

# Information about radiation dose and risks in connection with radiological examinations: what patients would like to know

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## Abstract

**Objectives** To find out patients' wishes for the content and sources of the information concerning radiological procedures.

**Methods** A questionnaire providing quantitative and qualitative data was prepared. It comprised general information, dose and risks of radiation, and source of information. Two tables demonstrating different options to indicate the dose or risks were also provided. Patients could give one or many votes. Altogether, 147 patients (18–85 years) were interviewed after different radiological examinations using these devices.

**Results** 95 % (139/147) of the patients wished for dose and risk information. Symbols (78/182 votes) and verbal scale (56/182) were preferred to reveal the dose, while verbal (83/164) and numerical scale (55/164) on the risk of fatal cancer were preferred to indicate the risks. Wishes concerning the course, options and purpose of the examination were also expressed. Prescriber (3.9 on a scale 1–5), information letter (3.8) and radiographer (3.3) were the preferred sources. Patients aged 66–85 years were reluctant to choose electronic channels.

**Conclusions** Apart from general information, patients wish for dose and risk information in connection with radiological examinations. The majority preferred symbols to indicate dose and verbal scales to indicate risks, and the preferred source of information was the prescriber or information letter.

## Key points

- 95 % of patients expect information on the dose and risks of radiation.
- Symbols and verbal scale are preferred to indicate the dose.
- Verbal and numerical scales are preferred to indicate fatal cancer risk.
- Patients expect information on course, options and purpose of examination.
- Prescriber, information letter and radiographer are popular sources of the overall information.

**Keywords** Informed consent · Communication · Patient safety · Radiation, ionizing · Radiology

## Introduction

Global radiation doses to the public have increased by 20 % since the beginning of the 20th century. Especially, the use of computed tomography (CT) has increased vastly. It has been estimated that about 0.4 % of all cancers in the US might be attributable to radiation from CTs and that some decades from now, the incidence will be from 1.5 to 2 % [1–4]. As an example, the dose of radiation from a single head CT is about 2 millisievert (mSv), equivalent to 8 months of background radiation in Finland. This may cause about 1:10,000 statistical risk of fatal cancer [5, 6].

Concerns about the effectiveness of implementation of justification have been highlighted [7, 8]. It is the responsibility of the prescriber as well as the practitioner to perform justification of a radiological procedure. However, the patient's opinion should also be considered in this process; the patient should be provided with due information before any consent can be received (so-called informed consent) [7, 9, 10]. Informed consent is a part of safety culture [11, 12]. A part of the

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medical practitioners are known to have limited awareness of the doses and risks of radiation, and patients are often confused [13–16]. Today, there is little or no information on these issues for patients, the units are complex, and the language may be arcane [7, 16].

Nevertheless, the International Atomic Energy Agency (IAEA) has stated that there is a need for improved communication, both between professionals and between professionals and patients. The manner in which communication is undertaken is also important and undue fear should be avoided. It is stated in the IAEA Basic Safety Standards that the patient has to be informed of the potential benefit of the radiological procedure, as well as radiation risks [17]. According to the IAEA report, it is important to concentrate on what a “reasonable person in the patient’s position” would like to know in contrast to what a “reasonable physician” thinks a patient should or might want to know [7]. Suggestions for due communication have been published [7, 11, 18]. However, to our knowledge, there are no thorough surveys concerning the attitudes and wishes of the patients themselves.

The purpose of this study was to find out the expectations of adult patients concerning the information given to them prior to radiological examinations using ionizing radiation, and especially their wishes for the content of the information and the preferred sources for it.

## Materials and methods

This study was performed in 2012 (from June to September) in the Department of Diagnostic Radiology, Oulu University Hospital, Oulu, Finland. The study was approved by the Institutional Review Board and oral informed consent was required. The questionnaire developed for the study contained multiple choice and open questions and scales, and was comprised of general information on the examination, the dose and risks of radiation, and the source for information. One of the multiple choice-questions was a single-answer type, while two were multiple-answer types. Three out of seven questions were open, providing descriptive information.

Using an open question, the patients were asked what issues regarding a radiological examination they would like to be informed about. The question was an open one to elicit spontaneous wishes and to provide qualitative data. The other open question inquired about wishes concerning the situation for giving information. The last 40 consecutive patients were also asked for their opinions regarding the survey, because we wanted to know the patients’ attitudes toward the interview itself, as well as toward asking about radiation issues.

