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Factors Associated With Delayed Concussion Reporting by United States Service Academy Cadets

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Context: Approximately half of individuals who sustain a concussion do not immediately report their injuries. Motivators for not reporting include thinking the suspected concussion was not a serious injury and wanting to continue participating in activity. Additionally, military personnel have concerns about how concussions may affect their careers. However, delayed reporting can prolong neurobehavioral recovery. Understanding the frequency of delayed reporting and contributing factors will aid in identifying individuals who may be more likely to delay reporting.

Objective: To describe the frequency of delayed concussion reporting by service academy cadets and determine if sex, injury setting, sport level, or medical history is capable of predicting delayed reporting.

Design: Cohort study.

Setting: Service academies.

Patients or Other Participants: A total of 316 patients with concussions were observed from January 2014 to August 2016.

Main Outcome Measure(s): All cadets completed an annual concussion baseline collection of demographic, medical history, and sports participation information. Delayed concussion reporting served as the outcome variable. Predictor variables were sex, injury setting, and sport level, as well as concussion, headache, and learning disorder history. Frequencies were calculated to describe the proportion of participants who delayed reporting. Univariable and multivariable logistic regression models were used to assess if the predictor variables were associated with delayed concussion reporting. Odds ratios (ORs) and 95% confidence intervals were calculated for all variables included in the final model.

Results: Of the patients with concussion, 51% were classified as delayed reporting. In univariable models, females (OR = 1.70) and National Collegiate Athletic Association cadet-athletes (OR = 1.98) were more likely to delay reporting than males and intramural cadet-athletes, respectively. The multivariable model yielded similar findings.

Conclusions: Roughly half of the cadets who sustained a concussion failed to immediately report their injury. Specifically, our data suggested that female cadets, cadets injured outside of competition, and highly competitive cadet-athletes were almost twice as likely to delay reporting as others.

Key Words: mild traumatic brain injuries, concussion recognition, education strategies, collegiate athletes

Key Points

- On par with numbers observed in athletic settings, 51% of cadets delayed reporting a concussion to medical personnel.
- Sex, injury setting, and competitive sport level were associated with delayed reporting, with females, cadets injured outside of competition, and highly competitive athletes more likely to delay.
- These findings should be conveyed to female cadets as well as other stakeholders in the service academy setting to reshape the culture around concussion disclosure.

Approximately half of individuals who sustain a concussion do not immediately report their injuries for various reasons.[1] However, delayed reporting has been shown to prolong neurobehavioral recovery and potentially result in more serious injury.[1,2] Although not well understood, the motivating factors for not reporting a concussion at the time of injury have included underestimating the seriousness of the injury and wanting to continue participating in the activity or sport despite the injury.[3,4] Other factors influencing the decision to report a concussion were a lack of education regarding the signs and symptoms of a concussion and perceived pressure from coaches, teammates, parents, and fans to continue to perform.[5,6] Additionally, in service academy cadets, a history of concussion may be disqualifying for accession, can lead to medical disqualification from military service,

or can limit the job specialties into which a soldier can enter.[7] Therefore, understanding the frequency of delayed reporting and factors that may contribute to delayed reporting may aid in identifying individuals who do not immediately disclose their injury and could be at risk for prolonged recovery.[1]

Some evidence indicates that delayed reporting of a concussion can lead to poorer outcomes, including prolonged recovery.[1] Athletes and service members who delay reporting and continue to engage in competition and military duty are exposed to an increased risk of catastrophic events (eg, postconcussion syndrome, subdural hematoma) due to recurrent injury.[8] Also, athletes with a history of unreported concussions may experience more serious symptoms or prolonged recovery after subsequent concussions.[9] Although immediate reporting appears to affect the recovery trajectory,[1,10] little is known about the factors that influence the decisions by athletes and service members to postpone reporting concussions.

