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Effectiveness and safety of paramedic administration of verapamil and adenosine for the treatment of supraventricular tachycardia: A review of the literature

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Review

Effectiveness and safety of paramedic administration of verapamil and adenosine for the treatment of supraventricular tachycardia: A review of the literature

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Abstract

Introduction

Adenosine and verapamil are the most commonly used pharmacological agents to treat supraventricular tachycardia (SVT). This review aims to identify the effectiveness and safety of pre-hospital use of adenosine and verapamil by paramedics.

Methods

A comprehensive electronic literature search was conducted. Studies of pre-hospital comparative effectiveness of adenosine and verapamil were included for further analysis. Studies where individual effectiveness of either verapamil or adenosine was reported in either the medical or pre-hospital setting were excluded. Animal studies and those articles unavailable in English were also excluded.

Results

Two pre-hospital studies were identified. Verapamil demonstrated greater reversion effectiveness across both studies, with side effects more commonly reported in the adenosine arm of each. The duration and severity of side effects resulting from verapamil administration was greater than that of adenosine. Paramedic electrocardiogram (ECG) interpretation was questionable, resulting in a number of errors across both studies.

Conclusion

Available studies report that verapamil is more effective for pre-hospital SVT reversion. Effective pre-hospital drug therapy for SVT must incorporate a measure of patient impact with regard to severity, duration and interventions required to correcting adverse effects. A larger contemporary study is required to further evidence paramedic use of pharmacological agents to treat SVT. Paramedic ECG interpretation is a key factor influencing correct treatment, and adequate education must form the basis of pre-hospital guidelines for SVT management.

Keywords

pre-hospital; paramedic; supraventricular tachycardia; verapamil; adenosine

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Introduction

Supraventricular tachycardia (SVT) is a transient cardiac arrhythmia that affects approximately 35 in 100 000 people in the community (1). The most common presentation includes a 'racing' heart (heart rate >140 beats per minute) accompanied by palpitations, chest discomfort, shortness of breath and dizziness (2). International resuscitation guidelines recommend two primary therapies for treating SVT in the acute setting: vagal manoeuvres and pharmacological interventions, while synchronised cardioversion is reserved for the unstable and deteriorating patients (3-5). Where included in Australian pre-hospital clinical guidelines, synchronised cardioversion is reserved for the management of unstable SVT resulting in haemodynamic collapse (6-10). Vagal manoeuvres provide a non-invasive means of increasing the refractoriness of the atrio-ventricular node (AV-node) by triggering baroreceptors in the aortic sinus and carotid bodies, thus terminating the arrhythmia, while pharmacological agents provide a similar increase in refractoriness by impairing normal ion activity through AV-node cell wall channels.

The primary pharmacological interventions for SVT are verapamil (a calcium channel blocking agent), and adenosine (a naturally occurring purine nucleoside which acts to inhibit sodium channels) (11).

A meta-analysis of the effectiveness of adenosine and verapamil in reverting SVT reported that both drugs have a similar reversion effectiveness (~92%) (12). Adenosine was noted to have a greater number of transient side effects, while verapamil was likely to demonstrate side effects that were prolonged or required immediate intervention.

In the pre-hospital setting, the use of a pharmacological agent that provides both safe and effective termination of the arrhythmia is important. To this end, the 2012 Ambulance

Victoria Clinical Practice Guideline A0403: Supraventricular tachycardia, acknowledges the potentially significant side-effects of verapamil through the inclusion of aramine (a synthetic alpha-agonist that increases peripheral vascular resistance) to the treatment algorithm where patients in SVT have blood pressures <100 mmHg systolic (10).

This literature review examines the pre-hospital use of pharmacological agents by paramedics, specifically comparative studies of verapamil and adenosine reversion effectiveness and safety.

Methods

An electronic literature search was conducted, which included the Cochrane Database of Systematic Reviews, the Cochrane Register of Controlled Trials (Central), MEDLINE, Cumulative Index of Nursing and Allied Health Literature (CINAHL), EMBASE and Google Scholar. Studies in which comparative effectiveness of adenosine and verapamil were measured in the pre-hospital setting with treatment by paramedics were included for further analysis. Studies in which individual effectiveness of either verapamil or adenosine were measured in the pre-hospital setting were excluded. Studies of hospital or medical use of verapamil and or adenosine for SVT, or where pre-hospital care was provided by qualified physicians, were excluded. Animal studies and those articles unavailable in English were also excluded. The search strategy is reported in Figure 1.

