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# Management of Ventricular Tachycardia in the Emergency Department


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I have no financial disclosures or conflicts of interest to declare

# Objectives:

- Recognize different etiologies and forms of ventricular tachycardia (VT)
- Analyze different pharmacological options for treating VT

# Definitions

VT = ventricular tachycardia
OHCA = Out of Hospital Cardiac Arrest
PEA = pulseless electrical activity
DCCV = direct current cardioversion
PVC = premature ventricular contraction
TdP = torsades de pointes
MI = myocardial infarction
SCD = sudden cardiac death
ARVD = arrhythmogenic right ventricular dysplasia
LVEF = left ventricular ejection fraction
WCT = wide complex tachycardia
pVT/VF = pulseless ventricular tachycardia / ventricular fibrillation
HCM = hypertrophic cardiomyopathy
LQTS = long QT syndrome
ICD = implantable cardioverter defibrillator

# Pre-assessment

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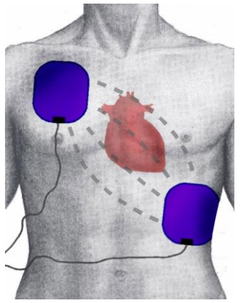
Which of the following best fits the definition of Ventricular tachycardia?

A. Heart rate > 200 with a wide QRS complex
B. Ectopic ventricular reentry circuit and HR>180
C. Three or more consecutive PVCs
D. 10 seconds duration of a consistent QRS > 120 ms

# Out-of-Hospital Cardiac Arrest

| Initial rhythm | Cause | Survival [1,2,3] |
|---|---|---|
| OHCA overall survival[1] | | 10% |
| pVT/VF | Coronary | 25% - 74% |
| PEA | Reversible Causes<br>• Hypovolemia<br>• Hypoxia<br>• Hydrogen ion (acidosis)<br>• Hypo-/hyperkalemia<br>• Hypothermia<br>• Tension pneumothorax<br>• Tamponade, cardiac<br>• Toxins<br>• Thrombosis, pulmonary<br>• Thrombosis, coronary | 8% |
| asystole | ??? | 1 % |




1. Daya MR, et al. Resuscitation Outcomes Consortium (ROC). Resuscitation. 2015 Jun;91:108-15.
2. Valenzuela TD, N Engl J Med. 2000 Oct 26;343(17):1206-9
3. Kudenchuck PJ. N Engl J Med. ALPS Trial. 2016 May 5;374(18):1711-22.

Images: https://commons.wikimedia.org/wiki/

# Causes and prognosis of VT:

initial VF/pVT:
37% of OHCA patients[1]

ventricular dysrhythmia associated w 3-6x higher rate of MI[3,4]

18% of initial pVT/VF requires Medications[2] (refractory to shock)

*Pediatric/adolescent VT/VF:*
HCM, ARVD, LQTS…
Brugada… toxicology…
**Congenital and high risk of SCD**

Initial shockable rhythm[5,6]
50% have evidence of acute MI
3x more likely to have acute MI

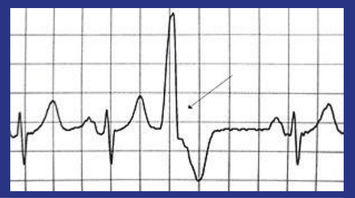


1. Oving I et al. Resuscitation. 2020 Jun;151:67-74
2. Kudenchuck PJ. N Engl J Med. ALPS Trial. 2016 May 5;374(18):1711-22.
3. Henkel DM, et al. Am Heart J. 2006 Apr;151(4):806-12
4. Zeyons F, et al. Eur Heart J Acute Cardiovasc Care. 2017 Mar;6(2):103-111
5. Resuscitation. 2012 Dec;83(12):1444-50.
6. Zeyons F et al. Eur Heart J Acute Cardiovasc Care. 2017 Mar;6(2):103-111.

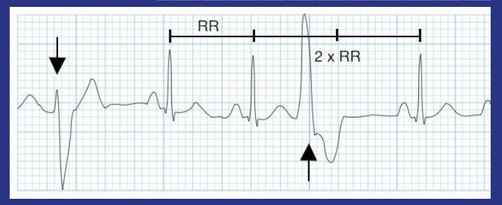
# PVC – premature ventricular contraction

Why is a normal QRS complex narrow?

