

Food Safety Knowledge and Self-Reported Food-Handling Practices in Cancer Treatment

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OBJECTIVES: To explore awareness of foodborne infection risk during chemotherapy treatment, to assess knowledge of risk-reducing food safety practices in patients with cancer and their family caregivers, and to determine self-reported food-handling practices.

SAMPLE & SETTING: A convenience sample of 121 patients receiving chemotherapy and 51 family caregivers of patients receiving chemotherapy in the United Kingdom recruited in the community and using online advertising.

METHODS & VARIABLES: Participants completed a self-report questionnaire to determine food safety knowledge and self-reported food-handling practices.

RESULTS: Although patients receiving chemotherapy and family caregivers reported awareness of food safety practices, self-reported practices indicated that potentially unsafe practices may be used in relation to temperature control, handwashing, safe cooking, and adherence to use-by dates. Such practices may increase the risk of foodborne illness to patients receiving chemotherapy treatment.

IMPLICATIONS FOR NURSING: Nursing research is required to explore the food safety training and awareness of healthcare providers. Highly focused and specifically targeted food safety interventions need to be developed and delivered to increase awareness and to implement food safety practices.

KEYWORDS chemotherapy; family caregivers; food safety; knowledge; self-reported practices; foodborne infection

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Because of the cytotoxic drugs used in chemotherapy for the treatment of cancer, immune responses in patients with cancer are suppressed (Oliver & Nouri, 1992). Consequently, patients with cancer receiving chemotherapy treatment have an increased risk of infection, including foodborne infections. Given that patients with cancer have very little defense against opportunistic pathogens, these infections may be more difficult and take longer to treat; consequently, the mortality rates of enteric viral infections are elevated in patients with cancer (Gerba, Rose, & Haas, 1996). Cancer and chemotherapy are recognized as underlying conditions for foodborne infections from *Campylobacter* (Pacanowski et al., 2008), *Salmonella* (Rolston & Bodey, 2000), and *Listeria monocytogenes* (Silk et al., 2012; Swaminathan & Gerner-Smidt, 2007). Among people with suppressed immune systems, infections (e.g., norovirus) are reported to pose an increased risk of more severe consequences (Mattner et al., 2006). The evidence suggests that 15%–25% of serious *Salmonella* infections occur among patients with cancer (Rolston & Bodey, 2000). A large proportion of listeriosis cases in England and Wales is reported to be associated with patients with cancer (Gillespie et al., 2009; Mook, O'Brien, & Gillespie, 2011). Patients with cancer are reported to have a five-fold increased risk of listeriosis, and one-third of non-pregnancy-associated listeriosis cases are reported to be among patients with cancer (Mook et al., 2011). Invasive listeriosis has a hospitalization rate of less than 90% (Centers for Disease Control and Prevention, 2011) and a mortality rate of less than 41% (Mook, Patel, & Gillespie, 2012); therefore, reducing the risk of developing such foodborne infections among patients receiving chemotherapy is essential.

Background

Neutropenic Diet

To reduce the risk of foodborne infection, a need exists to reduce the likelihood of consuming foodborne

pathogens. Patients with cancer who experience neutropenia are advised to follow a neutropenic diet (Wilson, 2002). The neutropenic diet has a strict limitation of foods to reduce potential microbial intake and reduce the risk of foodborne infection; research evaluating the potential benefits and effects of the neutropenic diet on infection rates and related outcomes in patients receiving chemotherapy with neutropenia is limited (DeMille, Deming, Lupinacci, & Jacobs, 2006; Fox & Freifeld, 2012; van Dalen et al., 2012). Many people fail to adhere to neutropenic diet restrictions (Wilson, 2002); however, following safe food-handling and storage practices may allow for a more liberal diet among patients with cancer (Fox & Freifeld, 2012). Without scientific evidence, the best advice for people with neutropenia is to follow food safety guidelines as indicated by government entities (Jubelirer, 2011).

Domestic Food Safety Practices

The domestic kitchen is a multifactorial contributor to foodborne infection (Scott, 2003). Risk-reducing food safety practices are required throughout all stages for which the consumer is responsible, including purchase, transportation to the home, domestic storage, preparation, cooking, and consumption, to ensure food safety (SafeFood, 2012). Internationally, cross-contamination, insufficient heat treatment of foods, inadequate refrigerated storage of food, inadequate hand decontamination practices, and improper cleaning of food-contact surfaces are the most common contributory factors associated with the transmission of foodborne infection (Public Health England, 2013; U.S. Food and Drug Administration, 2000). Therefore, consumer food safety recommendations refer to personal and domestic hygiene practices, separation of raw foods from ready-to-eat (RTE) produce, heat treatment, refrigeration temperatures, and the selection of safe food and drink (World Health Organization [WHO], 2006). Recommended practices to reduce the risks associated with listeriosis at home relate to the ability of *Listeria monocytogenes* to grow at refrigeration temperatures. Risk-reducing practices include the following (Evans & Redmond, 2014):

