Inpatient Management of Hyperglycemia

Guillermo Umpierrez, MD, CDE

Saturday, February 10, 2018

10:30 a.m. – 11:15 a.m.

There are over 7.5 million hospital admissions for patients with diabetes in the US. About 20 to 30% of patients have prior history of diabetes. The prevalence of hyperglycemia is even higher and reported in 38% of patients in community hospitals, 41% of critically ill patients with acute coronary syndromes, and in 80% of patients after cardiac surgery. Diabetes imposes a substantial economic burden on society. The total estimated cost of diagnosed diabetes in 2012 in the US was $245 billion, of which $76 billion (41%) represented inpatient medical care. Extensive data from observational and randomized controlled trials indicate that inpatient hyperglycemia, in patients with or without a prior diagnosis of diabetes, is associated with an increased risk of complications and mortality. It is also well established that improvement in glucose control with goal-directed insulin regimens reduces hospital complications and mortality in critically ill, as well as in general medicine and surgery patients. Recent studies and meta-analyses have shown that intensive insulin therapy is associated with increased risk of hypoglycemia, which has been independently associated with increased morbidity and mortality in hospitalized patients.

In patients with adequate oral intake, the basal bolus approach is the preferred regimen as it addresses the three components of insulin requirement: basal, nutritional, and correctional doses. The use of basal-bolus insulin had greater improvement in blood glucose control than sliding scale alone. In general surgery patients, the basal bolus regimen resulted in significant improvement in glucose control and in a reduction in the frequency of the composite of postoperative complications including wound infection, pneumonia, respiratory failure, acute renal failure and bacteremia. In patients with reduced total caloric intake due to lack of appetite, acute illness, medical procedures or surgical interventions, the Basal Plus trial in patients with type 2 diabetes compared a standard basal bolus regimen with glargine once daily and glulisine before meals and a single daily dose of glargine and supplemental doses of glulisine for correction of hyperglycemia (>140 mg/dL) per sliding scale. There was similar improvement in glycemic control and in the frequency of hypoglycemia with Basal Plus regimen compared to basal bolus regimen.

The use of oral antidiabetic agents is generally not recommended in hospitalized patients due to the limited data available on their safety and efficacy. The safety and efficacy of sitagliptin, a DPP-4 inhibitor, for the management of inpatient hyperglycemia was recently evaluated in 3 randomized controlled studies in general medicine and surgery hospitalized patients with type 2 diabetes. These studies indicate that in patients with mild to moderate hyperglycemia (BG < 200 mg/dl), there was no difference in the mean BG concentration or in the occurrence of hospital complications.

Transition to an outpatient setting requires planning and coordination. Although insulin is used for most patients with diabetes in the hospital, many patients do not require insulin after discharge. Patients with acceptable diabetes control could be discharged on their pre-hospitalization treatment regimen (oral agents and/or insulin therapy). Patients with suboptimal control should have intensification of therapy, either by addition or increase in oral agents, addition of basal insulin, or a more complex insulin regimen as warranted by their admission glucose control. Our preliminary experience indicates that measurement of HbA1c on admission is useful in guding treatment regimen at the time of hospital discharge in patients with type 2 diabetes. Patients admitted with a HbA1c <7% can be discharged on the same pre-admission diabetes therapy. Those with HbA1c between 7%-9% can be discharged on oral agents plus basal insulin at 50% of the hospital basal insulin and patients with HbA1c >9% should be discharged on basal bolus insulin or in the combination of metformin plus basal insulin at 80% of hospital dose.

This lecture will i) review the results of recent randomized control studies, in non-ICU patients with hyperglycemia and diabetes, ii) will present easy to follow insulin- and non-insulin-based treatment regimens for the management of inpatient hyperglycemia; iii) will discuss treatment regimens for the management of patients with diabetes after hospital discharge

Management of Hyperglycemia and Diabetes in Non-ICU Settings: Current and Future Recommendations

Guillermo E. Umpierrez, MD, FACP, FACE
Professor of Medicine
Director, Clinical Research Diabetes & Metabolism Center
Emory University School of Medicine

Director, Diabetes & Endocrinology Section
Grady Health System

Dr. Guillermo Umpierrez, MD, CDE, FACE, FACP
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External Industry Relationships *	Company Name(s)	Role
Equity, stock, or options in biomedical industry companies or publishers	BMJ Open Diabetes Research & Care ADA AACE	Editor-in-Chief Professional Practice Committee Board of Directors Diabetes Council Committee
Industry funds to Emory University for my research	Merck, Sanofi, Novo Nordisk Boehringer Ingelheim Astra Zeneca	Investigator-Initiated Research Projects
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Lecture Agenda

- Scope of the Problem
  - Prevalence and impact of hyperglycemia
  - Glycemic targets in non-ICU
- Management of Hyperglycemia in Non-ICU
  - Basal Bolus Insulin Regimen
  - Alternatives to Basal Bolus
    - Basal Plus (basal + correction)
    - DPP4-inhibitors
  - Hospital Discharge Regimens

Case Presentation:

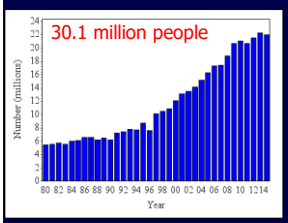
- 68 y/o male with an 8 yr history of DM admitted with SOB and CHF.
  Treated with metformin and sitagliptin.
- Lab: BG 172 mg/dL, A1c: 7.8%; serum creatinine 1.3 mg/dL, eGFR: 45 ml/min

- 42 y/o male with an 10 yr history of DM with diabetic foot and osteomyelitis left toe.
  Treated with metformin and glipizide.
- Lab: BG 294 mg/dL, A1c: 9.2%; serum creatinine 1.4 mg/dL, eGFR: 60 ml/min

What is the best treatment option for glycemic control?
Should both patients be treated with insulin and to the same glucose target?

