Improved IPGM: Demonstrating the Value to both Patients and Hospitals

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Joslin Diabetes Center
Harvard Medical School, Boston, MA

Outlines

– Cost and epidemiology inpatient diabetes management

– Three successful models of better resource utilizations
  • Diabetes care by an endocrinology team versus hospitalists
  • EVADE protocol (management of DKA in ED)
  • Proper nutrition for patients with diabetes
Blood Glucose >180 mg/dL

Total estimated cost of diabetes in 2012 was $245 billion (41% up from 2007), with $176 billion direct cost and 69 billion reduced productivity.

Largest component of medical expenditures attributed to diabetes was hospital inpatient care (~43% of costs)
According to the CDC, diabetes ranked second after circulatory diseases as a first-listed diagnosis upon hospital discharge.

Discharges with diabetes as a first-listed diagnosis accounted for ~2.8 million days of hospital stay.

1 in 5 healthcare dollars is spent on diabetes.

$83 billion per year in hospital fees, 23% of total hospital spending.

Average stay: 5.3 days.

Average cost: $7,830.

2010 AHRQ Report: Hospital Stays for Patients with Diabetes, 2008

Resource Utilization for Inpatient Diabetes Management and its Impact on 30-day Readmission and Overall Cost.
756 Charts Reviewed
(Patients admitted to non-critical care

392 Eligible Charts
(Age >18, non-pregnant, Type 1 or 2 for >3 months)

262 Patients were matched

131 Primary Service Team (PST)
131 Diabetes Team (DT)

* Matching was based on the average 4 blood glucose readings after admission

Models of Inpatient Diabetes Management

Primary Service Team (PST)
- House staff
- General Discharge plan
- Follow up

Diabetes Team (DT)
- Endocrinologist
- Basic Diabetes Education
- Diabetes Discharge plan
- Transition of care
Baseline Characteristics of the Intervention Groups: Primary Service Team (PST) versus Diabetes Team (DT)

<table>
<thead>
<tr>
<th></th>
<th>PST</th>
<th>DT</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>131</td>
<td>131</td>
<td></td>
</tr>
<tr>
<td>Female gender (%)</td>
<td>45.0</td>
<td>42.0</td>
<td>NS</td>
</tr>
<tr>
<td>Age (years)</td>
<td>69.1±11.1</td>
<td>59.1±15.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Admitted to medicine service (%)</td>
<td>55</td>
<td>55</td>
<td>NS</td>
</tr>
<tr>
<td>Admitted to surgery service (%)</td>
<td>45</td>
<td>45</td>
<td>NS</td>
</tr>
<tr>
<td>Average of the first 4 blood glucose readings after admission (mg/dl)</td>
<td>202.8±52.4</td>
<td>202.6±60.5</td>
<td>NS</td>
</tr>
</tbody>
</table>

Data is presented as mean ± standard deviation  
NS= None Significant

Baseline HbA1C among Diabetic Patients Managed by Primary Service Team (PST) versus Diabetes Team

* p<0.001  
n= 262 (131 in each group)

Hamdy O et al, ADA 2013
Degree of Complexity during Hospitalization per Intervention Group: Primary Service Team (PST) versus Diabetes Team (DT)

<table>
<thead>
<tr>
<th></th>
<th>PST</th>
<th>DT</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>131</td>
<td>131</td>
<td></td>
</tr>
<tr>
<td>Most recent HbA1C (%)</td>
<td>7.4±1.3</td>
<td>8.7±2.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Patients with type 1</td>
<td>4.6</td>
<td>34.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Patients on oral hypoglycemic agents</td>
<td>21.4</td>
<td>9.9</td>
<td>0.011</td>
</tr>
<tr>
<td>Patients on basal insulin</td>
<td>45.8</td>
<td>58.0</td>
<td>0.048</td>
</tr>
<tr>
<td>Patients on insulin pump</td>
<td>0</td>
<td>7.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Patients on insulin drip</td>
<td>0</td>
<td>3.0</td>
<td>0.004</td>
</tr>
<tr>
<td>Patients with any infection</td>
<td>6.8</td>
<td>8.4</td>
<td>NS</td>
</tr>
<tr>
<td>Patients with any inpatient complication</td>
<td>20.6</td>
<td>60.6</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Patients seen by JDT have higher A1C, more of type 1 and more complicated

Data is presented as mean ± standard deviation   NS= None Significant
Chi-Square Goodness of Fitness Test used for significance testing
Hamdy O et al, ADA 2013