Due to differences in therapy regimens (specifically drug dosage and frequency) between the two studies, meta-analysis was not conducted. Both included studies were retrospective case series reviews, and as such were unable to be assessed for methodological quality using recognised tools, although this is likely to be less than optimum.

Figure 1. Search strategy

Results

The search identified two pre-hospital studies that compared verapamil and adenosine effectiveness when used by paramedics to treat SVT (Table 1). Both studies employed a 12-month sample of retrospective chart review for verapamil, and a similar period of prospective chart review for adenosine. This pre-post model enabled comparison of factors such as paramedic electrocardiogram (ECG) interpretation, reversion effectiveness of each drug, adverse effects noted and inappropriate administrations by paramedics.

All items were rated very similar by the two raters, except for item six, which dealt with the definition of the target users of the guideline. This discrepancy can be explained by a difference in understanding of ARC Guideline 1.4, which states the ARC guidelines 'shall be resource documents for individuals and organisations that teach and practise resuscitation' (2). The issues associated with a poorly identified, and perhaps too broad a group of target end users, is discussed further below.

Table 1. Studies of pre-hospital adenosine vs verapamil effectiveness

Study	Pharmacological agent	Sample size n (%)	Dosage regimen	Reversion success n (%)
Madsen et al [13]	Verapamil	17 (23.3)	2.5 mg and 5 mg	4 (23.5)
	Adenosine	56 (76.7)	6 mg and 12 mg	25 (44.6)
Brady et al [14]	Verapamil	52 (37.4)	2.5 mg and 5 mg	43 (82.7)
	Adenosine	87 (62.6)	6 mg, 12 mg and 12 mg	60 (69.0)

The adverse events reported in each study (Table 2) reflect commonly reported side-effect profiles of each pharmacological agent. The administration of verapamil in both studies reported less side effects, however, where these were experienced by patients they were prolonged (>5 minutes) and required invasive intervention including fluid resuscitation and synchronised cardioversion to correct. Conversely, those side

effects reported as a result of adenosine administration in both studies were transient in nature, and resolved after a period of less than 30 seconds without further intervention. An exception to this was two episodes of adenosine-induced bronchospasm in patients with known asthma, which were resolved rapidly with the administration of salbutamol.

Table 2. Adverse effects reported in pre-hospital studies of adenosine vs verapamil

Study	Verapamil Detail (n)	Adenosine Detail (n)
Madsen et al [13]	Ventricular tachycardia (1) Hypotension (1) Bigeminy (1) Uncontrolled voiding (1)	Atrio-ventricular blockade (7) Asystole (5) Ventricular ectopy (4) Central chest pain (4) Headache (4) Flushing (4) Weakness (2) Bronchospasm (2)
Brady et al [14]	Ventricular tachycardia (2) Hypotension (1) Ventricular fibrillation (1)*	Central chest pain (1) Shortness of breath (1) Bradycardia (1) Ventricular tachycardia (1)

* Patient subsequently diagnosed in hospital with myocardial infarction found to have precipitated the SVT

Paramedics within each study identified the arrhythmia using a single lead (Lead II) ECG, which was sent via telemetry to a local hospital for medical confirmation. Quality of data was reported to be limited by screen size and the absence of detail provided by a 12-lead ECG, and by the quality of transmission to the hospital for physician analysis. Both study articles identified that paramedic interpretation of ECG strips suffered from deficiencies. It was noted on ECG review in

both studies that there were a similar number of interpretation errors by paramedics and physicians between studies, resulting in administration of pharmacological agents incorrectly to a number of patients (Table 3). Additionally, a large proportion of errors were noted in the prospective arm of each study, with 24/34 (70.1%) and 34/36 (94.4%) ECG interpretation errors occurring in the prospective arm of each study respectively.