Delayed reporting is of concern because of the high prevalence of concussions in athletes and military service members.[11] About 20% of high school athletes and 25% of collegiate football players have a history of at least 1 diagnosed concussion.[12,13] Between 2000 and 2017, 315 989 concussions occurred among US service members.[14] Furthermore, up to 20% of veterans returning from Iraq and Afghanistan had a history of concussion,[15] which has been strongly associated with posttraumatic stress disorder and physical health impairments.[16] The injury itself has adverse effects and potential long-term health sequelae,[17] yet waiting to report a concussion can amplify these consequences.[1,8,9]

A patient may delay reporting a concussion intentionally or unintentionally. For example, athletes may sustain blows to the head, experience symptoms, and deliberately choose not to report the injury to medical personnel knowing that the consequence of reporting will be removal from competition. For these individuals, performance supersedes safety. Other athletes may simply lack immediate access to care and delay reporting because the injury occurred outside of sport or at a practice where medical coverage was not provided. Some patients may unintentionally delay reporting because their symptoms mimic those of a preexisting medical condition, such as a learning or headache disorder. Fatigue, difficulty concentrating, difficulty remembering, lack of balance, and trouble sleeping are all concussion-like symptoms that individuals with learning disorders can experience.[18] Similarly, patients with migraine headaches can experience headaches, nausea, and sensitivity to light and sound.[19] Regardless of the reason for delay, females have been more willing to report concussion symptoms and disclose injuries than their male counterparts.[3] Understanding how sex, injury setting, competitive sport level, and medical history influence delayed reporting could help inform future concussion-education strategies.

Although delayed reporting and delayed removal from activity have been examined in athletes,[1,2,10,20,21] little is known about delayed reporting in service members and cadets. Additionally, factors that may influence the decision to disclose a concussion to medical staff are unknown. Therefore, the purpose of this study was to describe the frequency of delayed concussion reporting in service academy cadets and to determine if sex, injury setting, competitive sport level, and a history of concussion, learning disorder, or headache disorder described at the preinjury baseline were associated with delayed concussion reporting. We hypothesized that male cadets, cadets injured outside of competition, cadet-athletes competing at higher levels of competition, and cadets with a history of concussion, learning disorder, or headache disorder would be more likely to delay reporting a concussion.

METHODS

Study Design and Setting

A prospective cohort study was conducted at 2 US service academies to examine the frequency of delayed reporting by cadets and determine if characteristics noted at preinjury baseline were associated with delayed reporting. Both sites were participating in the Concussion Assessment, Research and Education (CARE) Consortium. The CARE Consortium is a multisite prospective cohort study to investigate the natural history of concussion, including injury risks, treatment, and management in student-athletes and service academy cadets.[22] Data are currently being collected at 4 US service academies (United States Military Academy [USMA], United States Naval Academy, United States Air Force Academy [USAFA], and United States Coast Guard Academy). For the current study, we extracted data from January 2014 to August 2016 for the 2 largest service academy cohorts, USMA and USAFA, which consisted of 9576 cadets (23% female). All cadets were between the ages of 17 and 27 years and participated in mandatory athletics, military training, and physical education requirements during the study period. Participation in National Collegiate Athletic Association (NCAA), competitive club, or intramural athletics is a requirement for all cadets while at their respective institutions. All participants signed informed consent documents approved by each site's institutional review board and the US Army Human Research Protections Office before data collection.

Procedures

The structure and methods of data collection in the CARE Consortium have been described in detail elsewhere[22] and are summarized here in relation to the current study. At the service academies, all cadets who agreed to participate in the CARE Consortium completed the standard CARE clinical assessments (ie, Balance Error Scoring System, Standardized Assessment of Concussion, ImPACT) and provided demographic, sports participation, concussion history, and medical history information via a customized computer portal (QuesGen Systems Inc, Burlingame, CA). For this investigation, we extracted the following key baseline variables from the database: competitive sport level, concussion history, headache disorder history, migraine headache history, and learning disorder history. All variables were self-reported. Respondents were asked to select the level of competitive sport in which they participated based on the 3 levels of athletic activity (ie, intramurals, club, NCAA) at the service academies. For concussion, headache disorder, migraine headache, and learning disorder history, participants were asked to answer *yes* or *no* based on the operational definitions in Table 1. Injury information for participants

Table 1. Operational Definitions for the Baseline and Postinjury Data

Variable	Operational Definition
Concussion	A change in brain function after a force to the head, which may be accompanied by temporary loss of consciousness, but is identified in awake individuals with measures of neurologic and cognitive dysfunction[32,33]
Headache disorders[a] (nonmigraine)	A pattern of frequent headaches that can be classified as chronic tension type, medication overuse, or new persistent daily headaches
Migraine headaches[a]	Multiple headaches with moderate or severe pain that can be accompanied by nausea, sensitivity to light, or sensitivity to sound (or some combination of these) and have been diagnosed by a physician
Learning disorders	A cognitive difficulty that causes lower-than-expected academic achievement despite intelligence level
Delayed report	A case in which the concussion was not immediately reported by the cadet; cases in which the cadet neglected to report the event or the cadet continued to participate beyond the concussive event were classified as delayed reports.