PVC is wide because it is slow



Unifocal vs multifocal PVCs



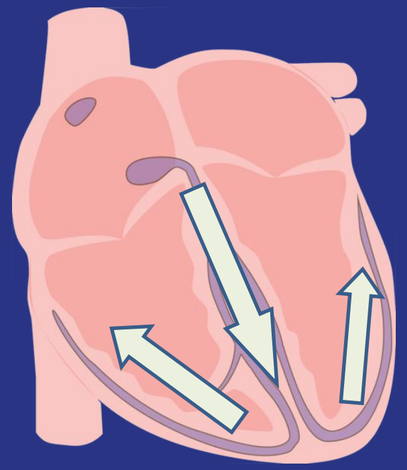

Definition of VT:

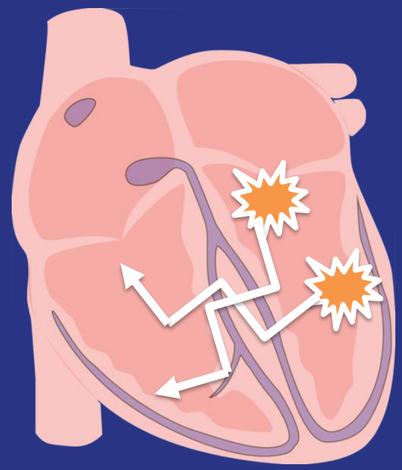
≥ 3 consecutive PVCs

Monomorphic vs polymorphic

Sustained VT:

VT ≥ 30 sec (or requiring DCCV)





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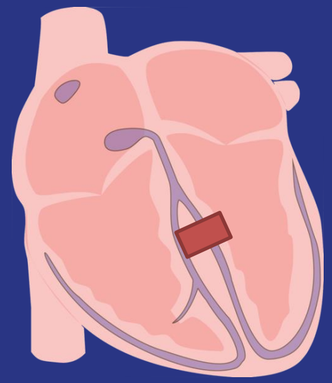
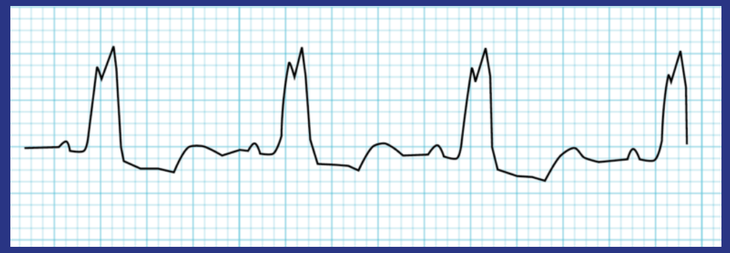
Ventricular Tachyarrhythmias. Ed. Brian Olshansky, Arrhythmia Essentials. 2nd Ed. Elsevier, 2017, p 219-277,
Images: Wikipedia commons



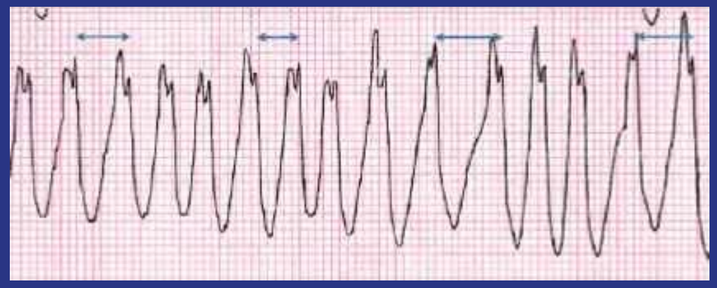


Bundle branch block

+

AFib

=



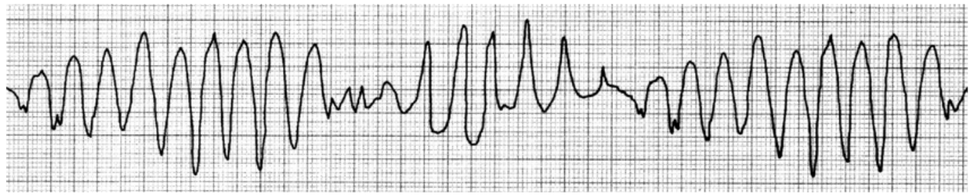
Not all wide-complex tachycardias are VT … always assume VT

