OPEN ACCESS

DOI: https://doi.org/10.59736/IJP.24.02.1071

ORIGINAL ARTICLE

# Efficacy of Intramuscular Midazolam for the Treatment of Status Epilepticus in Children

**Amnah Khan[1], Shamayal Mandokheil[2], Maria Sherani[3], Fasiha Javed[4], Umme Habiba[4] and Aqsa Mehmood[5]**

1,2,3,4,5 Department of Paediatrics, Balochistan Institute of Child Health Services, Quetta, Balochistan

## ABSTRACT

**Background:** Status epilepticus (SE) is a life-threatening pediatric neurological emergency requiring rapid seizure control to prevent neuronal injury. Establishing intravenous access in actively convulsing children is often challenging, leading to treatment delays. Intramuscular midazolam, due to its rapid absorption and high bioavailability, offers a practical alternative.

**Methods:** A prospective observational cohort study was conducted at the Department of Pediatrics, Balochistan Institute of Child Health Services, Quetta, from September 2025 to April 2026. Sixty-six children aged 1–12 years presenting with convulsive SE (>5 minutes) were enrolled through consecutive sampling. Patients with prior epilepsy, prehospital benzodiazepine use, or contraindications were excluded. Intramuscular midazolam (0.3 mg/kg; maximum 10 mg) was administered into the vastus lateralis (<2 years) or deltoid muscle (≥2 years). The primary outcome was seizure cessation within 5 minutes. Secondary outcomes included time to cessation, recurrence within 60 minutes, and adverse events. Data were analyzed using SPSS v22.0.

**Results:** Among 66 patients (57.6% male; mean age 6.2 ± 3.8 years), seizure cessation within 5 minutes was achieved in 93.9% (95% CI: 87.1–97.5%). The median time to cessation was 65 seconds (range: 24–310), with a mean door-to-drug time of 58.3 ± 22.4 seconds. Higher efficacy was observed in children aged 7–9 years (100%). Febrile SE and absence of prior seizures were associated with faster control ($p < 0.05$). Recurrence occurred at 4.8%, while adverse events were mild (9.1%), including transient respiratory depression (3.0%).

**Conclusion:** Intramuscular midazolam (0.3 mg/kg) is a highly effective and safe first-line treatment for pediatric SE when intravenous access is unavailable.

**Keywords:** Status epilepticus; midazolam; intramuscular; children; efficacy.

**This article may be cited as:** khan A, Mandokhel S, Sherani M, Javed F, Habiba U, Mehmood A. Efficacy of intramuscular midazolam for the treatment of Status epilepticus in children. Int J Pathol;24(2) DOI: https://doi.org/10.59736/IJP.24.02.1071

## Introduction

Status epilepticus (SE) is a life-threatening neurological emergency in children that requires immediate treatment to reduce morbidity and mortality. It is defined as continuous seizures lasting more than five minutes or repeated seizures without recovery between episodes (1). SE affects about 10–20 per 100,000 children each year, with the highest rates in those under five years of age (2).

**CORRESPONDING AUTHOR**

**Prof Dr. Shamayal Mandokheil**

Department of Paediatrics,

Balochistan Institute of Child Health Services, Quetta, Balochistan

Email: shamyl.saeed.23@gmail.com

DOI: https://doi.org/10.59736/IJP.24.02.1071

SE includes a range of seizure types, commonly divided into two main forms: convulsive status epilepticus (CSE), marked by obvious rhythmic jerking, and non-convulsive status epilepticus (NCSE), which presents with elusive signs such as confusion, reduced awareness, or coma without clear motor activity (3). Prolonged SE leads to serious brain injury through metabolic imbalance, excitotoxicity, inflammation, and neuronal cell death. Studies show that longer seizure duration is linked to greater hippocampal damage and cognitive decline (4). In children, the risk is higher due to increased seizure susceptibility during brain development. Prolonged SE is associated with epilepsy, developmental delay, learning difficulties, and, in severe cases, death (5). Mortality in pediatric SE varies by cause, setting, and access to care. In high-resource settings, it is around 3-5% but can reach up to 25% in low- and middle-income countries (6). Among survivors, 10–30% develop neurological complications such as motor deficits, intellectual disability, or behavioral problems. Early drug treatment is key, with benzodiazepines recommended as first-line therapy in all guidelines (7). Intravenous lorazepam and diazepam are commonly used due to their rapid action and safety. However, many cases occur outside hospitals, where IV access can be difficult or delayed, particularly in young children or those with poor perfusion (8, 9) Its short half-life (1.5–3.5 hours) allows seizure control with less prolonged sedation. Studies support its use. A key prehospital trial showed IM midazolam was as effective as intravenous lorazepam for stopping seizures, with similar safety (10). Pediatric studies have shown that intramuscular midazolam achieves seizure control more rapidly than buccal midazolam and has comparable efficacy to intranasal and rectal formulations.

