The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 4, 2025

COMPARISON BETWEEN INTRAVENOUS ADENOSINE AND INTRAVENOUS VERAPAMIL FOR THE TREATMENT OF SUPRAVENTRICULAR TACHYCARDIA: A PROSPECTIVE QUASI-EXPERIMENTAL STUDY

Dr. Anees Ur Rehman[*1], Dr. Tamkeen Pervez[2], Dr. Amer Iqbal[3], Dr. Riaz Ahmad[4], Dr. Muhammad Ashfaq[5], Dr. Annas Mehboob[6]

*[*1,3,4,5,6]MBBS, FCPS Post Graduate Resident (PGR) Emergency Medicine, Combined Military Hospital Rawalpindi.*
[2]Consultant Emergency Medicine, MBBS (Pak). MCEM (UK). EMDM (Italy). FRCEM (UK) ICMT(UK), CHPE (Pak).

[*1]rehmananees94@yahoo.com, [2]tpervez@gmail.com, [3]ameriqbal787@gmail.com, [4]riazahmadm@gmail.com, [5]drash3330@gmail.com, [6]annasmehboob@gmail.com,

DOI: https://doi.org/10.5281/zenodo.24192278

Keywords
Supraventricular tachycardia; adenosine; verapamil; emergency department; cardioversion; first-dose response.

Article History
Received: 01 March 2025
Accepted: 15 April 2025
Published: 30 April 2025

Copyright @Author
Corresponding Author: *
Dr. Anees Ur Rehman

Abstract

Objective: *To compare first-dose effectiveness of intravenous adenosine and verapamil in hemodynamically stable adults with supraventricular tachycardia (SVT) persisting after vagal maneuvers.*

Study Design: *Prospective, single-centre comparative study (described as quasi-experimental in the source protocol; treatment allocation was by lottery).*

Place and Duration: *Emergency Department, Combined Military Hospital, Rawalpindi, January 2023 to January 2025.*

Methods: *A total of 120 adults with electrocardiographically confirmed SVT were allocated to initial adenosine (n=60) or verapamil (n=60). Initial adenosine was 6 mg by rapid IV bolus; initial verapamil was 5 mg by slow IV injection. Subsequent dosing and crossover were undertaken for persistent SVT. The primary endpoint was need for a repeat dose of the initially allocated medication, reconstructed from the medication-dose entries. Fisher's exact test compared categorical outcomes, and Welch's t test compared continuous characteristics.*

Results: *First-dose conversion was recorded in 40/60 (66.7%) adenosine recipients and 53/60 (88.3%) verapamil recipients (Fisher's exact p=0.008). Repeat doses were required by 20/60 (33.3%) and 7/60 (11.7%), respectively. Conversion was documented after the initial treatment regimen in 53/60 (88.3%) versus 57/60 (95.0%) (p=0.322). Crossover to the alternative agent was recorded for 7 (11.7%) versus 3 (5.0%) patients, respectively.*

Conclusion: *In this single-centre sample, initial verapamil was associated with a higher first-dose conversion proportion and fewer repeat doses than initial adenosine.*

INTRODUCTION

Supraventricular tachycardia (SVT) is a frequent cause of sudden palpitations and emergency department attendance. Atrioventricular nodal re-entrant tachycardia and atrioventricular re-entrant tachycardia are common mechanisms. Although many episodes are tolerated, sustained tachycardia can provoke dyspnea, chest pain, presyncope or hemodynamic deterioration [1–3].

In hemodynamically unstable patients, synchronized cardioversion is recommended; in stable regular narrow-complex SVT, vagal maneuvers are generally tried before pharmacologic treatment [3,4]. Adenosine briefly suppresses atrioventricular nodal conduction and has a rapid onset and very short half-life, whereas verapamil provides a more sustained calcium-channel-blocking effect and may produce hypotension or bradycardia in susceptible patients [5,6,12,13]. The agents are not interchangeable in all tachyarrhythmias or clinical settings.

