St Vincent’s Diabetes Service
Transplant & Inpatient Models of Care

ACI NSW Diabetes Forum
24th March, 2017
Prof Jerry Greenfield – Head of Department Endocrinology & Diabetes
Mrs Joanne Taylor – Nurse Manager Diabetes Service
Background

• Approx. **1.5 million** Australians have diabetes\(^1\) (1/3 undiagnosed)\(^2\).

• The number of Australians with diabetes is expected to grow to **3.5 million by 2033**\(^2\).

• Diabetes is the projected *leading cause of disease burden* for men and the second leading cause for women by 2023\(^3\).

• Patients with diabetes are *hospitalised more frequently* than patients without diabetes\(^4\).

• **15 - 31\%** of hospitalised Australian patients have *comorbid diabetes*\(^5\).

• *Hyperglycaemia* in hospitalised patients is associated with *increased adverse outcomes* and *LOS*\(^4\).
Aim: Within 2-years establish a best practice system to manage non-ICU inpatients with diabetes.

System Elements:

1. **Model of Care** - Inpatient Diabetes Management Policy
2. **Procedures** - Associated best practice procedures
3. **Education** – Coordinated program for clinicians
4. **Documentation** – tools, charts
5. **Equipment** - to support best practice care
6. **Auditing System** - to monitor best practice care
Implementation

- **Dedicated role** established to implement the plan
  - Inpatient Diabetes CNC – fulltime 2012

- Inpatient Diabetes **Working Party** - 2013
  - Core Group:
    - HOD Diabetes & Endocrinology
    - Deputy Director Diabetes Service
    - Inpatient Diabetes CNC
    - Senior Pharmacist/ CDE
    - Quality Manager
  - Associates:
    - ICU Director / CNC
    - ED Senior physician / pharmacist
    - Transplant consultant
System Elements in Focus

1. Inpatient Diabetes Model of Care (Policy)

• **The Who, What, When**
• Screening & Assessment
• Clinician education
• Patient/carer education
• Documentation & Reporting
• Referral & Care Coordination
2. Best Practice Procedures

The How

Revision & development of new procedures:

1. Hypoglycaemia Management
2. Blood Glucose & Ketone Monitoring
3. Hyperglycaemia & Insulin Management (with associated insulin prescribing guidelines)
4. Management of DKA/HHS
5. Inpatient Subcutaneous Insulin Pump
6. Supervised Self-administration of Insulin & GLP-1 agonists
Hypoglycaemia Treatment Flowchart

START

Is the patient's BGL < 4 mmol/L with a decreased level of consciousness?

YES

Call PACE and commence treatment OR in ED initiate rapid response and commence treatment

NO

Is the patient's BGL < 4 mmol/L with no decrease in level of consciousness?

YES

NO

Is the patient able to eat & drink (See Box A)?

YES

Give 15 g of quick-acting carbohydrate (one of the following):
- 1/3 can lemonade
- 3 sachets of sugar
- 1½ juice cups (165mL)
Recheck BGL in 15 mins
Notify MO, if BGL remains less than 5mmol/L after 3 cycles of above treatment

NO

Does the patient have patent wide bore IV access?

YES

Flush IV cannula with 5mL Sodium Chloride 0.9%
Order / Administer IV 50% Glucose 25mL – 50mL
Recheck BGL in 15 mins
Notify MO, if BGL remains less than 5mmol/L after 3 cycles of above treatment

NO

Order / Administer Glucagon 1mg IM
Obtain IV access
Recheck BGL in 15 mins

Box A
Do not give patients oral treatment for hypoglycaemia if they are:
- Unconscious
- Drowsy
- Nil By Mouth
- Tolerating sips of H2O only
- Unable to swallow safely
- Receiving nasogastric tube feeds
Diabetes or Hyperglycaemia Prescribing Guideline

This is a guide and does not substitute for clinical judgement – consider the individual patient situation

Patient is Eating

Give all usual diabetes medication unless contraindicated AND

Does patient have Type 2 diabetes or hyperglycaemia (BGL>10mmol/L)?

Yes

Is patient on NO insulin?

Withhold all non-insulin medication

No

Is patient on BASAL insulin once or twice daily?

Withhold meal time bolus insulin

Give 50-80% of usual basal insulin

Give 50% of each dose as Protaphane®

Is patient on PREMIXED insulin daily, bd or tds?

Is patient on BOLUS insulin daily, bd or tds?

