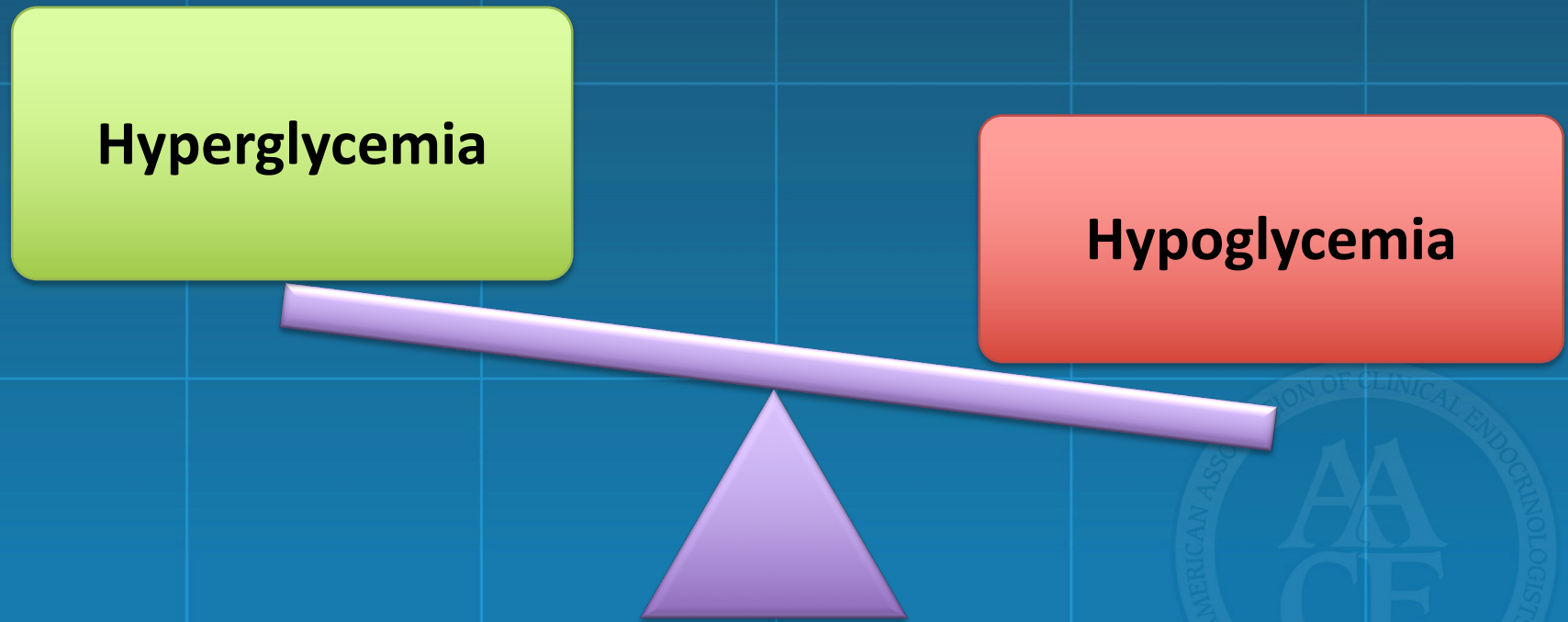


Avoiding Hypoglycemia in the Hospital Setting



Striking the Right Balance



Patient-Specific Factors Increasing Risk of Hypoglycemia in the Inpatient Setting

- Advanced age
- Decreased oral intake
- Chronic renal failure
- Liver disease
- Beta-blockers



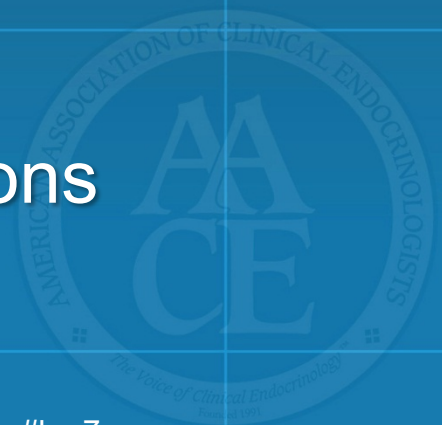
Provider-Specific Factors Increasing Risk of Hypoglycemia in the Inpatient Setting

- Lack of coordination between dietary and nursing departments leads to mistiming of insulin dosage with respect to food
- Inadequate glucose monitoring
- Inadequate insulin dose adjustment
- Lack of coordination between transportation and nursing
- Unsafe work environment
- Indecipherable orders



Factors Increasing Risk of Medication Errors With Insulin

- Use of “sliding scale” insulin in the absence of regularly scheduled insulin
- Use of “U” for units being misread as a number
- BG testing reporting and transcription errors
- Similar names of products, manufacturer’s labeling
- Accessibility as floor stock
- Nonstandard compounded IV solutions and infusion rates



Triggering Events for Hypoglycemia

- Transportation off ward causing meal delay
- New NPO status
- Interruption of any of the following:
 - Intravenous dextrose
 - TPN
 - Enteral feedings
 - Continuous renal replacement therapy



Deleterious Impact of Hypoglycemia

- Sympathoadrenal response
- Cardiac dysrhythmias
- Neuroglycopenia
 - Altered sensorium and vision
 - Falls
 - Aspiration
- Pro-inflammatory state?
- Pro-coagulant state?
- Endothelial dysfunction?



