

EsteR – A Digital Toolkit for COVID-19 Decision Support in Local Health Authorities

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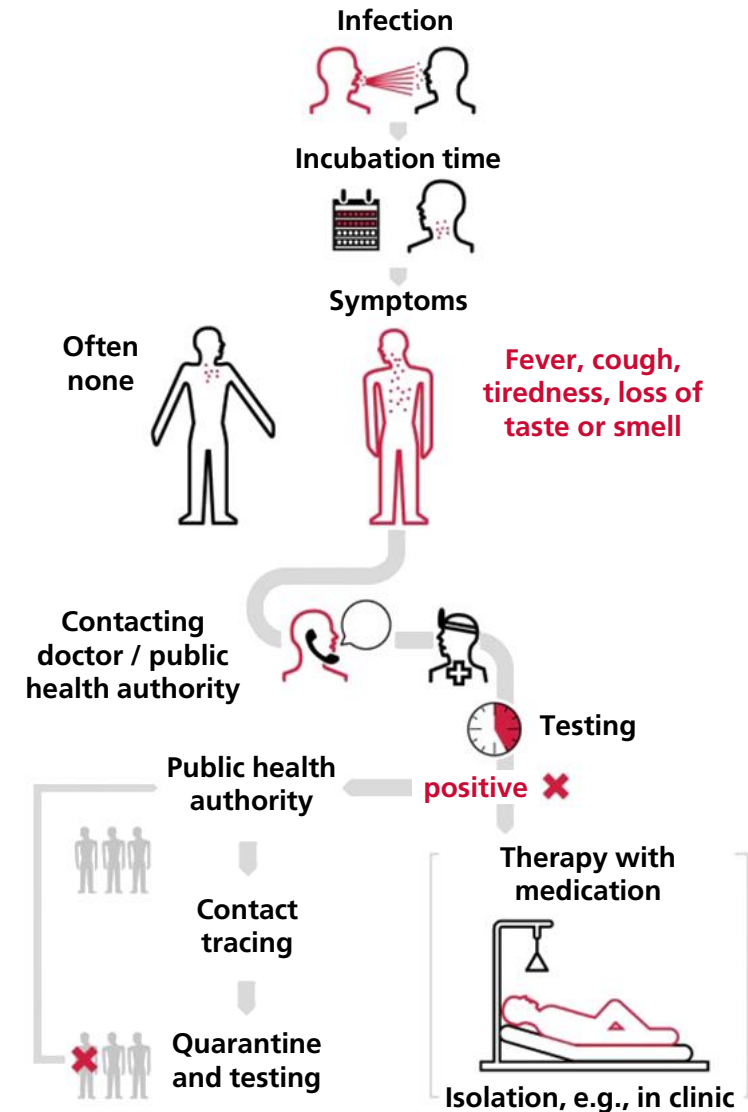
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und Epidemiologie - BIPS

German health offices

- Have to monitor all infected persons and have to report the COVID-19 cases to the Robert-Koch Institute (RKI)
- Have to find all contact persons of COVID-19 and has to decide about quarantines



Adapted & taken from: [dpa-100626](#) Quelle: Robert Koch-Institut, Bundesgesundheitsministerium, dpa

EsteR project

- Goal: Support employees in local health authorities with decision support tools

