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Original Article

Practices and predictors of 2009 H1N1 vaccination in cancer patients: a nationwide survey in Korea

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Background Because patients with cancer are considered to be at high-risk for influenza infection and related complications, annual vaccination is recommended. The emergence of the novel H1N1 influenza virus in 2009 complicated the medical care of patients with cancer. The present study examined H1N1 vaccination practices among patients with cancer during the pandemic season and investigated factors related to the vaccination.

Methods A national multicenter cross-sectional survey of patient–doctor dyads was performed; A total of 97 oncologists (response rates of invited participants, 87·4%) and 495 patients (response rates of recruited participants, 86·5%) were included. Patients with cancer provided information concerning vaccination practices and reasons for/against it. Oncologists answered questions about their recommendations and knowledge of H1N1 vaccination. Mixed logistic regression was used to identify patient-level and physician-level predictors of H1N1 vaccination.

Results Only 34·1% of the patients had received H1N1 vaccination, and 53·5% had not considered the need for vaccination. The H1N1 vaccine was proactively recommended by physicians in only a small fraction of patients (8·3%). Increasing age, higher educational status, longer time since the cancer diagnosis, comorbidities, and greater knowledge of H1N1 vaccination among oncologists were significant predictors of patients being vaccinated.

Conclusions The present results showed low levels of utilization and poor interaction between patients and physicians with regard to the need for vaccination. In addition, the oncologist's level of knowledge affected the adoption of preventive services. Intervention strategies are needed to maximize the rapid adoption of preventive methods to confront future pandemic threats in the cancer patient population.

Keywords Cancer, H1N1, influenza, pandemic, vaccination.

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Introduction

Seasonal influenza infection is a significant source of morbidity and mortality worldwide. It is responsible for a large number of deaths[1,2] and hospitalizations,[3] placing a high economic burden on society[4]. Patients with cancer, including those who are currently not undergoing treatment, are considered a high-risk group for influenza infection and its complications.[5,6] Compared with the general population, patients with cancer have an increased risk of complications[7,8] that lead to additional morbidity and mortality and can delay or interrupt cancer treatment.[9,10]

The most important and cost-effective management of influenza viruses includes prevention by vaccination.[5,11] Although the response rate was lower in patients with cancer, especially those with hematologic malignancies[12,13] and those undergoing chemotherapy,[14] studies showed that the influenza vaccine is safe and well tolerated in patients with cancer[14] and that it can induce a protective immunological response in 70–80% of patients.[11,13] The U.S. Centers for Disease Control and Prevention (CDC) recommends annual vaccination for high-risk populations, including patients with cancer.[15]

The situation of these patients became more complex during the fall and winter seasons of 2009, after the April

emergence and subsequent spread of the novel H1N1 influenza virus. In response, on June 11, 2009, the World Health Organization (WHO) declared the first pandemic of the 21st century.[16–18] The trivalent seasonal influenza vaccines did not provide protective immunity against the H1N1 virus, and a new vaccine was rapidly developed.[19] This product was approved by the U.S. Food & Drug Administration (FDA) in September 2009 on the basis of its safety profile and its effectiveness in inducing protective immunity. The vaccine subsequently became widely available at affordable costs.[18]

The Korean FDA also quickly approved the H1N1 vaccination and made the vaccine available at hospitals and community health centers nationwide. The Korean Ministry of Health and Welfare and Korean CDC recommended that high-risk population including the elderly, children, and people with chronic diseases including cancer to be vaccinated. The recommendation was publicized widely via radio and television and on wall posters in hospitals.

However, lack of knowledge and misconceptions among both patients and physicians about the benefits of vaccination, including concerns about safety and side-effect profiles, can hinder the timely administration of the vaccine.[9] Therefore, the availability of an effective vaccine might not ensure optimal vaccination practices,[20] especially during a new pandemic[21]. Decision making related to vaccination is a complex process, affected not only by scientific data but also by social and clinical contexts.[21]

To our knowledge, no studies have investigated vaccination practices among cancer patients during a new pandemic, especially as patient practices correlated with the practice and knowledge of their oncologists. The present study used patient–oncologist dyads to examine nationwide H1N1 vaccination practices among patients with cancer during the 2009 season. We investigated the experiences of patients and the knowledge and practice of their oncologists and primary care physicians (PCPs) with regard to H1N1 vaccination during that season, and we analyzed the associations between various factors and vaccination.

