Acute Traumatic Spinal Cord Injury, 1993–2000A Population-Based Assessment of Methylprednisolone Administration and Hospitalization

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Background: **Administration of methylprednisolone sodium succinate (MPSS) after acute traumatic spinal cord injury (TSCI) is controversial. This study compared differences in acute care charge, hospital stay, and related variables as a function of MPSS receipt.**

Methods: **Determinants of MPSS administration were examined after acute TSCI for South Carolina patients during the period 1993 to 2000 in a multivariate logistic regression model.**

Results: **Administration of MPSS was documented for 48.7% of 1,227 randomly selected patients with TSCI. Patients admitted via trauma centers and emergency departments were more likely to receive MPSS (trauma center level 1 odds ratio [OR], 4.06; 95% CI confidence interval [CI], 2.11–7.83; emergency department OR, 1.64; 95% CI, 1.20–2.23). Hospital charge and length of stay were significantly higher for MPSS recipients.**

Conclusions: **The study findings indicate MPSS use is associated with higher acute care charges and longer hospital stays. These findings suggest the need for outcome studies to assess the long-term benefits of MPSS administration.**

Key Words: **Spinal cord injury, Methylprednisolone, Acute care charges, Length of stay.**

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Traumatic spinal cord injury (TSCI) continues to be an important cause of long-term disability, and effective treatment options remain limited. The possibility that a pharmacologic agent could enhance neurologic recovery from acute TSCI emerged from animal studies and randomized clinical trials in humans.[1–10] The National Acute Spinal Cord Injury Study (NASCIS) 2 and 3 investigators concluded that administration of methylprednisolone sodium succinate (MPSS) within 8 hours of injury can enhance recovery of motor function in individuals with acute TSCI, whether classified initially as incomplete or complete.[5] Subsequently, numerous publications of these trials appeared, culminating in the recently issued Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injuries.[10]

From the release of the first results in 1991, the NASCIS studies attracted much attention and controversy, with multiple critiques of the study design and statistical analysis.[11–19] Some observers concluded that the results did not document a clinically important difference in outcome, and that the costs exceeded the benefits.[10,12–14,19] In contrast, several organizations supported the study conclusions, and many investigators stated that that placebo-controlled trials were no longer justified, referring to MPSS administration as "an entrenched practice"[11] and the "standard of care."[8,20,21]

Because of persistent disagreement, only limited endorsement of broad-based professional associations, and no federal agency support, practitioner response and the consequences for the health care system are uncertain. The limited amount of available information prompted examination of the NASCIS protocol use rate over time; determination of associated clinical, demographic, and hospital characteristics; and comparison of hospital charges and length of stay in a large population-based sample of patients with TSCI hospitalized in South Carolina between 1993 and 2000. In addition, emergency department physicians were surveyed for an assessment of attitudes regarding the use of MPSS.

MATERIALS AND METHODS

Data Sources

An essential information source was the South Carolina Hospital Discharge data set. South Carolina law mandates that all federal and nonfederal hospitals report data abstracted from the discharge uniform billing system to the State Budget and Control Board. The data set contains patient identifiers, demographics, dates of admission and discharge, up to 10 diagnoses coded according to the International Classification of Diseases (ICD) (9th Revision), clinical modifications (ICD-9-CM),[22] primary and secondary external causes of injury codes, lengths of stay, total charges, discharge dispo-

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sitions, sources of admission, principal payers, and types of care. Data are considered 99% accurate and complete, a level verified by the South Carolina Injury Surveillance System. Inclusion of personal identifiers prevented duplication of repeat visits for the same event. The institutional review board approved the study.

Of all the patients discharged with TSCI from acute care hospitals from January 1, 1993 through December 31, 2000, 75% were randomly selected to constitute the study sample. The statewide discharge data set provided the sample frame and the core variables for the analysis. Direct review of the medical record provided information on MPSS use, neurologic findings, and timing of drug administration. Patients were excluded if their initial hospitalization was out of state, they were admitted with late effects or complications, their medical records did not supply complete information on dosage and timing of MPSS administration, and their dosage did not conform to the recommended protocol.

