Predictors to Dysphagia and Recovery After Cervical Spinal Cord Injury During Acute Rehabilitation

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ABSTRACT

The purpose of this retrospective study was to identify factors that predict dysphagia in patients following cervical spinal cord injury and to identify factors that predict dysphagia recovery patterns/outcomes during acute rehabilitation. Data were collected on 131 consecutive patients with a diagnosis of a cervical cervical spinal cord injury over a 27-month period at 2 freestanding rehabilitation hospitals. On admission, 55% (72/131) of the patients were treated for dysphagia. Three significant predictors were identified to the likelihood that the patient would present with dysphagia: the co-occurrence of a brain injury (P= 0.003), the presence or history of a tracheotomy tube (P= 0.002), and undergoing a cervical spine surgery (P=0.02). Main dysphagia treatment outcome measures included: aspiration, laryngeal penetration, pharyngeal residue, days of dysphagia treatment provided, and the American Speech-Language-Hearing Association National Outcome Measurement System swallowing level discharge score. Fifty-nine of the 72 patients in the treatment group underwent an instrumental assessment of the swallow. Of these patients, aspiration was present in 39%, laryngeal penetration in 54%, and pharyngeal residue in 66% of the cases. Logistic regression analyses revealed for the outcome of aspiration, the predictor of a tracheotomy tube (P=0.008) was significant. For the outcome of laryngeal penetration, the predictors of a complete spinal cord injury (P=0.01) and the admission American Speech-Language-Hearing Association National Outcome Measurement System swallowing level admission score (P=0.018) were significant. For the outcome of pharyngeal residue, the predictors of an anterior spinal surgery (P=0.011), tracheotomy tube (P=0.004), and admission American Speech-Language-Hearing Association National Outcome Measurement System swallowing level (P=0.032) were significant. Linear

regression analyses were completed for the outcome of dysphagia days of treatment and discharge American Speech-Language-Hearing Association National Outcome Measurement System swallowing level and several significant predictors were identified. Results of this study demonstrate that dysphagia does occur following cervical spinal cord injury, several factors may play a role in the patient's recovery, and this patient population can make significant progress with dysphagia treatment during acute rehabilitation.

INTRODUCTION

Patients who suffer a cervical spinal cord injury (SCI) may experience difficulty swallowing.[1-5] Several potential causes for dysphagia following cervical SCI may include peripheral nerve damage to the recurrent laryngeal nerve, superior laryngeal nerve, or the glossopharyngeal nerve,[2,4] prevertebral soft tissue swelling, hypertonicity of the upper esophageal sphincter, esophageal perforation, and mechanical obstruction from the bone graft or screw loosening.[3-6] Additional factors that may also contribute to dysphagia following a SCI are the co-occurrence of a traumatic brain injury, chronic anterior subluxation of the cervical vertebrae, cervical orthosis, side effects from medications, presence of a tracheotomy tube, or the increase incidence of reflux disease.[7-13]

It is not uncommon for patients during the acute phase of hospitalization following cervical spinal involvement to demonstrate some transient dysphagia. However, the specific characteristics and recovery course for dysphagia in patients undergoing acute rehabilitation following cervical SCI are not well documented in the medical literature. Kirshblum et al[13] investigated the incidence of dysphagia and identified risk factors that predicted dysphagia in the rehabilitation setting following acute traumatic SCI. In that study, over 4 years, 31 patients presented to the rehabilitation setting following traumatic cervical SCI with dysphagia representing an incidence of 16.6%. Three significant variables (tracheotomy tube, age, and anterior spinal surgery) were identified to predict which patients would aspirate or require dietary modifications. This was the first study to address dysphagia following cervical SCI in the rehabilitation setting, however, the overall outcomes of the dysphagia treatment for these patients undergoing inpatient rehabilitation were not well described. Currently, there is no research evaluating both the predictive factors that may contribute to developing dysphagia and the predictive factors that may contribute to the outcomes of dysphagia treatment follow cervical SCI in patients undergoing comprehensive inpatient rehabilitation. The purpose of this current retrospective study was twofold. First, to identify factors that predict dysphagia in the rehabilitation setting following cervical SCI and secondly, to identify factors that predict dysphagia recovery patterns/outcomes in the rehabilitation setting following cervical SCI. By delineating the predictive factors for dysphagia and recovery following cervical SCI in the rehabilitation stage of recovery, it is anticipated that the rehabilitation team would be more aware of which patients would be at a higher risk for developing dysphagia. In turn, the rehabilitation team would then be able to provide appropriate dysphagia interventions, thus potentially avoiding any medical/dysphagia complications.

