Evaluation of a Web-Based Self-Reporting Method for Monitoring International Passengers Returning from an Area of Emerging Infection

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Abstract

Objectives. Emerging infectious diseases are a public health issue of international concern. Identifying methods to limit their expansion is essential. We assessed the feasibility of a screening strategy in which each traveler would actively participate in the screening process after an intercontinental flight by reporting their own health status via a web-based self-administered questionnaire.

Patients and methods. In 2015 and 2017, we invited passengers arriving at or departing from Pointe-à-Pitre international airport to answer an online health questionnaire during the four days following their arrival from or at Paris-Orly international airport. SPIRE 1 was intended for passengers arriving at Pointe-à-Pitre and was conceived as a pilot study. SPIRE 2 was an improved version of SPIRE 1 and consisted in three parts, which permitted to further assess the benefits of pre-flight request and email follow-up. Endpoints were the connection rates and response rates to online health questionnaire.

Results. For SPIRE 1, 4/1,038 travelers (0.4%) completed the two steps of the online health questionnaire. In SPIRE 2, response rates ranged from 3/1,059 (0.3%) to 19/819 (2.3%). Response rates were significantly better when passengers were approached before their flight.

Conclusions. The yield of an online health questionnaire was unexpectedly low.

Introduction

Over the past 20 years several severe and/or highly communicable infectious diseases emerged, such as severe acute respiratory syndrome, pandemic A H1N1 influenza, Middle East Respiratory Syndrome, and more recently Zika and Ebola virus diseases. They were sources of concern and sometimes fear, and raised many challenging questions to scientists, physicians, and decision makers. How to limit their spread from their primary or secondary source is one of these questions [1].

Travelers may contribute to the spread of a communicable disease from one area to another, and may represent epidemiological sentinels for these spreads. In addition, early detection of a communicable disease in travelers returning from an infected area might contribute to prevent the introduction or to limit the spread of an emerging disease to a new territory. Border screening, irrespective of the methods used, was shown to be poorly effective [2–11]. This was the case for systematic clinical screening [2–4,6,10,11] and the use of infra-red camera to detect feverish travelers [5,7–9]. Moreover, most passengers may be in the incubation phase of the disease and may go through border checkpoints undetectable and therefore undetected. Other approaches relied on self-report-based methods with daily questionnaires answered by travelers during and/or after the trip, using smartphone applications [12,13].

The aim of this study was to assess the feasibility of a screening strategy in which each traveler would actively participate in the screening process after a long-haul flight by monitoring and reporting their own health status via a web-based self-administered questionnaire. We called this study SPIRE, which stands for "Monitoring of international passengers returning from an emerging infection area".

Methods

Study Design

The study involved two phases, in 2015 and 2017 at the Pointe-à-Pitre international airport in Guadeloupe (French West Indies), and targeted passengers disembarking from/boarding on transatlantic flights from/to Paris. No health alert on an emerging infectious disease was ongoing at either date. During the first phase of the study (SPIRE 1), which was conceived to assess the strategy feasibility, all adult travelers disembarking from three different flights on the same day in November 2015, were given a flyer that provided information on the study objectives and the content of the online questionnaire they were invited to anonymously fill out two and four days after arrival at Pointe-à-Pitre. The flyer was handed out to the passengers in the luggage delivery area by four members of the research team who wore a jacket that identified them as health officers and were available to answer questions from passengers and had been trained to do so. The flyer contained both a URL address and a flash code to be used to access the online health questionnaire (OHQ).

After the results of SPIRE 1 became available, SPIRE 2 was designed to improve the yield of the strategy and included three parts. In SPIRE 2.1, the same methods as those of SPIRE 1 were reproduced to serve as appropriate control for SPIRE 2.2 and 2.3, the difference being the period of the year it was conducted (June, a period of the year where the reason for travelling is more often tourism than is November). In SPIRE 2.2 passengers were approached by the research assistants and given the flyer while in the boarding area, waiting for a flight to Paris. In SPIRE 2.3, passengers were approached in the same conditions as in SPIRE 2.2 but were additionally invited to provide investigators with their own email address to be used for sending them an email reminder to log onto the OHQ, had they not done so spontaneously 2 and 4 days after their flight arrival.

Analysis

In all SPIRE studies, completion of the OHQ automatically fed a database which was analyzed in real-time with pre-established algorithms. Once they had completed Day-2 OHQ, passengers received a pop-up message inviting them to re-log onto the OHQ web page two days later using a 4-digit code to be used to link Day-2 and Day-4 OHQs to the same passenger. The content of OHQ is provided in Figure 1. The number of individual connections to the OHQ web page was recorded for 10 days after each SPIRE study was launched. Study endpoints were the connection and response rates. For inter-study comparison of connection and response rates, we used Fisher's exact test, with a *p*-value significance threshold of 0.05. We used the software Prism 5.03 for statistical analysis.