→ Development of statistical models for certain use cases

→ Providing decision support tools as a open accessible web application

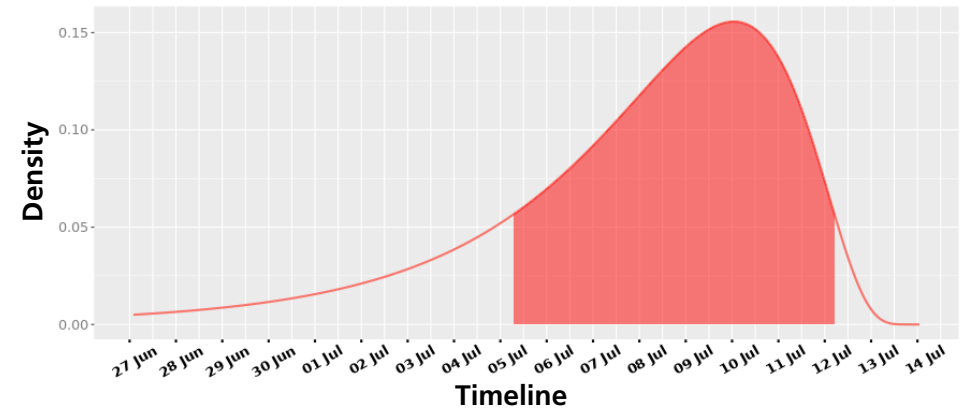
The screenshot shows the 'Covid-19 Entscheidungsunterstützung' web application. It features a dark sidebar with navigation options: 'Übersicht', 'Ansteckungszeitraum', 'Erkrankungszeitraum', 'Ansteckungsfähiger Zeitraum', 'Vorhersage weiterer Erkrankungen', and 'Risikoabschätzung Gruppenquarantäne'. The main content area is titled 'Fragestellungen' and contains five interactive charts: 'Ansteckungszeitraum für Einzelfälle und Gruppen', 'Erkrankungszeitraum für Einzelfälle', 'Ansteckungsfähiger Zeitraum für Einzelfälle', 'Vorhersage von Erkrankungen für Gruppen', and 'Risikoabschätzung Quarantäne für Gruppen'. Below the charts is a section 'Über diese Applikation' with a disclaimer and a list of developers: Fraunhofer ITWM, Fraunhofer MEVIS, and Leibniz BIPS. The footer includes logos for Fraunhofer ITWM, Fraunhofer MEVIS, and BIPS.

Infection period

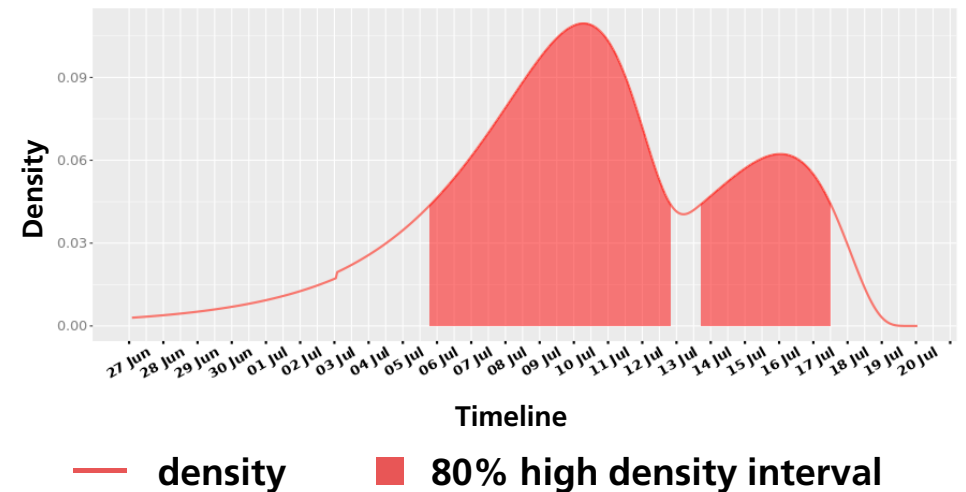
Question: *When did the person(s) become infected?*

- Incubation period of COVID-19 based on symptom onset (Xin et al 2021):
pooled mean: 6.3; pooled median 5.4
- Density for infection p_{inf} :
Log-normal with determined parameters
 $\mu = 1.69$; $\sigma = 0.55$
- For $n > 1$ persons with n_p different symptom onset dates:
Mixture density: $p_{inf}(t) = \sum_{i=1}^{n_p} w_i \cdot p_{inf_i}(t)$, $w_i = \frac{n_i}{n}$

One person with symptom onset on 14th July:



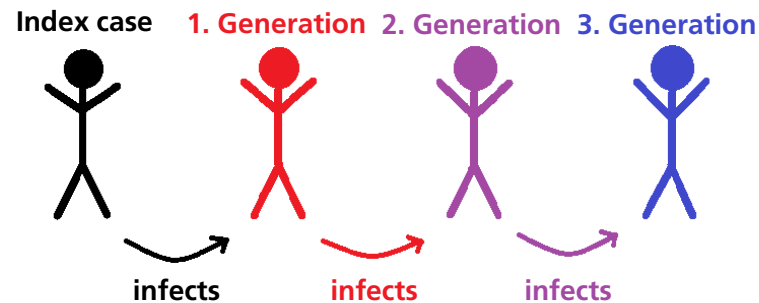
Five persons with symptom onset on 14th July and 20th July:



Illness period

Question: *When will the contacts show first symptoms?*

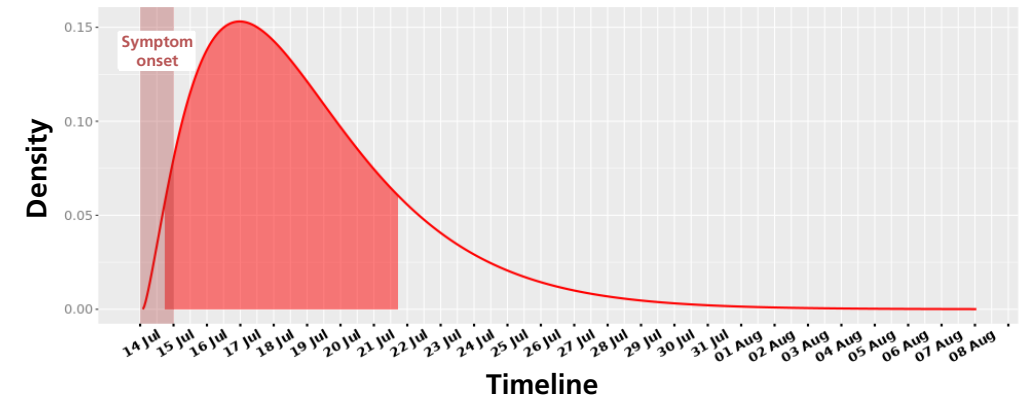
- Serial interval of COVID-19 based on symptom onset (Son et al 2020): gamma distribution p_{ill} with parameters shape: $\alpha = 2.02$; rate: $\beta = 0.37$



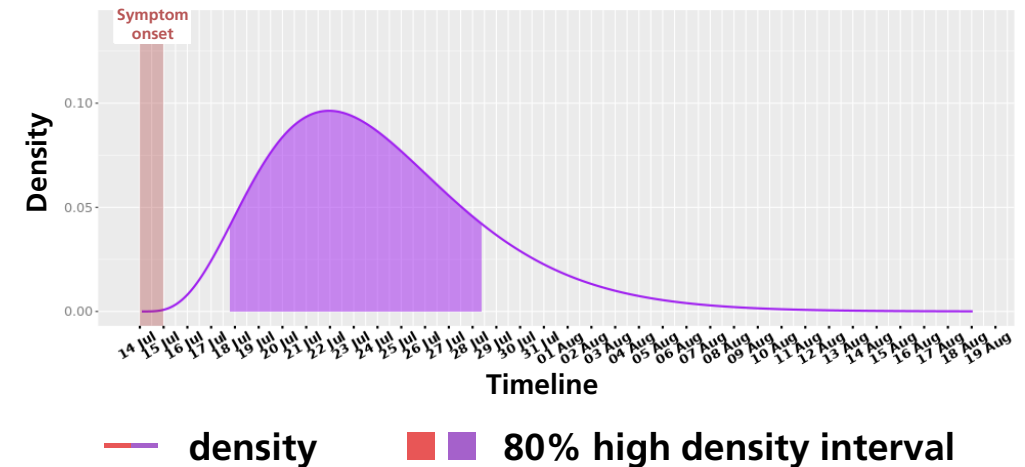
- Second and third generation ($g = 2, 3$) of contacts: Convolution of the density p_{ill} :

$$p_{ill_g}(t) \sim \Gamma(g \cdot \alpha, \beta)$$

First generation of contacts:



Second generation of contacts:

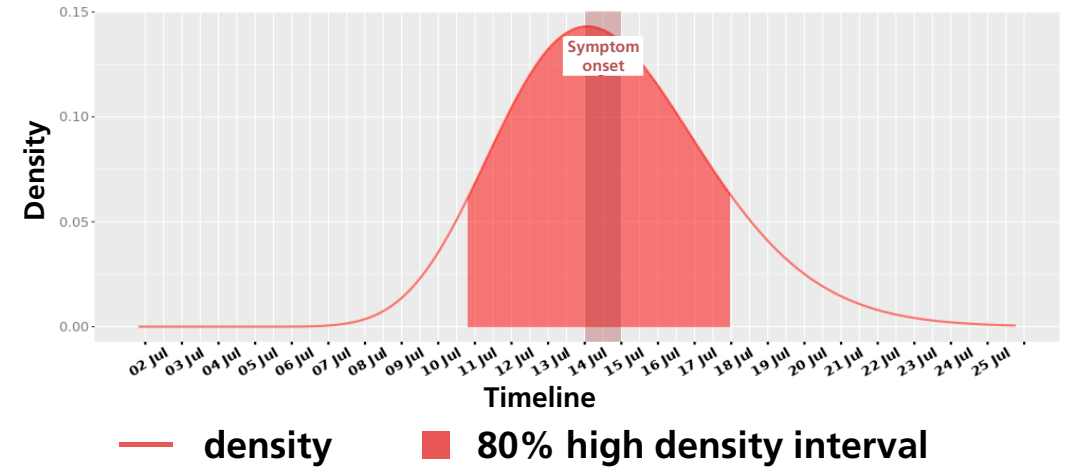


Infectious period

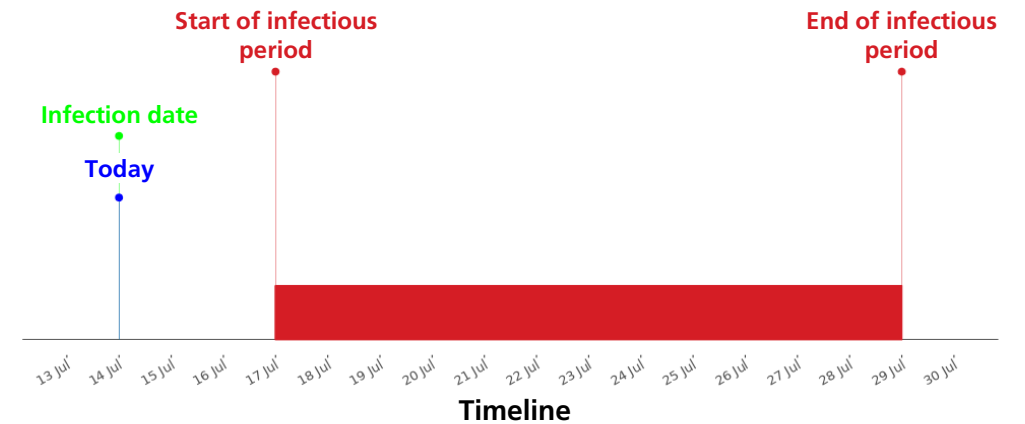
Question: *When was an infected person infectious?*

- Infectious period based on symptom onset (He et al 2020):
gamma distribution with parameters
shape: $\alpha = 20.52$; rate: $\beta = 1.60$
- Without symptoms:
Definition of infectiousness given by RKI (as of 02/2022)
based on test or infection date

Symptom onset on 14th July:



Infection date on 14th July:



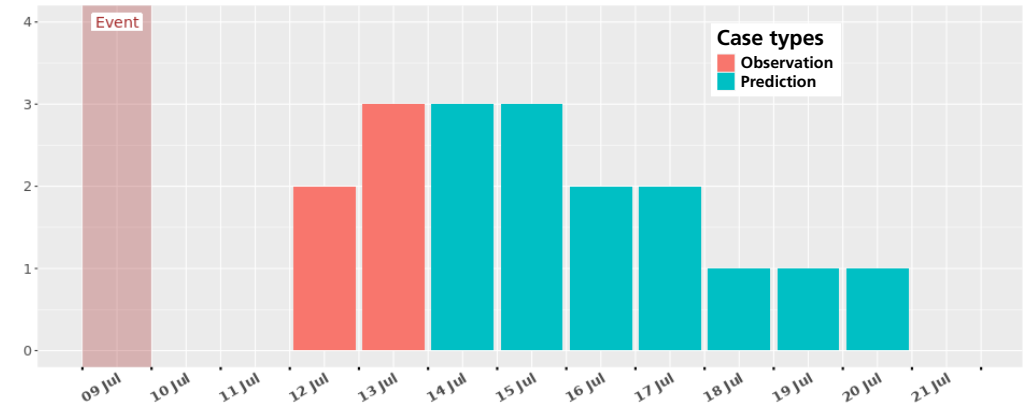
Infection spread

A group has met on a certain date and some of them start to show symptoms

Question: *How many further infected persons are expected in the next days?*

- Estimation of total expected infections based on the already reported infections
- Further expected infections follow the incubation period distribution (same as used for infection period)

Event on 9th July:

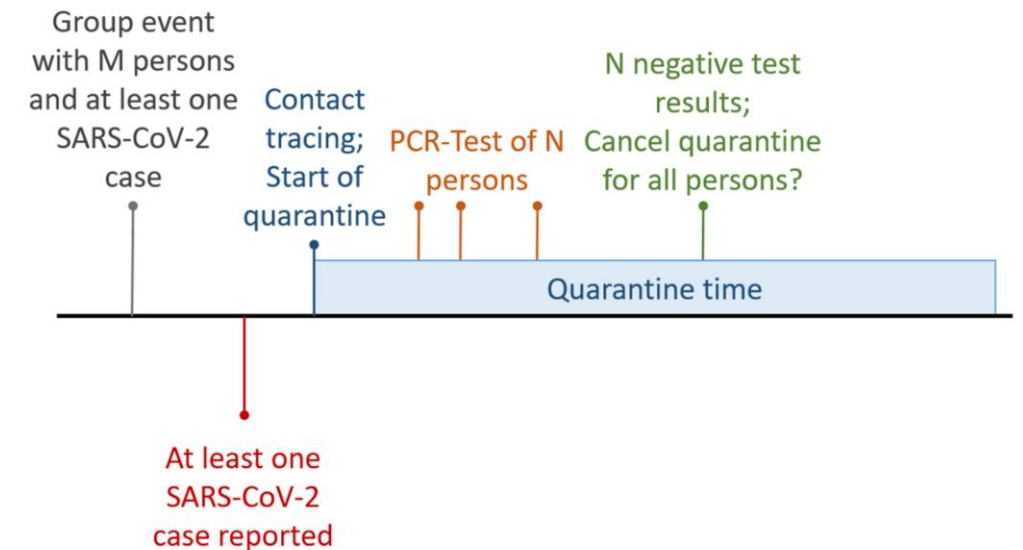


Risk assessment for group quarantine

A group has met on a certain date and one person is infected. Some persons conducted tests, which were all negative.

