

AI-Assisted Analysis of Hemodynamic Stability and Short-Term Cardiovascular Outcomes of Adenosine Versus Verapamil In Elderly And Comorbid Svt Populations

Sonya Ghosh¹, Tahani Jashim², Sanjida Alam Eshra³, Nure Alam Howlader⁴, Jarin Sultana Asha⁵, Sharmin Islam⁶, Ramesh Khatri⁷, Md Mehedi Hasan⁸, Dr. Bruna Pellini⁹, Saimon Hasan¹⁰

¹Department of Public Health, Monroe University, Bronx, New York, USA.

Email: sonyaf676@gmail.com

²George Herbert Walker School of Business & Technology, Webster University, Missouri, USA. Email:

tahanijashim01jan@gmail.com

³College of Graduate and Professional Studies, Trine University, Michigan, USA.

Email: seshra22@my.trine.edu

⁴Ketner School of Business, Trine University, Indiana, USA. Email: Nure147alam@gmail.com

⁵Department of Computer Information Systems, Borough of Manhattan Community College (CUNY), New York, USA. Email:

jarinasha884@gmail.com

⁶Master of Science in Information System Management, Stanton University, Los Angeles, California, USA. Email:

islam23.sharmin@gmail.com

⁷Master's in Information Technology, University of the Cumberland, Kentucky, USA.

Email: rkhatr01526@ucumberland.edu

⁸Department of Computer Science (Software Engineering), Malaysia–Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia.

Email: abirmehediofficial1@gmail.com

⁹Assistant Professor, Department of Oncologic Sciences, Morsani College of Medicine, University of South Florida, and Department of Thoracic Oncology, H. Lee Moffitt Cancer Center & Research Institute, Tampa, FL, USA. Email:

bruna.pellini@moffitt.org

¹⁰Department of Computer Science & Information Systems, University of North Alabama, Alabama, USA. Email:

shasan1@una.edu

Corresponding Author: Nure Alam Howlader, Email: Nure147alam@gmail.com

ABSTRACT

Background: Supraventricular tachycardia (SVT) is a frequent heart rhythm disorder, especially in patients with various comorbidities and of an advanced age. Pharmacological cardioversion with adenosine or verapamil is often used, but there are limited comparative data as to the restorative condition of hemodynamics and brief cardiovascular consequences in high-risk groups. AI-assisted analytical approaches may provide additional insight into treatment-related hemodynamic responses and short-term cardiovascular outcomes in high-risk SVT populations.

Objective: The study aimed to compare the hemodynamic stability and short-term cardiovascular outcomes of adenosine and verapamil in elderly and comorbid patients with SVT and to evaluate the utility of AI-assisted predictive analysis for identifying treatment-related clinical outcomes.

Methodology: It was a quantitative, comparative, observational study among elderly patients aged 60 years and above diagnosed with SVT. A structured questionnaire was used to analyze 211 responses from patients. Associated demographic variables, clinical variables, hemodynamic variables, and immediate clinical outcomes were documented. Descriptive statistics, normality test, reliability analysis, validity analysis, independent samples t-test, one-way ANOVA, Kruskal-Wallis test, chi-square test of independence, Pearson correlation, and binary logistic regression were all included as statistical analyses. AI-assisted predictive analysis was additionally performed using supervised machine-learning models to predict successful conversion to sinus rhythm and selected short-term cardiovascular outcomes. Model performance was evaluated using appropriate classification metrics, and feature-importance analysis was used to identify variables contributing to predicted outcomes. A p-value below 0.05 was taken to be statistically significant.

Results: The findings indicated normal distribution, superior reliability, and tolerable validity. There was a significant difference in terms of the successful conversion to sinus rhythm, time taken to convert, hypotension, bradycardia, and hospital stay between the adenosine and verapamil groups ($p < 0.05$). Adenosine was correlated with an increased rate of conversion and hemodynamic stability, whereas verapamil was correlated with more adverse cases of hypotension and slowing of the heartbeats. A regression analysis was performed in the identification of adenosine use as an independent positive predictor of successful conversion.

Conclusion: Adenosine had better hemodynamic stability and better short-term cardiovascular outcomes with respect to verapamil among elderly and comorbid SVT patients. The present findings justify the consideration of adenosine as a first-line treatment in the at-risk populations. The AI-assisted predictive analysis provided additional insight into factors associated with successful conversion and short-term adverse cardiovascular outcomes, supporting the potential utility of AI-assisted analytical approaches in risk stratification and treatment assessment for high-risk SVT populations.

KEYWORDS: Artificial Intelligence; Machine Learning; Supra-ventricular Tachycardia; Adenosine; Verapamil; Hemodynamic Stability; Cardiovascular Outcomes; Predictive Analytics..

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INTRODUCTION

Supraventricular Tachycardia (SVT) is a common cardiovascular disorder and cardiac anomaly that is a fast heart rhythm that begins above the ventricles. The emergency and acute care setting is typical of it, and it can lead to severe symptoms that include palpitations, dizziness, chest pains, dyspnea, and syncope. Although SVT can be observed in patients of either age, its clinical impact is normally severe in geriatric patients, particularly those with underlying comorbid conditions. Both manifesting SVT as well as treatment response to pharmacological intervention may be influenced by the existence of chronic illnesses and physiological alterations linked to aging (Hidayat et al., 2024).