Ethics and authorizations

The study was approved by the Ethics Committee of the University Hospital of Pointe-à-Pitre. In its statement, the Ethics Committee acknowledged that "logging on to the OHQ web page demonstrates participant's consent to fill out the questionnaire". Besides, according to French law, in such non-biomedical non-interventional research, there is no need to obtain the participant's consent. The study was conducted in collaboration with and under the supervision of the Border Health Surveillance Unit of the Health Regional Agency of Guadeloupe and the Pointe-à-Pitre airport Authority.

Results

SPIRE 1 was conducted in November 2015. Three flights originating from Paris were selected. According to the airline passengers' lists, a total of 1,038 adult passengers had traveled that day. Less than 20 passengers refused to take the flyer that was handed out to them. A few couples took only one flyer for the two of them. There were nine (0.9%) individual connections. Four (0.4%) different persons completed both OHQs.

SPIRE 2 was conducted in June 2017. For SPIRE 2.1, three flights from Paris to Pointe-à-Pitre were selected, accounting for a total of 1,059 passengers. No passenger refused the flyer and less than 10 couples took one flyer for the both of them. There were 21 (2%) individual connections. Six (0.6%) different persons completed the first OHQ and three (0.3%) completed both OHQs.

For SPIRE 2.2, three flights from Pointe-à-Pitre to Paris were selected, accounting for a total of 945 passengers. Less than 20 passengers refused the flyer and less than 10 couples took one flyer for the both of them. There were 70 (7.4%) individual connections. Fifty-one (5.4%) different persons completed the first OHQ and 14 (1.5%) completed both OHQs.

For SPIRE 2.3, two flights from Pointe-à-Pitre to Paris were selected, accounting for a total of 817 passengers. Less than 20 passengers refused the flyer and less than 10 couples took one flyer for the both of them. One hundred and eighty-seven (23%) passengers agreed to provide their personal email address for us to send them a reminder email to log on to the OHQ, two and four days after their flight arrival. An email was actually sent to all these 187 persons on a systematic basis. An automatic "undelivered email" reply was received back for 15 subjects (8%). There were 63 (7.7%) individual connections. Forty-two (5.1%) different persons completed the first OHQ and 19 (2.3%) completed both OHQs. All these results are summarized in Table 1, which also provides inter-study comparison of response rates.

Discussion

The OHQ response rates observed in the present study were exceedingly low (lower than 1% in SPIRE 1 and SPIRE 2.1 and between 1.5% and 5.4% in SPIRE 2.2 and SPIRE 2.3). In spite of these low response rates, the OHQ strategy seemed to be significantly more successful when proposed to passengers before rather than after the flight. However, sending a reminding email to passengers had no significant impact on the response rate.

To our knowledge, this study is the first to assess the feasibility of a screening strategy in which the traveler would actively participate in the monitoring of their own health status and reporting it via a web-based self-administered questionnaire.

Our work has several limitations. First, passengers were picked in a single site and outside a period of infectious disease emergence. One cannot exclude that response rates could be higher in other sites or in a crisis situation, although this seems unlikely as long as no coercion is enforced. Second, our study was not designed to identify reasons for non-response. These reasons may be numerous, such as the lack of interest or concern, but also a limited access to the Internet or poor understanding of the questions asked. The latter could help explain the gap between the number of individual connections and the number of completed questionnaires, which was observed for each of the SPIRE studies. However, we had tested the questionnaire among volunteers, before launching each survey. In addition, we decided to ask a limited number of very simple questions (Figure 1). Language barriers were unlikely as the vast majority of passengers of flights between mainland France and

French West Indies are French-speaking, French citizens. The very low yield of OHQ in this study may also be, in part, related to the low compliance of the French population to solicitations by national institutions, irrespective of the context. Our results were quite disappointing and may either reflect that travelers would not actively commit themselves to their own monitoring in case of an emerging infection international crisis or that the strategy we used does not fit travelers' expectations and should therefore be improved. Incentive messages issued by the airline companies might help, but French laws on people privacy prevent airline companies from sharing list of travelers along with their personal contacts.

Comparing our results to others' is not an easy task as we failed to identify any other study that used the same strategy as ours. We therefore compared our strategy with various other strategies aimed at limiting the spread of emerging infections.

Detection of febrile passengers by infrared thermal image scanners is the method that has been most evaluated. Several studies evaluated this method to identify febrile international travelers in various situations of emerging infection crisis (SARS, influenza, etc.) [2,6–9,11]. The results of these studies are quite heterogeneous, depending on the study site, the type of infectious disease targeted, or the type of infrared camera or scanner. The major problem of this expensive method is that it does not detect the sick but afebrile travelers or travelers still in the incubation phase. It also has a lower sensitivity than fever measurement using standard methods.