(20%) SVT with aberrancy

(80%) Ventricular tachycardia



Issa ZF et al. Clinical Arrhythmology and Electrophysiology. In: Braunwald's Cardiology. 21, 730 - 747
www.litfl.com/ecglibrary



# monomorphic

# polymorphic

Adult cardiovascular disease

Torsades de Poines (TdP)

Brugada syndrome

Long-QT syndrome (LQTS)

pediatric / congenital

95% of non-sustained VT have cardiomyopathy

Idiopathic Fascicular Left Ventricular Tachycardia (Verapamil-Sensitive VT)

Catecholaminergic Polymorphic VT (CPVT)

Accessory pathways?



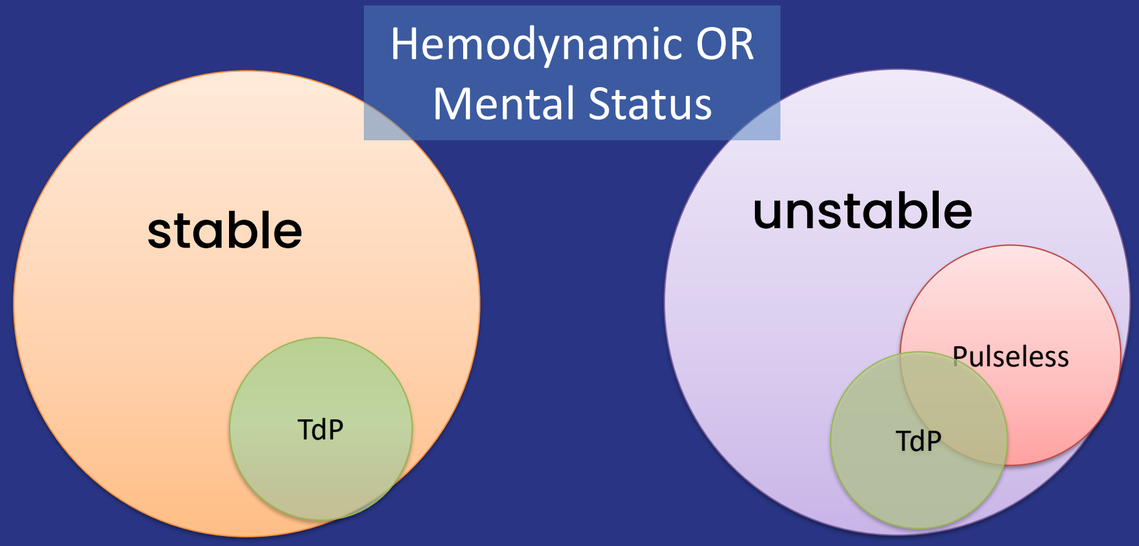
Ventricular Tachyarrhythmias. Ed. Brian Olshansky, Arrhythmia Essentials. 2nd Ed. Elsevier, 2017, p 219-277.
Images: litflecglibrary.com

## Characteristics:

180 – 280 bmp

## Stability dependent on:

rate, age, LVEF




Immediate cardioversion
(ACLS algorithm)



Ventricular Tachyarrhythmias. Ed. Brian Olshansky, Arrhythmia Essentials. 2nd Ed. Elsevier, 2017, p 219-277.

# Pre-assessment:

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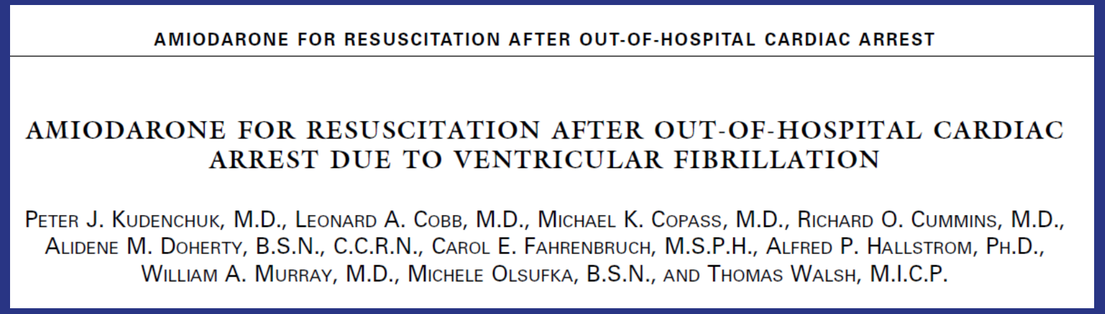
B. Magnesium has been shown to terminate TdP

