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Original Article

Survey of exposure to stranded dolphins in Japan to investigate an outbreak of suspected infection with highly pathogenic avian influenza (H5N1) clade 2.3.4.4(b) in humans

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ABSTRACT

Background: A highly pathogenic avian influenza (HPAI) A (H5N1) virus has been detected in domestic and wild animals worldwide. The incidence of HPAI infections in sea mammals has been increasing, as is the number of stranded marine mammals linked to H5N1 viral clade 2.3.4.4(b). In this study, we investigated a stranding event involving dolphins and human–dolphin contact, and investigated the potential risk of animal-to-human H5N1 transmission with a survey of exposure on the Tsurigasaki coast, Japan.

Methods: We performed a non-random, convenient-sample-based, survey on Tsurigasaki beach where around 30 melon-headed whales were stranded on April 3, 2023. Face-to-face (n = 25) and telephone (n = 1) interviews among surfers took place on April 7 and 8. A nasal swab for quick antigen testing was taken from those who wished to be tested (n = 13), to detect infections with influenza A virus.

Results: Although there was no confirmatory diagnosis of H5N1 in either humans or dolphins (while n = 3 dolphins were autopsied), we found that a large number of surfers had touched the dolphins with their bare hands while attempting to rescue them, and that some surfers were directly exposed to dolphin blood and body fluids in the ocean.

Conclusions: The adequate communication of risk is required to minimize the threat of viral transmission at this particular human–animal interface. Administrative and legal responses to cross-species transmission, including guidelines via one health frameworks, a rapid evaluation process of ethical approval, and the systematic involvement of experts in infectious disease, must be urgently formulated.

1. Background

In 1997, the first confirmed case of human infection with highly pathogenic avian influenza (HPAI) A (H5N1) virus, which had previously only circulated in bird species, was diagnosed in Hong Kong, China. The outbreak resulted in 18 confirmed human cases, including six deaths, by the end of that year [1]. Since then, HPAI has been detected worldwide, predominantly in poultry and wild waterfowl, although occasionally in wild animals [2–4]. For several decades, there has been a resurgence in outbreaks of H5N1, with increasing numbers of them caused by the reassortant clade 2.3.4.4(b), seen in aquatic mammals and other host species on land (e.g., fox and mink), most notably after 2022. These new hosts and outbreaks in new geographic areas have attracted global attention, with calls for the revised assessment of the risk posed to humans [5–7]. H5N1 clade 2.3.4.4(b) has not yet caused a human epidemic and the virus is not considered to have a substantial capacity for human-to-human transmission, so the risk of a pandemic is probably small [8]. Although the clinical picture of human H5N1 2.3.4.4(b) infections has yet to be documented, the virus is panzootic in animals, and once a person is infected with previously circulating HPAI H5N1, they experience severe symptoms, including conjunctivitis, fever (temperature of $\geq$37.8 °C), cough, and muscle ache [9]. According to the World Health Organization, there have been 868 cases of human H5N1infection worldwide, resulting in 457 deaths, as of January 2023, with a confirmed case fatality rate of 53 % [10]. If human-to-human transmission is established, the mortality risk will potentially be high, so there have been calls for careful monitoring [11,12].

The incidence of HPAI infection in sea (aquatic) mammals has gradually increased, and the number of stranded marine mammals infected with H5N1 2.3.4.4(b) has recently risen. The National Oceanic

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and Atmospheric Administration has reported an increase in stranded seals in North America since June 2022 [13]. In March 2023, it was discovered that over 3000 seals had died in Peru after the spread of H5N1 2.3.4.4(b) infections in wild animals [14]. In late June 2022, the first case of 2.3.4.4(b) in Risso's dolphins was confirmed in Sweden [15], and in mid-February 2023, the stranding of two common dolphins due to infection was reported in the UK [16].

Between April 3 and 5, 2023, melon-headed whales were found washed up on Tsurigasaki coast in Japan (Fig. 1). By April 3, 32 whales had washed ashore. Although many people on the coast, especially surfers, attempted to move the whales back into the ocean to save their lives, by April 5, 15 of them had died [17]. They were found along Tsurigasaki coast between Ichinomiya-cho and Taito in Isumi-shi, which is next to Ichinomiya-cho. The Tsurigasaki coast was chosen as a venue for surfing competitions at the Tokyo 2020 Olympic Games and is known for its excellent waves, so many surfers come from Tokyo and surrounding areas [18]. According to the Nippon Hoso Kyokai (Japan Broadcasting Corporation), most of the surfers who joined the rescue mission during the stranding event were local surfers [18,19]. Although recommendations and manuals for the management of stranded sea mammals have been published elsewhere to avoid the dangers posed by contact with stranded animals [19,20], such information was not widely disseminated at the time.

