RESCHEDULING OF ^{18}FDG PET/CT PROCEDURES CAUSED BY HIGHER FASTING BLOOD SUGAR LEVEL: A CLINICAL AUDIT

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ABSTRACT

BACKGROUND: Fasting blood sugar (FBS) level is an important confounding factor having an impact on qualitative and quantitative aspects of 18-Flourodeoxy glucose Positron Emission Tomography and Computerized Tomography (^{18}FDG PET/CT). FBS ≥ 200 mg% is an indication of rescheduling of procedure as recommended by various guidelines. Purpose of this clinical audit is to find out the frequency of rescheduling due to higher FBS and to explore the reason(s). **MATERIAL AND METHOD:** This audit was conducted at PET/CT services of Radiology Department Aga Khan University Hospital (AKUH) and consecutive ^{18}FDG PET/CT data from 1.1.2017 till 30.06.2017 was collected. Cohort was segregated into those having FBS within and beyond institutional benchmark (FBS = <200 mg%). Root cause analyses (RCA) for rescheduled procedures caused by FBS beyond acceptable limits were made. **RESULTS:** During study period total 534 ^{18}FDG PET/CT procedures were performed (Mean age 52 ± 17 years with male to female ratio was 58:42%). Mean FBS was 109 ± 35 mg% with range of 52-285 mg%). FBS beyond benchmark was found in 12 (02%) patients who were rescheduled. RCA revealed inadequate understanding by patient / attendant and poor compliance to instructions briefed to them at time of appointment. **CONCLUSION:** Frequency of rescheduling of ^{18}FDG PET/CT procedures during audit period was significantly low. Focused counseling by receptionist and involving treating physician could further reduce the rescheduling incidence and avoid inconvenience to patient and financial loss caused by decay of available dose of ^{18}FDG.

Key Words: Fasting blood sugar; PET/CT; ^{18}FDG; benchmark; rescheduled

Introduction

Positron emission tomography/computed tomography (PET/CT) is the most commonly used hybrid imaging modality used widely for staging, restaging, response evaluation, prognosis and diagnosis of some malignancies. Radiolabeled deoxy-2-(^{18}F) fluoro-D-glucose (^{18}F-FDG), a glucose analogue, is the standard tracer used to evaluate neoplastic tissue using glucose as energy substrate.[1] ^{18}FDG follows the same pathway as normal glucose except it is not further metabolized once phosphorylated intracellularly by hexokinase. ^{18}FDG competes with normal glucose and its uptake is regulated by fasting blood sugar and insulin levels.[2]

In addition to these FBS, several other factors also affect ^{18}F-FDG uptake by tumor like dose, uptake time, body mass index (BMI), and tumor biology.[3] Since these confounding factors affect qualitative and quantitative aspects of PET/CT imaging and it becomes more challenging when comparing the studies for response evaluation using quantitative parameters like standardized uptake values (SUV). Therefore, to address this important issue, various societies have published guidelines and emphasized upon its use to ensure a global standardized imaging protocol to minimize interpretation variations.[4] PET/CT

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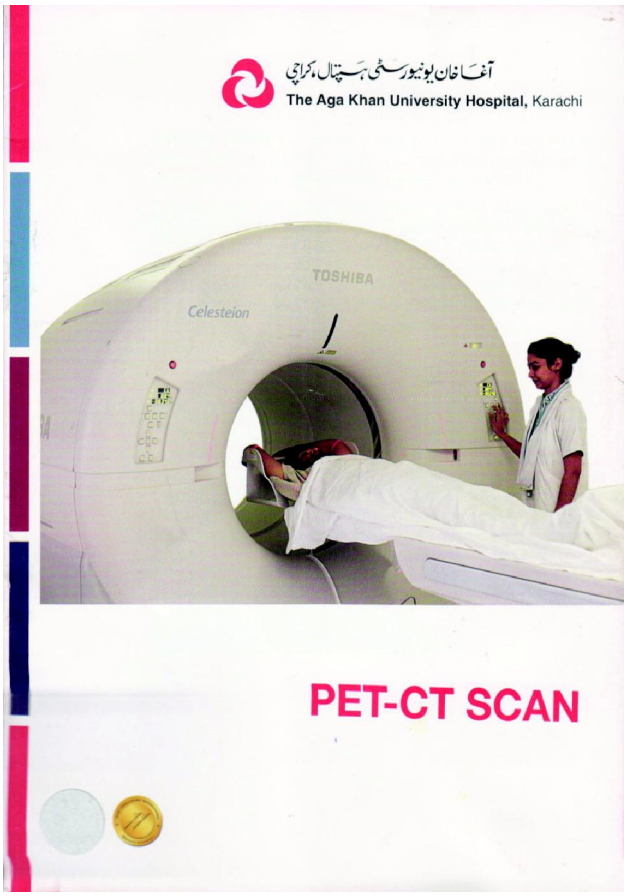
imaging services at Aga Khan University Hospital was com-menced in December 2015 and we adopted European Association of Nuclear Medicine (EANM) PET/CT imaging guidelines published in 2015.[4] These guidelines emphasize to reschedule the procedure if FBS is ≥ 200 mg%.[4] However, such rescheduling causes inconvenience, delay in decision making, treatment delay and financial loss caused by decayed dose of ^{18}FDG. The purpose of this clinical audit is to find out the reason(s) for rescheduling of ^{18}FDG PET/CT in patients having FBS beyond institutional benchmark.

