Quality control program to manage metformin stimulated 18-FDG bowel uptake in PET/CT imaging
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Metformin and Gut

- Metformin ↑ bowel glucose uptake from the bloodstream, ↓ luminal glucose uptake, and ↑ enterocyte glucose consumption.
  - Metformin ↑ 18-FDG uptake in the bowel (colon > small bowel)
  - May mimic or mask malignancy in the GI tract

- Discontinuing Metformin 48 hours prior to PET/CT scans has been shown to reduce this Metformin effect
Addressing the Problem…
Quality Improvement

• Adapt the methods from the literature into a viable change in clinical practice

• Use the PDSA or **Deming Wheel** Method to introduce and monitor changes

• Resources from the Institute for Healthcare Improvement
  • http://www.ihi.org/resources/Pages/default.aspx
Planning

- **Problem:** Metformin ↑ 18-FDG uptake in the bowel (colon > small bowel)

- **Aim:**
  - Discontinuing metformin should reduce this problem
  - Diabetic patients taking Metformin will have a 90% compliance rate in stopping Metformin 48 hours prior to injection of 18-FDG for PET/CT oncology imaging

- **Which of the Institute of Medicine’s 6 Quality Aims does this address?**
  - Safety
3 Month Baseline Data from Boston Medical Center

• N = 280 oncology patients scanned

• 21% of patients receiving PET/CT scans were diabetic (N= 48)

• 59% of diabetics took Metformin within 24 hours of injection of 18-FDG

• Increased bowel uptake => **Bowel/Liver SUVmax ratio >2** (exclude diseased areas)
  • Diabetics taking Metformin: 66%
  • Diabetics not taking Metformin: 17%
Fish Bone Diagram to determine the factors that will affect compliance

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Process</th>
<th>People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone system functioning</td>
<td>Referring MDs must remember to give patients pre-procedure instructions</td>
<td>Nuclear medicine technicians:</td>
</tr>
<tr>
<td></td>
<td>Complex patient instructions/ misplaced handout</td>
<td>* Overworked/ not available to give instructions</td>
</tr>
<tr>
<td></td>
<td>Patients referred from site not updated on changes</td>
<td>* Must provide clear instructions</td>
</tr>
<tr>
<td></td>
<td>Patients scheduled to receive PET/CT prior to seeing oncologist, so may not receive instruction sheet</td>
<td>* Must record reasoning for glitches in the process</td>
</tr>
<tr>
<td></td>
<td>Unable to contact patient</td>
<td>Referring physicians:</td>
</tr>
<tr>
<td></td>
<td>Blood glucose levels increase when not taking Metformin</td>
<td>* Must remember to give patients pre-procedure instructions</td>
</tr>
<tr>
<td></td>
<td>Many patients need rescheduling</td>
<td>Nuclear Medicine Manager:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Responsible for managing staff &amp; delegating duties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nuclear Medicine schedulers:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Aid in differentiating diabetic patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nuclear Medicine MDs:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Must decide when to reschedule patients, which could increase the number rescheduled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patients willing to comply</td>
</tr>
<tr>
<td>Patient instructions</td>
<td>Techs properly educated on process and their duties</td>
<td>Techs aware of new monitoring form and fill it out fully</td>
</tr>
<tr>
<td>Translated instructions</td>
<td></td>
<td>Documentation of why certain steps weren’t done</td>
</tr>
<tr>
<td>Diabetic monitoring sheet</td>
<td>Workload of staff in compliance with union</td>
<td>Schedulers aware that diabetics must have a different color folder</td>
</tr>
<tr>
<td>Letters for referring MDs and PCPs</td>
<td>Manager receptive to staff input on workflow/ new duties</td>
<td></td>
</tr>
<tr>
<td>Script technicians use to deliver patient instructions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Materials                          | Environment                                                          | Measurement                                                                                     |
|                                    |                                                                      |                                                                                                 |
|                                    |                                                                      |                                                                                                 |

Patient compliance with the discontinuation of Metformin 48 hours prior to PET/CT
Planning

Metrics

• **Outcome measure:**
  • % of patients discontinuing Metformin 48 hrs prior to PET/CT

• **Process measures:**
  • % patients receiving telephone reminders at 72 hrs and 24 hrs prior to PET/CT scan
  • % technicians recording whether Metformin was discontinued 48 hrs prior to scan, & if it wasn’t, the reasoning for that
  • % of patients receiving print-outs of pre-procedure instructions

• **Balancing measures:**
  • Blood glucose level on day of scan
  • Bowel uptake of 18-FDG ➔ bowel/liver SUVmax ratio
  • Extra hours per week to make phone calls to patients
## PET/CT: DIABETIC PATIENTS

**PATIENT NAME:** ______________________________  
**MRN:** ___________________  
**Phone #:** ___________________

**Diagnosis or reason for ordering scan:** ______________________________________________________

**ORDERING MD:**  
- **Name:** _________________________  
- **Dpt:** ___________________  
- **Phone #:** ___________________

**DATE**  
**INITIALS**

- **Patient received pre-procedure instructions from PET/CT technician in our department**
  - If no, reason __________________________
  - Is the PET/CT scheduled before or after an oncology appointment? (please circle)

- **72 hours prior to scan, patient received reminder phone call**
  - If no, reason ______________________________________________________