Methods

Study population

A nationwide survey was conducted from July 2010 to October 2010 as part of a government program designed to develop comprehensive supportive care in Korea. The program was developed and funded by the Korean Ministry of Health and Welfare and the Korean National Cancer Center (NCC). The NCC and nine regional cancer centers participated in the study, which are all of the government-designated cancer hospitals in 2010, and distributed nationwide.

Around 10 board-certified oncologists at each center were purposefully selected, and each oncologist was asked to recruit five consecutive patients over 18 years of age, who were diagnosed with cancer, and who had completed primary treatment. Out of 111 oncologists invited, 97 participated in the study (87·4%). Among 572 patients invited, 495 participated in the study (86·5%). Most oncologists recruited five patients (77·3%), but there was some variation (range, 1–11 patients per oncologist). Four oncologists did not answer the key question regarding H1N1 vaccination practice and they were excluded from all subsequent analyses together with their 13 patients. The study was approved by the institutional review board of the National Cancer Center, Korea.

Data collection

Eligible patients were provided with a brief overview of the study by the participating oncologists, after which they were asked about their willingness to participate. Once a patient was enrolled, a trained research coordinator explained the details of the study and obtained informed consent. The survey was self-administered, and most patients completed the questionnaire without help. The oncologists completed a parallel questionnaire for each of their patients.

Patients were asked whether they had received an H1N1 vaccination during the last fall–winter season and the reason for receiving or not receiving it. Emphasis was placed on how patients interacted with the oncologists or their PCPs in their decision making.

Physicians were asked whether they recommended H1N1 vaccination to their patients, with the following options as responses: (i) proactively recommended to the patients, (ii) recommended in favor when patients asked my opinion, (iii) recommended against it when patients asked my opinion, and (iv) recommended that patients should consult their PCP. To assess their knowledge on H1N1 vaccination for patients with cancer, they were also asked four yes/no questions developed for this study on the basis of common misunderstandings about H1N1 from the literature and frequently asked questions[6,15]: (i) patients with cancer need to get vaccination for H1N1 regardless of age (correct answer: yes), (ii) patients with cancer should not receive H1N1 vaccination because it is associated with complications (no), (iii) vaccination is not effective for patients with cancer as their immunity is decreased (no), and (iv) vaccination against the flu is not necessary in patients receiving H1N1 vaccination (no). No response was regarded as incorrect, and because of the high correct answer rate, the knowledge level was dichotomized into 'correct answers to all question' and others. The Cronbach's alpha coefficient for the knowledge scale was 0·94.

The patient survey also included the Korean version of instrumental activities of daily living (K-IADL) to measure physical impairment and the visual analog scale of EQ 5D

(EQ-VAS) to measure self-rated health status. Questions related to socio-demographic characteristics and comorbidities were also included. Information about cancer type, date of diagnosis, and the U.S. National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) stage were retrieved from the hospital information system of each participating center. The survey involving physicians included questions related to the practice of each doctor, such as clinical specialty and years of experience, and whether they usually provide care for non-cancer chronic medical conditions to the patients in need.

Statistical analysis

Descriptive statistics, including percentages, means, standard deviations (SD), 95% confidence intervals (CI), and adjusted odds ratios (aOR) were used to analyze the characteristics of the patient–oncologist dyads, such as the practices regarding receipt of vaccination and reasons for or against it among patients with cancer, and the application and knowledge of H1N1 vaccination among oncologists. To identify predictors for the receipt of H1N1 vaccination, we used mixed logistic regression models with patients nested within their doctors (*xtmelogit* command in STATA). Potential determinants of the use of vaccination were selected for this analysis on the basis of a review of the literature. For patients, these included demographic characteristics (age, sex, educational level, employment, and income status) and physical health status (physical impairment as measured by K-IADL, cancer type and stage, comorbidities, time since cancer diagnosis, and self-rated health status).[22,23] For oncologists, potential determinants included characteristics such as specialty, years of experience, knowledge of H1N1 vaccination, and self-reported practice policies concerning non-cancer care and H1N1 vaccination. Statistical analyses were performed using SAS version 9.13 (SAS Institute, Cary, NC, USA) and STATA 11.0 (STATA Corp, Houston, TX, USA). Statistical significance was defined as $P < 0{\cdot}05$ on two-tailed analyses.