Patient is Fasting

1. If on insulin monitor BGL 1-2 hourly and commence Glucose 5% IV if BGL<6mmol/L
2. Identify:
   a. Type of diabetes
   b. Usual diabetes medication (more than 1 may be required)

Does patient have Type 1 diabetes?

Yes

Is patient on BASAL + BOLUS insulin?

Give 80-100% basal insulin (never withhold) +
   Withhold meal time bolus insulin +
   Refer to Endocrine Team*

No

Is patient on an INSULIN PUMP?

Yes

Refer to Endocrine Team*

No

Special Information Links

- Supplemental Insulin Prescribing
- Elective Procedures
- Enteral/Parenteral Nutrition
- Patients on Corticosteroids
- IV Insulin Infusion Transition (non-DKA)
- Hypoglycaemia
- Management
- U-500 Insulin
- Insulin Profile chart
- Non-insulin medication list

1. Prescribe supplemental insulin for all patients (NovoRapid®, or usual bolus insulin preparation) at meal times – 07:00, 12:00, 17:00
2. Ensure dose is guided by pre-meal blood glucose level (BGL) and insulin sensitivity See Supplemental Insulin Prescribing
3. Each day add up all supplemental doses given in previous 24 hours, then either:
   a. If not usually on insulin: Divide total daily supplemental dose by 2 and prescribe as Protaphane® twice daily
   b. If usually on insulin: Add total daily supplemental dose to Basal or Premix insulin shared over the dose/s for the next 24 hours
4. Refer to Endocrine*: BGL >10mmol/L for 24 hours or more OR HbA1c >64mmol/mol (8%) OR if new to insulin

* Endocrine Registrar page 6810 or after hours Endocrinologist on call via switch

Supplemental Insulin - Prescribing Guideline

This is a guide and does not substitute for clinical judgement – consider each individual patient situation

Aim: To minimise hyperglycaemia by proactively adjusting usual insulin.

How: 1. **Prescribe** supplemental insulin for all patients (NovoRapid®, or usual bolus insulin preparation) at meal-times 07:00, 12:00, 17:00, or if NBM prescribe 6 hourly. **NOTE:** more frequent administration risks hypoglycaemia.
   2. Administer supplemental insulin as prescribed **in addition** to usual insulin doses.
   3. Each day **ADD UP** all supplemental doses given in previous 24 hours, **then either:**
      a. If not usually on insulin: Divide total daily supplemental dose by 2 and prescribe as Protaphane twice daily.
      b. If usually on insulin: Add total daily supplemental dose to basal or premix insulin shared over the dose/s for the next 24 hours

Dose: Determined by blood glucose level and patient’s insulin sensitivity (**see table below**).

<table>
<thead>
<tr>
<th>BGL (mmol/L)</th>
<th>Insulin sensitive or NBM e.g. underweight, elderly haemodialysis</th>
<th>Standard</th>
<th>Insulin-resistant e.g. obese on &gt;100 units/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 - 10</td>
<td>0 units</td>
<td>2 units</td>
<td>4 units</td>
</tr>
<tr>
<td>10.1 - 12</td>
<td>2 units</td>
<td>4 units</td>
<td>6 units</td>
</tr>
<tr>
<td>12.1 - 16</td>
<td>4 units</td>
<td>6 units</td>
<td>8 units</td>
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<tr>
<td>16.1 - 20</td>
<td>6 units</td>
<td>8 units</td>
<td>12 units</td>
</tr>
<tr>
<td>&gt;20</td>
<td>8 units</td>
<td>12 units</td>
<td>16 units</td>
</tr>
</tbody>
</table>
# Elective Procedure Diabetes Prescribing Guideline

This is a guide and does not substitute for clinical judgement – consider each individual patient situation

## TYPE 2 DIABETES

### Usual Medication
(more than one option may apply)

- **Non-insulin diabetes medication**
  - Diabetes tablets, Byetta®, Victoza®
  - (for diabetes medication list click here)

- **Basal insulin**
  - Lantus®, Levemir®, Protaphane®, HumULIN NPH®

- **Premixed twice daily insulin**
  - NovoMIX30®, HumALOG Mix 25®, Mixtard 30/70®, HumULIN 30/70®

- **Basal insulin + Bolus (mealtime) insulin**
  - Lantus®, Levemir®, NovoRAPID®, Apidra®, Protaphane®, HumALOG®, Actrapid®
  - HumULIN NPH®, HumULIN R®

