Stroke Rehabilitation

Indwelling Urinary Catheters, Enteral Feeding Tubes, and Tracheostomies Are Associated With Resource Use and Functional Outcomes

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Background and Purpose—The aim of this study was to investigate the associations between tracheostomies, enteral feeding tubes, and indwelling urinary catheters and functional outcome measures, incidence of medical complications, and resource use in an inpatient stroke rehabilitation program.

Methods—A cohort of 1553 patients consecutively admitted for inpatient stroke rehabilitation was studied. Demographic and stroke characteristics, impairment (National Institutes of Health Stroke Scale) and disability level (Functional Independence Measure [FIM]), preexisting medical conditions, and the presence of tracheostomies, enteral feeding tubes, and indwelling urinary catheters were recorded at admission. The occurrence of medical complications during rehabilitation, discharge disability level, length of rehabilitation stay, and rehabilitation hospital charges were recorded at discharge.

Results—Compared with patients with no medical tubes, patients with 3 medical tubes had significantly higher National Institutes of Health Stroke Scale scores, lower admission and discharge FIM scores, reduced FIM efficiency scores (average FIM score change per day), and twice the number of medical complications. Patients with 3 medical tubes stayed 28 days longer in acute hospitalization and 20 days longer in rehabilitation compared with patients with no medical tubes. The presence of even a single medical tube was associated with longer length of stay, more medical complications during rehabilitation, and greater disability level at discharge.

Conclusions—The presence of ≥1 medical tubes is associated with more severe and disabling strokes, an increased number of medical complications, longer acute and rehabilitation hospitalizations, and greater resource use. (Stroke. 2002;33:1845-1850.)

Key Words: catheters, indwelling ▪ cerebrovascular disorders ▪ enteral nutrition ▪ rehabilitation ▪ stroke outcome ▪ tracheostomy

Recent years have seen acuity levels in inpatient stroke rehabilitation increase dramatically. This trend has increased the burden on physicians, nurses, and other rehabilitation care providers to prevent, diagnose, and promptly manage medical complications during rehabilitation. Associated medical conditions may delay or inhibit participation in a therapeutic exercise program, complicate the rehabilitation course,1–4 and thereby reduce the potential outcomes5,6 that might be achieved during rehabilitation.

Tracheostomies, enteral feeding tubes, and other medical support procedures have become commonplace in many rehabilitation units. Clinicians must monitor, adjust, and regulate the use of these interventions, many of which carry some risk of complications themselves. Although these interventions are necessary for the care and survival of stroke patients, their mere presence indicates the medical complexity of these patients. Although these procedures tend to be more common among patients with severe strokes,7,8 the extent to which these interventions are related to functional outcomes, incidence of medical complications during rehabilitation, and resource use has not been studied systematically.

This study seeks to determine the associations between tracheostomies, enteral feeding tubes, and indwelling urethral catheters and measures of functional outcome, development of medical complications during rehabilitation, and resource use in stroke patients in an inpatient stroke rehabilitation program.

Methods

Patients

A total of 1561 consecutive patients with a primary diagnosis of stroke who were admitted between December 1993 and July 1999 to a freestanding urban academic specialty rehabilitation hospital for initial comprehensive acute inpatient stroke rehabilitation were studied. Subjects included in the study were ≥18 years of age, had their strokes in the prior 3 months, and remained in the inpatient...
stroke rehabilitation unit for ≥3 days. Stroke, defined as an acute event of cerebrovascular origin causing focal or global neurological dysfunction lasting >24 hours, was confirmed by both clinical and radiographic means.9

Procedures
On admission to the rehabilitation facility, age, sex, and ethnicity were documented for each patient, as were the type (hemorrhage versus infarction), depth (cortical versus subcortical), and side (right versus left versus bilateral) of the cerebral lesion. Duration between stroke onset and rehabilitation admission, rehabilitation hospital length of stay, and total hospital charges were recorded for each patient.

The impairment level of each patient was rated on admission to rehabilitation by a trained attending physician using the National Institutes of Health Stroke Scale (NIHSS), a well-validated instrument used to assess impairment levels in 15 neurological functions frequently affected by stroke.10,11 Total NIHSS scores can range from 0 (reflecting no neurological deficit) to 42 (reflecting maximal neurological deficit).

Using acute hospital medical record review and rehabilitation admission patient examination, physicians recorded whether a patient had an indwelling urethral catheter (Foley catheter), feeding tube, and/or tracheostomy either during the acute hospitalization or still on admission to the rehabilitation facility.