METHODS

Subjects

Subjects for this retrospective study included all patients who were admitted with a diagnosis of a cervical spinal cord injury over a 27- month period of time to 2 freestanding rehabilitation hospitals.

Both traumatic and non-traumatic injuries were included. Patients with profound cognitive deficits (comatose/unable to follow 1 step commands) were excluded from the study. After a comprehensive review of the patient's medical charts, 131 patients were selected for this study and were classified into 2 groups. Group 1 had the diagnosis of cervical SCI and dysphagia and Group 2 had the diagnosis of cervical SCI and no dysphagia.

Procedure

Retrospective chart reviews were completed on all patients who were admitted to the rehabilitation hospitals with the diagnosis of a cervical SCI. Both facilities' institutional review boards approved the study protocol. Table 1 summarizes the primary variables included in the medical chart review. A patient was classified as presenting with a concomitant brain injury when cognitive deficits were documented in the medical chart.

Upon admission to the rehabilitation hospitals, all patients are routinely screened for swallowing difficulties by the admitting physician. If dysphagia is clinicially suspected, a referral is then made to speech-language pathology for further evaluation. All of the patients assigned to the dysphagia treatment group (Group 1) had their swallow evaluated per physician's orders via clinical swallow examination by a speech-language pathologist. The clinical swallow exam involved an assessment of the oral and pharyngeal phases of swallowing with saliva, liquids, and solid foods as appropriate. If additional diagnositc information was required based upon the results of the clinical swallow examination, the patients also underwent an instrumental assessment of the swallow utilizing either a videofluoroscopic swallow study (VFSS) or a fiberoptic endoscopic exam of the swallow (FEES). Specific reasons that a patient may not have been referred for an instrumental assessment of the swallow included: a recent instrumental assessment of the swallow completed at the acute care hospital; the patient's dysphagia could be managed via their clinical swallow examination alone; and /or the patient's dysphagia was so severe that it was determined by the speech-language pathologist and attending physician that the instrumental assessment of the swallow would not provide any additional diagnostic information for the patient's dysphagia treatment plan.

If based upon the clinical swallow examination and/or instrumental assessement, the patient was placed on a modified diet, instructed on compensatory swallowing safety strategies, and/or instructed on swallowing rehabilitation strengthening exercises, they were assigned to the dysphagia treatment group. Patients who passed the initial swallow screening at admission and therefore did not require a formal clinical swallow examination or instrumental assessment and were consuming a regular diet, were presumed to demonstrate no dysphagia and were assigned to the non-dysphagia group (Group 2). Furthermore, patients who did have a clinical swallow examination and/or instrumental assessment and no dysphagia was found, were also assigned to the non-dysphagia group.

For the patients in the dysphagia treatment group, the initial and discharge scores for swallowing abilities were assigned utilizing the American Speech-Language-Hearing Association (ASHA) National Outcome Measurement System (NOMS) swallowing level scale developed by the National Center for Treatment Effectiveness in Communication Disorders.[14] The ASHA NOMS swallowing level scale is a multi-dimensional tool designed to measure both the

supervision level required and diet level by assigning a level ranging from 1 to 7 (Table 2). The patient's specific diet level and level of supervision was used to assign the ASHA NOMS swallowing scale. Initial diet and supervision levels were documented within 48 hours of admission and discharge diet and supervision levels were documented within 24 hours prior to discharge. Therapists assigning the ASHA NOMS swallowing level had successfully passed the national certification test.