### Test blood glucose level (BGL) 1-2 hourly from 0600 when fasting, if < 6mmol/L commence IV Glucose 5%

#### Fasting from midnight pre procedure

<table>
<thead>
<tr>
<th></th>
<th>Day before procedure</th>
<th>Day of procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-insulin diabetes medication</strong></td>
<td>Give usual non-insulin diabetes medication #</td>
<td>Withhold usual non-insulin diabetes medication #</td>
</tr>
<tr>
<td><strong>Basal insulin</strong></td>
<td>Give usual morning basal insulin</td>
<td>Give 50% morning basal insulin</td>
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<tr>
<td></td>
<td>Give 50-80% nocte basal insulin</td>
<td></td>
</tr>
<tr>
<td><strong>Premixed twice daily insulin</strong></td>
<td>Give usual morning premixed insulin</td>
<td>Give 50% of morning premixed insulin as Protaphane®</td>
</tr>
<tr>
<td></td>
<td>Give 50-80% nocte premixed insulin</td>
<td></td>
</tr>
<tr>
<td><strong>Basal insulin + Bolus (mealtime) insulin</strong></td>
<td>Give usual meal time insulin</td>
<td>Give 50% of morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give usual morning basal insulin</td>
<td>Give 50% of morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give 50-80% nocte basal insulin</td>
<td>Withhold breakfast meal time insulin</td>
</tr>
</tbody>
</table>

#### Fasting after early morning breakfast

<table>
<thead>
<tr>
<th></th>
<th>Day before procedure</th>
<th>Day of procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-insulin diabetes medication</strong></td>
<td>Give usual non-insulin diabetes medication #</td>
<td>Withhold usual non-insulin diabetes medication #</td>
</tr>
<tr>
<td><strong>Basal insulin</strong></td>
<td>Give usual morning basal insulin</td>
<td>Give 50% morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give 50-80% nocte basal insulin</td>
<td></td>
</tr>
<tr>
<td><strong>Premixed twice daily insulin</strong></td>
<td>Give usual premixed insulin</td>
<td>Give 50% of morning premixed insulin dose as Protaphane®</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Basal insulin + Bolus (mealtime) insulin</strong></td>
<td>Give usual meal time insulin</td>
<td>Give 50% of morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give usual morning basal insulin</td>
<td>Give 50% of morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give 50-80% nocte basal insulin</td>
<td>Withhold breakfast meal time insulin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subcutaneous Insulin Pump</strong></td>
<td>Contact Endocrine team for advice prior to planned procedure (Endocrine Registrar page 6810 or Endocrinologist on-call via switch)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not expose pump to plain X-Ray, MRI or CT-Scan. Advise patient to suspend pump (must not exceed 2-hrs) and remove from room.</td>
<td></td>
</tr>
</tbody>
</table>

# Withhold metformin for 24 hours before administration of IV contrast (especially if renal function impaired)

## TYPE 1 DIABETES

### Usual Medication
(more than one option may apply)

- **Basal insulin + Bolus (mealtime) insulin**
  - Lantus®, Levemir®, NovoRAPID®, Apidra®, Protaphane®, HumALOG®, Actrapid®
  - HumULIN NPH®, HumULIN R®

### Test blood glucose level (BGL) 1-2 hourly when fasting, if < 6mmol/L commence IV Glucose 5%

#### Fasting from midnight before procedure

<table>
<thead>
<tr>
<th></th>
<th>Day before procedure</th>
<th>Day of procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basal insulin</strong></td>
<td>Give usual mealtime insulin</td>
<td>Withhold breakfast mealtime insulin</td>
</tr>
<tr>
<td></td>
<td>Give usual morning basal insulin</td>
<td>Give 50-80% of morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give 80% nocte basal insulin</td>
<td></td>
</tr>
</tbody>
</table>

#### Fasting after early morning breakfast

<table>
<thead>
<tr>
<th></th>
<th>Day before procedure</th>
<th>Day of procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basal insulin</strong></td>
<td>Give usual meal-time insulin</td>
<td>Give usual morning basal insulin</td>
</tr>
<tr>
<td></td>
<td>Give 50-80% of morning basal insulin</td>
<td>Give 80% nocte basal insulin</td>
</tr>
<tr>
<td><strong>Subcutaneous Insulin Pump</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