Intramuscular midazolam has emerged as an effective alternative when intravenous access cannot be established promptly in children with convulsive status epilepticus. However, despite its widespread recommendation in international guidelines, there is limited published evidence from Pakistan regarding its effectiveness and safety in routine pediatric emergency practice, particularly from resource-limited healthcare settings (11). Therefore, this study evaluated the efficacy and safety of intramuscular midazolam in children presenting with convulsive status epilepticus. The primary outcomes were seizure cessation within 5 minutes, time to seizure cessation, seizure recurrence within 60 minutes, and treatment-related adverse events. This study was designed to generate local evidence to support the emergency management of pediatric convulsive status epilepticus in Pakistan.

## Methods

The prospective observational cohort study was conducted at the Department of Pediatrics, Balochistan Institute of Child Health Services, Quetta, Balochistan, from September 2025 to April 2026. This research study was conducted under institute approval with number BICHQ/14405/26. Sample size was calculated using the WHO sample size calculator at 95% confidence level, 8% margin of error, and expected efficacy of 87.5% based on previous literature (12). A total of 66 patients were included with Non-probability consecutive sampling technique. Children aged 1–12 years presenting with convulsive status epilepticus (continuous convulsive seizure activity lasting more than 5 minutes) were included after informed consent. Children with a diagnosis of epilepsy or

DOI: https://doi.org/10.59736/IJP.24.02.1071

another chronic seizure disorder requiring ongoing antiepileptic treatment, prehospital benzodiazepine use, contraindications to midazolam, or other confounding conditions were excluded. Status epilepticus was defined as continuous seizure activity lasting more than 5 minutes, and efficacy was defined as cessation of seizures within 5 minutes of a single intramuscular dose of midazolam.

Eligible patients received intramuscular midazolam as first-line therapy at a dose of 0.3 mg/kg (maximum 10 mg) using the commercially available 5 mg/mL injectable preparation. Injection was administered into the vastus lateralis (<2 years) or deltoid muscle (≥2 years) using a 23-25G needle over 5-10 seconds. Intravenous access was intentionally deferred until after administration of the study drug.

All children presenting to the Pediatric Emergency Department with active convulsive status epilepticus were screened for eligibility. Baseline data were recorded on a structured proforma, including age, gender, weight, seizure duration before arrival, seizure type (febrile/afebrile), past seizure history, prior antiepileptic drug use, and vital signs (heart rate, respiratory rate, oxygen saturation, blood pressure, temperature). Etiology was categorized as febrile, remote symptomatic, or idiopathic.

Data was analyzed using IBM SPSS Statistics version 22.0. Continuous variables (age, seizure duration, time intervals) were expressed as mean ±SD or median (range), depending on distribution. Categorical variables (gender, seizure type, prior seizure history, treatment outcome) were presented as frequencies and percentages. Primary outcome (treatment success) was reported as proportion with 95% confidence interval. Group comparisons were performed using Chi-square or Fisher's exact test for categorical variables and Mann-Whitney U test for non-parametric time data. Stratified analyses were conducted for age, gender, seizure type, and prior seizure history. Multivariate logistic regression was planned to identify independent predictors of treatment response, adjusting for relevant covariates. A p-value ≤ 0.05 was considered statistically significant. A p-value ≤0.05 was considered statistically significant.

## Results

A total of 78 children with status epilepticus were screened for eligibility during the study period from September 2025 to April 2026. Of these, 12 patients were excluded: 5 had received prehospital benzodiazepines, 4 had established IV access on arrival, 2 had known seizure disorders on chronic antiepileptic therapy, and 1 had parental refusal. The remaining 66 patients were enrolled and received intramuscular midazolam. All 66 patients completed the study protocol and were included in the final analysis (Figure 1).