Seaquist ER, et al. *Diabetes Care*. 2013;36:1384-1395; Cryer PE. *N Engl J Med*. 2013;369:362-372; Goto A, et al. *BMJ*. 2013;347:f4533; Rubin DJ, Golden SH. *Hosp Pract*. 2013;41:109-116; Hanefeld M, et al. *Cardiovasc Diabetol*. 2013;12:135.

The Hidden Costs of Inpatient Hypoglycemia

- Prolonged length of stay
- Medical-legal implications
- Centers for Medicare and Medicaid Services (CMS) “never events”



Centers for Medicare and Medicaid Services “Never Events”

- Medicare does not pay the extra cost of conditions resulting from medical errors or poor quality of care during hospital stays
- “Certain manifestations of poor glycemic control” are among the designated Never Events
 - Hypoglycemia is included in Never Events related to patient safety

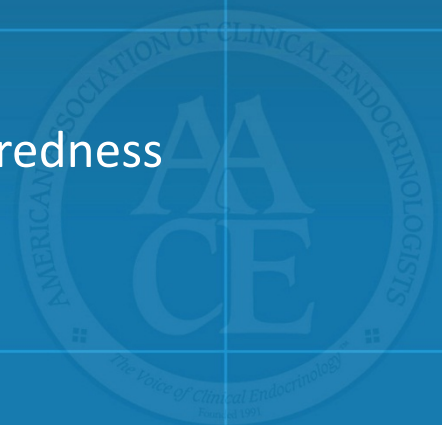
Table A
Patient Safety: CMS Initiatives Addressing Never Events

Current NQF Serious Reportable Adverse Events	HHS/CMS Value Driven Health Care Efforts
Care Management Events	
Death/disability associated with medication error	
Death/disability associated with incompatible blood	Hospital-Acquired Condition
Maternal death/disability with low risk delivery	
Death/disability associated with hypoglycemia	Hospital-Acquired Condition
Death/disability associated with hyperbilirubinemia in neonates	
Stage 3 or 4 pressure ulcers after admission	Hospital-Acquired Condition
Death/disability due to spinal manipulative therapy	

Link Between Safety and Quality of Care: Institute of Medicine (IOM) Report, 2001

- Significant gap between the quality of health care people should receive and the quality they do receive
- *Quality* is a system property
 - Lacking in current US system of healthcare delivery
 - Redesign of healthcare delivery is needed
- To truly achieve quality care, healthcare systems must focus on 6 key elements:
 - Efficiency
 - Effectiveness
 - Safety
 - Timeliness
 - Patient-centeredness
 - Equity

IOM. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press; 2001.



Hypoglycemia Rates in Intensive IV Insulin Protocols

Protocol	Hypoglycemia Definition	Percent of Patients
Leuven SICU ¹	<40 mg/dL	5.1%
Leuven MICU ²	<40 mg/dL	19%
Glucontrol ³	<40 mg/dL	8.6%
WISEP ⁴	<40 mg/dL	17.4%
NICE SUGAR ⁵	<40 mg/dL	6.5%

1. Van Den Berghe G, et al. *N Engl J Med.* 2001;345:1359.
2. Van Den Berghe G, et al. *N Engl J Med.* 2006;354:449-461.
3. Brunkhorst FM et al. *N Engl J Med.* 2008; 358:125-139.
4. Preiser JC, SCCM, 2007.
5. Finfer S, et al. *N Engl J Med.* 2009;360(13):1283-1297.