Other studies evaluated how the voluntary use by travelers of their personal smartphone could help detect and manage health issues in these travelers [12,13]. The underlying hypothesis is that using a specific application on their own smartphones would make travelers more prone to actively commit themselves to their own monitoring. This method was tested on 101 volunteers who had attended a travel medicine clinic in Zurich before traveling to Thailand for less than five weeks. Participants had a personal smartphone equipped with a SIM card providing free wireless Internet during their trip and accepted to complete a questionnaire before departure and then a health questionnaire daily until return using a specific application that had been downloaded to their smartphone prior to their journey. Seventy-five travelers (74.3%) responded to at least one questionnaire and they completed a median of 12 questionnaires (range 1-30), which corresponded to a median completion rate of days of travel of 85% [12,13]. In addition, the smartphone application passively collected positioning data on environmental exposures and daily itinerary, to be used to correlate the potential occurrence location and clustering of health issues. This strategy is quite attractive and should be further tested as its effectiveness highly depends on the traveler's commitment.

Other methods consist in systematically screening passengers returning from a high-risk emergence area by using combinations of various methods (oral or written information messages to travelers, interventions in the landing or boarding areas such as fever detection, survey, or clinical examination of travelers before and/or after travel, etc.). These methods have been evaluated and used in several countries [2–4,10,14]. They allow for the sorting of travelers into various risk categories and the customization of a public health strategy accordingly (quarantine, specific isolation, etc.). It is probably one of the most effective strategies, but it is expensive and highly time- and human resource-consuming. It can also induce fear in the population. This method was used in Taiwan between 2007 and 2010 and was able to detect approximately 50% of confirmed cases of imported dengue fever [2].

Conclusion

Online health questionnaires, although easy to implement and affordable, had low yield for monitoring international travelers' health in this study. Although this study may suggest that online health questionnaires would be of limited interest for health monitoring of international travelers, better performance might be reached in the setting of an international health crisis.

Disclosure of interests

The authors declare that they have no competing interests.

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References

1. Bedford J, Farrar J, Ihekweazu C, Kang G, Koopmans M, Nkengasong J. A new twenty-first century science for effective epidemic response. Nature. 2019 Nov;575(7781):130–6.

2. Kuan M-M, Chang F-Y. Airport sentinel surveillance and entry quarantine for dengue infections following a fever screening program in Taiwan. BMC Infect Dis [Internet]. 2012 Dec [cited 2018 Feb 12];12(1). Available from: http://bmcinfectdis.biomedcentral.com/articles/10.1186/1471-2334-12-182

3. St. John RK, King A, de Jong D, Bodie-Collins M, Squires SG, Tam TW. Border Screening for SARS. Emerg Infect Dis. 2005 Jan;11(1):6–10.

4. Pitman RJ, Cooper BS, Trotter CL, Gay NJ, Edmunds WJ. Entry screening for severe acute respiratory syndrome (SARS) or influenza: policy evaluation. BMJ. 2005 Nov 26;331(7527):1242.2-1243.

5. Cowling BJ, Lau LLH, Wu P, Wong HWC, Fang VJ, Riley S, et al. Entry screening to delay local transmission of 2009 pandemic influenza A (H1N1). BMC Infect Dis. 2010 Mar 30;10:82.

6. Kuan M-M, Lin T, Chuang J-H, Wu H-S. Epidemiological trends and the effect of airport fever screening on prevention of domestic dengue fever outbreaks in Taiwan, 1998–2007. Int J Infect Dis. 2010 Aug;14(8):e693–7.

7. Bitar D, Goubar A, Desenclos JC. International travels and fever screening during epidemics: a literature review on the effectiveness and potential use of non-contact

infrared thermometers. Euro Surveill Bull Eur Sur Mal Transm Eur Commun Dis Bull. 2009 Feb 12;14(6).

8. McBride WJH, Buikstra E, FitzGerald M. Investigation of febrile passengers detected by infrared thermal scanning at an international airport. Aust N Z J Public Health. 2010 Feb;34(1):5–10.

9. Priest PC, Duncan AR, Jennings LC, Baker MG. Thermal Image Scanning for Influenza Border Screening: Results of an Airport Screening Study. Cowling BJ, editor. PLoS ONE. 2011 Jan 5;6(1):e14490.

10. Malone JD, Brigantic R, Muller GA, Gadgil A, Delp W, McMahon BH, et al. U.S. airport entry screening in response to pandemic influenza: Modeling and analysis. Travel Med Infect Dis. 2009 Jul;7(4):181–91.

11. Chan LS, Lo JLF, Kumana CR, Cheung BMY. Utility of infrared thermography for screening febrile subjects. Hong Kong Med J Xianggang Yi Xue Za Zhi. 2013 Apr;19(2):109–15.