Results

Participant characteristics

The mean age of the patients included in the study was 58·1 (SD 12·4) years, and there were slightly more women than men (54·1% versus 45·9%, respectively) (Table 1). Stomach, colorectal, and breast cancers were the three most common primary cancers. Most patients had *in situ* local (45·9%) or regional (37·8%) cancer and had received surgical treatment (78·6%). On average, patients were surveyed 33·4 (SD 36·1) months after diagnosis. The majority of participating physicians were men (79·4%), and 48·5% of them had more than 10 years of experience as oncologists (Table 2). The proportions of surgical, medical, and radiological oncologists were 62·9, 32·0, and 5·2%, respectively. Thirty percent answered that they usually provide treatment for their patients' non-cancer chronic medical conditions as needed.

Practice of vaccination receipt and reason for/against it among patients with cancer

Thirty-four percent of the patients stated that they received the H1N1 vaccine during the 2009 season (Table 3). Forty-two percent of those patients answered that it was their own decision to undergo vaccination and that they had not discussed this issue with their physician. A small number of patients received the vaccine based on the recommendation of their oncologist, made either proactively (11·8%) or when asked for their opinion (7·7%). Another group of patients reported that vaccination was recommended by their PCP either proactively (12·4%) or when asked for their opinion (8·3%). Several patients reported receiving the vaccine through an employment health program from their workplace or through a public health program from a regional health promotion center.

Approximately, two-thirds (65·7%) of the patients reported that they had not received the H1N1 vaccine, and half of them (53·5%) reported never considering the need for vaccination. A total of 24·3% of these patients stated that they were neither interested in the vaccine nor had they discussed it with any of their oncologists or PCPs. Some patients refused to be vaccinated even though it was recommended by their oncologists (4·6%) or PCPs (3·1%), because they considered it unnecessary or even harmful. Other patients asked their oncologists (9·2%) or PCPs (2·8%) for their opinion on vaccination against H1N1, but were recommended against it.

Practice and knowledge of H1N1 vaccination among oncologists

Two-thirds (67·7%) of the oncologists included in the study answered that they recommended H1N1 vaccination when patients asked their opinion, and 22·6% reported that they proactively recommended it to most of their patients (Table 4). A few oncologists (8·6%) reported that they advised their patients to consult their PCP about such issues, and one oncologist recommended against it when asked for his opinion.

Regarding knowledge about H1N1 vaccination, most oncologists correctly answered that the vaccine does not lead to a higher rate of complications in patients with cancer (90·3%), that it is effective in patients with cancer (91·4%), and that the H1N1 vaccine needed to be administered in addition to the seasonal flu vaccine during the 2009 fall–winter period (89·2%). However, only 68·8% of the oncologists correctly answered that patients with cancer need to be vaccinated against H1N1 regardless of age.

Table 1. Characteristics of participating patients (n = 495)

Characteristics	n (%)
Age (Mean ± SD, years)	58·1 ± 12·4
Gender	
Female	268 (54·1)
Male	227 (45·9)
Marital status	
Unmarried	98 (19·8)
Married	397 (80·2)
Education	
Less than high school	231 (46·9)
High school and above	262 (53·1)
Having a job	
No	295 (60·1)
Yes	196 (39·9)
Household income	
<200 million KRW	330 (67·1)
≥200 million KRW	162 (32·9)
Cancer type	
Stomach	66 (13·3)
Lung	46 (9·3)
Liver	41 (8·3)
Colon/Rectal	78 (15·8)
Breast	72 (14·5)
Cervical	42 (8·5)
Others	150 (30·3)
SEER stage	
In situ and local	227 (45·9)
Regional	187 (37·8)
Distant	68 (13·7)
Unknown	13 (2·6)
Time since diagnosis (Mean ± SD, months)	33·4 ± 36·1
Comorbidities (any)	
No	277 (56·0)
Yes	218 (44·0)
Impairment in activities of daily living* (any)	
No	326 (65·9)
Yes	169 (34·1)
Self-rated health status (EQ-VAS)	
>70	235 (47·5)
≤70	260 (52·5)

KRW, Korean Won.
*Measured by instrumental activity of daily living-Korean version (K-IADL).