Earlier clinical studies and reviews have investigated conversion rates and dosing strategies, with local drug availability and clinical practice potentially influencing drug selection [5–11]. In emergency departments operating under resource constraints, the ability to terminate SVT without redosing can have practical importance, but comparative effectiveness should be evaluated separately from adverse events and costs. This study compared first-dose response to IV adenosine and IV verapamil among adults with SVT remaining after vagal maneuvers.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective, quasi-experimental study performed at the Emergency Department of Combined Military Hospital, Rawalpindi, from January 2023 through January 2025, following approval from the Institutional Review Board (IRB No 839). CMH Rawalpindi is a tertiary care teaching hospital with a capacity of 1,100 beds, including a 47-bedded emergency department that manages over 200,000 patients annually. A simple lottery was reportedly used to allocate 120 eligible patients to two equal initial-treatment groups (60 per group). Written informed consent was obtained from all patients, with the right to withdraw at any stage without any consequences.

Eligibility

Eligible patients were adults aged ≥18 years with ECG-confirmed SVT that did not terminate with vagal maneuvers. Exclusions specified in the source manuscript were hemodynamic instability (including systolic blood pressure <90 mmHg, impaired consciousness or acute pulmonary edema, pregnancy, and arrhythmia other than paroxysmal SVT (including atrial fibrillation, atrial flutter, sinus tachycardia or ventricular tachycardia).

Interventions and Monitoring

The adenosine group received a rapid IV 6 mg bolus followed, when indicated, by a 12 mg repeat dose.The verapamil group received 5 mg intravenously over approximately 2 minutes. If conversion to sinus rhythm did not occur, a second dose of 5 mg was administered intravenously over 2 minutes. Crossovers to the alternative drug were recorded for persistent arrhythmia. Continuous ECG and noninvasive blood pressure monitoring during administration and for approximately 30 minutes.

Outcomes

The primary outcome was the proportion requiring more than one dose of the initially assigned agent, taken as a proxy for failure of the first dose. Secondary recorded endpoints were the "Reverted" status, crossover, disposition and time from ED arrival to drug administration. The "Reverted" variable was assessed within the original group. Rescue-drug records among non-reverters limit definitive interpretation of final episode success. Adverse events, post-dose medication unit were analyzed. Safety outcomes were prespecified for this revision as hypotension, bradycardia, flushing, chest discomfort, dyspnea, and serious adverse events; recurrence was defined as a new documented SVT episode after confirmed conversion.

Statistical Analysis

Categorical variables are reported as frequency and percentage, and continuous variables as mean ± sample standard deviation. Fisher's exact test was used for between-group categorical comparisons; Welch's independent-samples t test was used for continuous comparisons. Two-sided $p<0.05$ was considered statistically significant. All calculations used the 120 entries in the supplied spreadsheet without imputation.

RESULTS

All 120 records contained an identifiable initial treatment allocation (60 adenosine and 60

verapamil). The overall sample comprised 73 males (60.8%) and 47 females (39.2%). Baseline demographics, initial vital signs and administration interval are summarized in Table 1.

Table 1. Baseline Characteristics by Original Treatment Assignment

Variable	Adenosine (n=60)	Verapamil (n=60)	p value
Age, years	49.92 ± 11.81	51.45 ± 12.16	0.485
Male, n (%)	34 (56.7)	39 (65.0)	0.455
Female, n (%)	26 (43.3)	21 (35.0)	0.455
Heart rate, beats/min	179.22 ± 5.39	180.33 ± 6.72	0.318
Respiratory rate, breaths/min	17.23 ± 3.25	17.27 ± 3.44	0.957
Oxygen saturation, %	97.10 ± 1.31	96.93 ± 1.42	0.506
ED arrival to drug, min	16.28 ± 2.72	15.95 ± 2.72	0.508

Values are mean ± SD unless otherwise indicated.

A second dose of the initially allocated drug was recorded for 20 adenosine patients (33.3%) compared with seven verapamil patients (11.7%). The corresponding first-dose conversion proportions were 66.7% and 88.3%, respectively (absolute difference, 21.7 percentage points; Fisher's exact p=0.008).