Because the whales were not confirmed as infected with H5N1 at the time of stranding and there was no suspected human case of infection, no public institutions responded to the outbreak to prevent potential human infections in real time, and only university researchers were actively engaged in the response to a potential outbreak. In this study, we investigated the human–dolphin contact during this stranding event to clarify the potential risk of transmission of H5N1 to humans, by surveying a large number of contacts on Tsurigasaki coast. Although no human outbreak of H5N1 2.3.4.4(b) has occurred after transmission from wild animals, it is essential to understand the characteristics and problems associated with exposure to suspected H5N1-infected wild animals [5,21]. To aid the development of future recommendations on wildlife management, we share our experience.

2. Materials and methods

A cross-sectional survey of human exposure to the stranded dolphins was undertaken, with non-random, convenient sampling on the beach where approximately 30 dolphins (melon-headed whales) stranded on April 3, 2023. Face-to-face interviews were conducted among visitors to the beach on days 5 and 6 after the stranding event (April 7 and 8). Because the beach is a well-known surfing spot, most of the interviewees were recruited from those who had just finished surfing in the ocean. Alternatively, some interviewees used text messages or telephones calls to voluntarily contact their friends who surfed regularly at the site of the dolphin stranding. Therefore, the sample of interviewees was drawn from a mixture of on-site recruitment and snowball-like invitations via the surfers' network.

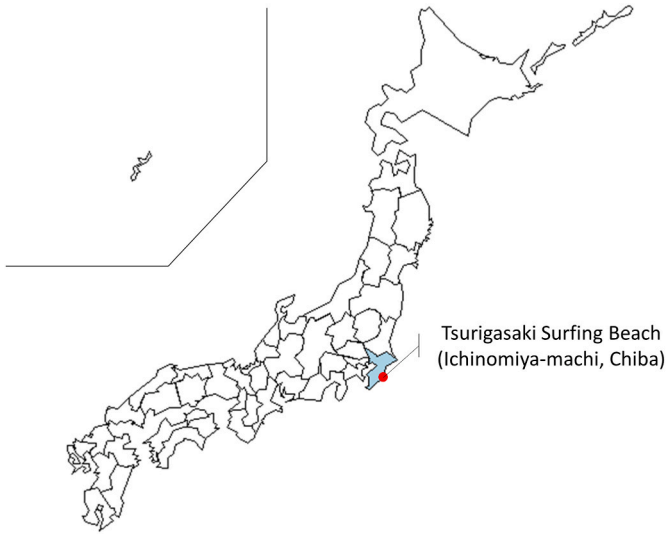

Fig. 1. Geographic location of the dolphin stranding, April 2023, Japan. The Tsurigasaki coast is located in Chiba prefecture, which is close to Tokyo, to its east.

During the interview, we protected ourselves from infection by wearing raincoats and face masks. We also followed the Center for Disease Control and Prevention's guidelines [22], taking a daily dose (75 mg) of oseltamivier (Tamiflu®) for post-exposure prophylaxis, starting on the first day of interviews.

Following the receipt of written informed consent from each interviewee, we asked their personal characteristics, and moreover, the details of individuals who had direct contact with the dolphins were collected: (i) age, (ii) sex, (iii) day of exposure to dolphins, (iv) physical distance from the dolphins (the extent of exposure), (v) whether they had worn gloves, masks, and/or gowns when they touched dolphins, and (vi) whether they had been exposed to body fluids, such as blood. The interview was followed by nasal swabbing in those who consented to participation in rapid antigen testing. We used highly sensitive immunochromatography (FUJI DRI-CHEM IMMUNO AG1, Fujifilm Co., Minatoku, Tokyo) for nasal swabbing to detect an antigen of influenza A virus [23]. After an interviewee agreed to swab testing, we explained that the test was only used to detect influenza A virus antigen, and that we were unable to identify the virus as the H5 subtype on site, although we could refer a positive individual to a nearby tertiary-care facility.

The present study adhered to the Declaration of Helsinki, and written informed consent was obtained from all the participants. During the verbal and written explanation of our survey, the participants were given an explicit right to refuse participation. The study was approved by the Medical Ethics Committee of Kyoto University Graduate School of Medicine (R3932).