Diabetes Epidemic in the U.S.

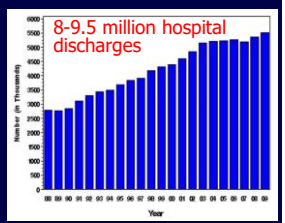
US Population



Diabetes Prevalence quadrupled, from 5.5 million to 21.9 million between 1980-2014

CDC's Division of Diabetes Translation. http://www.cdc.gov/diabetes/statistics.

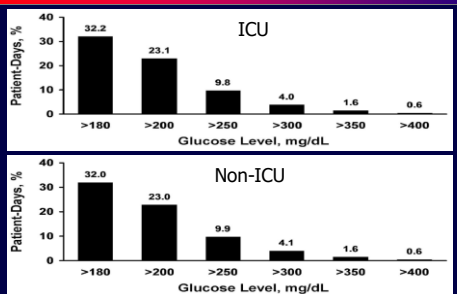
Inpatient Diabetes



- 23% of all discharges
- Annual cost: $124 billion *(2012)*

ADA. *Diabetes Care*. Mar 6 2013;
HCUP Nationwide Inpatient Sample (NIS) 2012. http://hcupnet.ahrq.gov/HCUPnet.jsp.

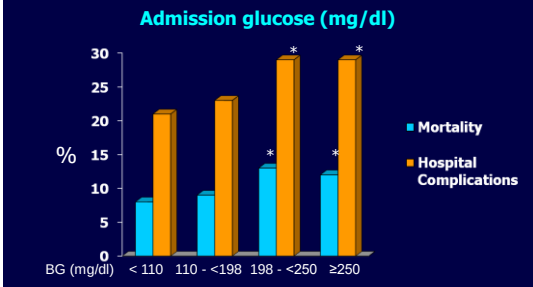
Distribution of patient-day-weighted mean POC-BG values for ICU



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

Swanson et al. Endocrine Practice, October 2011

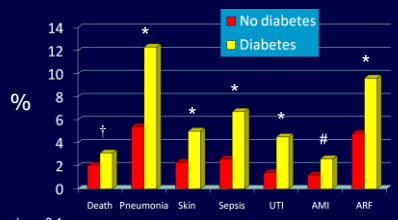
Hyperglycemia and Pneumonia Outcomes



* p: < 0.05 vs BG < 198 mg/dl (11 mmol/L)
N= 2,471 patients with CAP

McAllister et al, Diabetes Crae 28:810-815, 2005

Thirty Day Mortality and Inhospital Complications in diabetic and non-diabetic subjects Undergoing Non-Cardiac Surgery

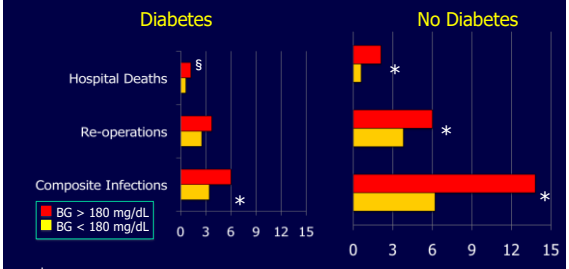


†p = 0.1
* p= 0.001
#p=0.017

3,184 non-cardiac surgery patients consecutively admitted to Emory University Hospital between 1/2007 and 6/2007.

A Frisch & Umpierrez et al. Diabetes Care, May 2010

Adverse Events Stratified by Perioperative Hyperglycemia

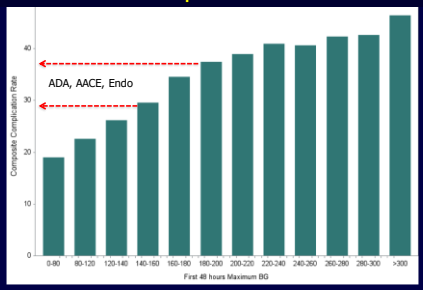


* P <0.01
§ p <0.05

BG at any point on the day of surgery, post-op day 1 and 2
N= 11,633, colorectal and bariatric surgery;
29.1% with hyperglycemia

Known et al. Ann Surg 2013

What Glucose Level Predicts Hospital Complications?



N= 55,530 patients records in ICU and non-ICU, Emory University Hospitals.
Composite of complications: pneumonia, acute renal or respiratory failure, acute MI, bacteremia, and death.

