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Current Controversies in the Management of Hyperkalemia

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Disclosure

- The program chair and presenters for this continuing education activity have reported no relevant financial relationships.

Published Today

Blog post summarizing key points from today's presentation

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Debates in the Management of Hyperkalemia: A Focus on Calcium and Insulin

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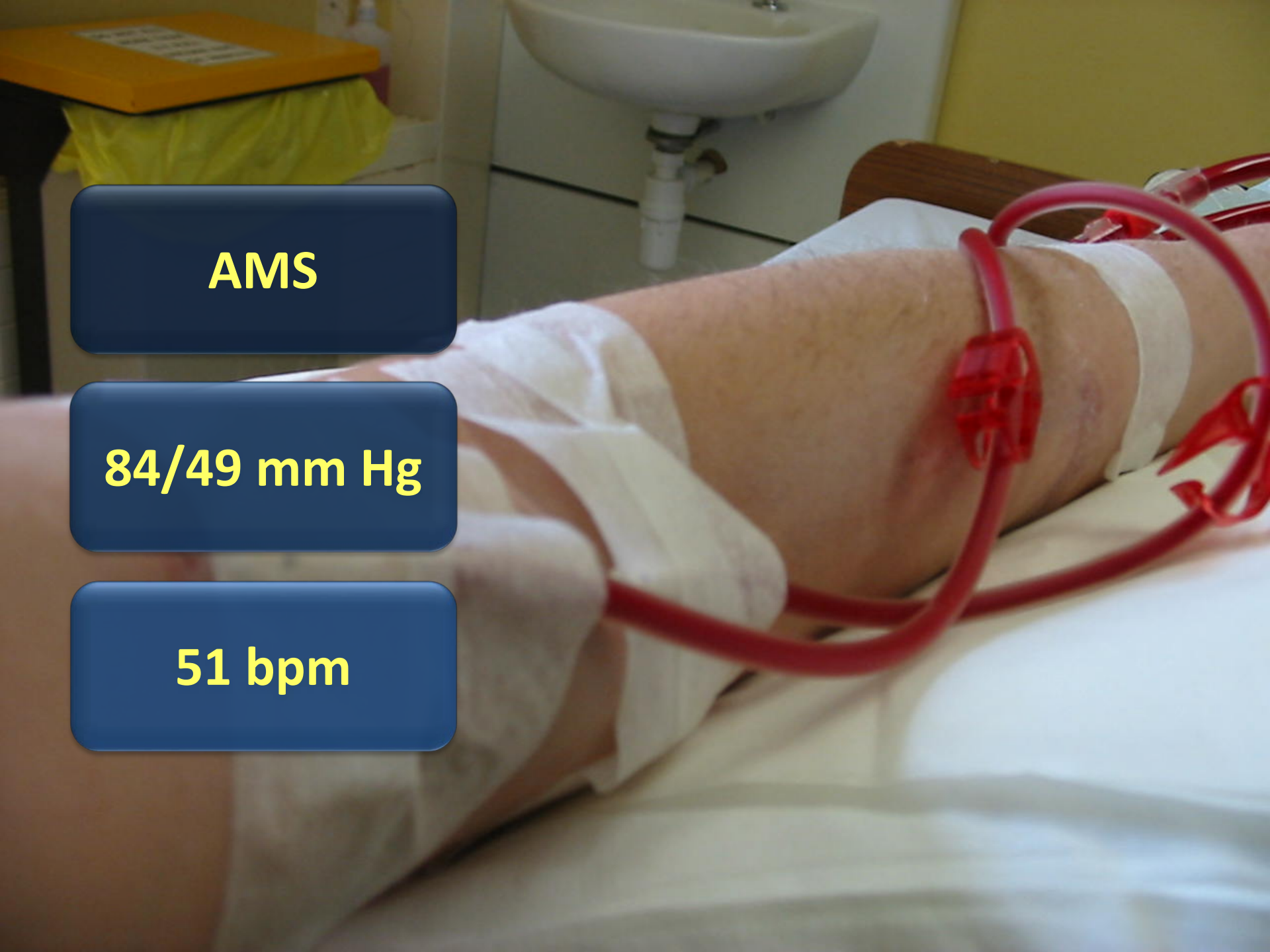
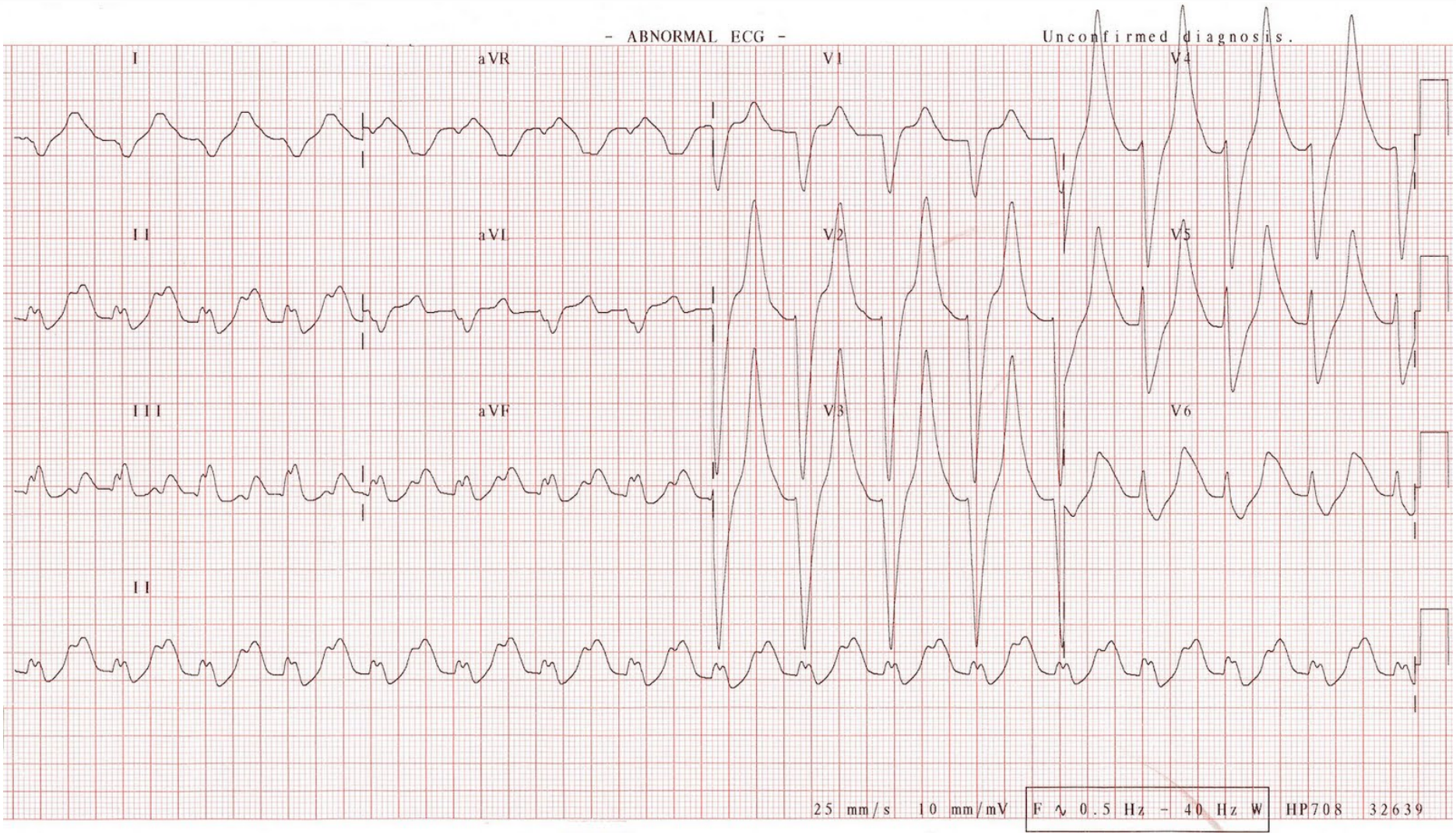
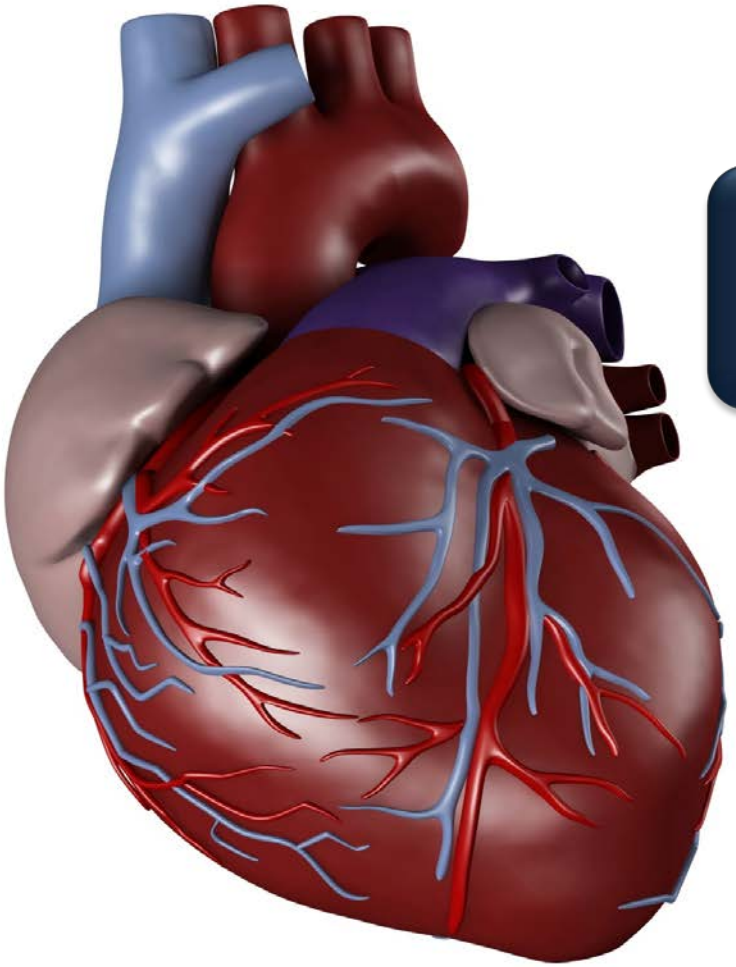

AMS
84/49 mm Hg
51 bpm




Ca



↓ depolarization

At what potassium concentration should calcium be administered?