For the practitioner survey, a one-page questionnaire was mailed once to a list of 233 physicians self-identified as practicing emergency medicine who in 1997 were members of the South Carolina Chapter of the American College of Emergency Medicine. They were asked to indicate the number of individuals with acute TSCI for whom they had provided care since 1993, whether they were aware of the MPSS recommendations, how they learned about the recommendations, whether they agreed with the recommendations and followed the protocol, their reasons if they disagreed, and their specialty certification. Only those who had provided care to at least one patient with acute TSCI in the preceding 5 years were included in the study.

Definitions and Statistical Analysis

A case of TSCI was defined as that involving any primary or secondary diagnosis of an acute traumatic lesion to neural elements in the spinal canal (spinal cord and cauda equina) matching the case definition for TSCI provided by the Centers for Disease Control and Prevention.[23] For case identification purposes, the ICD-9-CM nature of injury codes included were 806.0 to 806.9 and 952.0 to 952.9. All patients with TSCI coded as demonstrating late effects of spinal cord injury (907.2) were excluded.

Administration of MPSS was defined as "yes" if it was given according to the NASCIS treatment protocol (i.e., a loading dose of 30 mg/kg and a maintenance dose of 5.6 mg/kg/hour)[6] and "no" if no MPSS was administered. Hospitals were defined according to their designated trauma center status by the South Carolina Department of Health and Environmental Control as levels 1, 2, 3, and undesignated.

Injury severity was determined by translating ICD-9-CM diagnosis codes into the Abbreviated Injury Scale (AIS)[24] using ICDMAP-90 software.[25] This software generates AIS for the nine body regions. The severity of trauma was categorized by AIS as "critical" (5–6), "severe" (4), and "moderate" (2–3). Trauma was categorized by the number of body regions involved as "multiple" if two or more body regions were involved or "spine only" if the spine was the only body region involved. The type of TSCI lesion was defined as "open" if it involved a penetrating wound to the spine. Otherwise, it was considered "closed."

To adjust for the effect of comorbid conditions, the study used a comorbidity scale developed for use with administrative data that identifies 30 conditions known to be significant predictors of in-hospital mortality and resource use.[26] All 10 ICD-9-CM diagnosis fields were searched for any of these 30 conditions. One or more of these conditions categorized the comorbid condition of each patient as a chronic health problem either present or absent.

Four age categories were created: 19 years or younger, 20 to 44 years, 45 to 64 years, and 65 years or older. Race was dichotomized as "nonwhite" and "white." The patients identified as other than white or black (1.2%) were assigned to the nonwhite category.

A simple random sample involving 78% of all the cases was selected with a PC SAS random numbers generator (Ranuni) from an initial starting point in the sampling frame.[27] After the exclusion of 45 patients because of incomplete information on MPSS use or because the amount provided was not according to protocol, the effective sample size was reduced to 75%. The potential bias resulting from this exclusion is considered in the Discussion section.

The analysis used χ^2 tests to examine the significance of the association between the independent and response variables, and to determine the trend of MPSS administration.[28] The odds of MPSS administration were assessed by first examining the use of crude odds ratios for each of the explanatory variables in univariate logistic regression models. Unconditional multivariable logistic regression analysis then was conducted to explore the influence of age, gender, race, neurologic level, type of lesion, severity, type of trauma, chronic health condition, trauma level status, and admission source on the administration of MPSS. All the variables were entered simultaneously. The fit of the model was verified with the Hosmer–Lemshow Goodness-of-Fit test and the global likelihood χ^2 test. Multicollinearity among the independent variables was ruled out by assessing for wide deviations of the estimated regression coefficients and their standard errors between the fitted univariate and the multivariate regression models.[29] Length of hospital stay and acute care charge were compared between patients with TSCI who received MPSS and those without MPSS using least-square means in general linear model procedure (Proc GLM, PC SAS) that adjusted for severity and neurologic level of injury.[27]

