Use of Prospective Risk Analysis for radiation protection in healthcare

Background
An I-125 source is used as a tumour marker. The whole procedure involves several departments within the hospital, including the Radionuclide Centre, Radiology department and the Surgical Theatres. The I-125 source has a maximum activity of 14 MBq and a length of 4.5 mm (see Figure 1). The source is inserted into the tumour in the Radiology department using ultrasound or X-ray. After patient treatment, the tumour is removed during surgery using the I-125 source as a marker. Prior to examination of the extracted tumour, the I-125 source is extracted from the tissue in the Pathology department. All I-125 sources are collected by the Radionuclide Centre and are later disposed of as radioactive waste.

Introduction
The use of risk analysis in healthcare is mostly based on surveying the radiation dose during regulatory working conditions and in case of an incident. Depending on the outcome, further radiation protection measures are taken until the radiation dose is as low as reasonable achievable and no other dose limits are reached.

Before starting the procedure ‘I-125 source as a tumour marker’, standard risk analysis is performed. Safety precautions are taken to minimize the radiation dose and the possibility of losing an I-125 source. At the start of the procedure a checklist was introduced to monitor each critical step in the procedure. The use of this checklist is compulsory.

Despite all of the precautions, there were several (near) incidents of missing I-125 sources. The maximum calculated radiation dose was less than 0.2 mSv.

Methods
Because of the (near) incidents, a prospective risk analysis was performed to identify important risk moments in the procedure with the intention to reduce the possibility of losing an I-125 source. To accomplish this prospective risk analysis we used the Healthcare Failure Mode and the Effects Analysis (HFMEA) method. The HFMEA method is a proactive program to identify and reduce safety risks to patients, visitors, workers, facilities and equipment.

A multidisciplinary team approach is necessary to perform a HFMEA. The next steps must be taken in the HFMEA procedure:
1. selection of the process and delimitation
2. form a team
3. picture the process
4. perform an analysis and fill in the form
5. label the actions to improve
6. reporting
7. improving

The objective is to identify where a process may fail (Failure Modes) prior to failure occurring. Each failure mode has a potential risk, with some risks more likely to occur than others. Therefore, each risk must be evaluated (see table 1).

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Catastrophic</th>
<th>Large</th>
<th>Moderate</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>Very high</td>
<td>Very high</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Monthly</td>
<td>Very high</td>
<td>High</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>Yearly</td>
<td>High</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>Less than once a year</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
</tbody>
</table>

After the potential risks have been evaluated, actions are implemented into the process, in such a way that they significantly reduce the likelihood of the failure reoccurring. All evaluations/implementations have been documented in a rapport.

Discussion
It is proven that the use of I-125 as a tumour marker is very useful. Although this must never be a reason of implementing a procedure without looking at all the risks from radiation protection’s prospective.

Conclusion
Using a Prospective Risk Analysis such as the Health Failure Mode and the Effect Analysis (HFMEA) method is useful for determining the failure modes in a complex procedure such as described above. However the HFMEA is very time-consuming and therefore not suitable for application in all procedures.