[a] Combined as *headache disorder history* for analysis.

who sustained concussions during the surveillance period were documented by the treating clinicians.

Injury Surveillance

Cadets who completed preinjury baseline screening and subsequently sustained a concussion, as defined by the CARE Consortium[22] and described in Table 1, between January 2014 and August 2016 were included in this analysis. All concussions sustained by CARE participants were documented by research staff and the details entered into the database. The treating clinician documented whether the cadet immediately reported the injury as a *yes* or *no* and identified the injury setting as competition, practice/training, or outside of sport. Table 1 operationally defines the patients who were classified as delayed reports.

Statistical Analysis

Delayed report (*yes*, *no*) served as the primary outcome variable of interest. Due to small sample sizes, nonmigraine and migraine headache history were combined as *headache disorder history* for analysis. Thus, predictor variables were sex (*male*, *female*), injury setting (*competition*, *outside of sport*, *practice/training*), concussion history (*yes*, *no*), competitive sport level (intramural, club, NCAA), headache disorder history (*yes*, *no*), and learning disorder history (*yes*, *no*). Frequencies were calculated to describe the proportion of participants who delayed reporting. We used univariable and multivariable logistic regression models to assess if sex, injury setting, competitive sport level, concussion history, headache disorder history, or learning disorder history was associated with delayed injury reporting by concussed cadets. All predictor variables with significant univariable models ($P \leq .200$) were added to the multivariable model. History of concussion was included in the multivariable model because of the current literature[1,2] highlighting the relationship between concussion history and prolonged recovery time. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were reported for all variables included in the final model. The α level was set a priori at $P < .05$.

RESULTS

At the time of the analysis, 9576 cadets (23% female) were enrolled in CARE and had undergone baseline testing. During the surveillance period, 316 concussions were observed and documented in the CARE database. Twenty-four patients had to be excluded from the analysis due to missing data. Of the 292 remaining concussions, 49% were immediately reported to a member of the medical staff and 51% were classified as delayed reports. Study enrollment and inclusion criteria are outlined in the Figure. Descriptive statistics by reporting status (immediate, delayed) are provided in Table 2.

The univariable and multivariable models, including ORs and 95% CIs, are summarized in Table 3. In the univariable models, sex and level of sport competition were significantly associated with the delayed reporting of concussion. Female service academy cadets were 70% more likely to delay reporting an incident concussion than their male counterparts. Similarly, service academy cadets competing in intercollegiate competitive club sports or NCAA sports were nearly twice as likely to delay concussion reporting as those participating in intramural athletics; however, only the latter finding was statistically significant. Injury setting and concussion, headache, and learning disorder history were not significant.

Based on the univariable results and current literature, we included sex, injury setting, sport level, concussion history, and learning disorder history in the multivariable model. Results for the multivariable model were similar to those observed in the univariable analyses (Table 3). In the multivariable model, sex, injury setting, and level of competitive sport were significantly associated with

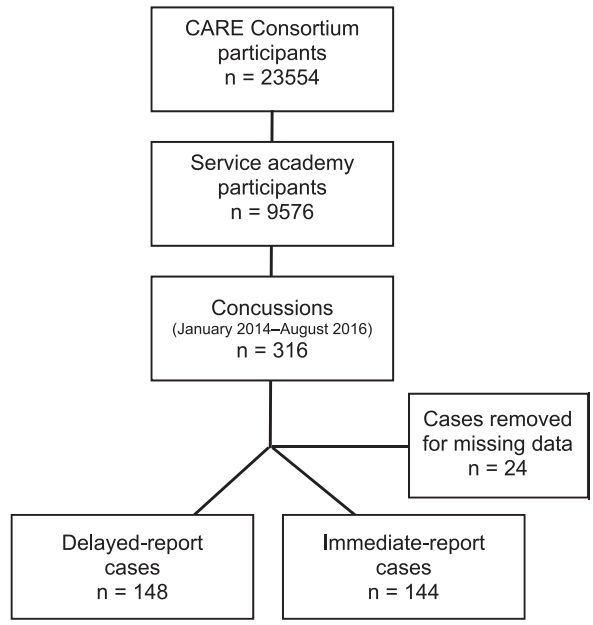

Figure. Study enrollment and inclusion diagram. Abbreviation: CARE, Concussion Assessment, Research and Education.