A 9.0 mmol/L

B 7.1 mmol/L

C 5.3 mmol/L

D It depends

At what potassium concentration should calcium be administered?

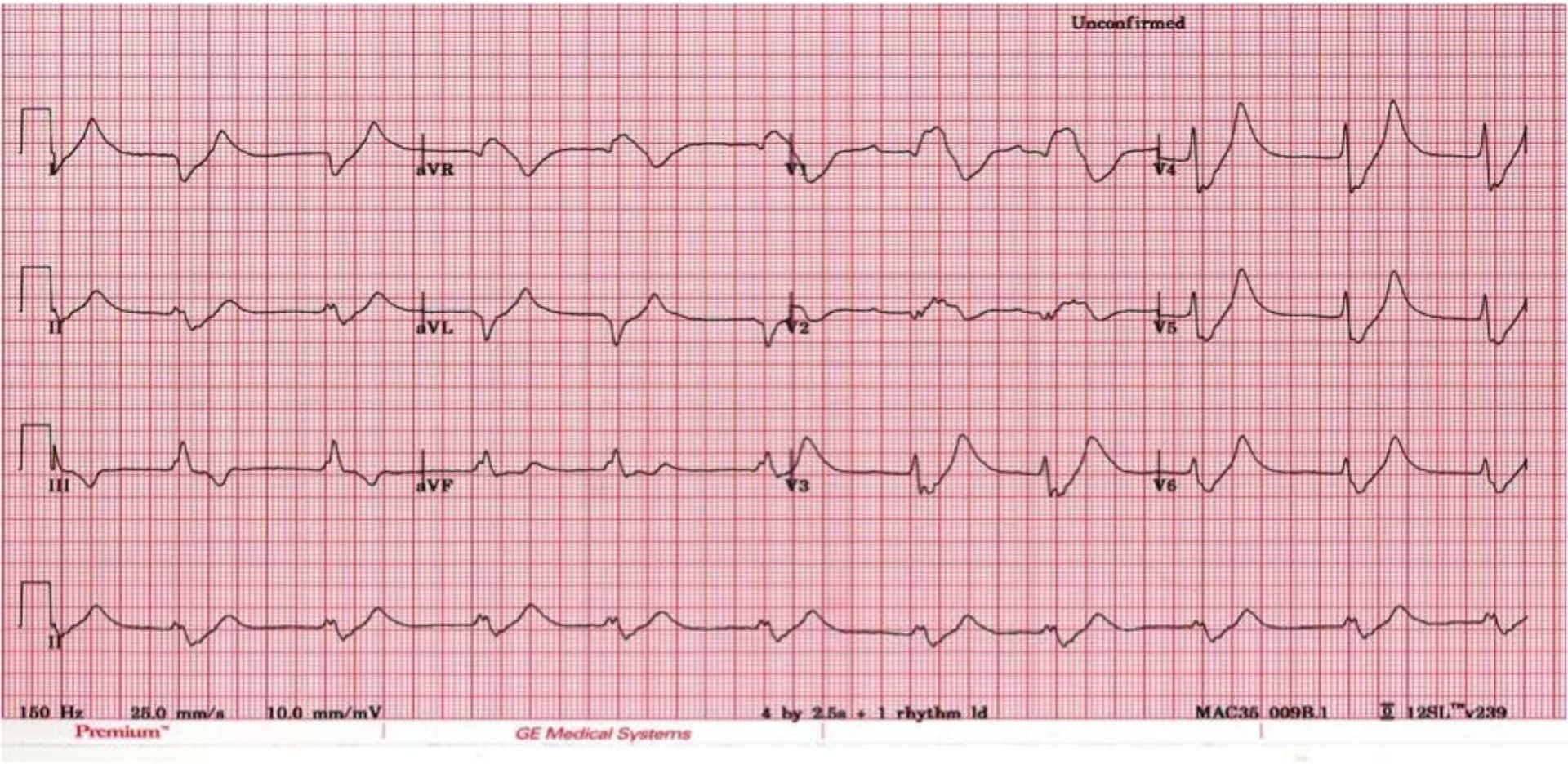
A 9.0 mmol/L

B 7.1 mmol/L

C 5.3 mmol/L

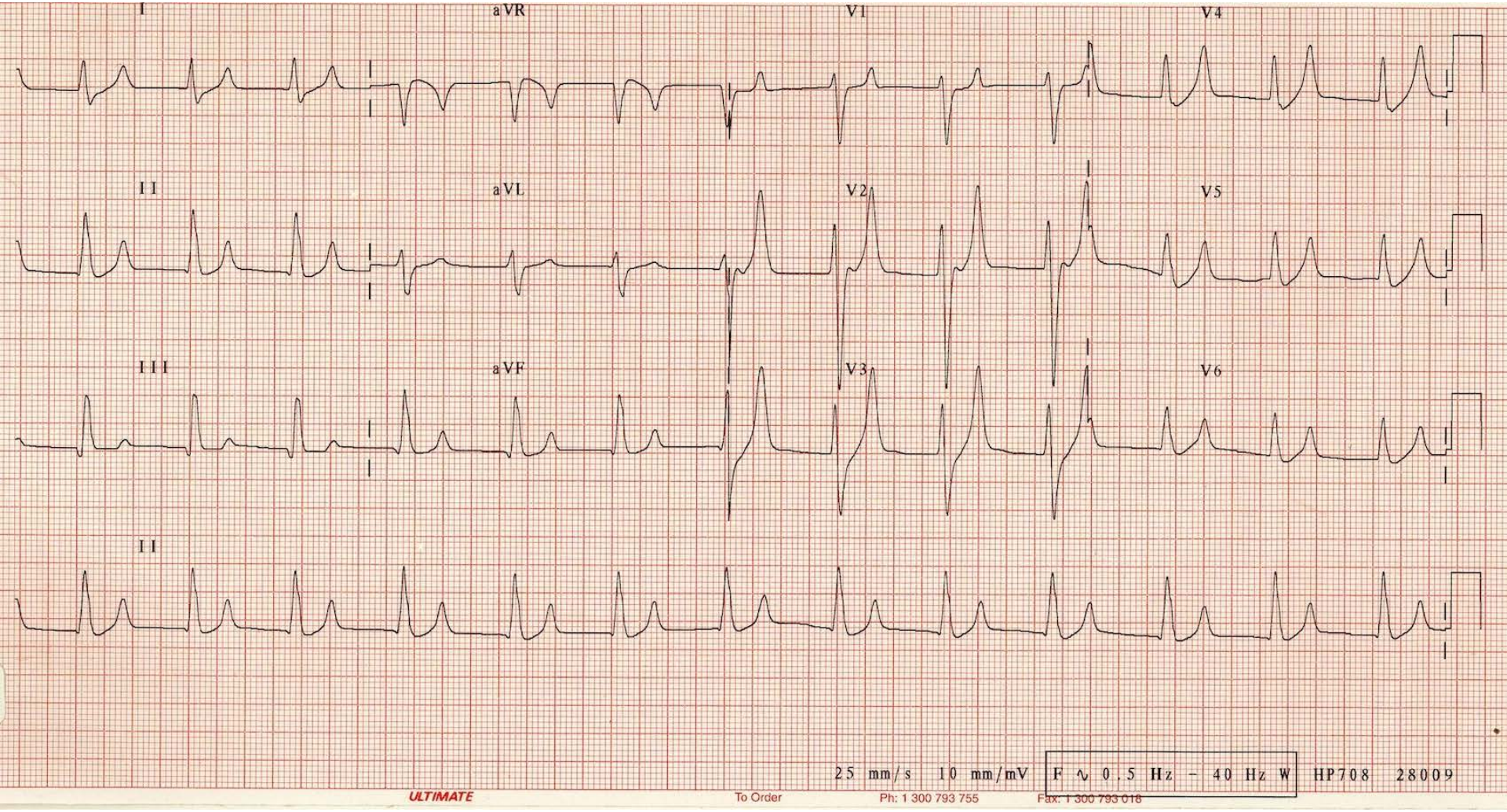
D **It depends**

K^+ 9.0 mmol/L



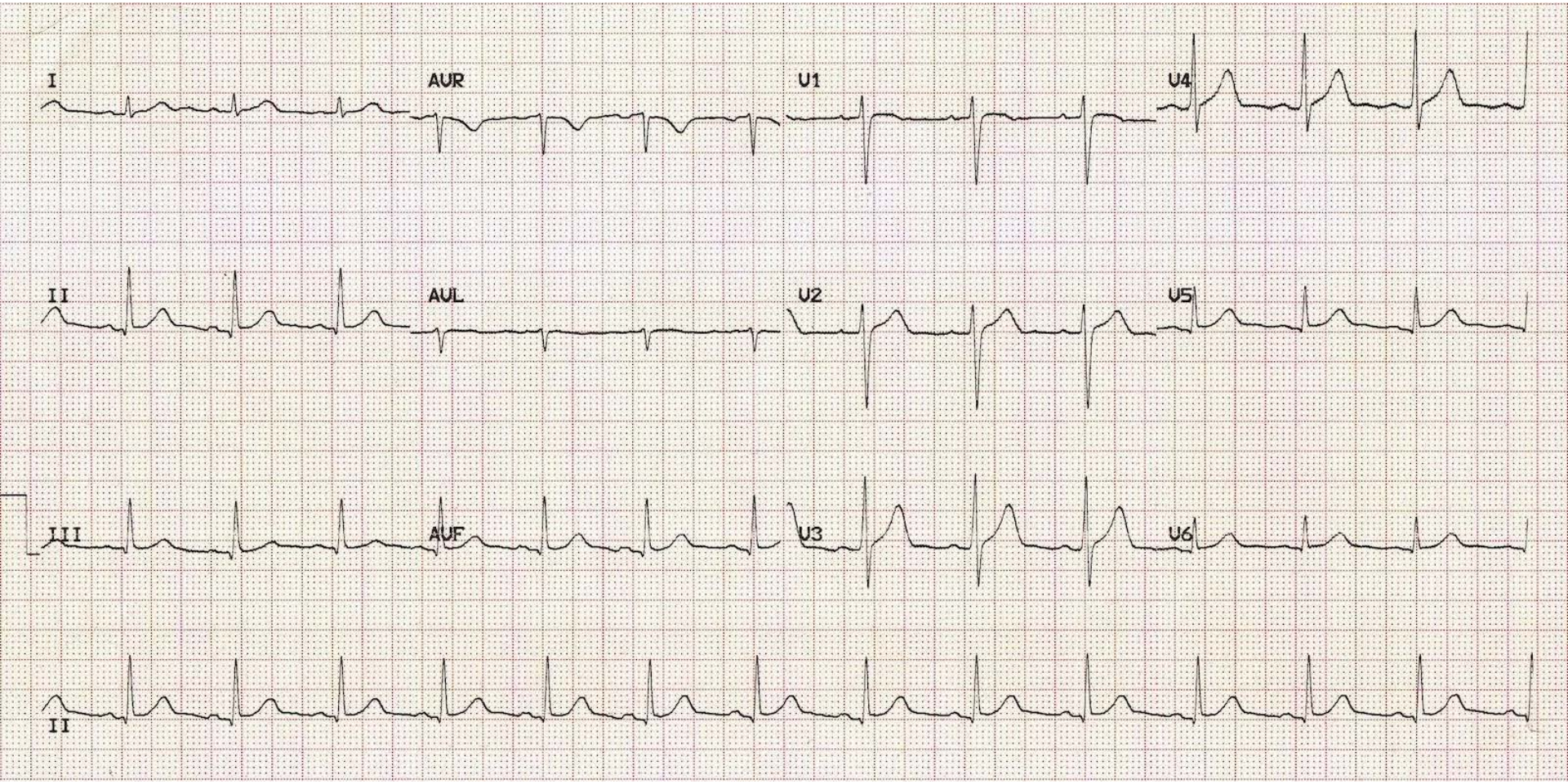
ECG courtesy of Life in the Fast Lane

K^+ 7.1 mmol/L



ECG courtesy of Life in the Fast Lane

K^+ 5.3 mmol/L



ECG courtesy of Life in the Fast Lane