Table 2. Characteristics of participating oncologists (n = 97)

Characteristics	n (%)
Year after board certification (Mean ± SD, years)	
<10 years	50 (51·5)
≥10 years	47 (48·5)
Specialty	
Surgical oncologist	61 (62·9)
Medical oncologist	31 (32·0)
Radiological oncologist	5 (5·2)
Providing care for non-cancer chronic medical condition (n = 93)	
Yes	28 (30·1)
No	65 (69·9)

Factors associated with receiving H1N1 vaccination in patients with cancer

In a multilevel multivariate logistic regression analysis, increasing age (aOR = 1·05; 95% CI = 1·03–1·08), higher educational level (aOR = 1·72; 95% CI = 1·02–2·93), longer time since cancer was diagnosed (aOR = 3·79; 95% CI = 1·95–7·38 for 5-year survivors; P-trend <0·01), and having comorbidities (aOR = 1·59; 95% CI = 1·02–2·50) were significantly associated with H1N1 vaccination (Table 5).

Among physician-level variables, higher knowledge of H1N1 vaccination among oncologists was the only significant factor associated with patients receiving H1N1 vaccination (aOR = 1·74; 95% CI = 1·05–2·89). Patients followed by surgical oncologists were less likely to receive H1N1 vaccination than those followed by medical oncologists with marginal significance (aOR = 0·54; 95% CI = 0·29–1·01). There was no significant association between patients receiving the vaccine and physician's years of clinical experience, self-reported practice patterns of the provision of non-cancer care, or recommendation of H1N1 vaccination.

Discussion

To the best of our knowledge, this is the first study investigating the pattern of H1N1 vaccination practice among patients with cancer during the 2009 pandemic period using patient–oncologist dyads in a nationwide setting. The matching design of this study and the use of appropriate statistical methods (i.e., mixed-effect model) enabled the estimation of the effect of physician factors on patient vaccination.

Since the first confirmed case was reported in May 2009 in Korea, 740 835 patients were diagnosed with pandemic H1N1 before January 31, 2010, and 225 of these patients died.[24] Patients with cancer comprised almost 25% of the total death cases,[25] implying a disproportionate risk of death in this population. Despite the increased risk of complications and death and the immediate availability of the vaccine,[26] our nationwide study showed that as many as two-thirds of patients with cancer were not vaccinated against H1N1.

The results of our study show that 42% of patients obtained a vaccination without any discussions with their physicians. Moreover, more than three-fourths of unvaccinated patients did not discuss vaccination issues with their physicians, either because they had never considered the

Table 3. Cancer patients' report about vaccination practices and reasons for or against it (n = 495)

Questions	*n*	%
Received vaccination for H1N1 during last fall–winter period		
Yes	169	34·1
No	325	65·7
No response	3	0·2
Reasons for receiving H1N1 vaccination (n = 169)		
Oncologist proactively recommended the vaccination	20	11·8
Oncologist recommended the vaccination when asked for the opinion	13	7·7
PCP proactively recommended the vaccination	21	12·4
PCP recommended the vaccination when asked for the opinion	14	8·3
I myself wanted the vaccination and have not discussed with the physician	71	42·0
Others	30	17·8
Reasons for not receiving H1N1 vaccination (n = 325)		
Oncologist recommended the vaccination, but refused thinking it might be unnecessary or even harmful	15	4·6
Asked oncologist for his/her opinion, but got recommendation against it	30	9·2
PCP recommended the vaccination, but refused it thinking it might be unnecessary or even harmful	10	3·1
Asked PCP for his/her opinion, but got recommendation against it	9	2·8
Did not wanted vaccination and have not discussed with any physician	79	24·3
Have not thought about the needs for vaccination	174	53·5
Others	3	0·9
No response	5	1·5

PCP, primary care physician.

need for vaccination or they did not want it. This may be due to low-risk perception, which has been reported as the main reason for non-vaccination among the general population.[27] It could also mean that oncologists were not proactive with respect to preventive care in a significant portion of the patients with cancer. Patients who decided not to get vaccinated against the recommendation of their physicians may have done so because they misunderstood the risks, at least in some cases.[21]

In this study, some patients were recommended not to be vaccinated against H1N1 by their physician. These situations are reported not only in this study, but also in a Canadian study that achieved similar results. In that study, despite physician's recommendation, patients with hematologic malignancy refused H1N1 vaccination because they were not convinced of safety and effectiveness.[28] There might be certain reason for recommending against vaccination, or some physicians might have inappropriate recommendation in some cases.

