

**International SARS control:  
analysis of European and non-European  
public health policies**

Master Thesis

by

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Hamburg, 2004

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to my parents

*“Let us not flatter ourselves overmuch on account of our human conquest of nature. For each such conquest nature takes its revenge on us. Each of them...has on the first place consequences on which we counted, but in the second and third places it has quite different unforeseen effect which only too often cancel out the first...It is still more difficult in regard to the remote social consequences of these actions.”*

*FRIEDRICH ENGELS*

## **Abbreviations**

<b>CCP</b>	Critical Control Point
<b>CDC</b>	Centers for Disease Control and Prevention
<b>Co-V</b>	Corona Virus
<b>EFTA</b>	European Free Trade Association
<b>EU</b>	European Union
<b>HCW</b>	Health Care Workers
<b>IHR</b>	International Health Regulations
<b>SARS</b>	Severe Acute Respiratory Syndrome
<b>WHO</b>	World Health Organization

**Word count** (index, tables, references, and appendix excluded): 6370

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# 1 Abstract

**Introduction:** Severe acute respiratory syndrome (SARS) is the first new major infectious disease of the 21<sup>st</sup> century following reports of cases of atypical pneumonia in Vietnam, Hong Kong, and China. By July 11 2003 8437 people had been effected by the disease. Within six months, 813 people died. SARS has spread rapidly across international borders resulting in significant morbidity, widespread public alarm, and economic loss. It is critical to assess the likelihood of similar occurrences and their possible impact on public health and economic performance. Therefore, the following study was carried out in order to analyze existing international guidelines and to elucidate policy diversity within 30 European countries. Results of this study should support international efforts to formulate effective strategies to combat against SARS.

**Methods:** Analysis of SARS guidelines was performed utilizing the “Hazard Analysis Critical Control Point” method. Major issues on outbreak management and SARS surveillance were the basis of the analysis. Quantitative evaluation of European SARS policies including analysis of common aspects, differences and synthesis was carried out.

**Results:** HACCP analysis revealed a hierarchically structure of global infectious disease surveillance activities. WHO’s global health activities and guidelines are the basis for national and local health policies. Surveillance activities are wildly interconnected at all levels and successful outbreak management faces a wide variety of demanding challenges and threats. SARS is an occupational disease and implementation of the latest guidelines are crucial for medical staff and patients. Inventory analysis revealed, that most European countries had reacted to the SARS outbreak with distinctive health policies and surveillance activities. However, several differences and pitfalls were recognized. The need for a central infectious disease surveillance authority, harmonization of existing guidelines and strengthening of possible synergies among existing structures in EU was identified.

**Discussion:** The basic strategy that can control SARS outbreaks worldwide are rapid and decisive surveillance and containment. The SARS outbreak has shown, that divisions between local and global health policy are no longer effective. Worldwide efforts are needed to further strengthen existing structures and to harmonized international health policies. Modern information technology will support the conversion from horizontal to vertical germ governance. International mechanisms for outbreak alert and response are needed as a global safety net that protects other countries when one nation’s surveillance and response system fails.

**Keywords:** SARS, public health, international infectious disease surveillance, health policy, germ governance

## 2 Introduction

SARS (severe acute respiratory syndrome) is the first new major infectious disease of the 21<sup>st</sup> century after reported cases of atypical pneumonia in Vietnam, Hong Kong and China. SARS emerged in the southern Chinese province of Guangdong in November 2002, but the worldwide epidemic was triggered in late February 2003 [1] [for review see 2 and 3]. By July 16 2003, 8460 people in 32 countries have been effected by the disease [4].

After the first recognition of SARS, the World Health Organization (WHO) issued a formerly unknown global alert for SARS in March 2003<sup>1</sup> [5]. Immediate worldwide research activities led to the identification of the etiologic agent in less than 2 weeks [6,7].

SARS is a viral infection caused by an apparently new coronavirus designated as “SARS-CoV” [8,9]. Evidence suggests that SARS-CoV emerged from an animal host followed a newly acquired ability to infect humans. Isolated new cases of SARS occurred in Singapore late 2003 [10]. Possible sources for a reintroduction of SARS-CoV include 1. new animal reservoir; 2. undetected transmission in humans; 3. persistent infection in humans; or 4. laboratories. SARS it a special threat to international public health due to the following characteristics: 1. previously unknown coronavirus, 2. no vaccine or treatment available, and 3. poorly understood epidemiology and pathogenesis.

Transmission of SARS-CoV in hospitals was a major factor in the amplification of outbreaks and spread into the community [11,12]. The majority of SARS infections have occurred predominantly among healthcare workers, patients, and hospital visitors; these groups accounted for 18% to 58% of all SARS cases in the five countries with the largest outbreaks. Consequently, the ease of nosocomial transmission posed a major occupational challenge for healthcare institutions [13].

SARS has a pandemic potential as all persons worldwide are susceptible; however, simple infection control measures can dramatically reduce the transmission of SARS-CoV [13]. Currently, early recognition and rapid infection control precautions are the most important strategies for controlling SARS. There are no fast diagnostic tests are currently available,

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<sup>1</sup> factors leading to the global alert:

- unknown causative agent
- outbreak appeared to pose a great risk for health care professionals and family members
- no effective antibiotic or antiviral drug available
- dramatic clinical course of SARS
- worldwide spread due to international travel activities

and clinical features<sup>2</sup> alone cannot with full confidence distinguish SARS from other respiratory illnesses [14]. Consequently, clinicians are routinely asked also to seek epidemiologic<sup>3</sup> clues suggestive of SARS-CoV exposure. When combined with clinical findings, these epidemiologic features provide a possible strategic framework for early recognition of SARS [14].

Over the last year, worldwide efforts have been undertaken to develop strategies against SARS. Intergovernmental and governmental organizations such as WHO, CDC, and EU [15,16,17] have formulated public health preparedness plans, protective guidelines, and responses. Regardless of those guidelines, weaknesses in international collaborations, health infrastructures and policy harmonization were recognized for instance by the European Centre for Disease Prevention and Control [18] and WHO [19].

On March 14 2003, the U.S. Centers for Disease Control and Prevention (CDC) launched an emergency public health response. “*Public Health Guidance for Community-Level Preparedness and Response to Severe Acute Respiratory Syndrome (SARS)*” (as follows: CDC-GL) had outlined a framework to assist public health and healthcare officials in its emergency response to a SARS outbreak [20]. This document is based on the United States Government “*Interagency SARS Concept of Operations Plan (CONPLAN)*”, which outlines the U.S. Federal government’s strategy for a coordinated national response to an outbreak of SARS. CDC-GL include procedures to be conducted both in the presence or absence of SARS-CoV. and tools such as checklists, internet links, questionnaires, telephone hotlines, and etc. for local-level preparedness and response activities are included.