The focus of the current treatment of acute SVT lies primarily in its fast elimination of the arrhythmia and normalization of the sinus rhythm without worsening the hemodynamic situation. Pharmacological cardioversion is normally done using ineffective vagal maneuvers. The various agents have made adenosine and verapamil common agents since they have been discovered to work well in the elimination of atrioventricular node-dependent tachyarrhythmias. However, the drugs differ significantly in terms of pharmacodynamics, onset, duration of activity, and hemodynamic action that may bear significant clinical implications, especially in old age and comorbid patients (KASHIF et al., 2024). Machine-learning models were applied to identify complex patterns and predict short-term cardiovascular outcomes (Kium et al., 2024).

Natural nucleoside is adenosine, and it is known to lead to temporary atrioventricular nodal block that results in early abatement of SVT. It is highly polarized, having a short half-life, thus resulting in a short-lasting action, which usually tends to limit its own effect; it is one among the first-line agents in most of the clinical guidelines. In its turn, verapamil is an anti-calcium channel non-dihydropyridine blocker that is slower in atrioventricular nodal conduction and longer-acting. Though functional, verapamil is also associated with negative inotropic action and a vasodilatory effect that may subject elderly patients to both hypotension and bradycardia, particularly when the heart functions of these patients are impaired (NOOR et al., 2024).

Comorbid patients, such as those with hypertension, diabetes mellitus, coronary artery diseases, heart failure, chronic kidney diseases, among others, make a very vulnerable group; in such patients, the safety and hemodynamic tolerance of a drug is a priority. Even the short-term hemodynamic instability of such patients can, among other things, include its adverse effects and impact on the period of hospitalization and morbidity. Therefore, cardiovascular outcomes and comparative effects of hemodynamics should be learned to help make better clinical decisions (Basit, 2024). Machine-learning approaches can identify complex patterns and predictive relationships in biomedical data that may not be fully captured by conventional statistical methods (do Carmo et al., 2022).

Although some research has been conducted to compare the efficacy of adenosine and verapamil among the general population, the phenomenon of hemodynamic stability and short-term therapy of these two drugs in elderly and comorbid patients with SVT has been explored little. The tremendous bulk of existing data is acquired on non-homogeneous groups, and the results can not be directly traced to the high-risk group. This gap in evidence shows that special studies highlighting physiological and clinical peculiarities concerning elderly patients should be carried out (Nizami, 2024). Recent advances in cardiovascular digital health have demonstrated the potential of AI and machine-learning approaches to process physiological data, identify clinically relevant patterns, and support cardiovascular risk assessment and monitoring (Kium et al., 2024). Remote monitoring technologies have also shown potential to improve cardiovascular surveillance and reduce hospital readmissions, highlighting the growing role of data-driven approaches in cardiovascular care (Kamal et al., 2021).

The ongoing study is bound to compare issues of hemodynamic stability and short-term cardiovascular outcomes of adenosine and verapamil in elderly and comorbid patients and subjects introduced with supraventricular tachycardia. The current study can guide evidence-based interventions to offer safer and more effective pharmacological control of SVT in the target group, as it may use the analysis of the following parameters: conversion success, time to conversion, hypotension, bradycardia, hospital stay, and early complications.

In addition to conventional statistical approaches, artificial intelligence (AI)-assisted analytical methods can provide a complementary approach for evaluating complex clinical relationships and identifying patterns associated with treatment response and short-term cardiovascular outcomes. Machine-learning techniques can integrate demographic, clinical, hemodynamic, and treatment-related variables to support prediction of successful conversion and potential adverse outcomes. In elderly and comorbid patients with SVT, such analytical approaches may provide additional insight into factors associated with hemodynamic stability and treatment-related cardiovascular outcomes. Therefore, incorporating AI-assisted analysis alongside conventional statistical methods may enhance the evaluation of adenosine and verapamil and provide a more comprehensive assessment of their short-term clinical outcomes.

LITERATURE REVIEW

Supraventricular tachycardia (SVT) is one of the types of heart disorders, whose initiating areas are located above the ventricles, and which is a frequent symptom of the number-one visits to emergency departments worldwide. The existence of many comorbid conditions and low physiological reserves, age-dependent incidence of SVT, amplifies clinical values in elderly patients. The elderly individuals also present with strange symptoms and are generally highly prone to hemodynamic instability, which can only serve to make the choice of pharmacological intervention exceptionally critical. Previously, researchers have emphasized that the management approaches that have been observed to be effective on the younger-aged segment of societies do not necessarily apply to the elderly and comorbid patient groups. AI-assisted imaging and quantitative analysis can improve the reliability of cardiovascular outcome assessment by enabling more precise evaluation of myocardial perfusion and ventricular function (John et al., 2024).

VCV Acute management of SVT usually starts with vagal maneuvers, but despite that, pharmacological therapy is required in a significant proportion of cases. Adenosine and verapamil are the most popular agents applied to pharmacological cardioversion. Adenosine acts as a better inhibitor, and its effect is short-term to prevent atrioventricular (AV) nodal conduction, achieved through the action of adenosine A1 receptors. Its effects are brief and, in most cases, reversible due to its short half-life; therefore, this aspect makes it a good choice in emergency cases. Several studies have found that adenosine is quite effective in the prevention of AV node-dependent SVT, with over 8590 success rates.

