

Surveillance and control of communicable diseases related to passenger ships in Europe

Christos Hadjichristodoulou¹, Varvara A. Mouchtouri¹, Carmen Varela Martinez², Gordon Nichols³, Tobias Riemer⁴, Jelena Rabinina⁵, Corien Swan⁶, Nina Pirnat⁷, Ona Sokolova⁸, Elina Kostara¹, George Rachiotis¹, Rainer Meilicke⁹, Clara Schlaich⁴, Christopher LR Bartlett¹⁰, Jenny Kremastinou¹¹, the SHIPSAN partnership[§]

¹Department of Hygiene and Epidemiology, Faculty of Medicine, University of Thessaly, Larissa, Greece

²National Centre of Epidemiology, Madrid, Spain

³Gastrointestinal, Emerging and Zoonotic Infections Department Health Protection Agency, Centre for Infections, London, United Kingdom

⁴Hamburg Port Health Centre, Institute of Occupational and Maritime Medicine, Hamburg, Germany

⁵Health Protection Inspectorate, Tallinn, Estonia

⁶National Institute for Public Health and the Environment, Bilthoven, Netherlands

⁷Institute of Public Health, Ljubljana, Slovenia

⁸Klaipeda Public Health Centre, Klaipeda, Lithuania

⁹Directorate General for Health and Consumers, European Commission, C3, Luxemburg

¹⁰University College London, Centre for Infectious Disease Epidemiology Department of Primary Care and Population Sciences Royal Free and University College Medical School, London, United Kingdom

¹¹Department of Public and Administrative Health, National School of Public Health, Athens, Greece

[§]Carmen Varela Santos and Sybille Rahmet (European Centre for Disease Prevention and Control, Stockholm, Sweden); Ourania Pinaka (Department of Hygiene and Epidemiology, Faculty of Medicine, University of Thessaly); Tasos Mastrogianakis (C.M.T. PROOPTIKI LTD, Athens, Greece); Paul Mckeown (Health Protection Surveillance Centre, Dublin, Ireland); Sandra Westacott (Association of Port Health Authorities, Southampton Port Health Authority, United Kingdom); Jaret Ames (Centers for Diseases Control and Prevention – Vessel Sanitation Program, Atlanta, Unites States of America); Nikos Mikelis (International Maritime Organization, Pollution Prevention, Marine Environment Division London, United Kingdom); Athina Kirlesi and Vasiliki Karaouli (Ministry of Health and Social Solidarity, Athens, Greece); Georgia Spala (Hellenic Centre for Disease Control and Prevention, Athens, Greece); Marie Baviile and Thierry Paux (Department of Alert, Response and Preparedness, General Directorate of Health, Ministry of Health, Paris, France); George Georgallas (Ministry of Health, Medical and Public Health Services, Nicosia, Cyprus); Maria Do Ceu Madeira (Directorate General of Health, Ministry of Health, Lisbon, Portugal); Aleksandra Shatalova (Latvian State Public Health Agency, Riga branch, Riga, Latvia); Daniel Menucci and Lena Hope (World Health Organization)

ABSTRACT

This study was conducted within the European SHIPSAN (ship sanitation) project and aims at exploring the legislative framework and current practices related to surveillance of communicable diseases and response aboard passenger ships in Europe. A detailed questionnaire was disseminated and completed by 59 competent authorities in 27 European countries. The majority of competent authorities used national legislation without special provisions for passenger ships. Only 20% had specific provisions for ships regarding quarantine, while a smaller proportion of new Member States (MS) have specific legislation in comparison with old MS ($p = 0.01$). The Maritime Declaration of Health (MDH) was the main reporting tool used. About 30.5% of the competent authorities declared that they require submission of MDH by all arriving ships, but 28.8% only from affected areas, and 11.9% never require MDH. A total of 45 outbreaks or incidents (36 gastrointestinal, 1 incident of legionellosis, 3 respiratory, and 1 influenza-like illness outbreak, occupational tuberculosis, varicella, scabies, and meningitis)

✉ Christos Hadjichristodoulou, Department of Hygiene and Epidemiology, Faculty of Medicine, University of Thessaly, 22 Papakiriazi Str., Larissa, 41222, Greece; tel: 0030 2410 565259, 0030 6932264685, fax: 0030 2410 565259, e-mail: xhatzi@med.uth.gr

were reported to EU competent authorities during 2006. About 75% of the responders stated that there are gaps in the surveillance and control of communicable diseases. A diversity of approaches in EU countries, and gaps regarding surveillance and response and training needs of personnel were identified.