- **Diabetic Meds (please circle):** Metformin  Glipizide  Gliburide  Insulin  Other:__________________

- **Reminded patients taking Metformin to stop it 48 hours prior to PET/CT**

- **AM Fasting Blood Glucose (*Note if patient doesn’t have a glucometer):**
  - **Date**  
  - **Time checked**  
  - **Time ate**  
  - **Blood glucose**
  1) __________________________________________________________
  2) __________________________________________________________

- **The day before the scan, patient received reminder phone call**
  - **Yes**  
  - **No**  
  - **N/A**  
  - **Patient discontinued Metformin 48 hours prior to scan**
  - **Date/Time Stopped**

- **Reminded patient to fast for ≤6 hours prior to scan & consume a low carb/high fat diet as the last meal**

- **Reminded patient to discontinue exercise 24 hours prior to scan**

- **AM Fasting Blood Glucose (today and yesterday):**
  - **Date**  
  - **Time checked**  
  - **Time ate**  
  - **Blood glucose**
  1) __________________________________________________________
  2) __________________________________________________________

**DAY OF SCAN:**  
- **Date** ____________  
- **Time** ______________

- **Tech name** __________________________________

- **Glucose:** _______ mg/dl  
- **Last Meal:** date/time:__________________  
- **content:** __________________

- **Yes**  
- **No**  
- **N/A**  
- **Patient discontinued Metformin 48 hours prior to scan**
  - **Date/Time Stopped**

**[IF NO] please provide reason:**  
- **Didn’t receive instructions from tech**  
- **Didn’t receive written instructions**  
- **Language barrier**  
- **Didn’t receive reminder phone call**  
- **Didn’t understand instructions**  
- **Forgot**  
- **Nervous glucose would increase**  
- **Lost instructions**  
- **Other**

- **Patients must be rescheduled if blood glucose >200 mg/dl, or if Metformin was not discontinued 48 hours prior to scans in patients with pelvic (ovarian, uterine, cervical) cancer, GI cancer, or lymphoma**
  - **Yes**  
  - **No**  
  - **Had to be rescheduled. If yes, reason __________________________

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**Sample of the Technologist’s Worksheet**
PDSA Cycle #1

• Interventions
  • Implemented policy to discontinue Metformin 48 hours prior to PET/CT scan
  • Staff education
  • **Head technician calls diabetics 72 and 24 hours prior to scan to give instructions**

• Outcomes
  • Number of diabetics taking Metformin each month after intervention:
    • N = 12 → 9 → 9 → 9
  • **Monthly compliance rates with instructions to discontinue metformin:**
    • 83%→ 89%→ 80%→ 67%
  • **Bowel/liver SUV ratio >2 = 15% of compliant patients**
    • Similar to diabetics not on Metformin
  • No significant increase in blood glucose
PDSA Cycle #2

• Changes:
  • Updated Patient Preparation Instructions
    • Simplify language and steps
  • Have referring physicians from oncology clinics distribute patient instructions when ordering a PET/CT scan
  • Re-educate Staff – continue technologist phone calls with repeat verbal instructions.

• Outcomes:
  • Compliance rate: 100% in first month (N = 6)
  • Bowel/liver SUV ratio >2 = 15% (same levels as those not taking metformin)
  • No patient had blood glucose over 200mg/dl
Bowel Activity: On vs. Off Metformin

<table>
<thead>
<tr>
<th>Bowel SUVmax (gm/ml)</th>
<th>Baseline</th>
<th>After Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Metformin</td>
<td>No Metformin Prescription</td>
</tr>
<tr>
<td>Mean</td>
<td>6.9</td>
<td>3.7</td>
</tr>
</tbody>
</table>

*Discontinuing Metformin for at least 48 hours reduced bowel activity while liver activity was unchanged*
Compliance with instructions to discontinue Metformin for 48 hours before injection:

- Cycle #1: almost reached target (90%) but fell 3 months later.
- Cycle #2: improved after 1st month

Fraction of patients with Bowel to Liver SUVmax ratio > 2 dropped to target level in compliant patients (See Green line vs. Orange curve)

* Month 5 after cycle #1 not included due to only 2 patients taking metformin and one with incomplete data

B/L = Bowel to Liver SUVmax Ratio

Green line is fraction of diabetics taking Metformin in the baseline period and with B/L SUVmax > 2
Lessons Learned

• **Metformin effect on the bowel results from increased uptake from the blood stream.**

• **Withholding Metformin for at least 48 hours before injection of 18-FDG reduces bowel activity to levels seen in diabetics not using metformin.**
  • This improves scan quality, and should improve diagnostic accuracy.
  • In our facility this change had no ill side effects in blood glucose levels at the time of injecting 18-FDG

• **This quality improvement was achieved using the Deming Wheel methodology, an accepted tool for quality improvement.**
  • Improvement required progressive interventions from verbal instructions to written instructions
  • It also required continued monitoring for compliance and effect on image quality

• **Additional lessons in the implementation of this project included:**
  • Small system changes are challenging
  • Buy-in of key stakeholders is essential
  • Multi-disciplinary team approach is critical to the success
  • Determining the best contacts and leaders is helpful
  • Having a clear goal and a direct outcome measurement helped focus our efforts and track progress
References:


