The American Association of Clinical Endocrinologists
presents

Management of Inpatient Hyperglycemia 2012

Today's Session

A Review of the Current Evidence for Glycemic Control

Commercial Support

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Faculty

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Disclosure

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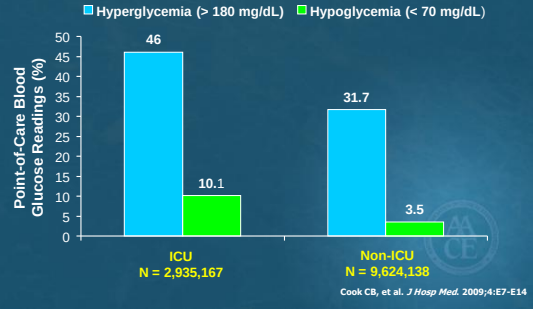
A Review of the Current Evidence for Glycemic Control

Increased prevalence of hyperglycemia is linked to increased utilization of resources

- **7.7 million annual admissions [4]**
- **1 in every 5 admissions is related to diabetes[1]**
- **Occupy ~ 12-25% of hospital beds[3,5]**
- **Hyperglycemia linked to more ED visits, longer LOS & higher costs[4]**

1. American Diabetes Association. (2008).. *Diabetes Care, 311*(3), 596–615. doi: DOI: 10.2337/dc08-9017
2. ADA. (2010).. *Diabetes Care, 33*(Supllement 1), S11-S61. doi: 10.2337/dc10-S011
3. Cook, C. B. et al. *Endocrine Practice, 15*(3), 263-269.
4. Fraze, T. et al. (HCUP Statistical Brief #93 ed., pp. 1-11): Agency for Healthcare Research and Quality.
5. Moghissi, E. *Cleveland Clinic Journal of Medicine, 71*(10), 801-808.

Hyperglycemia and Hypoglycemia Prevalence: 126 United States Hospitals



Cook CB, et al. *J Hosp Med.* 2009;4:E7-E14

Inpatient Hyperglycemia and Poor Outcomes in Numerous Settings

Study	Patient Population	Significant Hyperglycemia-Related Outcomes
Pasquel et al, 2010	Total parenteral nutrition	↑ Mortality risk, pneumonia risk, ARF
Frisch et al, 2009	Noncardiac surgery	↑ Mortality risk, surgery-specific risk
Schlenk et al, 2009	Aneurysmal SAH	↑ Mortality risk; Impaired prognosis
Palacio et al, 2008	All admitted patients, children's hospital	↑ ICU length of stay (LOS), ICU admissions
Bochicchio et al, 2007	Critically injured / trauma	↑ LOS, mortality risk, ventilator time, infection
Baker et al, 2006	Chronic obstructive pulmonary disease	↑ LOS, mortality risk, adverse outcomes
McAlister et al, 2005	Community-acquired pneumonia	↑ LOS, mortality risk, complications
Umpierrez et al, 2002	All admitted patients (87% non-ICU)	↑ LOS, mortality risk, ICU admissions ↓ Home discharges

Pasquel FJ, et al. *Diabetes Care.* 2010;33:739-741; Frisch A, et al. *Diabetes.* 2009;58(suppl 1):101-OR; Schlenk F, et al. *Neurocrit Care.* 2009;11:56-63; Palacio A, et al. *J Hosp Med.* 2008;3:212-217; Bochicchio GV, et al. *J Trauma.* 2007;63:1353-1358; Baker EH, et al. *Thorax.* 2006;61:284-289; McAlister FA, et al. *Diabetes Care.* 2005;28:810-815; Umpierrez GE, et al. *J Clin Endocrinol Metab.* 2002;87:978-982

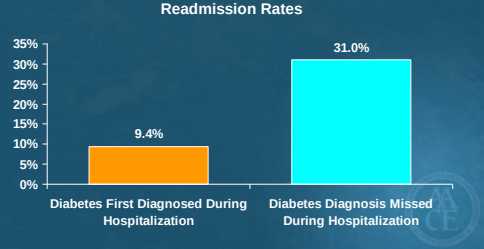
Economic Benefits Associated With Inpatient Insulin Protocols

Study	Economic Benefit	Source of Economic Benefit
Furnary[1]	$5580 per CABG patient per stay	↓ LOS and DSWI
Van den Berghe[2]	€2638 per patient per ICU stay	↓ LOS and cost-generating events
Krinsley[3]	$1,339,500 per year in a 305-bed hospital ($1560 per patient)	↓ LOS; ventilator days; laboratory, pharmacy, and radiology costs
Newton[4]	$6198 per 1000 days of IV insulin therapy	↓ LOS, central line infections ↑ Bed availability
Sadhu[5]	≈$5000 per patient	↓ LOS in ICU

DSWI, deep-sternal wound infection; ICU, intensive care unit; IV, intravenous.

