^{131}I in Blood Samples: A Danger for Professionals? A Problem for Immunoassays?

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Objective: Our objective was to investigate the safety of radioactive blood samples from patients receiving ^{131}I and whether the radioactivity affects the validity of assays.

Methods: First, the activity of samples from patients given ^{131}I was measured by 3 methods and compared with the upper threshold. Then, pilot sera were spiked with ^{131}I, and possible interference was investigated using 2 immunoradiometric assays.

Results: The activity of 13 of the 15 samples was below the European limit; the other 2 samples were from patients with reduced renal clearance rates. No differences in thyroglobulin level or thyroid-stimulating hormone level were found between sera that were spiked with ^{131}I and sera that were not.

Conclusion: These blood samples are safe because they contain negligible activity, and the use of radioimmunoassays or immunoradiometric assays on them produces reliable results.

Key Words: radiobiology/dosimetry; radioimmunoassay; radionuclide therapy; ^{131}I; radioprotection

J Nucl Med Technol 2005; 33:172–174

Patients with thyroid diseases may be subjected to ^{131}I treatment (*1*). One requirement for this therapy is that bystanders not be significantly exposed to radiation (*2*). For instance, U.S. federal regulatory authorities stipulate that no individual should receive more than 5 mSv (500 mrem) effective dose equivalent from the patient (*2–5*). Individual states may have specific regulations more stringent than this federal regulation. In France, in agreement with these radioprotection rules, patients receiving more than 740 MBq (20 mCi) of ^{131}I are inpatients until radioactivity falls below that level or until the externally measured dose rates are less than 50 μSv/h (5 mrem/h) at a distance of 1 m (*6,7*).

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During such hospitalizations, clinical conditions may require blood sampling for various assays (e.g., biochemistry, hematology, or immunology). If blood or urine specimens are to be collected, sampling should occur before ^{131}I administration. Of course, if medical conditions dictate the need for specimen collection during the isolation period, then the sampling should not be denied. Thus, in the days after ^{131}I administration, professionals may be involved in the manipulation of potentially radioactive blood, sera, or plasma. As nuclear medicine professionals, we are repeatedly questioned by nurses, technicians, and physicians about the safety of putatively radioactive samples and the validity of radioimmunoassays or immunoradiometric assays using ^{125}I in these ^{131}I-spiked samples.

For educational purposes, we thus investigated, first, the radioactivity of blood samples from patients administered therapeutic doses of ^{131}I and, second, the possible interference of this activity in thyroglobulin and thyroid-stimulating hormone immunoradiometric assays.

MATERIALS AND METHODS

Blood Samples

For a first set of activity measurements, at the request of the clinical department, blood was sampled (about 3 mL, $n = 15$) for biochemical analysis from patients administered ^{131}I for thyroid diseases (e.g., hyperthyroidism, goiter, or cancer). These blood samples were considered potentially radioactive and were immediately brought to the Department of Nuclear Medicine, the authority that could allow dispatching to biochemical laboratories.

For a second set of measurements, 2 sera (pilot sera) were spiked with ^{131}I (^{131}I-S1; Schering Cis bio) to achieve activity in the range of that in the patients' samples.

Measurements

First, the activity of samples was measured using a dose rate meter/dosimeter (Babyline 81; Nardeux) for measured dose rate, a surface detector (LB 122; Berthold) for activity in contact with the tubes, and a well detector (Cobra II Autogamma; Packard) for total activity. These measure-

ments (Table 1) were compared with the upper threshold to allow the exit of patients from the leaded rooms (<2.5 μSv/h), the disposal of solid radioactive wastes (<2-fold environmental background activity), and the disposal of radionuclides (<10^6 Bq for ^{131}I) (*6,7*).

Second, the possible interference of this ^{131}I-generated activity was investigated in 2 immunoradiometric assays (^{125}I): thyroglobulin (Schering Cis bio) and thyroid-stimulating hormone (Beckman-Coulter). The assays were conducted as recommended by the manufacturers.

RESULTS

A Danger for Professionals?

All activities but 2 (of the 15 samples) measured with devices calibrated for the ^{131}I energy spectrum (260–470 keV) were found to be below the European limits (Table 1) (*6,7*), and thus the warning stickers were removed. The 2 samples that had a measured dose rate above the limit (6 and 2.6 μSv/h; limit, <2.5 μSv/h) came from patients 1 and 7, to whom ^{131}I was administered 17 h (740 MBq) and 41 h (3,700 MBq), respectively, before sampling. Patients 1 and 7 had calculated renal clearances of 41 and 61 mL/min, respectively (Cockroft and Gault formula); the other patients' clearances ranged from 46 to 98 mL/min. The warning stickers were not removed: Biochemical analyses were performed, but the biologic samples and materials were discarded with radioactive waste.