Nurses certified by the Uniform Data System for Medical Rehabilitation rated each patient on rehabilitation admission and discharge for level of disability using the Functional Independence Measure (FIM) instrument. This well-validated functional assessment tool is used to rate patient performance on 18 activities of daily living.12–14 Total FIM scores can range from 18 (reflecting complete independence in all functional skills) to 126 (reflecting complete dependence on all functional skills).

Physicians used a standardized list of 124 medical diagnoses to record preexisting medical conditions that were present before stroke and medical complications that occurred during the acute poststroke hospital stay before rehabilitation admission.7 Statistical analyses were limited to only 24 medical conditions that either were present in >5% of the sample or were considered to be clinically important.

An experienced research assistant (L.L.) reviewed each patient’s medical record and documented values for admission body temperature, initial systolic and diastolic blood pressures, and 7 medical laboratory tests performed on most patients at rehabilitation admission. These laboratory tests assessed level of hemoglobin; serum concentrations of creatinine, albumin, sodium, potassium, and bicarbonate; and white blood cell count.

The occurrence of medical complications during rehabilitation was monitored continuously and prospectively. A standardized medical complication event guide was used to record these complications. Rehabilitation medical complications were defined as new or exacerbated medical conditions that produced alterations in the physician-documented plan of care, including additional physician evaluations, changes in medication, or additional medical interventions during the rehabilitation program. These 83 possible complications included but were not limited to pulmonary, cardiac, gastrointestinal, genitourinary, skin, musculoskeletal/rheumatological, endocrine, neurological, vascular, hematologic/oncological, trauma, and psychiatric problems.

Data Analysis
On the basis of the presence of individual or a combination of medical tubes, patients with indwelling urethral catheters, feeding tubes, and tracheostomies were grouped into 6 categories: no medical tubes, Foley catheter only, feeding tube only, Foley catheter and feeding tube, feeding tube and tracheostomy, and all 3 medical tubes. Five patients had a tracheostomy only, and 3 patients had a Foley catheter and tracheostomy combination. Because of the small sizes of these 2 groups, patients in these categories were not included in the statistical analyses. However, descriptive statistics showed that the patients in these 2 excluded groups did not differ from patients in the other tracheostomy combination groups in terms of type and side of stroke, mean age, mean onset-to-admission interval, mean admission and discharge FIM scores, mean rehabilitation length of stay, and mean charge per day. Therefore, their exclusion was not expected to affect the results of this study. The total sample size in the study was 1553 patients.

The number of medical complications developed or exacerbated during rehabilitation was counted for each patient. Average hospital charge per day was calculated as total inpatient rehabilitation charges (dollars) divided by length of rehabilitation stay (days). All currency is US dollars. The rate of functional gain (FIM efficiency) was calculated as total FIM change (discharge FIM score minus admission FIM score) divided by length of rehabilitation stay (days).

Univariate analysis was used to determine the relationships between the medical tube groups and each of the demographic, stroke characteristic, neurological impairment, and outcome variables. Discharge FIM score, FIM efficiency, number of complications developed during rehabilitation, rehabilitation length of stay, mean charge per day, days from stroke onset to rehabilitation admission, and neurological impairment were continuous variables. Demographic and stroke characteristics, preexisting medical conditions, abnormal admission laboratory values and total number of tubes for each patient were dichotomous variables. We used χ² analysis to assess differences for discrete variables. One-way analysis of variance was used for continuous variables. Between-group differences were tested for statistical significance by post hoc procedures (Tukey’s honestly significant difference).

Five separate multiple regression analyses were conducted with discharge FIM score, FIM efficiency, number of complications developed during rehabilitation, rehabilitation length of stay, and mean charge per day as the dependent variables. Independent variables included days from onset of stroke to rehabilitation admission, demographic, and stroke characteristics, neurological impairment level, preexisting conditions, abnormal admission laboratory values, and each of the medical tubes groups for each patient. Pearson’s correlation coefficients were used to evaluate the extent of collinearity among the independent variables before variables were entered into the regressions. Tolerance statistics were examined for each independent variable in each regression analysis. The values ranged from 0.605 to 0.975, indicating that none of the independent variables were linearly related to one another.

Although counts of events and summed scores are not equal interval measures, the Pearson correlation coefficients were used to evaluate the extent of collinearity among the independent variables before variables were entered into the regressions. Tolerance statistics were examined for each independent variable in each regression analysis. The values ranged from 0.605 to 0.975, indicating that none of the independent variables were linearly related to one another.

For all analyses, only values of P<0.001 were considered significant. The relatively rigorous significance level of 0.001 was selected to account for the effect of random events occurring in a large sample. The intent of this investigation was to determine the strongest associations between the dependent and independent variables. All analyses were performed with SPSS version 8.0 for Windows. Only patients with complete data for all relevant factors were included in each of the analyses.