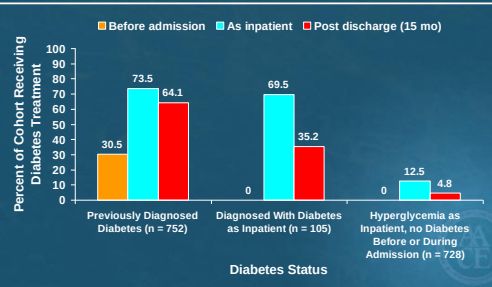
1. Furnary AP, et al. *Endocr Pract.* 2004;10(suppl 2):21-33.
2. Van den Berghe G, et al. *Crit Care Med.* 2006;34:612-616.
3. Krinsley JS, Jones RL. *Chest.* 2006;129:644-650.
4. Newton CA, Young S. *Endocr Pract.* 2006;12(suppl 3):43-48.
5. Sadhu AR, et al. *Diabetes Care.* 2008;31:1556-1561

Failure to Identify Diabetes Is a Predictor of Rehospitalization



Robbins JM, Webb DA. *Med Care.* 2006;44:292-296

Hospitalization: A Window of Opportunity for Diagnosing Diabetes?



Waddell M, et al. *Postgrad Med.* 2009;121:61-66;
Roman SH, Chassin MR. *Diabetes Care.* 2001;24:1371-1376.

Updated Guidelines from Professional Organizations on ICU Glucose Management

Year	Organization	Patient	Treatment Threshold (mg/dL)	Target BG Range (mg/dL)	Hypo Definition (mg/dL)	Updated post NICE-SUGAR
2009	AACE / ADA	ICU/	180	140-180	70	Yes
2009	Surviving Sepsis Campaign	ICU	180	150	Not stated	Yes
2009	Institute for Healthcare Improvement	ICU	180	< 180	< 40	Yes
2008	AHA	ICU ACS	180	90 - 140	Not stated	No
2007	ESC / EASD	ICU Cardiac	Not stated	"Strict"	Not stated	No

Kavanagh, McCowen, NEJM 2010; 363:2540-6

Glucose Targets in Non–ICU Patients

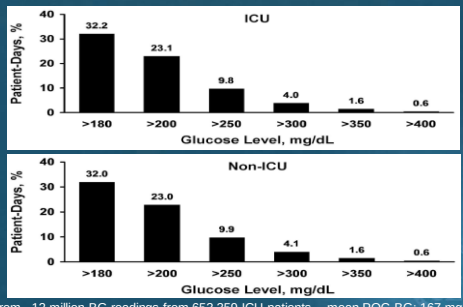
- Glucose Target in non–ICU setting:
  - Premeal glucose targets <140 mg/dL
  - Random BG <180 mg/dL
  - To avoid hypoglycemia, reassess insulin regimen if BG levels fall below 100 mg/dL
  - Occasional patients may be maintained with a glucose range below and/or above these cut-points

Moghissi ES, et al; AACE/ADA Inpatient Glycemic Control Consensus Panel. *Endocr Pract.* 2009;15(4). http:
Umpierrez G et al, J Clin Endocrinol Metabol 97: January 2012

Current recommendations for hospitalized patients

- All critically ill patients in intensive care unit settings
  - Blood glucose level 140–180 mg/dL
  - Intravenous insulin preferred
- Non–critically ill patients
  - Premeal: <140 mg/dL
  - Random: <180 mg/dL
  - Scheduled subcutaneous insulin preferred
  - Sliding-scale insulin is discouraged
- Hypoglycemia
  - Reassess the regimen if blood glucose level is <100 mg/dL
  - Modify the regimen if blood glucose level is <70 mg/dL

Distribution of patient-day-weighted mean POC-BG values for ICU

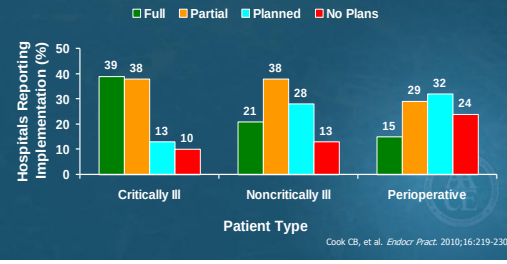


Data from ~12 million BG readings from 653,359 ICU patients - mean POC-BG: 167 mg/dL

