Effect of the H1N1 Influenza Pandemic on the Incidence of Epidemic Keratoconjunctivitis and on Hygiene Behavior: A Cross-Sectional Study

Hyun Su Kim¹, Ho Chun Choi¹, Belong Cho¹*, Joon Yong Lee², Min Jeong Kwon³

¹ Department of Family Medicine, Seoul National University Hospital, Seoul, Republic of Korea, ² Department of Family Medicine, Korea University Guro Hospital, Seoul, Republic of Korea, ³ Division of Infectious Disease Surveillance, Korea Centers for Disease Control and Prevention, Chungcheongbuk-Do, Republic of Korea

Abstract

Background: EKC is transmitted chiefly by direct hand contact. It is suspected that the 2009/2010 influenza pandemic influenced hand washing. This study aims to examine the relationship between the 2009/2010 H1N1 influenza pandemic and hygiene behavior.

Methods: We compared the EKC prevalence trends before, during and after the 2009/2010 influenza pandemic by using a t-test comparison of EKC sentinel surveillance.

Results: During the pre-pandemic period, the incidence of EKC increased from the 21st to the 44th week each year. However, during the pandemic period in 2009, there was no epidemic peak. In the post-pandemic period, the epidemic curve was similar to that in the pre-pandemic period. Compared to the pre-pandemic period, the total number of EKC patients during the pandemic period showed a decrease of 44.9% (t value = −7.23, p = 0.002). Comparing the pre-pandemic and pandemic periods by age group, we found there to be a significant decrease in the number of EKC patients for all age groups (−4.12 ≤ t value ≤ −7.23, all p<0.05). This finding was most evident in the teenage group (62%) compared to the other age groups (decreases of 29 to 44%).

Conclusions: A continuing effort should be made to educate the public on basic infection prevention behaviors in the aftermath of the pandemic, particularly to teenagers.

Introduction

While the World Health Organization (WHO) declared on August 10, 2010 that the influenza A (H1N1) pandemic was over, the Korean Government had already changed the National Infectious Disease Crisis Level to its lowest grading on April 1, 2010 [1,2]. In Korea, from the time the first case of influenza A was confirmed on May 3, 2009, until late January, 2010, a total of 740,835 patients were confirmed, with 225 of these reported to have died [3]. During the pandemic in Korea, before an effective vaccine was made available, mitigation strategies were aimed at identifying, isolating and treating individual patients, in addition to educating the public about preventive behaviors that could reduce the spread of infection. These messages emphasized covering the mouth and nose when coughing and sneezing, washing hands frequently with soap and water, and avoiding crowded places [4].

It is suspected that the 2009/2010 influenza pandemic influenced hygiene-related behavior such as hand washing. However, previous studies were mainly interested in the association between these behaviors and disease anxiety, flu severity, information reliability and effectiveness of control measures [5–11]. While some studies show that these behaviors can be improved transiently [11–14], we have little information on how long these improved behaviors will continue or what kind of groups could be most motivated.

Among the various infectious diseases, we considered those that can be transmitted by direct hand contact. As a result, EKC was selected for evaluation. This condition is transmitted chiefly by direct hand contact rather than other pathways, and cannot be prevented by vaccination [15–18]. In the present study, we assessed the effect of the 2009/2010 influenza pandemic on these behaviors by analyzing the incidence of this disease before, during and after the influenza pandemic.

Methods

We analyzed the EKC data of the Korean National Infectious Disease Surveillance System. The system in place to report EKC cases was not affected by the 2009 pandemic season because ophthalmology clinics were not busy managing patients who were infected with influenza. In addition, there were sufficient cases of EKC for analysis.

The sentinel surveillance of EKC is supported by the Korean Ophthalmologists Association and Korean Ophthalmological Society. 80 private ophthalmologic clinics voluntarily report
cases of patients with EKC on a weekly basis. We used the diagnostic criteria for EKC that were defined for the National Infectious Disease Surveillance. The criteria has been defined as a clinically compatible illness that was observed to have subcorneal opacity or one of several symptoms such as excessive tearing, soreness, eyelid swelling and preauricular lymphadenopathy with tenderness as observed by an ophthalmologist.