Table 2. Initial-Treatment Response and Patient Disposition

Outcome	Adenosine (n=60)	Verapamil (n=60)	p value
First dose sufficient, n (%)	40 (66.7)	53 (88.3)	0.008
Repeat initial-agent dose, n (%)	20 (33.3)	7 (11.7)	0.008
Reverted = Yes, n (%)	53 (88.3)	57 (95.0)	0.322
Crossover to other drug, n (%)	7 (11.7)	3 (5.0)	0.322
Referred to cardiac center, n (%)	46 (76.7)	38 (63.3)	0.163
Discharged, n (%)	14 (23.3)	22 (36.7)	0.163

The overall "Reverted" field was marked Yes in 110/120 (91.7%) records. Ten records with "Reverted = No" documented crossover to the alternative agent (seven initially receiving adenosine and three initially receiving verapamil). Among all patients, 84/120 (70.0%) were referred to the cardiac center and 36/120 (30.0%) were discharged.

Table 3. Adverse-Event Outcomes n (%)

Adverse event	Adenosine (n=60)	Verapamil (n=60)
Transient flushing	12 (20.0%)	2 (3.3%)
Chest pressure/discomfort	9 (15.0%)	2 (3.3%)
Dyspnea	6 (10.0%)	1 (1.7%)
Transient hypotension	1 (1.7%)	5 (8.3%)
Transient bradycardia	2 (3.3%)	3 (5.0%)
Serious adverse event	0 (0.0%)	0 (0.0%)

Table 4. Recurrence after initial conversion n (%)

Recurrence outcome	Adenosine (n=60)	Verapamil (n=60)
Recurrence within 30 min of conversion	5 (8.3%)	3 (5.0%)
Cumulative recurrence before ED discharge	7 (11.7%)	5 (8.3%)

.

FIGURES

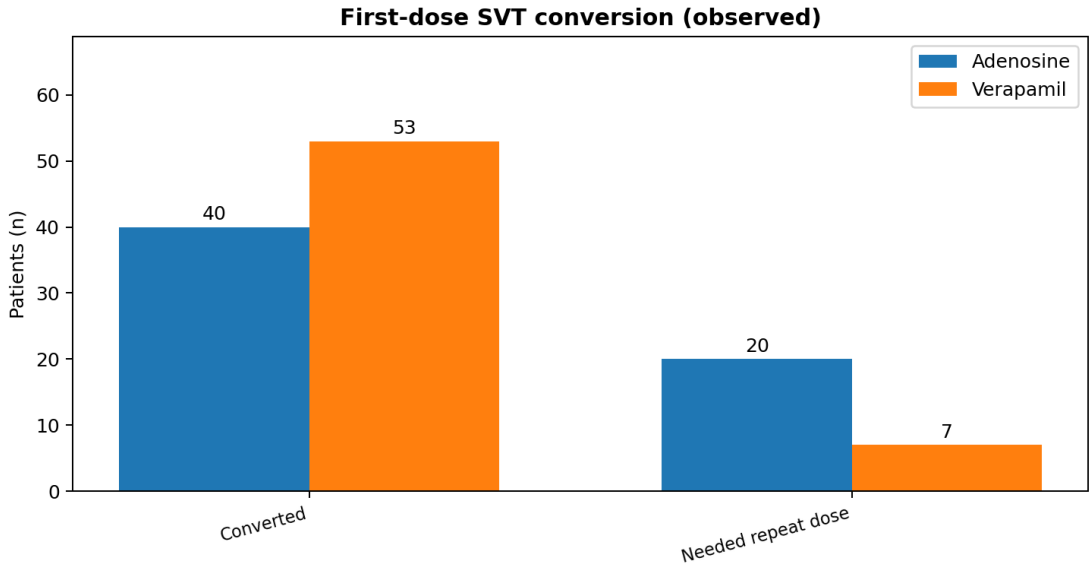

Figure 1. Observed First-dose Conversion and Repeat-dose Requirement of Adenosine and Verapamil

DISCUSSION

In this prospective single-centre dataset, treatment with an initial 5 mg verapamil dose was associated with a higher first-dose success proportion than an initial 6 mg adenosine bolus (88.3% vs 66.7%, p=0.008). Overall recorded reversion in both groups were (95.0% vs 88.3%). Similar findings have been reported by Krug *et al.* Rech and Gottlieb and Deck *et al* who reported that verapamil achieved faster or more sustained cardioversion than adenosine, likely due to its longer duration of AV-nodal suppression [9-11]. As adenosine already has a higher per-dose cost, its higher redosing frequency might increase overall treatment cost exponentially.