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<sup>2</sup> **initial symptoms**

non-respiratory syndrome lasting 2–7 days characterized by one or more of the following:

- fever
- rigors
- headache
- malaise
- myalgia
- diarrhea

respiratory phase beginning 2–7 days after onset characterized by:

- non-productive cough
- dyspnea
- absence of upper respiratory symptoms

**laboratory findings**

- abnormal or low total leukocyte cell count
- lymphopenia
- depressed platelet count
- elevated lactate dehydrogenase levels
- elevated creatine phosphokinase levels
- elevated transaminase levels
- prolonged activated partial thromboplastin time

**radiographic findings**

- abnormal chest x-ray results in almost all patients by the second week of illness

<sup>3</sup> **key epidemiologic risk factors:** 1. exposure to settings where SARS activity is suspected or documented, or 2. in the absence of such exposure, epidemiologic linkage to other persons with pneumonia (i.e., pneumonia clusters), or 3. exposure to healthcare settings



CDC-GL accounts for two important features of SARS outbreaks: 1. the outbreaks are neither regional nor national but rather confined to limited geographic – and even institutional – settings, and 2. they are dynamic, meaning that the characteristics of an outbreak can change quickly.

In contrast to the 50 federal states of the US, the European Union (EU) is a growing assembly of sovereign countries. The EU now consists of 25 member states with different languages, historical backgrounds, economical power, and individual structural differences. Millions of people are free to cross the borders of European countries each day, which results in major public health challenges. The management of infectious diseases among several independent but closely interconnected countries requires extraordinary efforts and strategies.

Since 1999, the European Commission has managed a “*Communicable Diseases Network*”. This is currently based on ad hoc cooperation between Member States within the legal framework of Council and Parliament (Decision 2119/98/EC). In June 2003, the “*European Commission SANCO Public Health Directorate*” published data on “*Control measures undertaken by member states and accession countries in order to control outbreaks of SARS*” [21]. This report was based on the results of a questionnaire compiled by the European Union expert group on SARS and set up under the “*Network for the Epidemiological Surveillance and Control of Communicable Diseases in the Community*”.

SARS has challenged the world. It has spread rapidly across international borders resulting in significant morbidity, widespread public alarm, and economic loss. Consequently, it is critical to assess the likelihood of similar occurrences and their possible impact on public health and economic performance. Therefore, the following study was carried out in order to analyze the existing international SARS health policies and to identify standards and diversities within the guidelines established by 30 European countries. Results of this study should support international efforts to formulate effective strategies for the combat against SARS.

### 3 Methods

#### 3.1 HACCP analysis

CDC-GL [20] were subject of hazard critical control point analysis (HACCP) [22]. This method allows the facilitation of a methodological inquiry into a complex situation, which may be used as a guide for targeting surveillance and responses to infectious diseases, as well as to map causal pathways/key transmission settings for the infection [23,24,25]. For this analysis, a HACCP model was developed to describe the actions taken in the management of a SARS outbreak emergency.

#### 3.2 Inventory analysis

Inventory analysis was based on results of an EU questionnaire on SARS [21]. SARS policies of the following countries were subject of analysis.

**Table 1. Summary of SARS measures of 30 European countries**

<i><b>EU member states</b></i> <i>n = 15</i>	<i><b>accession countries</b></i> <i>n = 10</i>	<i><b>EFTA</b></i> <i>n = 3</i>	<i><b>candidate countries</b></i> <i>n = 2</i>
Austria (A)	Cyprus (CY)	Iceland (IS)	Bulgaria (BG)
Belgium (B)	Czech Republic (CZ)	Norway (N)	Romania (RO)
Denmark (DK)	Estonia (EST)	Liechtenstein (FL)	
Finland (FIN)	Hungary (HR)		
France (F)	Latvia (LV)		
Germany (D)	Lithuania (LT)		
Greece (GR)	Malta (M)		
Ireland (IRL)	Poland (P)		
Italy (I)	Slovakia (SK)		
Luxembourg (L)	Slovenia (SLO)		
Netherlands (NL)			
Poland (P)			
Spain (E)			
Sweden (S)			
England (GB)			

Data were entered into a newly programmed Access<sup>4</sup>-database and quantitative analysis was performed. In addition, the following key issues relating to infectious disease surveillance and the potential impact on public health was considered:

- To what degree are the individual policies harmonized?
- What are the effects of different SARS policies on other adjoined countries?
- Where are common or individual weaknesses of the individual health proposals?
- Are certain population subgroups at higher risk such as health care workers, international travelers or other defined groups specifically considered?

<sup>4</sup> Microsoft

## 4 Results

The data in the CDC-GL was subject to HACCP analysis. The document is composed of four levels of increasingly detailed information: executive summary, core plan, stand-alone supplements that address the key measures for SARS preparedness and response, and appendices to each supplement<sup>5</sup> that provide guidance and tools for local-level preparedness and response activities.

### 4.1 HACCP analysis

Utilizing CDC-GL, a flow chart of various management steps was prepared. This flow chart forms the first step of the HACCP analysis. All steps of the management processes described, depend on each other and are interconnected to various extents.

#### 4.1.1 *Basic process flow chart: the outbreak management process*

Results of the HACCP analysis are illustrated in figure 1. Primarily, the flow chart is composed of three hierarchical management segments, which start at the global leadership level and conclude into local SARS outbreak management scenarios. Secondly, further information regarding the actual surveillance processes will be described in detail below.

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<sup>5</sup> **CDC stand-alone supplements**

- command and control
- surveillance and information technology
- preparedness and response in healthcare facilities
- community containment measures, including non-hospital isolation and quarantine
- management of international travel-related transmission risk
- laboratory diagnostics
- communication and education
- SARS investigations and epidemiologic research
- infection control