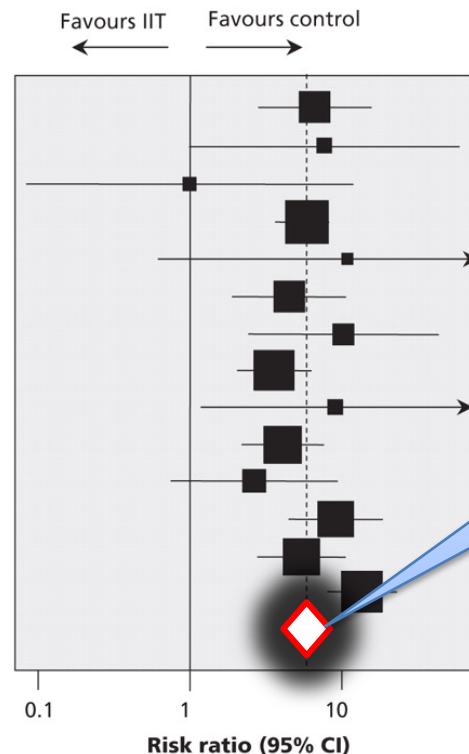


Potential Harm From Insulin Therapy

- The Joint Commission considers insulin to be 1 of the 5 highest-risk medicines in the inpatient setting
 - Consequences of errors with insulin therapy can be catastrophic
- In 2008, insulin accounted for 16.2% of harmful medication errors, more than any other product, in an analysis of the USP MEDMARX reporting program data
- In 2008-2009, 2685 insulin medication error event reports were submitted to the Pennsylvania Patient Safety Authority
 - 78.7% (n=2113) involved a patient (NCC MERP harm index = C to I); 1.8% (n=49) resulted in patient harm (harm index = E to I)
 - Medical surgical units accounted for 22.3% (n=599) of events; pharmacy for 8.7% (n=234), and telemetry for 7.1% (n=191)
 - Drug omission constituted the largest proportion of errors (24.7%, n=662), followed by wrong drug reports (13.9%, n=374), and wrong dose/overdosage (13%, n=348)

Severe Hypoglycemia Is More Likely With Intensive Insulin Therapy Than Conventional Glycemic Control: A Meta-analysis

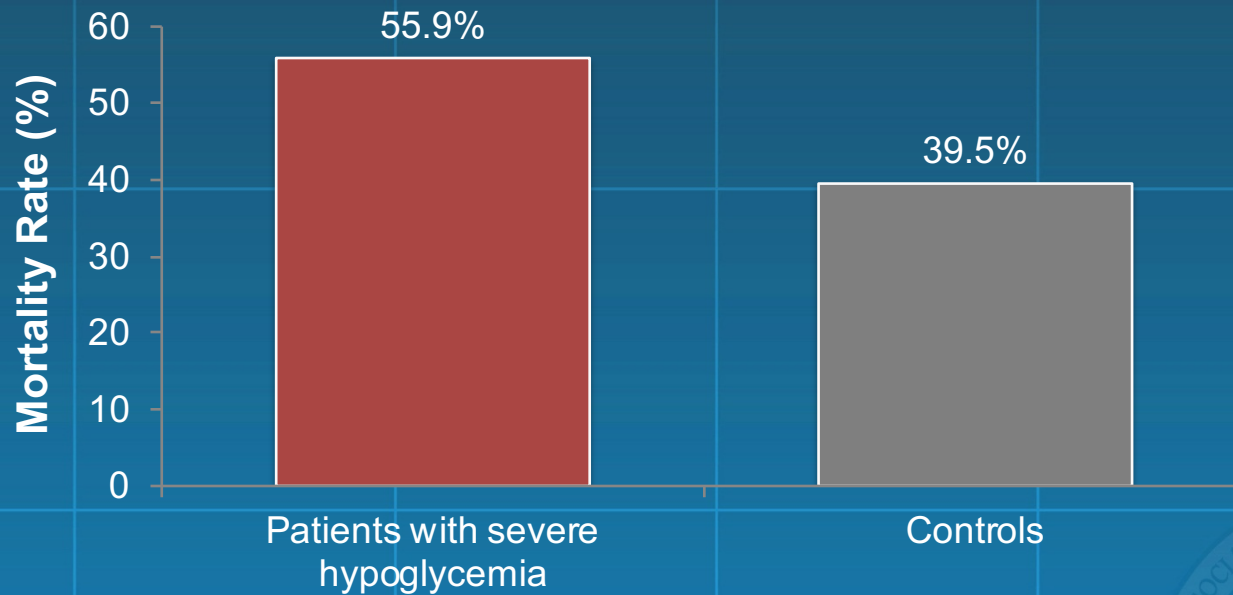
Study	No. events / total no. patients		Risk ratio (95% CI)
	IIT	Control	
Van den Berghe et al. ⁸	39/765	6/783	6.65 (2.83–15.62)
Henderson et al. ³¹	7/32	1/35	7.66 (1.00–58.86)
Bland et al. ²⁵	1/5	1/5	1.00 (0.08–11.93)
Van den Berghe et al. ⁹	111/595	19/605	5.94 (3.70–9.54)
Mitchell et al. ³⁵	5/35	0/35	11.00 (0.63–191.69)
Azevedo et al. ²²	27/168	6/169	4.53 (1.92–10.68)
De La Rosa Gdel et al. ¹²	21/254	2/250	10.33 (2.45–43.61)
Devos et al. ¹³	54/550	15/551	3.61 (2.06–6.31)
Oksanen et al. ³⁶	7/39	1/51	9.15 (1.17–71.35)
Brunkhorst et al. ¹¹	42/247	12/290	4.11 (2.21–7.63)
lapichino et al. ³²	8/45	3/45	2.67 (0.76–9.41)
Arabi et al. ¹⁰	76/266	8/257	9.18 (4.52–18.63)
Mackenzie et al. ³³	50/121	9/119	5.46 (2.82–10.60)
NICE-SUGAR ¹⁸	206/3016	15/3014	13.72 (8.15–23.12)
<i>Overall</i>	654/6138	98/6209	5.99 (4.47–8.03)



Overall severe hypoglycemia
RR 5.99
(4.47-8.03)