Materials and Methods

This clinical audit was conducted over 06 month period from January 1st 2017 till 30th June 2017. The primary objective was to find out the frequency of rescheduling of procedure caused by FBS ≥ 200 mg% and to find out reasons(s). Since this audit was a quality improvement project, no approval from ethical research committee (ERC) was required.

SETTING: This quality improvement audit was performed at PET/CT services, Radiology Department Aga Khan University Hospital. The PET/CT procedures are performed daily for five days a week from Monday to Friday. Prior booking is mandatory and usually procedures are booked through an e-request (in-patient) generated by referring clinical department or manually by a receptionists to the patients (on telephone or personally).

WORK-FLOW: The pre-procedural instructions are briefed to patient or attendant both by verbal and written information by the receptionists for outpatients at the time of appointment. For inpatients, once the e-request is generated, the technologist is used to call on given pager for procedural instructions (appendix I). The primary reason of patient preparation is to keep FBS <200 mg% and serum insulin at lower level to ensure reduce ^{18}FDG uptake by normal tissue (physiological uptake) and optimizing tracer uptake in the tumor tissue (abnormal uptake). For strict glycemic control, the complete food fasting is required, including cessation of tube feedings, dextrose-containing intravenous fluids, parenteral hyperalimentation,



PROPER PREPARATION IS IMPORTANT

How can I prepare myself BEFORE my PET-CT scan?

1. **Medications:** If you need to take your medication in the morning prior to the scan, take it with water. If you are on intravenous dextrose infusion, please discontinue it 6 hours prior to the scan.

2. **Food and drink:** You should drink at least 1 liter of plain water 2 hours before your test. Do not eat or drink anything for at least 6 hours before the scan, except water. You should have a low carbohydrate dinner the night before your scan. If your scan is scheduled in the afternoon, you may have a low carbohydrate breakfast. (See points A & B on next page for details).

3. **Food and drink for diabetic patients:** You may only drink water and cannot eat anything for at least 4 hours prior to your scan. You should have a low carbohydrate dinner the night before your scan. If your scan is scheduled in the afternoon, you may have a low carbohydrate breakfast. (See points A & B on next page for details). Take your oral medication or insulin (only rapid or short acting insulin like apidra, humalog or humulin) early in the morning (6 hours prior) on the day of your test. Take your diabetic medication as usual. If your doctor has told you to take your regular medicine, take it with plenty of water.

Appendix I:

oral hypoglycemic and insulin in known diabetics for at least four hours prior scan. Upon arrival, the patient's compliance about pre-procedure instructions is confirmed and blood sample is taken for FBS measurement using calibrated glucometer. Procedure is rescheduled if FBS ≥ 200 mg% in known or not-known diabetics.

DATA COLLECTION: The demographic data of consecutive PET CT were collected for the audit duration (1.1.17 till 30.06.17). The mean FBS with range was calculated along with age, gender and BMI. The studied cohort was segregated into those having FBS < 200mg% and ≥ 200 mg% (rescheduled group). Both groups were compared demographically to find out any significance. Root-cause-analysis (RCA) was done to ascertain the possible explanation(s).

Results

During the study period (1st January - 30th June 2017), total 534 PET/CT procedures were performed (Tab. 1). The mean age of patients was 52 ± 17 with minimum 4 years to maximum 93 years of ages and 113/534 were male and 223/534 were female. The mean BMI of audit population was 26.58 ± 5.77 Kg/m^2. The range of FBS was 50 mg/dl to 230 mg/dl respectively with mean of 106 ± 29 mg/dl (Tab. 1). In 522 patients, the

Total Cases of PET/CT (Duration=January till June 2017)	N=534
Age in years (Mean ± SD)	52 ± 17 (Range: 04-93) years
BMI in Kg/m^2 (Mean ± SD)	26.58 ± 5.77 (Range: 11.16-45.82) Kg/m^2
Male: Female	311: 223 (58%: 42%)
FBS in mg% (Mean ± SD)	109 ± 35 (Range: 50-285) mg/dl
% Rescheduled cases for FBS beyond recommended range (≥200 mg%)	02% (n=12)

SD=Standard Deviation
BMI=Body Mass Index
FBS=Fasting Blood Sugar

Table 1: Study demographics

FBS was less than 200 mg/dl resulted in 98% compliance to pre-procedural instructions. Remaining 12 patients (02%) were rescheduled based on their FBS beyond benchmark of ≥ 200 mg%. No significant difference was found between age, gender and BMI between two cohorts (p <0.05 – Tab. 2). The RCA of 2% audit population revealed a suboptimal understanding of verbal and written instruction by patients and attendants regarding importance of FBS < 200mg% prior PET/CT procedure.