- Adhering to use-by dates on unopened prepacked RTE food products
- Consuming RTE food products within two days of opening
- Ensuring the safe operating temperatures of domestic refrigerators (5°C/41°F or less)

Some domestic kitchen practices are associated with greater importance (Medeiros, Hillers, Kendall, & Mason, 2001), such as the avoidance of raw or

undercooked food products (e.g., seafood, eggs) and food products associated with *Listeria monocytogenes* (Kendall, Medeiros, Hillers, Chen, & Dimascola, 2003; Lund, 2015).

Role of Family Caregivers

As more cancer care is delivered in the home, the value of the support and informal caregiving provided by family caregivers of patients with cancer is expected to increase (Rivera, 2009). Household maintenance, including buying food, preparing meals, and cleaning the house, have been identified as key factors for caregivers' well-being (Tamayo, Broxson, Munsell, & Cohen, 2010). The provision of food is reported to be an important role for family caregivers of patients receiving chemotherapy; it has been cited to be comforting and identified as one of the few roles families can assist people with during chemotherapy (Evans & Redmond, 2017). Therefore, understanding the knowledge and behavior of family caregivers in relation to food safety in the home is essential. To date, few studies have reported the knowledge and practice of informal family caregivers of patients receiving chemotherapy regarding personal hygiene and food safety (Bagcivan, Masatoglu, & Topcu, 2015). Research suggests that patients receiving chemotherapy and family caregivers are aware of the increased risk of infection and implement control measures to reduce the risk of communicable diseases; however, the risk of foodborne infection is underestimated (Evans & Redmond, 2017).

Food Safety Information

Education is essential in reducing the likelihood of foodborne illness, particularly among those at greatest risk (Kendall et al., 2003). The U.S. Department of Agriculture and U.S. Food and Drug Administration (2011) produce food safety information specifically for patients with cancer. In the United Kingdom, less than one-third of National Health Service chemotherapy providers have online food-related patient information resources that refer to essential food safety information. However, such resources were found to be inconsistent and insufficient to inform patients receiving chemotherapy because considerable gaps regarding food safety information exist. Many resources fail to highlight the increased risk of foodborne infection or emphasize the importance of food safety for patients receiving chemotherapy, particularly in relation to listeriosis prevention (Evans & Redmond, 2017). A need exists for appropriate food safety advice specifically tailored to target patients with cancer in the United Kingdom and to highlight

TABLE 1. Reported Details of Patients Receiving Chemotherapy Related to Treatment (N = 172)

Treatment Detail	Yes		No		Do Not Know	
	n	%	n	%	n	%
Cachexic during treatment	6	4	103	60	63	37
Malnourished during treatment	28	16	126	73	18	11
Neutropenic during treatment	60	35	69	40	43	25
Received a transplantation	6	4	163	95	3	2
Received food safety information during treatment (N = 136)	61	45	64	47	11	8
Received private healthcare treatment	15	9	154	90	3	2
Saw a dietitian during treatment	42	24	127	74	3	2
Treated for a blood-related cancer	23	13	145	84	4	2

Note. Because of rounding, percentages may not total 100.

the importance of food safety to patients with cancer to assist efforts to reduce the risk of foodborne infections (Evans & Redmond, 2017; Mook et al., 2011). To develop a highly focused food safety intervention, healthcare providers need to use a patient-oriented approach to obtain insight on the current practices and awareness of patients receiving chemotherapy and associated family caregivers to understand what food safety practices this group implements in the home kitchen. However, there is a lack of evidence detailing the knowledge and self-reported food-handling practices of patients with cancer and family caregivers during chemotherapy.

This study aims to establish what patients receiving chemotherapy and family caregivers know about food safety and to determine self-reported food safety practices in the home. Findings will increase understanding of food safety awareness and provide insight into food safety practices implemented in the home, which will help to inform the development of future targeted food safety communication approaches to increase implementation of risk-reducing behaviors.

Methods

Sample and Setting

A convenience sample of patients receiving chemotherapy treatment and family caregivers in the United Kingdom were recruited following a period of publicizing the research study online and in person. To enable distribution and completion of the questionnaires, methods included distribution of questionnaires at cancer support groups. Online promotion using social media (Twitter and Facebook) and emails to cancer support groups in the United Kingdom circulated project information and links

to an online questionnaire. Posters promoting the project with information on how to access the online version or obtain a paper version were displayed in supermarkets, community centers, and libraries, as well as on local notice boards in the County and City of Cardiff in the United Kingdom.