Interestingly, there were gaps between the oncologists' self-reported practice and vaccination rate and reasons for or against vaccination among patients with cancer. Although 22·6% of the oncologists reported that they proactively recommended the vaccine to their patients, only 20 patients (4·0%) stated that they received it based on the recommendation of their oncologists. Although two-thirds of the oncologists reported that they recommended it when the patients asked for the opinion, only 13 patients (2·6%) reported that this was the case. Although these questions were not directly matched in pairs, a significant discrepancy was noted implying that some oncologists overestimated their attitude toward their actual involvement in H1N1 vaccination.

Certain patient characteristics were associated with H1N1 vaccination. Older patients showed a higher vaccination rate, consistent with the results of a previous study conducted among US cancer survivors[23] and high-risk groups overall.[15] The lack of awareness of the specific guidelines for the high-risk groups among some physicians might also explain low vaccination rate in younger cancer survivors.[28] An association between vaccination and higher levels of education was also expected from previous studies.[23] Higher vaccination rates in patients who have other chronic conditions are also consistent with a previous study[22] and this could be due to the interactions with other types of physicians, including the PCPs.[22,29,30] Female sex, income status, and self-rated health status, which were shown to be associated in previous seasonal flu studies,[23] were not significant factors in this study.

Contrary to the results of a previous study showing no significant differences in seasonal flu vaccination rates between current and previous patients with cancer,[23] our results showed that vaccination rates increased with longer periods from the time of cancer diagnosis. Patients who are

Table 4. Oncologists' report about practice and knowledge of H1N1 vaccination (n = 93)

Questions	*n*	%
Practice of H1N1 vaccination		
Did you recommend vaccination for the H1N1 to your patients?		
Proactively recommended to most of their patients	21	22·6
Recommended in favor when patients asked for their opinion	63	67·7
Recommended against it when patients asked for their opinion	1	1·1
Recommended that patients should consult their primary care physician	8	8·6
Knowledge of H1N1 vaccination		
Patients with cancer need to receive vaccination for H1N1 regardless of age		
Yes*	64	68·8
No	27	29·0
No response	2	2·2
Patients with cancer should not receive H1N1 vaccination because it is associated with complications		
Yes	4	4·3
No*	84	90·3
No response	5	5·4
Vaccination is not effective in patients with cancer because their immunity is decreased		
Yes	3	3·2
No*	85	91·4
No response	5	5·4
Vaccination against H1N1 is not necessary in patients receiving the seasonal flu vaccination		
Yes	6	6·4
No*	83	89·2
No response	4	4·3
Correct answer to all above four questions	55	59·1

*Intended correct answer.

diagnosed within a year are more likely to be under active treatment and are, therefore, considered to be at the highest risk of immunosuppression.[15] Previous studies showed that patients currently receiving treatment have only a marginal impairment in their ability to respond to vaccination,[11] and most physicians agree that influenza vaccination is safe even in patients undergoing chemotherapy.[31] The level of vaccination, however, was the lowest in this population. One potential reason for these results could be that the oncologists may have feared potential interactions with active cancer treatment, and therefore, did not recommend vaccination in these patients. A lot of patients with cancer participate in clinical trials for cancer treatment. In the United States alone, more than 25 000 patients with cancer participate in clinical trials supported by National Cancer Institution each year.[32] Clinical trial protocols are likely to preclude interventions not specifically allowed by the protocol, including vaccinations. Thus, oncologists would hesitate to recommend vaccination for the patients while the population would need it more because of the immunocompromised state.

Although correct knowledge regarding H1N1 vaccination can be expected from the current guidelines on seasonal flu vaccination, almost half of the oncologists answered some of the questions incorrectly. Some of them did not know exactly that patients with cancer of all ages need to receive flu vaccination. One study suggested that awareness of flu vaccine recommendations among specific groups of adults was low, and provider-based vaccination counseling may help.[33] However, the present results suggest that providers themselves may not be aware of the recommendation.