A total of 66 children were included in the study. Among them, 38(57.6%) were male and 28(42.4%) were female. The mean age of the study population was 6.2 ± 3.8 years. According to the age groups, 22 children (33.3%) were between 1-3 years, 16 (24.2%) between 4–6 years, and 14 (21.2%) each in the 7–9 years and 10–12 years groups. The mean body weight was 19.4 ± 8.2 kg. The median duration of seizures before arrival at the hospital was 12 minutes, with a range of 6 to 45 minutes. Regarding seizure type, febrile SE was observed in 35 patients (53.0%), while 31 patients (47.0%) presented with afebrile SE. In terms of etiology, febrile causes were identified in 35 cases (53.0%), followed by remote symptomatic causes in 18 cases (27.3%), and idiopathic causes in 13 cases (19.7%). A previous history of seizures was reported in 18 patients (27.3%), whereas 48 patients (72.7%) had no such history. Prior use of antiepileptic drugs was reported in 8 patients (12.1%), while the majority, 58 patients (87.9%), had not received any antiepileptic treatment before presentation.

DOI: https://doi.org/10.59736/IJP.24.02.1071

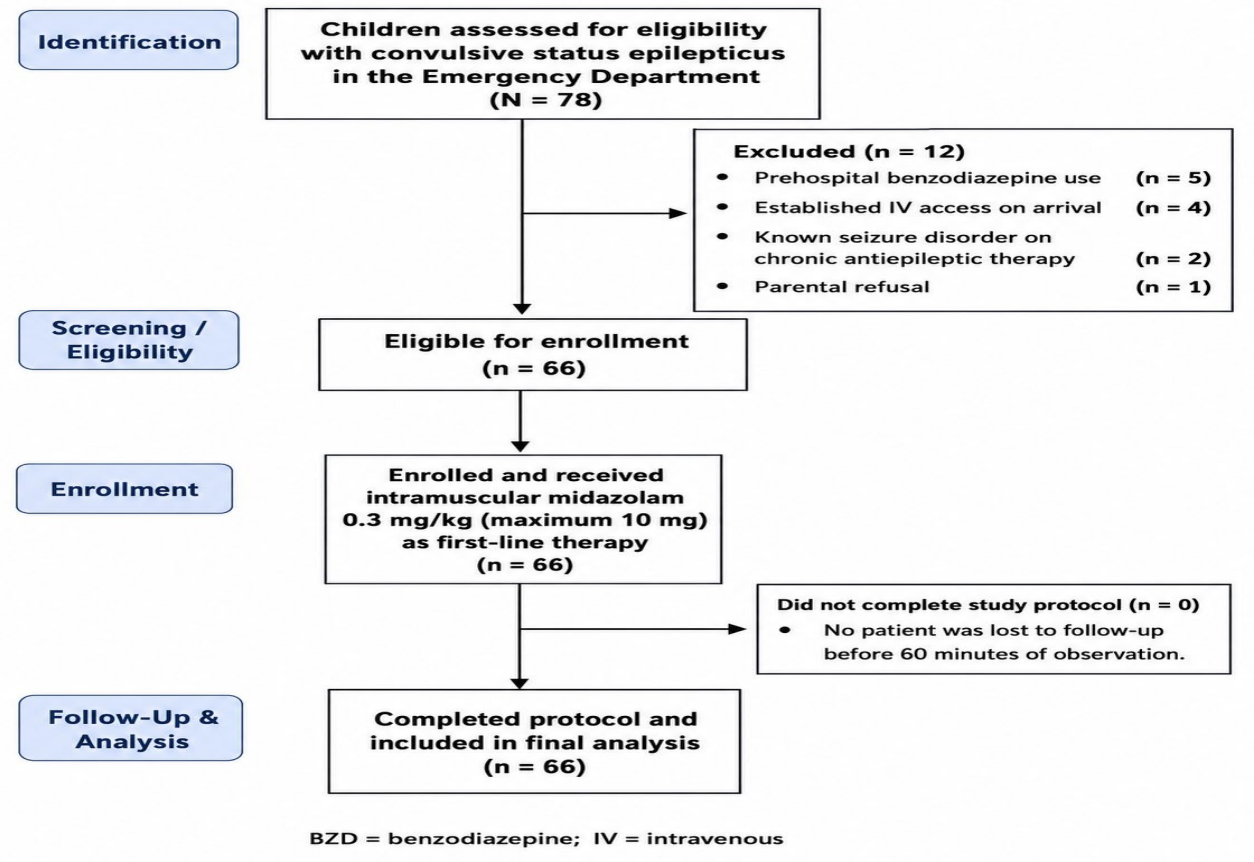


**Figure 1: sketch of the overall samples used in the study**

**Table 1: Baseline Characteristics of Study Population (N = 66)**

| Parameters | | Values |
|---|---|---|
| Gender, n (%) | Male | 38 (57.6%) |
| | Female | 28 (42.4%) |
| | Age (years), mean ± SD | 6.2 ± 3.8 |
| Age groups, n (%) | 1–3 years | 22 (33.3%) |
| | 4–6 years | 16 (24.2%) |
| | 7–9 years | 14 (21.2%) |
| | 10–12 years | 14 (21.2%) |
| Weight | Weight (kg), mean ± SD | 19.4 ± 8.2 |
| Seizure duration before arrival (minutes), median (range) | | 12 (6–45) |
| Seizure type, n (%) | Febrile status epilepticus | 35 (53.0%) |
| | Afebrile status epilepticus | 31 (47.0%) |
| Etiology, n (%) | Febrile | 35 (53.0%) |
| | Remote symptomatic | 18 (27.3%) |
| | Idiopathic | 13 (19.7%) |
| Previous history of seizures, n (%) | Yes | 18 (27.3%) |
| | No | 48 (72.7%) |
| Prior antiepileptic drug use, n (%) | Yes | 8 (12.1%) |
| | No | 58 (87.9%) |

DOI: https://doi.org/10.59736/IJP.24.02.1071

Among 66 pediatric patients with convulsive status epilepticus, intramuscular midazolam achieved seizure termination within 5 minutes in 62 cases (93.9%; 95% CI: 87.1-97.5). Treatment failure occurred in 4 patients (6.1%), all of whom required increase to second-line intravenous antiepileptic agents. Subsequent seizure control was achieved using intravenous lorazepam in 2 patients (50% of failures), levetiracetam in 1 patient (25%), and phenytoin in 1 patient (25%). No patient progressed to refractory status epilepticus, and no intensive care unit admissions were required. Early seizure recurrence within 60 minutes was observed in 3 of 62 initial responders (4.8%), all of whom responded to a repeat dose of intramuscular midazolam (0.2 mg/kg), resulting in sustained seizure control without further rise of medication. Gender-stratified analysis demonstrated comparable therapeutic efficacy between males (36/38, 94.7%) and females (26/28, 92.9%), with no statistically significant difference in treatment response(p=0.527).