Figure 1. Outbreak management process

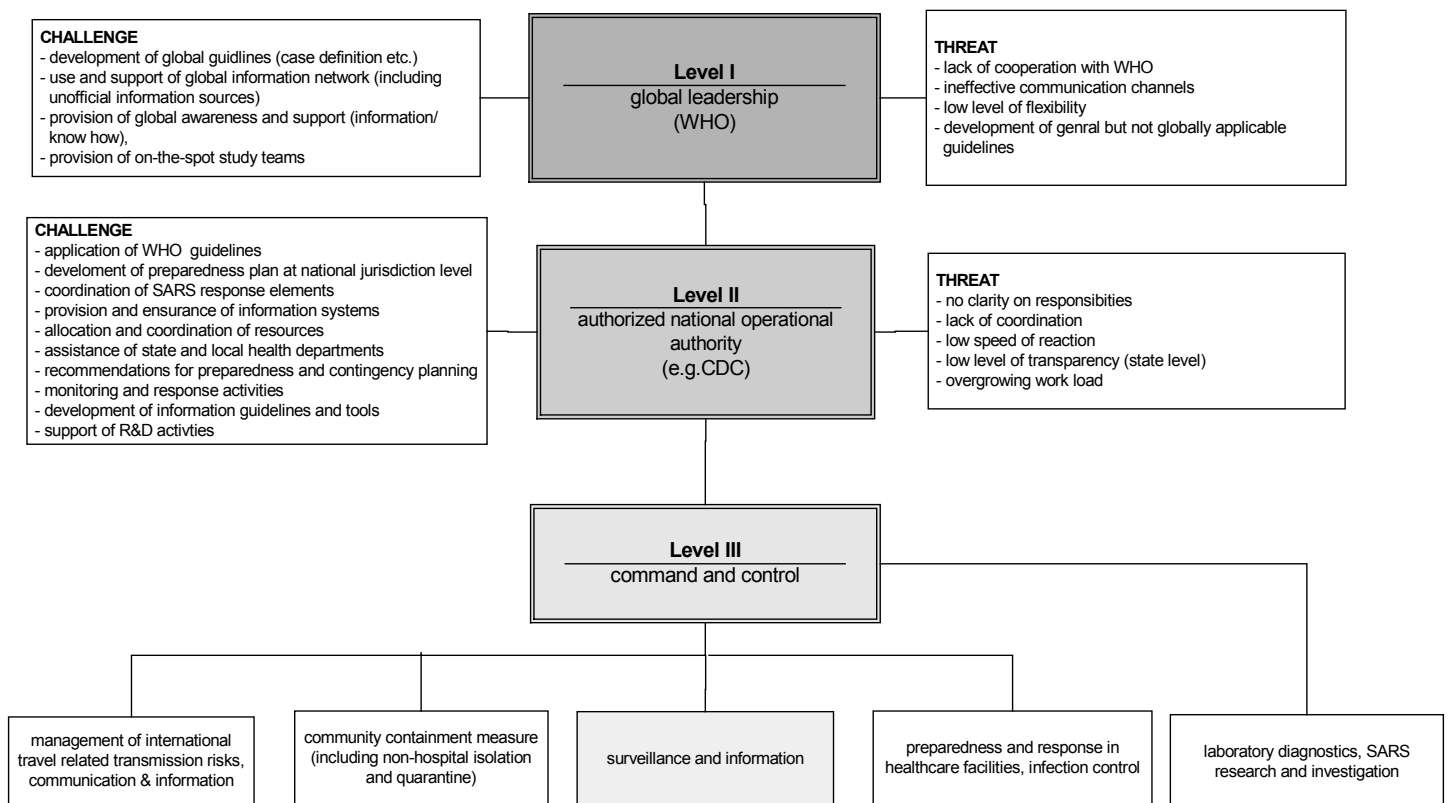


Figure 1: HACCP analysis of the SARS outbreak management process. Different levels of outbreak management are indicated by level I (global leadership), level II (authorized national operational authority), and level III (command and control).

### Level I: global leadership (role of WHO)

When a formerly unknown global alert for SARS was prompted by WHO in March 2003, WHO used the model of its electronically connected “*Influenza Network and the Global Outbreak Alert and Response Network*” to create three “virtual” SARS-dedicated networks of virologists, clinicians, and epidemiologists. WHO coordinated a rapid and intense worldwide response, which led to the identification of the etiologic agent and the implementation of control measures that contained the worldwide outbreak within four months.

SARS is only one of around 50 internationally important outbreaks to which WHO and its partners respond annually. Currently, WHO continues to offer operational support and specialized expertise in countries on request. However, the SARS outbreak provided firm evidence for the need for further improved “*International Health Regulations* “ (IHR) [26]. Such regulations and their operational arm (the Global Outbreak Alert and Response Network) must continue to identify specific areas in which revision and updating of existing guidelines are urgently needed.

Prompt and open reporting of cases is an essential prerequisite for the success of global surveillance activities. In case of a globally fast spreading pathogen, failure to adequately detect, report and manage cases in any country can jeopardize containment efforts worldwide. Therefore, global leadership also includes the provision of on-the-spot research teams can, that can assist and support local governments. Information technology and fast communication channels have played an important role in the fight against SARS. Daily tele-conferences of epidemiologists helped to refine case definitions, confirmed modes of transmission, tracked exported cases, and greatly increased knowledge about which control measures work best in different country settings. Since only few countries of the world have access to high level communication technology (e.g. satellite cellular telephones), global strategic planning to provide on time information to all participating countries was required. Monitoring the evolution of SARS has been hindered by the weak capability of many national surveillance systems to provide detailed daily information. After all, immediate political commitment at the highest level is crucial.

## **Level II: operational authority (role of CDC)**

True health protection comes only through uniformly strong national public health systems that are able to rapidly detect and respond to health threats at their source [27]. CDC operates at a national command and control level, and is responsible for developing and applying disease prevention and control, environmental health, health promotion activities.

CDC-GL on SARS provides a wide range of detailed information, tools, and instructions. Individual differences among federal states are pointed out (e.g. consideration of local jurisdiction). CDC’s frequently updated website is recommended as a daily tool for health care professionals [28]. Centralized national authority such as CDC should coordinate the response of local health departments, allocate and distribute resources, and ensure the on-time dissemination of information. Slow communication or ineffective information channels,

lack of flexibility and unclear organizational structures and responsibilities can jeopardize the success of national SARS surveillance.

CDC's surveillance definition for a suspect case of SARS was based on a definition first published by WHO [29] and later adopted to distinguish between suspected and probable cases [30]. Local health departments reported all respiratory diseases to CDC (note: health departments rely on passive reporting from medical and laboratory staff to health departments). Data collection system was paper-base, however, epidemiologic data were entered at CDC into an electronic database that was merged with laboratory data.

As shown in figure 1, CDC national authorities play a central role in the fight SARS. First the CDC implements global guidelines into national guidelines and action. Secondly, they have to report back to international operating institutions in order to support global surveillance activities.

### **Level III: command and control**

Level III represents activities on the operational level. It includes all types of surveillance activities, education, and information as well as the support of research activities. Effective SARS control requires clearly defined roles and responsibilities as well as operational authorities on state, community, and hospital level. Command structures must be clearly defined and empowered on the basis of jurisdiction. Hospital, community, and national public health authorities must work in concert towards the common goal of containing the spread of SARS. The legislative framework must be evaluated and if necessary supplemented or revised. Allocation of surge capacity and dissemination of consistent information must be organized. In addition to all surveillance activities, basic and public health research activities must be further strengthened. Activities on level III are on one hand widely spread but also highly interconnected. Since SARS surveillance plays the most important role in the management of an outbreak, a second flow chart "*surveillance and information processes*" was prepared.

#### 4.1.2 Surveillance and information flow chart: the local management process

Surveillance, or the monitoring of infections to identify them and their source, is essential to public health efforts. CDC-GL recognizes the dynamics of SARS since SARS outbreaks are neither regional nor national but rather confined to limited geographic, or institutional, settings, and SARS outbreaks are dynamic and the characteristics of an outbreak can change quickly.

The following diagram (figure 2) describes the HACCP of the surveillance and information system on local hospital level. This diagram includes challenges and hazards within the management process.