Results
Sample Characteristics
A description of demographic and stroke characteristics for each of the medical tubes groups and for the sample of 1553 patients is provided in Table 1. Most patients had no medical tubes (n=985, 63.4%). Of those patients with 1 medical tube, 193 (12.4% of the total sample) had a Foley indwelling urethral catheter, and 117 (7.4%) had a feeding tube. A total of 191 patients had a combination of 2 medical tubes. Of these patients, 147 (9.5% of the total sample) had a combination of an indwelling urethral catheter and a feeding tube, and 44 (2.8%) had a combination of a feeding tube and a tracheostomy. Sixty-seven patients (4.3%) had all 3 medical tubes.

Compared with patients with fewer tubes, patients with 3 tubes tended to be younger and were more commonly white.
Strokes in those patients with 3 medical tubes more commonly tended to be hemorrhagic, subcortical, and bilateral. A greater number of medical tubes was associated with longer onset-to-admission intervals: Patients with 3 tubes stayed 3 times as long in acute care before admission to stroke rehabilitation as did patients with no tubes.

**Associations With Medical Tubes**

Table 2 describes the mean values for admission neurological impairment, FIM score, discharge FIM score, FIM efficiency, number of rehabilitation medical complications, length of rehabilitation, and charge per day for each of the medical tubes groups. One-way analysis of variance showed a statistically significant difference between the medical tubes groups for each of the dependent variables ($P<0.001$).

Patients with no medical tubes had significantly less neurological impairment at admission compared with patients with ≥1 medical tubes. Post hoc analysis showed that those patients with both a Foley catheter and a feeding tube or with all 3 medical tubes were significantly more impaired than those with no tubes.

**TABLE 2. Functional Outcomes, Medical Complications Developed During Rehabilitation, and Resource Use Measures for Each Medical Tube Group**

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>No Medical Tubes (n=985)</th>
<th>Foley Catheter Only (n=193)</th>
<th>Feeding Tube Only (n=117)</th>
<th>Foley and Feeding Tube (n=147)</th>
<th>Feeding Tube and Tracheostomy (n=44)</th>
<th>All 3 Medical Tubes (n=67)</th>
<th>Significance, F(5)</th>
<th>Total (n=1553)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission NIHSS score</td>
<td>7.27±4.21</td>
<td>10.80±4.72</td>
<td>11.07±5.29</td>
<td>13.71±5.12</td>
<td>11.13±5.88</td>
<td>13.66±4.68</td>
<td>86.8*</td>
<td>9.01±5.13</td>
</tr>
<tr>
<td>Admission FIM score</td>
<td>68.0±19.7</td>
<td>51.4±16.6</td>
<td>44.7±17.7</td>
<td>35.8±13.9</td>
<td>31.4±11.8</td>
<td>31.4±11.8</td>
<td>146.0*</td>
<td>58.9±22.5</td>
</tr>
<tr>
<td>Discharge FIM score</td>
<td>91.4±20.1</td>
<td>79.1±19.4</td>
<td>70.1±22.7</td>
<td>62.2±24.6</td>
<td>75.5±28.1</td>
<td>59.4±23.7</td>
<td>84.8*</td>
<td>83.8±23.9</td>
</tr>
<tr>
<td>FIM efficiency</td>
<td>1.16±0.99</td>
<td>0.94±0.67</td>
<td>0.80±0.57</td>
<td>0.76±0.63</td>
<td>0.91±0.66</td>
<td>0.66±0.53</td>
<td>8.5*</td>
<td>1.04±0.89</td>
</tr>
<tr>
<td>Rehabilitation medical complications, n</td>
<td>1.6±1.8</td>
<td>2.7±2.0</td>
<td>2.4±2.0</td>
<td>2.9±2.2</td>
<td>2.2±2.1</td>
<td>3.4±2.8</td>
<td>30.1*</td>
<td>2.0±2.0</td>
</tr>
<tr>
<td>Rehabilitation length of stay, d</td>
<td>24.4±12.5</td>
<td>33.1±13.3</td>
<td>34.5±13.1</td>
<td>34.4±13.4</td>
<td>35.6±18.3</td>
<td>43.8±16.3</td>
<td>58.0*</td>
<td>28.4±14.3</td>
</tr>
<tr>
<td>Charge, $/d†</td>
<td>1246.07±560.65</td>
<td>1312.49±248.73</td>
<td>1385.4±344.91</td>
<td>1551.91±815.18</td>
<td>1741.98±523.55</td>
<td>1709.93±357.23</td>
<td>20.0*</td>
<td>1326.45±558.89</td>
</tr>
</tbody>
</table>

Values are mean±SD.

