

# Financial Impact of Inpatient Glycemic Control

Opportunities for Clinical and Financial Improvement



# Diabetes and Inpatient Costs

Higher rate of hospitalization

Chronic complications

More arteriosclerotic disease

Complicated pregnancies

Diabetes → Longer lengths of stay → Increased costs of hospitalization

More medications

More procedures

More infections



# Diabetes and Hospitalization: Scope of the Problem

- The total estimated cost of diabetes in 2007 was \$174 billion, with \$116 billion attributed to excess medical expenditures<sup>1</sup>
    - The largest component of medical expenditures attributed to diabetes was hospital inpatient care (~50% of costs)
  - Diabetes ranked #2, after circulatory diseases, as a hospital discharge diagnosis in 2009<sup>2</sup>
    - Diabetes made up 12% of all first-listed diagnosis ICD-9-CM Codes
      - N=688,000 patients
      - Average length of stay: 5.0 days
- 3.4 million inpatient-days**

1. CDCD. National diabetes fact sheet, 2011. Atlanta, GA: US Dept HHS, CDCP; 2011.

2. <http://www.cdc.gov/diabetes/statistics/hosp/adulttable1.htm>.

# Glucose Abnormalities Are Common in Hospitalized Patients

	Critically Ill	Noncritically Ill
Hyperglycemia (BG >180 mg/dL)	32.2% patient-days	32.0% patient-days
Hypoglycemia (BG <70 mg/dL)	6.3% patient-days	5.7% patient-days

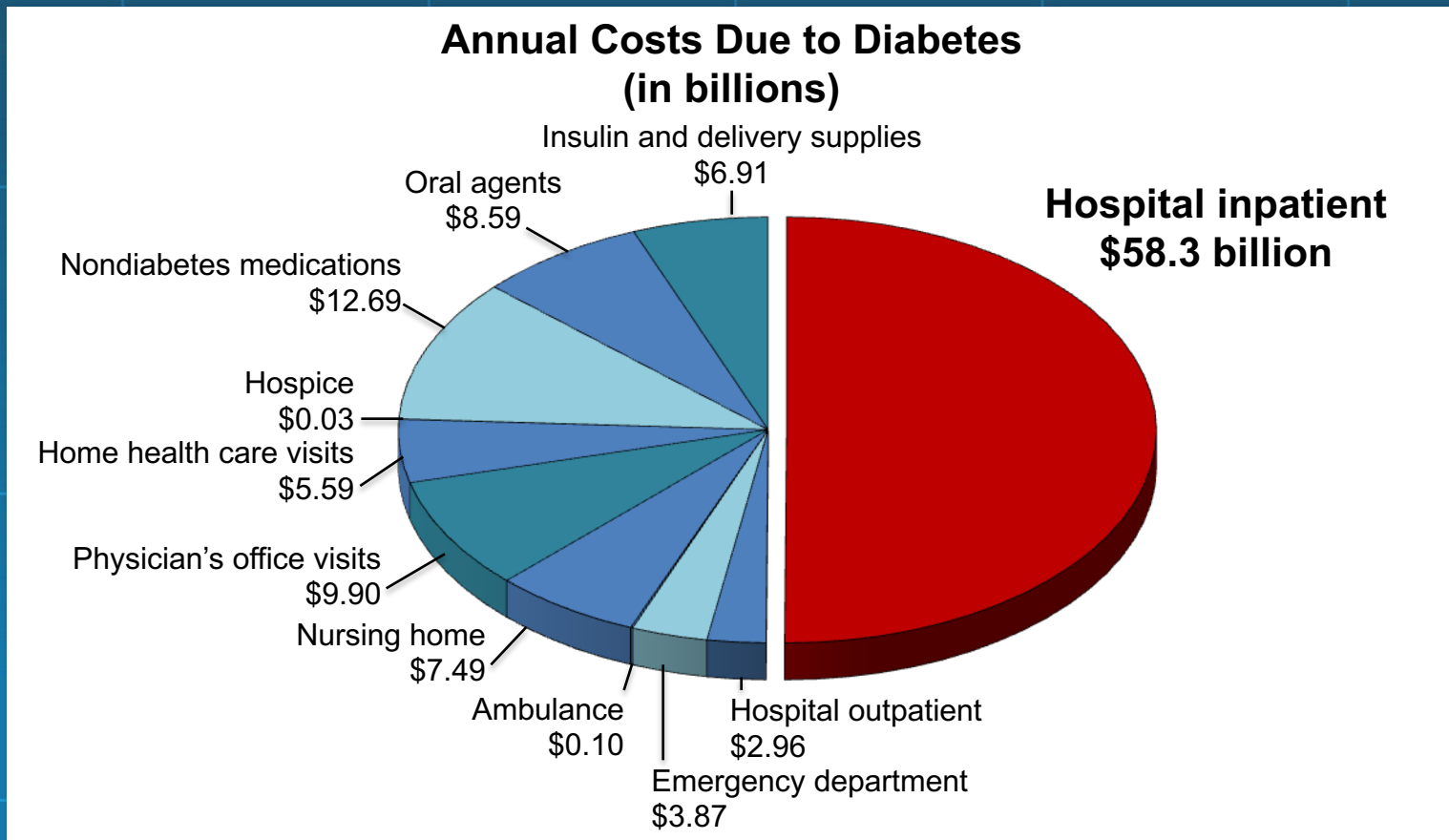


# Impact of Hyperglycemia and Diabetes in the Hospital

- Hyperglycemia on general medical or surgical units is associated with
  - 18-fold increase in in-hospital mortality
  - Longer length of stay
  - More subsequent nursing home care
  - Greater risk of infection
- Hyperglycemia, with or without prior diagnosis of diabetes, increases in-hospital mortality and congestive heart failure in patients with acute myocardial infarction

# Inpatient Hospital Costs Account for Greatest Proportion of Health Care Expenditures for Patients With Diabetes

Of \$116 billion attributed to excess medical expenditures, hospital inpatient days account for ~50% of dollars spent: >\$58 billion



# Admission Hyperglycemia Affects Costs in Acute Ischemic Stroke

- 656 acute ischemic stroke patients admitted to one hospital 7/93-6/98
- Hyperglycemia present in 40%
  - More likely to have prior diagnosis of diabetes
  - Most remained hyperglycemic during stay
    - Mean BG=206 mg/dL
    - 43% did not receive inpatient hypoglycemic drugs
- Longer length of stay (7 vs 6 days,  $P=0.015$ )
- 30-day mortality risk (HR 1.87,  $P<0.01$ )
- Higher hospital charges (\$6611 vs \$5262,  $P<0.001$ )

# Level of Glycemia Impacts Length of Stay (LOS)

## Brody School of Medicine , East Carolina University: 1574 CABG patients

- Each 50 mg/dL increase in perioperative BG level\*
  - Added 0.76 days to LOS
  - Increased hospital cost by \$2824

## Portland Diabetic Project: 5510 CABG patients, 1987-2005

- Each 50 mg/dL increase in 3-BG\*\* level added 1 day to LOS
  - Treatment-induced LOS savings: 1.8 days/patient
  - Actual non-OR charge for 1 CABG LOS day = \$1150
  - Savings from use of intensive insulin protocol,  $1.8 \times 1150 = \$2081$

\* Perioperative BG = average of day of and day after surgery.

