

# Continuous Quality Improvement of Radiation Safety Management for Treatment of Differentiated Thyroid Carcinoma with Iodine-131

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**Abstract:** Purpose: To explore the effect of continuous quality improvement (CQI) of radiation safety management for patients administered iodine-131 after thyroid cancer surgery. Methods: A total of 103 patients with differentiated thyroid carcinoma were randomly divided into control and experimental groups containing 51 and 52 patients, respectively. In the control group, the drug was administered according to the operating procedure for iodine-131 treatment of thyroid carcinoma. In the experimental group, CQI was adopted to manage the radiation safety of care in addition to the conventional iodine-131 thyroid cancer treatment procedures. We also improved radiation safety protection measures prior to drug administration, developed a flow chart of drug administration for patients, established a patient preview of the drug administration process, and enhanced health education and psychological intervention for the patient. Results: The environmental radiation around the drug delivery window was reduced ( $P < 0.05$ ), total duration of exposure to the radiation was shortened ( $P < 0.05$ ), drug drop rate was decreased to 0%, and patient satisfaction was improved in the experimental group compared to the control group. Conclusions: Application of CQI for management of radiation safety when treating thyroid cancer with iodine-131 can improve patient treatment, quality of care, and satisfaction and reduce radiation pollution in the surrounding environment and radiation injury to staff.

**Keywords:** Differentiated Thyroid Carcinoma, Iodine-131-Administered Care, Radiation Safety Management, Continuous Quality Improvement

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## 1. Introduction

The iodine-131 is widely used in the treatment of differentiated thyroid carcinoma [1-3]. According to the Law of the People's Republic of China on the Prevention and Control of Radioactive Pollution and the Regulations on the Safety and Protection of Radioisotopes and Radiation Devices, when radiopharmaceuticals are employed, radiation protection and safety issues should be considered in addition to the chemical and biological properties of the drug [2]. Supervision of radioactive source and device safety in

hospitals should be strengthened, radiation safety accidents should be reduced, the ability to respond to radiation accidents should be improved, and the consequences of accidents should be controlled and mitigated. Despite the clinical importance of measuring iodine deficiency, commonly used indicators have a number of limitations in their ability to reliably assess current iodine status. Urinary iodine concentration (UIC) from spot urine reflects recent dietary intake (hours to days) and can have high daily variability [4, 5].

According to the routine regulations during the treatment

of patients with thyroid cancer by administration of iodine-131, The radioactive liquid spill would be occurred frequently. In addition, the radiation levels around the delivery window were high after the drug was taken, which affected the patient quality of treatment/care and the environmental safety of the hospital. In addition, studies reporting iodine-131 is beta and gamma emitter and its special radiation in inducing damage is the beta particles. Beta particle irradiation, in comparison with 6 MV X-ray, has advantages in the cellular damage. However, in addition to create self-dose in the surrounding cells, iodine-131 transfers a cross dose to adjacent and distant cells which increases DNA strand breaks [6, 7].

To this end, our nursing unit set up a quality improvement team starting in June 2016 to apply continuous quality improvement (CQI) to clinical practice activities in response to radiation safety problems in iodine-131 administration and achieved satisfactory results as described below. The objective of our study is to assess the influence of Continuous quality improvement of radiation safety management for treatment of differentiated thyroid carcinoma with iodine-131.

## 2. Materials and Methods

### 2.1. Participants Enrollment and Study Methods

103 patients with differentiated thyroid cancer that was treated with iodine-131 in our hospital's nucleus ward were enrolled in this study, and divided randomly into control and experimental groups. There were 51 cases in the control group consisting of 14 males and 37 females with an average age of  $42.0 \pm 14.6$  years old. There were 52 patients in the experimental group consisting of 15 males and 37 females with an average age of  $37.6 \pm 9.3$  years. In research, the exposure duration to the radioactive source in the control area was measured by stopwatch and the self-perception and cognitive status of the patient before taking the medication was assessed using a self-designed questionnaire.

Both groups of patients completed the relevant examination within the expected time and were treated with an oral sodium iodide-131 solution at a dose of 100-150 mCi. The control group patients receive the routine thyroid cancer treatment protocols in our study. On the other hand, we provide the CQI management to the experimental group patients. The CQI team consisted of nursing director, nursing team leader, and responsible nurse. The nursing director was responsible for technical guidance, the nursing team leader was responsible for project implementation and quality control, and the

responsible nurse was in charge of recording group activity.

Inclusion criteria: patients (1) being treated with iodine-131 for differentiated thyroid cancer, (2) being treated with iodine-131 to clear residual thyroid tissue, (3) having normal cognitive and behavioral ability, and (4) providing informed consent for and being of stable condition during this study. Exclusion criteria: patients having (1) difficulty swallowing, (2) a physical activity disorder, (3) severe anxiety or depression, (4) severe damage to the oral mucosa, (5) received iodine-131 treatment of differentiated thyroid cancer more than once, and (6) severely impaired liver and kidney function.

### 2.2. Statistical Method

Statistical analysis was performed using SPSS 17.0 software. The data is presented as mean  $\pm$  standard deviation. Wilcoxon rank-sum tests were used to compare groups. The count data were analyzed by  $\chi^2$  test. A difference was considered statistically significant at  $P < 0.05$ .

## 3. Results

### 3.1. Comparison of Radiation Monitoring Values After Patients Were Administered the Drugs

After the CQI principle was applied for radiation safety management, the difference in radiation monitoring values between the two groups was statistically significant ( $P < 0.05$ ), as shown in Table 1.