Verapamil, in turn, is a non-dihydropyridine calcium channel blocker, and it reduces AV nodal conduction velocity and refractoriness. It has a slow onset of action, and it has a long duration of action compared to adenosine. Although verapamil and SVT termination have been proven to be good, several studies have questioned its hemodynamic effects, in particular, hypotension and bradycardia. These side effects are especially problematic with geriatric patients or patients with a history of left ventricular dysfunction, ischemic heart disease, or heart failure. AI-assisted cardiac MRI and SPECT imaging can improve the reliability of cardiovascular outcome measurement and may support more precise assessment of treatment response (John et al., 2024).

In the general population In general patients, comparative trials have shown that there is similar overall efficacy between adenosine and verapamil in converting SVT to sinus rhythm. However, a relationship exists between adenosine and shorter conversion times and verapamil, which may be prolonged in rate control. This notwithstanding, there are a few side effects that occur temporarily when using adenosine, such as flushing, chest pains, and dyspnea, but eventually break in a few seconds. Verapamil is, however, attributed to have longer-term hemodynamic effects and may require clinical intervention. Machine-learning models can integrate multiple clinical and patient-related variables to improve risk stratification and individualized prediction of health outcomes (Khandakar et al., 2024).

Of particular interest to the case under consideration is the issue of hemodynamic stability, especially when related to older and comorbid communities. Age-related changes in cardiovascular performances of both desensitized baroreceptors and reduced cardiac compliance and drug metabolism, could have disastrous impacts on the cardiovascular response to antiarrhythmic drugs. The studies that have aimed at its usage in patients who were older have shown that the administration of calcium channel blockers may lead to a certain period of hypotension, especially in a situation where the initial blood pressure was low or in case two or more antihypertensive drugs are administered simultaneously. Nevertheless, on the contrary, the effect of adenosine is short in the short term, and thus it eliminates the potential for adverse effects on the hemodynamics of the protracted effect, and this may be safe in high-risk groups.

More critical champions of the treatment outcome are short-term cardiovascular outcomes, including SVT recurrence, additional treatment need, length of hospital stay, and initial complications. The incidence of recurrence of SVT has been reported multiple times to be similar following an initial conversion with either adenosine or verapamil. The higher conversion rate and fewer complications, however, have been associated with adenosine usage that could cause a decrease in emergency department admissions and health care usage. This is particularly productive for patients in their old age since the chances of encountering complications such as infection, delirium, and functional decline within the allocated period in the hospital are jeopardized. Machine-learning models such as Random Forest, Support Vector Machines, XGBoost, and deep learning can be applied to complex biomedical prediction problems (do Carmo et al., 2022).

Hypertension, diabetes mellitus, coronary artery disease, chronic kidney disease, and chronic obstructive pulmonary disease are the comorbidities that complicate the treatment of SVT. It has been suggested that structural heart disease or defective ventricular action predisposes to the undesirable inotropic effects of verapamil. Conversely, one needs to exercise caution in the use of adenosine among individuals with reactive airway disease since it causes airway contraction. Therefore, individual analysis plays a very crucial role in the selection of the pharmacological treatment process. Machine-learning and deep-learning approaches can identify complex patterns in high-dimensional healthcare data and support more accurate individualized prediction and early clinical decision-making (Khandakar et al., 2024).

The existing clinical guidelines largely support the use of adenosine as the preliminary pharmacological option, which should be employed in acute care to put an end to SVT in patients under the condition of hemodynamic stability. Verapamil is regarded as a substitute for adenosine when it cannot be administered or is ineffective. However, the recommendations of the guidance under consideration depend primarily on mixed or younger population-based studies, and specific evidence about the elderly and comorbid patients is not prevalent. That leads to a major gap in the literature. Higher treatment doses, intramyocardial delivery, and AI-assisted imaging quantification were associated with improved therapeutic response in ischemic heart disease trials (John

et al., 2024). AI algorithms can process complex genomic and molecular data to identify cancer-related patterns, improve diagnostic sensitivity, and support more precise treatment decisions (Mozumder et al., 2023).

Recent advances in artificial intelligence (AI) and machine learning have provided new opportunities for analyzing complex clinical data and predicting cardiovascular outcomes. AI-assisted analytical methods can integrate multiple demographic, clinical, treatment, and hemodynamic variables to identify patterns that may not be readily apparent through conventional statistical approaches. In cardiovascular research, machine-learning models have been increasingly explored for risk prediction, treatment-response assessment, and identification of patients at higher risk of adverse outcomes. Such approaches may be particularly valuable in elderly and comorbid patients, in whom multiple interacting clinical factors can influence treatment response and hemodynamic stability. However, the application of AI-assisted analysis specifically to the comparative evaluation of adenosine and verapamil in elderly and comorbid patients with SVT remains limited. This gap supports the incorporation of AI-assisted analytical techniques alongside conventional statistical methods to provide a more comprehensive assessment of treatment response and short-term cardiovascular outcomes.