Therapy time spent on dysphagia treatment was also recorded by reviewing dysphagia treatment charges. Dysphagia therapy time was charged in 15-minute units. The total number of days that the patient received dysphagia treatment was also recorded.

Dysphagia complications were tracked for dehydration and pneumonia and were coded as present or absent for each chart/patient reviewed. Criteria for the diagnosis of pneumonia included documentation in the medical chart by a physician along with one or more of the following: elevated while blood cell count (12,000), fever (> 100.5° F), and new infiltrate on chest radiograph. Criteria for the diagnosis of dehydration included documentation in the medical chart by physician along with one or more of the following clinical features: blood urea nitrogen (BUN) and creatinine measurements/ratio (BUN elevated and creatinine normal or slightly elevated), evidence of hypotensive episodes (dizziness, reduced blood pressure, reduced blood pressure when standing), and a physician's order to increase fluid intake (intravenous fluids ordered).

The number and type of instrumental assessment of the swallow were also tracked. The speech-language pathologists completing either the VFSS or FEES had successfully completed the hospitals' competency-training program. Analysis of the instrumental assessment involved only a review of the written report. The written report included an evaluation of bolus flow for laryngeal penetration, aspiration, and pharyngeal residue.

Table 1. Medical Chart Review of the Primary Variables

- Age
- Gender
- Type of injury (complete spinal cord injury versus an incomplete injury)
- Circumstances of the injury (traumatic versus non-traumatic)
- Surgical approach for stabilization
- Presence and type of a cervical orthosis
- Presence or history of a tracheotomy tube
- Diet and supervision level at admission and discharge
- Frequency and length of dysphagia treatment
- Results of the swallowing instrumental assessment
- Presence of a brain injury
- Dysphagia/medical complications

Data Analyses

χ^2 analyses were completed for the categorical variables. Paired t-tests and one-way analysis of variance (ANOVA) were completed on the continuous variables. In order to evaluate the significant predictive relationships, logistic and linear regression analyses were completed. Logistic regression analyses were completed on the binary dependent variables of aspiration, laryngeal penetration and pharyngeal residue. Linear regression analyses were completed for the continuous dependent variables of days of treatment and for the discharge NOMS. Both the logistic regression and linear regression models were completed using a backward stepwise elimination technique.

RESULTS

Predictors to Dysphagia

The 131 patients selected for this study had been admitted to 2 freestanding rehabilitation hospitals over a 27-month

Table 2. ASHA NOMS Swallowing Scale, Dietary Levels/Restrictions, and Cueing

ASHA NOMS Swallowing Scale

LEVEL 1:	Individuals is not able to swallow anything safely by mouth. All nutrition and hydration is received through nonoral means (eg, nasogastric tube, PEG)
LEVEL 2:	Individual is not able to swallow safely by mouth for nutrition and hydration but may take some consistency with consistent maximal cues in therapy only. Alternative method of feeding is required.
LEVEL 3:	Alternative method of feeding required as individual takes less than 50% of nutrition and hydration by mouth, and/or swallowing is safe with consistent use of moderate cues to use compensatory strategies and/or requires maximum diet restrictions.
LEVEL 4:	Swallowing is safe but usually requires moderate cues to use compensatory strategies, and/or individual has moderate diet restrictions and/or still requires tube feedings and/or oral supplements.
LEVEL 5:	Swallow is safe with minimal diet restrictions and/or occasionally requires minimal cueing to use compensatory strategies. May occasionally self cue. All nutrition and hydration needs are met by mouth at mealtime.
LEVEL 6:	Swallowing is safe, and individual eats and drinks independently and may rarely require minimal cueing. Usually self cues when difficulty occurs. May need to avoid specific food items (eg, popcorn and nuts), or requires additional time (due to dysphagia).
LEVEL 7:	Individual's ability to eat independently is not limited by swallow function. Swallowing would be safe and efficient for all consistencies. Compensatory strategies are effectively used when needed.