30-day Readmission Rate per Service among Diabetic Patients Managed by Primary Service Team (PST) versus Team (JDT) in non-ICU

<table>
<thead>
<tr>
<th></th>
<th>All Readmission 2011</th>
<th>All Readmission 2012</th>
<th>BST</th>
<th>JDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Service</td>
<td>16.6</td>
<td>15.1</td>
<td>22.5</td>
<td>32.4 *</td>
</tr>
<tr>
<td>Surgical Service</td>
<td>13.9</td>
<td>9.7</td>
<td>21.7</td>
<td>26.7 *</td>
</tr>
</tbody>
</table>

* *p<0.05
n= 262 (131 in each group)

Hamdy O et al, ADA 2013

Total Diabetes Admissions to non-ICU

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicine</td>
<td>6695</td>
<td>5567</td>
</tr>
<tr>
<td>Surgery</td>
<td>1080</td>
<td>880</td>
</tr>
</tbody>
</table>
Involvement of DT in Diabetes management in surgical patients is relatively late.

Transition of Care per Intervention Group: Primary Service Team (PST) versus Diabetes Team (DT)

<table>
<thead>
<tr>
<th></th>
<th>PST</th>
<th>JDT</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transition of Care:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL Patients (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCP/Surgery</td>
<td>69.5</td>
<td>87.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Endocrinologist</td>
<td>2.3</td>
<td>32.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Compliance with transition:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL Patients (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCP/Surgery</td>
<td>46.6</td>
<td>67.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Endocrinologist</td>
<td>2.3</td>
<td>22.9</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Patients seen by DT have better transition of care to PCPs and Endocrinologists

Data is presented as percent  
NS= None Significant  
*Fisher’s Exact Test used for frequency of events<5, otherwise chi-square used for significance testing

Hamdy O et al, ADA 2013
Estimated Cost Saving for Patients Managed by Diabetes Team (DT) in the non-ICU (Model Calculated Based on the Actual Consultations in 2011, 2012)

- Estimated net saving in 2011: $1,068,599*
- Estimated net saving in 2012: $1,178,566*

*Model is calculated based on the Average National cost of admission to non-critical care unit for 2010 ($7,830 per admission for diabetic patient)

Postulated Model of Cost Saving if Diabetes Team (DT) Manages All Patients with Diabetes Admitted to the Studied hospital (649 Beds)
(Model Calculated Based on the Actual Admissions in 2011, 2012)

<table>
<thead>
<tr>
<th></th>
<th>PST</th>
<th>DT</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost 2011</td>
<td>$60,878,250</td>
<td>$57,307,770</td>
<td>$3,570,480</td>
</tr>
<tr>
<td>Total Cost 2012</td>
<td>$50,480,010</td>
<td>$47,504,610</td>
<td>$2,975,400</td>
</tr>
</tbody>
</table>

Two Years Saving: $6.546 Million

*Average National cost of admission to non-critical care unit for 2010
Study Conclusions

- Management of patient with diabetes by specialized diabetes team reduces 30-day readmission by 30%

- Transition of care and adherence to post discharge appointments are significantly higher

- Significant cost saving and better resource utilization is achieved by shifting diabetes care to a specialized diabetes team

DKA Management and Emergency Valuable Approach and Diabetes Education (EVADE)
Goals

A significant percentage of admissions are avoidable in well-managed, coordinated health care systems

Goals

- To provide optimal and cost-effective management for DKA

- To reduce DKA admission by ~10% in order to reduce cost and improve and maintain good quality of care
Blood glucose >300 mg/dl
Bicarbonate ≤20 mEq/L

EVADE Protocol Implementation
EVADE

Cost savings: ~$12,000/patient (difference between ER only vs. ICU admittance)

<table>
<thead>
<tr>
<th>Emergency Department Team</th>
<th>Joslin Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify the potential cases (electronic algorithm)</td>
<td>1. Help identify the cause of DKA</td>
</tr>
<tr>
<td>2. Confirm the diagnosis according to the protocol</td>
<td>2. Provide the needed education to prevent its recurrence</td>
</tr>
<tr>
<td>3. Manage independently</td>
<td>3. Craft the insulin plan that the patient may use after discharge</td>
</tr>
<tr>
<td>4. Decide if admission is needed after observation for up to 24 hours</td>
<td>4. Follow-up with patient</td>
</tr>
</tbody>
</table>

- The dashboard reviews all patients every 60-90 seconds
- If it detects that a patient meets the enrollment criteria it will display a message “Consider DKA pathway”
The user can then:

- Enroll or Decline the patient
- MD’s will not be able to admit or discharge the patient without addressing the flag.
- Once a patient is enrolled, an auto-page is sent to the primary RN and to the Joslin EVADE Team

**Email Notification**

On Mar 21, 2014, at 6:00 PM, "notify@bidmc.harvard.edu"
notify@bidmc.harvard.edu> wrote:

Patient Name: John Doe
BIDMC MRN: 7543990
Joslin MRN: 23 23451
Patient DOB: 05/14/90
Location in ED: Hall 10
Pathway: DKA
Status: enrolled
User: Mary Noinsulin
Screening Criteria: 1 at 03/21/2014 17:29
Comments:
BIDMC Diabetic Ketoacidosis Clinical Pathway Flowchart
EVADE; (Emergency Valuable Approach and Diabetes Education)

This document serves only as recommendations for the adult and adolescent general populations, and should not replace clinician’s judgment when treating individual patients.

**This pathway assumes the following calculation for determining the anion gap: Na-C- HCO3. The BIDMC lab uses a different calculation so providers need to re-calculate lab results in order to determine the correct anion gap.

**Providers should use the Bicarbonate lab result produced by the Chem 7 and NOT the Venous Blood Gas.

ED Dashboard flags all patients with:
Blood glucose > 300 mg/dl
AND
Bicarbonate ≤ 20 mEq/L.

If meets above criteria, ENROLL in pathway. If meets above criteria but does not have DKA (blunt trauma, cardiac arrest, etc), DECLINE enrollment. DISPOSITION SHOULD NOT EFFECT WHETHER A PATIENT IS ENROLLED/DECLINED.

Do NOT give an initial bolus of either IV or subcutaneous insulin if any suspicion of even mild DKA. Initial management with IV fluids while awaiting labs.

For patients with mild acidosis but no anion gap, please start insulin drip and continue until bicarbonate level is 21 as endpoint.

Patient enrolled
Joslin consult automatically placed =
Will be seen in ED by NP or MD between 8:30 a.m. and 5 p.m. Page Joslin consult attending (81708) 24/7 for any questions related to consult or clinical issues.

Pathway declined
PATHWAY END

ED Obs Management

STOP
Mandatory Team Huddle: MD, RN, Tech

ICU Admission
Immediate ICU admission if:
- pH ≤ 7.2 or bicarbonate < 15
- Signs of MI
- Severely altered mental status or coma
- Signs of pneumonia, sepsis or severe infection (WBCs may be high in DKA without infection)
- Signs of respiratory failure
- Patients transferred from outside BIDMC system for admission
- Attending physician discretion

For ICU admissions:
**ED Obs Management**

**STOP**

Mandatory Team Huddle: MD, RN, Tech

**ICU Admission**

Immediate ICU admission if:
- pH < 7.3 or bicarbonate < 15
- Signs of MI
- Severely altered mental status or coma
- Signs of pneumonia, sepsis or severe infection (WBCs may be high in DKA without infection)
- Signs of respiratory failure
- Patients transferred from outside BIDMC system for admission
- Attending physician discretion

For ICU admissions:
- Fingersticks q1h, electrolytes and VBG q2h; aggressive fluid resuscitation, and closer monitoring of urine output
- Bicarbonate: for VBG pH < 6.9, give 100mEq NaHCO3 over 45 mins (ref), recheck in 30 min and repeat if < 6.9

**PATHWAY END**

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**Insulin/blood glucose management**

- **Fingerstick** – Repeat every 1 hour
- **Venous blood gas and electrolytes (including K, Mg, Phos)** – Check every 3 hours

<table>
<thead>
<tr>
<th>Insulin protocol (goal of 100-180 mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blood Glucose</strong></td>
</tr>
<tr>
<td>&gt; 300</td>
</tr>
<tr>
<td>450 – 500</td>
</tr>
<tr>
<td>400 – 450</td>
</tr>
<tr>
<td>350 – 399</td>
</tr>
<tr>
<td>300 – 349</td>
</tr>
<tr>
<td>250 – 299</td>
</tr>
<tr>
<td>200 – 249</td>
</tr>
<tr>
<td>150 – 199</td>
</tr>
<tr>
<td>100 – 149</td>
</tr>
<tr>
<td>&lt; 100</td>
</tr>
</tbody>
</table>

Even if patient is eating, if blood glucose drops to < 250mg/dl, change fluid to D5NS and continue insulin infusion.
- Once blood glucose reaches 250, discontinue D5NS, but do not stop insulin drip until acidosis resolves.
- For more severe hypoglycemia (number up to attending discretion) give a bolus of D50. After reaching the target blood glucose (100-180 mg/dl) resume insulin infusion at 1/2 previous rate.