For single pairwise comparison of arithmetic means between patients with MPSS and those without MPSS, Student's *t* test was used. Statistical significance was determined by *p* values less than 0.05. In addition to the reported measures of association, results also were reported as the percentage of patients with TSCI by MPSS administration and the

proportion of emergency medicine physicians who reported awareness of the NASCIS protocol and agreement with it.

RESULTS

During the study period, 1,630 eligible patients were discharged from South Carolina acute care facilities with a diagnosis of TSCI. After exclusions from the study, the data for 1,227 patients (75%) were analyzed. For those who received MPSS, the average dosage given for the initial bolus treatment approximated 2,400 mg. Table 1 presents the characteristics of the patients with TSCI by MPSS administration. The records of 597 patients (48.7%) documented receipt of MPSS according to the NASCIS protocol. Among those receiving MPSS, significantly fewer patients ($p < 0.001$) were noted in the following categories: age 65 years and older (13.0%), hospitalization in facilities with an undesignated trauma center (5.9%), neurologic level of the lesion in the lumbar region (9.6%) or sacrococcyx (8.4%), and other hospital referral (9.1%) or ambulatory clinic (16.1%) as the admission source. Overall, definitive care for the patients with TSCI was at level 1 trauma centers for 60.7%, level 2 trauma centers for 14.3%, level 3 trauma centers for 18.1%, and hospitals not designated as trauma centers for 6.9%. No significant differences in terms of race, gender, lesion type, or

Table 1 Demographic, Clinical, and Hospital Characteristics Among Traumatic Spinal Cord Injury Hospital Discharges, South Carolina, 1993–2000 (n = 1227)

Characteristics	MPSS Administration		Unadjusted OR (95% CI)	Adjusted OR (95% CI)
	Yes (%) (n = 597)	No (%) (n = 630)		
Age (years)[a]				
65 and older	13.0	20.3	0.45 (0.30–0.69)[b]	0.46 (0.29–0.74)[b]
45–64	21.5	25.9	0.59 (0.40–0.87)[b]	0.58 (0.38–0.88)[a]
20–44	50.7	43.6	0.82 (0.58–1.17)	0.78 (0.54–1.13)
0–19	14.8	10.2	Reference level	Reference level
Mean[a]	39.5 (±18.7)	44.2 (±20.2)		
Race				
Nonwhite	38.2	35.2	1.14 (0.90–1.43)	0.96 (0.75–1.24)
White	61.8	64.8	Reference level	Reference level
Gender[a]				
Female	22.3	29.1	1.42 (1.09–1.83)[b]	1.13 (0.85–1.50)
Male	77.7	70.9	Reference level	Reference level
Neurologic level[a]				
Cervical	61.1	49.2	1.37 (0.89–2.09)	1.02 (0.65–1.66)
Thoracic	20.9	26.0	0.88 (0.54–1.41)	0.66 (0.40–1.08)
Lumbar	9.6	15.6	0.68 (0.41–1.15)	0.70 (0.41–1.19)
Sacrococcygeal	8.4	9.2	Reference level	Reference level
Lesion type				
Open	3.2	2.4	1.35 (0.68–2.68)	1.00 (0.49–2.08)
Closed	96.8	97.6	Reference level	Reference level
Severity[a]				
Critical (AIS 5–6)	14.9	9.4	1.98 (1.38–2.83)[b]	1.52 (1.10–2.41)[a]
Severe (AIS-4)	29.3	21.3	1.71 (1.31–2.24)[b]	1.70 (1.25–2.30)[b]
Moderate (AIS 2–3)	55.8	69.3	Reference level	Reference level
Type of trauma[a]				
Multiple	32.7	26.4	1.36 (1.06–1.73)[a]	1.20 (0.92–1.57)
Spine only	67.3	73.6	Reference level	Reference level
Chronic health conditions				
Present	57.0	53.2	0.86 (0.69–1.08)	0.98 (0.77–1.26)
None	43.0	46.8	Reference level	Reference level
Trauma center status[a]				
Level 1	64.8	56.8	6.48 (3.46–12.1)[b]	4.06 (2.11–7.83)[b]
Level 2	17.9	11.0	9.30 (4.70–18.4)[b]	6.20 (3.08–12.60)[b]
Level 3	15.3	20.8	4.17 (2.14–8.12)[b]	3.20 (1.62–6.35)[b]
Undesignated	2.0	11.4	Reference level	Reference level
Admission Source[a]				
Emergency Department	74.8	57.1	2.23 (1.68–2.96)[b]	1.64 (1.20–2.23)[b]
Other Hospital	9.1	15.4	1.00 (0.65–1.51)	0.74 (0.47–1.16)
Ambulatory Clinics	16.1	27.5	Reference level	Reference level

MPSS, methylprednisolone sodium succinate; OR, odds ratio; CI, confidence interval; AIS, Abbreviated Injury Scale.
[a] $P < 0.05$.
[b] $P < 0.01$.
Model global likelihood $\chi^2 < 0.001$.

chronic health conditions were identified. Furthermore, the researchers noted no differences as a function of year of event ($p = 0.92$, χ^2 test of trend).

Unadjusted and adjusted odds ratios estimating the likelihood of MPSS administration as a function of demographic, clinical, and hospital characteristics also are shown in Table 1. The unadjusted odds ratios (OR) were significant for all the variables except race, neurologic level, lesion type, and chronic health conditions. After adjustment, age, severity, trauma level of the hospital, and source of admission remained significant.

The trauma level status of the hospital was the strongest predictor of MPSS administration. The patients with TSCI whose definitive care was in level 1 and level 2 trauma centers were 3.2 to 6.2 times more likely to receive MPSS than patients discharged from hospitals not designated as trauma centers, after adjustment for the covariates in the model. Regardless of the hospital's trauma level, MPSS administration decreased with advancing age. Older patients with TSCI were less than half as likely as the youngest age group (age, <19 years) to receive MPSS. The source of admission was significantly associated with MPSS administration. The patients first evaluated in the emergency department of hospitals that provided definitive care were nearly twice as likely to receive MPSS as the patients first evaluated elsewhere and then referred.

Similarly, the severity of TSCI was independently associated with MPSS administration. The likelihood of MPSS administration was 52% higher among patients with TSCI who had critical injuries (OR, 1.52; 95% CI, 1.10–2.41) and 70% higher among patients with severe injuries (OR, 1.70; 95% CI, 1.25–2.30).

Comparisons of hospital length of stay and acute care charges are presented in Table 2. The 17.5-day unadjusted mean length of hospital stay (95% CI, 16.0–19.0) for MPSS recipients is approximately 4 days longer than for those not receiving MPSS (13.8 days; 95% CI, 12.6–15.0). This difference is statistically significant. After adjustment for severity, in-hospital death, and neurologic level of injury, the statistically significant difference between the groups declined to 2.5 days: 17.8 days (95% CI, 16.5–19.2) for those who received MPSS and 15.2 days (95% CI, 13.8–16.7) for those who did not receive MPSS. Similarly, comparison by acute care charge remained significant for both the unadjusted mean (MPSS recipients, $42,316 [95% CI, $38,303–46,328]; nonrecipients, $25,471 [95% CI, $22,543–28,400]) and the adjusted mean (MPSS recipients, $43,480 [95% CI, $39,978–46,982]; nonrecipients, $27,778 [95% CI, $24,062–31,494]). The difference of $16,845 noted in the unadjusted mean remained comparable after adjustment for severity, in-hospital death, and neurologic level of injury.