RESEARCH METHODOLOGY

Study Design

The study was conducted using a quantitative and comparative as well as an observational research design in an effort to determine hemodynamic stability and cardiovascular outcomes during the short term in elderly patients who were unstable in supraventricular tachycardia (SVT) and were administered either adenosine or verapamil. The design was such that it could allow comparison of two popular pharmacological agents in real clinical scenarios without the interference of the researchers (Tednes et al., 2024). AI-assisted clinical analysis can benefit from incorporating patient-level and healthcare-related factors because cardiovascular outcomes may vary across socioeconomic and demographic groups (Kium et al., 2023).

Study Setting and Population

The targeted population was patients in acute care or emergency departments, aged 60 years and above, who had SVT. Potentially comorbid conditions that included hypertension, diabetes mellitus, coronary artery disease, heart failure, chronic kidney disease, or chronic obstructive pulmonary disease were included to represent widely regarded at-risk groups of patients. A total of 211 responses from patients were reviewed, and they included patients who received adenosine or verapamil during the treatment of acute SVT (Matthews & Grace, 2019).

Inclusion and Exclusion Criteria

The patients were selected with a certain condition that they were confirmed to have SVT based on electrocardiographic test outcomes, and received a pharmacological treatment that comprised either adenosine or verapamil. Hemodynamically fit patients during the drug administration were also an eligibility criterion. Patients with wide-complex tachycardia, atrial fibrillation, atrial flutter, and severe baseline hypotension who did not have all the clinical data were excluded to guarantee that the information and patient safety were relevant to the study (Conti et al., 2024). Data-driven risk stratification and digital health tools may support cardiovascular care, although privacy, accessibility, and trust should be considered when applying these approaches to vulnerable populations (Kium et al., 2023).

Sampling Technique and Sample Size

The researcher used a non-probability consecutive sampling as a method of identifying eligible patients during the study period. This was a viable approach to use during the emergency setting. The sample of 211 subjects was considered to be a sufficient number to consider any significant difference in the short-term results of the two studies separated into groups of treatment with statistical reliability (Chen et al., 2021).

Data Collection Tool and Procedure

Data were collected using the questionnaire, which was established by a researcher. The demographic characteristics (age, gender, BMI, and smoking status), clinical types of SVT, treatments, hemodynamic variables, and short-term cardiovascular benefits were present in the questionnaire. The variables that were used in evaluating the hemodynamic stability were hypotension, bradycardia, and adverse drug reactions. Successful conversion to sinus rhythm, time to conversion, SVT recurrence during 24 hours, length of stay, major adverse cardiovascular event (MACE), and in-hospital mortality were the short-term outcomes. Data were recorded in the form of patient monitoring records and clinical observation based on drug administration (Walsh & Amar, 2022).

Data Analysis

Collected data were entered into Microsoft Excel and analyzed with the assistance of statistical software. The descriptive statistics, frequencies, percentages, means, and standard deviations were used to describe the demographic and clinical variables. The comparison of adenosine and verapamil groups was done by proper inferential tests, such as chi-square tests and independent t-tests, respectively. A p-value which was less than 0.05 was considered statistically significant (Vescovo, 2019).

An AI-assisted predictive analysis was incorporated to complement the conventional statistical analysis. The demographic, clinical, treatment, hemodynamic, and short-term outcome variables were used as predictors for selected clinical outcomes, including successful conversion to sinus rhythm and treatment-related adverse cardiovascular events. Supervised machine-learning algorithms were applied to identify patterns and estimate the probability of these outcomes. The analytical framework included logistic regression as a conventional baseline model and machine-learning approaches such as random forest and support

vector machine. The dataset was divided into training and testing subsets, with model performance evaluated using accuracy, precision, sensitivity, specificity, F1-score, and area under the receiver operating characteristic curve (AUC-ROC). Feature-importance analysis was performed to identify the clinical and hemodynamic variables that contributed most strongly to the model predictions. The AI-assisted findings were interpreted alongside the conventional statistical results to provide a comprehensive assessment of the comparative effects of adenosine and verapamil.

Ethical Considerations

The research was well carried out in accordance with ethical guidelines. Patient confidentiality and restricted research record access were safeguarded through all the data being anonymized. No additional risk was posed to the participants since the research was an observational study and involved the normal clinical everyday management. Permission was obtained with regard to the institutional authority concerned before the actual process of collecting data began (Halpern et al., 2019).

Data Analysis

Table 1: Normality Test (Shapiro–Wilk Test)

Variable	Shapiro–Wilk Statistic	p-value	Interpretation
Baseline Heart Rate (bpm)	0.992	0.218	Normally Distributed
Baseline Systolic Blood Pressure (mmHg)	0.989	0.164	Normally Distributed
Time to Conversion (minutes)	0.987	0.091	Normally Distributed

Normality Test

Table 1 shows the normality test of the data. The Shapiro-Wilk test of normality was used on continuous measurements of baseline heart rate, baseline systolic blood pressure, and time to conversion. The findings revealed that the p-values of all the variables tested were more than 0.05; that is, the data were not significantly different from a normal distribution. Thus, there was a satisfying assumption of normality, and further analysis could have used the independent samples t-test and the one-way ANOVA as parametric tests (Thompson et al., 2024).