≥ 2 gm

≥ 1 gm

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Which calcium salt works faster?

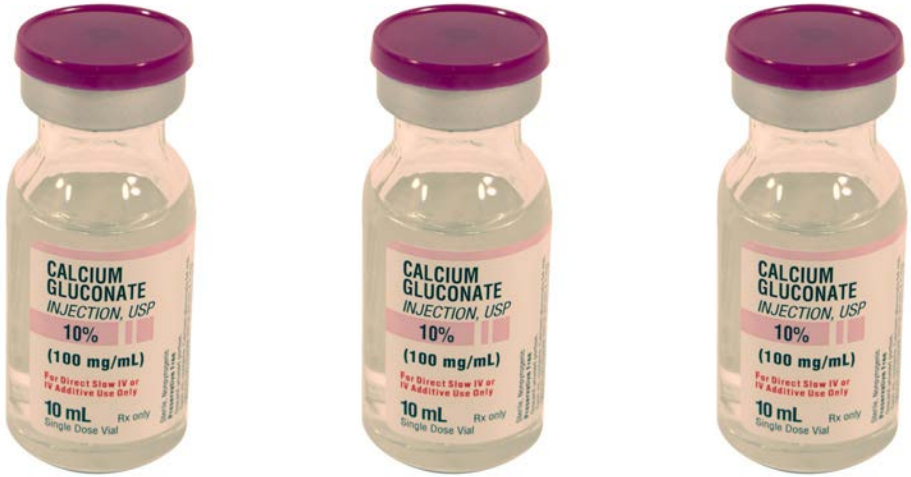
A Calcium chloride

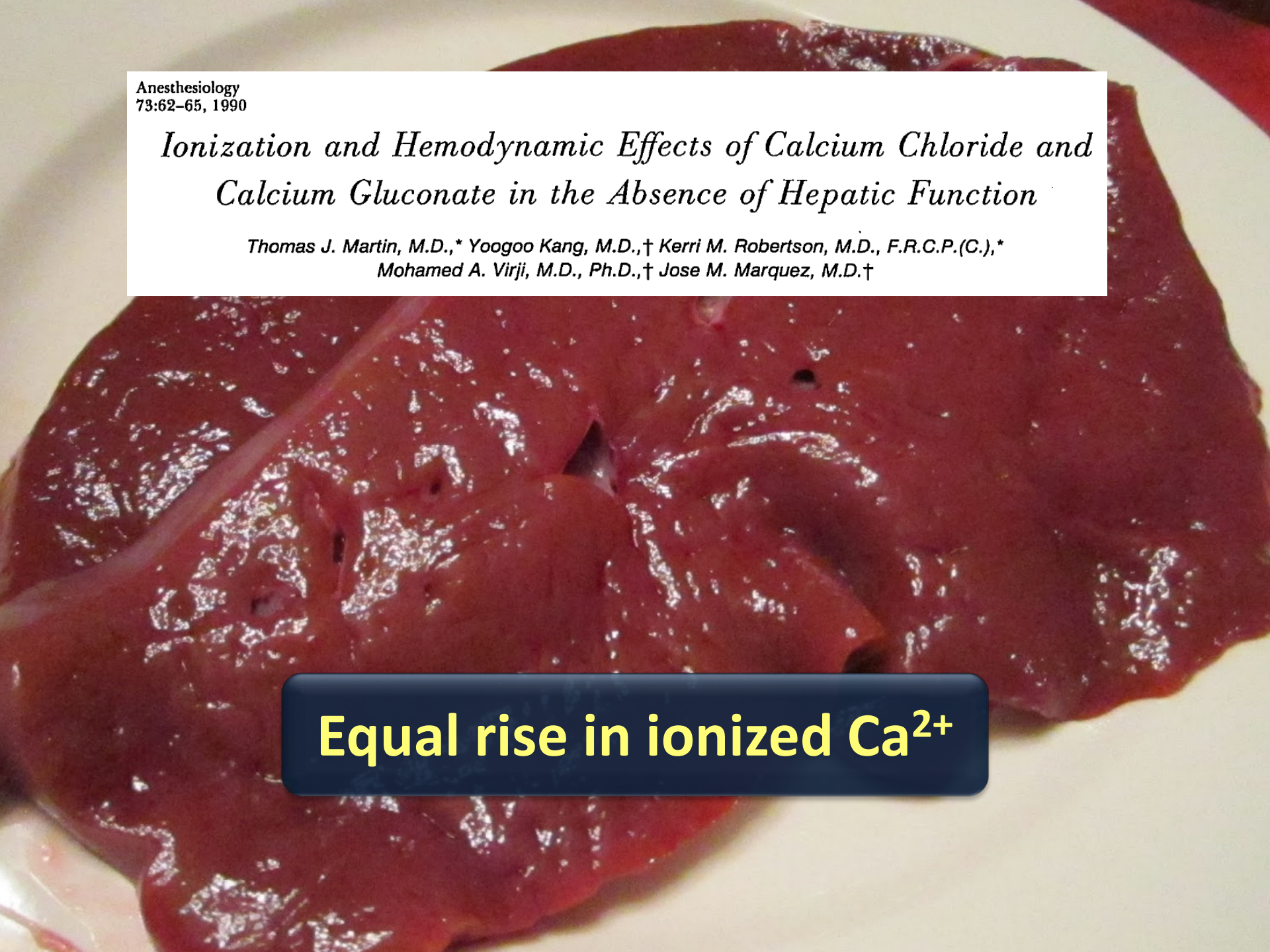
B Calcium gluconate


Onset: 3 min
Duration: 30 min


NDC 0517-2710-25
CALCIUM CHLORIDE
INJECTION, USP
10% (100 mg/mL)
(13.6 mEq Calcium/10 mL)
10 mL SINGLE DOSE VIAL
FOR IV USE ONLY
Rx Only
AMERICAN REGENT, INC.
SHIRLEY, NY 11967