\*\* 3-BG: 3-day average perioperative blood glucose.

Both studies: Levels measured up to >250 mg/dL; lowest level measured <150 mg/dL, no threshold effect specified.

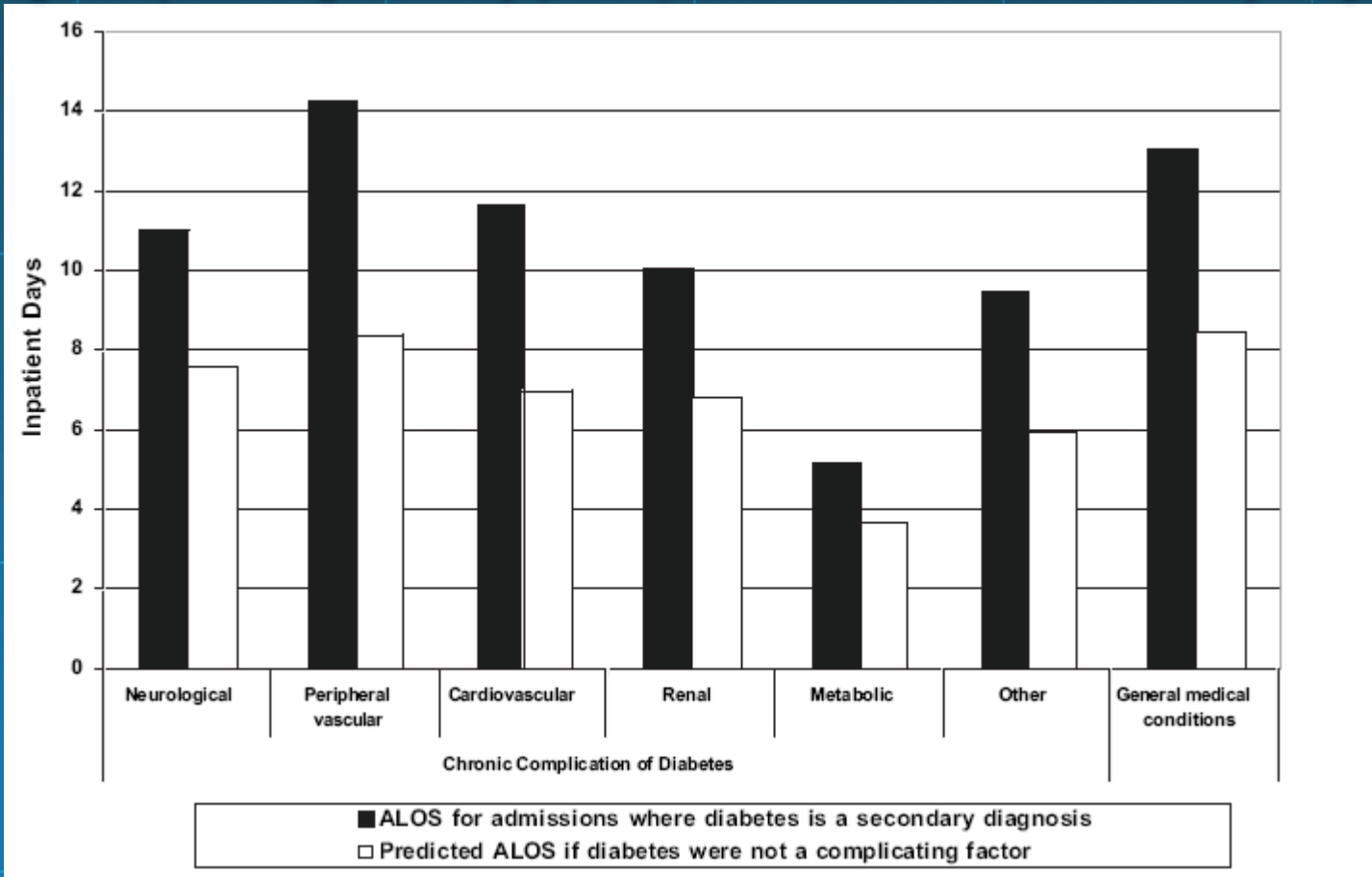
Estrada et al. *Ann Thorac Surg.* 2003;75:1392-1399; Furnary, et al. *Endocr Pract.* 2006;12(Suppl 3):22-26.

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# Patients With Comorbid Diabetes Have Longer Lengths of Stay Than When Diabetes Is Not a Complicating Factor