**Table 2: Primary Outcome, Recurrence, and Gender-Based Efficacy of Intramuscular Midazolam**

| Parameter | Subgroup/ Outcome | n | Response / Event | Percentage (%) | Additional Details | p-value | 95% CI |
|---|---|---|---|---|---|---|---|
| Primary efficacy | Successful seizure cessation (≤5 min) | 66 | 62 | 93.9 | Complete seizure termination achieved after IM midazolam | – | 87.1–97.5 |
| | Unsuccessful (>5 min) | 66 | 4 | 6.1 | Required escalation to second-line therapy | – | 2.5–12.9 |
| Rescue therapy in failures | IV lorazepam | 4 | 2 | 50.0(of failures) | Achieved seizure control after escalation | – | – |
| | IV levetiracetam | 4 | 1 | 25.0(of failures) | Successful secondary control | – | – |
| | Phenytoin | 4 | 1 | 25.0(of failures) | Successful secondary control | – | – |
| Refractory outcomes | Refractory SE / ICU admission | 66 | 0 | 0 | No progression to refractory SE or ICU requirement | – | – |
| Seizure recurrence | Recurrence within 60 min | 62 | 3 | 4.8 | Managed with repeat IM midazolam (0.2 mg/kg) | – | – |
| Gender-based efficacy | Male | 38 | 36 | 94.7 | No significant sex-based difference in response | 0.527 | – |
| | Female | 28 | 26 | 92.9 | Comparable therapeutic response | | – |

The median time from drug administration to seizure cessation was 65 seconds (range: 24–310), with a mean of 72.4 ± 48.6 seconds. The mean door-to-drug time was 58.3 ± 22.4

DOI: https://doi.org/10.59736/IJP.24.02.1071

seconds (median: 55; range: 40–180). Overall, the total time from hospital arrival to seizure termination was 130.7 ± 58.2 seconds (median: 120; range: 75–420), indicating rapid pharmacodynamics response following intramuscular administration.

**Table 3: Time to Treatment and Seizure Termination Following Intramuscular Midazolam in Pediatric Status Epilepticus**

| Time Interval | Mean ± SD (seconds) | Median(range) (seconds) |
|---|---|---|
| Arrival at drug administration | 58.3 ± 22.4 | 55 (40–180) |
| Drug administration to seizure cessation | 72.4 ± 48.6 | 65 (24–310) |
| Arrival to seizure cessation (total) | 130.7 ± 58.2 | 120 (75–420) |

Overall efficacy remained consistently high across all age groups (85.7–100%) with no statistically significant difference ($\chi^2$ p = 0.672). The highest success rate was observed in the 7–9-year group (100%), while the lowest was in the 10–12-year group (85.7%). Mean time to seizure cessation varied across age strata, with the shortest duration in 7–9 years (65.8 ± 35.2 s) and the longest in 10–12 years (85.4 ± 62.1 s), although differences were not statistically significant (F(3,62) = 1.84, p = 0.148). A weak positive correlation was observed between age and time to seizure cessation (r = +0.28, p = 0.023), indicating a modest increase in response time with advancing age.