(*Int Marit Health* 2011; 62, 2: 138–147)

Key words: surveillance, passenger ship, communicable diseases, port health, outbreak, Europe

INTRODUCTION

As on land, cases or outbreaks of communicable diseases can occur during travelling on board passenger ships including ferries and cruise ships. In recent years outbreaks of communicable disease such as influenza [1], gastroenteritis [2], and Legionnaires' disease [3, 4] have been reported on ships sailing in Europe. The results of a literature review showed that from 1970 through June 2003 there were a total of 21 reported waterborne outbreaks [5], 50 foodborne outbreaks [6], and 51 incidents of Legionnaires' disease, associated with ships of all types [7]. From 1997 to 2006, 9 confirmed outbreaks of influenza occurring on ships were published in the scientific literature. Between 1 January and 5 July 2006, 42 reported outbreaks of gastroenteritis on 13 different cruise ships sailing in European waters were confirmed or suspected to be caused by norovirus [8].

During 2009 there were 188 cruise ships sailing in Europe with a capacity of 203,600 cabins, generating 23.8 million passenger visits to European port cities. The European cruise market grew by 41% from 2006 to 2009 and more than doubled over the last 10 years [9]. Approximately 320 million passengers ferry trips were recorded through European ports in 2007 [10]. An increasing proportion of the European population travels in modern ships, which are becoming more complex and which are designed to carry many more passengers and crew. Passenger ships have public health importance since the semi-closed environment favours person-to-person transmission of pathogens. Moreover, travellers share common food and water, and potential contamination can cause waterborne and foodborne disease outbreaks. Finally, passenger ships could contribute to transnational transmission of communicable diseases.

Systematic collection of data related to infectious diseases on board passenger ships and reporting of diseases to competent authorities is important for both shipping companies and competent authorities at ports. Competent authorities are public health agencies responsible for the implementation and applica-

tion of measures for the prevention and control of communicable diseases on ships.

The International Health Regulations (IHR) 2005 require strengthening of countries' surveillance capacities and include specific provisions for ship-to-port reporting of diseases and port-to-port information sharing.

The European Parliament and Council Regulation 851/2004 established a European Centre for Disease Prevention and Control (ECDC) that is responsible for the surveillance of infectious diseases at a European level. ECDC has established an EU-wide standard case reporting system and maintains the databases for epidemiological surveillance. All 27 EU MS and three European Economic Area countries report their available data on communicable diseases to the ECDC [11] using standard case definitions of 46 diseases (listed in the Decisions 2002/253/EC and 2003/534/EC) plus SARS, West Nile Fever, and Avian Influenza. ECDC operates the European Surveillance System (TESSy) for the collection, validation, cleaning, analysis, and dissemination of data. Moreover, ECDC monitors trends of diseases across Europe and coordinates the operation of dedicated surveillance networks. ECDC's Preparedness and Response Unit monitors emerging threats in Europe and internationally, and supports the EU Member States in assessing, investigating, and responding to them. The Unit relies on a set of advanced information technology tools to detect potential threats, with special attention paid to events threatening more than one EU Member State. The assessment of such threats is done jointly with experts from the EU Member States.

In 2002, the European Parliament and the Council adopted a Decision establishing a programme of Community action in the field of public health (2003–2008). One of the general objectives of this programme was to enhance the capability of responding rapidly and in a coordinated fashion to health-related threats. In 2006, the European project SHIPSAN was funded by the Directorate General for Health and Consumers of the European Commission

in order to address such ship-related health issues (www.shipsan.eu). ECDC was a collaborative partner of the SHIPSAN project and played a key advisory role during its implementation. The main objective of the EU SHIPSAN project was to assess the usefulness of an integrated common programme for communicable diseases surveillance and hygiene inspections in Europe. The aim of this study was to describe the current situation regarding the surveillance practices of the authorities and relevant legislation in competent authorities of 30 EU MS and European Free Trade Association (EFTA) countries responsible for detection, surveillance, and response to communicable diseases related to ships.

MATERIAL AND METHODS

DATA COLLECTION

The data collection process was implemented in two phases and lasted from August 2007 until February 2008. During the first phase, a questionnaire was disseminated to the Ministry of Health or Public Health Institute of each country. The questionnaire asked for contact details of competent authorities having the responsibility for communicable disease surveillance and response related to ships at a national or local level in each country. The recipient and person responsible for completing the questionnaire was the director of the authority. Follow up e-mails were sent and telephone communications were conducted to ensure correct completion of questionnaires. Contact details for 61 national and regional competent authorities were identified in 30 EU MS and EFTA countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, the Netherlands, Turkey, and the United Kingdom. Luxembourg and FYROM were not relevant to this study since they do not receive visits from inland or sea-going passenger ships.