Using a single-answer type question, the patients were asked whether they would like to be informed about the radiation dose and risks in connection with an examination producing low ( $<1$  mSv), medium (1–10 mSv), or high

( $>10$  mSv) levels of radiation, or whether they would not like to be informed at all. The dose levels mentioned were defined for the study. Various examples of examinations were given: thorax and bones of the extremities for low doses of radiation, fluoroscopy examinations and head CT for medium doses, and body CT and some nuclear medicine examinations for high doses.





A table demonstrating six different ways to inform about the dose (Table 1) and another table demonstrating four ways to tell about the risks (Table 2) were also prepared with modifying available data [5–7, 18, 19]. Using the tables, the patients were asked which ways they would prefer. The entire table was shown at once and examples of the examinations and different options were introduced. The patients were able to choose one or many options (votes; i.e., multiple-answer questions).

Furthermore, using a scale from 1 to 5, the patients were asked about the preferred sources for the overall information, including the dose and the risks. The questionnaire provided different alternatives: referring practitioner, radiographer, radiologist, using a notice sent from the hospital, personal e-mail and hospital website.

The patients took part in the study voluntarily and responded anonymously. The method was based on convenience sampling. The patients were selected by the radiographer after different examinations so that the number of participants was almost equally distributed among low, medium and high dose examinations [20]. The radiographer conducted the interviews during her times for research and interviewed the available patients. All the patients were interviewed in person in a peaceful atmosphere. The radiographer asked the questions, showed the tables, explained any unclear aspects and filled in the printed questionnaire. At first, the radiographer asked about the information the patients had possibly obtained before the prior examination to allow them to orient themselves to the issues of radiological examinations (not reported in this paper). After that, the radiographer inquired about the wishes related to future information (this study).

Altogether, 147 patients from five different units of the department were interviewed. The data was taken to the Webropol survey and analysis software (2.0) [21], rechecked and analyzed. Frequency distributions were calculated for gender, age (categorized into three groups: 18–41, 42–65, and 66–85 years), and the dose levels of the previous examinations (low, medium, high). The critical dose level at which the patients wished to know about the dose and the risks of radiation, and the expression of the dose and the risks preferred were compared between men and women, different age groups, and the dose levels of the previous examinations by using Chi-square test or Fisher’s exact test. The preferred source of information was compared between men and women using independent samples *t* test, and between different age groups and the dose levels of the previous examinations by using analysis of variance with Tukey’s test as a post-hoc test.

**Table 1** The table used in the interview, revealing six different ways to indicate the radiation dose

Examination	The symbol of radiation	The scale of radiation	Dose mSv	Corresponding number of pa <sup>a</sup> chest x-rays	Corresponding period of natural background radiation <sup>b</sup>	Corresponding number of flights from Oulu to Australia <sup>c</sup>
US MRI		None	0 mSv			
Knee (x-ray)		Minimal	0.01 mSv	0.3	1 day	< 1 flight
Cervical spine (x-ray)		Low	0.2 mSv	7	24 days	5 flights
Head CT		Medium	2.0 mSv	70	8 months	50 flights

<sup>a</sup> pa = posterior-anterior

<sup>b</sup> In Finland

<sup>c</sup> One flight (Oulu, Finland – Sydney, Australia) corresponding to about 19 hours

IBM SPSS Statistics 22 (IBM Corporation, Armonk, NY) [22] was used to conduct the statistical analyses. The open questions were analyzed using content analysis and counting in percentages. The data were categorized into appropriate subject groups and the number of expressions in each group was counted (i.e., quantification) [23].

## Results

Altogether, 99 % (147/149) of the patients invited were willing to take part in the survey. The patients were between 18–85 years (average 52.8 years) of age, 60 % were women and 40 % were men. Prior to the interview, the patients had undergone altogether 156 examinations causing different levels of radiation: 40 with a low dose, 70 with a medium dose and 46 with a high dose. The examinations were plain x-ray (thorax, bone,  $n=49$ ), mammography ( $n=14$ ), fluoroscopy ( $n=21$ ), CT ( $n=24$ ), nuclear medicine examination (bone scintigraphy,  $n=11$ ), positron emission-CT (PET-CT,  $n=13$ ) and angiography ( $n=24$ ).