The inclusion criteria for participation in the study included being aged 18 years or older, being a person currently receiving or having recently (within the past three years) received chemotherapy in the United Kingdom for the treatment of cancer or a family caregiver (involved with the informal/non-professional care) of a person currently receiving or having recently received chemotherapy for the treatment of cancer. No inclusion or exclusion criteria related to cancer type or site were used. Recruitment and data collection were conducted from December 2014 to February 2015. The Cardiff School of Health Sciences, Research, and Ethics Committee granted ethical approval for the completion of the study (project reference number: 0001-SREC-2014[01]).

Instruments

A review of literature was performed to identify important food safety practices that reduce the risk of foodborne infection among patients receiving chemotherapy. The literature review, along with frequently used knowledge and self-reported practice questions from consumer food safety research, informed the design and development of a self-report questionnaire. The questionnaire determined the awareness and practices of patients receiving chemotherapy and their family caregivers related to recommended food safety practices (WHO, 2006) and risk-reducing behaviors for listeriosis (Evans & Redmond, 2014).

Food safety knowledge was determined using 16 multiple-choice questions and 3 open-ended knowledge questions, and self-reported food safety practices were measured using a three-point frequency scale (always, sometimes, or never). The questionnaire collected quantitative and qualitative data.

The validity and reliability of the questionnaire were considered during the development and piloting stages of the questionnaire design. The questionnaire was piloted with five people meeting the inclusion criteria (three people who had received chemotherapy for the treatment of cancer and two caregivers), which allowed for the validity and reliability of the

questionnaire to be determined. Although limitations exist in the use of self-reported questions, self-report data are said to have very high degrees of validity (Ray, 1987). Test-retest reliability was determined by means of administering the questionnaire to the pilot participants on two different occasions. Content validity was determined in a structured meeting held by the research team.

Following piloting, minor amendments to the questionnaire were implemented to reduce ambiguity, reword any leading questions, and remove any potentially stressful questions. The questionnaire was available in a paper-based format or online.

TABLE 2. Significant Differences in Knowledge of Food Safety Practices Among Patients and Family Caregivers Who Reported Receipt of FSI During Chemotherapy Treatment

	Received FSI (N = 61)	Did Not Receive FSI (N = 64)		
Food Safety Knowledge	n	n	χ^2	ϕ
Drying equipment with a towel used to dry hands could increase the risk of cross-contamination.	53	51	(1, n = 113) = 3.796*	0.216
Hands should be washed before handling ready-to-eat food products.	49	41	(1, n = 113) = 6.597*	0.264
Hands should be washed before taking medication.	49	40	(1, n = 113) = 7.554*	0.28
Check the operating temperature of the refrigerator.	44	38	(1, n = 113) = 4.129*	0.191
Know foods to be avoided during chemotherapy.	44	18	(1, n = 102) = 40.111***	0.647
Hands should be washed using soap, hot water, and a clean or disposable towel.	33	22	(1, n = 113) = 5.487*	0.238
Know the operating temperature of the home refrigerator.	30	17	(1, n = 109) = 7.512*	0.281
Own and use a refrigerator thermometer.	24	15	(1, n = 113) = 4.513*	0.2
Food Safety Knowledge	n	n	χ^2	Cramer's V
Wash hands with soap and hot water.	53	50	(2, n = 114) = 4.407*	0.197
Use the same towel to dry hands, equipment, and utensils. ^a	45	32	(2, n = 112) = 13.768***	0.351
Rub hands and between fingers with soap for 20 seconds, then rinse with hot water.	41	24	(2, n = 114) = 15.929***	0.374
Use a thermometer to check the operating temperature of the refrigerator.	15	3	(2, n = 114) = 12.1**	0.326
Check that meat products are thoroughly cooked by using a meat thermometer.	11	3	(2, n = 110) = 7.462*	0.26

* p < 0.05; ** p < 0.005; *** p < 0.001
^a Potentially unsafe practice for which "never" is the best response
 FSI—food safety information

Participant information sheets were provided, and completed return of a questionnaire implied consent to participate.

Data Analysis

The dataset of online completed responses was downloaded, and paper-based responses were manually entered to the dataset. All responses were coded and only identifiable by an assigned identification number for each participant. Descriptive statistics were conducted to achieve information regarding the sample, giving an illustrative summary of the data using Microsoft® Excel. Statistical analyses were conducted using IBM SPSS Statistics, version 20.0.