In the second phase of the data collection process, a questionnaire was constructed, pilot tested, and disseminated to the competent authorities which were identified during the first phase. The pilot testing of the questionnaire was conducted by site visits in one small (Malta) and in one large country (Germany). In these site visits all the competent authorities were visited and a meeting with the director was arranged to fill in the questionnaire. This questionnaire was used to collect data on legisla-

tion and practices for the surveillance of communicable diseases related to passenger ships: i) legislation related to quarantine of humans or animals, surveillance, control, outbreak detection, and investigation of communicable diseases, and guidelines to control specific communicable diseases (e.g. norovirus, Legionella), ii) diseases required to be reported by ships, iii) provision of specific outbreak definition on ships, iv) number of cases or outbreaks reported by ships during 2006, v) requirements for issuance of an order to not sail, vi) policy related to the IHR Maritime Declaration of Health submission, vii) collection of information related to travel on passenger ships within the routine surveillance system, and viii) training needs and gaps regarding knowledge on communicable disease surveillance related to passenger ships. To facilitate the data collection process, site visits were organised to competent authorities of countries belonging mainly to groups A and B. Since the questionnaire was drafted in English, translations were asked for by three competent authorities in Greece, Italy, and Romania. Follow up e-mails were sent and telephone communications were conducted to ensure correct completion of questionnaires.

DATA ANALYSIS

The data collected were entered into a specifically designed database using EPI Info version 3.01, and descriptive and correlation analyses were conducted. Chi-square or Fischer exact tests were used to compare qualitative variables. Results were considered statistically significant when the P value was < 0.05.

EU countries were divided into four priority groups (group A, B, C, and D) depending on the number of passenger ships sailing in their country, volume of passenger visits, and number of ports. The following countries were included in group A (having a higher number of passenger movements, ships, and ports than groups B, C, and D): Denmark, France, Germany, Greece, Italy, Spain, Sweden, and the United Kingdom. Group B (having a higher number of passenger movements, ships, and ports than groups C and D): Belgium, Croatia, Estonia, Finland, Ireland, the Netherlands, Norway, Poland, and Portugal. Group C (having a higher number of passenger movements, ships, and ports than group D): Bulgaria, Cyprus, Latvia, Lithuania, Malta, Iceland, Romania, and Slovenia. The countries in Group D (having a lower number of passenger movements, ships, and ports than groups A, B, and C) were Austria, the Czech Republic, Hungary, and Slovakia.

Additionally, EU countries were categorised as old or new MS. The old ones consist of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Norway, Portugal, the Netherlands, Spain, Sweden, and the United Kingdom. The new ones (those countries that joined the EU in 2004 or later) consist of Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, and Croatia. The data were analysed according to groups A, B, C, and D and old and new EU MS. The results from groups A and B (merged into one group) were compared to the results from groups C and D (merged into one group).

RESULTS

COMPETENT AUTHORITIES IN THE EU

In the EU MS and the EFTA countries, the type of competent authorities responsible for communicable disease surveillance on ships and response differ from country to country. In particular, the competent authorities may include: a) ministries of health, b) national surveillance centres or institutes of public health; c) regional authorities for public health and inspections; d) ministries of transport; e) food and veterinary services; f) public health or epidemiological units within municipalities; and g) port health authorities. In some ports, authorities responsible for occupational health, communicable disease surveillance, and environmental health have been merged into one authority. Analytical results of this study containing the types of authorities and contact details can be found at the SHIPSAN project website (www.shipsan.eu).

There were 59 completed questionnaires collected out of a total of 61 sent questionnaires related to communicable disease surveillance in passenger ships (response rate 96.7%) from 27 countries. In this study, there are no data by competent authorities in Belgium, Romania, and Turkey. Thirty-six were national authorities and 23 were regional authorities.

Not all questions were answered by the 59 competent authorities. Thus, the percentages were calculated using the number of authorities that answered the specific question as the denominator (excluding the missing values).

LEGISLATION RELATED TO COMMUNICABLE DISEASES

The majority of competent authorities used national legislation without special provisions for passenger ships regarding quarantine of humans or animals (74.6%), surveillance and control of communicable diseases (81.4%), detection and investigation of outbreaks (83.1%), and guidelines for the control of specific communicable diseases (77.2%). Specific legislation for passenger ships regarding the above-mentioned issues was in place at a maximum by up to 5 authorities in Iceland, Italy and, the Czech Republic out of the 59 authorities (Table 1).