Swallowing: Dietary Levels/Restrictions

Maximum restrictions:	Diet is two or more levels below a regular diet status in solid and liquid consistency.
Moderate restrictions:	Diet is two or more levels below a regular diet status in either solid or liquid consistency (but not both), or diet is one level below in both solid and liquid consistency.
Minimum restrictions:	Diet is one level below a regular diet status in solid or liquid consistency.
Solids:	
Regular:	No restrictions
Reduced one level:	Meats are cooked until soft, with no tough or stringy foods. Might include meats like meat loaf, baked fish, soft chicken. Vegetables are cooked soft.
Reduced two levels:	Meats are chopped or ground. Vegetables are of one consistency (e.g. souffle, baked potato) or are mashed with a fork.
Reduced three levels:	Meats and vegetables are pureed.
Liquids:	
Regular:	Thin liquids, no restrictions.
Reduced one level:	Nectar, syrup; mildly thick.
Reduced two levels:	Honey; moderately thick.
Reduced three levels:	Pudding; extra thick

Cueing

Frequency of Cueing:	
Consistent:	Required 80-100% of the time.
Usually:	50-79% of the time.
Occasionally:	20-49% of the time.
Rarely:	Less than 20% of the time.
Intensity of Cueing:	
Maximal:	Multiple cues that are obvious to nonclinicians. Any combination of auditory, visual, pictorial, tactile, or written cues.
Moderate:	Combination of cueing types, some of which may be instrusiveintrusive.
Minimal:	Subtle and only one type of cueing.

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Table 3. Predictors to Dysphagia

Characteristic	Group 1 (Dysphagia, n=72)	Group 2 (No dysphagia, n=59)	χ^2
Traumatic Injury	66.4%	67.8%	$\chi^2 = 0.04$
Non-Traumatic Injury	30.6%	32.2%	*df*=1
			P = 0.840
Tracheotomy tube	33.3%	10.2%	$\chi^2 = 9.85$
No tracheotomy tube	66.7%	89.8%	*df*= 1
			P= 0.002
Brain Injury	37.5%	10.17%	$\chi^2 = 4.57$
No Brain Injury	62.5%	89.83%	*df*=1
			P= 0.003
Orthosis			
None	6.9%	17%	$\chi^2 = 5.14$
Collar	65.3%	64.4%	*df*= 3
SOMI	9.7%	3.4%	*P*=0.16
Halo-brace	18.1%	13.6%	
Surgery			
None	27.8%	39%	$\chi^2 = 9.69$
ACSS	43.1%	23.7%	*df*=3
PCSS	15.3%	30.6%	*P*=0.02
ACSS & PCSS	13.9%	6.8%	

period. Group 1 (N=72, 55%) had a diagnosis of cervical SCI and dysphagia and Group 2 (N=59, 45%) had a diagnosis of cervical SCI and no dysphagia. The characteristics of patients in Group 1 (those with a diagnosis of cervical SCI and dysphagia) and Group 2 (those with a diagnosis of cervical SCI and no dysphagia) were compared as a first step toward identifying predictors of patients who would require treatment for dysphagia.

The age of patients in the total sample ranges from 17 to 87, with a mean age of 55.6 (SD=19.8). There was no significant difference in the mean age of patients in Group 1 and 2 (Group 1 mean age = 55.5, SD=19.1, Group 2 mean age = 55.9, SD=20.8; *t*=.104, non-significant). There were more female patients in Group 1 (82%, 59/72) and this difference was significant (χ^2= – 8.18, *P*=.004).

