

**“Second reported outbreak of pneumococcal pneumonia among shipyard employees in Turku, Finland, August – October 2023: a case-control study”**

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**Supplementary material S2:** Outbreak investigation protocol

**Title: Pneumococcal disease outbreak at a shipyard in Turku, Finland  
August – October 2023**

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## Background

On August 29<sup>th</sup>, 2023 the Finnish Institute for Health and Welfare (THL) was notified of a potential cluster of pneumococcal pneumonia among workers connected to a shipyard in Turku, Western Finland.

As at October 14<sup>th</sup>, 2023, 7 suspected and 7 confirmed cases of pneumococcal pneumonia have been identified. All persons were employees at the Turku shipyard in Finland. There are in total more than 6 000 workers in the shipyard.

The first case was confirmed on August 19<sup>th</sup>, 2023 and the latest case on October 15<sup>th</sup>, 2023. Five of the cases have been confirmed as serotypes 4, two as serotype 9V. The cases represent seven different nationalities: Finland (4), Poland (2), Lithuania (2), Russia (2), Ukraine (2), Romania (1), and Latvia (1).

Pneumococcal disease outbreaks among shipyard workers have been observed previously, notably one outbreak of invasive pneumococcal disease (IPD) was reported in the same shipyard in Finland in 2019 [1]. Similar events have also been observed in France in 2020, Norway in 2019, and in Northern Ireland in 2015 [2–4].

Outbreak control measures have been implemented, including a mass pneumococcal vaccination campaign since September 28<sup>th</sup>. The target groups for vaccination are shipyard workers who are frequently exposed to metal fumes, who work in closed, poorly ventilated conditions and who will participate in a sea trial within a month (N=approximately 3000). As at October 16<sup>th</sup>, approx. 50% of the 3500 workers participating in the sea trial have been vaccinated. Overall, around 3000 shipyard employees have been vaccinated (not all belong to the risk groups).

Because this is the second such outbreak to take place in this shipyard, it was decided to perform an outbreak investigation aimed at identifying risk factors associated with the disease in this specific setting, in order to further inform control measures.

It will also allow to formulate targeted recommendations for prevention of future outbreaks.

## **Proposed methods**

### *Objectives*

- To identify risk factors associated with pneumococcal disease among shipyard workers in order to further assess and inform control measures.
- To formulate recommendations in order to prevent future outbreaks.

### *Population at risk*

The population at risk comprises the employees of Turku shipyard, Finland, excluding full-time office workers.

### *Analytical design*

We will conduct a case-control study as part of the outbreak investigation.

### *Operational definitions:*

A suspected case is an individual who was working in Turku Shipyard and was diagnosed after August 1<sup>st</sup> 2023 AND

- has a clinical presentation consistent pneumococcal pneumonia (supported by radiographic imagery) or IPD

A confirmed case is an individual who fulfils the criteria for a suspected case AND

- *Streptococcus pneumoniae* isolated from a normally sterile site (i.e., blood or cerebrospinal fluid)

- OR
- *Streptococcus pneumoniae* antigen detected in urine

A control is an individual who has worked at Turku Shipyard at least since the 1st of August 2023 AND does not fulfil the criteria of a suspected or confirmed case.

Exclusion criteria: we will exclude individuals who work exclusively in an office setting, and do not work in or around the construction areas of the ships.

#### *Sampling procedure*

Controls will be identified through convenience sampling during a site visit to the shipyard. We will stop recruitment after the desired number of controls (65 persons) have answered the questionnaire or the end of the working day.

All identified cases will be invited for an interview if sufficient contact details (telephone or email) are available.

#### *Sample size*

The sample size will consist of the 14 identified cases, as well as 5 controls per case ( $N = 70$ ). If more cases are identified before control recruitment is concluded, the total number of controls will be increased accordingly.

#### *Data collection*

Data on controls will be collected by the Varha/THL outbreak investigation team during a field visit. The questionnaires will be paper-based and self-administered. To ensure sufficient quality of the questionnaires, members of the outbreak investigation team will be present in the room where the questionnaires are being completed and ensure that all survey questions are answered to the best of the respondent's ability. It is expected that data collection will span over 1 working day. The questionnaire will contain questions on demographics, living conditions, occupation details, working patterns, occupational exposures, use of protective equipment, risk factors for pneumococcal disease, and vaccination. The questionnaire will be offered in 5 languages: Finnish, English, Polish, Russian, Portuguese, and Spanish.

Data on cases will be collected through phone interviews to be conducted by the Varha/THL outbreak team. The interview will follow a very similar questionnaire as for the controls. The main difference will be the referenced exposure period, which will be limited to the time before illness onset. Any supplementary figures/pictures will be shared by link or SMS. If possible, the interviews will be conducted in the preferred

language of the respondent (mainly Finnish, English, Polish, Russian, Portuguese, or Spanish). It is expected that data collection will span over 1-2 working days around the same time as data collection for controls.

#### *Data entry*

Data from questionnaires will be transferred into an electronic database by way of a data entry mask created using Epi Info software. Due to time constraints and limited human resources, double entry is not planned.