3. Results

Table 1 shows the demographic and contact characteristics of the participants who had direct contact with the stranded dolphins (Fig. 2). We interviewed 26 individuals, including in a telephone interview of one individual. Eighteen interviewees had direct contact with the dolphins and eight did not (but were on the beach on the day of the stranding event or shortly thereafter). In total, 13 individuals agreed to nasopharyngeal swab testing, but none was positive for influenza.

The median duration of contact (or what could be interpreted as 'rescue') was 2.75 h, and 13 of 18 individuals (72.2 %) were exposed to the blood or body fluids of the dolphins. Fifteen individuals (83.3 %)

Table 1
Characteristics of the participants (n = 26).

Characteristics	Direct contact with stranded dolphins	
	Yes (n = 18)	No (n = 8)
Male	10 (61.1 %)	6 (75 %)
Median age	49 (min: 33, max:62)	46 (min: 34, max: 73)
Swabbing	10 (61.1 %)	3 (37.5 %)
Test positive	0	0
Median contact duration (hours)	2.75 (min: 0.25, max: 12)	–
Contact blood or body fluid (including "perhaps")	13 (72.2 %)	–
Any protective equipment	15 (83.3 %)	–
Use of wet suit	14 (77.8 %)	–
Use of cotton gloves	4 (22.2 %)	–
Use of waterproof gloves or surfing gloves	3 (16.7 %)	–

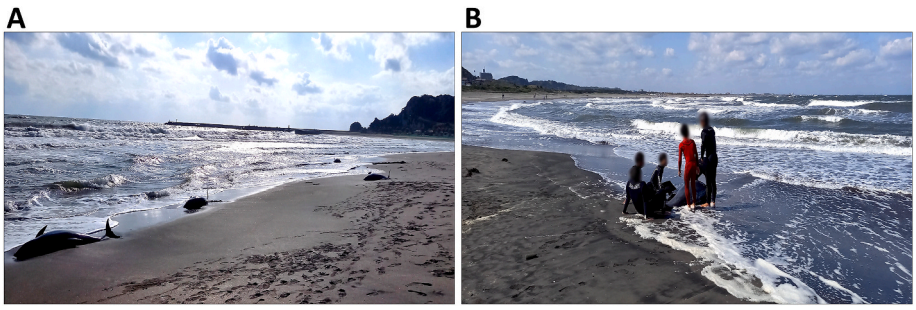

Fig. 2. Stranded dolphins and surfers discussing the rescue mission.
(A) Stranded dolphins on the beach, and (B) the scene of the rescue mission in the morning of the first day of the stranding event, April 3, 2023, on Tsurigasaki beach.

used some type of personal protective equipment, and although 14 (77.8 %) wore wet suits, only three (16.7 %) wore waterproof gloves or surfing gloves. Most dolphin rescuers worked with bare hands, although some later used cotton gloves (e.g., to protect their skin from physical scratches). The call to wear gloves was given by friends via social networks and some of these friends supplied cotton gloves.

Upon interview, many participants reported continuing to feel well after contact with the dolphins. However, one individual reported clinical symptoms, including vomiting and coughing, although their relevance to exposure remains unclear. A proportion of the participants complained of muscle ache (due to hard activity), and one was hit hard in the chest during the rescue mission (but the pain disappeared after a short rest). A proportion of the participants also reported being depressed by their sense of helplessness regarding the dolphins. Although this was not established quantitatively, the majority of surfers in the rescue mission were local residents from nearby areas (i.e., Ichinomiya Town or Isumi City) and some joined the rescue voluntarily after seeing posts on social media. With the survey, we found that most of the surfers knew each other and remembered who was involved in the rescue missions, implying that anyone who suffered intense exposure could be identified retrospectively. Once they joined the rescue, most people were directly exposed to live dolphins, and some were aware that they might have touched dead or injured dolphins (see Supplementary video).

In terms of recognizing of the risk of exposure, one participant reported that the dangers of using their bare hands were discussed on site, and from day 2, warning signs were posted on the beach exhorting people to avoid contact with the dolphins. By placing these signs, the Ichinomiya town council directly called for the small number of rescuers to stay away from the dolphins, but there was no legally binding prohibition on contact. After the rescue, alcohol-based disinfectants were used by a few participants. Two participants who were walking their dogs on the beach that day reported that the dogs had approached the stranded dolphins, and one dog was off leash.