*Average hospital length of stay (ALOS) when diabetes is a secondary diagnosis*

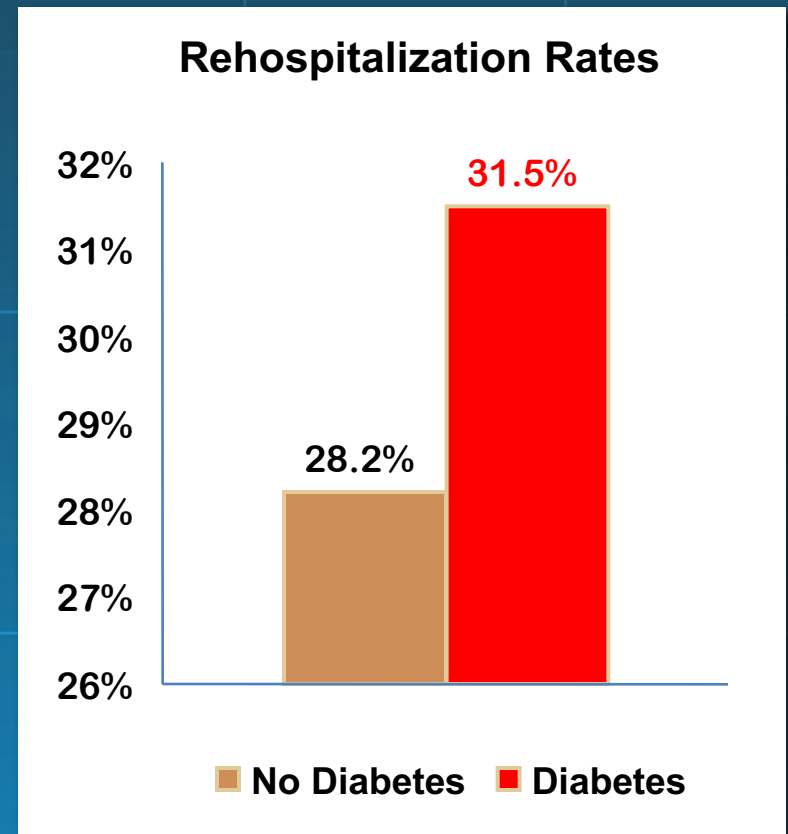


# Potentially Preventable Hospitalizations Associated With Uncontrolled Diabetes

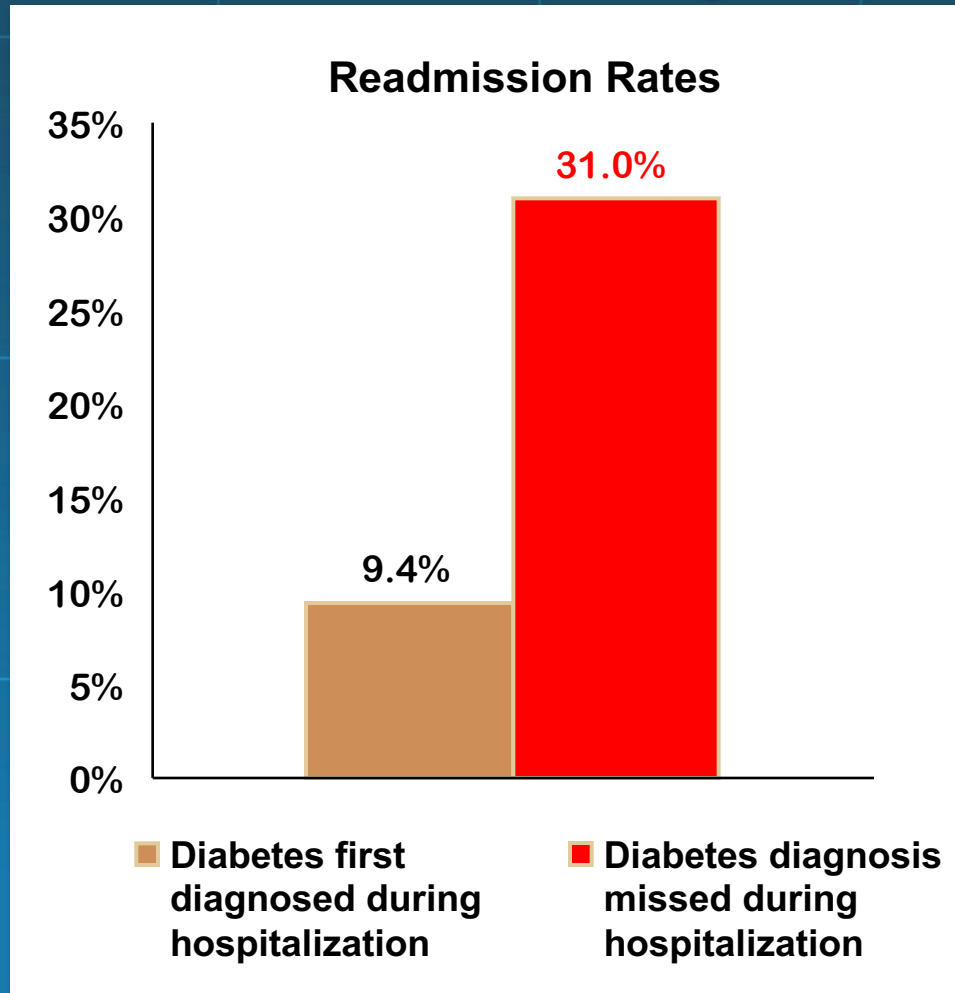
Uncontrolled diabetes diagnosis (ICD-9-CM code)	Hospitalizations estimated from the NHDS-2004		Hospitalizations estimated from the HCUP-NIS	
	Total admissions (95% CI)	Total hospital reimbursement (\$ millions)	Total admissions (n)	Total charge (\$ millions)
Without complications (250.02-250.03)	52,798 (43,976-61,620)	722	52,294	552
With ketoacidosis (250.10-250.13)	119,174 (104,485-33,863)	1372	124,510	1821
With hyperosmolarity (250.20-250.23)	14,984 (10,601-19,367)	201	14,572	298
With diabetic coma (250.30-250.33)	4225 (1948-6502)	84	4948	164
Total	191,181 (170,786-211,576)	2380	196,324	2836

# Readmission Rates Higher for Patients With Diabetes

- Among 48,612 patients with congestive heart failure from 259 hospitals, 42% had diabetes
- All-cause rehospitalization was significantly greater for patients with diabetes than for patients without diabetes (31.5% vs 28.2%;  $P=0.006$ )