The current results showed that exact knowledge about H1N1 vaccination had a significantly positive effect on the rates of vaccination among patients with cancer. Several studies support the positive effect of recommendation by healthcare providers on vaccination practices.[34,35] To improve the rate of vaccination among patients, emphasis should be placed not only on patient education but also on physician education.[36] The rapid dissemination of information through online education for oncologists could be an effective approach in the event of a new pandemic disease.

A communication gap between oncologists and PCPs could be another reason of low vaccination rate. A study reported there are significant differences between PCPs and oncologists in knowledge, attitudes, and practices for cancer survivorship care.[37] Oncologists might consider that preventive health service like vaccination is PCP's role, thus

Table 5. Factors associated with receiving H1N1 vaccination in patients with cancer: results of multilevel analysis

Factors	aOR (95% CI)
Patient-level variables	
Age (year)	1·05 (1·03–1·08)
Male (versus female)	0·65 (0·37–1·14)
Having a job (versus not having a job)	0·99 (0·61–1·59)
High school and above (versus less than high school)	1·72 (1·02–2·93)
Married (versus unmarried)	1·04 (0·59–1·83)
Monthly income ≥2 million KRW (versus <2 million KRW)	0·67 (0·39–1·15)
Current smoker (versus non-/past-smoker)	0·83 (0·36–1·90)
Cancer type	
Stomach cancer	Reference
Lung cancer	0·72 (0·27–1·92)
Liver cancer	1·04 (0·39–2·80)
Colorectal cancer	0·95 (0·43–2·10)
Breast cancer	0·69 (0·26–1·88)
Cervical cancer	0·37 (0·13–1·11)
Hematological cancer	1·03 (0·30–3·50)
Other cancer	0·48 (0·21–1·10)
SEER Stage	
In situ and local	Reference
Regional	1·15 (0·70–1·89)
Distant	1·24 (0·57–2·71)
Time since diagnosis (months)	
<12	Reference
12–36	2·03 (1·17–3·56)
36–60	1·71 (0·84–3·47)
≥60	3·79 (1·95–7·38)
Comorbidity, any (versus none)	1·59 (1·02–2·50)
Impairment in activities of daily living (any)	0·91 (0·53–1·59)
Good self-rated health (versus poor)	1·32 (0·84–2·08)
Physician-level variables	
Specialty	
Medical oncologist	Reference
Surgical oncologist	0·54 (0·29–1·01)
Radiological oncologist	1·45 (0·48–4·35)
Years after board certification ≥10 years (versus <10 years)	1·18 (0·71–1·96)
Self-report of providing care for non-cancer chronic medical condition	1·39 (0·83–2·33)
Self-report of proactive recommendation of H1N1 vaccination	1·10 (0·79–1·42)
Knowledge score regarding H1N1 vaccination (range: 0–4)	1·74 (1·05–2·89)

KRW, Korean Won; aOR, adjusted odds ratio.
Measured by instrumental activity of daily living-Korean version (K-IADL).

they might not recommend the vaccination proactively to the patients with cancer.

Our study has several limitations. First, the utilization of the H1N1vaccine in our survey was self-reported and it may, therefore, differ from the actual utilization pattern. However, previous studies have reported the high validity of self-reported influenza vaccination status.[38–40] Second, the interaction between patients with cancer and their PCPs could not be explored in detail. The role of the PCP in the provision of preventive health services, including influenza vaccination, is very important.[22,29,30] In the present study, some but not many patients consulted their PCP about H1N1 vaccination. Involvement of the PCP in the provision of preventive health services should be considered in future studies and in the development of a public health strategy. Third, selection bias may have been present in the study sample. The participants were recruited only at the outpatients clinic in large cancer centers in Korea even though they did live in different regions. The oncologists were also purposely invited to this study, not randomly selected.