REPORTING, SURVEILLANCE, AND OUTBREAK INVESTIGATION OF COMMUNICABLE DISEASES

About 63% of authorities declared that ships on international voyages were reporting diseases under the IHR, while about 54% of the authorities declared that ships on national voyages were reporting diseases according to national legislation (Table 2).

Table 1. Legislation for communicable disease surveillance and outbreak investigation applied by competent authorities (the data collection process lasted from August 2007 until February 2008)

Subject of legislation	Number of authorities that applied legislation			
	Specific for passenger ships	National with provisions for passenger ships	National without provisions for passenger ships	Other*
	Yes/Total (%)	Yes/Total (%)	Yes/Total (%)	Yes/Total (%)
Quarantine of humans or animals	5/59 (8.5)	7/59 (11.9)	44/59 (74.6)	5/59 (8.5)
Surveillance and control of communicable diseases	3/59 (5.1)	6/59 (10.2)	48/59 (81.4)	2/59 (3.4)
Outbreak detection and investigation of communicable diseases	3/59 (5.1)	5/59 (8.5)	49/59 (83.1)	3/59 (5.1)
Control of specific communicable diseases (e.g. norovirus, Legionella)	2/57 (3.5)	4/57 (7)	44/57 (77.2)	7/57 (12.3)

*Guidelines based on best practice

Table 2. Communicable disease reporting in 59 competent authorities (the data collection process lasted from August 2007 until February 2008)

Subject area	Number of authorities (%)		
	Ships on international travel	Ships on national travel	
Diseases reported to competent authority by ships*	IHR diseases	37 (62.7)	29 (49.2)
	All notifiable	25 (42.4)	32 (54.2)
	Voluntary basis	16 (27.1)	15 (25.4)
	Other**	4 (6.8)	4 (6.8)

*More than one answer was applicable; **authorities provided the titles of national legislation

Table 3. Submission of Maritime Declaration of Health in 59 competent authorities (the data collection process lasted from August 2007 until February 2008)

Occasions of submission of the MDH	Number of authorities (%)	
	Previous IHR	IHR 2005
Not required	3 (5.1)	7 (11.9)
All ships	25 (42.4)	18 (30.5)
Ships arriving from affected areas	20 (33.9)	17 (28.8)
Ships on which communicable disease or death has occurred	21 (35.6)	16 (27.1)
Don't know	-	7 (11.9)

Eighteen out of 59 (30.5%) authorities declared that they require submission of a Maritime Declaration of Health (MDH) by all arriving ships, and about 28% of the authorities require submission by ships arriving from affected areas or by ships in which a communicable disease or death has occurred. About 12% of the responding authorities stated that it was not clear when submission of the MDH was required with the new IHR (Table 3).

A total of 36 gastrointestinal outbreaks on board passenger ships (three attributed to norovirus, one to *Campylobacter*, and five to *Salmonella*) were reported to competent European authorities during 2006 according to the completed questionnaires collected. Furthermore, one incident of legionellosis, three respiratory, and one influenza-like illness outbreak were also reported. Other diseases that were reported included occupational tuberculosis, varicella, scabies, and meningitis.

Thirty-three authorities out of the 53 (62.2%) declared that they did not receive any outbreak report on passenger ships during 2006. Twelve authorities out of 53 (22.6%) declared that they received one outbreak report. Seven authorities reported an average of two to five outbreaks, and only one authority reported eight outbreaks.

About 7% of the responding authorities never investigated outbreaks on ships, while about 51% of the authorities investigated every outbreak reported on ships. Specific criteria for outbreak investigation of ships on international and national voyages had been used by about 24% and 27% of the authorities, respectively (Table 4).

About 57% of the authorities (32 out of 56) declared that they collect information related to travel with passenger ships in their routine surveillance systems or in the routine case investigation procedure.

No authority declared providing a specific outbreak definition different from that for community outbreaks. About 59% of the authorities (32 out of 54) had specific criteria to issue an order that a ship cannot sail.

TRAINING ON SURVEILLANCE AND CONTROL OF COMMUNICABLE DISEASES

The personnel of 38 authorities had received training on surveillance and outbreak investigation within the last three years. About 67% of the national authorities (21 out of 32) and 74% (17 out of 23) of regional departments declared that they had received training. The personnel of only two out of 54 (3.7%) responding authorities from Hungary and

Table 4. Outbreak investigation practices in 59 competent authorities (the data collection process lasted from August 2007 until February 2008)

Subject area		Number of authorities (%)	
		Ships on international travel	Ships on national travel
Outbreak investigation	Never investigated outbreaks	4 (6.8)	4 (6.8)
	Investigated every outbreak	30 (50.8)	30 (50.8)
	According to specific criteria (severity, attack rate, etc.)	8 (13.6)	11 (18.6)
	After requested by the ship's master	14 (23.7)	16 (27.1)
	After passenger complaints	12 (20.3)	15 (25.4)
	Other*	12 (20.3)	12 (20.3)

*After requested by public health authorities in charge

Portugal had received training specifically for investigations on ship. Thirty-five of the 54 responding authorities (64.8%) believed that specific training for surveillance and outbreak investigation on passenger ships is needed.