# Failure to Identify Diabetes Is a Predictor of Rehospitalization



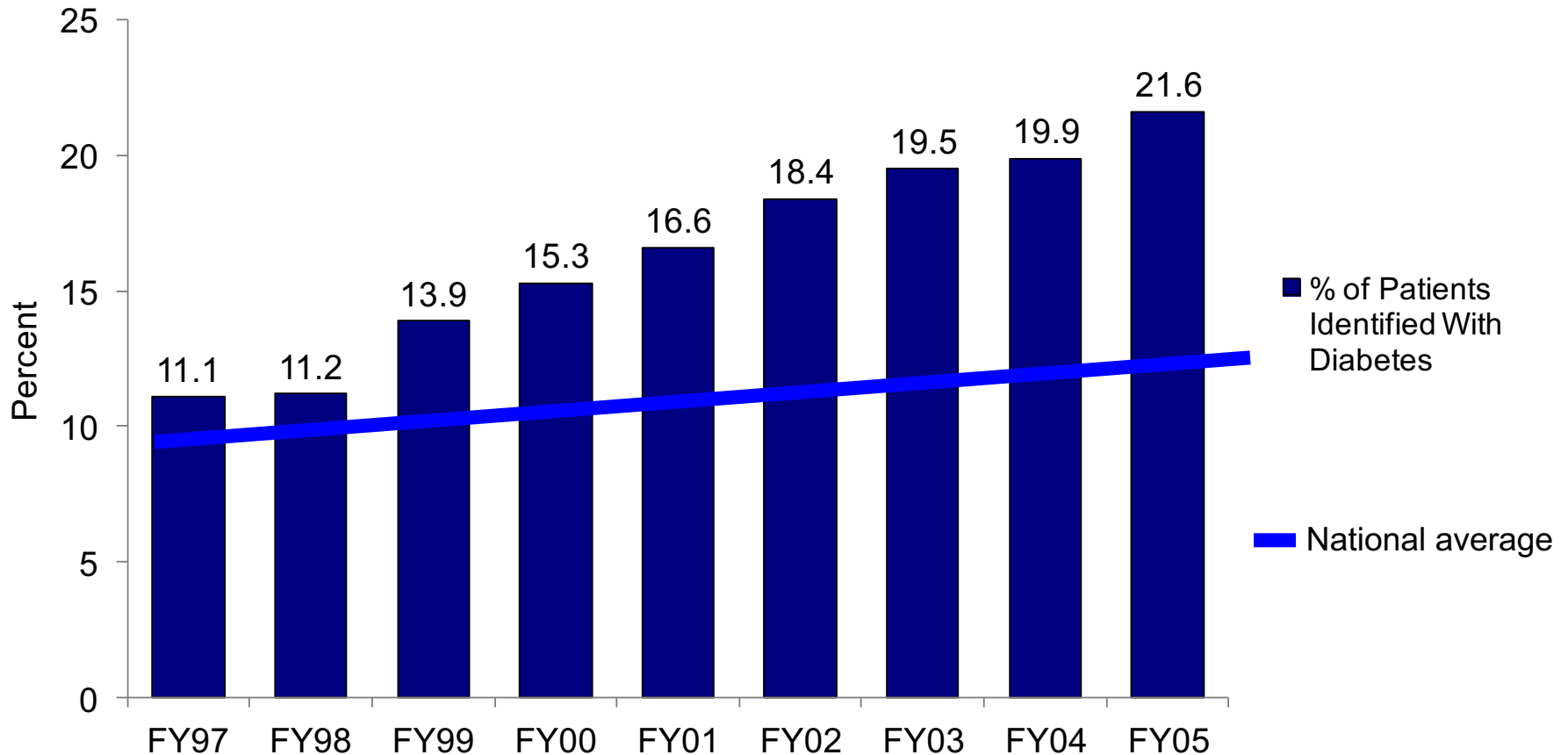
Identify Patients With  
Undiagnosed Diabetes

**OPPORTUNITY**



# Increased Identification/Coding of Patients With Diabetes

*Diabetes as a First or Second Diagnosis*



# Increased Revenue From Newly Identified Patients

## *Diabetes as a Secondary Diagnosis*

	Revenue - Cost	Newly Identified Patients	Increased Margin
FY 97	\$2640		
FY98	\$4665	-28	-\$130,620
FY99	\$3694	790	\$2,918,260
FY00	\$4221	534	\$2,254,014
FY01	\$4394	325	\$1,428,050
FY02	\$5410	407	\$2,201,870
FY03	\$4785	155	\$741,675
FY04	\$5917	128	\$757,376
FY05	\$6233	667	\$4,157,411

**Total \$14,328,036**

**Reduce the Average Length of Stay (ALOS) Gap  
Between Patients With and Without Diabetes  
Through Effective Diabetes Management**

**OPPORTUNITY**

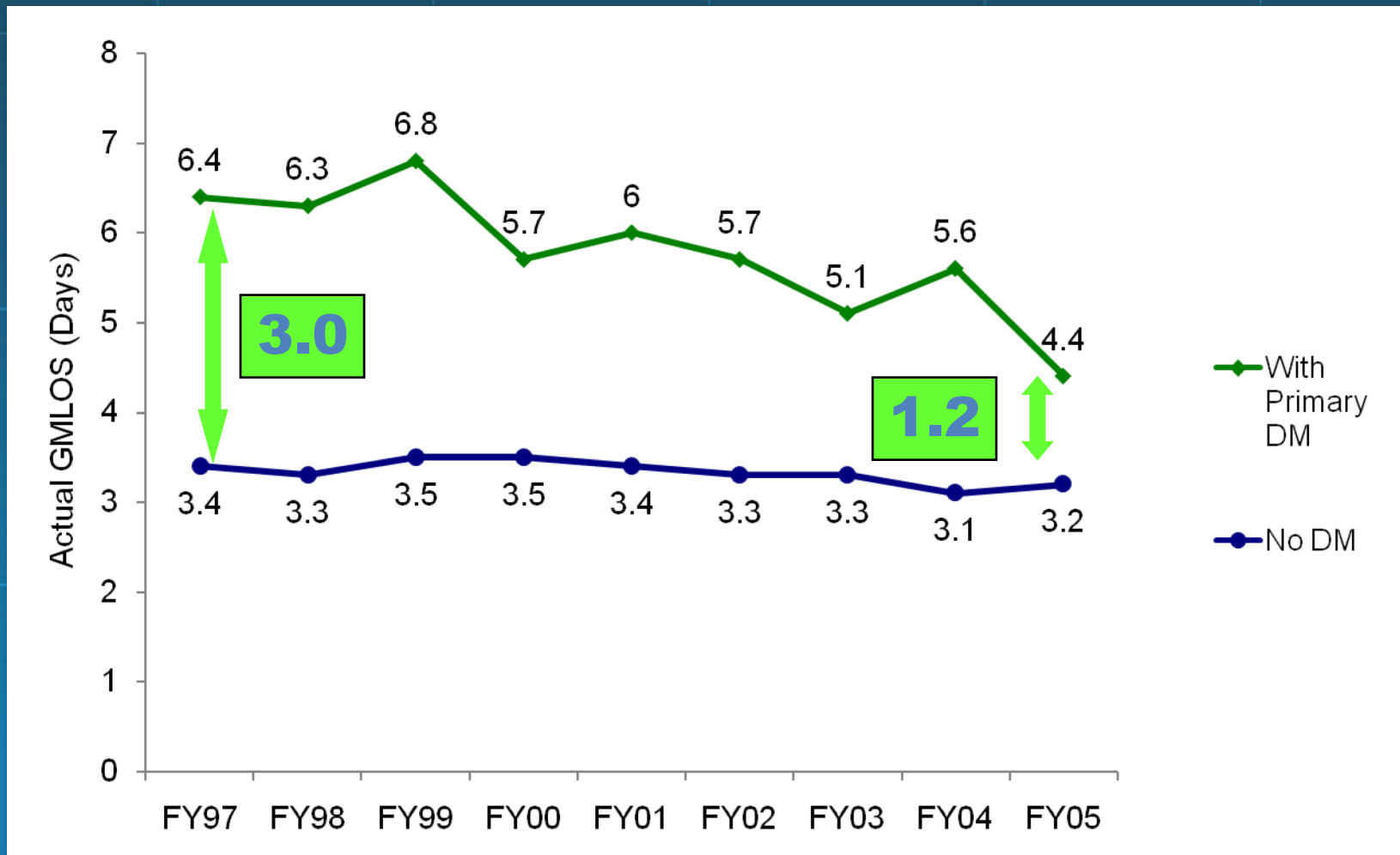




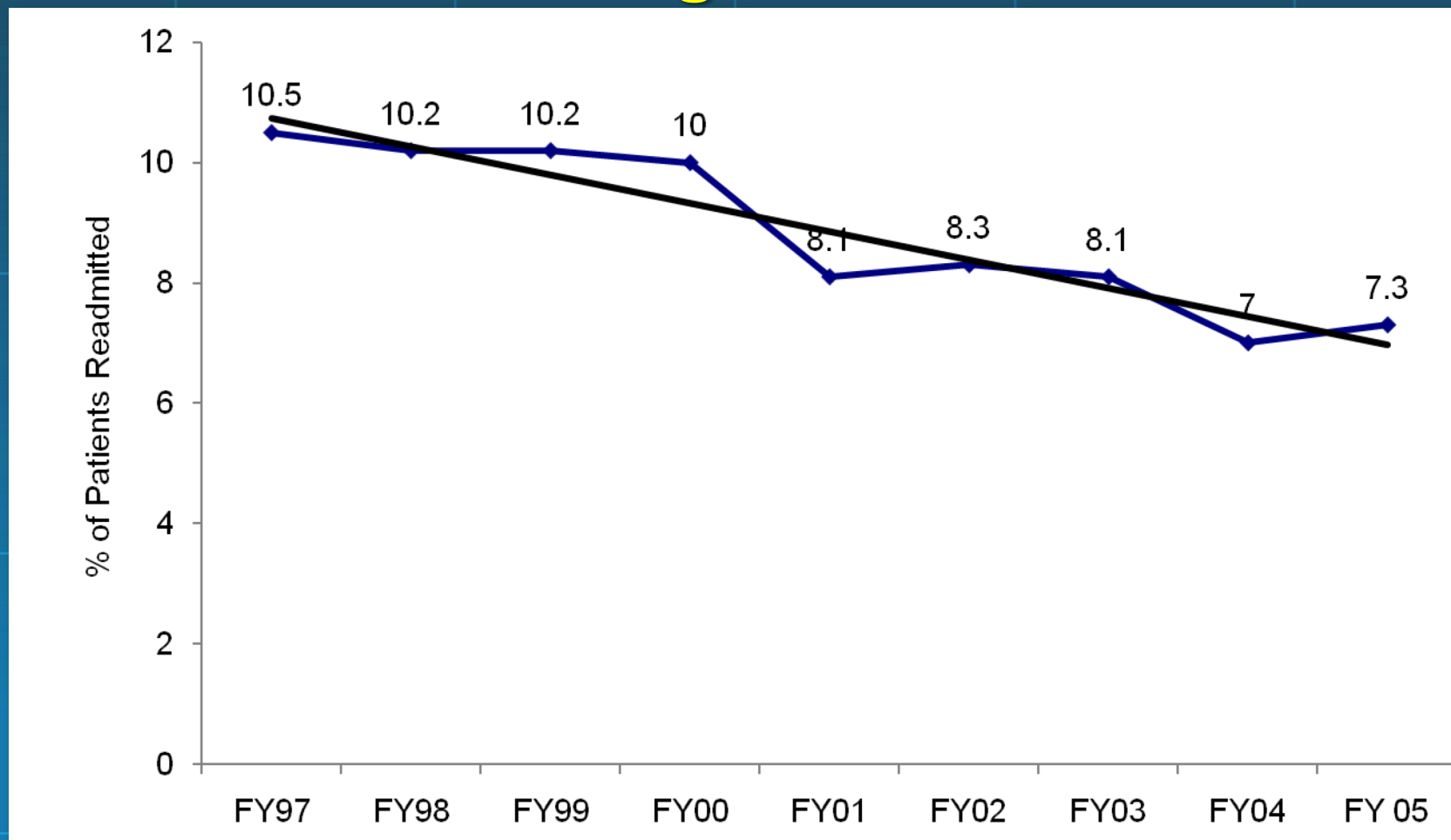
**After implementing a new hyperglycemia protocol, average blood glucose levels dropped from 243 mg/dL to 148 mg/dL**



# Reducing the ALOS Gap Patients With and Without Diabetes as a First Diagnosis



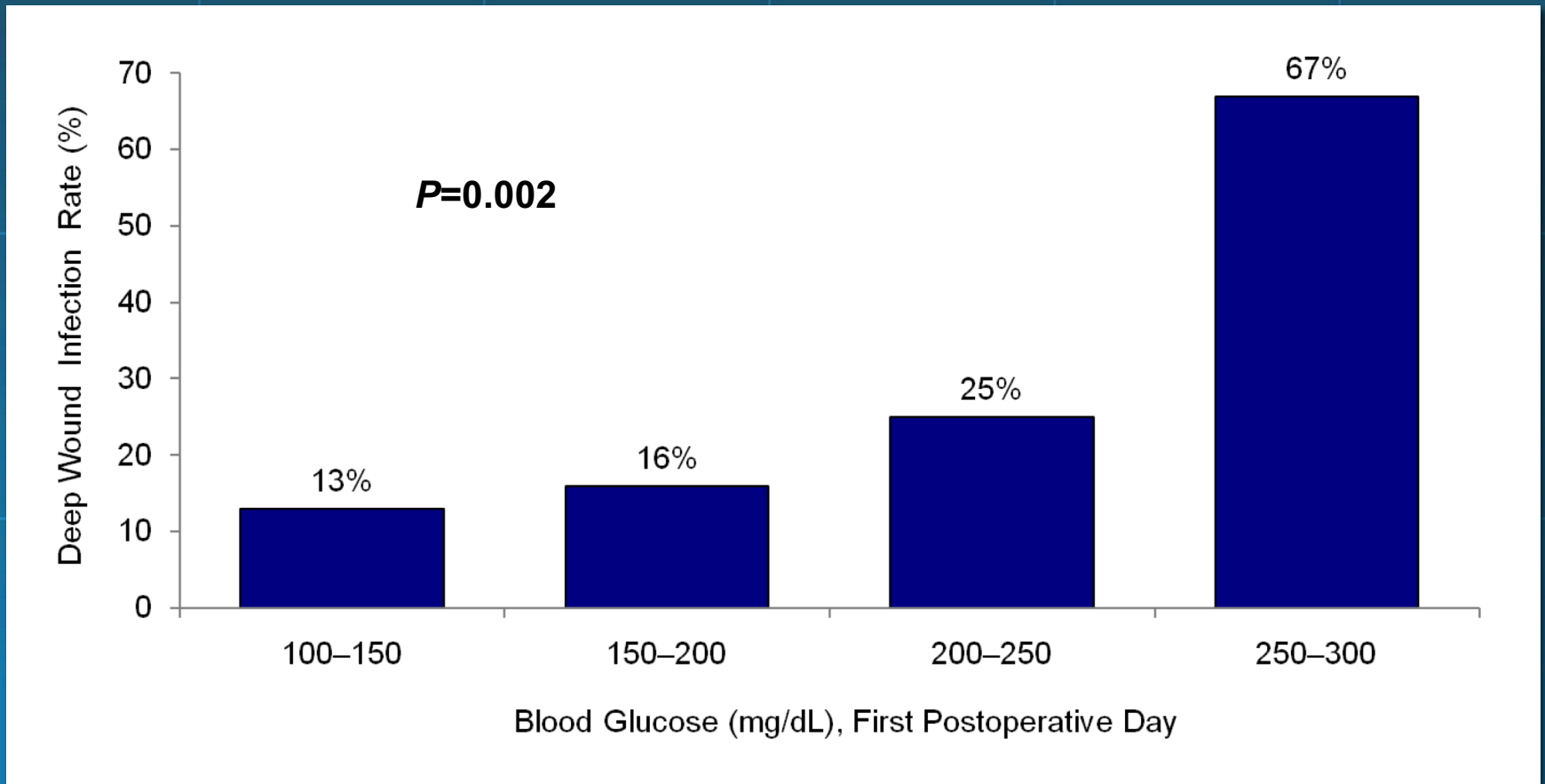
# Readmission Trends: Patients With Diabetes as a Secondary Diagnosis



# Implementation of Inpatient Diabetes Management Program Improves the Bottom Line

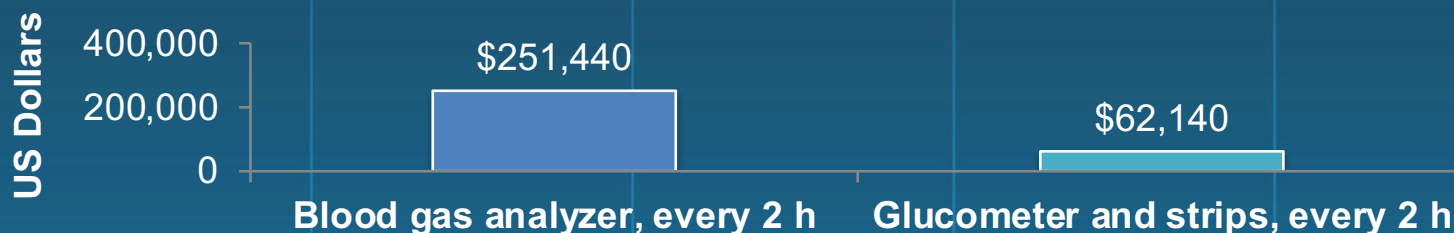
- Accurately identifying and coding patients for diagnosis of diabetes added \$632,797 to the bottom line
- The gap between average length of stay (ALOS) for patients with diabetes vs those without diabetes was reduced from 3 to 1.2 days
- Readmission of patients with diabetes as a second diagnosis decreased from 10.5% to 7.3%