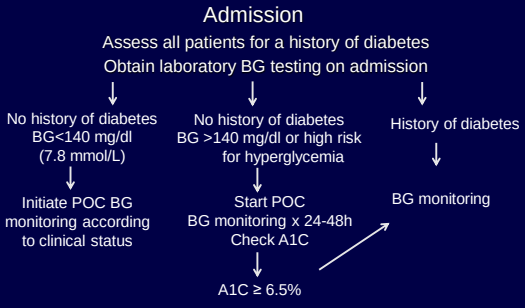
Umpierrez et al. Endocrine Society Annual Meeting, 2014

Glycemic Targets in Non-Critical Care Setting

1. Premeal BG target of <140 mg/dl and random BG <180 mg/dl for the majority of patients
2. 2016 American Diabetes Association – glucose target 140-180 mg/dl for most patients with T2D
3. Glycemic targets be modified according to clinical status.
   - Patients with terminal illness <180-200 mg/dl
4. For avoidance of hypoglycemia, therapy should be reassessed when BG<100 mg/dl

ADA/AACE Guidelines, Diabetes Care 2009;
Endocrine Society. J Clin Endocrinol Metabol, 2012; Under Revision 2018
2018 Standard of Diabetes Care, # 14, Hospital Management of Diabetes, Diabetes Care 2018

Diagnosis & recognition of hyperglycemia and diabetes in the hospital setting



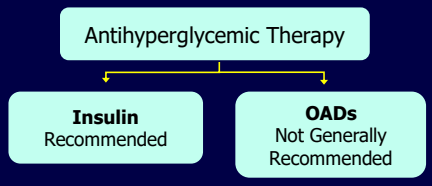
Umpierrez et al. J Clin Endocrinol Metabol. 97(1):16-38, 2012

A1C for Diagnosis and Management of Hyperglycemia in the Hospital

- Measure HbA1c in non-DM subjects with persistent BG >140 mg/dl and in DM subjects if not done within 2-3 mo.
- Implementation of A1C testing can be useful:
  - Assess glycemic control prior to admission
  - Assist with differentiation of newly diagnosed diabetes from stress hyperglycemia
  - Predicts inpatient glycemic control and hypoglycemia
  - Design an optimal regimen at hospital discharge

ADA Standard of Care, 14. Hospital Management of Diabetes. Diabetes Care January, 2018
Umpierrez et al, J Clin Endocrinol Metabol, February 2012
Pasquell et al. Diabetes Care 2014

Recommendations for Managing Patients With Diabetes in Non-ICU Setting



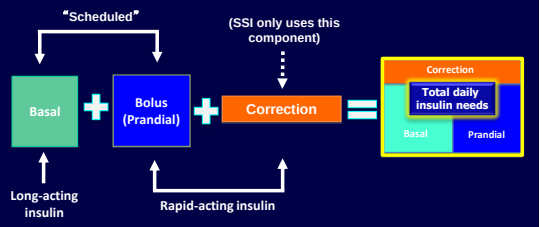
1. ACE/ADA Task Force on Inpatient Diabetes. Diabetes Care. 2009
2. Umpierrez et al. J Clin Endocrinol Metabol. 97(1):16-38, 2012

Management of Patients With Diabetes in Non-ICU Settings

- **Discontinue oral antidiabetic agents**
- **Insulin naïve:** starting total daily dose (TDD):
  - 0.3 U/kg to 0.5 U/kg
  - Lower doses in the elderly and renal insufficiency
- **Previous insulin therapy:** reduce outpatient insulin dose by 20-25%
- **Basal bolus regimen:** Half of TDD as basal and half as rapid-acting insulin before meals

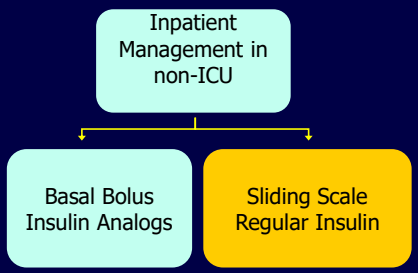
Umpierrez et al, Diabetes Care 30:2181–2186, 2007; Baldwin et al, Diabetes Care 10:1970-4, 2011; Rubin et al, Diabetes Care 34:1723-8, 2011; Umpierrez et al. J Clin Endocrinol Metabol. 97(1):16-38, 2012

SC Insulin Administration



Moghissi ES et al; American Association of Clinical Endocrinologists; American Diabetes Association. *Endocr Pract.* 2009;15(4):353–369.
Umpierrez et al. Endocrine Society Guidelines. J Clin Endocrinol Metabol. 97(1):16-38, 2012

Basal Bolus with Insulin Analogs vs. Sliding Scale Regular Insulin for the Management of Non-ICU Patients With Type 2 Diabetes



Randomized **B**asal **B**olus versus Sliding Scale Regular **I**nsulin in patients with **t**ype **2** Diabetes Mellitus (RABBIT-2 Trial)

- D/C oral antidiabetic drugs on admission
- Starting total daily dose (TDD):
  - 0.4 U/kg/d x BG between 140-200 mg/dL
  - 0.5 U/kg/d x BG between 201-400 mg/dL
- Half of TDD as basal insulin and half as rapid-acting insulin
  - Insulin glargine - once daily, at the same time/day.
  - Glulisine- three equally divided doses (AC)

Umpierrez et al, Diabetes Care 30:2181–2186, 2007

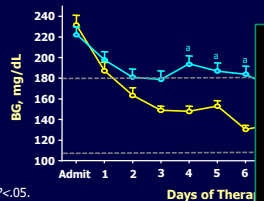
Sliding Scale Insulin Regimen

- **Before meal:** Supplemental Sliding Scale Insulin (number of units)
  - Add to scheduled insulin dose
- **Bedtime:** Give half of Supplemental Sliding Scale Insulin

Blood Glucose (mg/dL)	☐ Insulin Sensitive	☐ Usual	☐ Insulin Resistant
>141-180	2	4	6
181-220	4	6	8
221-260	6	8	10
261-300	8	10	12
301-350	10	12	14
351-400	12	14	16
>400	14	16	18

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

Rabbit 2 Trial: Changes in Glucose Levels With Basal-Bolus vs. Sliding Scale Insulin



[a] $P<.05$.
[b] $P<.05$.