Variables	FBS < 200 mg% n=522 (98%)	FBS ≥ 200 mg% n=12 (02%)	t-Test or Chi-squared	P value
Age in years (Mean ± SD)	52 ± 17 years (Range: 04-93)	47 ± 15 years (Range: 19-68)	-1.010	0.313
BMI in Kg/m^2 (Mean ± SD)	26.57 ± 5.77 Kg/m^2 (Range: 11.16 – 45.82)	26.94 ± 6.26 kg/m^2 (Range: 17.93-38.63)	0.219	0.827
Male: Female	304: 218 (58: 42%)	07: 05 (58:42%)	1.00	1.00
FBS in mg% (Mean ± SD)	106 ± 29 mg/dl (Range: 50 -200)	234 ± 20 mg/dl (Range: 210-285)	15.20	<0.0001*

Table 2: Demographic comparison of audit population within and beyond benchmark FBS level (>200 mg%).

Discussion

^{18}FDG based PET/CT is the most commonly performed hybrid imaging modality in oncology around the world. ^{18}FDG is transported to tumor cells by transporter protein (GLUT 1-7) and entered via sodium-independent facilitated diffusion.[5] ^{18}FDG competes directly with normal glucose, so it is assumed that its uptake could be impaired by high blood glucose level.[6] This would result lower SUV values in tumors imaged with higher FBS as compared to normal FBS. Interval change in SUVs between baseline and follow-up PET/CT procedures is the most commonly used semiquantitative parameter for response evaluation. Since SUV varies with FBS, it has been emphasized by various societies to have imaging with FBS < 200mg% to minimize impact of FBS on tumor uptake of ^{18}FDG. The recent EANM 2015 guidelines advise to reschedule the procedure if FBS ≥ 200 mg%.[4]

Based on these recommendation, our PET/CT imaging services also performs ^{18}FDG PET/CT when FBS < 200mg% and reschedule the procedure if FBS = 200 mg%. To ensure FBS within require limits, our receptionist and technologists are used to brief the patients / attendants to follow the instructions about diet, fasting and timing of administration of hypoglycemic agents. During this audit period we found a rescheduling frequency of 2%. Our rescheduling frequency is in concordance with study published by Artor et al in 2012 . They also had a rescheduling frequency of 2.2% after adopting the

imaging protocol. Interestingly the frequency was 9% before adopting imaging protocol.[7]

Although rescheduling is low in this audit but caused inconvenience to patients, delay in decision or therapy and waste of available radiopharmaceutical. Root cause analysis (RCA) of this audit revealed that our receptionists and technologists are robust in briefing the patients / attendants at the time appointments both verbally and through written brochures. However, suboptimal understanding was found primarily at end of patients / attendants. Based on these facts we have decided to give appointment of procedures at least 48 hour prior and get involve either referring physicians or general practitioner for adjusting dose of hypoglycemic agents in that period to ensure a FBS < 200 mg% on the day of procedure. We have planned to perform a follow-up audit to measure the target outcomes.

References

1. Hahn T, Hofmann W, Reich O, Lang I, Desoye G. Hyperglycaemia regulates the glucose-transport system of clonal choriocarcinoma cells in vitro. A potential molecular mechanism contributing to the adjunct of glucose in tumour therapy. Int J Cancer 1998; **78:** 353-60.

2. Diederichs CG, Staib L, Glatting G, Beger HG, Reske SN. FDG-PET: elevated plasma glucose reduces both uptake and detection rate of pancreatic malignancies. J Nucl Med 1998; **39:** 1030-3.

3. Sprinz C, Zanon M, Altmayer S, Klaus G, Marchiori E, Hochhegger B. Effects of blood glucose level on 18F fluorodeoxyglucose (^{18}F-FDG) uptake for PET/CT in normal organs: an analysis on 5623 patients. Sci Rep. 2018; **8:** 2126.

4. Boellaard R, Delgado-Bolton R, Oyen WJ, Giammarile F, Tatsch K, Eschner W, et al. FDG PET/CT: EANM procedure guidelines for tumour imaging: version 2.0. Eur J Nucl Med Mol Imaging. 2015; **42(2):** 328-54.

5. White MK, McCubrey JA. Changes in glucose transport associated with malignant transformation. Int J Oncol 1995; **7:** 701-12.

6. Zhuang HM, Cortes-Blanco A, Pourdehnad M. Do high glucose levels have differential effect on FDG uptake in inflammatory and malignant disorders? Nucl Med Commun. 2001; **22:** 1123-8.

7. Artor A, Iuele F, Merenda N, Pisani AR, Notaristefano A, Giuseppe R. ^{18}F-FDGPET/CT: diabetes and hyperglycaemia. Nuclear Medicine Review 2013; **2:** 57-61.