Results

Demographic Characteristics

A total of 172 respondents participated in the quantitative portion of the study. The majority (78%, $n = 134$) were female and reported living with others (partner, spouse, or family) (88%, $n = 151$). Thirty percent ($n = 52$) were aged 40–49 years, and 26% ($n = 45$) were aged 50–59 years. Seventy percent ($n = 120$) were patients who had received chemotherapy for the treatment of cancer within the past three years, and 30% ($n = 52$) were family caregivers who had been responsible for preparing food for someone who had received chemotherapy for the treatment of cancer within the past three years. Caring for a partner or spouse was reported by 27 caregiver respondents, and 17 respondents reported caring for a person aged younger than 18 years.

Findings determined that many patients receiving chemotherapy were at increased risk for infection during chemotherapy treatment: 35% ($n = 60$) were neutropenic, 16% ($n = 28$) were malnourished, and 4% ($n = 6$) were cachexic during treatment. In addition, 13% ($n = 23$) were treated for a blood-related cancer, and 4% ($n = 6$) received a transplantation (see Table 1). Although 45% ($n = 61$) reported that food safety information was received during treatment, statistical analysis determined that patients receiving chemotherapy with neutropenia, patients with blood-related cancers, or patients who received a transplantation were significantly ($p < 0.05$) more likely to receive food safety information.

Refrigeration

Food safety requirements in the United Kingdom for the domestic storage of refrigerated foods is 5°C/41°F or lower (Food Standards Agency and Department of Health, 2008). The majority of respondents (68%, $n =$

85) reported knowledge of the recommended temperature a domestic refrigerator should operate at to ensure the safety of food. However, only 57% ($n = 71$) gave the correct response. Although 73% ($n = 91$) were aware of the need to check refrigerator temperatures and 64% ($n = 80$) believed a refrigerator thermometer was needed to ensure this, 63% ($n = 79$) believed the dial should be checked to ensure a safe operating temperature. However, refrigerator dial settings are not associated with mean operating temperatures (Evans & Redmond, 2016b) and will not ensure a safe temperature. Awareness of the need to check the operating temperature of the refrigerator was significantly greater among those who received food safety information (see Table 2).

All respondents believed their home refrigerator to be cold enough, but reported ownership and usage of a refrigerator thermometer was lacking (35%, $n = 43$). Fifty-eight percent ($n = 73$) reported never using a thermometer to check the operating temperature of their refrigerator (see Table 3). Reported thermometer ownership and usage was significantly ($p < 0.05$) greater among those who received food safety information. Checking the refrigerator temperature and awareness of operating temperature was significantly ($p < 0.05$) greater among those who received food safety information.

Cooking

Inadequate heat treatment has often been implicated in incidence of foodborne disease (Gormley, Little, & Rawal, 2010). Consumers in the United Kingdom are advised to check cooking adequacy of meat by cutting the thickest part to ensure that juices run clear, it is steaming hot, and it has no pink (Food Standards Agency, 2018). However, research suggests that such visual inspection can result in food products not reaching recommended cooking temperatures; therefore, consumers should use a thermometer to ensure thorough cooking (Byrd-Bredbenner, Berning, Martin-Biggers, & Quick, 2013).

Although respondents in this study indicated awareness of the need to ensure that meat/poultry is safe to eat after cooking, about 77% ($n = 96$) believed the best methods of ensuring cooking adequacy were by means of piercing the thickest part to ensure juices run clear or ensuring that the center is piping hot. Only 37% ($n = 46$) were aware of the need to use a thermometer to check the internal temperature (see Table 4), and 19% ($n = 24$) were aware of the correct cooking temperature (greater than 70°C/158°F) to ensure food safety. Of note, 78% ($n = 94$) reported that

TABLE 3. Self-Reported Food Safety Practices During Chemotherapy in Patients and Family Caregivers by Frequency of Use