**Figure 2. Surveillance and information process**

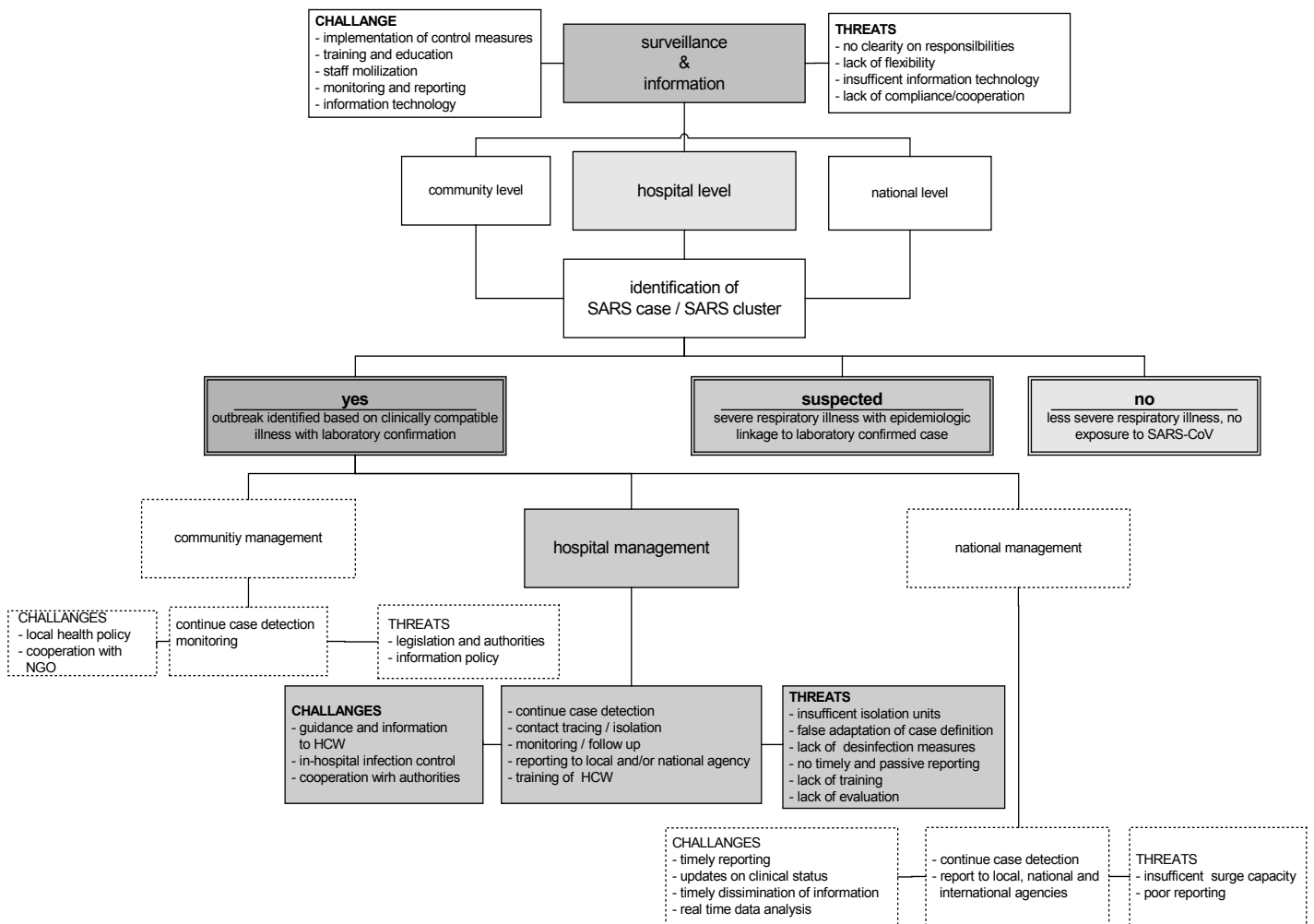


Figure 2: HACCP analysis of the surveillance and information process. Surveillance is performed on national, community, and hospital level. Outbreak management on hospital level was analyzed in detail.

As shown in figure 2, national surveillance includes activities on various levels. The following analysis focuses in particular on hospital management process. Activities on community and national level will be summarized in further detail later:

The primary goal of SARS surveillance is to maximize early detection of new cases of respiratory infections in the hospital and to interrupt the chain of transmission through the implementation of control measures. Once a case has been identified (within the hospital setting), a wide variety of control measures such as contact tracing, isolation and implementation of quarantine, adherence to infection control precautions, monitoring and follow up of dismissed patients, must be implemented. Timely notification of local and/or national authorities and the protection and education of health care staff must be managed as well.

The wide variety of different activities carries a high potential for threats and failures. HACCP analysis revealed the following common critical control points (CCP):

#### **CCP 1: case definition**

Surveillance might fail due to the utilization of outdated case definitions. In consequence, wrong numbers of true cases will be reported (either to few or to many). Over- and under-reporting can have fatal consequences for both possible cases and their surroundings. Healthy people could end up in quarantine or possibly sick people could further spread the virus. Consequently, only the most current version of WHO's case definition should be put into practice.

#### **CCP 2: lack of training and education**

Frequent training and education for health care workers should continue to ensure the reinforcement of basic infection control practices in hospitals and among hospital staff. Proper selection and correct use of personal protective equipment is crucial and should be exercised frequently. Most important, all healthcare settings need to re-emphasize the importance of basic infection control measures, including hand hygiene, for the control of SARS-CoV and other respiratory pathogens.

#### **CCP 3: insufficient isolation units and hygiene measures**

Suspected or confirmed cases must be isolated immediately, utilizing either special isolation units or improvised isolated hospital beds. Hence, special attention must be put on a sufficient hygiene plan which includes its proper implementations as well as supplying personal with the appropriate protective wear. Proper isolation and hygiene measures need money, but are not a matter of money only!



**CCP 4: overgrowing workload**

An outbreak situation is not comparable to daily routine work in a hospital. Existing staff members have to face a growing number of responsibilities. Therefore, all hospital activities should be evaluated based on a cost/benefit analysis determining which actions are crucial and which are of minor significance within the entire management process.

The currently recommended reporting channels were paper based and with only few cases to report, that system was likely to be successful. However, with increasing number of cases to report, the work and paper load will outgrow the existing capacities (e.g. sending hundred of faxes or filling in hundred of paper-based forms) and carry the risk of transmission inaccuracies

**CCP 5: reporting**

As described earlier, timely and complete reporting to national authorities is essential for global SARS surveillance activities. National and international authorities rely on passive reporting. Therefore, HCW and administrators need to be aware of the importance of their reporting routine.

**CCP 6: lack of cooperation**

Cooperation is essential for successful outbreak management. Responsibilities and roles should be clearly defined. Transparent structures could support cooperation activities among different authorities. Frequent training and education of all people involved could support a cooperative attitude.