**Table 4: Age-Stratified Efficacy and Temporal Variation in Seizure Cessation Following Intramuscular Midazolam in Pediatric Status Epilepticus**

| Age Group | n | Success n (%) | Mean Time ± SD (s) | Median (s) | Range (s) | 95% CI |
|---|---|---|---|---|---|---|
| 1–3 years | 22 | 21 (95.5) | 68.5 ± 42.3 | 62 | 28–185 | 77.2–99.9 |
| 4–6 years | 16 | 15 (93.8) | 71.2 ± 38.7 | 65 | 30–165 | 69.8–99.8 |
| 7–9 years | 14 | 14 (100.0) | 65.8 ± 35.2 | 58 | 24–150 | 76.8–100.0 |
| 10–12 years | 14 | 12 (85.7) | 85.4 ± 62.1 | 78 | 35–310 | 57.2–98.2 |
| **Total** | **66** | **62 (93.9)** | **—** | **65** | **24–310** | **87.1–97.5** |

Febrile seizures and absence of prior seizure history were associated with faster seizure termination, while overall treatment efficacy remained high across subgroups without statistically significant differences in most comparisons. Febrile status epilepticus demonstrated higher treatment success (97.1%) with a shorter median time to seizure cessation (58 s) compared to afebrile seizures (90.3%, 78 s; p = 0.032). Similarly, children without a prior seizure history showed higher success rates (95.8%) and faster response (62 s) than those with previous seizure history (88.9%, 85 s; p = 0.041). Gender-based analysis revealed comparable treatment outcomes between males (94.7%) and females (92.9%), with no statistically significant difference (p = 0.527).

**Table 5: Subgroup Analysis of Seizure Characteristics and Gender-Based Efficacy of Intramuscular Midazolam in Pediatric Status Epilepticus**

| Subgroup | n | Success n (%) | Median Time (s) | p-value |
|---|---|---|---|---|
| Febrile | 35 | 34 (97.1) | 58 | 0.032 |
| Afebrile | 31 | 28 (90.3) | 78 | — |
| Prior history (Yes) | 18 | 16 (88.9) | 85 | 0.041 |
| No prior history | 48 | 46 (95.8) | 62 | — |
| Male | 38 | 36 (94.7) | — | 0.527 |
| Female | 28 | 26 (92.9) | — | — |

DOI: https://doi.org/10.59736/IJP.24.02.1071

Multivariate logistic regression analysis did not identify any independent predictors of treatment success after adjustment for potential confounders. Although febrile status epilepticus (adjusted OR = 3.42, 95% CI: 0.92–12.68; p = 0.065) and shorter pre-hospital seizure duration (adjusted OR = 0.92 per minute, 95% CI: 0.84–1.01; p = 0.078) showed trends toward improved treatment response, neither association reached statistical significance. These findings should be interpreted cautiously because the analysis was limited by the very low number of treatment failures (n = 4), resulting in limited statistical power and wide confidence intervals.

**Table 6: Multivariate Logistic Regression**

| Variable | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| 4–6 years | 0.82 | 0.18–3.72 | 0.798 |
| 7–9 years | 1.45 | 0.22–9.56 | 0.698 |
| 10–12 years | 0.48 | 0.12–1.92 | 0.298 |
| Male gender | 1.15 | 0.28–4.72 | 0.845 |
| Febrile seizure | 3.42 | 0.92–12.68 | 0.065 |
| No prior history | 2.18 | 0.65–7.32 | 0.204 |
| Seizure duration (per min) | 0.92 | 0.84–1.01 | 0.078 |

No serious adverse events were recorded. Six patients (9.1%) experienced mild adverse events. Respiratory depression occurred in two patients, both in the 1–3 years age group and resolved with supplemental oxygen. No cases required assisted ventilation or intubation.