The subject areas that the competent authorities identified in which specific training should be required: routine surveillance, knowledge of special conditions aboard ships, legislation (international and national), environmental health control measures, outbreak investigation and management, methodology of epidemiological studies and presentation of findings, methods for data validation and their characteristics related to time, case management of an infectious disease (referral, transportation means), and finally information on IHR 2005 and the capability to implement present and future World Health Organisation guidelines.

GAPS IN SURVEILLANCE AND RESPONSE

Forty-two of the 56 (75%) responders stated that they believe there are gaps in the surveillance and control of communicable diseases related to ships. The issues reported by the competent authorities included: a) data collected by the local authorities at ports were not sent to the national authorities; b) lack of specific surveillance related to passenger ships; c) overlapping of responsibilities among different competent authorities within the same country; d) lack of communication between public health authorities within the same country and between different countries; e) underreporting of communicable diseases and outbreaks; f) lack of specific training in communicable disease surveillance and outbreak management; and g) lack of resources.

COMPARISON AMONG THE FOUR CATEGORIES OF GROUPED COUNTRIES AND OLD AND NEW EU MS

Surveillance practices, which statistically significantly differed among the four categories of grouped countries, and old and new MS (those countries that joined the EU in 2004 or later), are presented in Table 5 and Table 6, respectively. Statistical significant differences were found among the categories of grouped countries regarding reporting requirements, outbreak investigation on ships on national and international voyages, and gaps reported in training and surveillance related to ships (Table 5).

A higher percentage of new EU MS (21 out of the 23 authorities, 91.3%) in comparison to old EU MS (23 out of the 36 authorities, 63.9%) declared that they apply national legislation or regulations or guidelines on quarantine of humans or animals without provisions for passenger ships ($p = 0.01$). Furthermore, from the 16 authorities receiving reports on a voluntary basis from ships on an international voyage, only two authorities from Croatia belong to the new EU MS (2 out of 23, 8.7%), whereas all 15 authorities receiving reports on a voluntary basis from ships on a national voyage belong to the old EU MS. From the new EU MS, 13 out of 22 (59.1%) declared that there are gaps whereas from the old MS, 29 of 34 (85.3%) stated there are gaps in surveillance and control of communicable disease practices and legislation. Investigation of outbreaks on ships on international voyages was more common among authorities belonging to groups A and B (36 out of 59 authorities) in comparison to authorities belonging to groups C and D (19 out of 59 authorities), $p = 0.01$. The results were similar regarding the investigation of outbreaks of ships on national voyages (4 author-

Table 5. Results of correlation analysis regarding surveillance practices in four different priority country-groups

Surveillance practices	Group A	Group B	Group C	Group D	P value
	Yes/Total (%)	Yes/Total (%)	Yes/Total (%)	Yes/Total (%)	
Every ship on an international voyage is required to report all notifiable diseases for humans or animals as defined in national laws for epidemiological surveillance	10/21 (47.6)	1/15 (6.7)	9/16 (56.3)	5/7 (71.4)	0.008
Ships report diseases or outbreaks on a voluntary basis on an international voyage	12/21 (57.1)	4/15 (26.7)	0/16 (0)	0/7 (0)	0.0004
Every ship on a national voyage is required to report all notifiable diseases for humans or animals as defined in national laws for epidemiological surveillance	11/21 (52.4)	4/15 (26.7)	12/16 (75)	5/7 (71.4)	0.04
Ships report diseases or outbreaks on a voluntary basis on an international voyage	12/21 (57.1)	3/15 (20)	0/16 (0)	0/7 (0)	0.0002
Never investigated outbreaks on ships on an international voyage	0/21 (0)	0/15 (0)	1/16 (6.3)	3/7 (42.9)	0.0007
Never investigated outbreaks on ships on a national voyage	0/21 (0)	0/15 (0)	1/16 (6.3)	3/7 (42.9)	0.0007
Investigation of every outbreak	7/21 (33.3)	8/15 (53.3)	13/16 (81.3)	2/7 (28.6)	0.019
Investigation of outbreaks according to specific criteria	7/21 (33.3)	4/15 (26.7)	0/16 (0)	0/7 (0)	0.030
Specific training on surveillance and outbreak investigation for ships is needed	13/21 (61.9)	6/11 (54.5)	15/16 (93.8)	1/6 (16.7)	0.0057
Gaps in the surveillance and control of communicable diseases on board cruise ships and ferries	18/21 (85.7)	12/13 (92.3)	11/16 (68.8)	1/6 (16.7)	0.0022

ities belonging to groups C and D had never investigated an outbreak on a ship on a national voyage, $p = 0.01$). A total of 11 authorities belonging to groups A and B investigate outbreaks according to specific criteria, while no authority from groups C and D use such criteria ($p = 0.002$).