**CCP 7: link information to action**

All guidelines and activities should be evaluated on a regular basis, that includes the implementation of guidelines as well as their effectiveness. In addition, putting information into action also includes coordinated completion of existing regulations and guidelines.

Activities on community and national level include a wide variety of challenges and threats as described already. In addition to local surveillance activities (e.g. information, reporting, contact tracing), processes on the jurisdictional level and surge capacity revenues must be considered.

## 4.2 Inventory analysis / policy evaluation of European SARS policies

As of May 28 2003, 27 out of 30 countries (15 member states, 9 accession countries, 3 EFTA and 1 candidate country) have answered the questionnaire on SARS health policies. At the time of publication, contribution from Poland was not integrated in the final report. In order to identify necessary international requirements, possible pitfalls and difficulties, quantitative evaluation of the SARS inventory was carried out. Results of the analysis were structured based on the CDC-GL key components.

### 4.2.1 Command and control<sup>6</sup>

Overall, the majority of European countries have implemented control measures in their SARS health policies. Twenty-two countries (81,5 %) have included SARS in their lists of diseases with mandatory notification. Interestingly, five countries with mandatory notification policies have not implemented national guidelines (A, B, HR, IS, RO and SLO). Surprisingly, the identification of coordinated command and control measures played a minor role within the EU questionnaire. Nevertheless, in case of an outbreak in an EU member state, legislation of communicable diseases might be challenged not only for direct neighbor states but for all member states.

**Table 2. Summary of command and control measures**

action	yes	no	missing value
	<b>22</b>	4	4
SARS mandatory notification	A, B, CZ, DK, EST, FIN, F, D, HR, IS, IRL, I, LV, LT, M, N, P, RO, SK, SLO, E, S	GR, L, NL, GB	BG, CY, FL, P
obligation to quarantine	<b>19</b>	5	6
	A, B, CY, CZ, DK, EST, FIN, F, HR, IS, IRL, I, L, M, NL, N, P, SLO, E	LV, LT, RO, S, GB	BG, D, GR, FL, P, SK
presence of explicit national guidelines	<b>18</b>	0	12
	CY, CZ, DK, EST, FIN, F, D, GR, IRL, I, LV, LT, M, N, P, SK, E, S		A, B, BG, HR, IS, FL, L, NL, P, RO, SLO, GB
reports of suspected cases received centrally	<b>14</b>	2	<b>14</b>
	CY, CZ, DK, EST, FIN, D, GR, IRL, I, LV, M, P, E, S	IS, N	A, B, BG, F, HR, FL, LT, L, NL, P, RO, SK, SLO, GB
probable cases confirmed as SARS-CoV case (lab test)	7	7	<b>12</b>
	B, CZ, DK, FIN, IRL, N, S	F, IS, I, LV, LT, M, E	A, BG, D, HR, FL, L, NL, P, RO, SK, SLO, GB

<sup>6</sup> goals: establishment of operational authority, incident management structure, legal authority for response to an outbreak

#### 4.2.2 SARS surveillance<sup>7</sup>

Much effort was spent on classical infectious disease surveillance measures as indicated by the various actions as well as the distribution of responses. Reporting to the commission was implemented by all countries. The majority of countries (n = 26; exception: I) have enhanced their surveillance activities. The following procedures for SARS surveillance were generally implemented:

- routine reporting at central national level of all possible SARS cases
- contact tracing
- timely reporting to the European Commission and WHO
- provision of guidance to health care workers

**Table 3. SARS surveillance measures**

action	yes	no	missing value
enhanced surveillance activities	26 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	1 I	2 BG, FL, P
routine reporting at central level	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P
contact tracing	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P
isolation measures for suspect cases	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P
isolation measures for probable cases	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P
isolation measures for contacts of suspect cases	10 A, B, CZ, DK, IS, IRL, LV, M, NL, RO	13 EST, FIN, F, D, GR, I, LT, L, N, P, SLO, E, GB	6 BG, HR, FL, P, SK, S
isolation measures contacts of probable cases	18 A, B, CY, CZ, DK, FIN, F, D, GR, IS, IRL, LV, LT, L, M, NL, P, RO	5 EST, I, N, SLO, E	7 BG, HR, FL, P, SK, S, GB
reporting to other countries	15 A, B, CY, EST, FIN, F, LV, LT, M, NL, N, RO, E, S, GB	9 CZ, DK, D, GR, HR, IRL, I, P, SLO	6 BG, IS, FL, L, SK, P
reporting to WHO	25 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, L, M, NL, N, P, RO, SLO, E, S, GB	0	5 BG, FL, P, SK
reporting to commission	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P

<sup>7</sup> goals: early detection of cases, implementation of control measures, isolation, reporting, contact tracing

These results confirm the previous findings, that classic surveillance activities played a major role in the fight against SARS. However, the results do not allow for judging the quality of information channels. Gathering and distributing information within the EU network is the first step of infectious disease surveillance. However, resulting public health action was not subject of the questionnaire.

#### **4.2.3 Preparedness and response to healthcare facilities<sup>8</sup>**

Most responding countries have provided guidelines and special information materials to emergency and ambulance teams, laboratory staff, in-hospital infection control committees and medical staff at airports. The guidelines generated by all responding countries focus special attention on health care facilities and health care workers, but few responding countries have asserted the same efforts in the development of triage guidelines (24/27). Sufficient number of triage facilities were reported by 20 out of 27 countries. It becomes obvious, that during an outbreak situation, the demand for staff (health care workers, administrators and etc.) and supplies (isolation units, respirators, offices, fax machine, and etc.) will increase rapidly. Further health care workers must be recruited and flexible hire-policies should be put into action immediately. Then again, qualitative information on the implementation of triage guidelines are missing.

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<sup>8</sup> **goals:** rapid identification and isolation of cases, implementation of infections control measures, rapid communication within the facility

**Table 4. Preparedness and response to healthcare facilities measures**

action	yes	no	missing value
triage guidelines	24 B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, SK, SLO, E, S	0	6 A, BG, FL, P, RO, GB
triage facilities	20 B, CY, CZ, DK, EST, FIN, F, GR, HR, IS, IRL, I, LT, L, M, NL, N, P, E, S	1 SLO	9 BG, D, FL, P, RO, SK, A, LV, GB
guidance to emergency and ambulance teams	25 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, LV, LT, L, M, NL, N, P, RO, SLO, E, S, GB	1 I	4 P, BG, FL, SK
guidance to primary health care and general practitioners	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P
guidance to hospital staff	27 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	3 BG, FL, P
guidance to laboratory staff	25 A, B, CY, CZ, DK, FIN, F, D, GR, HR, IS, IRL, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	1 EST	4 BG, I, FL, P
in-house infection control committees	26 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB	0	4 BG, HR, FL, P
guidance to regional public health authorities	25 A, B, CY, CZ, DK, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, M, NL, N, P, RO, SK, SLO, E, S, GB	1 L	4 BG, EST, FL, P

#### 4.2.4 Community containment measures<sup>9</sup>

European countries put less attention on community containment measures. General actions such as provision of information material and information dissemination by media was provided by most countries.

