD. We performed the analysis with statistics software (StatView 5.0, SAS Institute, Cary, North Carolina), and we compared continuous variables with analysis of variance, with Scheffé's test, and categorical variables with the chi-square test. Differences were considered significant when $P < .05$.

Results

The neurosurgery step-down, trauma/surgery step-down, and trauma/surgery general units admitted 2,230 patients in the control period, and 2,805 patients in the 8 months following protocol initiation. The patients admitted after protocol initiation were older and had a slightly, but statistically significantly, higher mean Charlson score (Table 1).

There were no statistically significant differences in sex, ICU stay, or hospital stay, although after protocol initiation a slightly higher proportion of patients were admitted to a general or specialty medical service (16% versus 20%, see Table 1). There was no significant difference in overall mortality. Before protocol initiation 59 patients (3%) required ICU admission, compared to 93 patients (3%, difference not significant) after protocol initiation (Table 2). There was no significant difference in the overall proportion of patients who required ICU admission for respiratory reasons (27% before, 33% after). Most of the reasons for ICU transfer were not primarily respiratory (see Table 2).

After protocol initiation a greater number and proportion of patients received respiratory treatments (662 [30%] vs 1,341 [48%], $P < .01$ via analysis of variance). There was no significant difference in age, sex, or Charlson score between the patients who did and did not receive respiratory treatments (data not shown). In both the control and protocol periods, the patients who received respiratory treatments were predominantly trauma/general surgery patients (data not shown), whereas those who did not receive respiratory treatments were more frequently medical patients

Table 1. Patient Demographics

	Before Protocol Initiation (Nov 2002-Jun 2003)	After Protocol Initiation (Jul 2003-Feb 2004)
Number of patients	2,230	2,805
Age (mean ± SD y)	49.2 ± 19.0	51.3 ± 19.8*
Male (%)	56	57
Charlson score (mean ± SD)	0.7 ± 1.4	0.8 ± 1.4*
Stay (mean ± SD d)		
Intensive care unit	1.3 ± 4.3	1.4 ± 3.9
Hospital	4.8 ± 6.1	5.0 ± 6.2
Mortality (%)	0.3	0.4
Admit service (%)		
Trauma	46	43
General surgery	19	19
Specialty surgery	20	18
General medicine	4	7
Specialty medicine	12	13

* $P < 0.01$ via analysis of variance

Table 2. Primary Indications for Intensive-Care-Unit Admission

	Before Protocol Initiation (Nov 2002-Jun 2003) (*n*)	After Protocol Initiation (Jul 2003-Feb 2004) (*n*)
Respiratory (hypoxia, secretions, respiratory distress)	16	31
Postoperative monitoring	17	30
Volume (bleeding, hypotension, dehydration)	11	11
Cardiac (arrhythmia, hypertension)	4	3
Change in neurologic status	7	16
Other	4	2
Total number of patients transferred to intensive care	59	93

Table 3. Outcomes of Patients at High Risk for Pulmonary Complications

	Before Protocol Initiation (Nov 2002-Jun 2003)	After Protocol Initiation (Jul 2003-Feb 2004)
Number of patients	662	1,341
Age (mean ± SD y)	48.3 ± 18.7	51.3 ± 20.0*
Male (%)	54	56
Charlson score (mean ± SD)	0.8 ± 1.3	0.8 ± 1.4
ICU stay (mean ± SD d)	3.6 ± 7.2	2.3 ± 5.3*
Hospital stay (mean ± SD d)	7.8 ± 9.1	6.8 ± 7.7†
ICU admissions (%)	6.3	5.5
Mortality (%)	0.9	0.5
Hospital cost (thousand $)	20.3 ± 25.2	17.4 ± 21.5‡
Hospital charges (thousand $)	105.7 ± 126.3	88.8 ± 111.5‡

*$P < 0.002$
†$P < 0.02$
‡$P < 0.01$

Table 4. Respiratory Treatments Delivered

	Before Protocol Initiation (Nov 2002-Jun 2003) *n* (%)*	After Protocol Initiation (Jul 2003-Feb 2004) *n* (%)*
Patients	662	1,341
Incentive spirometry	270 (41)	777 (58)†
Positive-pressure treatment	192 (29)	310 (23)‡
Pharmacologic treatment	234 (35)	358 (27)†
Tracheostomy secretion management	230 (35)	268 (20)†
Treatments	20,192	23,157
Incentive spirometry	1,915 (10)	3,685 (16)‡
Positive-pressure treatment	2,462 (12)	6,680 (29)‡
Pharmacologic treatment	5,009 (25)	5,769 (25)
Tracheostomy secretion management	10,806 (54)	7,023 (30)‡