24/03/2017
Insulin Infusion Transition Prescribing Guideline (Non DKA/HHS)

Use when ceasing insulin infusion

This is a guide and does not substitute for clinical judgement – consider the individual patient situation

Patient on IV Insulin infusion (non-DKA)

Does patient have:
- Type 1 DM
- Cystic Fibrosis

No →
Consult Endocrine* before stopping IV insulin

Yes →

For all other patients:
1. Prescribe Supplemental Insulin (NovoRapid®) pre-meals – see Table A.
2. Monitor BGL QID (pre-meals) + 2am.
3. Add total insulin administered in preceding 6 hours on infusion to get calculated dose.

example: 3 + 3 + 2.5 + 2.5 + 2.5 + 2.5 = 16 units

Is calculated dose more than 10 units?

No →
1. Stop insulin infusion
2. Ensure Supplemental insulin prescribed

Yes →
1. Prescribe calculated dose as Protaphane® bd (at least 8 hours apart), e.g. 16 units man and 16 units nocte.
2. Administer first dose 3 hours before stopping IV insulin.
3. Refer to Endocrine* for follow-up on ward.

Stop insulin infusion

Table A

<table>
<thead>
<tr>
<th>BGL (mmol/L)</th>
<th>Dose of supplemental insulin – tds pre meals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin sensitive or NBM e.g. overweight elderly, haemodialysis</td>
<td>Standard</td>
</tr>
<tr>
<td>8.1 – 10</td>
<td>2 units</td>
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<tr>
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<td>16.1 – 20</td>
<td>8 units</td>
</tr>
<tr>
<td>&gt;20</td>
<td>12 units</td>
</tr>
</tbody>
</table>

To contact Endocrine*:
- Endocrine Registrar page 6810 or via switch Mon-Fri 08:00-17:00
- Endocrine Consultant on call via switchboard out of hours 24/7


24th March 2017
Corticosteroid & Hyperglycaemia Prescribing Guideline

This is a guide and does not substitute for clinical judgement – consider each individual patient situation

Aim: To minimise glucocorticoid exacerbated hyperglycaemia.

Why: Glucocorticoids increase insulin resistance and glucose production and impair β-cell function. Effects vary depending on the pharmacodynamics of the preparation prescribed.

Management:

Patient commencing corticosteroids

Is the patient usually on insulin?

NO

YES

Refer to Endocrine, Registrar page 6810 or after hours Endocrinologist on call via switch

Monitor blood glucose level qid ongoing:

DAY 1 of corticosteroid use:
1. Prescribe supplemental insulin whether previously known to have diabetes or not.

DAY 2 of corticosteroid use:
1. Add all supplemental insulin doses given in the previous 24 hrs = total daily supplemental dose
e.g. Supplemental NovoRAPID™ 6 units breakfast + 8 units lunch + 10 units dinner = 24 units total daily supplemental dose.

Is corticosteroid prescribed once daily?

NO

YES

Corticosteroid prescribed more than once daily?

Prescribed total daily supplemental dose as Protaphane™ at the same time the corticosteroid dose is prescribed.
e.g. Prednisone 40mg at 08:00
Prescribe Protaphane™ 24 units at 08:00

1. Review insulin dose daily and adjust according to BGL and supplemental insulin requirements.
2. Reduce insulin dose proportionally as corticosteroid dose reduces.

When corticosteroid ceased:
1. Discontinue Protaphane™
2. Continue supplemental insulin
3. Monitor BGL qid for 24hrs then review

Divide total daily supplemental dose as Protaphane™ divided ½ mane and ½ nocte.
e.g. Prednisone 20mg bd (08:00 + 20:00)
Prescribe Protaphane™ 16 units at 08:00 and 8 units 20:00

3. **Clinician Education**

1. SVHNS established Nurse Clinical Lead Program (NSQHS Standards)
   - *Diabetes Nurse Clinical Leads* (n = 14)

2. Nurse orientation calendar

3. Medical education calendar

4. *‘Diabetes Matters’* monthly in-services

5. Diabetes Matters – *Tip of the Week*

6. Moodle (HETI) educational videos

7. Hyper & Hypo Mx incorporated into RAMPAC
   (Recognition & Management of Patient with Acute Conditions: A-G assessment)
4. Documentation Tools (Charts)

### DKA/HHS Intravenous Insulin Infusion Management Chart

**Insulin Concentration:** 250 units (2.5 mL) of Actrapid insulin in 250 mL of 5% glucose. Therefore 1 unit insulin per 1 mL.