Swanson et al. Endocrine Practice, October 2011

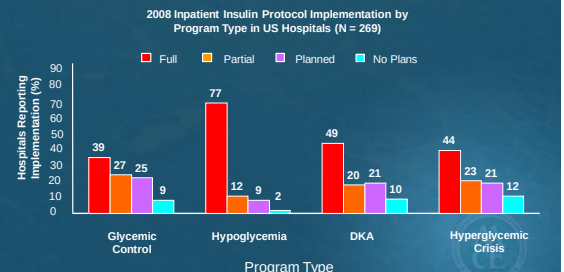
Most US Hospitals Have Not Fully Implemented Insulin Protocols for Different Inpatient Settings

2008 Inpatient Insulin Protocol Implementation by Patient Type in US Hospitals (N = 269)



Cook CB, et al. *Endocr Pract.* 2010;16:219-230.

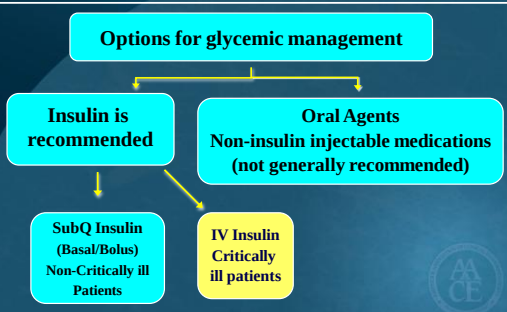
Variability in Hospital Glucose Management Programs



DKA = Diabetic Ketoacidosis

Cook CB, et al., Endocr Pract. 2010; 16:219-230

Recommended Management of Hyperglycemia in the Hospital Setting



ACE/ADA Task Force on Inpatient Diabetes. *Diabetes Care*.2009;31(suppl. 1):S1-S110.

Successful IV Insulin Protocol

- Reaches and maintains BG successfully within a pre-specified target range.
- Includes a clear algorithm for making temporary corrective changes in the IV insulin rate, as patient requirements change
- Incorporates the 'rate of change' in BG, not just the absolute values.
- Incorporates the current IV insulin rate.
- Minimizes hypoglycemia; provides specific directions for its treatment when it occurs.
- Provides specific guidelines for timing and selection of doses for the transition to SQ insulin

TRANSITION FROM IV TO SC INSULIN

Considerations for Transition from IV to SC Insulin

- Which patients on IV insulin will need a transition to scheduled SC insulin?
  - Type 1 DM
  - Type 2 DM on insulin prior to admission
  - Type 2 DM (or 'new hyperglycemia') requiring ≥ 1 units/hour of insulin

EL4, expert opinion

Transition from IV insulin to SC Insulin

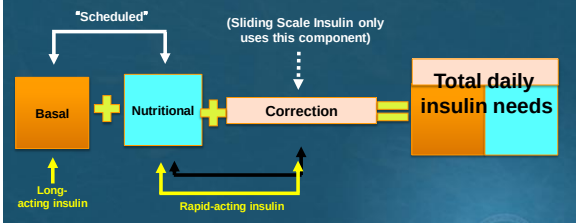
- IV insulin should be transitioned to SC basal bolus insulin therapy
  - When patient begins to eat and BG levels are stable
- Because of short half life of IV insulin, SC basal insulin should be administered at least 2-3 hours prior to discontinuing the drip
  - if short-acting insulin also administered, IV insulin may be able to be stopped sooner, e.g., after 1 hour

EL4, Expert opinion

Calculating the SC Insulin dose

- Establish the 24-hour insulin requirement by extrapolating from the average intravenous insulin dose required over the previous 6 to 8 hours (if stable)
- Take 75-80% of the Total Daily Dose (TDD) and give one half as an intermediate-acting or long-acting insulin for basal coverage and one half as a short-acting or rapid-acting insulin in divided doses before meals.

Subcutaneous Insulin Administration



Clement S, et al. *Diabetes Care.* 2004;27:553–591 EL4, review. Moghissi ES, et al. *Endocr Pract.* 2009;15:353–369. EL4, consensus Moghissi ES. *Curr Med Res Opin.* 2010;26:589–598. EL4, review. Trence DL, et al. *J Clin Endocrinol Metab.* 2003;88:2430–2437. EL4, review

- RAndomized Study of Basal Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes Undergoing General Surgery (RABBIT 2 Surgery)

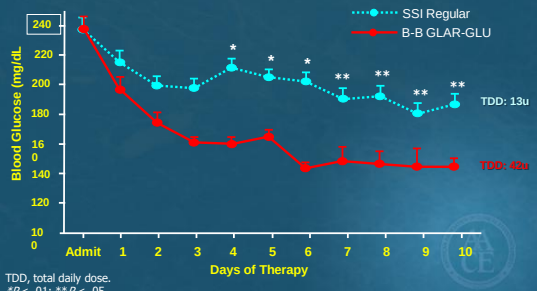
Umpierrez et al, Diabetes Care. 2011 Feb;34(2):256-61. Epub 2011 Jan 12

Basal-Bolus Insulin Regimen in Noncritically Ill Patients

- Discontinue oral antidiabetic drugs on admission
- Starting TDD
  - 0.4 U/kg/d if BG between 140-200 mg/dL
  - 0.5 U/kg/d if BG between 201-400 mg/dL
- Half of TDD as long-acting insulin and half as rapid-acting insulin
  - Long-acting insulin QD, at the same time of day
  - Rapid-acting insulin 3 equally divided doses (AC)

Umpierrez GE, et al. *Diabetes Care.* 2007;30:2181-2186.
Umpierrez GE, et al. *J Clin Endocrinol Metab.* 2009;94:564-569.

Basal-Bolus Analog vs SSI Regular Insulin in Noncritically Ill Inpatients (RABBIT 2)



TDD, total daily dose.
*$P < .01$; **$P < .05$

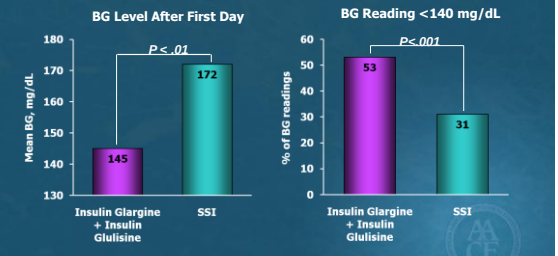
Umpierrez GE, et al. *Diabetes Care.* 2007;30:2181-2186.

Treatment Success With Basal-Bolus vs. Sliding Scale Insulin (RABBIT 2 Trial)

- 66% (43 patients) in the basal-bolus group reached the target, BG target of <140 mg/dL, while only 38% in the SSI group met this goal.
- 14% of patients on SSI remained severely hyperglycemic, (BG >240 mg/dL), despite dose maximization. (Glycemic control improved once they were switched to the basal-bolus regimen.)
- Two patients in each group had hypoglycemia (defined as BG <60 mg/dL). No cases of severe hypoglycemia (defined as BG <40 mg/dL) reported.

Umpierrez GE, et al. *Diabetes Care.* 2007;30:2181-2186

RABBIT 2 Surgery: Glycemic Control



SSI = sliding scale insulin.

Umpierrez et al, Diabetes Care. 2011;34(2):256-61

Rabbit 2 Surgery Trial: Postoperative Complications

Hospital Complications

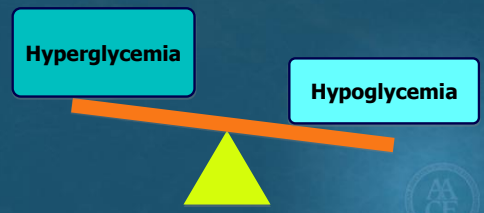
Variable	ALL	SSI	Basal Bolus	P value
Wound infections	14	11	3	0.050
Pneumonia	3	3	0	0.247
Acute respiratory failure	6	5	1	0.213
Acute renal failure	15	11	4	0.106
Bacteremia	3	2	1	0.999
# patients with complications	**35**	**26**	**9**	**0.003**
Total # of complications	**42**	**32**	**9**	
Post-surg ICU admission	34	21	13	0.159
% post-surg ICU admission	16%	19.6%	12.5%	
ICU LOS	2.51±1.90	3.19±2.14	1.23±0.60	0.003

Umpierrez et al, Diabetes Care. 2011;34(2):256-61.

Goals for Glucose Management in the Hospital

- To optimize glycemic control
- To provide adequate calories
- No ADA endorsed diet
- Consistent carbohydrate meals are preferred
- Registered Dietician is an important member of the inpatient team

Striking the Balance

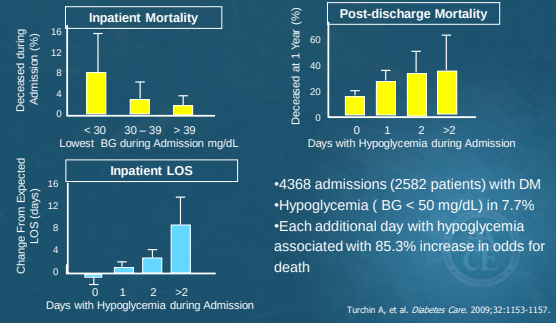


Hypoglycemia Is a Concern

Areas of risk:

- ✓ Changes in carbohydrate or food intake
- ✓ Changes in clinical status or medications
- ✓ Failure to adjust therapy based on BG patterns
- ✓ Prolonged use of SSI as monotherapy
- ✓ Poor coordination of BG testing with insulin administration and meal delivery
- ✓ Poor communication during patient transfers
- ✓ Errors in order writing and transcription

Poorer Outcomes for Diabetes Patients With Hypoglycemia in the General Ward



- 4368 admissions (2582 patients) with DM
- Hypoglycemia (BG < 50 mg/dL) in 7.7%
- Each additional day with hypoglycemia associated with 85.3% increase in odds for death

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

Clinical Scenarios Prompting Increased Monitoring & Possible Decreases in Insulin Doses

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

Clement S, et al. *Diabetes Care.* 2004;27:553-591.

Essential Part of Any Insulin Use: A Hypoglycemia Protocol

- Clear Definition of Hypoglycemia
  - BG < 70 mg/dL (ADA)
- Nursing Order to Treat Without Delay
  - Stop insulin infusion (if patient is on one)
  - Oral glucose (if patient is able to take oral)
  - IV dextrose or glucagon (if patient is unable to take oral)
  - Repeat blood glucose monitoring 15 min after treatment for hypoglycemia and repeat treatment if BG not up to target
  - Directions for when and how to restart insulin
- Documentation!
- 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. EL4, consensus

Transition to Outpatient Care

What are the optimal strategies for transitions to outpatient care?

- Preparation for transition to the outpatient setting should begin at the time of hospital admission.

- Clear communication with outpatient providers is critical for ensuring safe and successful transition to outpatient management.

Discharge Planning

Discharge Planning

- Be proactive! Start early (2-3 days before.)
- What can this patient handle at home?
- Consider side effects, drug intolerances, comorbidities, costs.
- Rx's, supplies, appointments
- *"Survival Skills"*
- Outpatient follow-up is key!

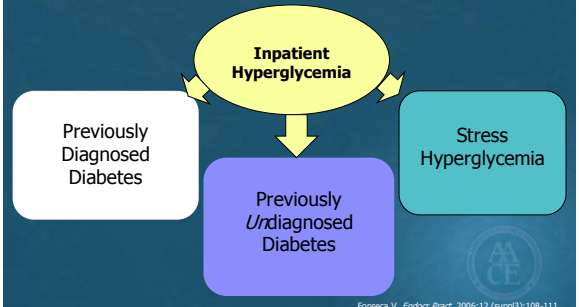
Predischarge Checklist

- **Diet information**
- **Monitor/strips (& Rx)**
- **Rx for/supplies of meds, insulin, needles**
- **Treatment goals**
- **Contact phone numbers**
- **"Medi-Alert" bracelet**
- ***"Survival Skills"* training**

"Survival Skills"

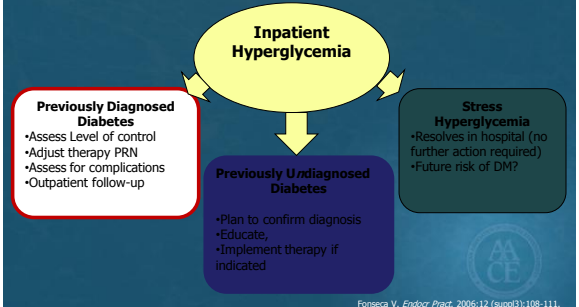
- How & when to take medication/insulin
- How & when to monitor blood glucose
- Basics regarding meal plan
- How to treat hypoglycemia
- *Sick day management*
- Date of next appointment with clinician
- How to access further diabetes education as an outpatient
- When to call health care team