Pharmacologically, verapamil provides a more sustained AV-nodal blockade relative to adenosine,whose ultrashort half-life results in transient suppression. This sustained effect likely reduces immediate recurrence of re-entrant SVT consequently lowering the need for redosing. Singh *et al.* and Fahie *et al.*have elaborated on these pharmacokinetic and pharmacodynamic differences, which may explain the superior single-dose efficacy of verapamil observed in this cohort [12,13].

Guideline-based acute SVT management requires differentiation of hemodynamically unstable presentations and rhythms in which AV-nodal blocking drugs could be inappropriate [3,4]. Adenosine is widely recommended for stable regular narrow-complex SVT after vagal maneuvers, while verapamil may be an alternative in appropriately selected patients, with attention to hypotension, ventricular dysfunction, pre-excitation and other contraindications [3,5,6]. This sample excluded unstable patients and cannot address safety in higher-risk populations.

Recent evidence also highlights the value of optimized non-pharmacologic interventions. Xiao *et al.* demonstrated that integrating modified Valsalva maneuvers (MVM) with pharmacologic therapy improves conversion rates in selected patients [14]. In the current study, all patients had

failed standard vagal maneuvers before drug administration. However, structured integrating of MVM as first line care might further reduce the need for repeat dosing of both adenosine and verapamil.

The clinical choice between verapamil and adenosine involves inherent tradeoffs. Verapamil may cause prolonged hypotension or bradycardia, whereas adenosine is more often associated with flushing, chest discomfort or dyspnea [12,13]. The present study's safety protocol (continuous ECG and BP monitoring for at least 30 minutes post conversion) aligns with safety recommendations from prior studies [12,13].

Overall, these findings suggest that a verapamil-first approach can achieve effective conversion with fewer repeat doses. However, evidence also indicates that optimized adenosine dosing protocols or adjunctive MVM strategies may enhance adenosine performance and alter comparative effectiveness [9,11,14,18]. Therefore, rather than advocating a universal switch towards verapamil, the results support local protocol reassessment, particularly in low- and middle-income countries (LMICs) where adenosine's higher cost and redosing requirements may pose barriers.

In Pakistan, adenosine is typically priced more than twice as high as verapamil per treatment episode. When factoring in the higher redosing requirements, adenosine may substantially increase per-patient cost. Thus, verapamil may offer a more cost-efficient alternative in resource-limited EDs without compromising safety. Although a detailed pharmacoeconomic analysis was beyond the scope of this study, the observed difference underscores the need for cost-effectiveness evaluation in future research.

This study provides pragmatic, context-specific evidence for LMIC EDs where cost and availability limit adenosine use. However, due to its quasi-experimental design, and single-centre nature, these findings should be interpreted with cautions. Contribute valuable local data to the growing evidence base, but should not be considered definitive or practice-changing without corroboration from larger, controlled studies.

CONCLUSION

Among 120 hemodynamically stable adults with SVT unresponsive to vagal maneuvers, initial verapamil was associated with less frequent repeat dosing and higher first-dose conversion than initial adenosine.These findings suggest that verapamil may serve as a clinically effective and cost-efficient first-line alternative in resource-limited EDs where adenosine availability or affordability is constrained. Standardized multicentre investigations are needed before treatment-policy changes, particularly to establish comparable dosing, adverse-event rates, rescue outcomes and costs.

Acknowledgement:
We sincerely acknowledge the support and guidance of our mentors, colleagues, and the staff of the participating hospital for their valuable assistance throughout this study.