Based on the Korean National Disaster Level and Influenza-Like Illness surveillance, the study period was divided into three phases: 2004–2008 as ‘pre-pandemic,’ 2009 as ‘pandemic,’ and 2010 as ‘post-pandemic’ [4]. According to this classification, we assessed the change in the weekly number of EKC cases for each of the three phases. For the pre-pandemic period we estimated the mean weekly number of cases (and 95% confidence interval) of EKC reported. After separating the total number of EKC cases into the epidemic season (weeks 21 to 44) and non-epidemic season (week 0 to 20 and 45 to 52), we investigated whether there was significant variation among the pre-pandemic, pandemic and post-pandemic periods for each season. For assessing the decrease of EKC patients during influenza pandemic, we performed t-test between mean of total EKC numbers in pre-pandemic period and those in pandemic period. As the same way, we assessed the increase of EKC patients after influenza pandemic by using a t-test between pre-pandemic and post-pandemic period. These tests were performed on the assumption that annual EKC epidemic is independent each other. Patients were grouped into ten year age groups of patients with EKC.

### Table 1. EKC cases reported from 2004 to 2010 according to age group.

| Age         | Number of EKC cases | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|-------------|---------------------|------|------|------|------|------|------|------|
| 0–9yr       | 10,329              | 9,937| 9,422| 10,101| 6,997| 5,558| 12,689|
| 10–19yr     | 12,379              | 10,678| 14,871| 19,242| 13,365| 5,406| 13,435|
| 20–29yr     | 7,725               | 6,700| 6,702| 6,503| 4,420| 3,792| 6,407|
| 30–39yr     | 10,601              | 9,873| 9,452| 9,051| 6,066| 5,109| 9,492|
| 40–49yr     | 6,597               | 6,424| 7,017| 7,300| 4,695| 3,720| 7,184|
| 50–59yr     | 4,701               | 4,830| 4,701| 5,424| 3,471| 3,349| 6,494|
| 60yr or more| 4,950               | 5,687| 5,282| 5,424| 3,471| 3,349| 6,494|
| All ages    | 57,282              | 54,129| 57,447| 62,475| 42,222| 30,159| 61,845|

*Epidemic keratoconjunctivitis.

doi:10.1371/journal.pone.0023444.t001

### Table 2. Comparison of EKC patients among pre-pandemic, pandemic and post-pandemic periods.

| Age         | Periods | t-value of t-test between pre-pandemic & pandemic | t-value of t-test between pre & post-pandemic |
|-------------|---------|-------------------------------------------------|---------------------------------------------|
| Total age   | Total   | 54711 [45282–64140] 30159 61845 t value = 2.10 (p = 0.104) | |
| 0–9yr       | Epidemic| 36608 [27092–46124] 17188 43095 t value = 1.95 (p = 0.123) | |
| 10–19yr     | Non-epidemic| 18103 [15415–20791] 12971 18750 t value = 1.95 (p = 0.123) | |
| 20–29yr     | Total   | 9357 [7667–11047] 5558 12689 t value = 2.10 (p = 0.104) | |
| 30–39yr     | Epidemic| 6223 [4859–7588] 3243 9173 t value = 1.95 (p = 0.123) | |
| 40–49yr     | Non-epidemic| 3134 [2590–3678] 2315 3516 t value = 1.95 (p = 0.123) | |
| 50–59yr     | Total   | 14107 [10072–18142] 5406 13435 t value = 1.95 (p = 0.123) | |
| 60yr or more| Epidemic| 10943 [6425–15461] 3426 9492 t value = 2.10 (p = 0.104) | |
| All ages    | Non-epidemic| 3164 [2528–3800] 1980 3566 t value = 2.10 (p = 0.104) | |

*Total, epidemic, and non-epidemic seasons are weeks 1 to 52, weeks 21 to 44, and weeks 1 to 20 and 45 to 52, respectively.

**Degrees of freedom of all values = 4.

doi:10.1371/journal.pone.0023444.t002
brackets, and analyses carried out with a view to identifying those age groups exhibiting the greatest overall change. All analyses were carried out with the use of STATA 10.0.

Results

The number of reported EKC cases from 2004 to 2010 is shown in Table 1. The mean number of total EKC patients during the pre-pandemic period was 54,711 (95% Confidence Interval [CI], 45,499 to 64,344). By comparison with pre-pandemic period, the total number of EKC patients during pandemic period showed a significant decrease of 44.9% (t value = -7.23, p = 0.002) and those during the post-pandemic period increased to 113.0% (t value = 2.10, p = 0.104) (Table 2).

With respect to changes in the weekly EKC incidence, while an increase was observed from the 21st through to the 44th week (epidemic season) during both the pre- and post-pandemic periods, there was no epidemic peak during the pandemic period (Figure 1).

![Figure 1. Comparison of the EKC incidence among pre-pandemic, pandemic and post-pandemic periods. A. Trends of the number of patients on a monthly basis. B. EKC incidence according to total, epidemic and non-epidemic season. doi:10.1371/journal.pone.0023444.g001](image-url)
In addition, there was also a significant decrease in the number of EKC patients during pandemic period in both the epidemic (t value = −5.67, p = 0.005) and non-epidemic seasons (t value = −5.30, p = 0.006) compared to the pre-pandemic period (Table 2). Moreover this result was more prominent in the epidemic season (from 36,608 to 17,188, 53.0% decrease) than in the non-epidemic season (from 18,103 to 12,971, 28.3% decrease).