### 3.2. Comparison of Self-perceived Patient Cognition Before Taking Drugs

The self-perception cognition of the two groups before drug administration was assessed and the experimental group was found to have superior self-perceived cognition compared to the control group. The difference was statistically significant ( $P < 0.05$ ), as shown in Table 2.

### 3.3. Comparison of Patient Satisfaction of the Explanation of the Medication Process and Implementation Methods

By comparing the satisfaction of the two groups concerning the medication administration process and implementation method, it was found the experimental group was statistically significantly ( $P < 0.05$ ) more satisfied than the control group, as shown in Table 3.

**Table 1.** Comparison of radiation monitoring after patient took drugs (Wilcoxon rank-sum test for comparison of raw data for two independent samples).

Group	Number of patients	Radiation monitoring for environment surrounding the dosing window (CPM)	Duration of exposure to radiation source (S)
Control	51	1879.2	465.62
Test	52	433.82	272.82
Z value		1.921	4.389
P value		0.001	0.000

**Table 2.** Comparison of patient self-perceived cognition before taking drug.

Item	Control (n = 51)		Test (n = 52)		X <sup>2</sup> value	P value
	Yes	No	Yes	No		
Not adapted to the hospital environment	33 (64.7)	18 (35.3)	25 (48.1)	27 (51.9)	2.894	0.089
Mental tension before taking the medicine	36 (70.6)	15 (29.4)	12 (23.1)	40 (76.9)	23.356	0.000
Worry about spillage when taking the medicine process	35 (68.6)	16 (31.4)	17 (32.7)	35 (67.3)	13.301	0.000
Familiar with medication process	36 (70.6)	15 (29.4)	51 (98.1)	1 (1.9)	12.807	0.000
Requirement of pre-medication training rehearsal	47 (92.2)	4 (7.8)	49 (94.2)	3 (5.8)	0.001	0.979
Flow chart of medication helps	47 (92.2)	4 (7.8)	51 (98.1)	1 (1.9)	0.882	0.348
Drug droplets spilling out	3 (5.9)	48 (94.1)	0 (0)	52 (100)	1.414	0.234

**Table 3.** Comparison of patient satisfaction of the medication process explanation and implementation methods (comparison of sample composition ratio).

Group	Number of patients	Very satisfied	Satisfied	Unsatisfied
Control	51	16	35	0
Test	52	39	13	0
X <sup>2</sup> Value	-	-	19.694	-
P value	-	-	0.000	-

### 4. Discussion

The key point of Continuous Quality Improvement (CQI) is focused on supervising and taking good care of patients during the quality improvement process, thus continuously improving the results [4]. Due to the widespread use of radionuclide iodine-131 for the treatment of thyroid cancer, related nursing processes and methods continue to advance and develop. Radiation safety management of iodine-131 administration is a topic of particular interest to many scholars in the clinic. Iodine-131 emits a gamma ray and, thus, is highly penetrating, is volatile, and has a long half-life. A lead plate is therefore needed as a shield to prevent iodine-131 penetration. If the radiation protection measures are improperly implemented during the administration to thyroid cancer patients, leakage of the liquid will not only inhibit decontamination of the staff, but also pollute the indoor air and surrounding environment [8, 9, 10]. At the same time, when a patient takes the drug and becomes a strong "radiation source", they should stay in the control area for a longer period to decrease the probability of environmental pollution. The nursing unit dosing window is connected to the ward corridor. Although the ward corridor is the control area, it is also used for staff to treat and care for the patient. According to radiation safety management regulations, the radiation dose that the staff receives should be minimized [11, 12]. Combined research indicates that time, distance, shielding, and other protective measures are the most beneficial to avoiding exposure to radiation [13-15]. Additionally, high thyroid volume is an indicator of long-term iodine deficiency that may persist for years after iodine repletion [16].

The results of CQI measures in this study showed the total duration of the patient medication administration was shortened and the radiation pollution value of the ground around the drug administration window was reduced. Of course, if the ambient radiation monitoring value was higher than 0.5µSv/hr (167CPM), the second layer of

anti-seepage adhesive paper was replaced to reduce the ambient radiation monitoring value and keep the area safe, thus confirming CQI measures could not only reduce the probability of environmental pollution, but also reduce the workload of and risk of radiation damage to the staff, thus playing a very important role in radiation safety management.

The International Committee on Radiological Protection (ICRP) suggests that the medical staff should take appropriate protective measurements since the radiation dose caused by <sup>131</sup>I is the largest among medical staff, relatives and caregivers. [8] This study showed that, via a series of improvements, the risk of care was reduced and no adverse events occurred. However, the following deficiencies still remain. (1) Patients who indicate they are not suitable for the drug administration environment may have an inability to adapt to changes in their living environment and the restriction of free going out after taking the medicine. (2) The psychological tension and worry about drug leakage by the patients before taking the drug may be related to the instructor using the whole-process monitoring video method during medication administration rather than providing face-to-face and hand-to-hand guidance for taking the drug. Meanwhile, factors, such as economy or treatment effect, can also cause patient psychological responses, such as tension and fear. (3) The patient proficiency level in the medication process may be related to limited language communication and hypothyroidism, which can also have certain effects on cognitive function. Therefore, we will continue to actively explore effective nursing measures for these patients while strengthening health education and psychological interventions in the future.

In conclusion, we have adopted the CQI method for routine iodine-131 administration for thyroid cancer and achieved positive results in radiation safety management of radiopharmaceutical administration. We ensured the accuracy of patient dose, improved the quality of and patient satisfaction in the treatment, and reduced unnecessary radiation damage of the staff. Therefore, the CQI method is worth promoting and implementing.

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