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Joslin Diabetes Center
### IV Fluids
- Start normal saline (Lactated Ringers is also acceptable; goal for first 4 hours is 3.5 – 4 L; adjust for elderly, CHF, renal failure, also may give more than 4 liters if indicated).
- After first 4 hours, use ½ NS (or D5 ½ NS if BG < 250) at approximately 125-250 cc per hour. For mild dehydration and if tolerating po, may discontinue fluid at provider discretion.

### Electrolyte Repletion
- K+: Add to each liter of IVF if K < 5.0 AND patient has voided. Amount and rate of potassium repletion will be left to physician discretion. Keep in mind that as acidosis is corrected the measured potassium level will decrease. If the potassium is profoundly low, consider temporarily stopping the insulin drip.
  - May give oral K+as needed once able to tolerate oral intake
  - For persistent hyperchloremic acidosis consider using K phosphate or K acetate
- Phosphate: If < 1.0 replete with intravenous potassium phosphate or sodium phosphate, otherwise oral repletion is sufficient.
Every 4 Hours: Reassess Status and

- See “ICU Admission” above
- Any deterioration of metabolic parameters
- Significant concomitant illness
- Attending discretion

ICU admission
PATHWAY END

Once Anion Gap Closed (< 14, or patients with no gap and bicarb of 21):
1. Give long acting insulin:
   a. If patient on long acting insulin (glargine, detemir, NPH), give the same home dose unless the Joslin consult recommends something different in which case it should be followed.
   b. If patient is newly diagnosed with diabetes or new to insulin, calculate long acting insulin (Glargine: body weight in Kg x 0.2, but should only be done with recommendations from Joslin).
2. PO challenge (ok to do at any point in time when patient feels well enough to eat/sit drink).
3. If tolerates PO challenge, give short acting insulin (Humalog, same as lispro) [body weight in Kg x 0.2] before each meal.
4. Stop insulin drip IMPORTANT: if you inject long acting insulin only, continue insulin infusion for 2 hours then stop infusion. If you inject short and long acting insulin, continue insulin infusion for only 1 hour.
5. If patient is on insulin pump, Joslin CDE will guide the pump reinstallation (program and time).

2 hours after insulin drip stopped:
- Recheck electrolytes and blood sugar, ensure AG closed.

Disposition and Treatment Decision Determination

<table>
<thead>
<tr>
<th>Continued Observation</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH &gt; 7.1</td>
<td>pH &gt; 7.3*</td>
</tr>
<tr>
<td>Bicarb ≥ 15</td>
<td>Anion gap ≤ 14*</td>
</tr>
<tr>
<td>Oral intolerance or vomiting</td>
<td>Blood glucose &lt; 250 mg/dL*</td>
</tr>
<tr>
<td>Reassess disposition status every 4 hours up to total of 24 hours</td>
<td>Tolerating PO and made switch to subcutaneous insulin without re-developing hyperglycemia*</td>
</tr>
<tr>
<td></td>
<td>Joslin NP/MD consultation completed</td>
</tr>
<tr>
<td></td>
<td>Transition patient to their home regimen which should reflect the recommendations made by the Joslin consult</td>
</tr>
</tbody>
</table>

* Criteria must be present 2 hours after stopping insulin drip before discharge.
Education

- Individualized for each patient
- Identification of situation leading up to DKA
- Review insulin action and technique of administration
- Review sick days rules
- Review ways to prevent recurrence of episode (i.e. etiology, adequate BG testing, etc)
- Lack of generalized knowledge of urine ketone testing
- Provide supplies (glucometer)
Education

- **Insulin Pump**
  - Removal of entire infusion set
  - Evaluate site of infusion set
  - Evaluate cannulas
  - Observe technique of infusion set placement by patient (air in pump)