At the time of the survey and even today, the cause of the stranding event was unknown. One of the three stranded dolphins that were subjected to autopsy was diagnosed with severe pneumonia. However, no positive test results for HPAI were announced by the National Museum of Nature and Science, Tokyo, which was in charge of the post-mortem pathological examination of the three dolphins.

4. Discussion

Panzootic transmission of H5N1 2.3.4.4(b) has been proposed to explain the increasing number of stranding events among marine mammal species across the world, and consistent with this, our research group responded in real time to a potential high-risk exposure event in humans. Although the cause of the stranding event has not been explicitly identified as H5N1 infections among dolphins, it is still possible that HPAI caused the stranding event discussed here. Our survey strongly suggests a critical need to communicate with the general public in such an emergency situation to minimize the amount and range of their exposure to potentially infected animals. This is not only an issue among surfers. People involved in the transportation of the stranded dolphins for autopsy and even marine mammal professionals who handled those dolphins did not necessarily take strict precautions (e.g., did not adhere to standard contact precautions and handled the dolphins without gloves or gowns). Touching dolphins with their bare hands was in stark contrast to how experts responded to stranded otters on the Chilean coast, wearing face shields, gowns, and gloves. To the best of our knowledge, the present study is the first to describe an alarming situation involving risky behaviours, which was not regulated well by governmental organizations.

There are two critical lessons to be learnt. First, adequate communication is required to minimize the risk of transmission at this particular human–animal interface. Second, the appropriate administrative and legal responses to cross-species transmission, including guidelines and the systematic involvement of infectious disease experts, must be formulated urgently.

The communication of risk in such situations is essential, not only because of the high pathogenicity of H5N1, but also because many people are unaware of the risks involved in the voluntarily rescue of dolphins without proper protective strategies. This need is not restricted to marine mammals, and the dead bodies of a wide range of mammals, including foxes, cats, and minks, are frequently found throughout the world. Given the evolving host range of H5N1, proper crisis communication is called for, involving the general public. Moreover, no officially sanctioned guidance on the avoidance of possible infections from marine mammals was included in the administrative guideline prepared by the Fisheries Agency of Japan or by the Ministry of Environment for animals other than wild birds. To date, there has only been an administrative manual for local governments on the proper handling of stranded marine mammals in cooperation with specialized haulers [23,24]. Although an increased risk of exposure to zoonotic diseases such as HPAI was anticipated, no professional guidance from the local town hall was provided on the first day of the stranding event, and was only made available on the afternoon of day 2, when the first and last authors made a phone call to the town hall after watching the stranding event on TV news.

The need for a systematic response requires attention because there has been no specific guidance on how local governments can involve infectious disease experts. As briefly mentioned in the Results, news media reported the preliminary autopsy result, suggesting encephalitis and pneumonia in one dead dolphin, but the officials in charge did not immediately communicate with the public, and no pathological details, including the testing results, were made available to them. When infectious disease experts are involved, the precautions of laboratory experts can be greatly improved, and the rapid collection of fresh samples for virological testing is possible. To be more specific, when a viral survey is undertaken, at least those who handle the dead bodies or samples in the laboratory must abide by biosafety level 2 (BSL-2) protocols. When an infection is confirmed to be HPAI, BSL-3 protocols must

be followed. Despite the lack of suspicious findings at autopsy, there are sporadic yet consistent reports of suspected or confirmed HPAI in poultry and wild birds, and the increasing host ranges of these viruses are clear, suggesting the need for routine precautions when handling marine mammals.

Even more importantly, the appropriate approach to human–animal interactions is not necessarily instituted rapidly enough to improve patient outcomes, or to contain an outbreak at the source. In the United Kingdom, it takes 2–3 weeks to confirm a diagnosis of influenza of avian origin in non-avian wildlife and to announce it officially. In Japan, the field epidemiology training program of the National Institute of Infectious Diseases can only commence an outbreak investigation upon official request from local government (and therefore usually after diagnosis). If an infection caused by a novel HPAI is suspected and the risk of secondary transmission must be limited, its rapid investigation is crucial to the response. Peak viral shedding is likely to occur on the first day of illness, and the infectious period can last approximately 5 days [24,25]. Early treatment and post-exposure prophylaxis (e.g., with oseltamivir) are options that improve the prognosis of the infection and limit unnecessary secondary transmission. We emphasize the need for the pro-active engagement of infectious disease epidemiologists to prepare the public by filling such gaps in the response to a potential outbreak.