Food Safety Practices	N	Always		Sometimes		Never	
		n	%	n	%	n	%
Allow dishes and equipment to air dry after washing rather than using a towel to dry.	123	55	45	59	48	9	7
Allow food to go cold outside of the refrigerator before refrigerating.	122	70	57	34	28	18	15
Check that meat products are thoroughly cooked by using a meat thermometer.	120	16	13	10	8	94	78
Eat leftover ready-to-eat food within two days of preparing.	123	44	36	57	46	22	18
Eat ready-to-eat food beyond its use-by date. ^a	127	13	10	36	29	78	62
Follow the use-by date on food products.	125	88	70	33	26	4	3
Refrigerate leftover food immediately after cooking. ^a	123	37	30	31	25	55	45
Reheat leftovers thoroughly only once.	123	71	58	36	29	16	13
Rely on appearance to decide if food is OK to eat. ^a	123	9	7	49	40	65	53
Rely on smell to decide if food is OK to eat. ^a	123	9	7	50	40	64	52
Rely on taste to decide if food is OK to eat. ^a	123	2	2	34	28	87	71
Rub hands and between fingers with soap for 20 seconds, then rinse with hot water.	126	73	58	39	31	14	11
Store raw meat above ready-to-eat food in the refrigerator. ^a	114	14	12	14	12	86	76
Use a thermometer to check the operating temperature of the refrigerator.	126	23	18	30	24	73	58
Use the same chopping board for raw and ready-to-eat food. ^a	120	2	2	10	8	108	89
Use the same towel to dry hands, equipment, and utensils. ^a	123	12	10	26	21	85	68
Wash hands after handling raw meat before handling ready-to-eat food.	117	108	92	4	3	5	4
Wash hands in a bowl of clean, hot, soapy water without touching the taps.	123	16	13	33	27	74	60
Wash hands with soap and hot water.	125	114	91	11	9	-	-
Wash raw poultry before cooking. ^a	118	19	16	19	16	80	69

^a Potentially unsafe practice for which “never” is the best response
Note. Because of rounding, percentages may not total 100.

TABLE 4. Patient and Family Caregiver Knowledge of Safe Cooking Practices for Raw Meat and Poultry (N = 124)

Safe Cooking Practice	n	%
Pierce thickest part to ensure juices run clear.	96	77
Ensure that the center is piping hot.	83	67
Follow instructions for stated time and temperature.	78	63
Check internal color of meat or poultry.	69	56
Use a thermometer to check temperature.	46	37
Check external appearance of meat or poultry.	22	18
Surface feels hot to touch.	1	1

Note. Although some of these practices indicate doneness, use of a thermometer is the only method to ensure that a safe internal temperature is achieved to ensure food safety.

they would never use a meat thermometer to check that meat products are thoroughly cooked. Reported thermometer usage was significantly greater among those who received food safety information.

Handwashing

The inclusion of adequate handwashing is one of the most important practices for controlling infection and maximizing food safety (Health Protection Agency, 2013). Recommendations for handwashing consist of the use of hot water and soap; palms, fingers, and the back of hands should be rubbed, and hands should be rinsed and dried well with paper towels (Health Protection Agency, 2013). Family caregivers have previously indicated awareness of the importance of handwashing when caring for people with neutropenia (Bagcivan et al., 2015).

Findings indicate that the majority (98%–100%, $n = 120$ – 123) were aware of the need to implement handwashing at different occasions during food preparation, including before commencing food preparation, after handling raw meat and poultry, and after handling pets or going to the toilet. However, a smaller number of participants were aware of the need to implement handwashing before handling RTE foods (79%, $n = 97$). Those who had received food safety information were significantly more likely to be aware of the need to implement handwashing before taking medication and before handling RTE food products. In relation to adequacy of handwashing practices, 94% ($n = 116$) were aware of the need to use soap for handwashing, and 93% ($n = 114$) were aware of the most adequate methods of drying hands. Eighty-two percent ($n = 101$) used disposable kitchen paper, and 61% ($n = 75$) used an unused hand towel. Only 50% ($n = 62$) recognized the need to use soap, hot water, and a clean or disposable

towel for hand drying as the best way to clean hands at home; knowledge of this differed significantly according to receipt of food safety information.

Ninety-two percent ($n = 108$) reported always washing hands after handling raw meat and before handling RTE food, and 91% ($n = 114$) reported always using soap and hot water to wash hands. However, only 58% ($n = 73$) reported that they always perform adequate handwashing by rubbing hands and between fingers with soap into a lather for 20 seconds and rinsing with hot water, and only 68% ($n = 85$) responded that they never used the same towel to dry hands, equipment, and utensils. Self-reported handwashing practices were reported to be significantly ($p < 0.05$) better among those who reported receiving food safety information.

Cross-Contamination

Cross-contamination is reported to be one of the most common contributory factors associated with the transmission of foodborne disease (Gormley et al., 2010). Cross-contamination events are common during food handling in the home, particularly during the preparation of raw poultry (Mazengia, Fisk, Liao, Huang, & Meschke, 2015).