Hypoglycemia and Hospital Mortality

Case Control Study



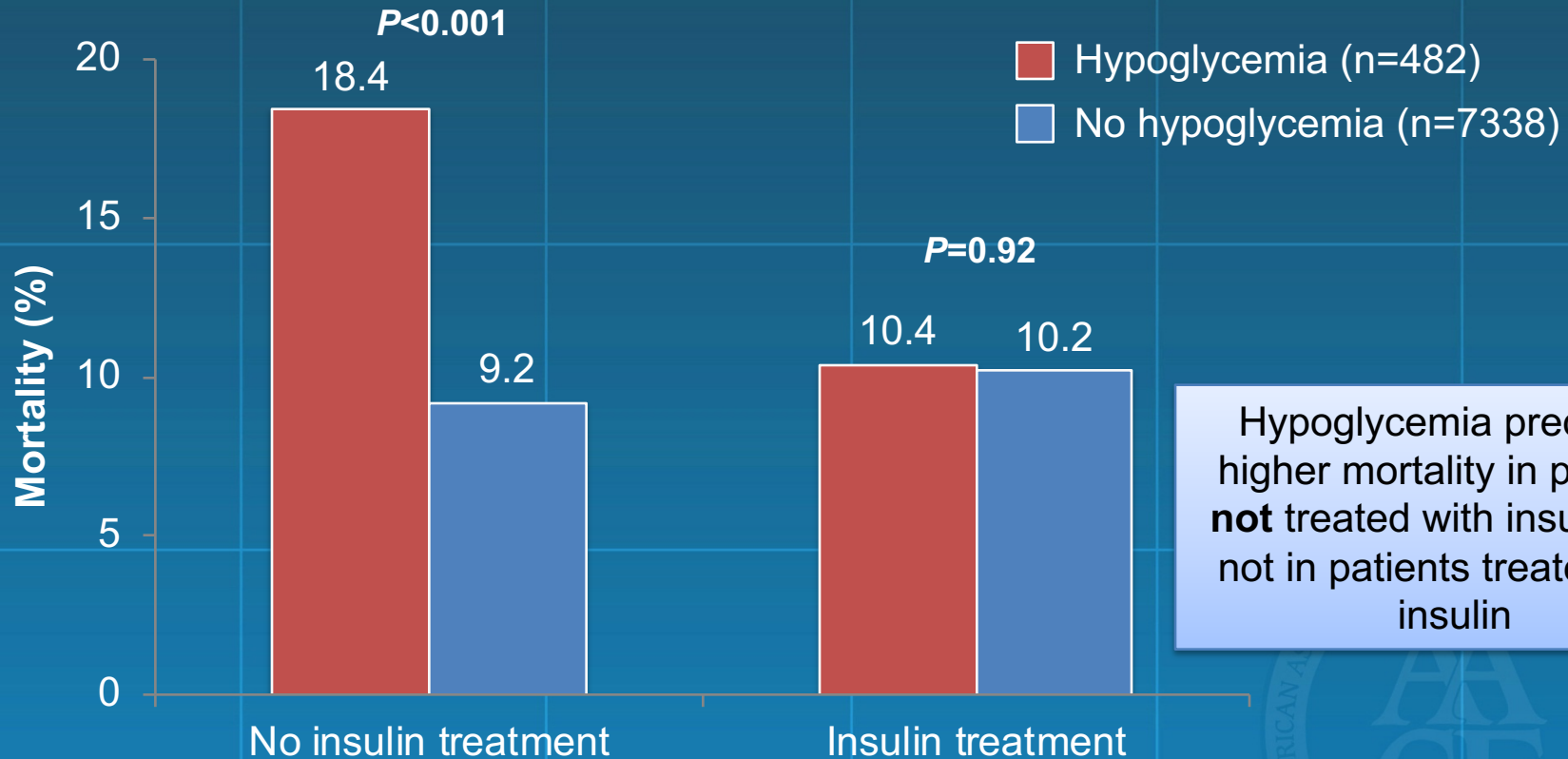
Severe hypoglycemia (<40 mg/dL) doubled the risk of mortality
(OR 2.28; 95% CI, 1.41-3.70; $P=0.0008$)

CI, confidence interval; OR, odds ratio.

Krinsley JS, Grover A. *Crit Care Med.* 2007;35:2262-2267.

AACE Inpatient Glycemic Control Resource Center

Hypoglycemia and Mortality in AMI Patients Receiving vs Not Receiving Insulin



Hypoglycemia predicted higher mortality in patients **not** treated with insulin, but not in patients treated with insulin

Hypoglycemia defined as blood glucose <60 mg/dL.