**Commencement Rate:** _____ mL/HOUR

**Doctor Name (Print):** __________ Signature: __________ Date: __________

DO NOT CEASE INFUSION WITHOUT CONTACTING ENDOCRINE TEAM

| DATE: __________ |

<table>
<thead>
<tr>
<th>HOURS FROM START</th>
<th>0</th>
<th>1</th>
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<th>4</th>
<th>5</th>
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<td><strong>Document BGL Here</strong></td>
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<tr>
<td><strong>Plot BGL on graph</strong></td>
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</tbody>
</table>

| **Change to 5% Glucose when BGL <15mmol/L** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Insulin Infusion Rate (mL/hour)** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Insulin Infusion units/hour** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

| **pH** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **K (replace when K ≤ 4.5)** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **HCO₃⁻** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

| **2-Hourly** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **PO₄** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Mg** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Blood Ketone (DKA)** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Osmolality (HHS)** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **RN Initials:** |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

**Infusion Prepared by:** Signature: __________

**Infusion Checked by:** Signature: __________
# Insulin pump chart

**Subcutaneous Insulin Pump Settings Chart**

**Alerts**
- Patient to self-manage pump according to the parameters below.
- Do not expose pump to X-Ray, CTscan, MRI - advise patient to suspend pump, REMOVE and ensure it remains outside of the procedure room.
- Suspending pump for more than 2 hours may lead to DKA, contact Endocrine Registrar (page 6810 or Consultant on-call via Switchboard ext. 59) for an alternative subcutaneous insulin dose before pump is removed.

<table>
<thead>
<tr>
<th>Pump Make / Model:</th>
<th>Insulin Type:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On Admission</strong> (MO or DE to complete)</td>
<td><strong>Adjustment (MO only to complete)</strong></td>
</tr>
<tr>
<td><strong>Date/Time:</strong></td>
<td><strong>Date/Time:</strong></td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td><strong>Insulin</strong></td>
</tr>
<tr>
<td>-</td>
<td>units</td>
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<td>-</td>
<td>units</td>
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<tr>
<td>-</td>
<td>units</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insulin Sensitivity Factor (ISF):</th>
<th>Blood Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td><strong>Insulin</strong></td>
</tr>
<tr>
<td>-</td>
<td>units</td>
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<tr>
<td>-</td>
<td>units</td>
</tr>
<tr>
<td>-</td>
<td>units</td>
</tr>
</tbody>
</table>

**Active Insulin Time:**

**MRN | SURNAME**

**GIVEN NAME(S)**

**DOB | SEX | AMO | WARD/CLINIC**

*(Please enter information or affix Patient Information Label)*
5. Equipment

1. Appointed a Blood Glucose Meter Point of Care Coordinator (QC & QA programs)

2. Implemented Standardised Hypoglycaemia Kits in all acute areas
6. System to Monitor (Clinical Audits)

- Biannual Hypoglycaemia Management Audits

![Graph showing Best Practice Hypoglycaemia Management](image)
6. System to Monitor (Clinical Audits)

- Annual DKA/HHS Management Audit

![Graph showing Best Practice DKA / HHS Bundle for 2013, 2014 & 2015.](image)

*Tests are performed with unequal sample sizes.*
6. System to Monitor (Clinical Audits)

- Annual Insulin Prescribing Audits (IVII Transition) etc…

![Graph showing blood glucose levels over time](image-url)
6. System to Monitor (Clinical Audits)