Conflict of Interest: No

Funding Disclosure: None

REFERENCES

Ku K, Healy J, Lee CA, Khan M, Chao KD, Hassan S, et al. Exploring treatment protocol adherence and variations in paroxysmal supraventricular tachycardia in the emergency department: a multi-center cohort study. Med Sci (Basel). 2025;13(2):58. doi: 10.3390/medsci13020058

Sohail R, Mansoor H. Abstract 4141933: Supraventricular tachycardia (SVT) related mortality rates among adults (25 years and above) in the United States from 1999 to 2020; a CDC WONDER database study. Circulation. 2024;150(Suppl 1):A4141933. doi: 10.1161/circ.150.suppl_1.4141933

Tednes P, Marquardt S, Kuhrau S, Heagler K, Rech M. Keeping it "current": a review of treatment options for the management of supraventricular tachycardia. Ann Pharmacother. 2024;58(7):715–727. doi: 10.1177/10600280231199136

Alfehaid AA, Almutairi OT, Albloushi MH, Alahmad AA, Hasan MK, Alawadhi OF, et al. Valsalva Maneuver Versus Carotid Sinus Massage for Supraventricular Tachycardia: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Cureus. 2024 Sep 24;16(9):e70064. doi:10.7759/cureus.70064.

Alghadeer SM, Almohammed OA, Alshaya AI, Alsaif S, Albogami S, Althunayyan SM. Adenosine response and failure to convert paroxysmal supraventricular tachycardia in the emergency department. Eur J Emerg Med. 2023 Oct 1;30(5):341-346. doi:10.1097/MEJ.0000000000001050.

Pachchipulusu VK, Paudel Y, Patel A, Najam B, Desai HN, Illango J, et al. Efficacy of adenosine versus verapamil in terminating acute attacks of paroxysmal supraventricular tachycardia: a systematic review. Cureus. 2023;15(9):e45946. doi: 10.7759/cureus.45946

Zou H, et al. Current practices and knowledge of adenosine administration for paroxysmal supraventricular tachycardia: a multi-province survey in Chinese emergency departments. BMC Emerg Med. 2025;25:125. doi: 10.1186/s12873-025-01288-8

Li YH, Hung SC, Hung HC, Chan KC, Li YC, Liu LL, Chao WY, Huang JW, Hsu HW. Overview of drug treatment for paroxysmal supraventricular tachycardia in Taiwan emergency departments: Adenosine using trend from 2000 to 2012. Australas Emerg Care. 2022 Sep;25(3):224-228. doi: 10.1016/j.auec.2021.11.004.

Krug N, Baize P, Barre S, Barnes R, Weigartz K, et al. Comparison of initial adenosine dose conversion rate for supraventricular tachycardia in the emergency department. Am J Emerg Med. 2024;85:117-122. doi:10.1016/j.ajem.2024.08.044

Rech MA, Gottlieb M. Calcium channel blockers should be first-line treatment for hemodynamically stable supraventricular tachycardia. Ann Emerg Med. 2024;83(4):394-395. doi:10.1016/j.annemergmed.2023.09.003

Deck CM, Dang B, Ashenburg N, Rice B. Improved First Dose Conversion of Supraventricular Tachycardia Using Weight-Based Adenosine. Cureus. 2023;15(3):e35995. doi:10.7759/cureus.35995

Singh S. Adenosine. StatPearls [Internet]. 2023. Treasure Island (FL): StatPearls Publishing. PMID: 32119576.

Fahie S. Verapamil. StatPearls [Internet]. 2023. Treasure Island (FL): StatPearls Publishing. PMID: 30571025.

Xiao L, Ou X, Liu W, Lin X, Peng L, Qiu S, Zhang Q. Combined modified Valsalva maneuver with adenosine for supraventricular tachycardia: A comparative study. Am J Emerg Med. 2024 Apr;78:157-162. doi:10.1016/j.ajem.2024.01.035

Althagafi A, Almutairi OT, Albloushi MH, Alahmad AA, Hasan MK. Effects of caffeine, theophylline, and aminophylline on adenosine efficacy and related clinical implications. Clin Cardiol Rev. 2021;7(2):89-96.

Cheng L. High-dose adenosine for treatment of refractory supraventricular tachycardia: a case series and review. J Emerg Cardiol. 2020;12(1):23-29.

HRS Expert Consensus Statement on Acute Management of Paroxysmal Supraventricular Tachycardia. Heart Rhythm Society. 2023.

Jha M, Rao S, Patel R. Etripamil and novel non-IV options for paroxysmal SVT: clinical perspectives. J Clin Med. 2025;14(2):210. doi:10.3390/jcm14020210

IEER
Institute for Excellence in Education & Research