Comparing the pre-pandemic and pandemic periods by age group, we found there to be a significant decrease in the number of EKC patients for all age groups (Figure 2, Table 2). This finding was most evident in the teenage group (decreased of 62%) compared to the other age groups (decreases of 29 to 44%).

Discussion

This study attempted to evaluate the effect of the H1N1 pandemic influenza on the incidence of epidemic keratoconjunctivitis (EKC) and hygiene behavior in Korea. Although we did not carry out a questionnaire-based study to investigate whether the public complied with recommended hygiene behavior such as hand washing, we utilized the incidence of EKC as an indirect indicator of hand washing on the assumption that hand washing is one of the most effective ways to prevent EKC infection [15–18].

Regarding the absence of an EKC epidemic peak during the pandemic period, it is assumed that the influenza pandemic helped
Our study has several limitations. First, because it had a cross-sectional design format, we cannot definitively infer a causal relationship between the increase of hand washing and the decrease of EKC. Second, the diagnosis of EKC is based on clinical symptoms, so it is possible that some forms of non-infectious conjunctivitis which are not related to hand washing, such as allergic conjunctivitis, were included in our data. However, such cases would only contribute to a very small proportion of the total number of cases of EKC. The reason for this is that epidemic season of EKC is different from that of allergic conjunctivitis and EKC has more severe symptoms that could discriminate from allergic conjunctivitis. Lastly, given the lack of specific sociodemographic informations such as sex and detailed age, we couldn’t analyze the epidemic trends according to those.

In conclusion, we postulate that hygiene behaviors improved during the pandemic period, which lead to a reduction in the number of EKC cases during this period. However, this behavioral change did not persist into the post-pandemic period in Korea. This relationship was most marked in teenagers. WHO and Public Health Service of governments should do to sustain hygiene behaviors in the post-pandemic period.

Acknowledgments

We acknowledge 80 private ophthalmology clinics which have participated in the Sentinel Surveillance of epidemic keratoconjunctivitis.

Author Contributions

Conceived and designed the experiments: HSK HCC. Performed the experiments: HSK HCC BC JYL MJK. Analyzed the data: HSK HCC BC JYL MJK. Contributed reagents/materials/analysis tools: HSK HCC. Wrote the paper: HSK HCC.

References

1. World Health Organization (2010) H1N1 in post-pandemic period. Available: www.who.int/mediacentre/news/statements/2010/h1n1_vpc_20100810/en/index.html. Accessed 23 January 2011.
2. Korea Centers for Disease Control and Prevention (2010) Pandemic alert status downgraded to “interest [Blue]**: Available: www.cdc.go.kr/flu/WebContent. Accessed 23 January 2011.
3. Kim JH, Yoo HS, Lee JS, Lee EG, Park HK, et al. (2010) The spread of pandemic H1N1 2009 by age and region and the comparison among monitoring tools. J Korean Med Sci 25: 709–12.
4. Lee DH, Shin SS, Jun BY, Lee JK (2010) National level response to pandemic (H1N1) 2009. J Prev Med Public Health 43: 99–104.
5. Akan H, Gurul Y, Isbirak G, Ozlatli S, Yilmaz G, et al. (2010) Knowledge and attitudes of university students toward pandemic influenza: a cross-sectional study from Turkey. BMC Public Health 10: 413.
6. Cowling BJ, Ng DM, Ip DK, Liao Q, Lam WM, et al. (2010) Community psychological and behavioral responses through the first wave of the 2009 influenza A(H1N1) pandemic in Hong Kong. J Infect Dis 202: 867–76.
7. Lau JT, Griffiths S, Choy KC, Lin C (2010) Prevalence of preventive behaviors and associated factors during early phase of the H1N1 influenza epidemic. Am J Infect Control 38: 374–80.
8. Liao Q, Cowling B, Lam WT, Ng MW, Fielding R (2010) Situational awareness and health protective responses to pandemic influenza A (H1N1) in Hong Kong: a cross-sectional study. PLoS One 5: e13530.
9. Park JH, Cheong HK, Son DY, Kim SU, Ha CM (2010) Perceptions and behaviors related to hand hygiene for the prevention of H1N1 influenza transmission among Korean university students during the peak pandemic period. BMC Infect Dis 10: 222.
10. Ruben GJ, Amlot R, Page L, Wessely S (2009) Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: cross-sectional telephone survey. BMJ 339: b2631.