- Biennial Diabetes Point Prevalence & Patient Experience Surveys
### 6. System to Monitor (Clinical Audits)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Xavier 10N</td>
<td>11</td>
<td>33</td>
<td>26.5%</td>
<td>33.3%</td>
<td><strong>33.3%</strong></td>
</tr>
<tr>
<td>Xavier 10S</td>
<td>11</td>
<td>30</td>
<td>45.2%</td>
<td>34.4%</td>
<td><strong>36.7%</strong></td>
</tr>
<tr>
<td>Xavier 9N</td>
<td>10</td>
<td>31</td>
<td>26.5%</td>
<td>17.6%</td>
<td><strong>32.3%</strong></td>
</tr>
<tr>
<td>Xavier 9S</td>
<td>2</td>
<td>16</td>
<td>39.4%</td>
<td>34.8%</td>
<td><strong>12.5%</strong></td>
</tr>
<tr>
<td>Xavier 8N</td>
<td>10</td>
<td>30</td>
<td>7.1%</td>
<td>12.5%</td>
<td><strong>33.3%</strong></td>
</tr>
<tr>
<td>Xavier 8S</td>
<td>7</td>
<td>34</td>
<td>18.2%</td>
<td>10%</td>
<td><strong>20.6%</strong></td>
</tr>
<tr>
<td>Xavier 7N</td>
<td>8</td>
<td>31</td>
<td>30.3%</td>
<td>18.2%</td>
<td><strong>25.8%</strong></td>
</tr>
<tr>
<td>Xavier 7S</td>
<td>7</td>
<td>33</td>
<td>14.3%</td>
<td>14.3%</td>
<td><strong>21.2%</strong></td>
</tr>
<tr>
<td>Intensive Care</td>
<td>7</td>
<td>17</td>
<td>22.2%</td>
<td>26.7%</td>
<td><strong>41.1%</strong></td>
</tr>
<tr>
<td>Emergency *</td>
<td>3</td>
<td>22</td>
<td>12.5%</td>
<td>19.2%</td>
<td><strong>13.6%</strong></td>
</tr>
<tr>
<td>PECC</td>
<td>2</td>
<td>6</td>
<td>16.7%</td>
<td>20%</td>
<td><strong>33.3%</strong></td>
</tr>
<tr>
<td>Caritas</td>
<td>2</td>
<td>27</td>
<td>7.7%</td>
<td>4%</td>
<td><strong>7.4%</strong></td>
</tr>
<tr>
<td><strong>Sub Acute Units</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rehab</td>
<td>9</td>
<td>32</td>
<td>26.7%</td>
<td>20%</td>
<td><strong>28.1%</strong></td>
</tr>
<tr>
<td>Pall Care</td>
<td>4</td>
<td>26</td>
<td>11.4%</td>
<td>11.1%</td>
<td><strong>15.4%</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>93</td>
<td>368</td>
<td>22.8%</td>
<td>19.4%</td>
<td><strong>25.3%</strong></td>
</tr>
</tbody>
</table>
Background – Transplant MOC

• Incidence of new-onset diabetes mellitus following transplantation (NODAT):
  – 30-40% after heart and lung transplantation
  – ~25% after kidney and liver transplantation

• Risk factors for NODAT: age, weight, ethnic background, family history, co-infection with hepatitis C and treatments that promote diabetes, including steroids

• Diabetes results in increased risk of infection, graft failure and reduced survival after transplantation
Does treatment of diabetes improve survival?

**Background – Transplant MOC**

Diabetes Is a Major Risk Factor for Mortality After Lung Transplantation

K. L. Hackman¹,², M. J. Bailey³, G. I. Snell¹,⁴ and L. A. Bach¹,²,⁺

**Table 6:** Mortality and mean survival in patients with CF

<table>
<thead>
<tr>
<th>Diabetes status</th>
<th>n</th>
<th>Mortality, n (%)</th>
<th>Mean survival days (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No diabetes</td>
<td>16</td>
<td>4 (25)</td>
<td>3547 (2882–4211)</td>
</tr>
<tr>
<td>DM pre- and post-LTx</td>
<td>37</td>
<td>14 (38)</td>
<td>2318 (1805–2832)</td>
</tr>
<tr>
<td>New onset DM post-LTx</td>
<td>38</td>
<td>17 (45)</td>
<td>2617 (2094–3141)</td>
</tr>
<tr>
<td>Preadeath Divi</td>
<td>1</td>
<td>1 (100)</td>
<td>8</td>
</tr>
<tr>
<td>DM early mortality</td>
<td>1</td>
<td>1 (100)</td>
<td>96</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>93</td>
<td>37 (40)</td>
<td>2801 (2427–3176)</td>
</tr>
</tbody>
</table>

CF, cystic fibrosis; CI, confidence interval; DM, diabetes mellitus; LTx, lung transplant.
Implementation

• Commenced in 2014
  • *Collaboration* between Department of Endocrinology and Heart-Lung Transplant team
  • Initially lung only – heart in last 12 months
  • Initial *funding* from Curran Foundation, Transplant Medicine and Department of Endocrinology

• Main objectives:
  • Screen for and treat diabetes *prior to transplant*
  • *Identify* patients at high risk of NODAT (e.g. IGT, CFRH)
  • Screen for and *treat NODAT*
  • Screen for and *treat osteoporosis*