12. Farnham A, Blanke U, Stone E, Puhan MA, Hatz C. Travel medicine and mHealth technology: a study using smartphones to collect health data during travel. J Travel Med. 2016 Jun;23(6).

13. Farnham A, Furrer R, Blanke U, Stone E, Hatz C, Puhan MA. The quantified self during travel: mapping health in a prospective cohort of travellers. J Travel Med. 2017 Sep 1;24(5).

14. Zhang J, Jin X, Zhu Z, Huang L, Liang S, Xu Y, et al. Early detection of Zika virus infection among travellers from areas of ongoing transmission in China: Table 1. J Travel Med. 2016 May;23(5):taw047.

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Figure 1. Online Health Questionnaire used in the SPIRE studies.

Questions about your trip
When did you make your flight from Pointe-à-Pitre to Orly? /__/__/____/
Airline company: Flight number:

Questions about yourself
How old are you? /__/__/ years
Are you? ☐ Female ☐ Male
Where is your place of residence?

In which country(s) other than France did you stay during the three weeks preceding your flight Pointe-à-Pitre - Orly?

Have you been sick during the 5 days preceding your flight Pointe-à-Pitre - Orly?
☐ Yes ☐ No
Did you develop fever?
☐ Yes ☐ No

Questions about your state of health within 2 days after arrival of your flight

1. Health questionnaire number 1, to be completed between 24 and 48 hours after arrival
Date: __/__/____
Hour:
Q1. Is your health "as usual"? ☐ Yes ☐ No ☐ not pronounced
Q2. Have you had fever/chills since your arrival? ☐ Yes ☐ No ☐ not pronounced

If you answered no to Q1, answer the questions that follow:
Maximum temperature measured since arrival of your intercontinental flight: /__/__/.°/__/ C not measured ☐
Check the boxes corresponding to the symptoms that you present or have presented since your arrival and specify:

	Yes	No	Not pronounced	Date
Headache	☐	☐	☐	/__/__/__/
Difficulties of concentration	☐	☐	☐	/__/__/__/
Drowsiness	☐	☐	☐	/__/__/__/
Diarrhea	☐	☐	☐	/__/__/__/
Nausea	☐	☐	☐	/__/__/__/
Vomiting	☐	☐	☐	/__/__/__/
Abdominal pain	☐	☐	☐	/__/__/__/
Cough	☐	☐	☐	/__/__/__/
Difficulty breathing	☐	☐	☐	/__/__/__/

Other	☐	☐	☐	/__/__/__/
If other specify:				
Did you consult a doctor?	☐	☐	☐	

1. Health questionnaire number 2, to be completed between 24 and 48 hours after the first questionnaire
Date: __/__/____
Hour:
Q3. Is your health "as usual"? ☐ Yes ☐ No ☐ not pronounced
Q4. Have you had fever/chills since your arrival? ☐ Yes ☐ No ☐ not pronounced

If you answered no to Q3, answer the questions that follow:
Maximum temperature measured since the arrival of your intercontinental flight: /__/__/.°/__/ C not measured ☐
Check the boxes corresponding to the symptoms that you present or have presented since your arrival and specify:

	Yes	No	Not pronounced	Date
Headache	☐	☐	☐	/__/__/__/
Difficulties of concentration	☐	☐	☐	/__/__/__/
Drowsiness	☐	☐	☐	/__/__/__/
Diarrhea	☐	☐	☐	/__/__/__/
Nausea	☐	☐	☐	/__/__/__/
Vomiting	☐	☐	☐	/__/__/__/
Abdominal pain	☐	☐	☐	/__/__/__/
Cough	☐	☐	☐	/__/__/__/
Difficulty breathing	☐	☐	☐	/__/__/__/
Other	☐	☐	☐	/__/__/__/
If other specify:				
Did you consult a doctor?	☐	☐	☐	

Table 1. Connection and response rates to the online health questionnaires (OHQ) in the various SPIRE studies

	SPIRE 1	SPIRE 2.1	SPIRE 2.2	SPIRE 2.3	*p* value		
					SPIRE 2.1 vs 1	**SPIRE 2.2 vs 2.1**	**SPIRE 2.3 vs 2.2**
Number of passengers	1,038	1,059	945	819			
Number of connections (%)	9 (0.9)	21 (2.0)	70 (7.4)	63 (7.7)	0.042	<0.0001	0.86
Responses to OHQ1, n (%)	4 (0.4)	6 (0.6)	51 (5.4)	42 (5.1)	0.75	<0.0001	0.83
Responses to OHQ2, n (%)	4 (0.4)	3 (0.3)	14 (1.5)	19 (2.3)	0.72	0.005	0.22