**Table 7: Adverse Events by Age Group (n = 66)**

| Adverse Event | 1–3yrs (n=22) | 4–6yrs (n=16) | 7–9yrs (n=14) | 10–12yrs (n=14) | Total n (%) |
|---|---|---|---|---|---|
| Respiratory depression | 2 | 0 | 0 | 0 | 2 (3.0) |
| Hypotension | 0 | 0 | 0 | 0 | 0 (0) |
| Apnea | 0 | 0 | 0 | 0 | 0 (0) |
| Intubation | 0 | 0 | 0 | 0 | 0 (0) |
| Injection site pain | 2 | 1 | 1 | 0 | 4 (6.1) |
| Injection site swelling | 1 | 0 | 0 | 0 | 1 (1.5) |
| Hypersensitivity | 0 | 0 | 0 | 0 | 0 (0) |
| Any adverse event | 4 | 1 | 1 | 0 | 6 (9.1) |

## Discussion

This prospective observational cohort study evaluated the efficacy of intramuscular midazolam for the treatment of status epilepticus in 66 children aged 1 to 12 years presenting to a tertiary care hospital in, Quetta, Balochistan. The rapid onset of action observed in our study is one of its most clinically significant findings. The median time from drug administration to seizure cessation was 65 seconds, which is remarkably similar to the 66 seconds reported by Momen et al. (2015) and substantially faster than the 130 seconds they reported for rectal diazepam (13). Furthermore, the mean time from hospital arrival to drug administration in our study was only 58.3 seconds, demonstrating that intramuscular midazolam can be administered almost immediately upon patient arrival. This rapid administration is a critical advantage in the management of status epilepticus, as every minute of ongoing

DOI: https://doi.org/10.59736/IJP.24.02.1071

seizure activity contributes to progressive neuronal injury, increased metabolic demand, and higher risk of neurological sequelae (14). The pharmacokinetic properties of midazolam explain this rapid onset: as a water-soluble benzodiazepine, midazolam is rapidly and completely absorbed following intramuscular injection, achieving therapeutic serum concentrations within 5 to 10 minutes, with peak levels reached even sooner when injected into highly vascular muscles such as the deltoid or vastus lateralis (16). In contrast, rectal diazepam requires passive absorption across the rectal mucosa, which can be unpredictable and is often delayed by the presence of stool or inadequate retention of the medication (13). The clinical implication of this difference is meaningful: a reduction of approximately 60 seconds in time to cessation, as observed in our study compared to published data on rectal diazepam, may translate into improved neurological outcomes, particularly in children with prolonged seizures (16).

When we stratified our analysis by age group, treatment success remained consistently high across all ages, ranging from 85.7% in the 10–12 years group to 100% in the 7–9 years group, with no statistically significant difference between groups (chi-square test p = 0.672). The highest success rate was observed in the 7–9 years group (100%, 95% CI: 76.8–100.0%), whereas the lowest was noted in the 10–12 years group (85.7%, 95% CI: 57.2–98.2%). The mean time to seizure cessation varied across age groups, with the shortest time observed in children aged 7-9 years (65.8 ± 35.2 seconds, median 58 seconds) and the longest in those aged 10-12 years (85.4 ± 62.1 seconds, median 78 seconds). However, this difference was not statistically significant (one-way ANOVA: $F(3,62) = 1.84$, $p = 0.148$). A weak but statistically significant positive correlation was observed between age and time to seizure cessation (Pearson $r = +0.28$, $p = 0.023$), indicating that older children tended to have slightly longer times to seizure control.

Although Hayashi et al. (2007) evaluated intravenous rather than intramuscular midazolam, their findings provide useful comparative evidence regarding factors associated with benzodiazepine response in pediatric status epilepticus. Therefore, comparisons with our results should be interpreted cautiously because of the different routes of administration (14). One possible explanation for this age-related difference is that older children in our cohort had a higher proportion of afebrile seizures (64.3% in the 10–12 years group compared to 36.4% in the 1–3 years group). Afebrile status epilepticus is often associated with underlying neurological abnormalities, remote symptomatic etiology, or chronic epilepsy, conditions that are known to be associated with altered GABA-A receptor expression and relative benzodiazepine resistance (16, 17). Alternatively, although our weight-based dosing of 0.3 mg/kg should have accounted for differences in body mass, it is possible that the pharmacokinetic profile of intramuscular midazolam differs slightly with age, warranting further investigation into age-specific dosing strategies (13).