Hypoglycemia rate:

- Basal Bolus Group:
  - BG < 60 mg/dL: 3%
  - BG < 40 mg/dL: none
- SSRI:
  - BG < 60 mg/dL: 3%
  - BG < 40 mg/dL: none

• Sliding scale regular insulin (SSRI) was given 4 times daily
• Basal-bolus regimen: glargine was given once daily; glulisine was given before meals.
0.4 U/kg/d x BG between 140-200 mg/dL
0.5 U/kg/d x BG between 201-400 mg/dL

Umpierrez GE, et al. *Diabetes Care*. 2007;30(9):2181-2186.

General Surgery

Basal Bolus Insulin Analogs | **Sliding Scale Regular Insulin**

RABBIT-2 Surgery Trial:

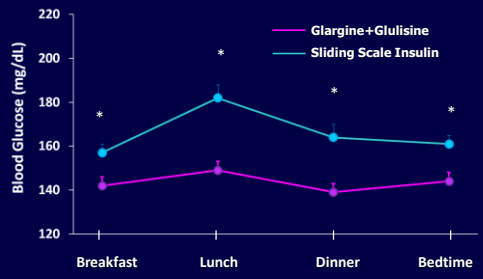
- Research Question:

T2DM on diet, oral agents or insulin treatment, does treatment with basal bolus regimen with glargine and glulisine is superior to SSRI?

Composite of hospital complications: wound infection, pneumonia, respiratory failure, acute kidney injury, and bacteremia

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011

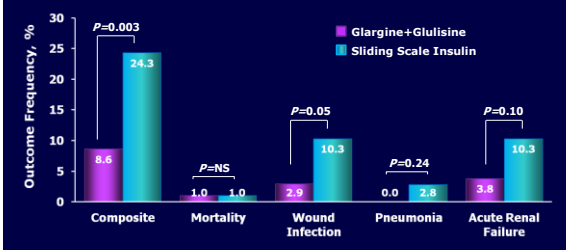
Mean BG before meals and at bedtime during basal bolus and SSI therapy



*p<0.001

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011

Postoperative Complications



* Composite of hospital complications: wound infection, pneumonia, respiratory failure, acute renal failure, and bacteremia.

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011

Hospitalization Outcomes and Costs

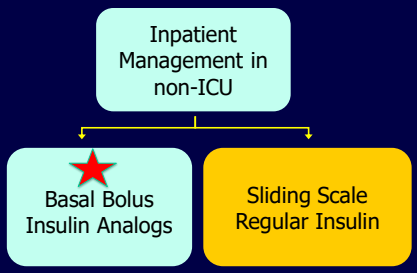
	All (n= 180)	Basal Bolus (n= 88)	SSI (n= 92)	p value
Length of hospital stay, days	7.9 ± 5.5	7.3 ± 5.1	8.5 ± 5.9	0.15
Patients with complications, n (%)*	28 (16%)	6 (7%)	22 (24%)	0.002
Postsurgical ICU admission, n (%)	23 (13%)	10 (11%)	13 (14%)	0.66
Total hospitalization costs, USD	24457 ± 18359	23226 ± 18745	25641 ± 17991	0.09
Inpatient cost per day	4541 ± 18359	3907 ± 6606	3724 ± 4020	

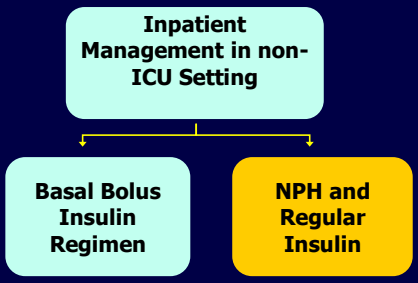
Treatment with BB compared with SSI reduced average total inpatient costs per day by $US751 (14%; 95% confidence interval 20–4).

Data presented as mean ± SD
*Wound infections, pneumonia, acute respiratory failure, acute renal failure, bacteremia

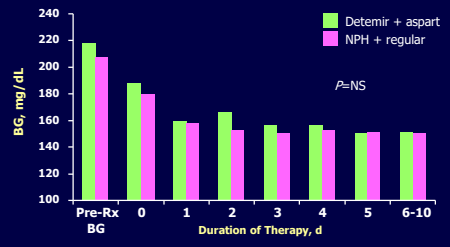
Phillips VL et al. PharmacoEconom Open, 1(2):109-115 , 2017

Basal Bolus with Insulin Analogs vs. Sliding Scale Insulin regimen in Non-ICU Patients With Type 2 Diabetes





DEAN Trial: Detemir + Aspart vs. NPH + Regular

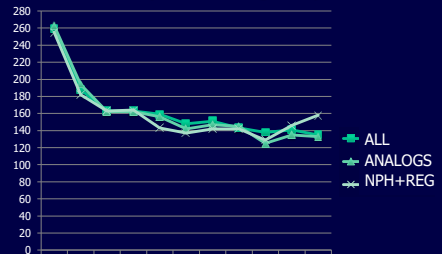


Data are means ±SEM.

Basal-bolus regimen: detemir was given once daily; aspart was given before meals.
NPH/regular regimen: NPH and regular insulin were given twice daily, two thirds in AM, one third in PM.

Umpierrez GE, et al. *J Clin Endocrinol Metab.* 2009;94(2):564-569.