DISCUSSION

This study identified a diversity of approaches in EU countries, and gaps in surveillance and training needs of personnel. Only a few countries enforced specific legislation for ships, while the majority of them use national legislation applied on land. One important finding of our study is that a small proportion of new EU MS have specific legislation or provisions for ships, while at the same time the frequency of reported gaps is lower than those reported by the old EU MS. Thus we can assume that the new MS do not have, to the same priority, the surveillance and control of communicable diseases on board passenger ships. Investigations of outbreaks on ships on international voyages were more common among coun-

tries belonging to groups A and B having higher maritime traffic and more experience in outbreak response, in comparison to countries belonging to groups C and D. Countries belonging to groups A and B seem to have a more standardized approach regarding response to reported outbreaks, since they use specific criteria when deciding to respond and conduct outbreak investigations. These findings also show the diversity of experience among personnel of public health authorities.

Surveillance on board passenger ships seems to be an easy task, especially on ships with a doctor on board. The reference population on board (crew and passengers) is known on a daily basis. Moreover, ill persons can refer to medical staff on board making the data collection easy. Passengers and crew, when on board, can be contacted at any time, and therefore surveillance data can be accurate and complete. On the other hand, passengers may avoid visiting the doctor, especially for relatively mild diseases (gastrointestinal or respiratory) for economical reasons or because they are afraid of possible isolation. Ho-

Table 6. Results of correlation analysis regarding surveillance practices in old and new EU MS

Surveillance practices	New EU MS	Old EU	P value
	Yes/Total (%)	Yes/Total (%)	
National Legislation or regulations or guidelines without provisions for cruise ships and ferries on an international voyage	21/23 (91.3)	23/36 (63.9)	0.01
National Legislation or regulations or guidelines without provisions for cruise ships and ferries on a national voyage	22/23 (95.7)	27/36 (75)	0.038
Ships reported diseases or outbreaks on a voluntary basis on an international voyage	2/23 (8.7)	14/36 (38.9)	0.009
Every ship on a national voyage was required to report all notifiable diseases for humans or animals as defined in national laws for epidemiological surveillance	16/23 (69.6)	16/36 (44.4)	0.05
Ships reported diseases or outbreaks on a voluntary basis on a national voyage	0/23 (0)	15/36 (41.7)	0.0001
Authorities never investigated outbreaks on ships on an international voyage	4/23 (17.4)	0/36 (0)	0.019
Authorities never investigated outbreaks on ships on a national voyage	0/36 (0)	4/23 (17.4)	0.019
Authorities investigated every outbreak	17/23 (73.9)	13/36 (36.1)	0.004
Submission of the Maritime Declaration of Health is not required by any arriving ship	5/23 (21.7)	2/36 (5.6)	0.073
Gaps in the surveillance and control of communicable diseases	13/22 (59.1)	29/34 (85.3)	0.029

wever, laboratory confirmation of a diagnosis is not always possible since there are not many reliable microbiological examination methods that can be conducted on board or in due time on land. Therefore, surveillance of diseases may be more feasible if it is based on syndromes. Moreover, some of the communicable diseases with a long incubation period can be diagnosed after disembarkation and could be collected through the national surveillance systems and related to travelling with passenger ships afterwards.

Improved surveillance on board as well as national and international outbreak surveillance has been highly emphasised by many authors, investigators, and organisations [1, 12–17]. Maintenance of medical logs and the active monitoring of illness on board allows ships to detect outbreaks and other untoward communicable disease events early to enable timely application of preventive measures. Ships that conduct enhanced surveillance are able to collect baseline information on communicable diseases by season and specific itineraries, to determine thresholds for outbreak detection and evaluate and decide additional control measures.

Ships report diseases to competent authorities at ports according to international and national legislation. If an infection has occurred on board a ship on an international voyage, the master is required to report it to the competent authority of the next port of call according to the IHR [18]. Subsequently, if an outbreak is suspected, the competent authority staff may wish to see the ship's surveillance data whilst undertaking a risk assessment. If they consider that there is a risk of transmission of the infection in their country or other MS, they may alert their national surveillance centre and/or national focal point. It is important, therefore, that good surveillance logs are maintained by the ship.