Table 3. ECG interpretation results by study

Study	ECG misinterpretation n (%)	Rhythm identified on ECG review	
		Adenosine Detail (n)	Verapamil Detail (n)
Madsen et al [13]	34/64 (53.1)	Sinus tachycardia (5) Atrial tachycardia (5) Atrial fibrillation (11) Ventricular tachycardia (2) Atrial flutter (1)	Sinus tachycardia (1) Atrial tachycardia (5) Atrial fibrillation (4)
Brady et al [14]	36/211 (17.1)	Sinus tachycardia (7) Atrial fibrillation (18) Wide complex tachycardia (7) Ventricular tachycardia (2)	Wide complex tachycardia (2)

Discussion

This review identified limited evidence to support and describe paramedic use of adenosine or verapamil for SVT reversion. Previous studies have demonstrated that both adenosine and verapamil have similar reversion effectiveness, (11,12,15-19) yet these pre-hospital studies reported opposing views on reversion effectiveness between the two pharmacological agents. It is likely that the study-specific treatment regimen affected these results, with the use of medical oversight through authority to intervene via telemetry also influencing both intervention rate and reversion effectiveness as not all patients were treated within the study sample.

Differing treatment regimens and opposing findings precluded meta-analysis of results reported, and highlighted the need for more contemporary and larger studies into pre-hospital management of SVT. The findings of these studies, and their disparity with previous studies, offer insight into the challenges of conducting pre-hospital research generally. Issues of paramedic compliance with the study protocol, differing focus on the constitution of effectiveness overall and study design quality are all factors that impede the nature of development of such evidence.

It is important to consider the incidence, severity and duration of side effects when determining the suitability of pharmacological agents for pre-hospital use. The proportions of side effects reported within these two studies may represent a misleading factor in decision-making regarding the effectiveness of verapamil and adenosine. This is because those side effects reported within the adenosine arm of each study were largely resolved within 30 seconds, while those in the verapamil arm were prolonged (>5 minutes) and largely required significant intervention by paramedics to resolve. Circumstances where aggressive fluid resuscitation is required due to prolonged or profound hypotension, or where synchronised cardioversion is required as a consequence of rapidly deteriorating perfusion

are not optimal within the confines of an ambulance with limited resources, and may potentiate further deterioration in the patient and a delay in transport to definitive care. Conversely, paramedics providing appropriate reassurance and information to patients before drug administration may ameliorate the impact of a higher incidence of transient effects. Thus, a careful assessment of patient impact is required in order to decide on an appropriate pre-hospital pharmacological intervention for the treatment of SVT.

Of importance is the ability for paramedics to demonstrate appropriate levels of knowledge and skill in order to correctly interpret the arrhythmia before intervention, as the consequence of inappropriate drug administration may be devastating for the patient (20-22). Each of the emergency medical services identified in these studies employed a single lead (Lead II) ECG, and it is likely that this contributed to the error rate, although this is not quantified within the two studies. Notably, this error rate increased dramatically within the prospective arm of each study. It is unclear why this has occurred, as each study did not require paramedics to interpret arrhythmias in the prospective period that differed from those in the retrospective period. It could be speculated that the potential to perform a new intervention impacted other aspects of assessment; however this is again unquantifiable within these two studies.

Limitations of this review

There are several potential limitations within this review. The absence of randomised controlled trials impacts the quality of evidence reported. The two pre-hospital studies identified were somewhat dated, and the small sample size within each may inhibit generalisation of results. The reporting of opposing results and limited number of comparative studies provides challenges to identifying a preferred pharmacological agent through measurement of effectiveness. Variations in therapeutic regimens prevent meta-analysis of results.

Conclusion

These two comparative studies report opposing results for the effectiveness of verapamil and adenosine for the reversion of SVT in the pre-hospital setting. This highlights the need for a larger contemporary study to provide further evidence for pharmacological intervention by paramedics to patients with SVT. Paramedic ECG interpretation is a key factor influencing correct treatment, and adequate education must form the basis

of any consideration of drug therapy inclusion in a pre-hospital guideline for SVT management.

Competing interests

The author currently serves as an Associate Editor with the *Australasian Journal of Paramedicine*. No other interests, financial or otherwise, are declared. The author has completed the ICMJE conflict of interest statement.

References

1. Orejarena LA, Vidaillet H, DeStefano F, et al. Paroxysmal supraventricular tachycardia in the general population. *J Am Coll Cardiol* 1998;31(1):150–7.
2. Smith G, Morgans A, Boyle M. Use of the valsalva manoeuvre in the prehospital setting: a review of the literature. *Emerg Med J* 2009;26(1):8–10.
3. Australian Resuscitation Council. Guideline 11.9: Managing acute dysrhythmias. Available at: www.resus.org.au/policy/guidelines/.
4. European Resuscitation Council. ERC Guidelines 2010. Available at: www.erc.edu/.
5. United Kingdom Resuscitation Council. Resuscitation guidelines - adult tachycardia, 2010. Available at: www.resus.org.uk/pages/tachalgo.pdf [Accessed 20 June 2013].
6. South Australian Ambulance Service. Supraventricular tachycardia. Guideline. 2009;2. Available at: www.saambulance.com.au/.
7. Australian Capital Territory Ambulance. Guideline 8: Tachycardias. Available at: <https://esa.act.gov.au/actas/about-us/clinical-management-guidelines/>.
8. Ambulance Service New South Wales. Guidelines: Dysrhythmias - tachycardia. Available at: www.ambo.com.au/download/protocol_2011.pdf.
9. Queensland Ambulance Service. Narrow complex tachycardia. Queensland Ambulance Service Clinical Practice Manual 2011. Available at: <https://ambulance.qld.gov.au/clinical.html>.
10. Ambulance Victoria. CPG A0403: Supraventricular tachycardias. Ambulance Victoria Clinical Practice Guidelines 2009. Available at: https://ambulance.qld.gov.au/docs/cpm_introduction.pdf.
11. Holdgate A, Foo A. Adenosine versus intravenous calcium channel antagonists for the treatment of supraventricular tachycardia in adults. *Cochrane Database Syst Rev* 2009(4).
12. Delaney B, Loy J, Kelly AM. The relative efficacy of adenosine versus verapamil for the treatment of stable paroxysmal supraventricular tachycardia in adults: a meta-analysis. *Eur J Emerg Med* 2011;18(3):148–52.
13. Madsen CD, Pointer JE, Lynch TG. A comparison of adenosine and verapamil for the treatment of supraventricular tachycardia in the prehospital setting. *Ann Emerg Med* 1995;25(5):649–55.
14. Brady WJ, DeBehnke DJ, Wickman LL, Lindbeck G. Treatment of out-of-hospital supraventricular tachycardia: adenosine vs verapamil. *Acad Emerg Med* 1996;3(6):574–85.
15. Gausche M, Persse DE, Sugarman T, et al. Adenosine for the prehospital treatment of paroxysmal supraventricular tachycardia. *Ann Emerg Med* 1994;24(2):183–9.
16. Lozano M, McIntosh BA, Giordano LM. Effect of adenosine on the management of supraventricular tachycardia by urban paramedics. *Ann Emerg Med* 1995;26(6):691–6.
17. Furlong R, Gerhardt RT, Farber P, Schrank K, Willig R, Pittaluga J. Intravenous adenosine as first-line prehospital management of narrow-complex tachycardias by EMS personnel without direct physician control. *Am J Emerg Med* 1995;13(4):383–8.
18. McCabe JL, Adhar GC, Menegazzi JJ, Paris PM. Intravenous adenosine in the prehospital treatment of paroxysmal supraventricular tachycardia. *Ann Emerg Med* 1992;21(4):358–61.
19. O'Toole KS. Intravenous verapamil in the prehospital treatment of supraventricular tachycardia. *Ann Emerg Med* 1990;19(3):291–4.
20. Ornato JP, Hallagan LF, Reese WA, et al. Treatment of paroxysmal supraventricular tachycardia in the emergency department by clinical decision analysis. *Am J Emerg Med* 1988;6(6):555–60.
21. Rostagno C, Paladini B, Pini C, et al. Feasibility of out-of-hospital treatment of supraventricular tachycardias. *Am J Cardiol* 1991;68:119–22.
22. Slovis CM, Kudenchuk PJ, Wayne MA, Aghababian R, Rivera-Rivera EJ. Prehospital management of acute tachyarrhythmias. *Prehosp Emerg Care* 2003;7(1):2–12.