=


CALCIUM GLUCONATE
INJECTION, USP
10%
(100 mg/mL)
10 mL
Rx only
Single Dose Vial



Anesthesiology
73:62–65, 1990

Ionization and Hemodynamic Effects of Calcium Chloride and Calcium Gluconate in the Absence of Hepatic Function

Thomas J. Martin, M.D., Yoogoo Kang, M.D.,† Kerri M. Robertson, M.D., F.R.C.P.(C.),**
Mohamed A. Virji, M.D., Ph.D.,† Jose M. Marquez, M.D.†

Equal rise in ionized Ca^{2+}

Anesthesiology
66:465–470, 1987

Calcium Chloride Versus *Calcium Gluconate: Comparison of Ionization and Cardiovascular Effects in Children and Dogs*

Charles J. Cote', M.D., Lambertus J. Drop, M.D.,† Alfred L. Daniels, M.S.,‡ David C. Hoaglin, Ph.D.§*

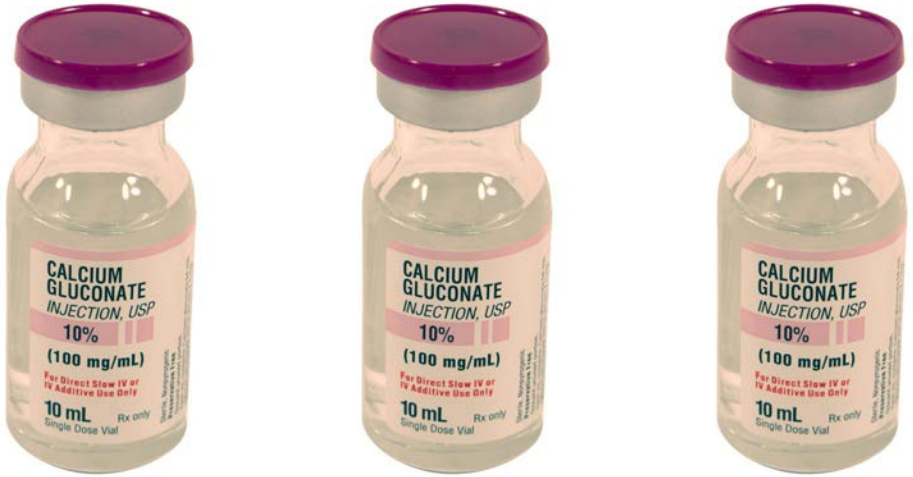
Equal rise in ionized Ca^{2+}

Equal rise in ionized Ca^{2+}

Heining MP, et al. *Anaesthesia* 1984;39(11):1079-82.

$CaCl_2$ NOT faster

=



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Which calcium salt works faster?

A Calcium chloride

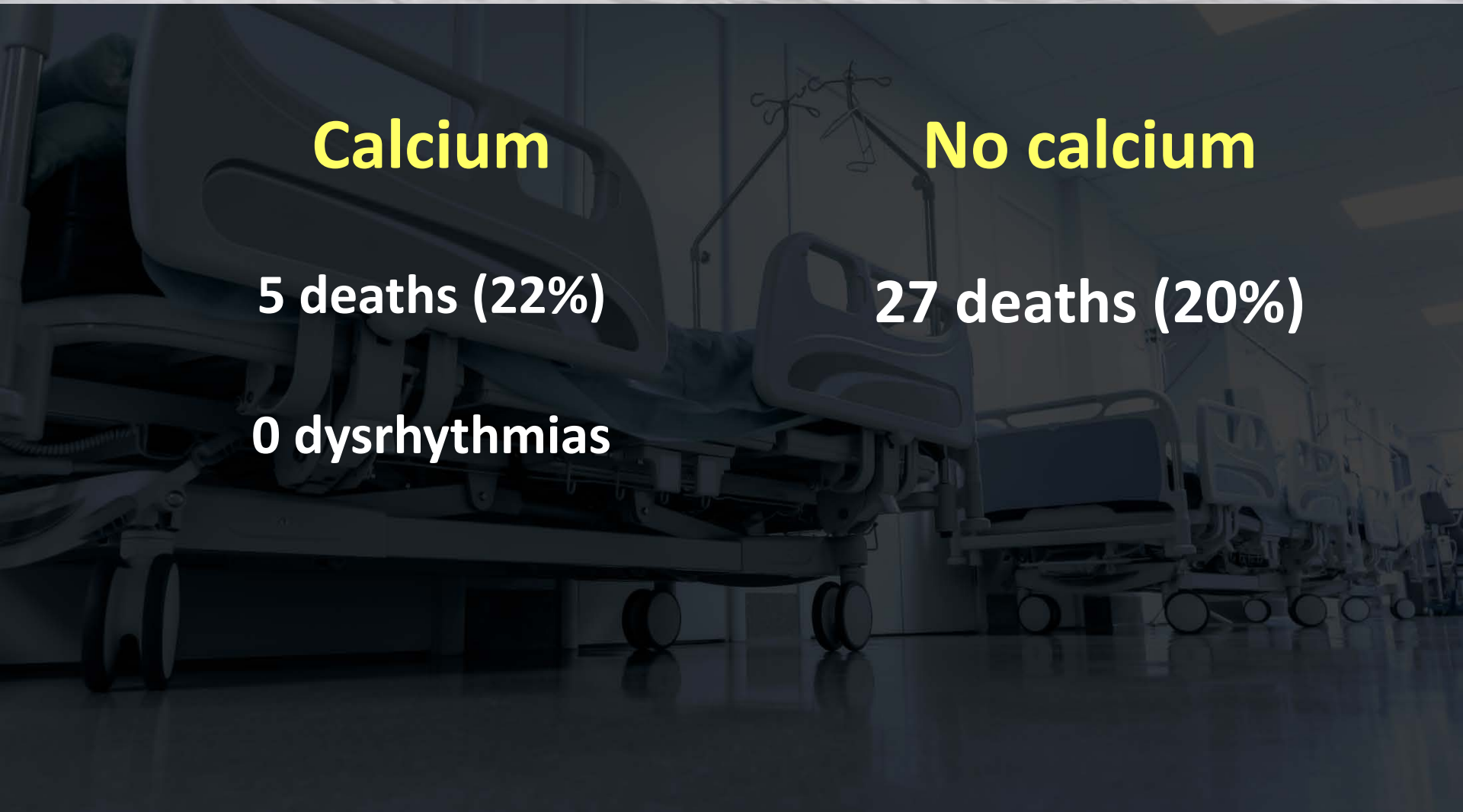
B **Calcium gluconate**


potassium
19
K
39.098
calcium
20
Ca
40.078


5 cases
Flawed animal models

The effects of IV calcium in patients with digoxin toxicity.

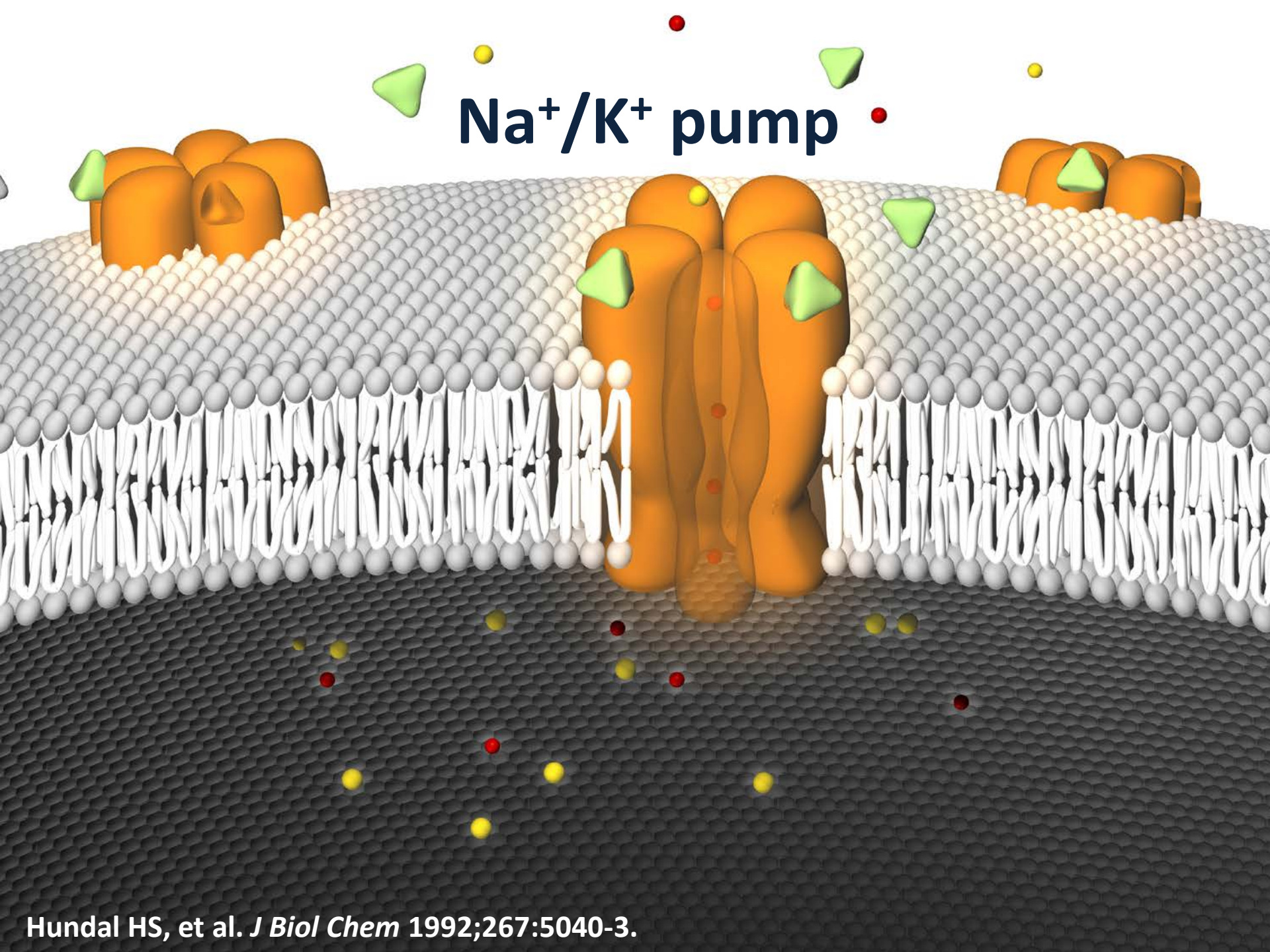
Levine M, et al. *J Emerg Med* 2011;40(1):41-6.