*TO PROVIDE A CONTINUUM OF CARE FROM TIME OF LISTING TO POST-TRANSPLANTATION*
<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>0730</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LTX/CTX case conference (meeting room 3)</td>
</tr>
<tr>
<td>0900</td>
<td>Bone &amp; Calcium (fortnightly)</td>
<td>TEND clinic (weekly)</td>
<td>Diabetes clinic (fortnightly)</td>
<td>Endocrine Case Conference (Garvan Institute)</td>
<td>TEND clinic (weekly)</td>
</tr>
<tr>
<td>1115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td>Bone &amp; Calcium case discussion</td>
<td>1330 – 1430 Diabetes Meeting (Garvan Institute AZA boardroom)</td>
<td>1300-1400 Endo Meeting (Garvan Institute AZA boardroom)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1400</td>
<td>Ward Round</td>
<td>Ward Round</td>
<td>Endocrine clinic (weekly)</td>
<td>Stabilization Research Admin catch-up</td>
<td>Ward Round</td>
</tr>
</tbody>
</table>
Proposed Diagnostic Criteria

- CF pts – earlier blood glucose peak at 60 or 90 min
- Early glucose abnormalities associated with ↓ body weight & lung function in preceding 12 months
- BGL testing at 30 min intervals
- $BG_{\text{max}}$ (peak BGL during OGTT) ≥ 8.2mmol/L
- Correlates with Lung function decline
- Higher Sensitivity and Specificity

Hameed S et al. Pediatric Pulmonology 2011
Diagnostic Criteria

Have you screened your patients for diabetes?

PRE LUNG TRANSPLANT

Search results to determine if meets ADA Criteria for diabetes
HbA1c ≥ 6.5% or
Fasting plasma glucose (FPG) ≥ 7.0 mmol/L or
OGTT at 2h ≥ 11.1 mmol/L or
Random plasma glucose (RPG) ≥ 11.1 mmol/L

One or more of the criteria

Diabetes
Advise Transplant Endo Reg at pager 6830

None of the criteria

Request for OGGT

CF patients

If FPG ≥ 7.0 mmol/L or
OGTT at 2h ≥ 11.1 mmol/L

Diabetes
Advise Transplant Endo Reg at pager 6830

OGTT with 60, 90 and 120 min time points
OGTT at 60 or 90 min ≥ 8.2 mmol/L

CFRH
Advise Transplant Endo Reg at pager 6830

If FPG < 7.0 mmol/L or
OGTT at 60 or 90 min < 8.2 mmol/L or
OGTT at 2h < 11.1 mmol/L

No Diabetes
Reassess Post Transplant

Non CF patients

If FPG ≥ 7.0 mmol/L or
OGTT at 2h ≥ 11.1 mmol/L

Diabetes
Advise Transplant Endo Reg at pager 6830

If FPG < 7.0 mmol/L or
OGTT at 2h < 11.1 mmol/L

No Diabetes
Reassess Post Transplant
Prevalence of diabetes pre-lung transplant

Actively waitlisted lung transplant patients with CF*
N = 30

- CFRD
  N=18 (60%)
- CFRH
  N=9 (30%)
- No CFRD
  N=3 (10%)

Actively waitlisted lung transplant patients* without CF
N = 50

- DM
  N=8 (16%)
- IGT/IFG
  N=12 (24%)
- No DM
  N=30 (60%)

24th March 2017
Prevalence of diabetes post lung transplant

Transplanted patients with CF
N = 25

- Pre-existing CFRD
  N=14 (56%)

- CFRH pre-transplant & CFRD post-transplant
  N=7 (28%)

- No known CFRD/CFRH pre-transplant & CFRD post transplant
  N=3 (12%)

- No known CFRD/CFRH pre-transplant
  no diabetes post transplant
  N=1 (4%)

Transplanted patients without CF
N = 53

- Pre-existing DM
  N=3 (6%)

- Pre-diabetes pre-Tx & NODAT post Tx
  N=3 (6%)

- No/unknown DM pre -Tx & NODAT post -Tx
  N= 27 (51%)

- No/unknown DM pre-Tx
  Pre-diabetes post Tx (OGTT)
  N=5  (9%)

- No/unknown DM pre or post-Tx ( no OGTT)
  N=9 (17%)