A Problem for Immunoassays?

We found that about 15% of ^{131}I-generated activity (cpm) was detectable in a γ-counter calibrated for ^{125}I (15–75 keV). We thus spiked 2 sera with ^{131}I to reach an activity within the range of activity in the patients' samples. When these sera were processed through the immunoradiometric assay, the ^{131}I-generated activity was washed away. Indeed, no difference in thyroglobulin levels was observed between sera without ^{131}I and sera with ^{131}I: <1 ng/mL versus <1 ng/mL, respectively, and 3.1 ng/mL versus 3.1 ng/mL, respectively. Similar results were obtained for a thyroid-stimulating hormone assay: <0.06 μUI/mL versus <0.06 μUI/mL, respectively, and 4.1 μUI/mL versus 4.4 μUI/mL, respectively.

DISCUSSION

Generally speaking, before activity measurements all samples from ^{131}I-treated patients have to be considered potentially radioactive. They should be systematically labeled in the clinical department with a sticker displaying the international symbol of activity. After measurements, and if the activity is considered negligible according to the legal limits, the warning is cancelled in the Nuclear Medicine Department. Processing of the samples and their subsequent disposal thus return to a normal, nonradioactive routine. Conversely, radioactive samples have to be processed as radioactive waste. The 2 patients who had samples with slightly elevated levels of radioactivity had a relatively low clearance of creatinine. Although disappearance of iodine from the blood depends on other factors (including, of course, intake by thyroid cells), kidney function is involved in iodine elimination (*8*) and could have contributed to our findings.

High-energy radiation (260–470 keV) can be detected in counters calibrated for lower energies (15–75 keV). This known phenomenon (Bremsstrahlung effect) is the consequence of energetic β-particles emitted by ^{131}I (in the present case) interfering with the surrounding matter that reemits γ-rays detected by the γ-counter (Cobra II). Also involved may be x-rays with a similar spectrum for the 2

TABLE 1
Radioactivity of Blood Samples Obtained After ^{131}I Intake

Patient no.	Indication	^{131}I dose (MBq)	Delay (h)*	Measured dose rate (μSv/h) < 2.5†	Surface activity (Bq/cm²) < 5†	Activity (Bq) < 1,000,000†
1	Graves' disease	740	17	6	13.7	69,171
2	Graves' disease	740	113	0.20	0.80	2,478
3	Multinodular goiter	1,110	89	1.50	1.60	22,166
4	Graves' disease	1,850	17	2.30	2.30	38,380
5	Multinodular goiter	1,850	41	<0.01	1.20	4,314
6	Thyroid carcinoma	3,700	17	0.28	1.42	51,157
7	Thyroid carcinoma	3,700	41	2.60	1.20	51,966
8	Thyroid carcinoma	3,700	41	1.30	1.60	11,971
9	Thyroid carcinoma	3,700	41	1.30	1.60	13,617
10	Thyroid carcinoma	3,700	41	1.50	1.10	17,321
11	Thyroid carcinoma	3,700	41	1.50	2.10	12,949
12	Thyroid carcinoma	3,700	44	1.20	1.80	34,340
13	Thyroid carcinoma	3,700	89	1.50	2.20	27,594
14	Thyroid carcinoma	3,700	113	1.00	0.28	8,032
15	Thyroid carcinoma	3,700	113	1.30	1.50	11,315

*Time lag between ^{131}I intake and blood sampling or radioactivity measuring.
†Upper limit for disposal of biologic samples.

iodine isotopes. Fortunately, the therapeutic doses of ^{131}I made up of iodine ions are not permanently adsorbed to the antibody-coated tubes and do not interfere with the assay.

CONCLUSION

When dealing with experienced clinical departments, samples are taken infrequently from patients after ^{131}I administration (15 samples per year in our University Hospital). Collecting and testing the samples in the Nuclear Medicine Department, although not mandatory, does not cause excessive overwork and reduces distress. We thus continue using this procedure on all blood samples from patients administered ^{131}I for therapy. We have demonstrated here that these blood samples are safe because they contain negligible activity and that the use of radioimmunoassays or immunoradiometric assays on these samples produces reliable results. Finally, these results may be used for educational purposes.

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