*P<0.001.

†US dollars.
were patients with either a Foley catheter or a feeding tube alone. For patients with only 1 medical tube, there were no significant differences in impairment levels between the Foley catheter group and the feeding tube group. Patients with any combination of 2 medical tubes were similar to patients with all 3 medical tubes in impairment level.

The admission functional scores of patients with 2 or 3 medical tubes were at least 30 points lower than were those of patients with no medical tubes. At discharge, patients with 2 medical tubes continued to have lower FIM scores (15 to 32 points) compared with patients with no medical tubes. Even having only 1 medical tube, whether it was a Foley catheter or a feeding tube, was associated with significantly lower admission and discharge FIM scores (15 to 32 points) compared with patients with no tubes. Post hoc tests showed no significant difference between patients with either 1 or 2 medical tubes with respect to duration of rehabilitation hospitalization.

Finally, mean charges per day were 23% to 37% higher for patients with all 3 tubes compared with patients with 0 or 1 tube. Post hoc analyses showed that those patients with 0 or 1 medical tube had similar mean charges per day. Patients with the feeding tube–tracheostomy combination also had mean charges per day similar to those patients with all 3 medical tubes.

### Associations With Medical Tubes After Adjustment for Other Factors

Recognizing that other factors besides medical tubes may be significantly associated with these outcome measures, separate multivariate regression analyses were conducted with each dependent variable to determine the independent effects of demographic information, stroke characteristics, impairment level, comorbidities, abnormal laboratory values, and medical tubes groups.

Table 3 shows those factors found to be significantly related to functional outcomes and rehabilitation medical complications. Admission impairment was clearly most strongly related to discharge FIM scores, FIM efficiency, and rehabilitation medical complications. Three of the medical tubes

### Table 3. Factors Significantly Associated With Functional Outcomes and Rehabilitation Medical Complications

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>n</th>
<th>Significant Factors</th>
<th>β</th>
<th>P</th>
<th>Adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge FIM</td>
<td>1459</td>
<td>Admission NIHSS</td>
<td>−0.483</td>
<td>&lt;0.001</td>
<td>0.496</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age</td>
<td>−0.271</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Onset-to-admission interval</td>
<td>−0.130</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foley and food tube</td>
<td>−0.121</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feeding tube only</td>
<td>−0.116</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All 3 medical tubes</td>
<td>−0.112</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>History of a pressure ulcer</td>
<td>−0.084</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>History of prior stroke</td>
<td>−0.062</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>FIM efficiency</td>
<td>1480</td>
<td>Admission NIHSS</td>
<td>−0.302</td>
<td>&lt;0.001</td>
<td>0.141</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age</td>
<td>−0.134</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right hemisphere</td>
<td>−0.112</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Onset-to-admission interval</td>
<td>−0.098</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Rehabilitation medical complications</td>
<td>1510</td>
<td>Admission NIHSS</td>
<td>0.234</td>
<td>&lt;0.001</td>
<td>0.168</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foley catheter only</td>
<td>0.131</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All 3 medical tubes</td>
<td>0.109</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low hemoglobin levels</td>
<td>0.108</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elevated creatinine levels</td>
<td>0.107</td>
<td>0.001</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>History of hypertension</td>
<td>0.099</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elevated white blood cell counts</td>
<td>0.092</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foley and feeding tube</td>
<td>0.092</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>
tubes groups were associated with lower discharge FIM scores: the Foley catheter–feeding tube group, feeding tube only group, and all 3 medical tubes group. Other factors associated with lower discharge FIM scores included older age at stroke onset, increased onset-to-rehabilitation-admission interval, history of a pressure ulcer, bilateral hemisphere stroke, and history of a prior stroke. All these factors explained 49.6% of the variance in discharge FIM scores.

None of the medical tubes groups had an independent statistical relationship with FIM efficiency. Factors associated with FIM efficiency were greater neurological impairment at rehabilitation admission, older age at stroke onset, longer onset-to-admission interval, and a right hemispheric stroke. These 4 factors accounted for only 14.1% of the variance in FIM efficiency.

Three medical tubes groups were associated with increased number of medical complications during rehabilitation. These groups were the Foley catheter only group, all 3 medical tubes group, and Foley catheter–feeding tube group. Other factors related to increased number of rehabilitation medical complications were greater neurological impairment at rehabilitation admission, low serum hemoglobin levels, elevated serum creatinine levels, history of hypertension, and elevated white blood cell counts. These 8 factors explained 16.8% of the variance in number of rehabilitation complications.