In the open question, 95 % (140/147) of the patients expressed their opinion, giving 251 comments about the issues they would like to be informed about in connection with a radiological examination. Of the comments, 105 (42 %) concerned the risks, 46 (18 %) the course of the examination, 26

(10 %) the dose, 14 (6 %) the options (“possible options” expressed by the patients), and eight (3 %) the purpose of the examination. Sixteen (6 %) of the comments revealed no need for any information. Thirty-six (14 %) of the comments concerned issues not related to the question (e.g., “the location of the x-ray department”, “I rely on experts”). In the other open question, 58 % (85/147) of the patients gave 115 comments about their wishes concerning the situation for giving information. The situation should be peaceful, and sufficient time should be reserved ( $n=36$ , 31 %). It should also be natural and friendly ( $n=26$ , 23 %). The information given should be honest, explaining the basics briefly ( $n=27$ , 23 %). Altogether 18 comments (16 %) concerned the channel of information and eight comments (7 %) did not answer the question (e.g., “I trust professionals”, “There has been good service”). When asked about the interview itself, all the patients concerned (40/40) stated that they appreciated the survey.

In all, 95 % of the patients (139/147) wanted to know about the dose and risks of radiation: 81 patients (55 %) in connection with an examination causing any level of radiation and 58 (39 %) in connection with an examination causing a medium or high dose of radiation. The former choice was chosen by 37 men (62 % of the men) and 44 women (51 % of the women), the latter choice by 17 men (28 %) and 41 women (47 %). Five percent (8/147) did not want to know about the dose and risks in connection with any examination (low, medium or high

**Table 2** The table used in the interview, showing four ways to indicate the risks

Examination	Extra risk of fatal cancer	Extra risk of fatal cancer shown by number <sup>a</sup>	Number of cigarettes smoked; corresponding risk of death by lung cancer	Highway driving distance; corresponding risk of death by traffic accident
US MRI	None	None		
Knee (x-ray)	Almost zero	1: 1,000,000-2,000,000	3	12 km
Cervical spine (x-ray)	Minimal	1: 50,000-100,000	56	230 km
Head CT	Very low	1: 5,000-10,000	560	2300 km

<sup>a</sup> generalized numbers

dose). These eight patients were over 42 years old, six of them were men, and they had had an examination with various dose levels. The dose levels of the previous examinations or the age of the patients did not have an effect on the choice regarding the critical dose level for due information (data not shown).

Six different ways to indicate the dose are seen in Table 1. The patients were allowed to choose one or more options. Altogether 182 votes were given. The most popular ways to indicate the dose were “the symbol of radiation” (43 %, 78/182 votes) and “the scale minimal–low–medium” (31 %, 56/182) (Fig. 1). The option “the corresponding number of p a chest x-rays” was chosen by women more often than by men (20 % vs. 7 %,  $p=0.032$ ), but only by 4 % of those with a previous high-dose examination, compared to 17 and 20 % of those with a previous low-dose or medium-dose examination, respectively ( $p=0.056$ ). Age did not have an effect on the choice regarding the issues of the dose (data not shown).

The four ways to indicate the risks are seen in Table 2. There was a possibility to choose one or more options. Altogether 164 votes were given. The patients preferred “almost zero–minimal–very low risk of fatal cancer” (51 %, 83/164 votes) and “corresponding data shown by number” (34 %, 55/