# Glucose Control Lowers Risk of Wound Infection in Patients With Diabetes After Cardiac Surgery



# Glucose Control Lowers Costs Associated with Hospital-Acquired Infections

## Glucose Monitoring Costs



## Reduction in HAI

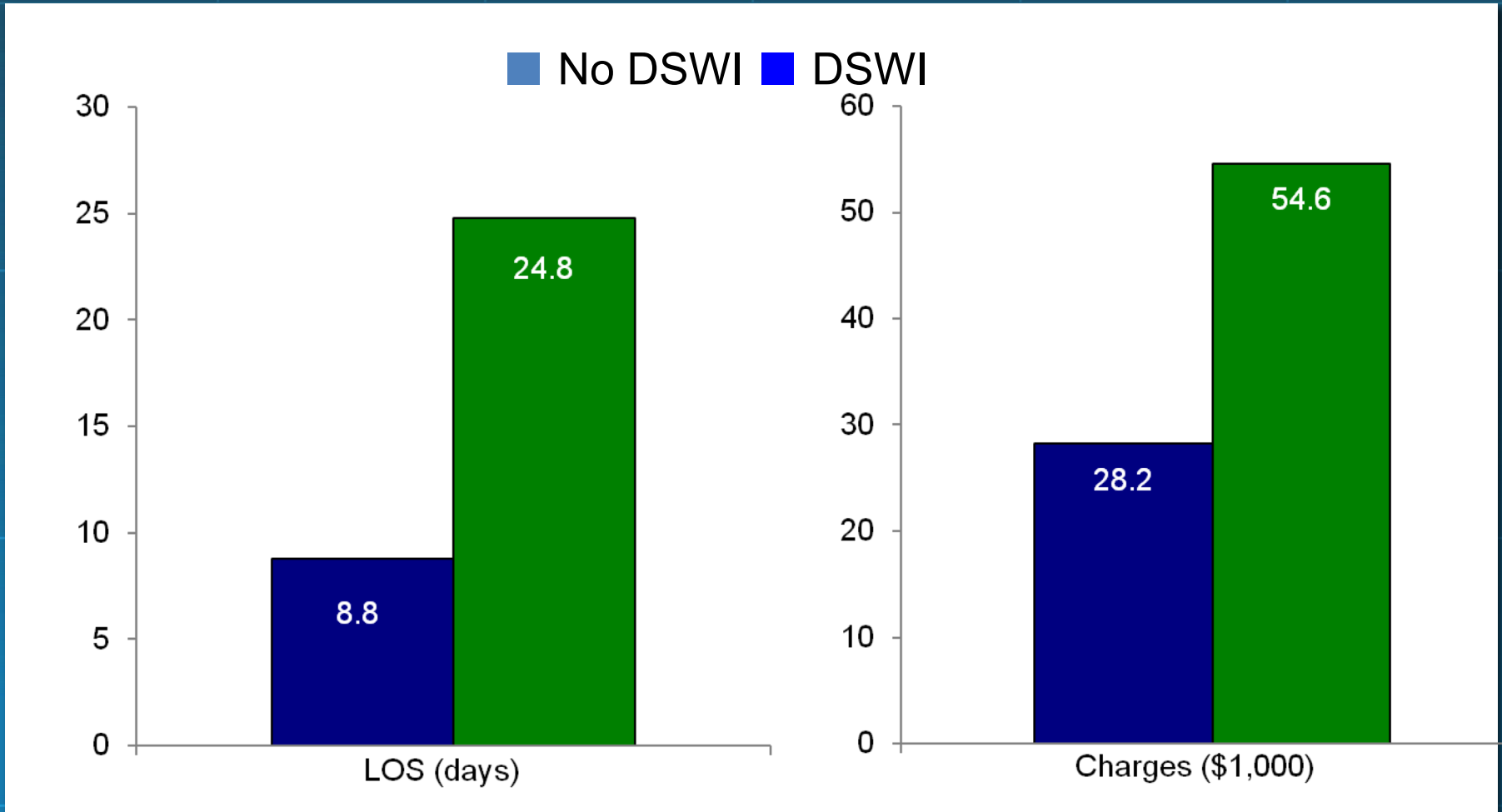
5%	Cost savings	\$262,500	
	Net benefit	\$11,060	\$200,360
10%	Cost savings	\$650,000	
	Net benefit	\$398,560	\$587,860
15%	Cost savings	\$1,162,500	
	Net benefit	\$911,060	\$1,100,360

HAI, hospital-acquired infection.  
Kransley JS. *Hosp Pract* (1995). 2014;42:53-58.

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# Length of Stay (LOS) and Cost Comparison

Socioeconomic Costs of DSWI: 16 Days and \$26,000



# Use of Intravenous Insulin Therapy Improves the Bottom Line

- In cardiac surgery patients with diabetes, continuous intravenous insulin therapy:
  - Reduced risk of deep sternal wound infection (DSWI)
    - Per patient cost savings from DSWI prevention = \$2613
  - Reduced average glucose level by 135 mg/dL, translating into 2.7-day decrease in LOS
    - Per patient cost savings from glucose reduction = \$3105

**Total cost savings = \$5580 per patient treated with continuous intravenous insulin therapy**



# Cost Analysis of Glycemic Control in Mixed ICU

- Annualized cost savings = \$1,340,000
- Savings per patient = \$1580
- Reduced LOS (mean = 3.4 days; median = 1.7 days)
- Number of ICU days reduced 17.2%
- Number of ventilator hours reduced 19.0%
- Laboratory costs reduced 24.3%
- Pharmacy costs reduced 16.7%
- Imaging costs reduced 5.0%



# Valuable Results in Clinical and Financial Outcomes

- Changes in the initiation of IV insulin therapy have reduced monthly average glucose values in the medical ICU from 169 to 123 mg/dL
- The rate of catheter-related bloodstream infection (CR-BSI) has been reduced 33.5%
- Reducing these infections is estimated to save \$6198 per 1000 event days, more than offsetting the additional cost of the IV insulin

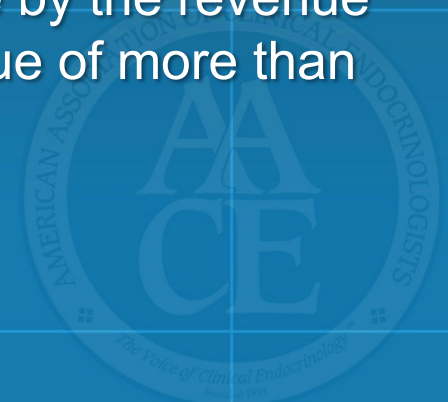


# Implementation of Inpatient Diabetes Management Program Improves the Bottom Line

- Implementing an inpatient diabetes management program was associated with a length of stay reduction of 0.26 days, resulting in:
  - Revenue enhancement of \$2,224,029 due to increased throughput
  - Return on investment of 467%
- Rate of catheter-related bloodstream infection was reduced by one-third in cardiac surgery patients, resulting in:
  - Estimated saving of \$6198 per 1000 event days

# The ALOS for Patients With a Diagnosis of Diabetes Decreased From 6.01 to 5.75

- Benefits include:
  - Cost aversion
    - Particularly relevant for patients who have a predetermined reimbursement based on DRG
  - Throughput
    - Appropriately discharging a patient more quickly makes the bed available to another patient
    - Multiplying an incremental inpatient volume by the revenue margin per patient totaled a throughput value of more than \$2 million/year



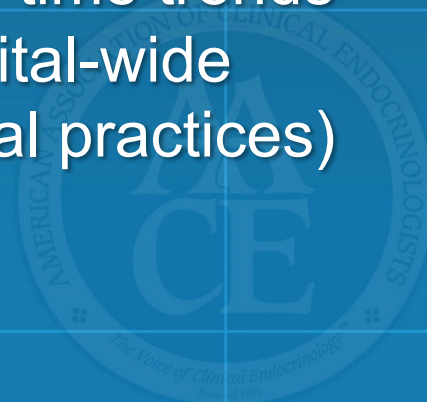
# Economic Benefits of Intensive Insulin Therapy in the ICU

## Targeted Insulin Therapy to Improve Hospital Outcomes

- Multidisciplinary approach to develop new insulin protocols and educate physicians, nurses, pharmacists, dietitians
- IV insulin protocol modified version of Markovitz protocol initiated for BG >140mg/dL
- Subcutaneous insulin incorporating basal, nutritional, and corrective insulin
- Core TRIUMPH team consisting of endocrinologist and diabetes educator would oversee management