#### *Laboratory specimen collection, transport, and analysis*

Clinical isolates from patients undergo phenotypic serotyping (*Quellung* method) and whole genome sequencing at THL. The sequences are serotyped using the PneumoCaT method for confirmation and cluster analysis is done through core genome MLST through Ridom SeqSphere.

#### *Case finding*

Cases are detected by consulting clinicians from TYKS.

#### *Data analysis*

The following analysis will be performed at THL:

- Descriptive analysis of the outbreak by time, place, and person.
- Univariate analysis to calculate the odd ratios (OR), 95% confidence intervals, and *p*-values for exposures of interest.

If possible, multivariable analysis will be performed to evaluate single exposures adjusted by age and sex and to control for possible confounders.

#### *Quality assurance*

Applying the same questions among cases and controls is a way of assuring quality because data would be comparable. The questionnaire will be reviewed by experts from THL, Varha, Turku Shipyard, and FIOH during its development.

#### *Bias and limitations*

There are several limitations and sources of bias:

- Due to a small sample size there is a possibility of underrepresentation of certain groups, as well as random error.

- There is a possibility of recall bias. This is minimized as much as possible by limiting the referenced exposure period.
- As this is a self-administered questionnaire, there is risk of misclassification bias.
- As the controls will be chosen through convenience sampling, there will be sampling bias and results will not be representative of the target population.
- Selection bias due to observer bias (researchers choose who to approach) and language barriers.
- There might be selection bias due to language barriers. We will minimize this by offering questionnaires in 5 languages: Finnish, English, Polish, Russian, Portuguese, and Spanish.

### **Risks and benefits**

No risks were identified for the participants. Identification of any risk factors associated with pneumococcal disease can lead to improved working environment and vaccination guidelines thus controlling such outbreaks and preventing future ones.

### **Confidentiality**

Data from questionnaires will be transferred into an electronic database. The paper forms will be scanned before the original papers will be securely discarded. Data will be kept on a secure THL network drive dedicated to storing sensitive data and data that could lead to the identification of individuals will not be shared.

### **Biological specimen**

Biological specimens are transported to THL for serotyping and WGS. This is part of THL mandate and is done routinely for all invasive *Streptococcus pneumoniae* infections.

### **Informed consent**

During the interviews, the participants will be informed about the purpose of the investigation and information confidentiality before they are asked to answer a questionnaire. Participants will give their consent by answering the questionnaire.

### **Ethical committee clearance**

This work falls within the responsibilities of THL according the Communicable Diseases Act 1227/2016 and ethical committee clearance is therefore not required. The investigation and this protocol have been approved by the Head of Department of Health Security at THL.

## **Timeline**

October - November 2023: protocol, questionnaire

November 2023: Data collection

November – December 2023: Data cleaning, analysis

December 2023: Report writing

## **Expected outputs**

A written outbreak report will be the main output of these investigations. A publication in a scientific journal is possible.

## **References:**

1. Linkevicius M, Cristea V, Siira L, Mäkelä H, Toropainen M, Pitkäpaasi M, et al. Outbreak of invasive pneumococcal disease among shipyard workers, Turku, Finland, May to November 2019. *Eurosurveillance* [Internet]. 2019;24(49). Available from: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2019.24.49.1900681>
2. Cassir N, Pascal L, Ferrieux D, Bruel C, Guervilly C, Rebaudet S, et al. Outbreak of pneumococcal pneumonia among shipyard workers in Marseille, France, January to February 2020. *Eurosurveillance* [Internet]. 2020;25(11). Available from: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.11.2000162>
3. Berild JD, Steens A, Winje BA, Danielsen TE, Fjeldheim JH, Holmemo HDQ, et al. Management and control of an outbreak of vaccine-preventable severe pneumococcal disease at a shipyard in Norway. *J Infect*. 2020;80(5):578–606.
4. Patterson L, Irvine N, Wilson A, Doherty L, Loughrey A, Jessop L. Outbreak of invasive pneumococcal disease at a Belfast shipyard in men exposed to welding fumes, Northern Ireland, April–May 2015: preliminary report. *Eurosurveillance* [Internet]. 2015;20(21). Available from: <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES2015.20.21.21138>

## Appendices

1. Dummy tables
2. Questionnaire for pneumococcal disease outbreak at the Turku Shipyard in Turku, Finland, Aug – Oct 2023 – version for controls (separate file)
3. Questionnaire for pneumococcal disease outbreak at the Turku Shipyard in Turku, Finland, Aug – Oct 2023 – version for cases (separate file)

### Appendix 1: dummy tables

*Table 1. Characteristics of participants.*

| Characteristics | Cases | Controls | p-value |
|-----------------|-------|----------|---------|
|                 |       |          |         |
|                 |       |          |         |

*Table 2. Univariate and multivariable analysis of risk factors associated with pneumococcal disease.*

| Exposure | Cases | Controls | OR (95% CI) | aOR (95% CI) | p-value |
|----------|-------|----------|-------------|--------------|---------|
|          |       |          |             |              |         |
|          |       |          |             |              |         |