RCT- Insulin Analogs (glargine + glulisine) vs. Human (NPH + regular) Insulin



	1	2	3	4	5	6	7	8	9	10	11
ALL	259	188	163	163	159	148	151	143	138	141	135
ANALOGS	263	194	162	162	156	142	147	145	125	135	133
NPH+REG	255	182	163	164	143	137	142	142	129	146	158

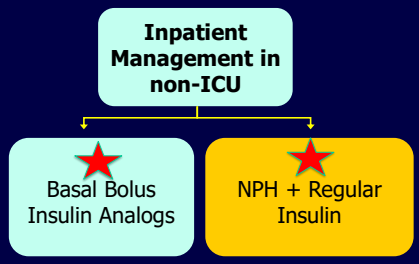
Bueno, Benitez eta al. Endocrine Practice, July 2015

Prevalence of Hypoglycemia in Patients Treated with Human and Analogs

	ALL N=134	Analogs N=66	Human n=68	p-value
Mild Hypoglycemia	37	35	38	p=0.68
Severe hypoglucemia	16	7.6	25	p=0.08
Patients withn ≥2 episodes, n (%)	19	10	16	p= 0.2

Bueno, Benitez eta al. Endocrine Practice, July 2015

Basal Bolus with Insulin Analogs vs. NPH+ Regular Insulin in Non-ICU Patients With T2D



Similar BG control, but less severe hypoglycemia with analogs

Management of Patients With Diabetes in the Non-ICU Setting

Insulin
Recommended

What is the best insulin formulation?

1. Basal Bolus preferred over SSI
2. Analogs vs. Human Insulin: Similar BG control, but less severe hypoglycemia with analogs

Limitations:
- Hypoglycemia Risk
- Regimen - Multiple injections
  - Over-treatment in many patients

Alternatives to Basal Bolus Insulin Regimen in Non-ICU Settings

- Basal Plus (basal + correction)
- DPP4-inhibitors

Insulin Treatment in in Non-ICU Setting

T2DM with BG > 140 mg/dl (7.7 mmol/l)

NPO
Uncertain oral intake

Adequate
Oral intake

Basal insulin
- Start at 0.2-0.25 U/Kg/day*
- Correction doses with rapid acting insulin AC
- Adjust basal as needed

Basal Bolus
TDD: 0.4-0.5 U/Kg/day
-½ basal, ½ bolus
-- adjust as needed

Umpierrez et al. J Clin Endocrinol Metabol. 97(1):16-38, 2012
ADA Standard of Care. Diabetes Care January 2017

Basal Plus Trial
Basal + Correction vs. Basal Bolus

Basal plus Correction
- Start glargine: 0.25 U/kg once daily
- Correction for BG >140 mg/dl per sliding scale

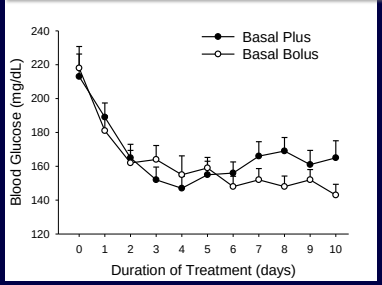
* Reduce TDD to 0.15 U/kg in patients ≥70 yrs and/or serum creatinine ≥ 2.0 mg/dL

Basal Bolus Regimen
- Start TDD: 0.5 U/kg
  - Glargine: 0.25 U/kg
  - Glulisine: 0.25 U/kg (AC)
  - Correction for BG >140 mg/dl per sliding scale

* Reduce TDD to 0.3 U/kg in patients ≥70 yrs and/or serum creatinine ≥ 2.0 mg/dL

Umpierrez et al, Basal Plus Trial. Diabetes Care 36(8):2169-74, 2013

Basal-PLUS vs Basal Bolus: 300 medical & surgical non-ICU patients



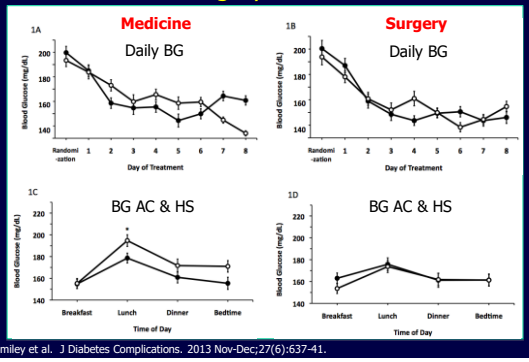
Basal Plus (n= 150)
glargine once daily
0.25 U/kg plus
glulisine supplements

Basal Bolus (n= 150)
TDD: 0.5 U/kg/d
Glargine 50%
glulisine 50%

Patients treated with diet, oral agents or with low-dose insulin ≤ 0.4 U/Kg/Day

Umpierrez et al. Diabetes Care. 2013 Aug;36(8):2169-74.

Basal-PLUS vs Basal Bolus: Medicine and Surgery Patients



Smiley et al. J Diabetes Complications. 2013 Nov-Dec;27(6):637-41.