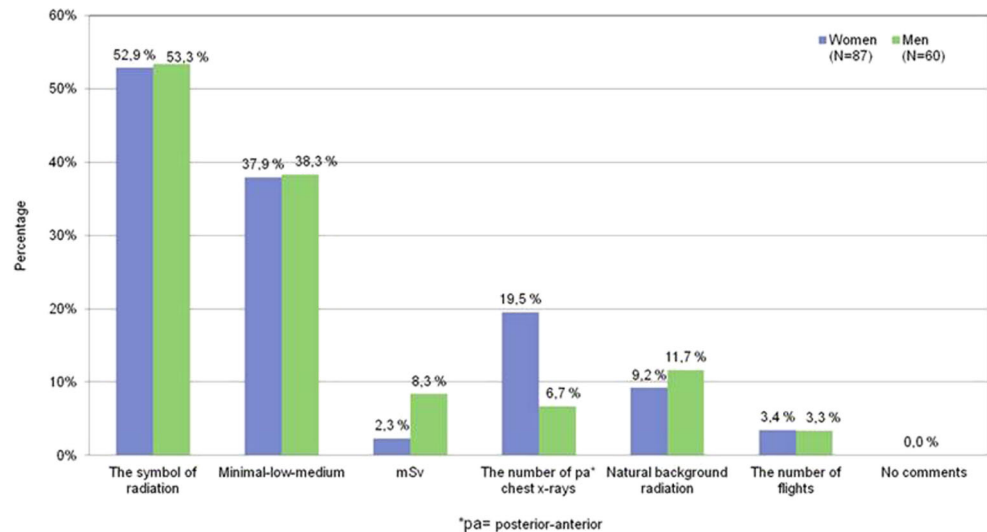
164) (Fig. 2). The latter option was chosen by 43 % of the men and by 33 % of the women ( $p=0.230$ ). Age or the dose levels of the previous examinations did not have an effect on the choice related to the expression of the risks (data not shown).

The results concerning the source of the overall information are shown in Fig. 3. The patients were asked to assess all the options. The referring practitioner, the information letter and the radiographer were the most popular choices. Women were more likely than men to prefer the choice “referring practitioner” (grade 4.1 vs. 3.6;  $p=0.038$ ). The preference for “hospital website” decreased with age (Table 3). The preference for “e-mail” was lowest for the oldest age group (Table 3). The option “radiologist” was chosen more often by those with a previous high-dose examination than those with a low-dose or medium-dose examination (3.1 vs. 2.1 and 2.5;  $p=0.019$ ).

## Discussion

Patients’ opinions should have a crucial role in the development of guidelines concerning patient information in

**Fig. 1** The preferences of the patients related to expression of the dose ( $n=182$  votes). The patients were allowed to choose one or many options (see also Table 1)



connection with radiological examinations. Our survey is the first one to find out patients' wishes and attitudes in this respect. The results of this study could be utilized when planning patient information.

A patient-centered approach to care including patient information has been strongly highlighted. Informed consent is a crucial part of the justification of a radiological procedure. Media and public interest in radiation exposure has also increased the need for appropriate information [7, 10, 24, 25]. Patients should be provided with appropriate information and informed about the associated uncertainties in a way that they can relate to, understand and trust [16]. The information should include the type and nature of the suggested examination, its benefits and risks, alternative examinations and risks of not undergoing an examination [12].

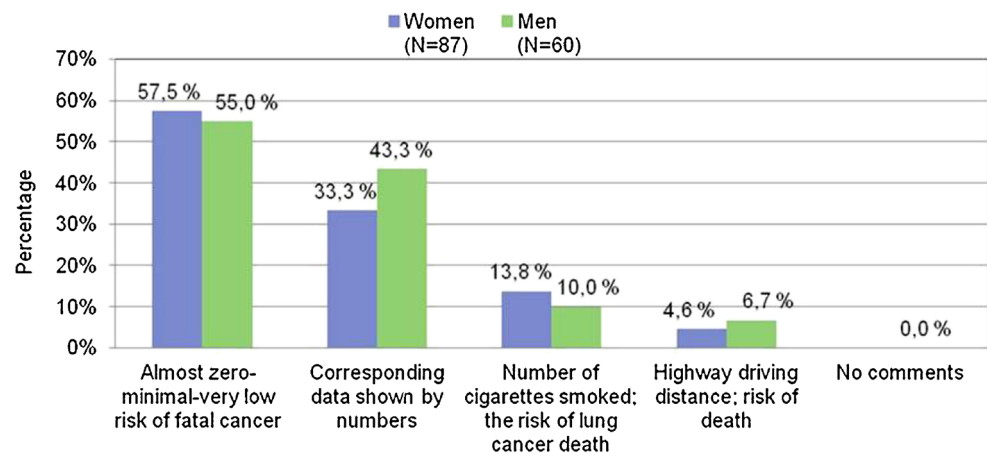
Despite some recommendations, many questions have been raised concerning the information, such as whether patients have any interest in the information, or whether there is a risk of causing undue fear, as well as what could be the best way to express the dose and the risks, who should be the counselor, what would be the critical dose level for due

information, and whether there is a need for consent. The need to be aware of patients' wishes in the justification process has also been emphasized [7, 26].