Four important limitations of this study must be acknowledged. First, we were only able to collect information retrospectively, mainly from those who were on the beach during our 2-day survey. Therefore, our findings are subject to recall bias. However, owing to the kindness of the local surfers, we were also able to interview those who were not surfing on the beach on the day of the survey. Second, we could not contact all the people exposed, and only a proportion of the interviewees consented to rapid antigen testing, which limited the power of our testing results. We also believe that this study identifies essential key issues associated with the exposure of those who participated in this dolphin rescue. Third, the paucity of regular dialogue between epidemiologists and marine mammal experts actually delayed the initial response required to establish the involvement of HPAI early in the event. Given the lack of long-lasting mutual trust, no interviews were undertaken with mammal experts, so they did not undergo antigen testing. An interdisciplinary network among experts is vital if the response to such situations is to be appropriately shared. Fourth, researchers could also respond in a more pro-active manner. For example, the review of a study protocol by an ethics committee can take a long time, and that timeline may be much longer than the response time required to undertake an exposure survey. Whenever we respond to potential human exposure to animals, it would be fruitful to undertake the fast track evaluation of ethics, i.e., an expedited evaluation process of ethics committee. The prompt preparation of essential equipment (e.g., testing kits and oseltamivir) also requires pro-active engagement.

In this particular event, dolphins were not confirmed to have died of infection with H5N1 2.3.4.4(b), and fortunately, we identified no infected humans. However, this serious real-time exposure survey identified a variety of issues in the prevention of exposure to HPAI and the timely response to future potential viral transmission events from animals to humans. We hope that our findings will be useful when considering our future preparedness for the management of dead or sick animals infected with H5N1.

5. Conclusion

In the present study, we surveyed a stranding event involving dolphins that involved human–dolphin contact with on-site interviews of exposed surfers on the Tsurigasaki coast, and have described the potential risk of transmission of H5N1 infection to humans. Although no confirmatory diagnosis of H5N1 was made in either humans or dolphins, we found that a large number of surfers had touched the dolphins with their bare hands during the attempted rescue, and that surfers were directly exposed to dolphin blood and body fluids. The adequate communication of risk is required to minimize the threat of transmission at this particular human–animal interface. Moreover, administrative and legal responses to the cross-species transmission of HPAI, including guidelines via one health framework, a rapid evaluation process of ethical approval, and the systematic involvement of infectious disease experts, must be formulated urgently.

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CRediT authorship contribution statement

Taishi Kayano: Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Tetsuro Kobayashi:** Data curation, Investigation, Writing – original draft, Writing – review & editing. **Seiko Fujiwara:** Data curation, Writing – original draft, Writing – review & editing. **Yuta Okada:** Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Hiroshi Nishiura:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nmni.2023.101214.

References

[1] Yuen KY, Chan PK, Peiris M, Tsang DN, Que TL, Shortridge KF, et al. Clinical features and rapid viral diagnosis of human disease associated with avian influenza A H5N1 virus. Lancet 1998;351:467–71.
[2] Lewis NS, Banyard AC, Whittard E, Karibayev T, Al Kafagi T, Chvala I, et al. Emergence and spread of novel H5N8, H5N5 and H5N1 clade 2.3.4.4 highly pathogenic avian influenza in 2020. Emerg Microb Infect 2021;10:148–51.
[3] Nguyen DC, Uyeki TM, Jadhao S, Maines T, Shaw M, Matsuoka Y, et al. Isolation and characterization of avian influenza viruses, including highly pathogenic H5N1, from poultry in live bird markets in Hanoi, Vietnam, in 2001. J Virol 2005;79:4201–12.

