

Methods and tools for biological risk assessment of naval vessels

Clara Inghels, Catherine da Cunha, Emmanuelle Billon-Denis, Audrey Duclos, Clément Beghin

▶ To cite this version:

Clara Inghels, Catherine da Cunha, Emmanuelle Billon-Denis, Audrey Duclos, Clément Beghin. Methods and tools for biological risk assessment of naval vessels. International conference CBRNE Research & Innovation, Mar 2024, Strasbourg, France. . hal-04529392

HAL Id: hal-04529392 https://hal.science/hal-04529392v1

Submitted on 2 Apr 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Clément BEGHIN - Naval Group, Lorient, France

NAVAL







Thanks to AID for part-funding the research project

Methods and tools for biological risk assessment of naval vessels

(1) Context

The COVID-19 epidemic highlighted the weaknesses of civil and naval vessels to overcome the propagation of infectious diseases on board, which impacts the availability of forces.

The French Aircraft Carrier Charles de Gaulle is an example, where protective measures were implemented to **limit the spread** of the COVID-19 virus.



French Carrier Charles De Gaulle Heading Home **Amid Suspicion Of Covid-19**

The French Navy (Marine Nationale) aircraft carrier and flag ship Charles de Gaulle is heading home early following suspicion of several Covid-19 cases among its crew å Xavier Vavasseur ② 08 Apr 2020

Naval News, 2020 ©

(2) Introduction and objectives

- The spread of pathogens is considered failure by common mode.
- The consequences of such spread of pathogens on board can be considerable like the inability of naval vessels to carry out their missions.
- → It is essential to assess **preventive and** protective solutions that limit the presence and spread of pathogens on board.

Expected results of the thesis

- Model of the propagation of pathogen on board
- Model of crew habits and movement on board
- Simulation tools to assess the level of biological resilience of naval vessels

(3) Method

- Definition of the concept of biological resilience
- Common characteristics of pathogens [1]
- > Categorization of pathogens according to common characteristics and identification of pathogens of interest \rightarrow Risk analysis approach

Risk assessment = Detectability × Probability × Gravity

Detectability Contagiousness

Impact on the capability of the crew

Risk approach analysis

(4) Thesis progress

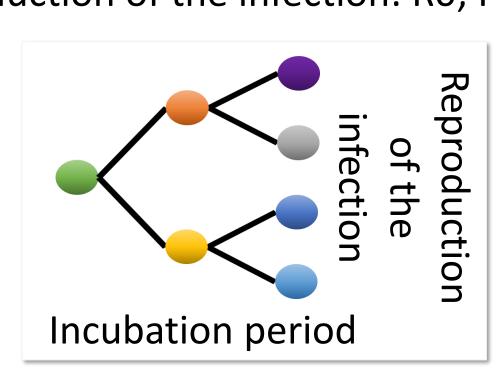
Concept of biological resilience

"The ability to prevent, detect and limit the effects of, and bounce back from, destabilizing events linked to pathogenic threats, with the aim of recovering functions as effectively as possible to a state as close as possible to the state prior to the disturbance."

Common characteristics of pathogens

The definition of solutions requires a sufficient understanding of:

- > Dynamic of the disease:
 - Incubation period Reproduction of the infection: R0; P:PFU; ID50...



- Human-to-human transmission
- > Type of pathogen: (increasing importance from 4 to 1)
 - 1. Viruses
 - Bacteria
 - 3. Fungi
 - 4. Parasites

➤ Mode of transmission:

(increasing importance from 3 to 1)

- Airborne (aerosol)
- Direct contact (droplet)
- 3. Indirect contact (vehicleborne and vector borne)

➤ Mode of propagation:

- By sneezing
- By coughing
- By breathing
- Bodily secretions
- Feces

> Capability impact (virulence)

symptoms of the infectio

Categorization of pathogens of interest

- Propagation and severity indicators
- Evaluation of the mode of transmission of the pathogen, its infectivity, and its impact on the crew health and capability through detectability, likelihood, and gravity criteria according to risk assessment method
- Comparison of our selection to existing lists: OMS, HCSP, ARNT-MIE, bioterrorism...

		Risk assesssment of pathogens											
	Disease	Charac	Symptoms	Dynamic of the d	lisease	Human-to- human	Type of pathogen	Mode of transmission	Symptoms assessment			<u>고</u> .	
t		cteristics		Incubation period	R0; P:PFU; ID50				Contagiousness (propagation and transmission) (C)	Impact on the capability (I)	Symptoms quotation (Q)	Risk assessment	
				Detectability (D)			ability (P)		Probability	Gravity	(–)		
			Symptom_a						•••	•••	Q = f(I,C)	R =	
	Disease_A	•••	Symptom_b	•••	•••	•••	•••	•••	•••	•••	•••	f(D,P,Q)	
			•••						•••	•••	•••		

(5) Roadmap

T0 + 12 months T0 + 24 months T0 + 30 months T0 + 6 months

Criteria for assessment of the propagation of pathogens on board

Definition of simulation parameters and simulation models

Propagation model of pathogens on a naval vessel

Model of crew habits and movement on board

Simulation-based assessment of the biological resilience of a naval vessel

Reference: [1]. R. Ghemraoui, C. Beghin, C. Roger, A. Duclos, B. Roussine, L. Celli, C. Yams, Study for epidemic safety assessment of military vessels, ATMA n°2791, 2023