Calcium	No calcium
5 deaths (22%)	27 deaths (20%)
0 dysrhythmias	


NDC 59060-1833-2
Novolin® R
Novo Nordisk®
NDC 59060-1834-2
Novolin® N
Novo Nordisk®

Na^+/K^+ pump



Hundal HS, et al. *J Biol Chem* 1992;267:5040-3.

What is the most common insulin dose used for hyperkalemia?

A 5 units IV

B 10 units IV

C 20 units IV

D 20 units/hr IV

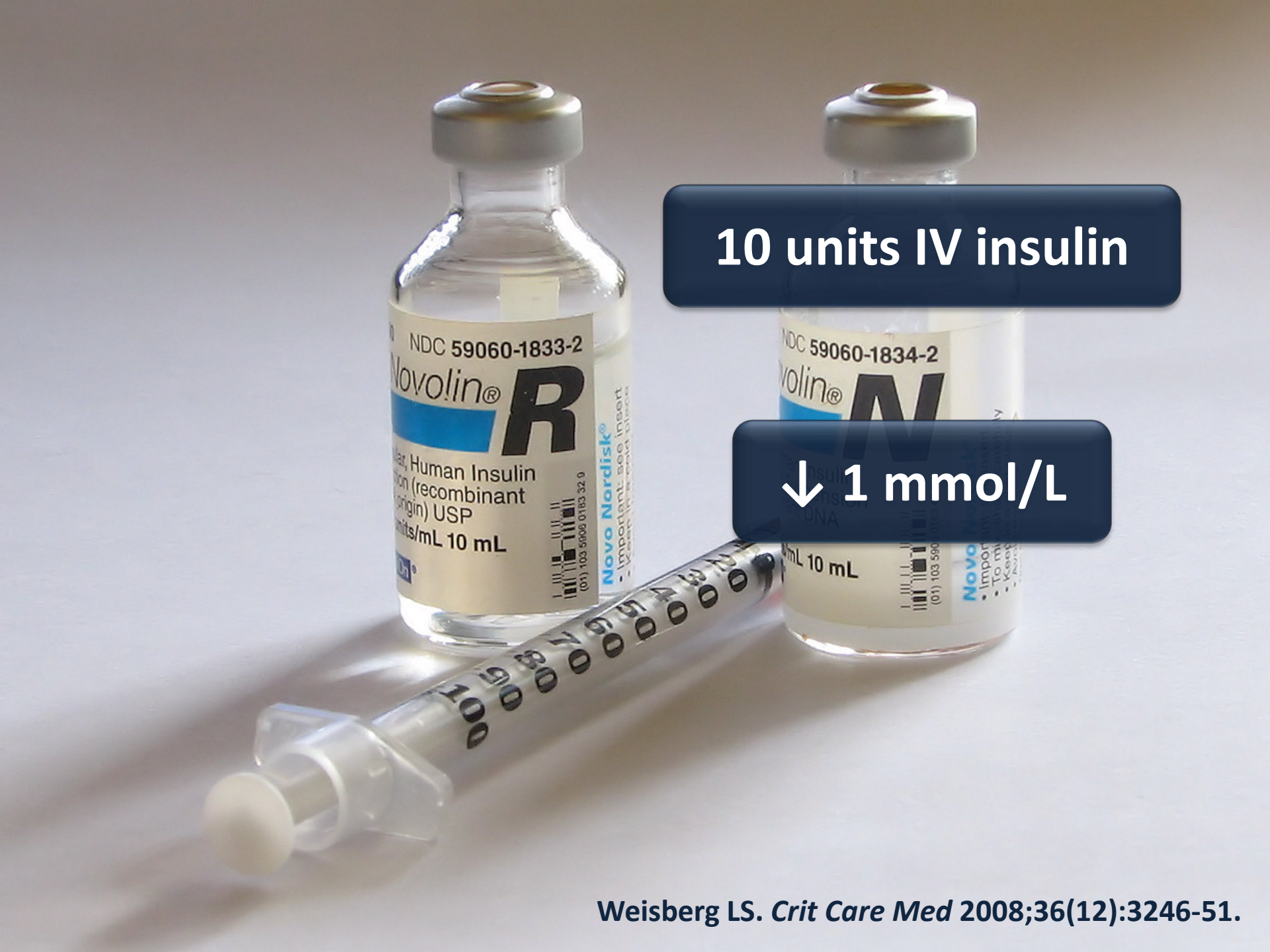
What is the most common insulin dose used for hyperkalemia?

A 5 units IV

B **10 units IV**

C 20 units IV

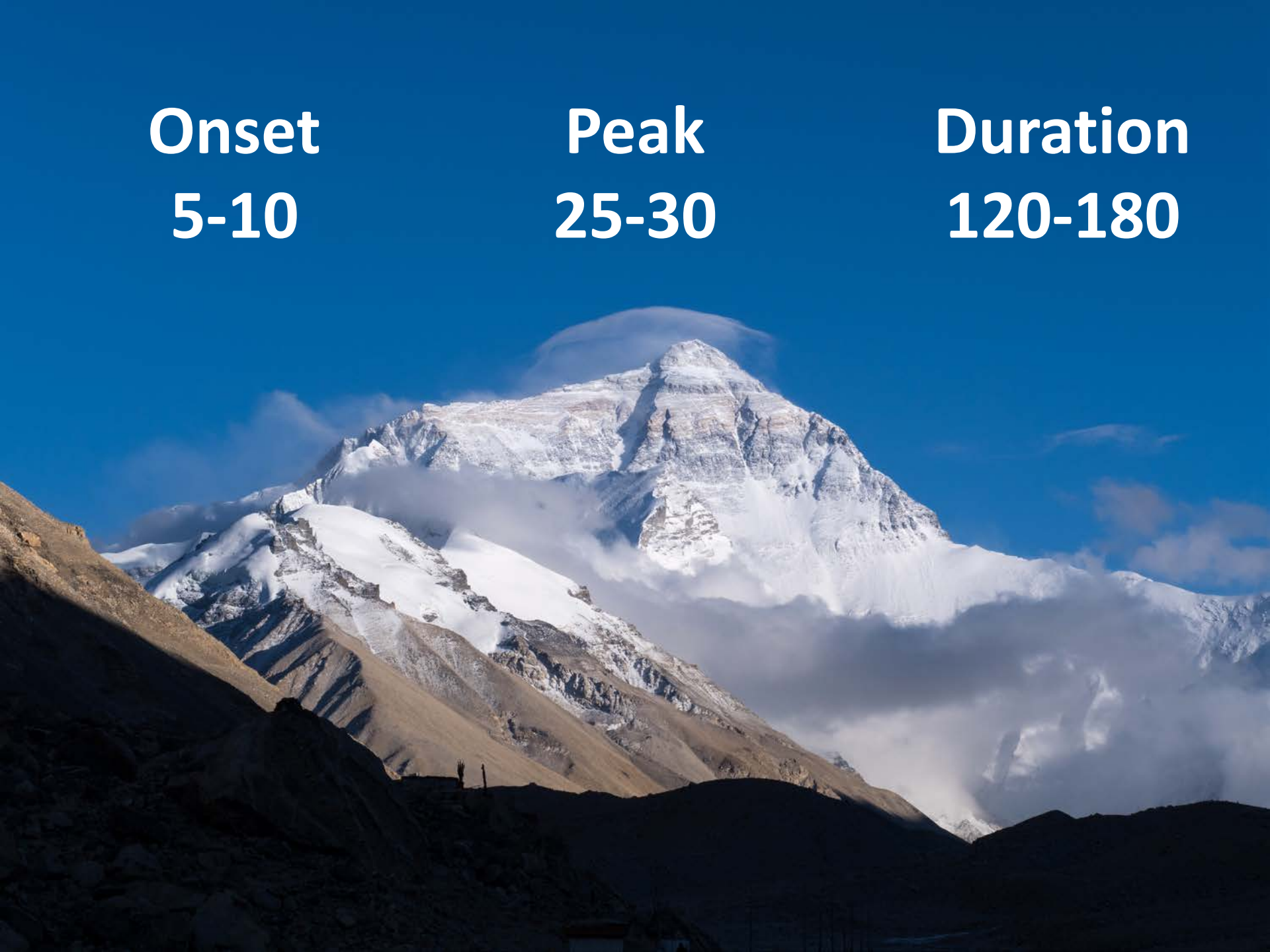
D 20 units/hr IV



Weisberg LS. *Crit Care Med* 2008;36(12):3246-51.