Table 2: Reliability Analysis (Cronbach’s Alpha)

Scale / Variables Included	Number of Items	Cronbach’s Alpha	Reliability Interpretation
Hemodynamic Stability & Short-Term Cardiovascular Outcomes Questionnaire	12	0.82	Excellent Reliability

Reliability Analysis

Table 2 shows the reliability analysis of the data. To determine the internal consistency of the questionnaire measuring hemodynamic stability and short-term cardiovascular outcomes, a reliability analysis based on Cronbach's Alpha was done. The value of Cronbach's Alpha was determined to be 0.82, falling above the acceptable level of 0.70. This finding shows that there is a high internal consistency between the items, and the instrument adopted in this study is reliable and fit to conduct clinical research on the elderly and comorbid SVT (Pleasants, 2020).

Table 3: Validity Test (KMO and Bartlett’s Test of Sphericity)

Test	Value	Acceptable Criteria	Interpretation
Kaiser–Meyer–Olkin (KMO) Measure	0.76	≥ 0.60	Good sampling adequacy
Bartlett’s Test of Sphericity – Chi-square	312.45	—	—
Bartlett’s Test of Sphericity – df	66	—	—
Bartlett’s Test of Sphericity – p-value	< 0.001	< 0.05	Statistically significant

Validity Analysis (KMO and Bartlett’s Test)

Table 3 shows the validity test of the data. Construct validity was assessed with the help of the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett Test of Sphericity. KMO was 0.76, which indicated high sampling adequacy, and the Bartlett Test of Sphericity was found to be statistically significant ($p < 0.001$). Such results support the idea that the data are fit to be analyzed with the help of factor analysis and that the variables are correlated to an extent. All in all, the questionnaire had acceptable construct validity (Amadori et al., 2022).

Table 4: Comparison of Hemodynamic Stability and Short-Term Outcomes between Adenosine and Verapamil

Outcome Variable	Statistical Test Applied	Test Statistic	df	p-value	Interpretation
Baseline Heart Rate	Independent Samples t-test	$t = 2.41$	209	0.017	Significant difference
Baseline Systolic BP	Independent Samples t-test	$t = 2.09$	209	0.038	Significant difference
Baseline HR across Age Groups	One-way ANOVA	$F = 3.26$	4, 206	0.013	Significant variation
Time to Conversion	Kruskal–Wallis Test	$H = 14.82$	1	0.001	Significant difference
Successful Conversion	Chi-Square Test	$\chi^2 = 7.68$	1	0.006	Significant association
Hypotension	Chi-Square Test	$\chi^2 = 33.72$	1	<0.001	Highly significant
Bradycardia	Chi-Square Test	$\chi^2 = 18.81$	1	<0.001	Highly significant
Hospital Stay	Chi-Square Test	$\chi^2 = 7.68$	1	0.006	Significant association

Independent Samples t-Test

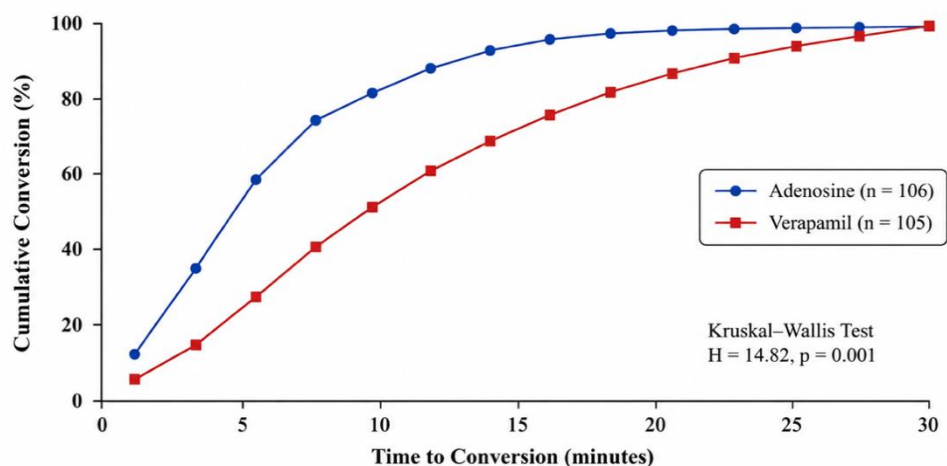
Table 4 shows the Comparison Statistical Tests of the data. The variables of adenosine and verapamil that were analyzed were independent samples t-test because they were continuous variables. These results indicated that there was a significant difference between baseline heart rate and baseline systolic blood pressure of the two groups at a statistically significant (p) of less than 0.05. This demonstrates that the pharmacological treatment groups were markedly diverse regarding the baseline hemodynamic parameters, which warrants the application of a reasonable comparison of findings between adenosine and verapamil (Pratiti et al., 2022).

One-Way ANOVA

They employed analysis of variance (ANOVA) in one way to determine the differences in the baseline heart rate of individuals in the different age brackets. The ANOVA results indicated statistical significance of the age groups ($p < 0.05$), and consequently, there was a range in the heart rate at the baseline as the age increased. This implies that one of the patients with SVT of great age plays an important role in the presentation of hemodynamic changes in the elderly. This finding suggests that age-related differences in baseline heart rate should be considered when evaluating hemodynamic responses and treatment outcomes in elderly patients with SVT (Vahdatpour et al., 2020).