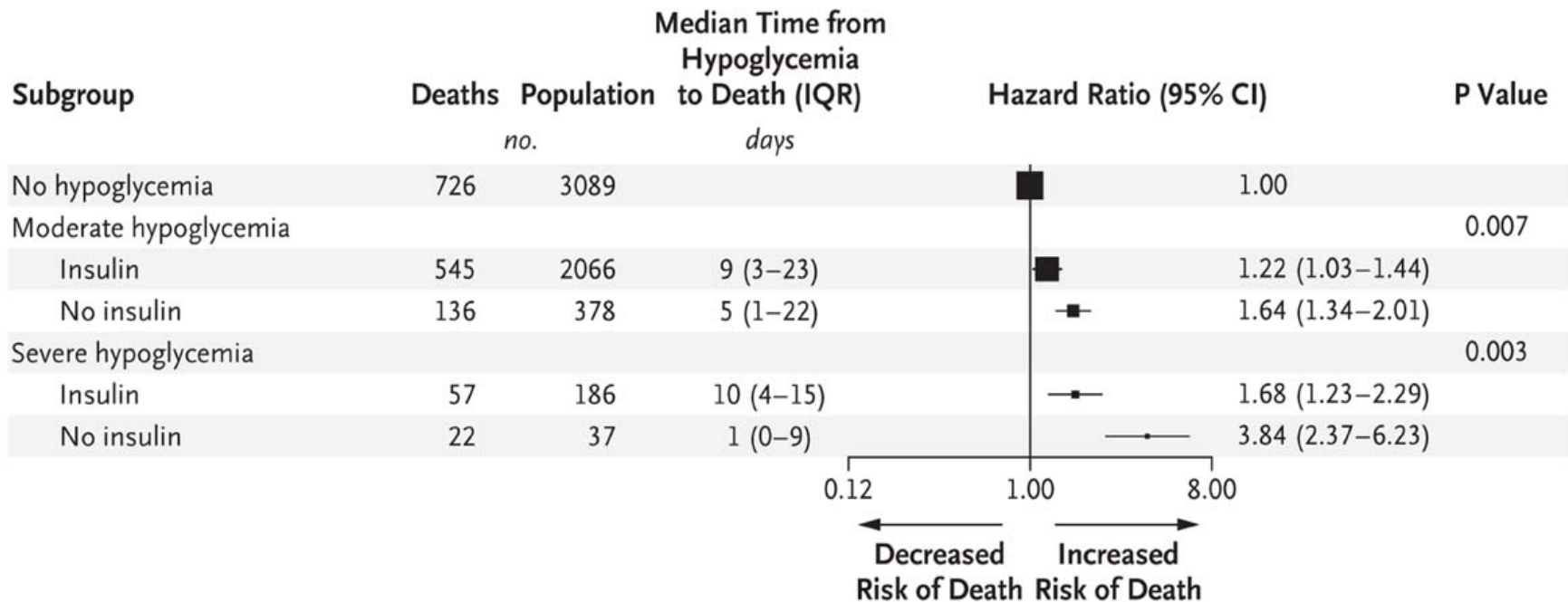
AMI, acute myocardial infarction.

Kosiborod M, et al. *JAMA*. 2009;301:1556-1564.

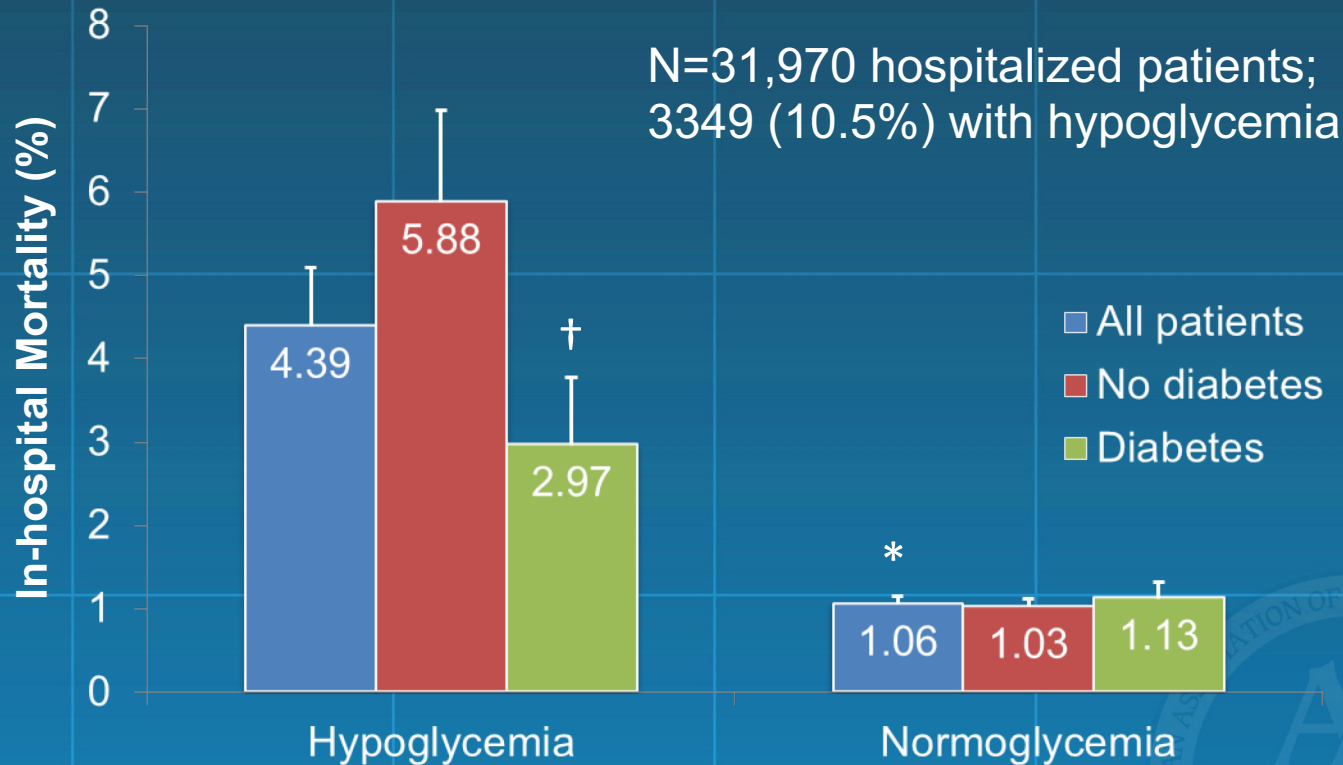
AACE Inpatient Glycemic Control Resource Center