**Table 5. Community containment measures**

action	yes	no	missing value
general information on SARS	26 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SLO, E, S, GB	0	4 BG, FL, P, SK
information disseminated by telephone hot line	20 A, B, CY, DK, EST, FIN, F, D, GR, IS, IRL, I, L, NL, N, P, SLO, E, S, GB	6 CZ, HR, LV, LT, M, RO	4 BG, FL, P, SK
information disseminated by media	26 A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SLO, E, S, GB	0	4 P, BG, FL, SK

<sup>9</sup> goals: prevention of transmission throughout the community

#### 4.2.5 Management of international travel related transmission risk<sup>10</sup>

Global transportation was one cause for the rapid global spread of SARS. Ironically, the latest SARS outbreak had a major negative financial impact on the travel industry. All countries issued travel advice to the general public based on WHO recommendations. Most countries provided advice to travelers but to varying degrees. Interestingly, rather small and non-transit countries such as CY, LT or RO have implemented personnel and cost intensive health screening procedures at airports. However, no general EU approach was observed.

**Table 6. Management of international travel related transmission risk**

action	yes	no	missing value
	8	17	5
health screening at arrival	CY, HR, I, LV, LT, M, RO, E 25	A, B, CZ, DK, EST, FIN, F, D, GR, IRL, L, NL, N, P, SLO, S, GB 1	BG, IS, FL, P, SK 4
travel advice provided	A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, P, RO, SLO, E, S, GB 19	N 7	BG, FL, P, SK 4
information leaflets to incoming travelers	A, CY, DK, F, D, GR, HR, IS, IRL, I, LV, LT, M, NL, P, RO, SLO, E, GB 10	B, CZ, EST, FIN, L, N, S 13	BG, FL, P, SK 7
information leaflets to departing passengers	A, EST, IRL, I, LV, LT, L, NL, SLO, E 8	B, CY, CZ, DK, F, D, GR, HR, IS, M, N, P, RO 17	BG, FIN, FL, P, SK, S, GB 5
distribution of traceability cards to all passengers coming from affected areas	CY, CZ, F, GR, I, LT, P, E	B, DK, EST, FIN, D, HR, IS, IRL, LV, L, M, NL, N, RO, SLO, S, GB	A, BG, FL, P, SK

#### 4.2.6 Laboratory guidance<sup>11</sup>

Diagnostic procedures should be standardized in order to make results (internationally) comparable. Twenty-three countries have initiated a centralized system for SARS testing, in which reference laboratories are performing PCR for SARS-CoV. Even though most countries have implemented a centralized laboratory testing procedure, only 18 responding countries have applied national protocols for SARS diagnosis.

<sup>10</sup> goals: prevention of cross border spread, reduction of risk for outbound and travelers

<sup>11</sup> goals: provision of high-quality diagnostics

**Table 7. Laboratory guidance measures**

action	yes	no	missing value
	<b>23</b>	3	4
centralized testing	A, B, CZ, DK, FIN, F, GR, HR, IS, IRL, I, LV, LT, L, NL, N, P, RO, SK, SLO, E, S, GB	EST, D, M	BG, CY, FL, P
	10	<b>15</b>	5
serology for SARS-CoV	B, D, GR, I, NL, P, RO, E, S, GB	A, CZ, DK, EST, FIN, F, HR, IS, IRL, LV, LT, L, M, N, SLO	BG, CY, FL, P, SK
	<b>23</b>	3	4
PCR for SARS-CoV	A, B, Czech Republic, DK, FIN, F, D, GR, HR, IS, IRL, I, LT, L, NL, N, P, RO, SK, SLO, E, S, GB	EST, LV, M	BG, CY, FL, P
	<b>18</b>	2	10
national protocols for SARS diagnosis	B, CZ, DK, EST, FIN, F, GR, HR, IS, IRL, M, NL, N, RO, SLO, E, S, GB	D, P	A, BG, CY, I, LV, FL, LT, L, P, SK

#### 4.2.7 Communication and education<sup>12</sup>

Most countries have provided general information material to the public. Information was made available via various channels such as leaflets, telephone hotlines and other media.

**Table 8. Communication and education measures**

action	yes	no	missing value
	7	<b>13</b>	10
actions to counter discrimination	CY, DK, F, HR, L, NL, GB	B, CZ, EST, FIN, D, GR, IS, IRL, LT, M, N, P, RO	A, BG, I, LV, FL, P, SK, E, SLO, S
	<b>27</b>	0	3
guidance how individuals should react to appearance of symptoms	A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, L, M, NL, N, P, RO, SK, SLO, E, S, GB		BG, FL, P

#### 4.2.8 SARS investigations and epidemiologic research<sup>13</sup>

In general, SARS investigation and public health research play a minor role in the measures undertaken to fight SARS. Only a minority of countries have initiated research activities to various extent and on different topics. However, countries such as the NL and GB showed intensive and various research activities. Surprisingly, research on SARS epidemiology was not generally carried out, even though “presence of an epidemiological link” is part of the SARS diagnostic procedure.

<sup>12</sup> **goals:** minimization of fear, provision of accurate information, addressing rumors, inaccuracies, prevention of stigmatization

<sup>13</sup> **goals:** support of worldwide research efforts

**Table 9. SARS investigation and epidemiologic research**

action	yes	no	missing value
	7	13	10
epidemiology	B, F, D, GR, I, NL, GB	CZ, DK, EST, FIN, HR, IS, IRL, LV, LT, M, N, P, SLO	A, BG, CY, FL, L, P, RO, SK, E, S,
health policy	4	16	10
	I, NL, S, GB	B, CZ, DK, EST, FIN, F, GR, HR, IS, IRL, LV, LT, M, N, P, SLO	A, BG, CY, D, FL, L, P, RO, SK, E
diagnostics	9	12	9
	A, B, DK, F, D, GR, I, NL, GB	CZ, EST, FIN, HR, IS, IRL, LV, LT, M, N, P, SLO	BG, CY, FL, L, P, RO, SK, E, S
virology	9	13	8
	A, B, DK, F, D, I, NL, S, GB	CZ, EST, FIN, GR, HR, IS, IRL, LV, LT, M, N, P, SLO	BG, CY, FL, L, P, RO, SK, E
molecular biology	6	14	10
	B, F, I, NL, N, GB	A, CZ, DK, EST, FIN, GR, HR, IS, IRL, LV, LT, M, P, SLO	BG, CY, D, FL, L, P, RO, SK, E, S
risk communication	1	19	10
	I	A, B, CZ, DK, EST, FIN, F, GR, HR, IS, IRL, LV, LT, M, NL, N, P, SLO, GB	BG, CY, D, FL, L, P, RO, SK, E, S

#### 4.2.9 Infection control in healthcare, home, and community settings<sup>14</sup>

Most countries provide medical staff at airports. Special measures at mass gatherings however was only implemented by seven countries.