Fifty-seven percent of respondents ($n = 70$) were aware of six practices that can cause cross-contamination in the home. No respondents were unaware of any practices. Those who had received food safety information were aware of more practices ($n = 6$) than those who had not received information ($n = 5$) ($U = 1290$, $z = -1.987$, $p < 0.05$, $r = 0.2$). From 98%–99% ($n = 121$ – 122) of respondents were aware that failing to wash hands and chopping board or using the same chopping board after preparing raw meat before preparing RTE food could result in cross-contamination. The majority of respondents reported that some practices that may increase the risk of cross-contamination were never implemented, including storing raw meat above RTE food in the refrigerator (76%, $n = 86$) and using the same chopping board for raw and RTE food (89%, $n = 108$). However, 25% ($n = 31$) believed that failing to wash raw meat could increase the risk of food poisoning in the home; 67% ($n = 82$) were aware that washing raw poultry could result in cross-contamination. No significant difference ($p > 0.05$) existed in relation to awareness of washing raw poultry. Thirty-three percent ($n = 38$) reported that raw poultry should be washed before cooking, but no significant difference ($p > 0.05$) existed in reported implementation of this practice between those who had and had not

received food safety information. This finding is of concern because laboratory-based research has established that water splashes created when washing raw meat can result in the transfer of pathogens and cause cross-contamination of the domestic kitchen environment (Everis & Betts, 2003).

Date Labeling

Use-by dates are calculated using the growth abilities of pathogens that may be present in foods to ensure that potentially dangerous levels are not exceeded between production and consumption; therefore, it is essential that people adhere to use-by dates (Evans & Redmond, 2015). Seventy-five percent (n = 92) of respondents in this study were aware that the use-by date is the best indicator that food is safe to eat. However, some confusion may exist because 15% (n = 18) of respondents believed it to be the same as a best-before date, and 7% (n = 9) believed that all date labeling has the same meaning. No significant differences (p > 0.05) in knowledge of use-by dates were determined if food safety information had reportedly been received.

This study determined that 70% (n = 88) of patients receiving chemotherapy and family caregivers reported always adhering to the use-by dates on foods, and 62% (n = 78) reported never consuming food beyond the use-by date. However, previous research suggests that consumers may more frequently rely on their senses rather than date labels to determine food safety (Van Boxstael, Devlieghere, Berkvens, Vermeulen, & Uyttendaele, 2014). In this study, 47% (n = 53) reported that the appearance and smell of foods would be relied upon to decide if food is safe to eat. Taste alterations experienced during chemotherapy may prevent individuals from detecting when foods are spoiled or tainted (McLaughlin & Mahon, 2012). Smell, taste, and

appearance are not reliable methods to detect food safety because foodborne pathogens can be at potentially unsafe numbers without adverse effects on the sensory attributes of the food (WHO, 2015).

Storage Duration

Modified atmosphere packaging (MAP) increases the shelf life of RTE foods by limiting microbial growth (Ballantyne, Stark, & Selman, 1988; Stollewerk, Jofré, Comaposada, Ferrini, & Garriga, 2011). However, after opening, the desirable properties that restrain microbial growth are lost; therefore, it is recommended RTE products are consumed within two days of opening (Food Standards Agency and Department of Health, 2008). More than half of the respondents were knowledgeable of safe storage duration of opened RTE, with most believing cooked, sliced meat (72%, n = 89) and smoked fish (51%, n = 63) should be stored and consumed within two days after opening. More than one-third believed sliced, cured meats (40%, n = 49) and soft cheeses (34%, n = 42) could be consumed beyond the recommended two days. Similarly, about one-third of respondents were aware that pâté (28%, n = 34) and soft cheeses (33%, n = 41) should not be consumed during chemotherapy treatment (see Table 5). Although many patients receiving chemotherapy and family caregivers were aware of the need to consume RTE food products within two days of opening, only 36% (n = 44) reported that the recommendation was adhered to.

Risk-Associated Foods

It is recommended that, during chemotherapy treatment, food products associated with an increased risk of foodborne infection (e.g., raw and undercooked seafood, eggs, and meat; soft cheeses;

TABLE 5. Knowledge of Storage Duration of Ready-to-Eat Food Products Associated With Listeriosis and General Recommendations of Whether These Foods Should Be Eaten (N = 123)

Food Product	Less Than 2 Days		Greater Than 2 Days		Should Not Eat		Do Not Know	
	n	%	n	%	n	%	n	%
Cooked, sliced meat	89	72	23	19	1	1	10	8
Pâté ^a	54	44	18	15	34	28	16	13
Sliced, cured meats ^a	49	40	49	40	12	10	12	10
Soft cheeses	33	27	42	34	41	33	7	6
Smoked fish	63	51	21	17	17	14	22	18

^aN = 122

TABLE 6. Knowledge of Food Products to Be Avoided During Chemotherapy Treatment (N = 67)