3 Types of Patients with Hyperglycemia in the Hospital



Fonseca V. *Endocr Pract.* 2006;12 (suppl3):108-111.
Garber A., et al. *Endocr Pract.* 2004;10:77-82

3 Types of Patients with Hyperglycemia in the Hospital



Fonseca V. *Endocr Pract.* 2006;12 (suppl3):108-111.
Garber A., et al. *Endocr Pract.* 2004;10:77-82

3 Types of Patients with Hyperglycemia in the Hospital

Inpatient Hyperglycemia

Previously Diagnosed Diabetes
- Assess Level of control
- Adjust therapy PRN
- Assess for complications
- Outpatient follow-up

Previously *Un*diagnosed Diabetes
- **Plan to confirm diagnosis**
- **Educate**
- **Implement therapy if indicated**

Stress Hyperglycemia
- Resolves in hospital (no further action required)
- Future risk of DM?

Fonseca V. *Endocr Pract.* 2006;12 (suppl3):108-111.
Garber A, et al. *Endocr Pract.* 2004;10:77-82

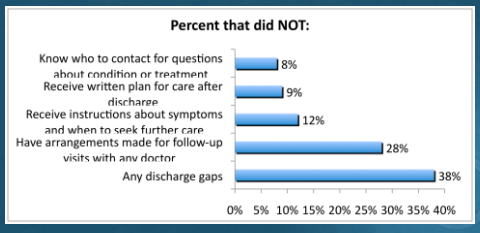
AACE and ADA 2010 Diagnosis of Diabetes Mellitus

NORMAL	AACE 2010 DIABETES	ADA 2010 DIABETES
FPG <100 mg/dl	FPG ≥126 mg/dl	≥ 126 mg/dl* (7.0 mmol/l)
OGTT 2-h PG <140 mg/dl	2-h PG ≥200 mg Random PG ≥200 + symptoms	≥ 200 mg/dl (11.1 mmol/l)
A1c[1]	≥6.5% *Secondary test*	≥ 6.5% *If FPG & A1c results discordant, default to most abnormal test.*

Endocrine Pract. 2010;16:155–156. *Diabetes Care* 2011;34(suppl 1):S11-S61. EL4, consensus

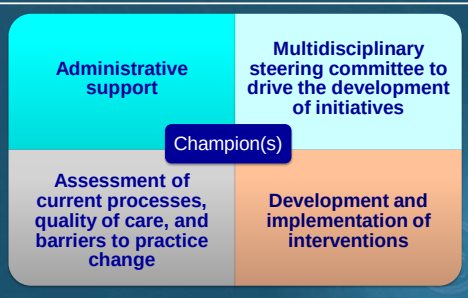
Gaps in US Hospital Discharge Planning & Transitional Care

Adults with any chronic condition who were hospitalized in past 2 years



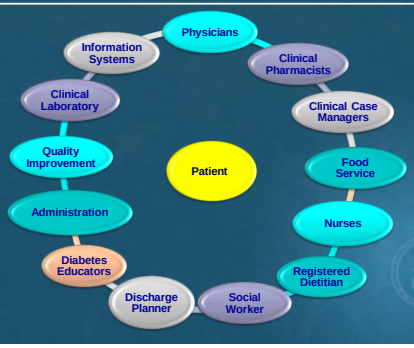
Data collection: Harris Interactive, Inc.
Source: 2008 Commonwealth Fund International Health Policy Survey of Sicker Adults

Successful Strategies for *Quality Improvement* of Inpatient Glycemic Control



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

Multidisciplinary Team Approach to Care



Patient Care Components

- Inpatient diabetes management team"
- Identification (& coding) of patients
- Policies & procedures
- Patient education tools
- Transition to outpatient care (access)
- Point-of-Care BG Testing
- Institutional BG Targets (ICU, non-ICU)
- Hypoglycemia protocol
- ICU IV insulin order sets and protocols
- Standardized SQ insulin order sets and protocols

Questions

Resources for More Information

Resource	Contact Information
AACE Inpatient Glycemic Control Resource Center	http://resources.aace.com/
Georgia Hospital Association Diabetes Special Interest Group	http://www.gha.org/pha/health/diabetes/index.asp
Glucometrics Web site (free service to calculate inpatient glucose control data)	http://metrics.med.yale.edu/main/

AACE Inpatient Glycemic Control Resource Center

http://resources.aace.com/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Management of Inpatient Hyperglycemia 2012
A Webinar Educational Series intended for Physicians, Nurses, Pharmacists, CDEs and other interested health care providers
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