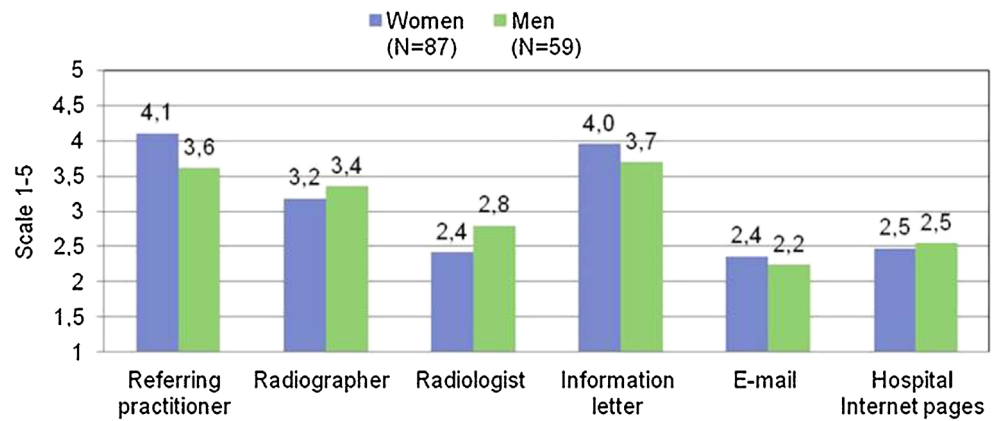
This study was performed using both quantitative and qualitative data collection methods. Qualitative research can provide in-depth insight into a question. However, it is possible to quantify the data by turning it from words into numbers [23]. The method is descriptive and the results cannot be generalized as such, but they may provide some indication of generalization [20].

The open question revealed risks to be the most popular area on which patients wished to be informed. The course of the examination came far behind. Only 5 % of the patients did not want any information about the dose and risks in connection with any examination using ionizing radiation. There were more men than women in this group and they were all over 42 years of age. Altogether, 95 % of the patients wished to be informed about the dose and the risks. It seems that health care professionals should not be too concerned about causing undue anxiety. Information should always be provided. However, the extent of the information should depend on

**Fig. 2** The preferences of the patients concerning expression of the risks ( $n=164$  votes). The patients were allowed to choose one or many options (see also Table 2)



**Fig. 3** The results related to the source of the information using a scale from 1 to 5. The patients were asked to assess all the options



the nature of the examination and on the patient. The patient’s autonomy and feelings must be considered, and the patient can refuse to receive the information.

There are no other similar studies to compare with our results. However, studies have revealed patients’ wishes to receive information on various risks [27, 28]. A recently published study also reported that 91 % of parents wish to receive risk information before their children’s radiological examinations, although willingness to proceed with CT was somewhat reduced after risk disclosure [29]. Another study revealed no impact on willingness [30]. It is to be noted that awareness of the risks may decrease patients’ demand for inappropriate examinations. Appropriate information about the risks might also reduce anxiety and help to see the benefits [30, 31].

There are different views concerning the way of how to tell patients about the dose and the risks involved [7, 11, 12, 26, 32]. Complex units, uncertainty of the risks and the difficulty of explaining these in a clear manner have been highlighted [15, 33]. Tables, figures and illustrations have been recommended. The dose expressed in equivalent number of chest

x-rays or equivalent period of natural background radiation have been used, and the use of familiar risks or lifetime additional risk of cancer per investigation has been suggested.

We selected various available ways for the tables (Table 1, 2) but did not include high-dose examinations (>10 mSv), as this was a survey, not an occasion for information and discussion prior to a scheduled examination. In particular, we wanted to avoid creating fear for patients who had undergone a previous high-dose examination. The symbols and the scale revealing the dose and extra risk of fatal cancer, and that shown by numbers were the most comprehensible, but other options received votes as well (Fig. 1, 2). However, the dose in mSv, corresponding number of flights and the risk comparable to that of death related to highway driving distance were not popular. The gender of the patients had some effect on the choices. The patients seemed to like these tables and were keen to choose their preferences. Hence, tables of this kind with tailored options could be usable in practice.