Table 3 shows comparisons of the mean hospital length of stay and acute care charges as a function of discharge status and MPSS administration. Among the patients with TSCI who were discharged alive, those who received MPSS had significantly longer hospital stays ($p < 0.01$) and higher acute care charges ($p < 0.01$) than those who did not receive MPSS. However, there was no significant difference between the two groups in either length of stay ($p = 0.58$) or hospital charge ($p = 0.71$) when death occurred during acute care hospitalization. In contrast, among the patients with TSCI who received MPSS, those who were discharged alive had a significantly longer hospital stay ($p < 0.01$) than those who died while hospitalized. Among the patients with TSCI who did not receive MPSS, those who died during acute care hospitalization had significantly higher acute care charges ($p = 0.04$) than those discharged alive.

All (100%) of the emergency department physicians who responded to the survey were aware of the NASCIS protocol, and 91.3% reported agreement with the recommendations (Table 4). Journal articles (76.3%) were the most frequently cited source of information about the protocol. Among the physicians who disagreed with the protocol, the main reasons given were lack of strongly convincing data or flawed study design.

DISCUSSION

The results from this large population-based study covering an 8-year period show a robust assessment of MPSS use and the factors affecting its application in patients with TSCI. This comprehensive study investigating the clinical use of MPSS also is an important example of the practical response to the recommendations from clinical trials. The strength of the study was its ability to merge data from a well-defined, population-based system with information obtained directly

Table 2 Mean Length of Hospital Stay and Acute care Charge by MPSS Use (n = 1227)

Characteristics	Unadjusted Mean (95% CI)	Adjusted Mean[a] (95% CI)
Length of hospital stay		
MPSS administered	17.5 (16.0–19.0)[b]	17.8 (16.5–19.2)[b]
MPSS not administered	13.8 (12.6–15.0)[b]	15.2 (13.8–16.7)[b]
Acute care charge (USD)		
MPSS administered	42,316 (38,303–46,328)[b]	43,480 (39,978–46,982)[b]
MPSS not administered	25,471 (22,543–28,400)[b]	27,778 (24,062–31,494)[b]

MPSS, methylprednisolone sodium succinate; CI, confidence interval; USD, US dollar.
[a] Adjusted for severity of spinal cord injury, neurologic level of injury, and in-hospital death.
[b] Statistically significant at 0.05 level.

Table 3 Comparison of Acute Care Charge and Length of Hospital Stay by MPSS Administration and Discharge Disposition

Mean	Discharge Disposition						MPSS Administration					
	Discharged Alive (n = 1,161) MPSS Administration			In-hospital Death (n = 66) MPSS Administration			MPSS Administered (n = 597) Discharge Status			MPSS Not Administered (n = 630) Discharge Status		
	Yes (n = 566) OR (95% CI)	No (n = 595) OR (95% CI)	*t* Test (*p* Value)	Yes (n = 31) OR (95% CI)	No (n = 35) OR (95% CI)	*t* Test (*p* Value)	Alive (n = 566) OR (95% CI)	Dead (n = 31) OR (95% CI)	*t* Test (*p* Value)	Alive (n = 595) OR (95% CI)	Dead (n = 35) OR (95% CI)	*t* Test (*p* Value)
LOS	17.7	13.8	3.92[a]	12.6	14.3	−0.56	17.7	12.6	2.75[a]	13.8	14.3	−0.18
	(16.2–19.3)	(12.5–15.0)	(<0.01)	(9.2–16.0)	(9.3–19.2)	(0.58)	(16.2–19.3)	(9.2–16.0)	(<0.01)	(12.5–15.0)	(9.3–19.2)	(0.86)
Charge[b]	41,831	24,258	6.89[a]	51,174	46,099	0.37	41,831	51,174	−1.01	24,258	46,099	−2.11[a]
	(37,708–45,953)	(21,414–27,101)	(<0.01)	(33,004–69,343)	(25,307–66,891)	(0.71)	(37,708–45,953)	(33,004–69,343)	(0.31)	(21,414–27,701)	(25,307–66,891)	(0.04)

MPSS, methylprednisolone sodium succinate; LOS, length of hospital stay; CI, confidence interval.