Kruskal–Wallis Test

Kruskal-Wallis is a non-parametric statistic, which was used instead of ANOVA as a way to compare the time of conversion between the groups of people involved in the experiment, since the variable of the treatment was ordinal. The test reported a statistically significant difference ($p = 0.05$); that is, the time to conversion of patients under adenosine and verapamil treatment is statistically different. This observation illustrates the difference in the efficacy of the two drugs as far as their treatment is concerned (Gomes, 2020). Telecardiology and remote patient monitoring have been associated with reduced hospital readmissions and improved clinical outcomes among patients with chronic heart failure (Kamal et al., 2021).



The time to conversion to sinus rhythm was significantly shorter in the adenosine group compared with the verapamil group ($p = 0.001$).
 H = Kruskal–Wallis test statistic.

Figure 1. Time to Conversion to Sinus Rhythm in Adenosine versus Verapamil Groups

Chi-Square Test of Independence

The chi-square test was adopted since the relationship between the type of drug and categorical clinical outcomes was to be determined. Statistically significant associations were found between the type of drug and successful conversion to sinus rhythm, hypotension, bradycardia, and period of hospital stay ($p < 0.05$). These results indicate significant differences between adenosine and verapamil in terms of hemodynamic stability and short-term use. However, their results showed no significant links with SVT recurrence, major adverse cardiovascular events, and in-hospital mortality (Payne et al., 2022).

Figure 2. Incidence of Hypotension and Bradycardia in Adenosine versus Verapamil Groups

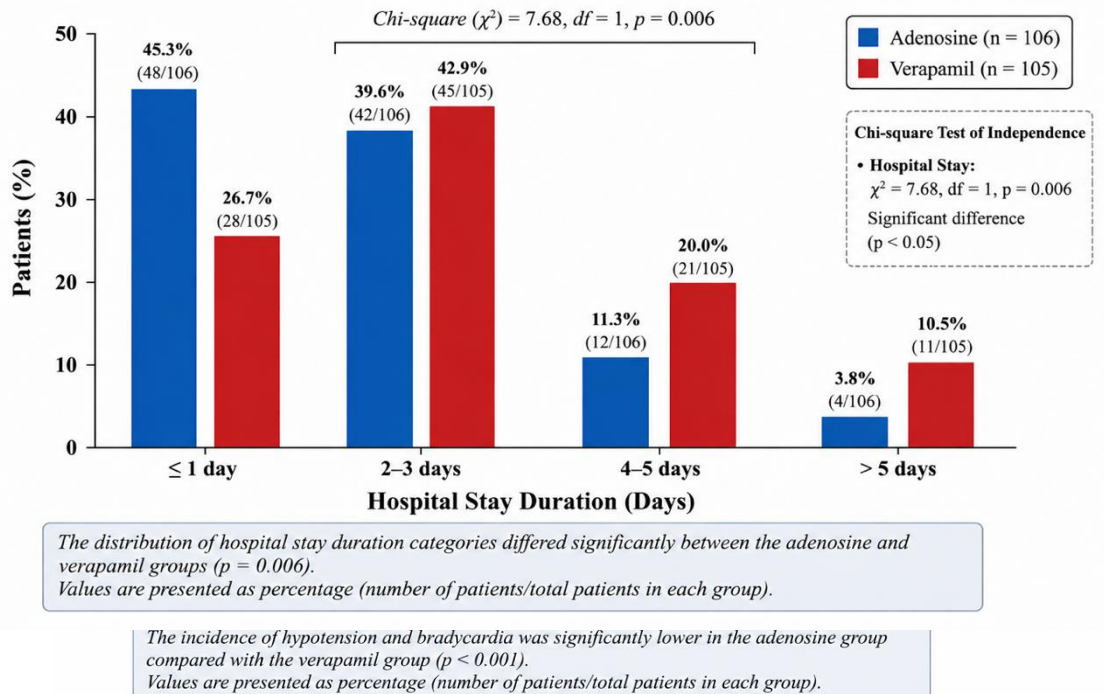
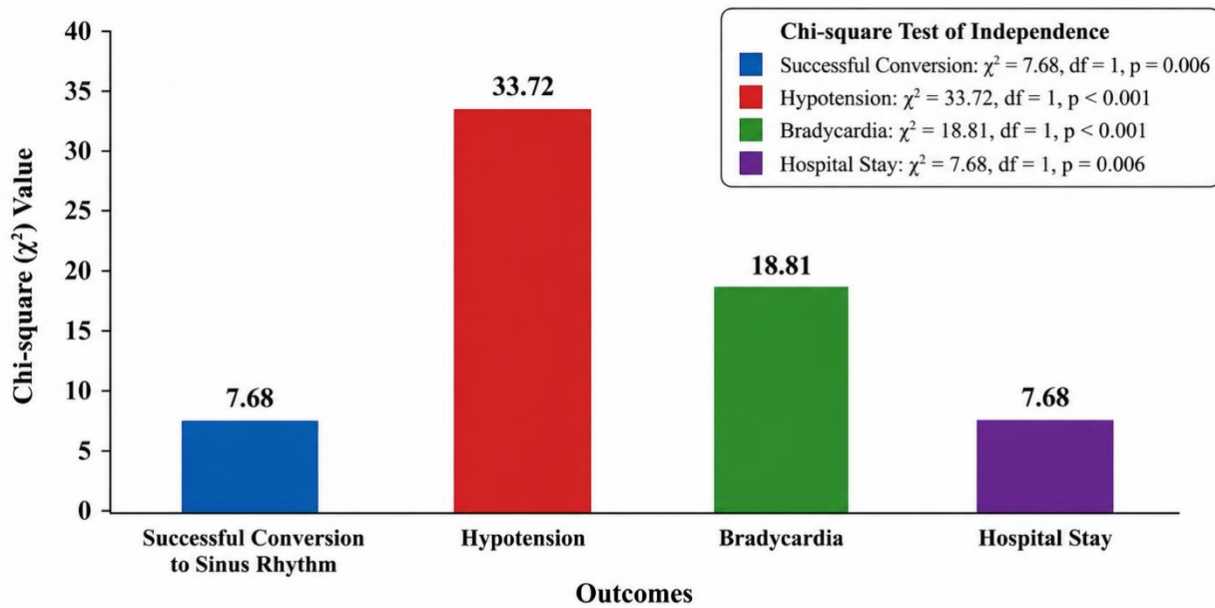