**Table 10. Infection control measures**

action	yes	no	missing value
special issues for mass gatherings	6	18	6
	F, GR, IRL, M, P, GB	B, CY, CZ, DK, EST, FIN, D, HR, IS, I, LV, LT, L, NL, N, RO, ,SLO, S	A, BG, FL, P, SK, E
medical staff at airports	25	2	3
	A, B, CY, CZ, DK, EST, FIN, F, D, GR, HR, IS, IRL, I, LV, LT, M, NL, N, P, RO, SK, SLO, E, GB	L, S	BG, FL, P
models and exercises	11	9	8
	CY, DK, F, IS, I, LV, M, NL, E, S, GB	A, B, EST, FIN, D, GR, LT, N, P	BG, CZ, HR, IRL, FL, L, P, RO, SK, SLO

European countries have adopted fairly consisted measures for early detection of cases, implementation of isolation measures, guidance to health care professionals, and the public. Guidance to health care professionals was implemented across most countries. Travel advice was given to some extent by several countries. Measures to inform and educate the public, as well as travelers, show a high degree of heterogeneity. The laws of several countries were modified and quarantine was included into the national framework.

<sup>14</sup> **goals:** ensure early recognition of patients at risk, prevention of transmission



Other measures such as anti-discrimination action or research was implemented by few countries in an uncoordinated manner.

Results of the inventory analysis clearly indicate, that SARS health policies in Europe show a high degree of similarities and harmonization (e.g. surveillance activities). However, depending on certain measures undertaken, policies can vary from country to country (e.g. management of travel related risks). A comprehensive and intersectional EU preparedness plan could strengthen the health services at national, European, and international level.

## 5 Discussion

SARS, the first severe infectious disease to emerge in the 21<sup>st</sup> century, has taken advantage of opportunities for rapid international spread made possible by the unprecedented volume and speed of global travel activities. SARS does not respect national boundaries. The epidemic demonstrated that a new airborne infection is able to spread across international borders rapidly, which results in significant morbidity, widespread public alarm and downturns in unaffected countries [31]. The spread of SARS also shows that in a closely interconnected and interdependent world, a new and poorly understood infectious disease can adversely affect economic growth, trade, tourism, as well as public health and social stability [19].

SARS has several features that makes it a special threat to international public health. There is no vaccine or treatment, forcing health authorities to resort to control tools, dating back to the earliest days of empirical microbiology: isolation, infection control and contact tracing. Consequently, the basic strategy that controlled SARS outbreaks worldwide was rapid and decisive surveillance and containment [19].

Herein the outbreak management processes on global (WHO), national (e.g. CDC), and hospital level were evaluated utilizing HACCP analysis. The presented model displays a hierarchically organized structure of three different management levels, which start at the global leadership level (I) and conclude via the national operational level (II) into the level of local outbreak management processes (III). Even though each level represents efforts at a different stage, all levels show a wide variety of common features (e.g. development of guidelines “*from global WHO strategies to local hospital disinfection procedures*”). Each level relies on timely reporting, coordination of existing structures, monitoring and follow up of all activities, as well on further improvement of existing procedures. In addition to major challenges, threats like uncertainty of responsibilities, lack of cooperation, delays in reporting, inaccuracies of information, or low level of flexibility can jeopardize the success of outbreak management on all levels.

WHO is aware of these problems and the “*Intergovernmental Working Group on the Revision of the IHR*” is working on the evaluation of WHO’s health regulations [32]. The rapidity by which SARS has spread globally and the severity of the disease requires a formerly unknown international collaboration and response to SARS. Unfortunately, many WHO member states have experienced difficulties in obtaining information from provinces or cities, which creates an obstacle to rapid communications between national authorities

and WHO [19]. Nevertheless, newly vertical public health activities<sup>15</sup> from countries worldwide have become possible through modern channels of communication [33]. First the first time, WHO did not rely on official information only, but also received unofficial data via cellular phones and the internet from affected countries. It became clear, that modern communication technology (internet, satellite conferences and cellular telephones) is fundamental for real time data transmission coming generated by official and unofficial sources.

During the SARS outbreak, WHO had issued global alerts and specific travel advisories, that caused economic losses in the billions of dollars [27,34]. Yet, in the management of globally spreading diseases, national sovereignty has to step back in favor of successful global disease surveillance. This approach must be further strengthened by national governments and non-governmental organizations [35].

“The considerable medical, scientific, political, and public attention focused on SARS is helping the world to understand the severity of the infectious disease threat, the importance of international solidarity in the face of this threat, and the vital role of prompt and transparent reporting in the interest of protecting the citizens of all countries” [19]. In essence: *national surveillance is the basis for international surveillance* [36].

International surveillance relies on national activities and national public health institutions must mediate between global and local authorities. National authorities, like CDC, have responded to the SARS outbreak with the development of “*Preparedness and Response to SARS*” guidelines. This document provides guidance, strategies, and tools for local public health and healthcare officials. CDC-GL is available on the internet and provides the most current information on SARS. National authorities must be aware of the rapid turnover of the accuracy of the information provided, and all guidelines must be evaluated and updated on a regular basis. National authorities and the WHO face similar challenges and threats for the successful containment of SARS. They both depend on the correct implementation of their guidelines, accuracy of reporting, cooperation and last but not least, linking information into action.

People suffering from SARS were treated and monitored within hospital settings. Unfortunately, SARS became an occupational disease as indicated by the high number of infections among HCW [37]. In China, approximately 20% of cases were in health care workers and early in the outbreak the rate was closer to 90% [38].

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<sup>15</sup> infectious disease seen as threats within states rather than as exogenous threats to state's interests

Consequently, management processes within the hospital setting were further analyzed and critical control points identified. Non-specific disease signs and the lack of updated case definitions led to potential SARS transmission to frontline HCW and the community [39]. The high rate of infections among HCW has been attributed to exposures during respiratory intensive treatments<sup>16</sup> [37]. It became clear, that HCW on duty were under particular high risk. Special precaution measures such as effective hand hygiene, well-fitted facemasks, and frequent glove changes are essential in order to prevent further spread of the pathogen [28]. New infections among hospital staff and others can be prevented by interrupting the chain of transmission within the hospital setting. HCW should receive frequent training in prevention procedures and have the opportunity for easy and individual retrieval of the latest information (e.g. updated CDC-GL).

One of the critical consequences of the high rate of infections among HCW was the reduction of available personnel while the number of other SARS patients was increasing. In such a situation, adequate surge capacity should become available without delay [32]. The re-emergence of isolated SARS in Singapore and Taiwan [40,41] was traced to laboratory workers. However, this further supports the need for special guidelines and their implementation of these guidelines by people working in the health care sector.