Treatment success was comparable between males and females, with no statistically significant difference (94.7% in males vs. 92.9% in females, Fisher's exact test p = 0.527). Febrile seizures showed a higher success rate (97.1%) compared to afebrile seizures (90.3%), although the difference was not statistically significant (Fisher's exact test p = 0.341). However, when we analyzed time to seizure cessation by seizure type, children with febrile status epilepticus achieved seizure cessation significantly faster (median 58 seconds) than

DOI: https://doi.org/10.59736/IJP.24.02.1071

those with afebrile status epilepticus (median 78 seconds, Mann-Whitney U test p = 0.032). This observation is consistent with the report by Hayashi et al. (2007), who found that the effective ratio of midazolam was substantially higher in children with febrile seizures (83.3%) compared to those with encephalitis or encephalopathy (56.8%) (14). The biological plausibility of this difference rests on several factors. First, febrile seizures typically occur in otherwise neurologically normal children with intact benzodiazepine receptor function and normal GABA-A receptor expression (17). In contrast, afebrile status epilepticus often arises in the context of pre-existing brain abnormalities, chronic epilepsy, or acute central nervous system infections conditions associated with neuroinflammation, receptor dysfunction, and relative pharmaco-resistance (16, 18). Second, although not statistically significant in our study, children with afebrile seizures had a numerically longer median pre-arrival seizure duration (14 minutes) compared to those with febrile seizures (10 minutes). Prolonged seizure duration before treatment is a well-established predictor of poorer response to benzodiazepines, as sustained seizure activity leads to internalization and downregulation of GABA-A receptors, reducing their sensitivity to benzodiazepines (18).

Study Limitations: This study has several limitations. It was a single-arm descriptive study without a comparator, precluding direct comparison with alternative benzodiazepine routes. The lack of blinding introduces potential observer bias in time-to-cessation assessment based on visual identification of motor seizure activity, although standardized timing using a digital chronometer was implemented as described by Momen et al. (2015) (13). Seizure cessation was defined clinically without electroencephalographic confirmation; therefore, electroclinical dissociation cannot be excluded, as highlighted by Hayashi et al. (2007) (14). The sample size (n = 66) limits precision in subgroup analyses and reduces statistical power for detecting independent predictors, particularly given the low rate of treatment failure. The single-centre design may limit generalizability to prehospital or resource-limited settings. Exclusion of patients receiving prehospital benzodiazepines restricts applicability to routine clinical scenarios.

A major limitation of this study is the absence of long-term neurological follow-up. Consequently, although intramuscular midazolam demonstrated excellent short-term efficacy and safety, the study could not evaluate subsequent neurological recovery, cognitive outcomes, seizure recurrence beyond the observation period, or the later development of epilepsy. Future prospective studies with extended follow-up are needed to assess these clinically important outcomes.

## Conclusion

Intramuscular midazolam (0.3 mg/kg) is an effective and safe treatment for pediatric status epilepticus, achieving seizure cessation within 5 minutes in 93.9% of cases with a median time of 65 seconds. In the absence of intravenous access, intramuscular midazolam represents a reliable first-line option, particularly in resource-limited and emergency settings. Further multicenter studies are needed to compare alternative non-intravenous routes and optimize dosing.

## Data Availability Statement

The data percentages and the dose procedure are clearly explained in the manuscript. Further information and De-identified data may be shared with clinician and researcher

DOI: https://doi.org/10.59736/IJP.24.02.1071

upon proper request to the corresponding author.

## Funding Statement

The current research study was conducted as part of an academic research project at the department of Paediatric, Balochistan Institute of Child Health Services, Quetta, Balochistan. All costs associated with data collection, drug administration, and patient care were covered by the institutional resources. This research received no specific grant from any external or internal organization.

## Authors' Conflict of Interest

The authors declare no conflicts of interest in the current research study.

## Ethics Approval Statement

This study was conducted in accordance with the Declaration of Helsinki (2013 revision). The research study was conducted under institute approval with number BICHQ/14405/26. Written informed consent was obtained from the parents or legal guardians of all participating children. For children aged 7 years and above, verbal assent was also obtained.