C. The best available evidence supports procainamide over amiodarone for stable monomorphic VT

# unstable VT

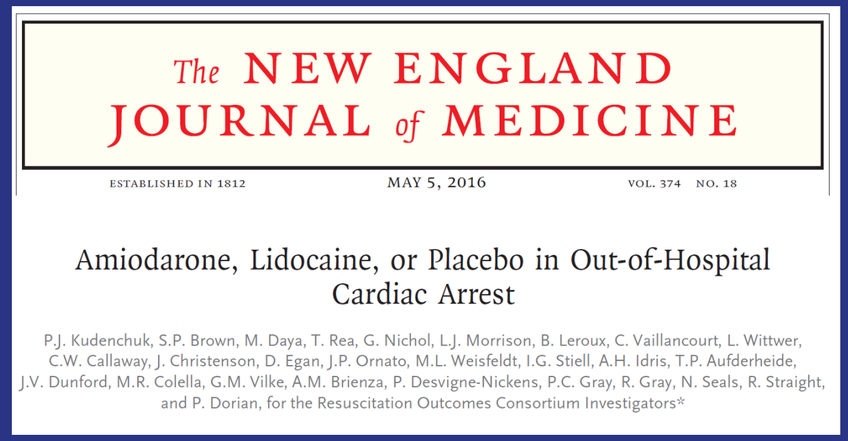
## Out-of-Hospital Cardiac Arrest



AMIODARONE FOR RESUSCITATION AFTER OUT-OF-HOSPITAL CARDIAC ARREST

AMIODARONE FOR RESUSCITATION AFTER OUT-OF-HOSPITAL CARDIAC ARREST DUE TO VENTRICULAR FIBRILLATION

PETER J. KUDENCHUK, M.D., LEONARD A. COBB, M.D., MICHAEL K. COPASS, M.D., RICHARD O. CUMMINS, M.D., ALIDENE M. DOHERTY, B.S.N., C.C.R.N., CAROL E. FAHRENBRUCH, M.S.P.H., ALFRED P. HALLSTROM, PH.D., WILLIAM A. MURRAY, M.D., MICHELE OLSUFKA, B.S.N., AND THOMAS WALSH, M.I.C.P.



The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 5, 2016 VOL. 374 NO. 18

Amiodarone, Lidocaine, or Placebo in Out-of-Hospital Cardiac Arrest

P.J. Kudenchuk, S.P. Brown, M. Daya, T. Rea, G. Nichol, L.J. Morrison, B. Leroux, C. Vaillancourt, L. Wittwer, C.W. Callaway, J. Christenson, D. Egan, J.P. Ornato, M.L. Weisfeldt, I.G. Stiell, A.H. Idris, T.P. Aufderheide, J.V. Dunford, M.R. Colella, G.M. Vilke, A.M. Brienza, P. Desvigne-Nickens, P.C. Gray, R. Gray, N. Seals, R. Straight, and P. Dorian, for the Resuscitation Outcomes Consortium Investigators*

### ARREST (1999)

- N = 504
- 74% witnessed
- Amiodarone 300mg vs placebo
- survival to admission
- 44% vs 34% (p = 0.03)

Procainamide and Survival in Ventricular Fibrillation Out-of-hospital Cardiac Arrest

David T. Markel, Laura S. Gold, MSPH, Judith Allen, MPH, Carol E. Fahrenbruch, MSPH, Thomas D. Rea, MD, MPH, Mickey S. Eisenberg, MD, PhD, and Peter J. Kudenchuk, MD

### Markel et. Al 2010

- Observational in VT or VF arrest
- N = 665
- Procainamide equal or
- worse than other meds

### ALPS ROC (2016)

- N = 4653
- Amio vs lido vs placebo
- No survival difference
- Lidocaine > ROSC at ED arrival
- Survival 74% if witnessed

### Lido/amio still benefited PEA[4]

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1. Kudenchuk Pj et al. N Engl J Med. 1999 Sep 16;341(12)4.
2. Markel et al. Acad Emerg Med. 2010 Jun;17(6):617-23
3. Kudenchuck PJ. N Engl J Med. 2016 May 5;374(18):1711-22.
4. Kudenchuk Pj et al. Circulation. 2017 Nov 28;136(22):2119-2131.