As reported in Table 3, there are no significant differences between the 2 groups in the circumstances of injury (traumatic vs. non-traumatic) and the presence and type of orthosis used. However, there are significant differences in the presence of a tracheotomy tube, concurrent brain injury, and surgery. Patients diagnosed with dysphagia had a higher use of tracheotomy tube, a higher co-occurrence of a brain injury, and were more likely to have undergone cervical spine surgery (particularly surgery using the anterior approach).

Predictors to Dysphagia Recovery

For the patients who presented with dysphagia (Group 1, N=72), the mean ASHA NOMS swallowing level for admission was 2.67 (SD=1.78) and for discharge 5.3 (SD=1.94). Differences between the admission and discharge ASHA NOMS were statistically signifi-

Table 4. Coding for Predictors for Logistic Regression Model

Predictor	Coding
Gender	1= male 2=female
Type of Injury	1=complete 2=incomplete
Age Cervical Vertebrae	Actual Age Total number involved
Trauma	1= traumatic 2=non-traumatic
Brain Injury	1=present 2=not present
Orthosis	0=none 1=collar 2=SOMI 3=Halo-brace
Surgery	0=none 1=Anterior 2=Posterior 3=Anterior & Posterior
Tracheotomy	1=present 2= not present
Admission ASHA NOMS	Score from 1-7
Medical Complications	1= present 2= not present

cant (t=-10.49, P=.0001). Length of treatment ranged from 1 to 71 days with a mean of 15.3 days (SD=13.9 days). Average number of treatment units (each unit equals 15 minutes of treatment) ranged from 2 to 182, with a mean of 40 units.

Fifty-nine of the 72 patients (82%) in the dysphagia treatment group underwent an instrumental assessment of the swallow of either a VFSS or FEES. The majority of patients (71%) had one assessment, but the remaining 17 (29%) underwent 2 to 4 assessments. Aspiration was present in 39% (23/59), laryngeal penetration 54% (32/59), and pharyngeal residue 66% (39/59), of the patients who underwent an instrumental assessment.

Pneumonia was documented in 14 of the 72 patients (19%) in the dysphagia treatment group. Nine of the 14 patients who presented with pneumonia demonstrated aspiration on either the VFSS or FEES and 3 presented with laryngeal penetration. Eleven patients were NPO and the other 3 were on a modified dysphagia diet. Four of the 14 patients presented with the pneumonia at the acute care. None of the patients in the treatment group presented with dehydration.

Multivariate logistic regressions were undertaken for the outcomes of aspiration, laryngeal penetration, and pharyngeal residue where each variable was coded as binary for the 59 patients who underwent either a VFSS or FEES. The predictor variables entered in each model are described in Table 4 and Table 5 summarizes the results of the logistic regressions.

Table 5. Multinomial Logistic Regressions for Aspiration, Laryngeal Penetration and Pharyngeal Residue

Outcome	Step & Predictor	Significance of Additional Variable at Step	Significance of All Predictors in the Model	Predicted (Percentage Correct)		
				Present	Not Present	Overall
Aspiration	0. Constant/base rate effect	N/A	N/A	0.0%	100%	61%
	1. Admission NOMS	0.002	0.001	82.6%	61%	69.5%
	2. Medical Complications	0.070	0.001	87%	61%	71.2%
Penetration	0. Constant/base rate effect	N/A	N/A	100%	0.0%	54.2%
	1. Admission NOMS	0.001	0.007	71.9%	59.3%	66.1%
	2. Injury Type (Complete)	0.008	0.001	65.6%	81.5%	79.9%
Residue	0. Constant/base rate effect	N/A	N/A	100%	0.0%	66.1%
	1. Tracheotomy Tube (Present)	0.000	0.000	92.3%	70%	84.7%

Table 6. Linear Regressions for Days of Treatment and Discharge ASHA NOMS Swallowing Level

Outcome	Predictor	Beta Error	Standard	t-score	Significance
Days of Treatment	Age	0.18	0.08	2.45	0.02
	Type of Injury	-8.01	3.88	-2.06	0.05
	Number of Vertebrae	7.48	1.74	4.3	0.0001
	Traumatic Etiology	-9.77	3.37	-2.89	0.01
	Orthosis	6.29	2.92	2.15	0.04
	ACSS	7.92	2.76	2.86	0.01
	Aspiration	-9.56	3.45	-2.77	0.01
	Pharyngeal Residue	7.05	3.12	2.2	0.03
	Admit NOMS	-9.94	5.41	-1.84	0.07
Discharge NOMS	Tracheotomy	1.30	0.52	2.53	0.02
	Admit NOMS	0.30	0.17	1.82	0.07
	Discharge Diet	0.45	0.23	1.95	0.06
	Days of Treatment	3.46	0.02	2.10	0.04
	Aspiration	1.88	0.46	4.09	0.0001

Results obtained for aspiration were significant (P=. 001) with a Nagelkerke R-square of .31. Aspiration was correctly predicted for 71% of cases overall, with 87% of cases with aspiration correctly predicted, and 61% of cases without aspiration predicted correctly. Of the variables entered in the model, two were significant predictors of aspiration: admission ASHA NOMS and medical complications. No other predictors in the model were significantly related to aspiration after consideration of the effects of these 2 variables.

The model for pharyngeal residue was significant (P=. 0001) with a Nagelkerke R-square of .49. Pharyngeal residue was correctly predicted for 84.7% of cases overall, with the presence of residue being correctly predicted 92.3% of the time and its absence correctly predicted 70%. The significant predictor in the model was the presence of a tracheotomy.

Results for laryngeal penetration were significant (P=.001) with a Nagelkerke R-square of .30. Laryngeal penetration was correctly predicted for 73% of cases overall, with the presence of penetration being correctly predicted 66% of the time and absence of penetration correctly predicted in 82%. Significant predictors of laryngeal penetration were admission NOMS and a complete spinal cord injury.

Table 6 summarizes the results of the linear regressions performed on dysphagia days of treatment and patients' ASHA NOMS swallowing level score for the 59 subjects who underwent either a VFSS or FEES. For dysphagia days of treatment, a significant R-square of .63 was observed (F=6.50, df=12, 46, P<. 0001). Several significant predictors to days of dysphagia treatment were identified and are summarized in Table 6.

For discharge ASHA NOMS swallowing level score, a significant R-square of .51 was observed (F=8.95, df=6, 52, P<.0001). Significant predictors to the outcome of the discharge ASHA NOMS swallowing level score are summarized in Table 6. The discharge ASHA NOMS swallowing level score was lower when a patient had a tracheotomy tube, received fewer days of treatment, and demonstrated aspiration on either the VFSS or FEES.

DISCUSSION

The results of this study present both significant predictors for patients who may be likely to develop dysphagia and the significant predictors to dysphagia

treatment outcomes for aspiration, laryngeal penetration, pharyngeal residue, length of dysphagia treatment, and ASHA NOMS swallowing level discharge scores following cervical SCI in patients undergoing acute rehabilitation. This current study demonstrated a much higher incidence of dysphagia following cervical SCI in the rehabilitation setting than previous research at 55% versus 16.1%.[13] The suspected reason for the difference between these two studies is the definition/criteria used to diagnose dysphagia. In this current study, the presence of laryngeal penetration, pharyngeal residue, aspiration, placement on a modified diet, and receiving instruction on compensatory swallowing safety strategies or on swallowing rehabilitation strengthening exercises qualified the patient into the dysphagia treatment group. In the previous study,[13] the criterion for the diagnosis of dysphagia was aspiration or diet modification.