Despite these limitations, the present study makes a unique contribution to the literature in that it explores the utilization of preventive methods among patients with cancer and the factors affecting the advent of a new pandemic disease at a time when there were not established guidelines or firm scientific data. Most importantly, our study showed that the level of vaccination was far from ideal, that interaction between the patient and physician was inadequate, and that the oncologists' knowledge and practice can affect the process. Our findings support the need for rapid dissemination of appropriate knowledge to the oncologists and the need to improve communication regarding non-cancer problems. We believe that the findings of this study of H1N1 vaccination practices during the 2009 H1N1 pandemic season provides valuable information for the future design of intervention strategies to maximize the rapid adoption of preventive methods, so as to better confront future pandemic threats in the population of patients with cancer.

Additional author contributions

Weon Young Chang (Cheju National University Hospital, Jeju, Korea) and Seung Pyung Lim (Chungnam National University Hospital, Deajon, Korea) contributed as authors to data collection, data interpretation, and manuscript drafting.

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References

1 Thompson WW, Moore MR, Weintraub E *et al.* Estimating influenza-associated deaths in the United States. Am J Public Health 2009; 99(Suppl 2):S225–S230.

2 Thompson WW, Shay DK, Weintraub E *et al.* Mortality associated with influenza and respiratory syncytial virus in the United States. JAMA 2003; 289:179–186.

3 Thompson WW, Shay DK, Weintraub E *et al.* Influenza-associated hospitalizations in the United States. JAMA 2004; 292:1333–1340.

4 Molinari NA, Ortega-Sanchez IR, Messonnier ML *et al.* The annual impact of seasonal influenza in the US: measuring disease burden and costs. Vaccine 2007; 25:5086–5096.

5 Francisci D, Labianca R, Roila F. Prevention and treatment of pandemic influenza in cancer patients. Ann Oncol 2010; 21:2301–2303.

6 Center for Disease Control and Prevention. Cancer, the Flu, and You. What Cancer Patients, Survivors, and Caregivers Should Know About the Flu. Available at http://www.flu.gov/individualfamily/about/h1n1/index.html (Accessed 20 March 2011).

7 Kunisaki KM, Janoff EN. Influenza in immunosuppressed populations: a review of infection frequency, morbidity, mortality, and vaccine responses. Lancet Infect Dis 2009; 9:493–504.

8 Whimbey E, Elting LS, Couch RB *et al.* Influenza A virus infections among hospitalized adult bone marrow transplant recipients. Bone Marrow Transplant 1994; 13:437–440.

9 Ring A, Marx G, Steer C, Harper P. Influenza vaccination and chemotherapy: a shot in the dark? Support Care Cancer 2002; 10:462–465.

10 Ortbals DW, Liebhaber H, Presant CA, Van Amburg AL 3rd, Lee JY. Influenza immunization of adult patients with malignant diseases. Ann Intern Med 1977; 87:552–557.

11 Pollyea DA, Brown JM, Horning SJ. Utility of influenza vaccination for oncology patients. J Clin Oncol 2010; 28:2481–2490.

12 Mazza JJ, Yale SH, Arrowood JR *et al.* Efficacy of the influenza vaccine in patients with malignant lymphoma. Clin Med Res 2005; 3:214–220.

13 Nordoy T, Aaberge IS, Husebekk A *et al.* Cancer patients undergoing chemotherapy show adequate serological response to vaccinations against influenza virus and *Streptococcus pneumoniae*. Med Oncol 2002; 19:71–78.

14 Vilar-Compte D, Cornejo P, Valle-Salinas A *et al.* Influenza vaccination in patients with breast cancer: a case-series analysis. Med Sci Monit 2006; 12:CR332–CR336.

15 Fiore AE, Shay DK, Broder K *et al.* Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009. MMWR Recomm Rep 2009; 58(RR-8):1–52.

16 Brammer L, Blanton L, Epperson S *et al.* Surveillance for influenza during the 2009 influenza A (H1N1) pandemic-United States, April 2009–March 2010. Clin Infect Dis 2010; 52(Suppl 1):S27–S35.

17 Fowlkes AL, Arguin P, Biggerstaff MS *et al.* Epidemiology of 2009 pandemic influenza A (H1N1) deaths in the United States, April–July 2009. Clin Infect Dis 2010; 52(Suppl 1):S60–S68.

18 Boehmer LM, Waqar SN, Govindan R. Influenza vaccination in patients with cancer: an overview. Oncology (Williston Park) 2010; 24:1167–1170.