Table 2. Participant Demographic Statistics by Concussion Reporting Status

Characteristic	n	Males	Females	Mean ± SD		
				Age, y	Height, in (cm)	Weight, lb (kg)
Immediate report	144	102	42	18.96 ± 1.33	69.33 ± 4.11 (176.0 ± 10.44)	164.40 ± 28.36 (74.57 ±12.86)
Delayed report	148	87	61	18.90 ± 1.28	68.89 ± 4.21 (174.98 ± 10.69)	167.84 ± 37.60 (76.13 ±17.06)

delayed concussion reporting after we controlled for concussion and learning disorder history at baseline and the other variables in the model. Females were 74% more likely to delay reporting than males after controlling for the other variables in the model. Similarly, those participating in competitive club or NCAA sports were nearly 2.5 times as likely to delay reporting as cadets participating in intramural sports. Finally, service academy cadets who sustained concussion injuries outside of sport or during practice or training were nearly twice as likely to delay reporting as those injured during competition; however, only injuries that occurred during practice or training were statistically significant at the .05 level. Concussion history and learning disorder history were not significant predictors in the multivariable model.

DISCUSSION

The aim of our study was to describe the frequency of delayed concussion reporting by service academy cadets and to determine if sex, injury setting, competitive sport level, or a history of concussion, headache disorder, or learning disorder was associated with delayed reporting. During the study period, roughly half (51%) of all concussions observed were classified as delayed reports. Although a history of concussion, headache disorder, or learning disorder was not an important factor, sex, injury setting, and competitive sport level had significant effects on delayed reporting. More specifically, female cadets, cadets who sustained a concussion during practice or training, and competitive club and NCAA cadet-athletes were more likely to delay reporting a concussion. These results are consistent with our hypothesis that cadet-athletes competing at a higher level (ie, competitive club, NCAA) would be more likely than intramural cadet-athletes to delay reporting and that cadets injured outside of competition (where an on-site medical provider was less likely to be present) would be more prone to delay concussion reporting. However, these results were inconsistent with our hypothesis that males would be more likely than females to delay reporting. Additionally, we found that medical history at baseline, including a history of concussion, headache disorder, or learning disorder, did not appear to play a significant role in delayed reporting.

This is one of the first investigations to prospectively examine delayed concussion reporting by a military population, specifically service academy cadets. The current literature has primarily focused on patients who never report their concussion symptoms as opposed to the subset of patients who wait to report.[5,23] Asken et al[1] were the first to recognize this gap and evaluate delayed reporting by an athletic population. They found that 51.5% of Division I athletes did not immediately report symptoms of a concussion. Similarly, in our study, a substantial number of cadets (50.7%) waited to report their injury to a medical provider. Thus, the frequency of delayed reporting does not appear to differ between the environments, suggesting that the factors motivating athletes to delay reporting a concussion, pressure from coaches or teammates, and wanting to continue participating in their sport may have been present in both groups. This is problematic because other researchers[2,10,21] have shown that continuing to play after concussion results in longer

