Radioactive iodine treatment

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My background

ICRP committee addressing use of radioactive drugs (radiotherapeutics) in medicine (ICRP 140, 2019)
EANM radiation protection committee
BNMS molecular radiotherapy group

Clinical nuclear medicine service and research into imaging and radiation dosimetry

Treatments of cancer with radiotherapeutics:

I-131 NaI (radioiodine) for thyroid cancer
I-131 mIBG for neuroblastoma
Ra-223 for bone metastases from prostate cancer
Y-90 DOTATATE for neuroendocrine tumours
NICE recommends...

‘A research recommendation was made by the committee to determine which RAI strategy is likely to be clinical and cost effective (fixed versus calculated strategy).’

K.1 Research question: What is the long-term clinical and cost effectiveness, including safety, of radioactive iodine for hyperthyroidism?

K.2 Research question: What is the clinical and cost effectiveness of dosimetry-guided radioactive iodine strategies for hyperthyroidism?
Some physics....

Scientists don’t understand or explain -
They measure and describe...

How much activity? The Becquerel (Bq)
1 MBq = 1 million radioactive decays per second

How much radiation dose?: The Gray (Gy)
1 Gy = 1 joule of energy in one kg.

How much radiation effect at low levels? The Sievert (Sv)
Accounts for type of radiation and radiation sensitivities

How much time for radiation to decay? The half-life.

People are different! The same amount of radiation (MBq) will deliver a wide range of radiation doses (Gy) to different people.

Fixed vs calculated strategy: Should we treat according to the radiation administered (MBq) or according to the radiation dose delivered (Gy)?
My involvement and interest

RMH: Study of 300 patients treated to deliver 60 Gy. Mean administered activity ~ 100 MBq, range of 17 – 1400 MBq).

After 10 years:

50% of patients needed more radiiodine
20% patients became hypothyroid
30% of patients naturally euthyroid

Hyer et al/ Nucl Med Commun 2018
Risks of radiation
Risks of radiation

Diagram:
- Y-axis: Effect
- X-axis: Radiation Dose
- Markers indicating Bomb data points
Risks of radiation

Effect

Medical data in this range!

Bomb data

Radiation Dose
Risks of radiation

ALARA!
Keeping radiation exposures As Low As Reasonably Achievable
Risks of radiation

A little radiation is not as harmful as we might expect
Risks of radiation

A little radiation isn’t at all harmful to anyone!
A little radiation is more dangerous than you might expect!
Risks of radiation

A little radiation is positively good for you...
Risks of radiation

The risk of cancer is generally considered to be 5.5% /Sv

Radiation dose delivered from radioiodine therapy ~ 0.01 – 0.10 mSv/MBq

For a 400 MBq administration, there may be a risk of cancer of 1 in hundreds to 1 in thousands

However...
The risks vary according to the model, age, rate of dose delivery, radiosensitivity...

10% - 90% of the radiation goes to the thyroid. Therefore less radiation to the rest of the body, and smaller risks
The risks from radioiodine are not known.

If they were very large we would know, but that does not mean they do not exist, and many patients are treated.

Pets and friends receive only the smallest fraction of the radiation dose that a patient receives.

Risks are relative:

From eating one banana there may be a risk of cancer of 1 in 200 million...

Also radiation risks from potatoes, brazil nuts, from yourself, from sleeping next to your partner, from living in Cornwall, from being hyperthyroid...

Greater risks from obesity, lack of fibre in the diet, too little exercise...
Can you believe what you read?

What is the evidence?

Lies, damned lies & statistics...

Over 10,000 treatments each year in the UK...

1 million treatments per year world wide?

50 million treatments over 50-80 years?

NICE found only 6 RCTs that tested whether to treat according to MBq or Gy. These studies are of poor quality.
NICE: ‘A clinical trial is necessary to address the issue of the level of activity to administer, the role of radiation dosimetry and the effect on patient quality of life.

This trial should use the technology and methodology now available.

It is envisaged that a multi-disciplinary working party will be formed, including endocrinologists, nuclear medicine physicians, physicists, radiation oncologists, primary care and patients, to develop a robust trial protocol that will definitively answer these questions.’
Next?

It may take 50,000 patients to quantify the effect of 100 mSv and very long term follow up

Not possible until now.

Would need a multicentre, multidisciplinary effort, including patients and GPs as investigators.

Physics interest: to apply methods developed for cancer treatments to personalise treatment and to estimate individual risks.

All other questions could also be addressed.

Would there be interest in a UK programme grant?
Thanks to all

The magnificent radioisotope physics team at the RMH/ICR

The NICE committee

The BTF and all patients