Insulin Treatment in in Non-ICU Setting

T2DM with BG > 140 mg/dl (7.7 mmol/l)

NPO
Uncertain oral intake

Adequate
Oral intake

Basal insulin
- Start at 0.2-0.25 U/Kg/day*
- Correction doses with rapid acting insulin AC
- Adjust basal as needed

Basal Bolus
TDD: 0.4-0.5 U/Kg/day
-½ basal, ½ bolus

- Adjust basal as needed

ADA Standard of Care. Diabetes Care, January 2017

Management of Patients With Diabetes with Oral Agents in Non-ICU Settings

Inpatient Management in non-ICU

Basal Bolus Regimens
50% Basal
50% Prandial

Oral Agents:
DPP4-Inhibitors

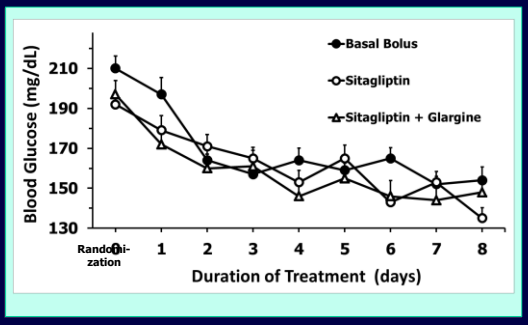
DPP-4 Therapy in Hospitalized Patients

- Study Type: Multicenter, prospective, open-label randomized clinical trial
- Patient Population: Patients with T2D admitted to general medicine and surgery services at 3 hospitals: Emory University, Grady, and University of Michigan
- Treatment Groups*
- Group 1. Sitagliptin once daily (n=30)
- Group 2. Sitagliptin plus glargine insulin once daily (n=30)
- Group 3. Basal bolus regimen with glargine once daily and lispro before meals (n=30)

* All groups received supplemental doses of lispro for BG > 140 mg/dl before meals

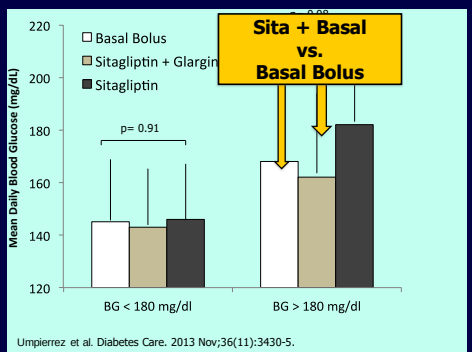
Umpierrez et al. Diabetes Care. 2013 Nov;36(11):3430-5.

Mean Daily BG During Treatment



Umpierrez et al. Diabetes Care. 2013 Nov;36(11):3430-5.

Randomization Blood Glucose (<180 mg/dl and >180 mg/dl) and Mean Daily Glucose concentration



Umpierrez et al. Diabetes Care. 2013 Nov;36(11):3430-5.

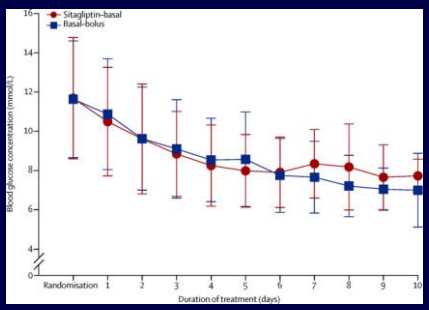
Sita Hospital Trial
Research Design and Methods

- Study Type: Multicenter, prospective, open-label randomized clinical trial
- Patient Population: Patients with T2DM admitted with BG between 140-400 mg/dl, treated with diet, OADs and insulin at TDD < 0.6 Unit/kg
- Treatment Groups*
  - Group 1. Sitagliptin plus glargine once daily (n=140)
  - Group 2. Basal bolus regimen with glargine once daily and rapid-acting insulin before meals (n=140)

* Both groups received supplemental (correction) doses of rapid-actin insulin for BG > 140 mg/dl before meals

Pasquel et al. Lancet Diabetetes & Endocrinology, 5 (2) 125-133, 2017

Sita-Hospital Trial: Mean Daily BG During Treatment



Pasquel et al. Lancet Diabetetes & Endocrinology, 5 (2) 125-133, 2017

Insulin Dose and # Injections/day

	Sitagliptin + Basal	Basal Bolus	P-value
Total daily dose, U/kg/day	0.2 ± 0.1	0.3 ± 0.2	< 0.001
Total daily dose, U/day	24.1 ± 16.2	34.0 ± 20.1	< 0.001
Basal- Glargine, U/day	17.9 ± 12.5	16.8 ± 10.4	0.94
Prandial- aspart/lispro, U/day		11.7 ± 7.9	<0.001
Supplements- U/day*	5.8 ± 5.7	5.5 ± 4.7	0.91
Number of Injections			
# injections/day (Hospital stay)	2.2 ± 1.0	2.9 ± 0.9	< 0.001
# injections/ day (Day 2-10)	2.1 ± 1.4	2.9 ± 1.1	< 0.001

Pasquel & Umpierrez et al. www.thelancet.com/diabetes-endocrinology Published online December 6, 2016

Linagliptin Surgery Trial

A Randomized Controlled Trial on the Safety and Efficacy of Linagliptin Therapy for the Inpatient Management of General Surgery Patients with Type 2 Diabetes

General Surgery Patients

Basal Bolus | **Linagliptin**

General surgery (non-cardiac) patients with T2DM admitted with BG between 140-400 mg/dl, treated with diet, OADs and insulin at TDD < 0.5 Unit/kg

Vellanki & Umpierrez et al. **ADA 2017 Scientific Meeting**

Linagliptin Inpatient Trial

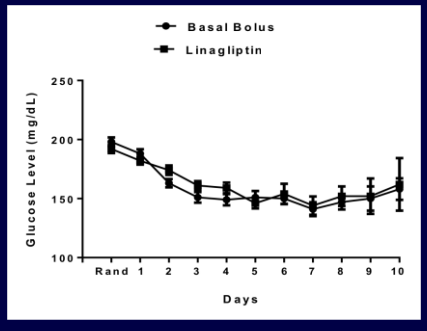
A Randomized Controlled Trial on the Safety and Efficacy of Linagliptin Therapy for the Inpatient Management of General Surgery Patients with Type 2 Diabetes