Schafers S, et al. *J Hosp Med* 2012;7(3):239-42.
Allon M, et al. *Kidney Int* 1990;38(5):869-72.

Onset	Peak	Duration
5-10	25-30	120-180



30-60 min

Dickerson RN, et al. *Nutrition* 2011;27:766-72.

Apel J, et al. *Clin Kidney J* 2014;0:1-3.

Initial [glucose]	Initial Dextrose Dose	Supplemental Dextrose **	Glucose Monitoring
> 200 mg/dL (> 11.1 mmol/L)	None	50 mL (25 gm) of D50 if blood glucose < 70 mg/dL	Hourly up to 3 hours
100-200 mg/dL (5.6-11.1 mmol/L)	50 mL (25 gm) of D50	50 mL (25 gm) of D50 if blood glucose < 70 mg/dL	Hourly up to 3 hours
< 100 mg/dL (< 5.6 mmol/L)	100 mL (50 gm) of D50* **OR** 50 mL (25 gm) of D50 + D10 infusion 250 mL/hr for first hour	50 mL (25 gm) of D50 if blood glucose < 70 mg/dL	q 30 minutes for first hour, then hourly up to 3 hours

D50 = dextrose 50%; D10 = dextrose 10%

Apel J, et al. *Clin Kidney J* 2014;7(3):248-50.

Summary

1. ECG changes? Give calcium
2. Calcium gluconate = $CaCl_2$
3. Dig toxicity? Give antidote (+ calcium)
4. Anticipate hypoglycemia

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Debates in the Management of Hyperkalemia: A Focus on Calcium and Insulin

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Debates in the Management of Hyperkalemia: Sodium "Redux" and Novel Therapies

Nadia I. Awad, PharmD, BCPS

Emergency Medicine Pharmacist

Robert Wood Johnson University Hospital

@Nadia_EMPharmD

Sodium bicarbonate is frequently administered to hyperkalemic patients in my institution.

A Yes

B No

Preferred Therapy of Hyperkalemia in Renal Insufficiency: Survey of Nephrology Training-Program Directors

N Engl J Med 1989; 320:60-61.

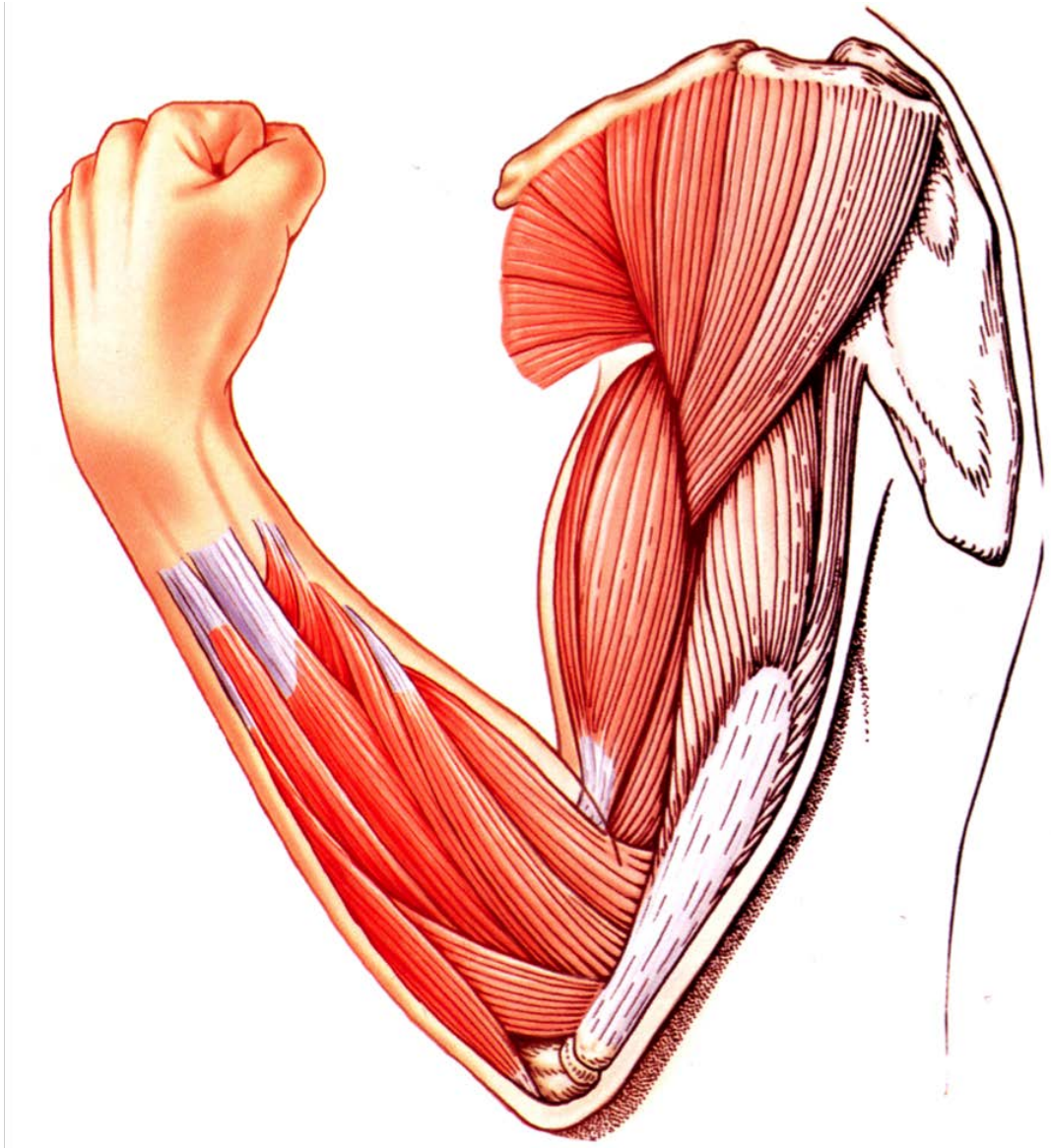
Sodium bicarbonate works in hyperkalemia because it:

A. Enhances K^+ excretion

B. Shifts K^+ to the intracellular space

C. Decreases H^+ in the extracellular fluid

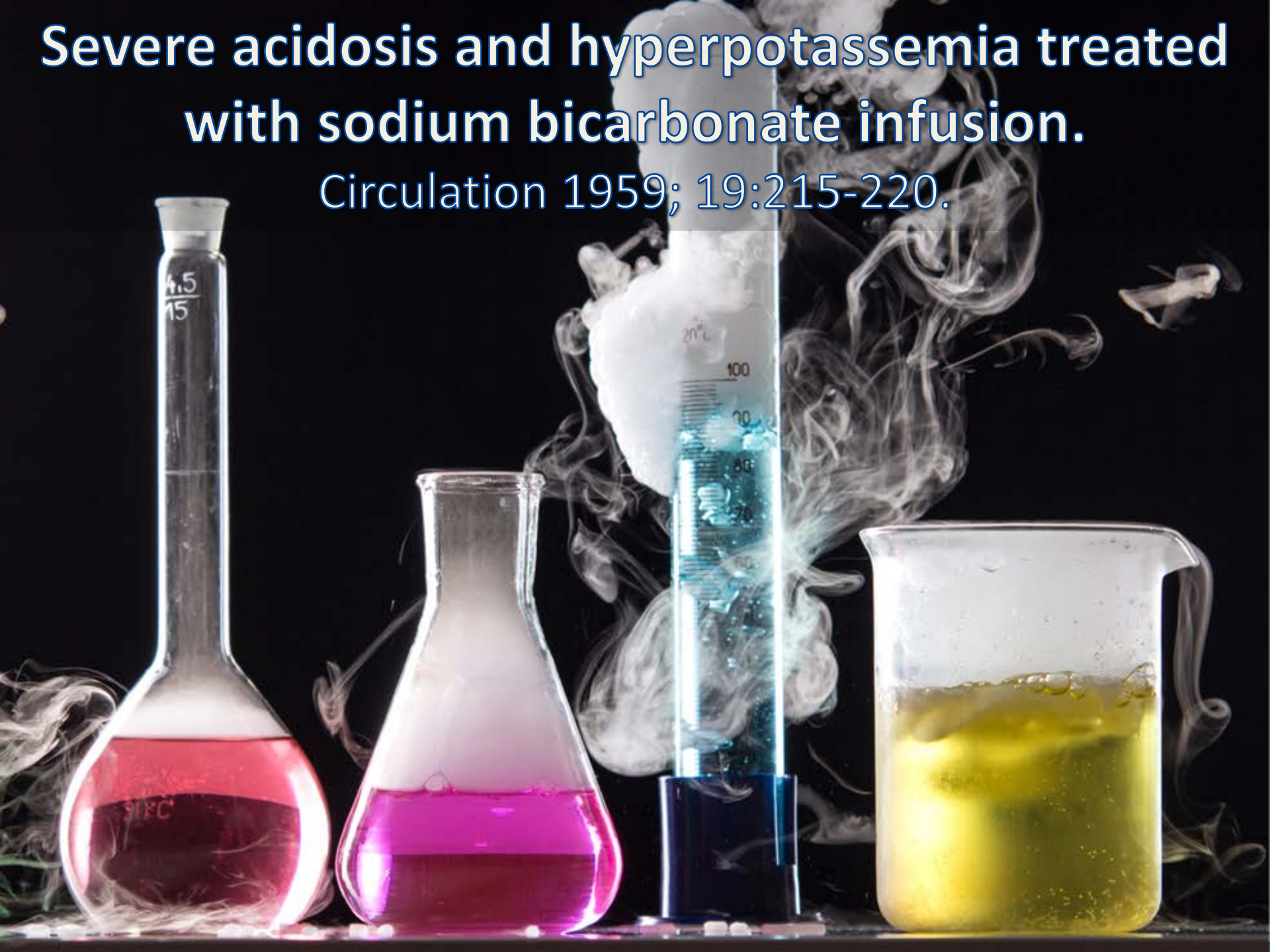
D. Works some other way that I learned about but cannot recall right now



Clin J Am Soc Nephrol 2015; 10:1050-1060.