NICE-SUGAR: Hypoglycemia and Mortality



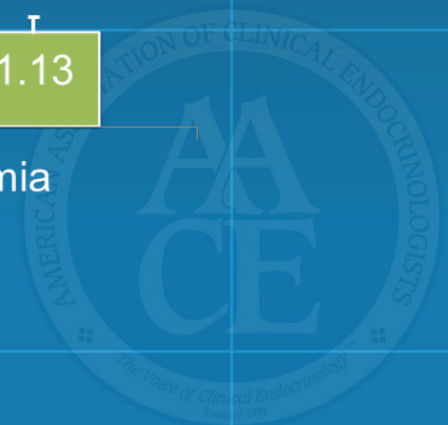
Hypoglycemia-Associated Inpatient Mortality Is Not Drug-Associated but Linked to Comorbidities



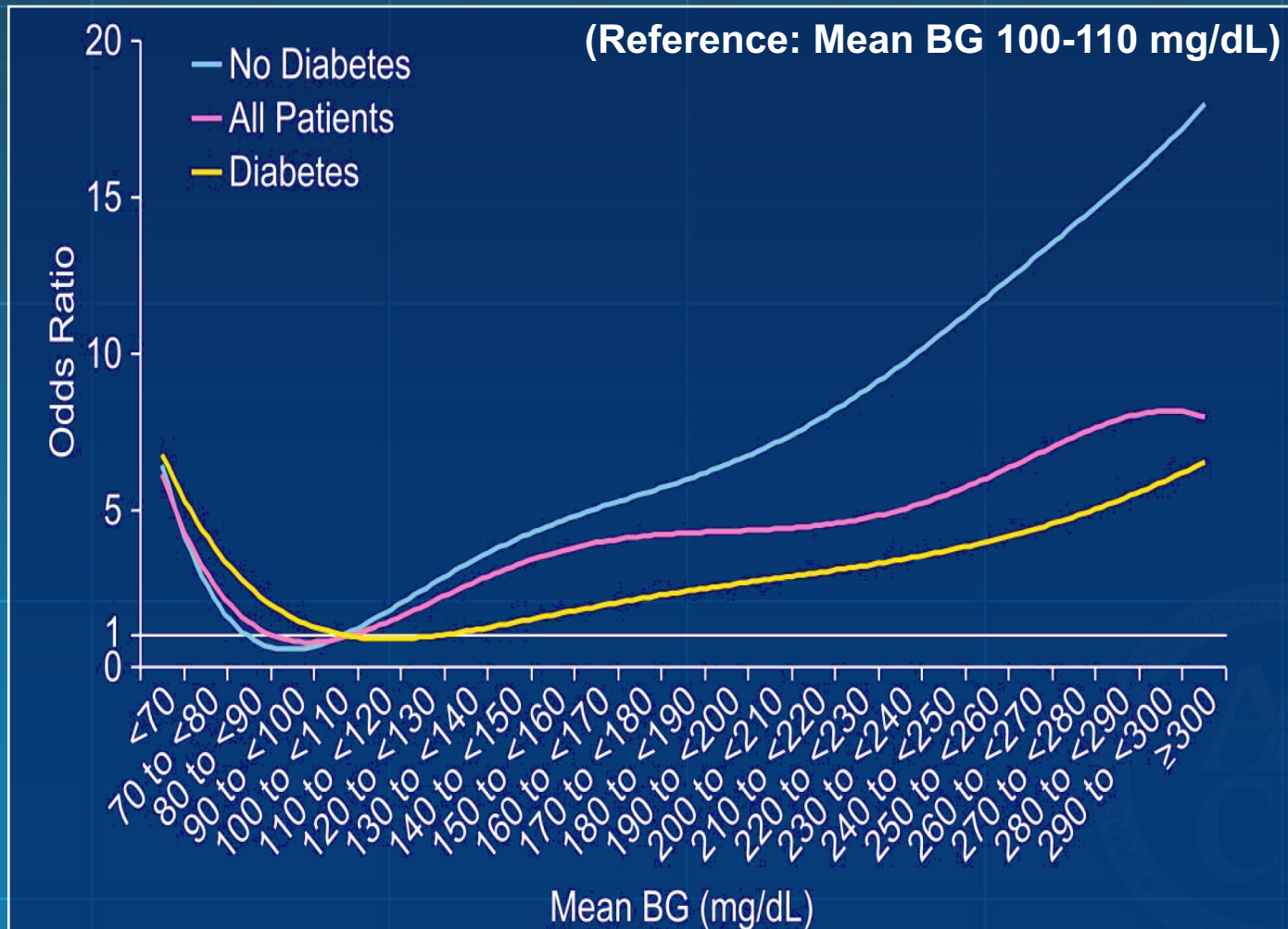
* $P < 0.001$ for all hypoglycemic vs normoglycemic patients.