The patients would like to receive the information from various sources, the referring practitioner and a notice sent from the hospital prior to the examination being most popular (Fig. 3). A small group of young patients preferred the hospital Internet pages and e-mail as well. Patients with a previous high-dose examination preferred a radiologist. This may be due to the presence of the radiologist during the examination, e.g. during angiographies. In the literature, there are different views related to the source, e.g. the referrer, the radiologist or the radiographer. Leaflets, notices and electronic material have also been recommended [12, 31, 34]. Patients seem to appreciate information provided in advance. The referring practitioner has the most complete clinical information, while the radiologist may be more familiar with radiation. However, the referrer could inform the patient in connection with primary justification, enabling the patient to ask questions and give consent. The radiographer or the radiologist might give additional information, if necessary, or be the source of primary information if the patient has not been able to meet the referring doctor. A printed or electronic notice could also be provided and it alone might be a good source in the case of a low-

**Table 3** The wishes concerning the source of the information analyzed by age groups. A scale from 1 to 5 was used

	Age (years)			<i>p</i> value <sup>b</sup>
	18–41, <i>n</i> =25 Mean (SD)	42–65, <i>n</i> =103 <sup>a</sup> Mean (SD)	66–85, <i>n</i> =18 Mean (SD)	
Referring practitioner	4.1 (1.2)	3.9 (1.3)	3.9 (1.4)	0.670
Notice sent from the hospital	4.0 (1.4)	3.8 (1.5)	3.6 (1.3)	0.645
Radiographer	3.0 (1.5)	3.4 (1.4)	2.7 (1.5)	0.136
Radiologist	2.5 (1.7)	2.6 (1.7)	2.2 (1.5)	0.527
Hospital Internet pages	3.1 (1.7)	2.5 (1.7)	1.7 (1.4)	0.023
E-mail	2.4 (1.8)	2.5 (1.8)	1.4 (1.1)	0.007

SD = standard deviation

<sup>a</sup> One patient in the age group 42–65 years did not give any comments

<sup>b</sup> Significance from analysis of variance

dose examination. There seems to be a need for different sources, and older people are not very well prepared to receive information via electronic channels.

Furthermore, according to the open question, the patients wished to receive brief and honest information without any sense of being rushed. It has been highlighted that patients' feelings, instincts and personal circumstances should also be taken into account when informing them [7, 32]. The process of information is the duty of health care personnel, but it requires the education of the referring practitioners and the staff of the radiology department as well as resources; recommendations as to division of responsibilities could be of help in providing the information.

There are limitations in this study. The survey is from one university hospital only. However, the hospital is the only central hospital in our area. Patients had also undergone different examinations with various levels of radiation and there were patients by appointment as well as acute patients. Furthermore, this study was done by an interview where responses were recorded by the radiographer, which can cause a risk of bias. However, we wanted the survey to be easy for the patients and not to bother them to fill in forms or answer via the internet at home. This strategy may also have yielded more patients for the study. Some patients may also find radiation itself strange and frightening. The presence of the radiographer could help the patients to feel safe and it enabled questions when necessary. The first part of the interview concerning obtained information in connection with the previous examination may have had some effect on patients' wishes. However, some familiarity with radiological examinations and associated terms could also help the patients to respond to the questions of this study.

Open questions provide descriptive information, but they were aimed to elicit spontaneous wishes and not to direct the patients too much. Multiple choice questions and scales were also used to receive quantitative and more detailed data. We also realize that the tables are simplified, but they were developed for the survey and should be processed further for use in practice. The risk indicators in Table 2 do not imply any relation with age or gender. Young females are subject to much greater risks than older males. It seems to be difficult to find "proper" expressions in this respect, which reflects the complexity of the whole issue. The dose of an examination may also vary depending on the department, and natural background radiation depends on the location. For the future use, information on higher-dose examinations should also be included.

In conclusion, this study shows that apart from general information, patients wish to receive information on the dose and risks of radiation in connection with radiological examinations. The majority of patients preferred symbols to indicate dose and verbal scales to indicate risks, and the preferred source of information was the referring practitioner or the information letter. Different persons have different wishes,

and hence, various expressions and different sources should be provided. The wishes of the patients should be taken into consideration when planning patient information.

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