## References

1. Coppler PJ, Elmer J. Status epilepticus. Crit Care Clin. 2023;39(1):87-102. doi: 10.1016/j.ccc.2022.07.006.
2. Chiu WT, Campozano V, Schiefecker A, Rivero Rodriguez D, Ferreira D, Headlee A, et al. Management of refractory status epilepticus: an international cohort study (MORSE CODe) analysis of patients managed in the ICU. Neurology. 2022;99(11): e1191-e1201. doi:10.1212/-WNL.0000000000200818
3. W. Henry Chiu, Campozano V, Alois Josef Schiefecker, Dannys Rivero Rodríguez, Ferreira D, Headlee A, et al. Management of Refractory Status Epilepticus. Neurology. 2022 Sep 13;99(11).
4. Afsar N, Kaya D, Aktan S, Aykut-Bingol C. Stroke and status epilepticus: stroke type, type of status epilepticus, and prognosis. Seizure. 2003 Jan;12(1):23–7.
5. Santana-Gomez CE, Engel J, Staba R. Drug-resistant epilepsy and the hypothesis of intrinsic severity: What about the high-frequency oscillations? Epilepsia Open. 2021 Dec 3;7(S1).
6. Scott RC, Surtees RAH, Neville BGR. Status epilepticus: pathophysiology, epidemiology, and outcomes. Archives of Disease in Childhood. 1998 Jul 1;79(1):73–7.
7. Chibuike Daniel Onyejesi, Alsabri M, Carlos J, Aziz MM, Ram MD, Abady EM, et al. Pediatric emergency disaster preparedness: a narrative review of global disparities, challenges, and policy solutions. International Journal of Emergency Medicine. 2025 May 6;18(1).
8. Vossler DG. First Seizures, Acute Repetitive Seizures, and Status Epilepticus. CONTINUUM Lifelong Learning in Neurology. 2025 Feb 1;31(1):95–124.
9. Brigo F, Lattanzi S. Anti-convulsant Agents: Benzodiazepines (Clobazam, Clonazepam, Diazepam, Lorazepam, Midazolam). Springer eBooks. 2022 Jan 1;12(22):3753–60.
10. Gettings JV, Alizadeh M, Patel AA, Shorvon S, Goodkin HP, Loddenkemper T. Diagnosis and management of status epilepticus: improving the status quo. The Lancet Neurology. 2024 Dec 1;24(1).
11. Mohammed MZ, Elagouza I, El Gaafary M, El-Garhy R, El-Rashidy O. Intranasal

DOI: https://doi.org/10.59736/IJP.24.02.1071

Versus Buccal Versus Intramuscular Midazolam for the Home and Emergency Treatment of Acute Seizures in Pediatric Patients: A Randomized Controlled Trial. Pediatric Neurology. 2024 Sep 1;158(12):135–43.
12. Zubairu Sadiq I, Usman A, Muhammad A, Haliru Ahmad K. Sample size calculation in biomedical, clinical and biological sciences research. Journal of Umm Al-Qura University for Applied Sciences. 2024 Jun 26;12(33).
13. Mohammad Alizadeh Chafjiri F, Dailey S, Sadeghian S, Ulate-Campos A, Loddenkemper T. Antiseizure medication effects on the autonomic nervous system in pediatric patients with epilepsy. Epilepsy Research. 2025 Dec;218(12):107688.
14. Momen AA, Azizi Malamiri R, Nikkhah A, Jafari M, Fayezi A, Riahi K, et al. Efficacy and safety of intramuscular midazolam versus rectal diazepam in controlling status epilepticus in children. European Journal of Paediatric Neurology. 2015 Mar;19(2):149–54.
15. Hayashi K, Osawa M, Aihara M, Izumi T, Ohtsuka Y, Haginoya K, et al. Efficacy of Intravenous Midazolam for Status Epilepticus in Childhood. Pediatric Neurology. 2007 Jun;36(6):366–72.
16. Chamberlain Jm, Altieri Ma, Futterman C, Young Gm, Ochsenschlager Dw, Waisman Y. A prospective, randomized study comparing intramuscular midazolam with intravenous diazepam for the treatment of seizures in children. Pediatric Emergency Care. 1997 Apr;13(2):92–4.
17. Chin RF, Neville BG, Peckham C, Bedford H, Wade A, Scott RC. Incidence, cause, and short-term outcome of convulsive status epilepticus in childhood: prospective population-based study. The Lancet. 2006 Jul;368(9531):222–9.
18. Jones DM, Esmaeil N, Maren S, Macdonald RL. Characterization of pharmaco-resistance to benzodiazepines in the rat Li-pilocarpine model of status epilepticus. Epilepsy Research. 2002 Jul;50(3):301–12.
19. Naylor DE, Liu H, Wasterlain CG. Trafficking of GABAA Receptors, Loss of Inhibition, and a Mechanism for Pharmacoresistance in Status Epilepticus. Journal of Neuroscience. 2005 Aug 24;25(34):7724–33.


| HISTORY | |
|---|---|
| Date received: | 20-04-2026 |
| Date sent for review: | 20-06-2026 |
| Date received reviewers comments: | 29-06-2026 |
| Date received revised manuscript: | 29-06-2026 |
| Date accepted: | 03-07-2026 |


| CONTRIBUTION OF AUTHORS | |
|---|---|
| **AUTHOR** | **CONTRIBUTION** |
| Conception/Design | SM,MS, |
| Data acquisition, analysis and interpretation | FJ,UH,AM |
| Manuscript writing and approval | AK, |
| All the authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed. | |