Discharge Plan

| Follow-up | Patients who do not see Joslin for diabetes care may choose to go to their regular PCP or Joslin for a follow up appointment
| Joslin educator will follow up with patients within 24 hours of discharge | Educational specialists will attempt to make contact with the patient via phone.
| | If no contact is made, a voicemail will be left for the patient.
<p>| | For patients seen on a Friday or weekend, BIDMC will notify Joslin that a priority follow up call should be made on Monday morning. |</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Yes</th>
<th>No</th>
<th>n/a or Unknown</th>
<th>QA Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrollment parameter met</td>
<td>82</td>
<td>10</td>
<td>6</td>
<td>100% - Meeting enrollment parameter</td>
</tr>
<tr>
<td>No insulin bolus given</td>
<td>66</td>
<td>10</td>
<td>6</td>
<td>13% - Still getting insulin bolus</td>
</tr>
<tr>
<td>Fingersticks performed every hour</td>
<td>61</td>
<td>15</td>
<td>6</td>
<td>20% - Not getting fingersticks every hour</td>
</tr>
<tr>
<td>VBGs and electrolytes drawn every 3 hours</td>
<td>62</td>
<td>14</td>
<td>6</td>
<td>18% - Not getting VBGs and electrolytes drawn every 3 hours</td>
</tr>
<tr>
<td>Insulin gtt adjusted appropriately to glucose level</td>
<td>67</td>
<td>9</td>
<td>6</td>
<td>12% - Insulin gtt not adjusted appropriate to glucose level</td>
</tr>
<tr>
<td>NS or LR given, at 3.5-4L within the first 4 hours</td>
<td>35</td>
<td>40</td>
<td>7</td>
<td>53% - Not getting NS or LR at 3.5-4L within the first 4 hours</td>
</tr>
<tr>
<td>Appropriate electrolyte repletion</td>
<td>65</td>
<td>11</td>
<td>6</td>
<td>14% - Not getting appropriate electrolyte repletion</td>
</tr>
<tr>
<td>D5 initiated and stopped according to parameters</td>
<td>36</td>
<td>4</td>
<td>42</td>
<td>10% - Not getting D5 and/or having D5 stopped according to parameters</td>
</tr>
<tr>
<td>Individual insulin pump stopped if present</td>
<td>28</td>
<td>40</td>
<td>14</td>
<td>59% - Not having individual insulin pump stopped (when present)</td>
</tr>
<tr>
<td>All 4 hour stops met with appropriate disposition (discharge/obs/admit)</td>
<td>67</td>
<td>14</td>
<td>1</td>
<td>17% - 4 hour stops not met with appropriate disposition</td>
</tr>
</tbody>
</table>

**Once anion gap has closed**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Yes</th>
<th>No</th>
<th>n/a or Unknown</th>
<th>QA Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate subcutaneous insulin given</td>
<td>17</td>
<td>1</td>
<td>5</td>
<td>1% - No subcutaneous insulin given</td>
</tr>
<tr>
<td>Insulin drip stopped per appropriate parameters</td>
<td>18</td>
<td></td>
<td>5</td>
<td>100% - Insulin drip stopped per appropriate parameters</td>
</tr>
<tr>
<td>Discharged per appropriate parameters</td>
<td>17</td>
<td>1</td>
<td>5</td>
<td>1% - Not discharged per appropriate parameters</td>
</tr>
</tbody>
</table>

**EVADE Results 9/1/13 - 3/24/14**

151 Flagged as potential candidates

54 Ineligible for pathway

97 Eligible for pathway

74 Admitted

23 Discharged

31% Discharged from ED

15 Not placed on pathway, but patient correctly dispositioned

82 Placed on pathway

61 Good pathway adherence (> 75% markers)

10 Fair pathway adherence (50-75% markers)

11 Poor pathway adherence (<50% markers)

31% treated and discharged from ED

74% Good adherence to EVADE pathway
Length of Hospital Stay

97 Eligible for pathway

23 Discharged from ED
LOS in ED – 20 hrs

74 Admitted

20 to non-ICU
LOS – 133 hrs

54 to ICU
LOS in ICU – 34 hrs

LOS in non-ICU reduced to 133 hrs
LOS in ICU + Post ICU reduced to 113 hrs

EVADE Program
43% Reduction in DKA Admissions
Decrease LOS

<table>
<thead>
<tr>
<th></th>
<th>Pre-EVADE LOS</th>
<th>Post-EVADE LOS</th>
<th>Reduction in LOS</th>
<th>6 mos DKA Admissions (9/1/13-3/24/14)</th>
<th>Decrease LOS impact*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>6.5</td>
<td>4.7</td>
<td>1.8</td>
<td>54</td>
<td>$108,000</td>
</tr>
<tr>
<td>Non-ICU</td>
<td>6.5</td>
<td>5.5</td>
<td>1.0</td>
<td>20</td>
<td>$24,092</td>
</tr>
</tbody>
</table>

National data (2010) DKA admission cost ICU $13,000 / 6.5 (LOS) = $2,000
National data (2010) DKA admission cost non-ICU $7,830 / 6.5 (LOS) = $1,204

Estimated EVADE impact for 6 mos $221,000. Annualized savings $464,185
EVADE Conclusions

- Treatment of mild and moderate DKA by ED team is feasible and reduces hospital admission for DKA management by 43%.