[a] Statistically significant differences.

[b] Acute care charge.

from the medical record. The merged data allowed adjustment for the effect of clinical conditions on MPSS administration. The odds of receiving MPSS was found to be higher among the younger patients, those admitted to hospitals via designated trauma centers or an emergency department, and those with more severe injury. The acute care charge and hospital length of stay were much higher for patients receiving MPSS than for those not receiving it. Administration of the MPSS protocol was independent of race, gender, neurologic level, and payer status. The analysis provides a framework for more specific investigation of the explanatory factors.

A possible explanation for the higher charges and longer hospital stays among the patients receiving MPSS could be a greater occurrence of complications, particularly severe pneumonia and sepsis.[6,7,12,13,15,30–32] An additional factor could be the need for multiple procedures among those with more severe TSCI, a group overrepresented among the MPSS recipients. Although NASCIS studies 2 and 3 suggest that functional improvements from MPSS therapy offset the longer lengths of stay and costs of care, the current study could not document these potential benefits because follow-up evaluation of the patients after discharge from acute care facilities was lacking.

In-hospital death could confound the observed difference in lengths of stay and acute care charges associated with MPSS administration. This is especially important in relation to TSCI because it is an expensive condition to treat.[33] Also, in-hospital deaths are common among patients with high cervical injuries[34] and gunshot wounds to the spine.[32] Furthermore, some studies have noted higher hospital charges after 3 days of hospitalization,[35] whereas lower charges might be expected among those who die closer to the admission date. However, the impact of in-hospital death in the current study was minimal. There were 66 deaths (5.4%) after admission (Table 3), 31 of which occurred among persons who received MPSS. There was no statistically significant difference between the patients who received MPSS ($p = 0.79$) and those who did not ($p = 0.59$) with regard to the occurrence of death after hospital admission or duration of hospital stay before death. Consequently, when in-hospital death was included as a covariate in the general linear model, the differences in mean length of hospital stay and acute care charges remained significant (Table 2).

The site of initial care was highly important. For the South Carolina group, the patients treated in hospitals designated as level 1 or 2 trauma centers were more likely to receive the drug. In contrast, the earlier Colorado study found that patients initially treated in smaller emergency departments before transfer to larger facilities were more likely to receive the MPSS protocol.[14]

An initial conclusion from the current administration rate of 48.7% is that MPSS use was below the desired levels, given the extent of support in the literature and in the survey of emergency medicine physicians. On the other hand, the range of controversy suggests that an even lower rate could

Table 4 Emergency Medicine Physician Survey on MPSS Use (n = 69)

Survey Question	Response	
	Yes (%)	No (%)
Are you aware of NASCIS recommendations on MPSS use for acute spinal cord injury?	100.0	0
Do you agree and follow the protocol?	91.3	8.7

MPSS, methylprednisolone sodium succinate; NASCIS, National Acute Spinal Cord Injury Study.

occur. A previous study of this type in the United States, preceding the NASCIS 3 and Cochrane reports, showed similar results, but analyzed a much smaller number of patients over a shorter study period.[6,9,14] A study from a spinal cord injury referral center in the United Kingdom also concluded that the rate of MPSS administration was much less than expected.[36] The researchers found that 75% of the delegates to a European Cervical Spine Research Society meeting agreed with the use of MPSS, but had a number of reservations, a response similar to that of the South Carolina emergency physicians.