Collection of surveillance data by competent authorities from passenger ships sailing in European waters can improve the evidence base for preventive actions taken in the control of outbreaks on passenger ships. It can help authorities in case investigation, management, and follow up. It can also be of benefit for authorities when assessing the risks from communicable diseases and public health events and evaluating preventive actions. Finally, the surveillance data can help EU and international systems

in early detection and response and to assist in contact tracing.

Our study results show that underreporting of diseases may occur, since almost 62% of the responding authorities declared zero outbreaks for the year 2006. A total of 36 gastrointestinal outbreaks (3 norovirus, 6 bacterial, and 27 of unknown pathogen) were reported by the competent authorities which participated in our study. According to the literature, between 1 January and 5 July 2006, 42 reported outbreaks of gastroenteritis on 13 different cruise ships sailing in European waters were confirmed or suspected to be caused by norovirus [8]. In the same year, 35 outbreaks of norovirus gastroenteritis, 4 unknown, and 1 due to *E. coli* were reported in the Centres for Diseases Control and Prevention, Vessel Sanitation Programme in the US (www.cdc.gov/nceh/vsp/surv/GIlist.htm#2006).

Among the reported gaps was the failure of local authorities to report data that are collected by ships to competent regional authorities or at a national level. Enhanced communication of data received by competent authorities at ports at a national level is needed.

Underreporting may be also attributed to the lack of knowledge of reporting requirements by the ship personnel. Even if the ship reports to the local authority, in many cases there is an absence of a detailed investigation and it is therefore difficult to identify the possible cause or hygiene deficiencies related to the incident. The length of stay on passenger ships ranges from a few hours for ferries to one or more weeks for cruise ships. The limited time period on board decreases the possibility of retrospectively linking the travel with the disease. A passenger may have left the ship before symptoms begin or become serious enough to warrant medical attention. Diseases diagnosed after the disembarkation of a passenger are difficult to link to a specific ship unless case investigation forms include queries about previous travel of the patient by ship. Furthermore, offshore activities contributing to disease may become evident during a cruise [19], while passengers might be exposed to sources of infection such as hotels before or after the cruise. It can therefore become difficult to clearly identify the ship as the source of an infection [4]. Exclusively ship-related infectious diseases are, therefore, probably underestimated [19]. However, in some instances they are overestimated in comparison with land-based premises when an enhanced, specific surveillance system is in place such as the gastrointestinal/

/norovirus surveillance conducted by the US CDC Vessel Sanitation Programme.

Since priority country group A is the group with the highest number of ports, passenger ships, and number of passengers, a more effective outbreak investigation routine would have been expected. In addition, almost 24% of the authorities belonging to group A investigate outbreaks when requested by the ship company. Only 33.3% and 27.7% of the authorities from priority groups A and B, respectively, investigate outbreaks with specific criteria for international and national voyages.

Training needs on the surveillance and control of communicable diseases specifically for ships were reported by the majority of the authorities which participated in our study. Regular training courses could be organised on a regional, national, or international level. Special training seems to be needed for the application of the IHR and the requirement of the MDH. The WHO organises training courses, and training using electronic means is also provided (www.who.int).

Our study results showed a diversity of approaches regarding response to outbreaks. When an outbreak occurs on a ship sailing in Europe it is often possible that more than one port authority within a country or more than one country may be involved in the investigation and outbreak management. Communication regarding health measures implemented, inspection findings, and investigation results is needed. Coordination of actions so as to avoid duplication is also necessary. When more than one country is involved European level coordination is needed. All EU MS have procedures and tools in place to monitor and assess early threats detected through event-based surveillance and by using the ECDC Threat Tracking Tool (TTT) to perform joint risk assessment in the event that a threat is potentially affecting more than one EU MS. If an outbreak on a ship is considered to be a threat affecting the EU, this should be reported through the web-based Early Warning and Response System (EWRS). Through the EWRS, the information is sent to the country of the next port of call using routes at a national level.

Our study revealed useful information for the situation in Europe regarding surveillance and control of communicable disease related to ships. These results could be valuable for competent authorities, policy makers, and the shipping industry. Improved surveillance is needed since underreporting of infectious diseases from ships to ports could be suspected, as well as training of personnel.