- **Linagliptin*:**
  - Linagliptin : 5 mg/day
- **Basal Bolus Regimen*:**
  - Total daily insulin dose: 0.4 unit/kg/day for BG between 140-200 mg/dl and 0.5 unit/kg/day for BG between 201-400 mg/dl
  - Half of total daily dose (TDD) given as glargine once daily
  - Half of TDD given as lispro in three equal doses before meals

*** Supplemental (correction) doses of rapid-acting insulin analog** per sliding scale given as needed before meals for BG > 140 mg/dl or bedtime > 200 mg/dl

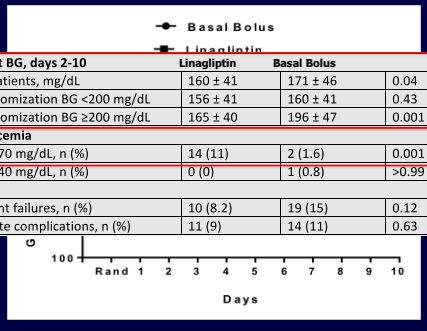
Vellanki & Umpierrez et al. **ADA 2017 Scientific Meeting**

Lina Surgery Trial: Daily Glucose Levels



Vellanki & Umpierrez et al. **ADA 2017 Scientific Meeting**

Lina Surgery Trial: Daily Glucose Levels



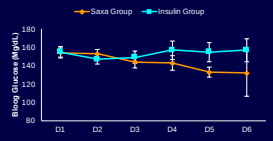
Inpatient BG, days 2-10	Linagliptin	Basal Bolus	
- All patients, mg/dL	160 ± 41	171 ± 46	0.04
- Randomization BG <200 mg/dL	156 ± 41	160 ± 41	0.43
- Randomization BG ≥200 mg/dL	165 ± 40	196 ± 47	0.001
Hypoglycemia			
- BG <70 mg/dL, n (%)	14 (11)	2 (1.6)	0.001
- BG <40 mg/dL, n (%)	0 (0)	1 (0.8)	>0.99
Treatment failures, n (%)	10 (8.2)	19 (15)	0.12
Composite complications, n (%)	11 (9)	14 (11)	0.63

63%

Vellanki & Umpierrez et al. **ADA 2017 Scientific Meeting**

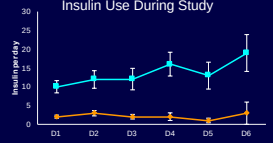
Saxagliptin in Non-Critically ill Hospitalized Patients with T2D and Mild Hyperglycemia

Mean Blood Glucose During Study



N= 62
Mean A1c: 6.6%
Random BG: 158 mg/dl

Insulin Use During Study



BMJ Diabetes Research & Care March 5 (1) e000394, 2017

Management of General Medicine Patients With T2D

Glucose <200 mg/dl → Basal* or DPP4-I*

Glucose >200 mg/dl → Basal* | Basal + DPP4-I | Basal Bolus

Basal*: Basal Insulin once daily PLUS correction per sliding scale

DPP4-I*: Sitagliptin or linagliptin PLUS correction per sliding scale

Management of Patients With Diabetes a After Hospital Discharge

Inpatient Management in non-ICU

Basal Bolus or Basal Plus Regimens

What Regimen Should We Use at Hospital Discharge?

Recommendations for Managing Patients With Diabetes After Hospital Discharge

Use admission A1C to adjust therapy at discharge

ADD basal or REPLACE with basal/bolus	10%
ADD basal insulin therapy	9%
Adjust original therapy, ADD another agent or basal insulin	8%
Return to original therapy	7%

Umpierrez G et al, J Clin Endocrinol Metabol, 2012

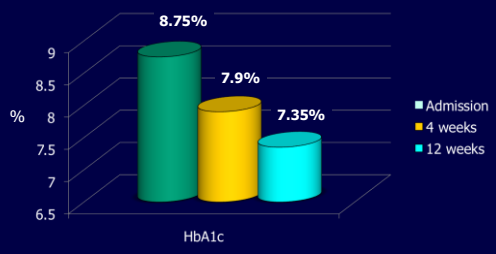
Discharge Insulin Algorithm

Discharge Treatment

A1C < 7%	A1C 7%-9%	A1C >9%
Re-start outpatient treatment regimen (OAD and/or insulin)	Re-start outpatient oral agents and D/C on glargine once daily at 50% of hospital dose	D/C on basal bolus at same hospital dose. Alternative: re-start oral agents and D/C on glargine once daily at 80% of hospital dose

Umpierrez et al, Diabetes Care. 2014 Nov;37(11):2934-9.

Hospital Discharge Algorithm Based on Admission HbA1C for the Management of Patients with T2DM



Umpierrez et al, Diabetes Care. 2014 Nov;37(11):2934-9.