Severe acidosis and hyperpotassemia treated with sodium bicarbonate infusion.

Circulation 1959; 19:215-220.



Am J Med 1988; 85:507-512.
Nephron 1996; 72:476-482.
Am J Kidney Dis 1996; 28:508-514.
Korean Med Sci 1997; 12:111-116.

Miner Electrolyte Metab 1991; 17:297-302.
Kidney Int 1992; 41:369-374.

J Am Med Assoc 1954; 155:877-883.
Am J Kidney Dis 1996; 28:508-513.
East Afr Med J 1997; 74:503-509.

“Given this uncertainty we still use sodium bicarbonate to treat acute hyperkalemia in patient with a significant degree of acidosis, but not as the only emergency therapy.”

Nephrol Dial Transplant 2003; 18:2215-2218.

“We suggest that intravenous sodium bicarbonate infusion is not used routinely for the acute treatment of hyperkalemia.”

Hyperkalemia Guidelines, UK Renal Association 2014.

Management of severe hyperkalemia

Lawrence S. Weisberg, MD

Crit Care Med 2008; 36:3246-3251.

Citations: **130** (as of October 2016)

Am Heart J 1962; 64:483-488.

Am J Med 1953; 14:504.

Acad Emerg Med 1997; 4:93-99.

Acad Emerg Med 2000; 7:965-973.

Code Name: Nav1.5

Depolarization

Cellular perfusion

Afterload

Dilution

Am J Physiol 1975; 229:935-940.
Acad Emerg Med 2000; 7:965-973.
Kidney Int 2016; 90:450-451.

The dose of sodium polystyrene sulfonate routinely given for hyperkalemia within my institution is:

A 0 g

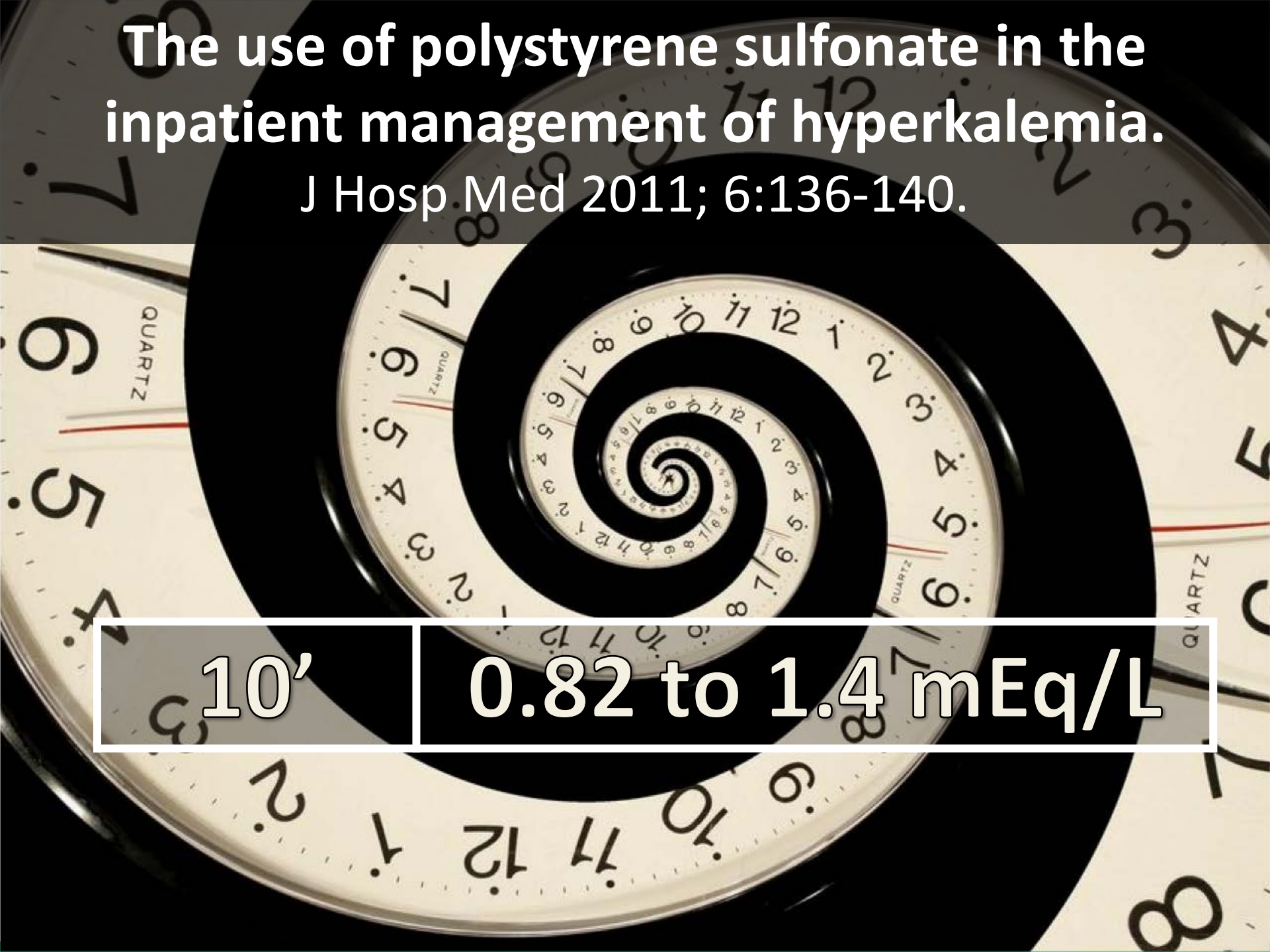
B 15 g

C 30 g

D 60 g

The use of polystyrene sulfonate in the inpatient management of hyperkalemia.

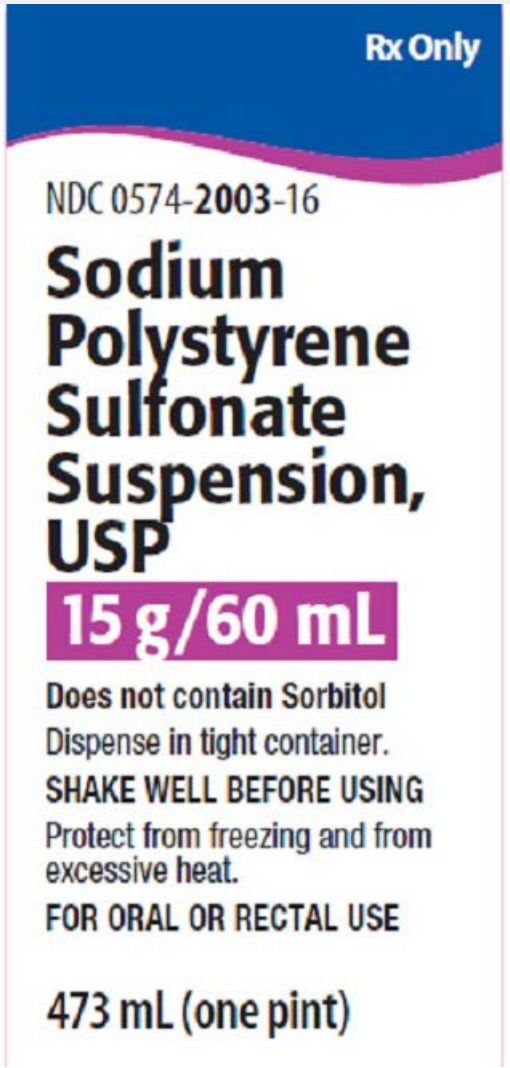
J Hosp Med 2011; 6:136-140.



10’	0.82 to 1.4 mEq/L

1958

1962

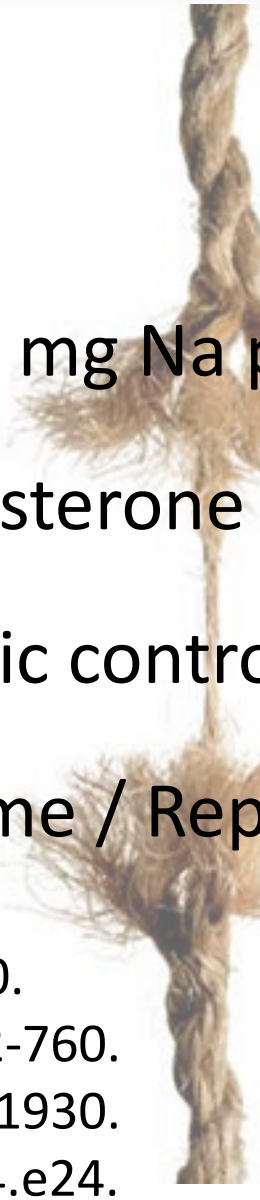


J Am Soc Nephrol 2010; 21:733-735.

Lancet 1953; 265:791-795.

Gastroenterology 1994; 107:548-571.

N Engl J Med 1961; 264:111-115. (n = 1)
N Engl J Med 1961; 264:115-119. (n = 32)



100 mg Na per g SPS

Aldosterone and ESRD

2009: Cathartic controversy: 33% / 70%?