*Because of rounding, percentage values do not necessarily sum to 100.
†$P < 0.001$
‡$P < 0.005$

or surgical specialty patients (data not shown). Compared to patients who received no respiratory treatments, patients who received respiratory treatments had longer ICU stay (2.7 ± 6.0 d vs 0.5 ± 1.4 d, $P < .001$), longer total hospital stay (7.1 ± 8.2 d vs 3.4 ± 3.5 d, $P < .001$), and higher total hospital costs ($18.4 ± 22.9 thousand vs $8.0 ± 8.0 thousand, $P < .001$). These data support the hypothesis that patients who received respiratory treatments had more severe illness.

One would anticipate that the benefit of objective patient assessment and protocolized respiratory care would be greatest in patients at highest risk for pulmonary complications. We tested that hypothesis by comparing the patients who received respiratory treatments before and after protocol initiation. The patients who received respiratory treatments after protocol initiation were older, but their sex and Charlson score were similar (Table 3). ICU stay and total hospital stay were shorter and total hospital costs were lower in the patients who received respiratory treatments after protocol initiation. They also had nonsignificantly fewer ICU admissions and nonsignificantly lower overall mortality (see Table 3).

Table 4 summarizes the respiratory treatments delivered before and after protocol initiation. Significantly more pa-

tients received incentive spirometry after protocol initiation. The percentage of patients who received PEP treatments, pharmacologic treatments, and tracheostomy secretion-management care all decreased after protocol initiation. In the patients who received respiratory treatments, the mean and median number of treatments per patient decreased after protocol initiation, although the standard deviation was high (pre-protocol median 7 treatments/patient, pre-protocol mean ± SD 21.4 ± 50.6 treatments/patient, protocol median 4 treatments/patient, protocol mean ± SD 14.7 ± 35.5 treatments/patient, $P < .001$ via analysis of variance).

The total number of respiratory treatments increased after protocol initiation (see Table 4). The proportion of total pharmacologic treatments was unchanged, but tracheostomy secretion-management treatments significantly decreased, and the proportion of incentive spirometry and PEP treatments increased after protocol initiation.

We also compared the patients who did not receive respiratory treatments before and after protocol initiation (1,568 patients and 1,464 patients, respectively). After protocol initiation, the patients who did not receive respiratory treatments were older (51.2 ± 19.6 y vs 49.6 ± 19.1 y) and had a higher Charlson score (0.8 ± 1.4 vs 0.7 ± 1.4, $P < .02$), but overall mortality was low and statistically similar (0.21% before vs 0.06% after protocol initiation, $P = .29$). The groups had similar total hospital stay (3.3 ± 3.6 d vs 3.5 ± 3.4 d, difference not significant). ICU stay was slightly longer (0.5 ± 1.5 d vs 0.4 ± 1.2 d, $P = .001$), and total hospital costs were slightly higher ($8.3 ± 8.7 thousand vs $7.7 ± 7.2 thousand, $P = .05$) after protocol initiation. Those differences were statistically significant but are not clinically important.

After protocol initiation there was no significant change in the percentage of patients admitted to an ICU (1.1% before vs 1.3% after, difference not significant) or the percentage of patients admitted to an ICU for respiratory reasons (3/17 admissions [18%] before vs 1/19 admissions [5%] during the protocol) from this lower-risk group.

Discussion

RT-driven protocols decrease mechanical-ventilation days, decrease ventilator-weaning time, promote noninvasive ventilation in the ICU, and are used to diagnose/treat hypoxia.[2-5,19,20] Previous studies found improved appropriateness of respiratory treatments and better adherence to respiratory protocols when respiratory treatments were directed by RTs, compared to by physicians.[7-15] Determining whether those effects decrease morbidity or mortality is difficult. Previous studies[7-15] either did not assess morbidity/mortality or were limited by small numbers of patients.

We instituted the protocol to facilitate early identification and treatment of patients who would benefit from respiratory treatments. In the patients who received respiratory treatments, the protocol was associated with decreased total hospital costs and stay, and there was a trend toward fewer ICU admissions and lower hospital mortality. The mean and median number of respiratory treatments per patient decreased after protocol initiation, but the total number of respiratory treatments increased. After protocol initiation there was more use of incentive spirometry and PEP, and fewer patients received tracheostomy secretion-management treatments. Those data support our hypothesis that routine assessment and treatment by RTs in non-ICU, surgery-ward settings is associated with better patient outcomes.