19 Zhu FC, Wang H, Fang HH *et al.* A novel influenza A (H1N1) vaccine in various age groups. N Engl J Med 2009; 361:2414–2423.

20 Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. Lancet 2011; 378:526–535.

21 Galarce EM, Minsky S, Viswanath K. Socioeconomic status, demographics, beliefs and A(H1N1) vaccine uptake in the United States. Vaccine 2011; 29:5284–5289.

22 Earle CC. Influenza vaccination in elderly patients with advanced colorectal cancer. J Clin Oncol 2003; 21:1161–1166.

23 Shih YC, Pan IW. Influenza vaccination among individuals with cancer and their family members. Am J Prev Med 2010; 38:61–69.

24 Kim JH, Yoo HS, Lee JS *et al.* The spread of pandemic H1N1 2009 by age and region and the comparison among monitoring tools. J Korean Med Sci 2010; 25:1109–1112.

25 Kim HS, Kim JH, Shin SY *et al.* Fatal cases of 2009 pandemic influenza A (H1N1) in Korea. J Korean Med Sci 2011; 26:22–27.

26 Liao Q, Cowling BJ, Lam WW, Fielding R. Factors affecting intention to receive and self-reported receipt of 2009 pandemic (H1N1) vaccine in Hong Kong: a longitudinal study. PLoS ONE 2011; 6:e17713.

27 Chin-Yee BH, Monkman K, Hussain Z, Minuk LA. Attitudes toward vaccination for pandemic H1N1 and seasonal influenza in patients with hematologic malignancies. J Support Oncol 2011; 9:156–160.

28 Loulergue P, Mir O, Alexandre J, Ropert S, Goldwasser F, Launay O. Low influenza vaccination rate among patients receiving chemotherapy for cancer. Ann Oncol 2008; 19:1658.

29 Snyder CF, Earle CC, Herbert RJ, Neville BA, Blackford AL, Frick KD. Preventive care for colorectal cancer survivors: a 5-year longitudinal study. J Clin Oncol 2008; 26:1073–1079.

30 Snyder CF, Frick KD, Kantsiper ME *et al.* Prevention, screening, and surveillance care for breast cancer survivors compared with controls: changes from 1998 to 2002. J Clin Oncol 2009; 27:1054–1061.

31 Melcher L. Recommendations for influenza and pneumococcal vaccinations in people receiving chemotherapy. Clin Oncol 2005; 17:12–15.

32 National Cancer Institute. National Cancer Institute Fact Sheet: TRICARE beneficiaries can enter clinical trials for cancer prevention and treatment through a department of defense and national cancer institute agreement. Available at http://www.cancer.gov/cancertopics/factsheet/NCI/TRICARE.

33 Maurer J, Uscher-Pines L, Harris KM. Awareness of government seasonal and 2009 H1N1 influenza vaccination recommendations among targeted US adults: the role of provider interactions. Am J Infect Control 2010; 38:489–490.

34 Petersen RL, Saag K, Wallace RB, Doebbeling BN. Influenza and pneumococcal vaccine receipt in older persons with chronic disease: a population-based study. Med Care 1999; 37:502–509.
35 Nichol KL, Mac Donald R, Hauge M. Factors associated with influenza and pneumococcal vaccination behavior among high-risk adults. J Gen Intern Med 1996; 11:673–677.
36 Zimmerman RK, Nowalk MP, Bardella IJ *et al.* Physician and practice factors related to influenza vaccination among the elderly. Am J Prev Med 2004; 26:1–10.
37 Potosky AL, Han PK, Rowland J *et al.* Differences between primary care physicians' and oncologists' knowledge, attitudes and practices regarding the care of cancer survivors. J Gen Intern Med 2011; 26:1403–1410.
38 Ajani UA, Ford ES, Mokdad AH. Examining the coverage of influenza vaccination among people with cardiovascular disease in the United States. Am Heart J 2005; 149:254–259.
39 Mac Donald R, Baken L, Nelson A, Nichol KL. Validation of self-report of influenza and pneumococcal vaccination status in elderly outpatients. Am J Prev Med 1999; 16:173–177.
40 Martin LM, Leff M, Calonge N, Garrett C, Nelson DE. Validation of self-reported chronic conditions and health services in a managed care population. Am J Prev Med 2000; 18:215–218.