- Length of stay for admitted patients is lower by 1.8 days in ICU and 1 day in non-ICU.

- Cost saving per evaded single admission to the ICU is ~$12,000.

Objective and Methods

- **Design**
  - Retrospective review of all inpatients and hospital-based outpatients within Premier Research Database
  - N=>500 geographically diverse hospitals
  - Comparisons made between:
    - Diabetic patients fed diabetes specific formula (DSF)
    - Diabetic patients fed standard nutrition (STD)

- **Population**
  - All inpatients discharged - Jan 1, 00 and Dec 31, 09 (acute setting)
  - Diagnosis of diabetes (identified using ICD-9 code 249.x and 250.x).

Patients receiving STD or DSF nutrition were matched across many characteristics to isolate impact of nutrition type.

**Propensity score matching** was utilized to adjust for imbalances in the patient demographic and clinical characteristics. This score was used to match DSF fed patients and similar patients that received STD before modeling of outcomes.

<table>
<thead>
<tr>
<th>Matching Variables</th>
<th>Hospital Characteristics</th>
<th>Regression variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics/Patient Characteristics</td>
<td>• Regional Mix</td>
<td>• Discharge Status</td>
</tr>
<tr>
<td>• Age/Gender/Race</td>
<td>• Bed Size</td>
<td>• Admit Type and Source</td>
</tr>
<tr>
<td>• Primary Payor</td>
<td>• Urban</td>
<td>• Nutrition Duration (days)</td>
</tr>
<tr>
<td>• Diabetes type</td>
<td>• Teaching Status</td>
<td>• Infection</td>
</tr>
<tr>
<td>• APR-DRG Severity of Illness and Mortality Risk</td>
<td></td>
<td>• Amputation</td>
</tr>
<tr>
<td>• Insulin types</td>
<td></td>
<td>• Obesity</td>
</tr>
<tr>
<td>• Oral/parenteral non-insulin antidiabetic agents</td>
<td></td>
<td>• Malnutrition</td>
</tr>
<tr>
<td>• Co-morbidities (e.g., obesity, hypertension...)</td>
<td></td>
<td>• Renal failure</td>
</tr>
</tbody>
</table>
Population Flow

- Diabetic Population
  - 8.8 million discharges (2000-2009)

- Fed either STD or DSF
  - 191,473 discharges

- Tube Fed
  - 85,481 discharges

- Diabetic Nutrition
  - 37,171 discharges

- Standard Nutrition
  - 48,310 discharges

Results

- Feeding DSF to patients with diabetes results in significant* improvement in patient efficiency and cost of care

<table>
<thead>
<tr>
<th>Per patient</th>
<th>Tube Fed PWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Length of Hospital Stay</td>
<td>0.9 days</td>
</tr>
<tr>
<td>Total Hospital Costs</td>
<td>$2,586</td>
</tr>
</tbody>
</table>

* Average LOS and hospital cost statistically significant at P < 0.001
Using DSF drives reduction in room & board, pharmacy, and labor costs for tube fed PWD

Tube Fed PWD - $2,586 total savings per patient

Note: Analysis adjusted the Other cost consistent with total cost savings since all costs independently modeled. Other costs include Surgery, Lab, Diagnostic Imaging, and Cardiology. All cost values statistically significant at $< 0.0001 except TF Central Supply Costs ($ < 0.003). N for each sample population > 30k

Study Conclusions

- The use of diabetes-specific nutrition formula for tube feeding of hospitalized patients with diabetes reduces the length of stay (LOS) and the overall hospital cost in comparison to standard nutrition

- Considering that 43% of the $176 billion direct cost is attributed to hospital cost, this magnitude of saving is valuable and warrants better resource utilization for inpatient nutrition
Take Home Messages

- Better resource utilizations result in significant value to both patients and hospitals

- Managing diabetes by a specialized diabetes team versus primary service team and hospitalists reduces 30-day readmission, improves post-discharge adherence and reduces overall hospital cost

- Managing mild and moderate cases of DKA by a trained ED team supplement by diabetes education reduces admission to ICU, hospital LOS and increases patients’ quality of life

- Using diabetes-specific formula for tube feeding reduce LOS and overall hospital cost

Thank You