# Economic Analysis of Intensive Insulin Therapy in Critically Ill: TRIUMPH Study

- Economic impact of implementation of a clinical glucose management service in the ICUs
- Difference analysis:
  - Change in a given outcome between intervention vs comparison groups over the pre- and post-intervention periods
  - Accounted for any confounding secular time trends over the years (eg, price inflation, hospital-wide financial changes, and other new clinical practices)



# Types of Hospitalization Costs

<b>Direct</b>	Patient care expenses <ul style="list-style-type: none"><li>• Examples: nursing, radiology, pharmacy, laboratory</li></ul>
<b>Indirect</b>	Ancillary care expenses <ul style="list-style-type: none"><li>• Examples: patient escort, nutrition, administration, financial services</li></ul>
<b>Variable</b>	Costs that change with volume
<b>Fixed</b>	Do not change with volume <ul style="list-style-type: none"><li>• Example: cost of building space</li></ul>
<b>Total</b>	All above costs together

# TRIUMPH Study: Cost Analysis After 1 Year

Outcome	Change in Outcome N=6719 2003-2005
Total costs	-\$4746 (-\$10,509, \$1832)
Direct variable costs	-\$2210 (-\$5593, \$1584)
Total ICU costs	-\$5231 (-\$13,775, \$3591)
Direct variable ICU costs	-\$1143 (-\$4096, \$2068)
Total hospital LOS	-0.47 (-1.87, 1.02)
ICU LOS	-1.19 (-1.93, -0.43)*
Mortality	-.011 (-0.05, 0.03)

\*  $P \leq 0.05$ .

Sadhu A, et al. *Diabetes Care*. 2008;31(8):1556-1661.



# TRIUMPH Study: Cost Analysis After 3 Years

Outcome	Change in Outcome N=11,129 (2003-2007)**
Total costs	-\$7580 (-\$13,643, -\$1180)*
Direct variable costs	-\$4960 (-\$8998, -\$850)*
Total ICU costs	-\$9919(-\$17,995, -\$2175)*
Direct variable ICU costs	-\$3216 (-\$6219, -\$371)*
Total days	-0.25 (-1.55, .99)
ICU days	-1.88 (-2.78, -0.89)*
Mortality	-.026 (-.06,.00006)
Average glucose per patient day (mg/dL)	-9.18 (-12.49, -5.97)**

\*  $P \leq .05$ .

\*\* Glucose readings are from 2004 to 2007.

Costs are CPI adjusted; 95% empirical, bias-corrected bootstrapped confidence intervals shown in parentheses.

Sadhu A, et al. *Diabetes*. 2010;59(Supp 1):Abstr. 433-PP.

# Bottom Line

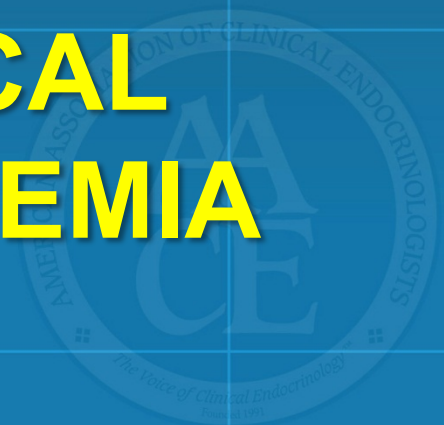
- 3381 admissions treated under the TRIUMPH program from 2005-2007
- Total cost savings of \$7580/patient



**\$25,627,980**



# ECONOMIC AND CLINICAL IMPACT OF HYPOGLYCEMIA



# LOS and Hypoglycemia

- 2538 patients treated with IIT after cardiac surgery<sup>1</sup>
  - 77 patients with hypoglycemia ( $\leq 3.3$  mmol/L or 60 mg/dL) had:
    - Increased ICU LOS by 3 days ( $P < 0.001$ )
    - Increased hospital LOS by 11 days ( $P < 0.001$ )
- 4368 admissions of patients with diabetes<sup>2</sup>
  - Increase in LOS of 2.5 days for each additional day with hypoglycemia ( $\leq 2.5$  mmol/L or 50 mg/dL)
  - Difference between actual LOS and expected LOS was 8.8 days for patients with  $> 2$  days with hypoglycemia

1. Stamou SC, et al. *J Thorac Cardiovasc Surg* . 2011;142:166-173.

2. Turchin A, et al. *Diabetes Care*. 2009;32:1153-1157.

# Impact of Hypoglycemia During Hospitalization

Outcome	Patients with hypoglycemia Mean (median)	Patients without hypoglycemia Mean (median)	Comparison	
			Difference/OR (95% CI)	P value
<b>Total Charges (2006 \$)</b>				
BG <70 mg/dL	85,905 (33,446)	54,038 (17,609)	39% (36-42)	<0.001
BG <50 mg/dL	98,304 (25,401)		50% (43-55)	<0.001
<b>Length of stay (days)</b>				
BG <70 mg/dL	11.7 (8.0)	5.1 (3.8)	3.0 (2.8-3.2)	<0.001
BG <50 mg/dL	13.6 (9.1)		4.2 (3.8-4.6)	<0.001
<b>Hospital mortality (%)</b>				
BG <70 mg/dL	4.8%	2.3%	1.07 (1.02-1.11)	0.007
BG <50 mg/dL	6.3%		1.16 (1.09-1.30)	<0.001
<b>New discharge to SNF</b>				
BG <70 mg/dL	26.5%	14.5%	1.58 (1.48-1.69)	<0.001
BG <50 mg/dL	22.7%		1.84 (1.65-2.04)	<0.001

# Key Points

- Diabetes is an increasingly prevalent diagnosis among hospitalized patients
  - Many patients have unrecognized diabetes
- Diabetes contributes to greater lengths of stay and increased costs among hospitalized patients
- Identifying and treating diabetes:
  - Reduces risk of serious and expensive complications
  - Reduces length of stay
  - Improves the bottom line



# Key Points

- Hospitals and physicians who are diabetes experts, with the support of other allied health professionals, can work together to:
  - Enhance the quality of care and improve outcomes
  - Increase revenues with appropriate payment for care provided and resources expended

**Proactive implementation of programs to improve diabetes control improves both patient outcome and hospital bottom lines.**

# Conclusion

- Glycemic control in the hospital should become a priority
  - Enhance quality and patient safety
  - Competitive advantage
  - Cost savings
  - The Joint Commission Certification