Food Product	n
Undercooked eggs	25
Soft cheeses	23
Pâté	14
Seafood and shellfish	12
Takeout food	11
Raw or undercooked meat	10
Unpeeled or unwashed fruit and vegetables	9
Unpasteurized cheese	8
Unpasteurized food product	8
Raw or smoked fish and sushi	7
Unpasteurized milk	7
Reheated food product	4
Blue cheese	3
Buffet-style food	3
Deli counter meat	3
Yogurt	3
Black pepper or ground spice	2
Food avoided during pregnancy	2
Ice cream	2
Salad	2
Cured meat product	1
Food beyond the use-by date	1
Food with live bacteria	1
Raw food	1
Smoked food	1
Undercooked food	1
Unpasteurized fruit juice	1

unpasteurized dairy products) should be avoided (Kendall et al., 2003; Medeiros, Chen, Kendall, & Hillers, 2004). Awareness of food products to be avoided was lacking; 55% reported awareness of specific food products to be avoided during chemotherapy treatment. Analysis of qualitative responses (N = 67) determined that respondents were most knowledgeable about avoiding undercooked eggs (n = 25), soft cheeses (n = 23), and pâté (n = 14) during chemotherapy treatment to reduce the risk of foodborne illness (see Table 6). Some respondents referred to the avoidance of foods to reduce the risk of cancer recurrence (e.g., dairy, meat, sugar) or referred to foods that may react with medication (e.g., grapefruit). Those who reported receiving food safety information were significantly ($p < 0.001$) more likely to be aware of recommended food products to be avoided during chemotherapy.

Discussion

The results from this study suggest that some key food safety behavioral practices are ignored in the home, which may increase the risk of foodborne infection to patients receiving chemotherapy. No significant differences were determined in self-reported refrigeration practices because the majority of all respondents reported that refrigeration temperatures were never checked (Evans & Redmond, 2016a). A comparative study may be needed to determine if significant differences exist in food safety knowledge and self-reported practices of patients receiving chemotherapy and the general population not undergoing chemotherapy treatment. This study reports food safety behavioral practices that may increase the risk of foodborne infection in patients with cancer and caregivers.

Overall, fewer than half of respondents reported receipt of food safety information during chemotherapy treatment. People with neutropenia, those with blood-related cancers, and those who received a transplantation received food safety information most frequently. The food safety knowledge and self-reported implementation of food safety practices of those who had reportedly received food safety information was significantly different, with greater awareness of food safety knowledge and self-reported implementation of food safety practices. Consequently, a need exists for food safety information to be designed, developed, and delivered to target patients receiving chemotherapy treatment who do not experience additional health complications or treatment pathways, such as neutropenia. Currently, these patients are less likely to receive food safety information. All patients receiving any type of immune-compromising therapy should receive food safety information prior to commencement of treatment or development of complications. In addition, given the important role of the family caregiver in the provision of food for patients receiving chemotherapy treatment (Evans & Redmond, 2017), future interventions should also target and be accessible to family caregivers of patients receiving chemotherapy.

Although knowledgeable of the need to ensure safe refrigeration temperatures, usage of a thermometer to assess safe operating temperature was particularly lacking. Regarding cooking, although awareness of the need for thorough cooking existed, use of a meat thermometer to ensure cooking adequacy was lacking.

Widespread awareness for the implementation of handwashing at key occasions existed, and handwashing practices were most frequently reported to be implemented in the home. However, the reported implementation of adequate handwashing practices

was lacking. Insufficient knowledge regarding the potential risk associated with washing raw poultry was found, and respondents reported to engage in this risk behavior. Although respondents were knowledgeable of use-by date labeling, failure to adhere to these labels and reliance on sensory attributes to determine the safety of foods were determined. Failure to consume MAP RTE food within two days of opening was widespread, and awareness of risk-associated food products to be avoided during chemotherapy treatment was lacking.

Limitations

Potential limitations regarding the nature of this study must be acknowledged. Although food safety knowledge and self-reported practices are insightful, knowledge does not equate to behavior (Evans & Redmond, 2018). Observational data provide the most reliable information denoting actual food safety behavior (Redmond & Griffith, 2003). Conducting behavioral observation of food safety practices in the homes of patients undergoing chemotherapy may be invasive, but time-temperature data logging of refrigerator usage would not be too invasive or require extensive participation (Evans & Redmond, 2016b).

Cognitive data provide insightful consumer food safety findings, which are useful for informing food safety education and evaluating the effectiveness of interventions, but behavioral data may have greater value when assessing actual food safety practices (Evans & Redmond, 2014). Because the sample is self-selected, it may not be representative of the population, particularly with individuals of varying literacy levels and socioeconomic circumstances in which adherence to food safety practices may be challenging.