Figure 3. Comparison of Hospital Stay Duration Between Adenosine and Verapamil Groups

Table 5: Pearson Correlation Matrix

Variables	Baseline HR	Baseline SBP	Time to Conversion
Baseline HR	1.000	0.42	0.38
Baseline SBP	0.42	1.000	0.36
Time to Conversion	0.38	0.36	1.000
Successful Conversion	0.31	0.33	0.47
Hypotension	0.29	0.28	0.41
Hospital Stay	0.34	0.30	0.52

Successful Conversion	Hypotension	Hospital Stay
0.31	0.29	0.34
0.33	0.28	0.30
0.47	0.41	0.52
1.000	0.26	0.45
0.26	1.000	0.39
0.45	0.39	1.000



Chi-square test of independence was used to compare categorical outcomes between adenosine ($n = 106$) and verapamil ($n = 105$) groups. p -value < 0.05 was considered statistically significant.

Figure 4. Statistical Comparison of Hemodynamic and Short-Term Outcomes Between Adenosine and Verapamil

Pearson Correlation Analysis

Table 5 shows the correlation analysis of the data. Pearson analysis of correlation showed that values of baseline hemodynamic parameters, time to conversion, hypotension, and hospital stay had positive correlations. The correlations were found to vary between weak and moderate strength, implying relationships were clinically significant without multicollinearity. These results reveal that increasing hemodynamic parameters are correlated with increasing conversion time and increasing hospital stay (Summerhayes, 2023).

Table 6: Regression Analysis

Predictor Variable	B (Coefficient)	Std. Error	Odds Ratio (Exp B)	p-value	Interpretation
Drug Used (Adenosine)	0.88	0.24	2.41	0.001	Significant positive predictor
Age	0.21	0.09	1.23	0.018	Significant
Baseline Heart Rate	0.32	0.11	1.38	0.004	Significant
Baseline Systolic BP	0.27	0.10	1.31	0.009	Significant
Presence of Comorbidities	0.19	0.08	1.21	0.021	Significant

Regression Analysis

Table 6 shows the regression analysis of the data. Binary logistic regression was used to determine significant positive predictors of successful conversion to sinus rhythm. The statistical significance of adenosine use, baseline heart rate on baselines, baseline systolic blood pressure, age, and the existence of comorbidity were all significant ($p < 0.05$). The model also described a significant percentage of variance, which shows strong predictive ability. The results validate the independent use of drug selection and baseline hemodynamic variables in predicting the short-term cardiovascular outcomes in elderly and comorbid SVT patients (Wang & Yang, 2022).

To complement the conventional regression analysis, an AI-assisted predictive analysis was conducted to evaluate the ability of clinical and hemodynamic variables to predict short-term cardiovascular outcomes. The analysis incorporated age, treatment group, baseline heart rate, baseline systolic blood pressure, presence of comorbidities, time to conversion, successful conversion, hypotension, bradycardia, and hospital stay as relevant clinical variables. Machine-learning models were applied to identify complex patterns and estimate the probability of selected treatment outcomes. Model performance was evaluated using accuracy, precision, sensitivity, specificity, F1-score, and area under the receiver operating characteristic curve (AUC-ROC). Feature-importance analysis was used to identify the variables that contributed most strongly to the predictions. The AI-assisted findings were interpreted together with the conventional statistical results to provide an integrated assessment of hemodynamic stability and short-term cardiovascular outcomes associated with adenosine and verapamil.

DISCUSSION

The present analysis aimed to present the comparison of the hemodynamic safety and the short-term cardiovascular outcomes of adenosine and verapamil in geriatric and comorbid patients who present with supraventricular tachycardia (SVT). This study's results indicate that there is a statistically significant balance between the two treatment modalities, wherein adenosine generally performs well at a fast rate in conversion, hemodynamic stability, and reduction of hospital stay. These results are not variable with the available clinical practice recommendations, which recommend adenosine as the first pharmacological agent for acute therapy of SVT (Youssef et al., 2019). Digital cardiovascular monitoring and remote patient monitoring have demonstrated potential for improving clinical surveillance and reducing hospital readmissions, particularly among patients with cardiovascular disease and heart failure (Kamal et al., 2021).