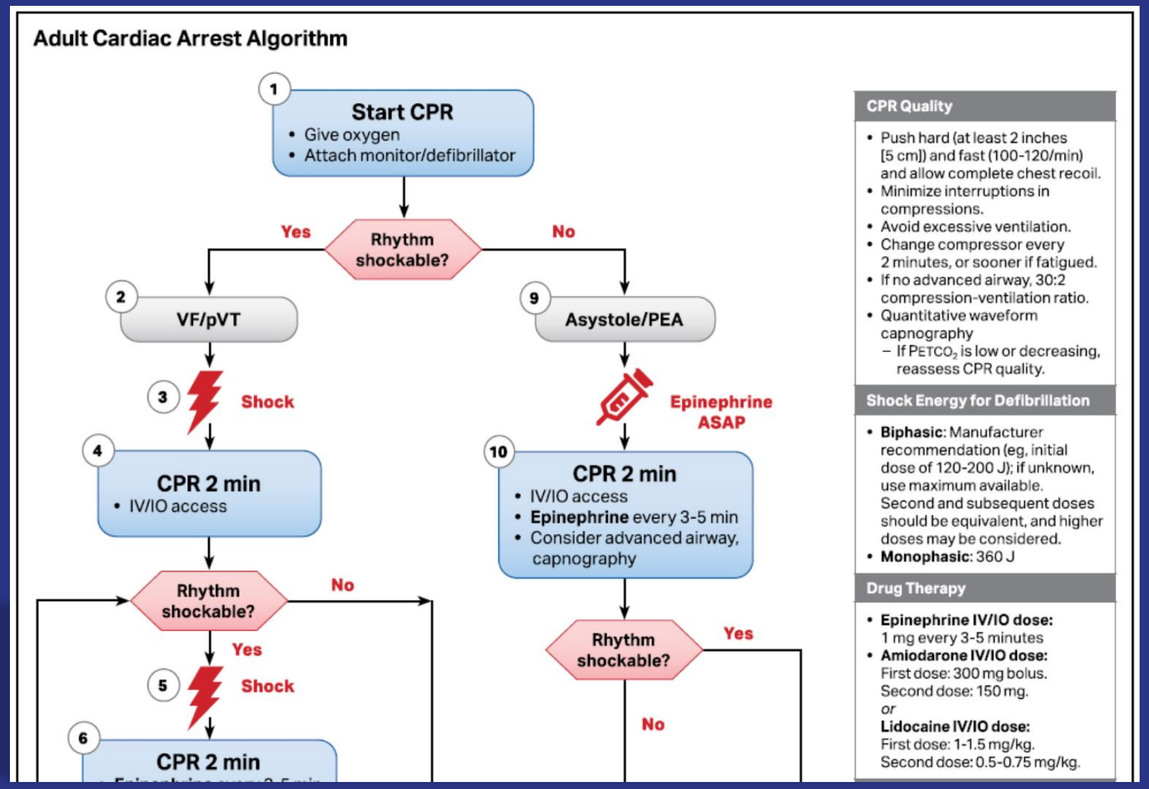
# unstable VT → ACLS

High quality CPR
Early shock
Epinephrine

<u>After 3 shocks:</u>

Amiodarone
or
Lidocaine

“May continue Infusion”

