Evaluation of prescribed and administered activity discrepancies for PET procedures using F-18 and Ga-68 radiopharmaceuticals over a sample taken at the Instituto Nacional de Cancerología in 2019.
Introduction

Nuclear Medicine Department

The radiopharmaceuticals are received from our certified high complexity radiopharmacy as a final product ready for administration.

In 2019, 20% of the diagnostic procedures were PET/CT images employing F-18 (FDG) and Ga-68 (DOTANOC and PSMA) radiopharmaceuticals.
Radiopharmaceutical dosage

Dosage of activity is responsibility of the nuclear physician. Our protocol is based on the patient’s weight.

<table>
<thead>
<tr>
<th>Radiopharmaceutical</th>
<th>Mass less than (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity (mCi)</strong></td>
<td>40 85 100 200</td>
</tr>
<tr>
<td>PET- 18F-NaF</td>
<td>7 8 9 10</td>
</tr>
<tr>
<td>PET-Ga68-DOTA</td>
<td>2 4 4 4</td>
</tr>
<tr>
<td>PET-Ga68-PSMA</td>
<td>4 4 4 4</td>
</tr>
<tr>
<td>FDG</td>
<td></td>
</tr>
<tr>
<td><strong>18F-FDG</strong></td>
<td>0.15 mCi /kg</td>
</tr>
</tbody>
</table>

10% is the set nominal tolerance between the prescribed and administered radiopharmaceutical activity. (AAPM Report No. 181, 2012)

Disparities between prescribed and administered activities lie in variations of, among others, late (or early) administration of the radiopharmaceuticals and residuals left into the used vials and syringes.

The activity is measured just before the administration. Also, the remnant activity (used vials, connectors and syringes).
Methods

We assessed the above two factors' impact in two modes:

1. Differences between prescribed times and administration times.

2. Evaluation of the remnant activities (vial, syringes-needle)

The information was obtained from the NMD reports (2019):
- Activity prescribed, and time of prescription
- Measured activity prior administration
- Remnant activity on syringe-needle
- Administered time

Administration of radiopharmaceutical reports included in the analysis:
F-18-FDG: 1190
Ga-68-DOTA: 150
Ga-68-PSMA: 83
**Results**

Differences between prescribed times and administration times

A. Eliminate inconsistent data (injection occurs before dosing)

B. Calculate the decay factor between the prescription time and the injection time

\[ FD = \frac{A}{A_0} = e^{-\frac{ln2}{T_{1/2}}t} \]

- For F-18-FDG, the decay factor is approximately 0.6 %/min.
- For GA-68-DOTA, the decay factor is approximately 1.0 %/min.

- **F-18-FDG**
  - 23 registers (2%) were eliminated from the analysis by being considered inconsistent.

- **GA-68-DOTA**
  - 16 registers (11%) were eliminated from the analysis by being considered inconsistent.
Evaluation of prescribed and administered activity discrepancies for PET procedures using F-18 and Ga-68 radiopharmaceuticals

Results

Removing the inconsistent data and making decay correction:

Differences between prescribed times and administration times

The FDG was administered on average 14 minutes later than prescribed time, causing a difference of 8.4% on the activities administered. For Ga-68-DOTA, a median difference of 21 minutes causes a difference of 21%.
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Results

Evaluation of the remnant activities (vial, syringes-needle)

The residual activity, which corresponds in the post injection (syringe + needle):

F-18-FDG: range 0.7 to 4.6 %. Median 2.2 %

Ga-68-DOTA: range 1.1 to 18.4 %. Median 3.5 %
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Results

Differences between prescribed times and administration times

Evaluation of the remnant activities (vial, syringes-needle)

- Administered activity within 10% of prescribed activity
  - F-18-FDG: 67%
  - Ga-68-DOTA: 37%

- Administered activity within 20% of prescribed activity
  - F-18-FDG: 88%
  - Ga-68-DOTA: 65%
- An activity of $8.97 \pm 0.13 \text{ mCi}$ is injected in a 95% confidence interval.
- The DRL for the F-18 FDG radiopharmaceutical is $9.0 \text{ mCi}$ in a range of 2.02 to 19.3 mCi.
- The average prescribed activity in the service is $9.62 \pm 0.13 \text{ mCi}$ in a 95% confidence interval [range 2.4 -15.0 mCi].
- An average weight for the patient of 64 kg and an average injected activity 0.65 mCi less than that prescribed.

- An activity of $3.98 \pm 0.17 \text{ mCi}$ is injected in a 95% confidence interval.
- The DRL for the Ga-68 Dotanoc radiopharmaceutical is $3.88 \text{ mCi}$ in a range of 1.7 to 6.7 mCi.

**Discussion**

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Conclusion

• Considering the short half-life of PET radioisotopes, the influence of time of administration has a higher impact on the differences between prescribed and administrated dosage.

• The delay time of 14 mins (FDG) and 21 mins (Ga-68-DOTA) can be adjusted on the protocol or the activity dosage by the radiopharmacy. It’s important to synchronize all the equipments to the same hour, including the radiopharmacy ones.

• It seems possible that differences between the calibration factor on dose calibrators between the radiopharmacy and the NMD (mostly due to shielding) should have an impact on the differences evaluated.

• In the practice, no rejecting values for the activity administrated (related to the prescribed one) have been set. When lower activity values than prescribed are administered, higher acquisition camera times are used to improve the image quality.

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Ga-68-PSMA

23 registers (2%) were eliminated from the analysis by being considered inconsistent.

- Administered activity within 10% of prescribed activity: 40%
- Administered activity within 20% of prescribed activity: 60%

GA-PSMA → 1.0 %/min