Significant predictors for developing dysphagia following cervical SCI included the presence of a tracheotomy tube and undergoing a cervical spinal surgery. These 2 predictors concur with previous research investigating the predictive variables for dysphagia.[13] The presence of a tracheotomy tube was also found to be a significant predictor for the outcome of aspiration, pharyngeal residue, and a lower ASHA NOMS discharge score. The presence of a cervical spinal surgery, specifically the ACSS, was also a significant predictor for the outcome of pharyngeal residue and increased days of dysphagia treatment. Several authors have reported dysphagia following cervical SCI, specifically following ACSS, as it is a common surgical approach following SCI.[1,2,4,13] During ACSS, the patient may be at risk for dysphagia due to peripheral nerve damage to the recurrent laryngeal nerve, superior laryngeal nerve, or the glossopharyngeal nerve.[2,4] Future research investigating the specific instrumental findings, treatment strategies, and outcomes of patients who experienced dysphagia following ACSS is warranted.

Two additional variables were also identified as significant predictors for dysphagia that included the presence of a complete type of spinal cord injury and the co-occurrence of a brain injury. In this current study, 30% (39/131) of the patients were identified as presenting with a cervical spinal cord injury and a brain injury. Several investigators have reported the co-occurrence of a brain injury with SCI.[15-20] Additionally, dysphagia following a brain injury alone has been well documented in the literature.[21-28] Even though this current study excluded patients with profound brain injuries (comatose patients), future research would benefit from evaluating the relationship between the severity of the brain injury in patients with cervical SCI with their dysphagia treatment outcomes.

One finding that was of interest is that some of the predictors that were not found to be significant to determine which patients would be likely to develop dysphagia were found to be significant predictors for the outcomes of dysphagia treatment. For example, the predictor regarding the circumstances of the injury, being traumatic versus a non-traumatic, was not significant to predict which patients would be likely to demonstrate dysphagia, however, it was significant for the outcome of increased days of dysphagia treatment. The presence and type of cervical orthosis was not a significant predictor for developing dysphagia, however, patients who had either a SOMI or Halo-brace were more likely to receive more days of dysphagia treatment. This finding concurs with previous investigators who have reported that the SOMI and Halo-brace may cause increase difficulty with swallowing.[7,12] Age was not a significant predictor for developing dysphagia, however for patients who had dysphagia

the older they were the more likely they were to receive more days of dysphagia treatment.

This study identified laryngeal penetration, aspiration, and pharyngeal residue in a large percentage of the patients in the dysphagia treatment group. The specific causes for these instrumental findings during the swallowing evaluation were not identified. Future research is warranted in order to identify the specific reason for aspiration, laryngeal penetration, and pharyngeal residue in this patient population such as the presence of pre-vertebral tissue swelling and/or reduced hyoid-laryngeal elevation/closure.

This study also identified that 19% of the patients in the dysphagia treatment group experienced pneumonia. Caution is recommended with interpretation of this finding, as respiratory complications are common in patients following cervical SCI.[29-34] Since pneumonia is a multi-factorial phenomenon,[35] there may be several potential causes for respiratory complications that need to be investigated. Further research is recommended to evaluate the incidence of pneumonia in high spinal cord patients with and without documented dysphagia.

CONCLUSION

This retrospective study demonstrated a 55% incidence of dysphagia following cervical spinal cord injury. This study identified several significant predictors for developing dysphagia and for the outcomes of aspiration, laryngeal penetration, pharyngeal residue, days of dysphagia treatment, and ASHA NOMS swallowing level discharge scores. It is important for the dysphagia treatment team to be aware of the significant predictive factors and how they may impact the patient's recovery. For predictors to dysphagia following a cervical spinal cord injury, the presence of a tracheotomy tube, the co-occurrence of a brain injury, and the presence of a cervical spinal surgery were considered to be significant. For dysphagia treatment outcomes, several significant predictors for aspiration, laryngeal penetration, pharyngeal residue, length of dysphagia treatment, and discharge ASHA NOMS swallowing level score were identified. Patients who developed dysphagia following cervical spinal cord injury are able to make significant gains and require a comprehensive dysphagia treatment team to address their needs. By being able to better identify both the predictive factors for patients who may develop dysphagia as well as the factors that may influence the overall outcome of their treatment, hopefully medical/dysphagia complications can be avoided.

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