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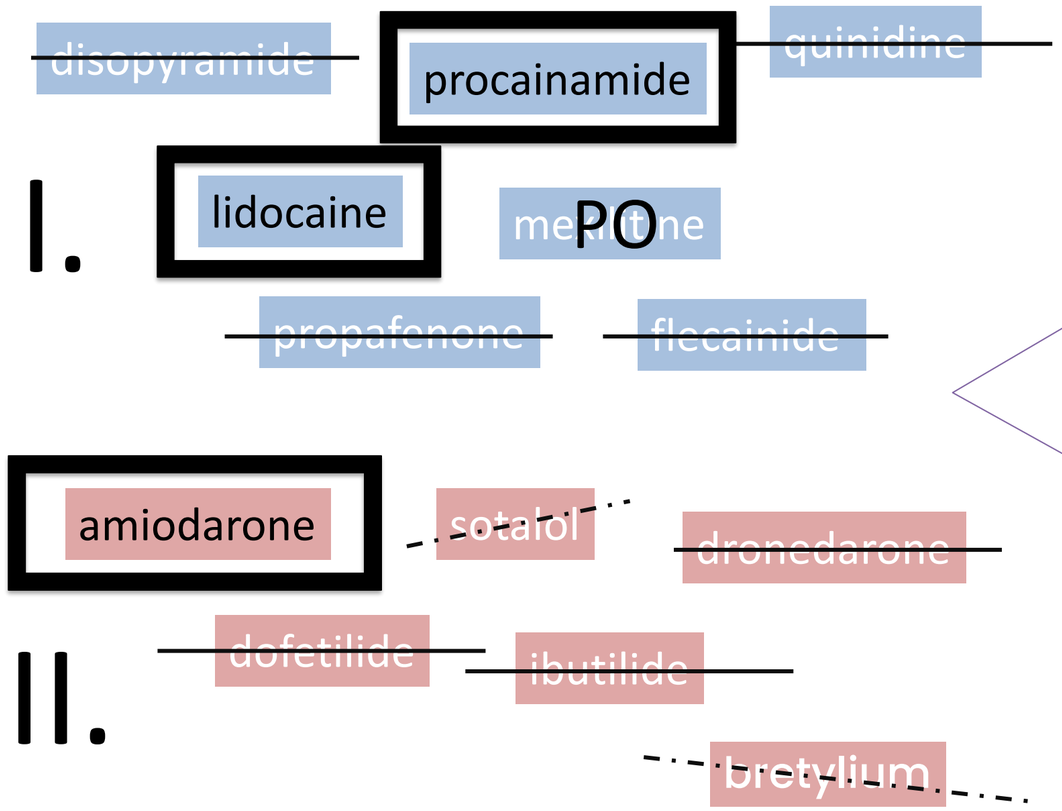
Circulation. 2020 Oct 20;142(16_suppl_2):S366-S468.Epub 2020 Oct 21. PMID: 33081529

# Antiarrhythmic drugs ...used for ventricular dysrhythmias




**Procainamide**
**Lidocaine**
**Amiodarone**



Chowdhury A, et al. Heart Lung Circ. 2018 Mar;27(3):280-290.

# stable vt

pad placement → Blood pressure → 12-lead ECG

"Consider adenosine" for diagnosis[1]

- No pause → probably a ventricular rhythm
- Not for irregular or polymorphic WCT

<u>Magnesium:</u>

- Only shown to prevent and NOT terminate TdP[2]
- 4 studies (n = 217) show no benefit in cardiac arrest[3]

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1. ACLS Circulation. 2020 Oct 20;142(16_suppl_2):S366-S468.Epub 2020 Oct 21..
2. Panchal AR etl al. Circulation. 2018 Dec 4;138(23):e740-e749.
3. Chowdhury et al. Heart, Lung and Circulation (2018) 27, 280–290

Deutsche Medizinische Wochenschrift 1988;113:1317–21

# stable monomorphic vt

## Prospective Randomized Trials

Gorgels 1996
- (n = 29) Procainamide superior to lidocaine[2] 80% vs 21%

Ho 1994
- (n = 33) Sotalol superior to lidocaine[3] 69% vs 20%

Manz 1988
- (n = 31*) amjaline superior to lidocaine 67% vs 13%

Ortiz 2017
- (n = 62) procainamide superior to amiodarone

## Retrospective:
- Amiodarone ≈ procainamide[4] (n = 90)

Lidocaine "0 for 3"

...IV sotalol **and** IV ajmaline ??