The 8 years covered by this study should allow for any time-dependent effects from dissemination of study results, particularly the confirmatory NASCIS 3 results.[6] Nevertheless, the proportion of patients with TSCI receiving MPSS remained constant by year. Other associations such as the greater likelihood of MPSS administration to younger patients and to those with more severe injuries (AIS of 4 and greater vs AIS of 2 or 3) are reinforced by the similar results of earlier studies.[13,14]

Limitations

A central issue in MPSS administration is the degree of protocol adherence. Although information on bolus and maintenance dosage and timing was acquired for all the patients in this study, body weights were not uniformly available. As a result, the consistency of the total administered dose could not be verified with the recommended protocol.

Another limitation of this study was its lack of sufficient information on intermediate outcomes or complications to explain the persistent differences in acute care charge and hospital stay as a function of MPSS receipt. Injury severity, neurologic level of the lesion, and in-hospital death played a role, but adjustment for these three variables resulted in only a partial reduction, from 4 to 2.5 days. Additionally, other variables not included in the current model could have influenced the results. For example, the time that elapsed between injury and hospital arrival could have affected the MPSS administration rate. Similarly, the authors could not collect information on other pharmacologic therapies or surgical interventions that may have been considered alternative treatments, and patients who received MPSS may have experienced improvement that was not reflected in the data from the acute care period.

Selection bias because of incomplete information on 3% of the sample selected (45 persons with acute TSCI) is a potential concern. However, the comparison of the patients with and those without complete information on MPSS showed no significant differences in demographic or clinical characteristics. This result is consistent with a minimal effect of selection bias on the observed associations.

The limitation of the survey to emergency physicians is a drawback of this study. Although emergency medicine physicians often are the first to encounter patients with acute TSCI, especially in smaller medical facilities, and consequently the first to effect MPSS administration, they are not the only physician group who would determine its use. The 30% response rate is low and may not be representative of all physicians with emergency medicine responsibilities. It also may not reflect the position of other decision makers regarding MPSS administration such as trauma surgeons and neurosurgeons.

Achieving a higher rate of compliance with the results of definitive randomized clinical trials is a complex issue.[37–43] One set of influences stems from logistic factors such as the elapsed time from injury to arrival at the treatment facility and the ease of access to the drug. Another set relates to practitioner perceptions regarding the benefit–risk relation, involving concerns such as the physiologic and immunologic effects from large doses of MPSS, the likelihood of inducing complications, and medicolegal consequences. Preventive measures with distant consequences for a group may be more difficult to implement than treatment that has immediate effects on a specific individual.[44]

The positions of experts and other opinion leaders and the official positions of professional organizations are influential. In this regard, expert opinions about the use of the NASCIS protocol are decidedly mixed. The most recent guidelines concluded that MPSS use is optional, with risks outweighing benefits.[45] In contrast, Bullock and Valadka[11] indicated that they will continue to use high-dose MPSS for most of their patients with TSCI; Delamarter and Coyle[46] supported the NASCIS recommendations; and Bracken[9,47] reiterated his defense of the NASCIS outcomes.

Finally, the characteristics of the health care delivery system certainly are key considerations. Necessary components of an effective strategy include adopting a clear policy, developing and implementing an action plan that includes all staff and has measurable criteria for accomplishment, and consistently reviewing progress with chart audits and similar types of specific data.[35,37,39–41]

In summary, despite the agreement of many investigators with the desirability of administering the MPSS protocol as established in the NASCIS trials, controversy persists. Against such a background, the population-based sample of the current study showed that 48.7% received the drug, and that the distribution of use was not uniform. The patient group receiving MPSS was more likely to be younger, to have more severe injuries, and to be admitted directly through a designated trauma center or emergency department. Patients who received MPSS had higher acute care charges and longer in-hospital stays than those who did not receive it. Additional studies appear necessary to broaden understanding of MPSS administration, and to weigh group improvements against the side effects of the drug, the higher acute care charges, and the longer in-hospital stays noted in this and other reports.

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