Future Research

Given the findings of this study, along with the identified lack of adequate food safety information available to patients receiving chemotherapy and family caregivers (Evans & Redmond, 2017), a need exists to explore the impact of a food safety education program that incorporates and targets family caregivers on food safety awareness and practices at home when preparing food for a patient receiving chemotherapy.

Social cognition models assume that food safety behavior may be influenced or determined by underlying factors (Clayton, Griffith, & Price, 2003). Application of models, such as the theory of planned behavior or the health action process approach, allows for the development of psychosocial food safety interventions. Food safety knowledge and self-reported

KNOWLEDGE TRANSLATION

- Fewer than half of participants reported receiving food safety information during treatment; people with neutropenia, blood-related cancers, or those who received a transplantation were most likely to receive food safety information.
 - Although participants who reported receiving food safety information were more knowledgeable about food safety, gaps remained and poor practices were reported.
 - Patients receiving chemotherapy and family caregivers may benefit from being informed by healthcare providers about the risks associated with foodborne infection to enable the implementation of risk-reducing food safety practices.
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data, as determined in this study, can assist in the exploration of how food safety interventions can be developed to assist in changing consumer food safety behaviors in the home (Milton & Mullan, 2010).

To successfully design and develop a food safety education initiative to communicate the risks associated with foodborne disease to patients receiving chemotherapy and family caregivers, it is necessary to understand what food safety practices this group of at-risk consumers implement in the home kitchen and to establish why such practices are implemented. Data relating to attitudes of patients receiving chemotherapy and family caregivers toward food safety and desires for food safety information are lacking.

An intervention alone cannot increase awareness of food safety and improve practices among patients receiving chemotherapy and their family caregivers. Interventions need to be delivered in a credible manner by trusted healthcare providers who are adequately trained to deliver food safety information to inform vulnerable people of increased foodborne illness risks and enable risk-reducing food safety practices.

Specialist oncology nurses and dietitians provide information and interventions to vulnerable patient groups and are identified as trusted, credible, and preferred sources for food safety information by patients (International Food Information Council Foundation, 2016; Medeiros & LeJeune, 2015). However, gaps in practicing registered dietitians' food safety knowledge have been identified (Medeiros & Buffer, 2012). Data from the United States suggest that registered dietitians may receive more food safety training and are more likely to provide food safety information to immune-compromised patients than RNs (Buffer, Kendall, Medeiros, Schroeder, & Sofos, 2013). However, researchers need to collate comparable data in the United Kingdom, focusing on healthcare

providers working with patients receiving chemotherapy treatment and explore the potential challenges in healthcare settings to deliver food safety information to patients receiving chemotherapy.

Such healthcare providers need appropriate and adequate knowledge and skills to deliver effective food safety advice. Consequently, a need exists to determine the food safety knowledge, attitudes, and training experiences of specialist oncology nurses and dietitians and to explore the role of healthcare providers in the provision of food safety information for patients receiving chemotherapy.

Implications for Nursing

Findings indicate that behavioral practices during domestic food handling by family caregivers and patients undergoing chemotherapy treatment may increase the risk of foodborne infection to the patients. Healthcare providers should inform patients receiving chemotherapy and family caregivers of increased risk of foodborne infection during chemotherapy treatment and enable adoption of risk-reducing food safety practices. To facilitate this, the study highlights the need for food safety communication in healthcare settings to patients receiving chemotherapy. Food safety intervention strategies need to be designed and developed to specifically target patients receiving chemotherapy and family caregivers to reduce the risk of foodborne infection.

In addition, researchers need to determine what level of knowledge healthcare providers have regarding the risk of foodborne infection during chemotherapy treatment, determine awareness of recommended food safety practices, and establish what food safety training healthcare providers should undergo.

Conclusion

Results from this study has identified that, although patients receiving chemotherapy and family caregivers may be knowledgeable of some aspects of food safety, self-reported data suggest that some key food safety behavioral practices may not be implemented in the home, which may increase the risk of foodborne infection to patients receiving chemotherapy. In addition, attitudinal research is required with patients receiving chemotherapy and family caregivers to determine why risky behavioral practices may be used in the home during times of immunosuppression to enable the development of suitable interventions. The food safety training experiences of healthcare providers, such as oncology nurses and dietitians, needs to be explored to determine awareness of key food safety practices, risk

perceptions, and reported food safety information provision. Research is required to explore the food safety training of oncology nurses. Highly focused and targeted food safety interventions need to be developed and delivered by adequately trained healthcare providers to enable the implementation of risk-reducing food safety practices. All future efforts to reduce the risk of foodborne illness among patients receiving chemotherapy need to incorporate family caregivers.

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