Those factors that were most significantly related to resource use during rehabilitation can be found in Table 4. Admission impairment level was the strongest factor related to rehabilitation length of stay, with patients who were more impaired having longer lengths of stay. Three medical tubes groups also were associated with longer stays in rehabilitation. These included the all 3 medical tubes group, Foley catheter only group, and feeding tube only group. Right hemispheric strokes also were found to be associated with longer rehabilitation hospitalization. These 5 factors accounted for 29.3% of the variance in rehabilitation length of stay.

Three medical tubes groups were the only factors significantly associated with mean charges per day, explaining 16.5% of the variance. These groups were the all 3 medical tubes group, Foley catheter–feeding tube group, and feeding tube–tracheostomy group.

Even after adjustment for a large number of other likely confounding factors, medical tubes remained associated with discharge FIM scores, number of rehabilitation medical complications, length of rehabilitation hospitalization, and mean charges per day.

**Discussion**

There is a recent and growing trend to refer more stroke patients who have high levels of medical severity and complexity to rehabilitation programs, a change that has shifted the occurrence and management of many acute medical problems into the rehabilitation setting. Among its many implications, this practice trend has brought to rehabilitation units more patients who need external support for nutrition, hydration, ventilation, and other physiological functions. Attempts to facilitate participation in a therapeutic exercise program and enhance functional status while simultaneously managing these medical interventions constitute some of the many challenges facing patients and stroke rehabilitation clinicians today.

There are several implications of the increasing presence of tracheostomies, feeding tubes, and other physiological support interventions in the rehabilitation unit. These tubes require daily attention and care for maintenance and management. Their presence can contribute to the occurrence of specific complications themselves, some of which prolong hospitalization. These interventions incur some level of expense for functions such as providing feeding supplements, performing tracheobronchial hygiene, and catheter irrigations. Considerable clinical time and effort are spent during the rehabilitation program on attempts to eliminate the need for these tubes. Furthermore, providing training to staff, families, and professional home caregivers in the proper methods of management of these tubes uses time and resources. Finally, when home placement becomes a less viable living option because of the presence of these tubes, time and resources are needed to establish alternative placement and care; these factors increase length of hospitalization, cost of care, and opportunities for complications.

Medical rehabilitation providers are beginning to modify practice patterns to address the Medicare prospective payment methodology, a system that will reimburse rehabilitation providers on the basis of disability type, age, admission functional status, and the presence of selected preexisting medical comorbidities. The findings of this study suggest that certain factors beyond the type and level of disability increase the rehabilitation resources required for stroke patients. Medical complexity increases the care requirements of the stroke patient. In the present study, patients with 3 medical tubes groups were associated with lower discharge FIM scores.
medical tubes had 3 times the length of stay in acute care and twice the length of stay in rehabilitation compared with patients with no medical tubes.

The results of the present study also support the common clinical observation that these tubes are associated with greater numbers of medical complications. These findings are unlikely to surprise stroke practitioners who deal with them every day; nonetheless, the magnitude and consistency with which tracheostomies, gastrostomy tubes, and indwelling urethral catheters are associated with increased morbidity and reduced function are striking.

The presence of medical tubes also was associated with reduced functional scores at both admission and discharge. Even patients with only 1 tube demonstrated lower admission and discharge FIM scores. Patients with all 3 medical tubes had substantially lower admission and discharge functional scores than did patients in most other groups.

The number of medical tubes has been found to be significantly associated with the severity of neurological impairment.7,8,20 This could lead one to suspect that impairment level is the only or the major correlate of outcome and resource use and that those medical tubes are simply a proxy measure for severity of neurological deficit. However, additional statistical analysis indicates that medical tubes remain an independent factor associated with increased medical complications, reduced function, and increased resource use, even after adjustment for differences in neurological impairment.

Generalizability of the results of this investigation is limited by the fact that only 1 stroke rehabilitation center was studied, and the patient referral patterns may be unique to that setting. However, the size and diversity of the patient sample should help to mitigate the potential effects of that limitation. Another limitation was the lack of cross validation of the findings of this study in an independent data set.

The reduced outcome observed in those patients who have medical tubes is not a basis on which to exclude patients from intensive stroke rehabilitation programs. Indeed, many stroke rehabilitation programs and clinicians have become adept at performing medical management and functional training simultaneously. Among other implications, this practice change means that stroke patients and clinicians do not need to wait for complete resolution of medical issues for rehabilitation training to occur. It is important to recognize that even those patients who had 3 medical tubes and substantial neurological deficit made significant rehabilitation gains. However, the results of the present study suggest that the type and intensity of care and monitoring may need to be altered in these patients.

Acknowledgments

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