- Pre-diabetes pre-Tx & Post-Tx
  N=1 (2%)

- No/unkown DM pre & post-Tx; (OGTT)
  N=5 (9%)
Use of empagliflozin post-heart transplantation

- *Diabetes* remains *common after cardiac transplantation*

- Diabetes may *adversely affect* future cardiovascular risk, graft function, and *post transplant survival*

- *Empagliflozin* is a novel diabetes agent that induces glycosuria via inhibition of the SGLT-2 receptor within the proximal tubule of the kidney

- *Benefits* in the *non-transplant setting* include significant reduction in major adverse cardiovascular events\(^1\), all cause mortality and progression of diabetic nephropathy\(^2\)

---

\(^1\)N Engl J Med 2015; 373:2117-28

\(^2\)N Engl J Med 2016; 375:323-34
Methods

• **Study Design:** single centre observational study of consecutive heart transplant recipients with diabetes attending an outpatient heart transplant clinic over the period spanning 01/01/2016 – 31/08/2016

• **Outcome Measures:** Pre-post comparison in clinical and biochemical outcomes following ≥ 3 months of follow-up for patients treated with empagliflozin and for those treated using conventional diabetes management without empagliflozin
Cohort

• **Clinic Attendance:** 316 heart transplant recipients

• **Diabetes Prevalence:** 106/316 patients (33%)

• **Empagliflozin Group:** 19 heart transplant recipients exposed to empagliflozin, with pre-post data available for 16

• **Non-empagliflozin Group:** 87 heart transplant recipients treated using conventional treatment (without empagliflozin), with pre-post data available for 74
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Empa (n = 16)</th>
<th>Non-Empa (n = 74)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>55 (±13)</td>
<td>58 (±10)</td>
<td>0.29</td>
</tr>
<tr>
<td>Male sex (%)</td>
<td>13 (81.3)</td>
<td>53 (71.6)</td>
<td>0.43</td>
</tr>
<tr>
<td>Diabetes duration (yrs)</td>
<td>7.1 (±6.2)</td>
<td>8.7 (±7.7)</td>
<td>0.42</td>
</tr>
<tr>
<td>Years since transplant</td>
<td>8.2 (±8.1)</td>
<td>9.6 (±7.7)</td>
<td>0.52</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>7.3 (±1.0)</td>
<td>6.8 (±1.2)</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Diabetes Treatment (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin</td>
<td>5 (31.3)</td>
<td>37 (50.0)</td>
<td>0.17</td>
</tr>
<tr>
<td>Metformin</td>
<td>11 (68.8)</td>
<td>27 (36.5)</td>
<td>0.02*</td>
</tr>
<tr>
<td>Sulfonylurea</td>
<td>5 (31.3)</td>
<td>9 (12.2)</td>
<td>0.06</td>
</tr>
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<td>DPP4 inhibitor</td>
<td>2 (12.5)</td>
<td>5 (6.8)</td>
<td>0.44</td>
</tr>
<tr>
<td>GLP1 agonist</td>
<td>0 (0.0)</td>
<td>1 (1.4)</td>
<td>0.64</td>
</tr>
<tr>
<td>Diet controlled</td>
<td>2 (12.5)</td>
<td>11 (14.9)</td>
<td>0.81</td>
</tr>
<tr>
<td><strong>Prednisone use (%)</strong></td>
<td>11 (68.8)</td>
<td>39 (52.7)</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Diuretic use (%)</strong></td>
<td>6 (37.5)</td>
<td>28 (37.8)</td>
<td>0.98</td>
</tr>
</tbody>
</table>
Summary

- **Almost ALL (88%) CF patients** will **have diabetes** post lung transplantation

- **EVERY CF patient** with CF-related Hyperglycemia (pre-DM) pre-lung transplant **will develop diabetes post-lung transplant**

- **> 60%** of non-CF recipients develop NODAT

- Empagliflozin appears safe post-heart transplantation and may have metabolic benefits
Proposed Impact

• Improved, more **efficient** and **integrated care** of (lung) transplant patients on campus
  – Improved **quality of life**
  – **Lower admission** rates for diabetes, infection and fractures

• **Improved survival** of transplant patients

• **Model for integrated care** of transplant patients in:
  – Other SVH transplant populations e.g renal, haematology
  – Other transplant units (SVH Melbourne, NADC)
  – Other patient groups with high rates of diabetes e.g. oncology
References