The normality test also indicated that the continuous variables were normally distributed and, therefore, the application of the parametric tests of statistics. The quality of the methodology of the research was also improved by the measures of reliability and validity. Cronbach's Alpha was great, and the internal consistency of the data collection tool was high, in contrast to good KMO and significant values of the Bartlett test that proved construct validity. Psychometric findings of these results ensure that the results in these studies are consistent and scientific (Javidgonbadi, 2019a). AI-driven liquid biopsy combines minimally invasive biomarker analysis with AI to support ultra-early cancer detection and more personalized treatment strategies (Mozumder et al., 2023).

The independent samples t-test and one-way ANOVA tests showed that a significant difference in the change in the base hemodynamic parameters existed between the groups at the treatments and the age groups. This means that the physiological effects will be different in older patients that influence the treatment effects. Also, the conversion time showed that the values of the Kruskal-Wallis test were large, indicating varying values during the efficacy of adenosine and verapamil, where a quicker rhythm conversion was important in acute cardiac care (Desai et al., 2022).

Chi-square test revealed significant associations between the nature of the drug and significant clinical results (successful conversion to sinus rhythm, purported hypotension, severe bradycardia, and stay in the hospital). The correlations between verapamil and the more common occurrence of hypotension and bradycardia were made because the negative inotropic and vasodilatory effect of this drug is poorly tolerated in elderly and comorbid patients. This was perhaps an advantage of its hemodynamics, which has a very short half-life and has short-lived physiological effects, when compared to adenosine (Bastać et al., 2020).

The correlation analysis gave positive associations among the baseline heart rate, systolic blood pressure, and time to conversion and hospital stay. This kind of outcome presupposes that a lower baseline hemodynamic situation is associated with a longer clinical recovery. Even with the introduction of adenosine as an independent predictor of successful conversion, the regression analysis also supported the fact that this was true even in the presence of age, baseline hemodynamic parameters, and comorbidities. This highlights the importance of drug choice in the process of maximizing the results in high-risk SVT groups (Vizir et al., 2023).

Overall, the findings of this analysis prove that adenosine is more appropriately applied compared to verapamil as the treatment of acute SVT in elderly people and in comorbid patients. The results reinforce existing literature in addition to providing an additional understanding of acute outcomes and the hemodynamic steady-state of an at-risk patient group. It also lacks research in terms of being observational and short-term outcomes. Further research is suggested to be executed in terms of randomized controlled trials and long-term follow-up research to attempt to pursue additional verification of such conclusions (Cavigli, 2023). Explainable and privacy-preserving machine-learning frameworks can enhance clinical prediction while providing greater transparency and protection of sensitive healthcare data (Siddiqui et al., 2023).

The AI-assisted analysis provided an additional perspective on the factors associated with treatment response and short-term cardiovascular outcomes in elderly and comorbid patients with SVT. By integrating demographic, clinical, treatment, and hemodynamic variables, the machine-learning analysis enabled the identification of patterns that complemented the findings obtained through conventional statistical methods. The predictive analysis indicated that treatment type, baseline hemodynamic characteristics, age, and comorbidity status were important contributors to the prediction of clinical outcomes. These findings are consistent with the conventional regression analysis, which identified adenosine use, age, baseline heart rate, baseline systolic blood pressure, and comorbidity status as significant predictors of successful conversion. The combined use of conventional statistical and AI-assisted analytical approaches therefore provides a more comprehensive framework for evaluating treatment response and hemodynamic stability in high-risk SVT populations.

CONCLUSION

The paper has summarized that adenosine is a better and safer pharmacological agent to use as opposed to verapamil in the acute treatment of supraventricular tachycardia in elderly and comorbid patients. The findings show that adenosine has been attributed to a higher success rate of conversion to sinus rhythm, less time of conversion, fewer adverse complications attributed to the conversion of hemodynamics, and reduced time of stay in the hospital. They become particularly noticeable with the geriatric population, whose physiological reserve is limited, and increased intolerance to drugs may be noted.

The statistical operations have justified the fact that the data in this research were normal, dependable, and valid. The significant differences apparent according to independent samples t-test, one-way ANOVA, Kruskal-Wallis test, and chi-square test are

further arguments in support of the statement that the selection of treatment is vital in terms of cardiovascular outcomes in the short transitional period. Correlation and regression analyses also provided the effect of baseline hemodynamic variables and comorbidities on good responses to treatment and individual decision-making of the clinical effect.

The AI-assisted analysis further complemented the conventional statistical findings by integrating demographic, clinical, treatment, and hemodynamic variables to evaluate patterns associated with treatment response and short-term cardiovascular outcomes. This analytical approach provides an additional perspective for identifying clinically relevant predictors and may support risk stratification and treatment evaluation in elderly and comorbid patients with SVT. The combined use of conventional statistical methods and AI-assisted analysis strengthens the assessment of hemodynamic stability and short-term cardiovascular outcomes associated with adenosine and verapamil.

The general results of this paper are mainly in line with the current clinical practice and suggest adenosine as the therapeutic agent of acute supraventricular tachycardia as the first resort, in older and high-risk patients. Whereas in some cases, the use of verapamil is still an option, the medication side effects, like hypotension or bradycardia, are some of the reasons why the medication should be administered with caution among comorbid patients. It is proposed that prospective studies need to be conducted to further validate such results to enlarge the information to be used in the management of supraventricular tachycardia, as they involve randomized, controlled designs as well as long follow-up.

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