† $P < 0.001$ for nondiabetic hypoglycemic patients vs diabetic hypoglycemic patients.

Boucai L, et al. *Am J Med.* 2011;124:1028-1035.



Mean Glucose and In-Hospital Mortality in 16,871 Patients With Acute MI



Kosiborod M, et al. *Circulation*. 2008;117:1018-1027.

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Hypoglycemia-Associated Inpatient Mortality Is Not Drug-Associated but Linked to Comorbidities

	Hazard Ratio (vs normoglycemia)	No. Deaths	P Value	95% CI
Unadjusted				
All hypoglycemia	1.67	451	<0.001	1.33-2.09
Spontaneous hypoglycemia	2.62	287	<0.001	1.97-3.47
Drug-associated hypoglycemia	1.06	164	0.749	0.74-1.52
Adjusted*				
Spontaneous hypoglycemia	1.11	171	0.581	0.76-1.64
Drug-associated hypoglycemia	0.72	114	0.115	0.45-1.13

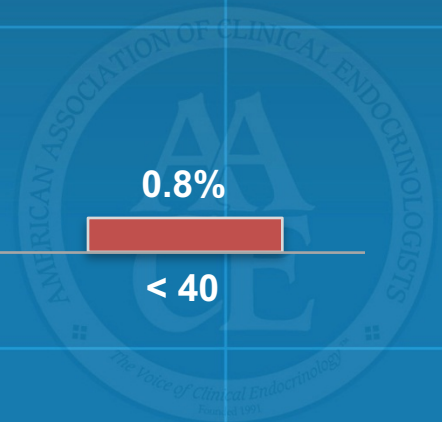
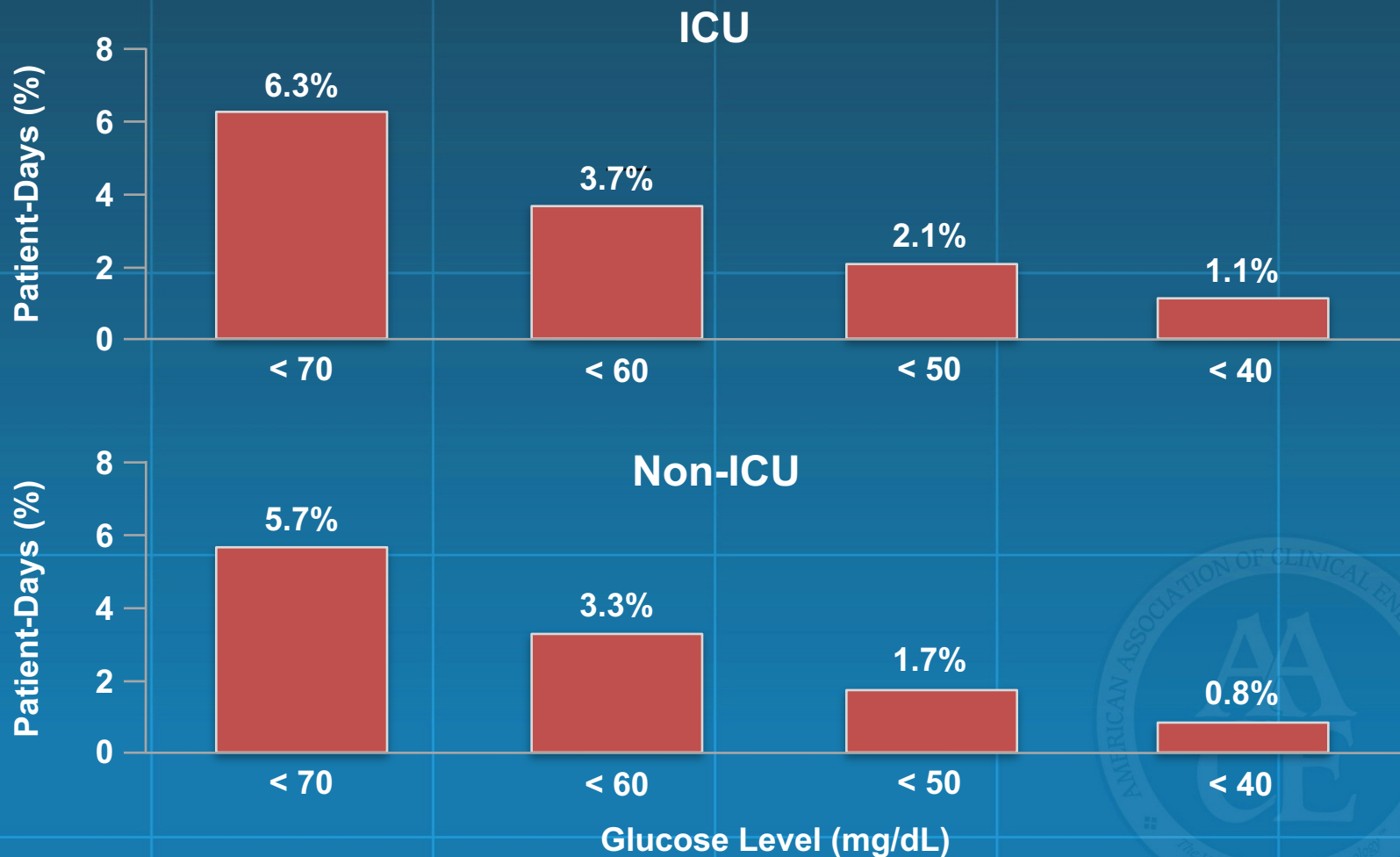
*Adjusted by age, sex, race, body mass index (BMI), diabetes, heart failure status, myocardial infarction, stroke, cancer, chronic obstructive pulmonary disease (COPD), shock, white blood cell count, albumin, creatinine, number of glucose determinations.