Hospital Discharge Algorithm Based on Admission HbA1C for the Management of Patients with T2DM

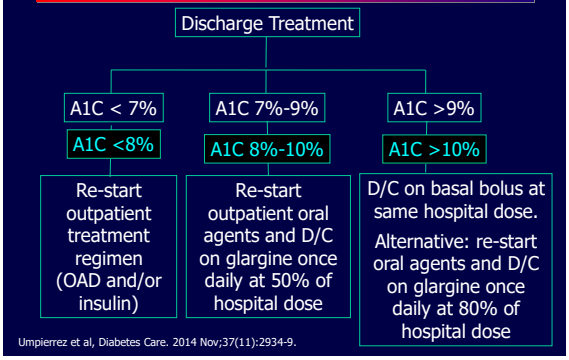
Primary outcome:
- change in A1C at 4 wks and 12 wks after discharge

	All Patients	OAD	OAD + Glargine	Glargine+ Glulisine	Glargine
# patients, n (%)	224	81 (36)	61 (27)	54 (24)	20 (9)
A1C Admission, %	8.7±2.5	6.9±1.5	9.2±1.9	11.1±2.3	8.2±2.2
A1C 4 Wks F/U, %	7.9±1.7*	7.0±1.4	8.0±1.4ψ	8.8±1.8ψ	7.7±1.7
A1C 12 Wks F/U, %	7.3±1.5*	6.6±1.1	7.5±1.6*	8.0±1.6*	6.7±0.8*

* p< 0.001 vs. Admission A1C; ψp=0.08

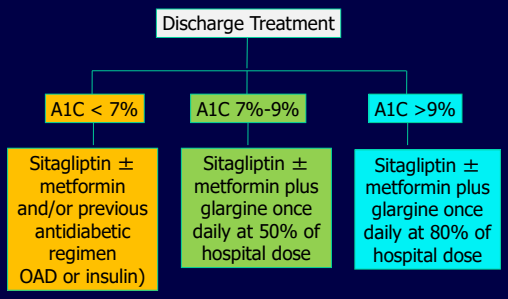
Umpierrez et al, ADA Scientific Sessions, 2012

Revised Discharge Insulin Algorithm



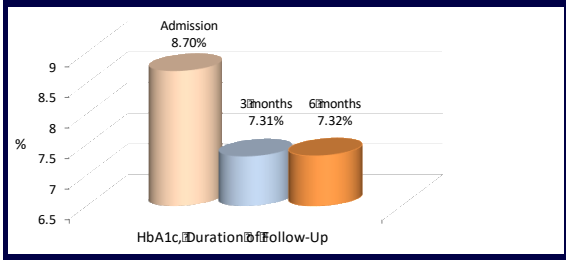
Umpierrez et al, Diabetes Care. 2014 Nov;37(11):2934-9.

Sitagliptin-Discharge Trial



Gianchandani et al, ADA 2016

Sitagliptin-Discharge Trial



Gianchandani et al, ADA 2016

Management of diabetes in non-critical care setting

So… What really have we learned?

Case Presentation:

- 68 y/o male with an 8 yr history of DM admitted with SOB and CHF.
  Treated with metformin and sitagliptin.
- Lab: BG 172 mg/dL, A1c: 7.8%; serum creatinine 1.3 mg/dL, eGFR: 45 ml/min
- 42 y/o male with an 10 yr history of DM with diabetic foot and osteomyelitis left toe.
  Treated with metformin and glipizide.
- Lab: BG 294 mg/dL, A1c: 9.2%; serum creatinine 1.4 mg/dL, eGFR: 60 ml/min

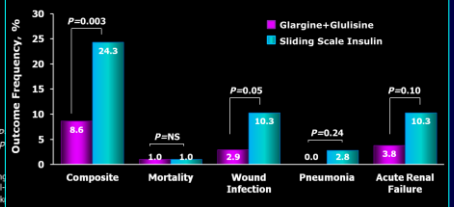
What is the best treatment option for glycemic control?

Should both patients be treated with insulin and to the same glucose target?

What Glucose Level Predicts Hospital Complications?

Rabbit 2 Trial: Changes in Glucose Levels With Basal Bolus vs Sliding Scale Insulin

Postoperative Complications

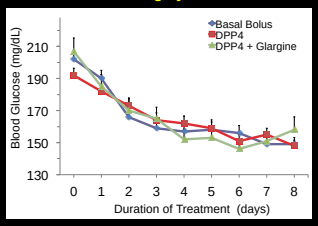


* Composite of hospital complications: wound infection, pneumonia, respiratory failure, acute renal failure, and bacteremia.

Umpierrez et al, Diabetes Care 34 (2):1–6, 2011

Basal-PLUS vs Basal Bolus:

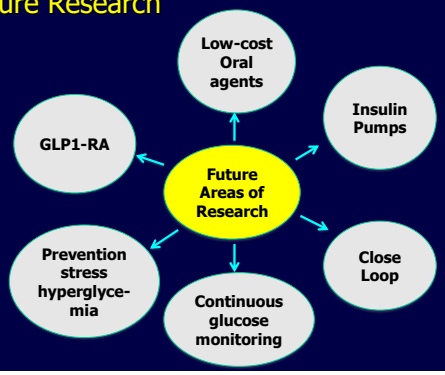
DPP4-inhibitors for the Inpatient Management of General Medicine and Surgery Patients with T2D



640 med-Surg patients, BG between 140 and 400 mg/d treated with diet, OADs or total insulin dose ≤0.5 unit/kg/day received DPP4-I alone (n=164), DPP4-I plus basal (n=167) or basal bolus (n=309). All groups received correction doses with rapid-acting insulin for BG>140 mg/dl.

Reyes-Umpierrez et al. ADA Scientific Meeting 2017

Hospital Management of Diabetes: Future Research



Thank you!

geumpie@emory.edu