Table 3. Results of the Univariable and Multivariable Logistic Regression Models

Predictor Variable[a]	n	Univariable		Multivariable	
		Odds Ratio (95% Confidence Interval)	*P* Value	Odds Ratio (95% Confidence Interval)	*P* Value
Sex	Males = 189	REF			
	Females = 103	1.70 (1.05, 2.77)	.032	1.74 (1.05, 2.89)	.033
Injury setting					
Competition	50	REF			
Outside of sport	106	1.50 (0.79, 2.97)	.244	1.93 (0.91, 4.07)	.085
Practice or training	134	1.85 (0.96, 3.58)	.068	2.14 (1.06, 4.32)	.033
Sport level					
Intramural	128	REF			
Club	51	1.86 (0.97, 3.60)	.063	2.43 (1.19, 4.96)	.015
National Collegiate Athletic Association	113	1.98 (1.19, 3.32)	.009	2.39 (1.37, 4.16)	.002
Concussion history	No = 170	REF			
	Yes = 122	0.81 (0.51, 1.28)	.363	0.70 (0.42, 1.14)	.153
Headache disorder history	No = 272	REF			
	Yes = 20	1.50 (0.59, 3.79)	.391	–	–
Learning disorder history	No = 286	REF			
	Yes = 6	4.99 (0.58, 43.33)	.144	5.42 (0.58, 50.90)	.139

Abbreviation: REF, referent group for each comparison.

[a] All variables were included in the multivariable model except for headache disorder.

recovery times, greater neurocognitive impairment, and an increased symptom burden. Conveying this evidence to cadets, soldiers, and athletes as well as superior officers, coaches, and others involved in patient care may improve timely injury reporting.

Cadets injured outside of competition, particularly during practice or training, were twice as likely to delay reporting than those injured during competition. One possible explanation for this is that medical coverage may be limited during practice or training events or nonexistent when concussions occur outside of sport. It is well known that observed concussion rates are higher during competitions than during practices.[24–26] Although these increased competition injury rates have been attributed to greater exposure to high-risk activities[25] and intensity of play,[26] they may reflect access to medical personnel and medical and nonmedical personnel paying closer attention during competition events. If the cadets who sustain concussions outside of competition are more likely to delay reporting their injuries, they may also be less likely to disclose a concussion altogether, which could contribute to the lower rates observed during practices. Future authors should document access to care to determine how it influences a patient's decision to report a concussion.

In our study, concussed competitive club and NCAA cadet-athletes were almost 2.5 times as likely to delay reporting an injury as concussed intramural athletes. These findings were interesting in that competitive club and NCAA cadet-athletes have direct access to medical care via an athletic trainer and undergo concussion education in which they must acknowledge that they "have a responsibility to report concussion-related injuries and illness to a medical staff member."[27] Still, the result is not surprising because many of the motivating factors to not report (ie, desire to continue participating; pressure from coaches, teammates, or fans) are specific to high-level athletic competition. The athletes' performance values may outweigh the safety structures in place (ie, athletic trainers, concussion education).[28] Similar trends have been observed in cross-sectional surveys dealing with behavioral intentions regarding concussion disclosure. Foster et al[29] found that intercollegiate cadet-athletes at USAFA reported less positive attitudes about concussion disclosure than their peers. However, when Register-Mihalik et al[30] investigated behavioral intentions for concussion reporting by USMA cadets, they found evidence to suggest that sport level did not play a role in cadets' intention to disclose. With conflicting evidence regarding sport level and the intention to disclose, it is unclear whether the latter may relate to actual disclosure at the time of injury. In other words, attitudes may not always equate with actions. Moving forward, we need to identify the context of concussion disclosure and delayed reporting to determine the factors that motivate highly competitive athletes to delay reporting or underreport concussions.

Female cadets in this study were almost twice as likely as male cadets to delay reporting a concussion. We initially hypothesized that males would exhibit a higher incidence of delayed reporting. Research has suggested that males were more willing to conceal a concussion[3,31] whereas females may have been more willing to report concussion symptoms during baseline testing and more likely to self-disclose an injury.[3,32,33] Although the frequency of delayed reporting was consistent with prior findings,[1] the increased OR in females may be a result of the population studied. Females represented less than 25% of service academy cadets, which reflects the armed forces population as a whole. Underrepresentation, in conjunction with stereotypes and the military atmosphere, can create an environment in which females feel the need to prove themselves to be as mentally and physically strong as their male counterparts.[34] Thus, females who did not immediately report their concussions may have assumed that they would be viewed as weak for seeking medical care. Previous investigators who examined attitudes and intentions related to concussion reporting found that sex did not play a role in underreporting or delayed reporting by athletes[1,23] or intention to disclose in cadets.[29,30] For example, Foster et al[29] observed that 26% of USAFA cadets were more likely to conceal a concussion than to disclose one but did not find any differences between sexes. Register-Mihalik et al[30] also noted that sex did not play a role in USMA cadets' intentions to disclose concussion symptoms. Our results may have been influenced by the type of study design (ie, prospective cohort of injured cadets versus cross-sectional surveys of behavioral intentions) or by the number of male cadets who sustained concussions during the study period but never disclosed the injury to medical personnel. Specifically, more females may have delayed reporting but still eventually reported their concussions, whereas males who delayed may have never reported.