Time / Replication

Am J Kidney Dis 1988; 8:105-110.
Gastroenterology 1995; 108:752-760.
J Am Soc Nephrol 1998; 9:1924-1930.
Am J Med 2013; 126:264.e9-264.e24.
J Am Soc Nephrol 2010; 21:733-735.

“In summary, we do not use resins for treatment of acute hyperkalemia. In the setting of chronic hyperkalemia, it seems that the addition of resins to cathartics adds little to the induction of diarrhea alone.”

Nephrol Dial Transplant 2003; 18:2215-2218.

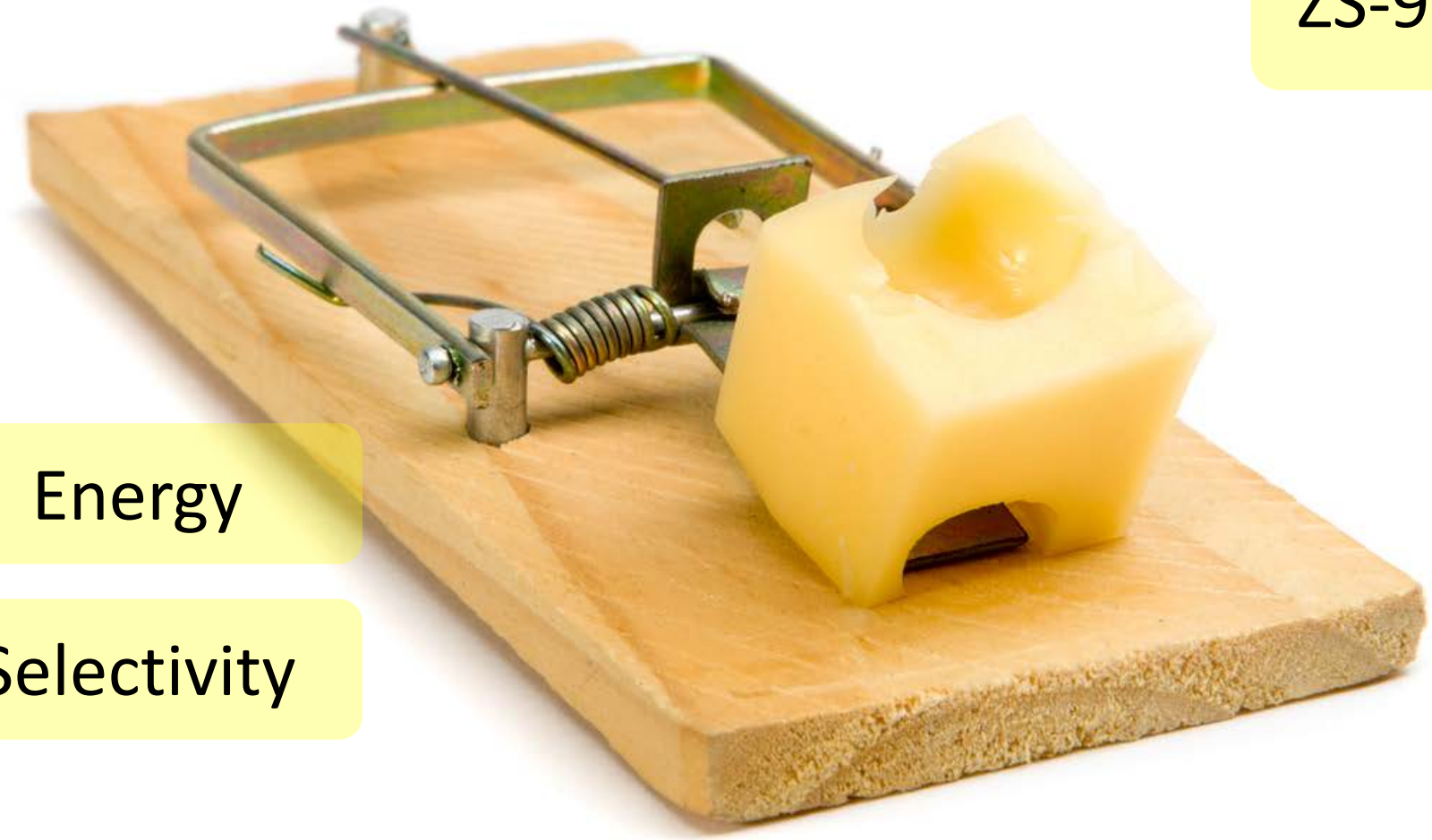
I believe the novel therapies for hyperkalemia (patiromer and sodium zirconium cyclosilicate) may have a role in treating hyperkalemia.

A Yes

B No

Eur Heart J 2011; 32:820-828.
N Engl J Med 2015; 372:211-221.
J Am Med Assoc 2015; 314:151-161.

ZS-9



Energy

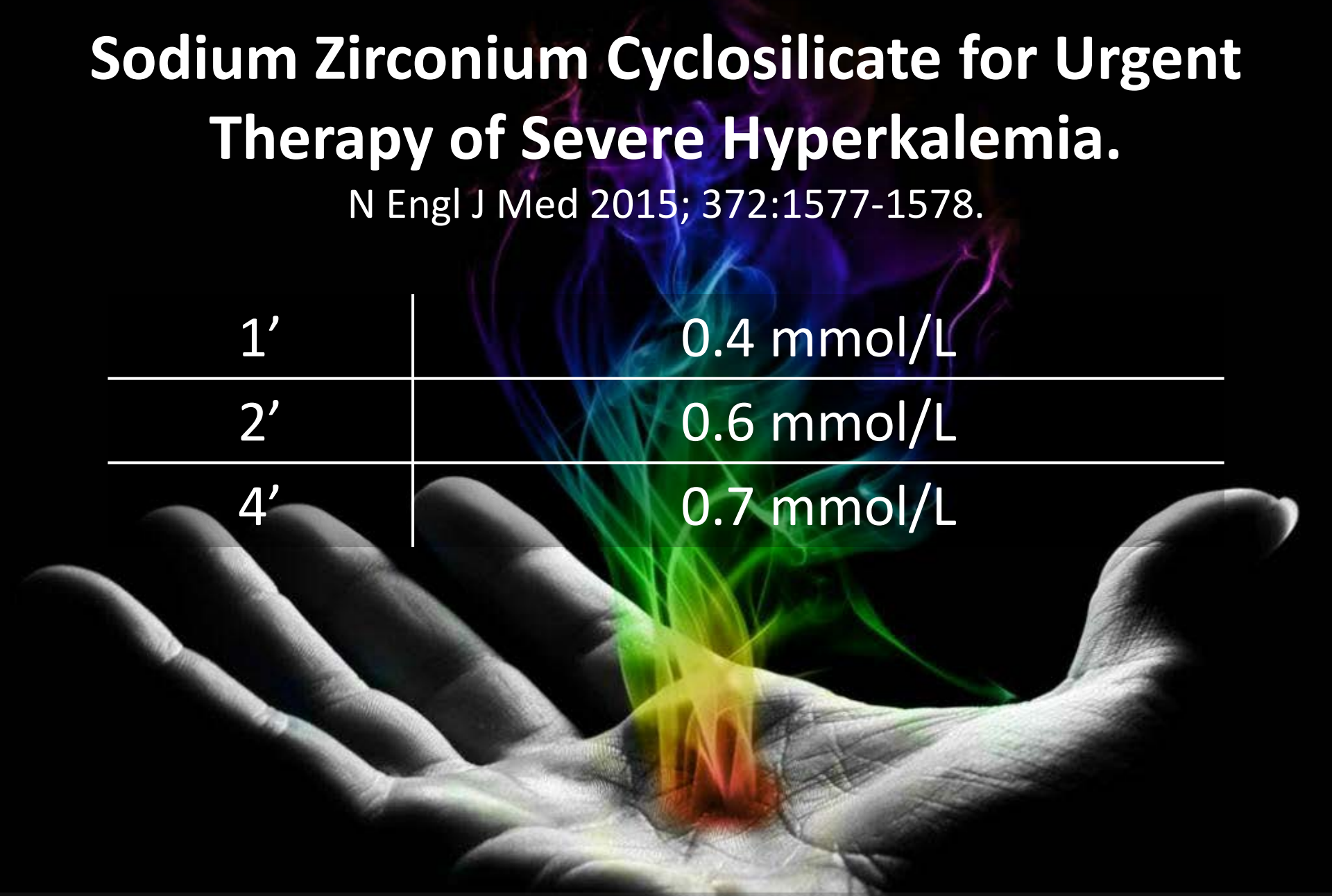
Selectivity

PLoS One 2014; 9:e114686.
Kidney Int 2015; 88:404-411.
N Engl J Med 2015; 372:222-231.

Sodium Zirconium Cyclosilicate for Urgent Therapy of Severe Hyperkalemia.

N Engl J Med 2015; 372:1577-1578.

1’	0.4 mmol/L
2’	0.6 mmol/L
4’	0.7 mmol/L



Serum K 6.1 to 7.2 mmol/L + 10g ZS-9

Kidney Int 2015; 88:404-411.
N Engl J Med 2015; 372:222-231.
Hypertension 2015; 66:731-738.
Pharmacotherapy 2016; 36:922-923.

SUMMARY

1. Sodium bicarbonate: More than meets the eye for acute hyperkalemia.
2. Think twice about sodium polystyrene sulfonate.
3. Patiromer = Chronic.
4. Sodium zirconium cyclosilicate: Don’t jump on the bandwagon.

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