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Gorgels AP, et al. Am J Cardiol. 1996 Jul 1;78(1):43-6.
Ho DSW, et al. Lancet 1994;344:18–23.)
Manz et al. Dtsch Med Wochenschr. 1988 Aug 26;113(34):1317-21.
Marill KA, et al. Acad Emerg Med 2010;17:297–306
Ortiz M et al. PROCAMIO study. Eur Heart J. 2017 May 1;38(17):1329-1335

# PROCAMIO Trial

Multicenter
Prospective
Randomized

Amiodarone 5mg/kg (n = 29)
over 20 min
Procainamide 10mg/kg (n = 33)

26 centers
6 years
n = 74

**Endpoint: major cardiac adverse events**
Amiodarone 41%
Procainamide 9 %
p = 0.006

**VT Terminated*:**
38%
67%

*p < 0.05

**Adverse events*:**
Amiodarone 48%
Procainamide 24 %

Most common ADR:
Hypotension
(amiodarone 7; procainamide 3)



Ortiz M et al. PROCAMIO study. Eur Heart J. 2017 May 1;38(17):1329-1335.

# PROCAMIO Trial

- No mention of actual doses
- LVEF ≈ 40%

Dose practical and available ?

Amiodarone is first-line outpatient medication for prevention of SCD/VT/VF

2020 ACLS Guidelines (Stable WCT):
*"Insufficient evidence to favor one agent over another amiodarone or sotalol or procainamide acceptable"*



Al-Khatib SM, et al. J Am Coll Cardiol. 2018 Oct 2;72(14):e91-e220.
Ortiz M et al. PROCAMIO study. Eur Heart J. 2017 May 1;38(17):1329-1335.

# VT in heart failure / ischemic cardiomyopathy

## Recurrent VT/VF[1]

MI → LV heart failure + ventricular dysrhythmia → transplant?

ICD → amiodarone or sotalol → +/- mexiletine

in ED

lidocaine gtt
amiodarone
procainamide

Ablation of VT and ICD better than drug escalation[2]

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1. Santangeli P, et al. J Am Coll Cardiol. 2017 Apr 11;69(14):1842-1860
2. Sapp JL: N Engl J Med. 2016 Jul 14;375(2):111-21

# Stop after loading dose ?

## VT maintenance infusion

**Amiodarone**
1 mg/min x 6 h
0.5mg/min thereafter

**Recurrent VT:**
"repeat initial load"

**Procainamide**
2 – 6 mg/min

? evidence
metabolites ?

**Lidocaine**
1 – 4 mg/min

? evidence



Cushing DJ et al. Eur J Pharmacol. 2009 Apr 1;607(1-3):167-72
Amiodarone Product Insert. Pfizer. 2018
Kates RE. Ann N Y Acad Sci. 1984;432:75-89.

# Random Fun Facts:

Amiodarone: polysorbate 80 or benzyl alcohol may be responsible for hypotension

- Cyclodextrin formulation *may* lack hypotensive effect
- ALPS study used cyclodextrin-formulation (?effect)

## Amiodarone is not a very effective rhythm control agent for AF or VT

indicated for the treatment of documented, life-threatening recurrent VF and VT in adults ***who have not responded to adequate doses of other available antiarrhythmics or when alternative agents cannot be tolerated***

## Procainamide dosing:

- FDA: 20 mg/min -or- 100mg ever 5 minutes
- Maximum 17 mg/kg
- 1000mg over 60 minutes ("Ottowa" for Afib)

Procainamide metabolized in liver to n-acetylprocainamide (K+ blocker class III antiarrhythmic)

Fast-acetylators vs slow acetylators…. ?



Cushing DJ, et al. Eur J Pharmacol. 2009 Apr 1;607(1-3):167-72.
Chevalier P, et al. J Am Coll Cardiol. 2003 Jan 15;41(2):255-62.
Ortiz M et al. PROCAMIO study. Eur Heart J. 2017 May 1;38(17):1329-1335
J Cardiovasc Pharmacol Ther. 1999 Jul;4(3):143-150.

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# Summary:

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VT is highly prognostic of acute MI

Unstable or pulseless VT: amiodarone = lidocaine (ALPS)

Stable VT can be treated with amiodarone or procainamide

Robust evidence on treating stable VT is lacking

PROCAMIO (2017):
procainamide 15mg/kg shown superior to
amiodarone 5mg/kg over 20 minutes