A previous history of concussion, headache disorder, or learning disorder has been linked to prolonged recovery time[1] and increased concussion-like symptoms[35]; however, none of these factors were significantly associated with delayed concussion reporting in our study. Although we did not find statistical significance in the multivariable model, the data suggested that the magnitude of the effect for learning disorder history was moderate to large. Regrettably, the sample size for a history of learning disorder was small ($n = 6$), which likely contributed to the lack of statistical significance, as well as the lack of measurement precision as reflected by the wide CI around the point estimate for this variable. Despite these limitations, given the large magnitude of the OR we demonstrated, the association between learning disorder history and delayed concussion reporting should be examined in future adequately powered investigations. In a previous study[30] of USMA cadets, a history of concussion was associated with less intention to disclose concussion symptoms: intent to disclose was high in roughly 80% of cadets with no concussion history and only 67% of cadets with a concussion history. Again, these findings highlight that intention to disclose and actual disclosure behaviors may not be synonymous.

LIMITATIONS

Our work was not without limitations. Although the current findings may not be generalizable to other athlete populations, these results may be important for clinicians working with service academy cadets, as well as active-duty military service members. Though the data were collected in a controlled environment with a strong medical presence, the athletes may not have had immediate access to care. Additionally, a history of concussion, headache

disorder, or learning disorder was self-reported at preinjury baseline, which may have introduced recall bias. Regrettably, we did not ask the cadets who delayed reporting their concussions why they chose not to immediately disclose the injury. A question has since been added to the CARE postinjury packet to capture these data. Lastly, we did not quantify how long it took for the concussion to be reported. Future researchers should qualitatively determine why patients wait to report, so that educational initiatives can be modified to target these factors. We should also aim to understand how outcomes, such as return-to-play time and postconcussion syndrome, are influenced by the delayed reporting of concussions by service academy cadets.

CLINICAL IMPLICATIONS

On par with the numbers observed in athletic settings, slightly more than half of service academy cadets delayed reporting a concussion to medical personnel. Delayed reporting was influenced by sex, injury setting, and competitive sport level, with females, cadets injured outside of competition, and highly competitive athletes more likely to delay. These results have important implications for athletic training practice because athletic trainers have a strong presence at the US service academies and are emerging as health care providers in other military settings. First and foremost, the presence of an athletic trainer may not be enough to influence immediate disclosure because highly competitive athletes who had access to care were more likely to delay. However, higher levels of athletic trainer availability have been associated with increased concussion reporting.[36] Until we have a better understanding of what causes an individual to delay (ie, behavior or attitudes, delayed symptoms, access to care), we must focus on improving both access to care and concussion-education strategies. Adjusting education strategies to emphasize the evidence-based consequences of delaying reporting, such as longer recovery times, may sway an individual to immediately seek medical attention or for a coach to encourage an athlete to report sooner. Second, athletic trainers working within a male-dominated service academy environment should be aware that females were almost twice as likely to delay. This information should be conveyed to female cadets as well as other stakeholders in the service academy setting (ie, coaches, professors, superior officers) to reshape the culture around concussion reporting. Revising education strategies to highlight the negative consequences of delayed reporting and informing individual at-risk groups (ie, females, competitive athletes) may reduce the incidence of delayed reporting.

CONCLUSIONS

Our data suggest that roughly half of the service academy cadets who sustained concussions failed to immediately report their injuries to medical staff. Sex, injury setting, and competitive sport level were associated with significantly increased odds of delayed reporting. More specifically, females, cadets injured outside of competition, and highly competitive athletes were almost twice as likely to delay concussion reporting. This information may be helpful for clinicians working with service academy populations who need to identify and manage individuals with concussions. It may also provide additional insight into subgroups outside of the service academies who could benefit from interventions to increase actual concussion-disclosure behavior and immediate injury reporting.

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