Boucai L, et al. *Am J Med.* 2011;124:1028-1035.

PREVENTION OF HYPOGLYCEMIA



Point of Care Blood Glucose Testing Reduces Prevalence of Hypoglycemia



Essential Part of Any Insulin Use: A Hypoglycemia Protocol

- Clear definition of hypoglycemia
 - Glucose level (ADA) <70 mg/dL
- Nursing order to treat without delay
 - Stop insulin infusion (if patient is on one)
 - Give
 - Oral glucose (if patient is able to take oral)
 - IV dextrose or glucagon (if patient is unable to take oral)
 - Repeat BG monitoring 15 min after treatment for hypoglycemia and repeat treatment if BG not at target
 - Provide directions for when and how to restart insulin
- Documentation is vital
 - Look for the cause of hypoglycemia and determine if other treatment changes are needed

ACE/ADA Task Force on Inpatient Diabetes. *Endocr Pract.* 2006;12:458-468;

ADA. *Diabetes Care.* 2009;31(suppl1):S1-S110; Umpierrez GE, et al. *J Clin Endocrinol Metab.* 2012;97:16-38.

Suggested Nurse-Initiated Strategies for Treating Hypoglycemia

Blood Glucose <70 mg/dL

Alert and able to eat and drink

Administer 15–20 g of rapid-acting carbohydrate

Alert and awake patient who is NPO or unable to swallow

Administer 20 mL dextrose 50% solution IV and start IV dextrose 5% in water at 100 mL/h

Patient with an altered level of consciousness

IV access: administer 25 mL dextrose 50% (1/2 amp) and start IV dextrose 5% in water at 100 mL/h

No IV access: give glucagon 1 mg IM
Limit, two times

Recheck BG and repeat treatment every 15 min until glucose level is at least 4.4 mmol/liter (80 mg/dL)

IM, intramuscular; IV, intravenous.

AACE Inpatient Glycemic Control Resource Center

Scenarios Prompting Increased Monitoring and Possible Decreases in Insulin Dose

- Patient is switched to NPO status
- Reduction in food intake
- Discontinuation of enteral feeding or TPN
- Discontinuation or reduction in IV dextrose
- Timing of premeal insulin if meal disrupted due to medical procedures or patient transport
- Reduction in corticosteroid administration



Summary

- Various patient- and provider-specific factors may increase the risk of inpatient hypoglycemia
- Hypoglycemia is costly
 - Patient level: increases risk of complications
 - Institutional level: increases cost of care and may reduce reimbursement (Medicare “never” event)
- Intensive insulin therapy increases the risk of severe hypoglycemia but **not** hypoglycemia-associated mortality
 - Hypoglycemia predicts higher mortality among hypoglycemic patients who are **not** receiving insulin, not in patients treated with insulin
 - Hypoglycemia-associated inpatient mortality is not drug-associated but linked to comorbidities
- Strategies to prevent hypoglycemia
 - Regular glucose monitoring, adjustment of insulin doses, and administration of carbohydrate, IV dextrose, or glucagon as needed
 - Improved communication and coordination between departments (nursing, dietary, transportation, pharmacy)

A documented hypoglycemia protocol is vital