As difficult as it is to implement guidelines within a single country, it becomes more complicated to coordinate SARS health policies among several sovereign countries of one continent. The EU now consists of 25 member states with different languages, historical backgrounds, economical power, and individual structural differences. Millions of people are free to cross European borders each day, which results in major challenges to public health. Inventory analysis of EU countries revealed, that even though Europe was not severely effected by SARS, most EU countries developed SARS related health policies. The majority of European countries had implemented control measures<sup>17</sup> and had further enhanced their infectious disease surveillance activities. Procedures such as routine reporting at a national level, contact tracing, timely reporting, and provision to HCW were generally implemented. Surprisingly, all participating countries had reported that special attention was provided to HCW and health care facilities, but some countries did not develop triage guidelines. It became clear, that coordination of efforts and implementation of guidelines must be further evaluated.

International travel activities led to the rapid spread of SARS. Evaluation of EU policies regarding travel-related SARS transmission revealed a wide variety of differences in the handling of international traffic. People of the EU are free to cross national borders every

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<sup>16</sup> e.g. bag-valve-mask ventilation, endotracheal intubation, cardiopulmonary resuscitation.

day without limitations, and therefore a coordinated and harmonized strategy among EU countries is highly recommended.

With SARS, epidemiologic research has helped to link the symptoms to the pathogen and the presence of an epidemiological link is part of the SARS diagnostic procedure [14]. Surprisingly, even though all countries have reported enhanced surveillance activities, only seven out of 30 countries have reported active epidemiological research on SARS.

Less effort was spent on the prevention of rumors and discrimination. Compared to Canada, European countries were less affected by SARS. Asian communities among European countries are rather rare and public education in order to prevent social stigmatization or discrimination might not have been issue for most countries.

Inventory analysis of European health policies was based on data provided by the European Commission [21]. However, the data set has its limitations. The survey was launched 10 weeks after the global WHO alert. On May 13<sup>th</sup>, the questionnaire was sent to 30 national authorities<sup>18</sup>. Ten days later, 27 countries have answered the Commissions request to report on the measures implemented to control the outbreak of SARS. It is obvious, that within that short time, results of the questionnaire are not complete and do not contain any qualitative data on the effectiveness of the implemented measures. However, results of the EU survey give a constructive overview of existing health policies throughout Europe.

As described already, national surveillance and health policies are the basis for internationally successful outbreak management. The EU, as a growing assembly of independent countries will face new challenges. Results of the inventory analysis revealed, that many countries have implemented national infectious diseases surveillance in their health policies. However, it also became evident, that collaboration and, in particular, harmonization must be further strengthened.

Sustained capacity to manage a fast spreading infectious disease, such as SARS, requires, the implementation of an effective health management policy. The EU can be seen as a model, which the individual member states represent different countries of the world. It must be pointed out, that the economical power and cultural differences among EU countries are much smaller than those of the countries worldwide. However, political, economical, and cultural differences must be taken into account when formulating global health policies.

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<sup>17</sup> e.g. presence of explicit guidelines, mandatory notification, obligation to quarantine

<sup>18</sup> 2003

Since 1999, the Commission has managed a “*Communicable Diseases Network*”. In 2000 and 2001, two external evaluations of the Network highlighted weaknesses in the functioning of existing structures and reviewed options for a more effective response capacity at the EU level. In 2002, state epidemiologists gave their view on the future of the surveillance of communicable diseases at the European Union level and favored the creation of an EU-level surveillance center. In addition, in 2002, the Network Committee also adopted conclusions favoring the creation of an EU coordinating center [18]. Despite the conclusion of the EU, the research of MacLehose *et al.* concluded that coordination of existing networks, are valuable but the authors did not envision the need for the development of a centralized European surveillance center [36].

Effective and coordinate response to any outbreak requires clarity on the responsibilities of those involved. In the light of SARS outbreak the need for a “*Communicable Diseases Network*” becomes obvious. The establishment of an “*European Center for Disease Prevention and Control*” could mobilize and significantly reinforce the synergies between existing national agencies for disease control.

Global leadership is a prerequisite for effective national surveillance, and effective national surveillance is the key to worldwide success in the global fight against SARS. Inadequate surveillance and response activities of one country can endanger the public health safety of the entire world [42]. As long as national capacities are weak or governments are not cooperative [43], international mechanisms for outbreak management are needed as a global safety net to protect other countries when one nation’s surveillance fails [42]. Emerging and re-emerging infectious diseases will confront the world with an increased number of “microbial storms” [44,45], but the SARS outbreak has triggered new ways of governance of a global infectious disease. Governance describes how societies structures respond to public health challenges like HIV/AIDS or SARS. In addition, “germ governance” addresses the borderless challenges of old and new emerging infectious diseases [46]. Traditionally, WHO’s IHR provide horizontal “germ governance”<sup>19</sup> and are only limited to report on cholera, plague, and yellow fever only. Former IHR are irrelevant for new emerging infectious diseases and SARS provided firm evidence for the need of further improved IHR [47,32]. After the SARS outbreak it became clear, that international outbreak detection and management will replace the former approach of horizontal to vertical germ governance.

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<sup>19</sup> infectious disease as an exogenous threat to a state’s national interests that could only be mitigated through international cooperation

## What are the lessons learned?

A small communicable disease outbreak in one country can become an international public health threat if national control measures are ineffective such as lack of appropriate coordination structures regionally and internationally. SARS was the first new infectious disease of the 21<sup>st</sup> century, but certainly not the last. In case of re-emergence of SARS (or other fast spreading infectious diseases), the following recommendations should be recognized:

### Figure 3. Summary box

- global leadership and vertical germ governance
- national effective operational authorities
- development of coordinated preparedness plans
- effective local, national, and international surveillance activities
- timely and accurate reporting and sharing information with local, national, and international agencies
- harmonization and further improvement of existing policies
- support of synergies among agencies and institutions
- up to date information worldwide available
- support of research activities

Policy formulation should be based on evidence, but political affairs require evidence AND values. However, values are independent of evidence. Therefore, coming up with just ONE framework might not fulfill the needs of a particular affected country. However, common strategies and recommendations must be developed and implemented to further strengthen collaboration and synergies among existing structures worldwide.

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## 7 Appendix

## **Certificate of Originality**

I hereby certify that the paper I am submitting is fully and completely original to me and that I neither copied, improperly used, nor otherwise violated any rights of any third party in preparing and submitting the paper and that it was not partially or in whole written, revised, or substantially edited by anyone other than me.

Rosengarten, August 2004

## **Acknowledgement**

At this point I like to express my thanks to the following people:

- First, my thesis supervisor Prof. Dr. Ralf Reintjes, University of Applied Sciences (Hamburg), for kindly providing guidance throughout the development of this study.
- Secondly, I thank Prof. Dr. Arja R. Aro, National Public Health Institute (Helsinki), for being my second thesis advisor.
- I would like to thank Rolf and Susanne for their support and friendship throughout the last year.