ACKNOWLEDGEMENTS

This study was financed by the Directorate General for Health and Consumers of the European Commission under the contract agreement No A/790577. The Department of Hygiene and Epidemiology of the University of Thessaly in Greece was responsible for the collection, analysis, and presentation of data. ECDC experts provided input on the design of the questionnaire about communicable disease, reporting, surveillance, and outbreak investigation and commented the manuscript. The following organisations were responsible for collecting data, reviewing result reports, and data interpretation: National School of Public Health Athens, Greece; the Health Protection Agency, London, UK; the Health Protection Surveillance Centre, Dublin, Ireland; the University Medical Centre Hamburg – Eppendorf, Hamburg, Germany; the National Institute for Public Health and the Environment, Bilthoven, Netherlands; the National Centre for Epidemiology, Madrid, Spain; the Institute of Public Health, Ljubljana, Slovenia; the Klaipeda Public Health Centre, Klaipeda, Lithuania; the Health Protection Inspectorate, Tallinn, Estonia; and Greece and CMT Prooptiki Ltd, Athens, Greece.

The EU SHIPSAN project partnership wishes to acknowledge the public health officers in all the EU and EFTA countries for their cooperation and for completing the questionnaires and providing data.

The SHIPSAN project has received funding from the European Commission under the Public Health Programme 2003–2008. However, the sole responsibility for the project lies with the author, and the European Commission is not responsible for any use that may be made of the information contained herein.

All authors declare that they have no conflicts of interest.

REFERENCES

1. Influenza B virus outbreak on a cruise ship – Northern Europe, 2000. *MMWR Morb Mortal Wkly Rep* 2001; 50: 137–140.
2. Koopmans M, Harris J, Verhoef L, Depoortere E, Takkinen J, Coulombier D. European investigation into recent norovirus outbreaks on cruise ships: update. *Euro Surveill* 2006; 11: E060706.
3. Ricketts KD, McNaught B, Joseph CA, European Working Group for Legionella Infections. Travel-associated legionnaires' disease in Europe: 2005. *Euro Surveill* 2007; 12.
4. Rowbotham TJ. Legionellosis associated with ships: 1977 to 1997. *Commun Dis Public Health* 1998; 1: 146–151.
5. Rooney RM, Bartram JK, Cramer EH et al. A review of outbreaks of waterborne disease associated with ships: evidence for risk management. *Public Health Rep* 2004; 119: 435–442.
6. Rooney RM, Cramer EH, Mantha S et al. A review of outbreaks of foodborne disease associated with passenger ships: evidence for risk management. *Public Health Rep* 2004; 119: 427–434.
7. WHO. Sustainable Development and Healthy Environments. Sanitation on ships: compendium of outbreaks of foodborne and waterborne disease and Legionnaire's disease associated with ships, 1970–2000.
8. Takkinen J. Recent norovirus outbreaks on river and seagoing cruise ships in Europe. *Euro Surveill* 2006; 11: E060615.
9. European Cruise Council. THE CRUISE INDUSTRY A €34 Billion Partner in Europe's Economic Growth Contribution of Cruise Tourism to the Economies of Europe 2010 Edition 2010.
10. Amerini G. Maritime transport of goods and passengers 1997–2007. *Eurostat Statistics in focus* 2009; 6.
11. European Union. Decision No 2119/98/EC of the European Parliament and of the Council of 24 September 1998 „setting up a network for the epidemiological surveillance and control of communicable diseases in the Community”. *Official Journal of the European Communities* 2003; L184: 35.
12. Update: outbreak of influenza A infection – Alaska and the Yukon Territory, July–August 1998. *MMWR Morb Mortal Wkly Rep* 1998; 47: 685–688.
13. Centres for Diseases Control and Prevention. Preliminary Guidelines for the Prevention and Control of Influenza-Like Illness Among Passengers and Crew Members on Cruise Ships. 1999.
14. Jernigan DB, Hofmann J, Cetron MS et al. Outbreak of Legionnaires' disease among cruise ship passengers exposed to a contaminated whirlpool spa. *Lancet* 1996; 347: 494–499.
15. McLaughlin JB, DePaola A, Bopp CA et al. Outbreak of *Vibrio parahaemolyticus* gastroenteritis associated with Alaskan oysters. *N Engl J Med* 2005; 353: 1463–1470.
16. O'Mahony M, Noah ND, Evans B et al. An outbreak of gastroenteritis on a passenger cruise ship. *J Hyg (Lond)* 1986; 97: 229–236.
17. Verhoef L, Depoortere E, Boxman I et al. Emergence of new norovirus variants on spring cruise ships and prediction of winter epidemics. *Emerg Infect Dis* 2008; 14: 238–243.
18. World Health Assembly. International Health Regulations. 2005.
19. Minooee A, Rickman LS. Infectious diseases on cruise ships. *Clin Infect Dis* 1999; 29: 737–743.