Limitations

The patient groups before and after protocol initiation were generally comparable in age, sex, and medical comorbidities, but we cannot exclude the possibility of comorbidities or differences that might not be identified by the Charlson score and might have impacted our results.

This was not a prospective randomized trial. We instituted the protocol to decrease ICU admissions for respiratory problems in hospital units where patients at risk for pulmonary complications are generally admitted. However, less than half the patients in the studied units, either before or after protocol initiation, were deemed by physicians or RTs to need any form of respiratory treatment. There was no significant reduction in ICU admissions, but that finding may be in part due to the small number of ICU admissions from the studied units, and the small percentage of ICU admissions due to respiratory problems. We began the protocol in the neurosurgery step-down, trauma/surgery step-down, and trauma/surgery general units because they have many patients at high risk for pulmonary complications. Patients admitted to these wards, however, were not restricted to those specific high-risk services, as is demonstrated by the number of admitting services listed in Table 1. Restricting the implementation of this protocol to specific services would be difficult, given RT staffing by hospital location rather than by service line. Therefore, geographical implementation of the protocol appeared to be the most feasible.

Implementing the protocol in selected units with a focused group of dedicated RTs, nurses, and physicians allowed an objective assessment of the protocol's benefits and disadvantages but may have limited the number of involved patients and our ability to detect differences between groups. Even with this implementation strategy, however, most patients did not require respiratory treatments, and the total number of adverse outcomes (death or ICU admission) was low, which makes it difficult to detect

differences between the groups. With a baseline mortality rate of 1% in patients who received respiratory treatments (see Table 3), we would need approximately 5,000 patients in each group for a mortality-rate reduction to 0.5% to be statistically significant (data not shown). That number of patients would be difficult to achieve in any single institution.

We found decreased ICU stay, hospital stay, and total hospital costs in the patients who received respiratory treatments after protocol implementation, but our data do not permit us to determine if the shorter stay was directly due to better pulmonary care. Physician confidence in the respiratory care provided in a step-down unit may indirectly influence admission and transfer decisions and therefore impact ICU stay, but we do not know if this factor played a role in our results. Our finding of decreased stay and hospital cost after protocol implementation, despite the fact that only one third of ICU admissions were due to respiratory issues, is noteworthy. Frequently there are multiple indications to transfer a patient to the ICU, but we noted only the primary indication, so we did not capture the frequency of respiratory issues as secondary reasons for ICU admission, and this may have impacted our results. Other components of pulmonary care that are important in surgery patients, such as early ambulation, continued without any specific change in the 3 study wards, were not measured in this analysis and would also contribute to the quality of pulmonary care and outcomes of these patients.

Prior to initiating the protocol we did not use an objective quantitative assessment tool to determine which patients should receive treatment. After initiating the protocol, more patients received respiratory treatments. That finding could be the result of the standardized assessment by RTs, who may have identified more patients at risk for pulmonary complications. Alternatively, the finding could suggest that RTs are more aggressive than physicians in recommending respiratory services, although the finding that the mean and median number of treatments per patient decreased suggests otherwise.

Our data differ somewhat from prior studies, which have generally found fewer respiratory treatments following introduction of RT-driven protocols.[7-18] The reasons for that finding are unclear. The increase in respiratory treatments was largely due to more incentive spirometry and PEP (see Table 4). The increase in incentive spirometry may have been due to the fact that it is a component of many of the protocols used with high-risk patients, and is used to objectively assess the patient's progress through several protocols. The increase in PEP treatments may reflect a general reluctance of surgeons to use PEP in surgery patients, whereas RTs may not have that reluctance. The causes of these findings are unknown and require further investigation.

Conclusions

Our RT-driven evaluate-and-treat protocol was associated with an increase in the number of patients who received respiratory treatments, but a decrease in the number of treatments per patient. Patients who received treatment under the RT-evaluator protocol had shorter ICU and hospital stay and lower total hospital costs than patients who received respiratory treatments directed by physicians prior to protocol initiation. Our data suggest that routine RT evaluation and protocolized treatment of non-ICU post-surgery patients improve outcomes and may merit implementation in other patient populations.

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