[4] Pulit-Penaloza JA, Belser JA, Brock N, Thakur PB, Tumpey TM, Maines TR. Pathogenesis and transmissibility of North American highly pathogenic avian influenza A(H5N1) virus in ferrets. Emerg Infect Dis 2022;28:1913–5.
[5] World Health Organization. Genetic and antigenic characteristics of zoonotic influenza A viruses and development of candidate vaccine viruses for pandemic preparedness. Wkly Epidemiol Rec 2023;98:111–25.
[6] Agüero M, Monne I, Sánchez A, Zecchin B, Fusaro A, Ruano MJ, et al. Highly pathogenic avian influenza A(H5N1) virus infection in farmed minks, Spain, October 2022. Euro Surveill 2023:28. https://doi.org/10.2807/1560-7917.ES.2023.28.3.2300001.
[7] Nishiura H, Kayano T, Hayashi K, Kobayashi T, Okada Y. Letter to the Editor: knowledge gap in assessing the risk of a human pandemic via mammals' infection with highly pathogenic avian influenza A(H5N1). Euro Surveill 2023;28:2300134.
[8] Centers for Disease Control and Prevention. Past examples of probable limited, Non-sustained, person-to-person spread of Avian Influenza A. Viruses 2023. https://www.cdc.gov/flu/avianflu/h5n1-human-infections.htm. [Accessed 26 October 2023].
[9] Centers for Disease Control and Prevention. Bird flu virus infections in humans. https://www.cdc.gov/flu/avianflu/avian-in-humans.htm. [Accessed 26 October 2023].
[10] World Health Organization. Avian Influenza Weekly Update Number 891. Avian Influenza Weekly Update n.d. https://www.who.int/docs/default-source/wpro—documents/emergency/surveillance/avian-influenza/ai_20230407.pdf?Status=Master&sfvrsn=22ea0816_26 (accessed April 14, 2023).
[11] Dejpichai R, Laosiritaworn Y, Phuthavathana P, Uyeki TM, O'Reilly M, Yampikulsakul N, et al. Seroprevalence of antibodies to avian influenza virus A (H5N1) among residents of villages with human cases, Thailand, 2005. Emerg Infect Dis 2009;15:756–60.
[12] Liem NT, Lim W. World health organization international avian influenza investigation team, vietnam. Lack of H5N1 avian influenza transmission to hospital employees, hanoi, 2004. Emerg Infect Dis 2005;11:210–5.
[13] National Oceanic and Atmospheric Administration Fisheries. Recent increase in seal deaths in Maine linked to avian flu. https://www.fisheries.noaa.gov/feature-story/recent-increase-seal-deaths-maine-linked-avian-flu. [Accessed 26 October 2023].
[14] Collyns D. First birds, now mammals: how H5N1 is killing thousands of sea lions in Peru. The Guardian; 2023.
[15] Thorsson E, Zohari S, Roos A, Banihashem F, Bröjer C, Neimanis A. Highly pathogenic avian influenza A(H5N1) virus in a harbor porpoise, Sweden. Emerg Infect Dis 2023;29:852–5.
[16] Schnirring L. H5N1 avian flu found in UK dolphins, Swedish porpoise. Center for Infectious Disease Research and Policy, University of Minnesota; 2023.
[17] Nippon Hoso Kyokai (Japan Broadcasting Corporation). Dolphins washed up on the beach, why? n.d. https://www.nhk.or.jp/shutoken/chiba/article/011/60/(accessed October 26, 2023).
[18] Ichinomiya Town Council. Tsurigasaki Coast n.d. https://www.town.ichinomiya.chiba.jp/machizukuri/2/408.html (accessed October 26, 2023).
[19] Fisheries Agency. Stranding and bycatch of cetaceans n.d. https://www.jfa.maff.go.jp/j/whale/bycatch.html (accessed October 26, 2023).
[20] Stranding Network Hokkaido. If dolphins or whales strand, drift, or become bycatch. 2012. https://kujira110.com/?page_id=424. [Accessed 26 October 2023].
[21] Van Kerkhove MD, Mumford E, Mounts AW, Bresee J, Ly S, Bridges CB, et al. Highly pathogenic avian influenza (H5N1): pathways of exposure at the animal-human interface, a systematic review. PLoS One 2011;6:e14582.
[22] Centers for Disease and Control and Prevention. Interim guidance on influenza antiviral chemoprophylaxis of persons exposed to birds with avian influenza A viruses associated with severe human disease or with the potential to cause severe human disease. 2023. https://www.cdc.gov/flu/avianflu/guidance-exposed-persons.htm. [Accessed 26 October 2023].
[23] Fujifilm. Dri-chem immuno ag1 n.d. https://www.fujifilm.com/th/en/healthcare/poct/immuno/ag1 (accessed October 26, 2023).
[24] Cori A, Valleron AJ, Carrat F, Scalia Tomba G, Thomas G, Boëlle PY. Estimating influenza latency and infectious period durations using viral excretion data. Epidemics 2012;4:132–8.
[25] Carrat F, Vergu E, Ferguson NM, Lemaitre M, Cauchemez S, Leach S, et al. Time lines of infection and disease in human influenza: a review of volunteer challenge studies. Am J Epidemiol 2008;167:775–85.