Question: *How likely is it that no one was infected?*

- Statistical model based on Bayesian statistics
(Jäckle et al 2021)
- Extensions:
Number of infected: one or more
Specific settings: school classes or day care centers
Test types: PCR tests or Antigen tests



R package smidm

- All statistical models were developed in R
- Bundled as R package *statistical modelling for infectious disease management* (smidm).
- Available at Fraunhofer Git repository <https://gitlab.cc-asp.fraunhofer.de/ester/smidm/> and soon on CRAN

The screenshot displays the GitLab interface for the 'smidm' repository. The top navigation bar includes the Fraunhofer logo, a search bar, and a 'Sign in' button. The left sidebar contains navigation links for Project information, Repository, Deployments, Packages & Registries, Monitor, Wiki, and Snippets. The main content area shows the repository name 'smidm' with a star count of 0 and project ID 31507. It indicates 26 commits, 1 branch, 0 tags, 5.6 MB files, and 6.3 MB storage. A commit by Rieke Alpers is highlighted, with a commit hash of a91d7ef9. Below this, there are buttons for README, License (BSD 3-Clause), and CI/CD configuration. A table lists the repository's files and their last commit details.

Name	Last commit	Last update
Meta	Initialization	2 months ago
R	limits for group sizes in calculate_prior_infecti...	2 weeks ago
doc	changed names of dataframes	1 month ago
input	changed negative_person and infected_perso...	1 month ago
man	update parameters for get_serial_interval_de...	2 weeks ago
tests	limits for group sizes in calculate_prior_infecti...	2 weeks ago
vignettes	update parameters for get_serial_interval_de...	2 weeks ago
.Rbuildignore	Update DESCRIPTION and Rbuildignore	3 weeks ago
.gitignore	Initialization	2 months ago
.gitlab-ci.yml	Update .gitlab-ci.yml file	3 weeks ago
DESCRIPTION	Update DESCRIPTION and Rbuildignore	3 weeks ago
LICENSE	Add BSD 3 License	2 months ago
NAMESPACE	Initialization	2 months ago
README.Rmd	fixed license info in README	1 month ago
README.md	fixed license info in README	1 month ago
smidm.Rproj	Initialization	2 months ago

Web application

- Developed with R shiny package
- Accessible at <https://ester.fraunhofer.de/>
- Each use case is structured with
 1. Description
 2. Needed inputs
 3. Result
 4. Visualization
 5. Corresponding literature

- 1. Fragestellung**

Eine Person / Gruppe hat sich mit Corona infiziert. Wann geschah die Infektion mit Corona? Geben sie dazu den Symptombeginn der erkrankten Personen ein.
- 2. Dateneingabe**

Symptombeginn: 14.07.2022
Anzahl an Erkrankten: 1

+
- 3. Antwort**

Die Ansteckung/en fand/en mit hoher Sicherheit (80%) im Zeitraum vom 05.07.2022 bis zum 12.07.2022 statt.

[Details](#)
- 4. Grafische Darstellung**

Expositionszeitraum

Wahrscheinlichkeit

Zeitverlauf
- 5. Wissenschaftliche Grundlagen [Stand 30.06.2022]**

Conclusion

- A toolkit for COVID-19 decision support
 - Statistical models as R package smidm
 - Web application for employees in the local health authorities

- Next steps
 - Update of the used literature
 - Evaluation of statistical models by simulation
 - Usability study of the web application

Contact: Sonja Jäckle, sonja.jaeckle@mevis.fraunhofer.de

The screenshot shows the 'Covid-19 Entscheidungsunterstützung' web application. The interface is divided into a dark sidebar on the left and a main content area on the right. The sidebar contains a navigation menu with the following items: 'Übersicht', 'Ansteckungszeitraum', 'Erkrankungszeitraum', 'Ansteckungsfähiger Zeitraum', 'Vorhersage weiterer Erkrankungen', and 'Risikoabschätzung Gruppenquarantäne'. The main content area is titled 'Covid-19 Entscheidungsunterstützung' and features a 'Fragestellungen' section with five sub-panels: 'Ansteckungszeitraum für Einzelfälle und Gruppen' (a red area chart), 'Erkrankungszeitraum für Einzelfälle' (a purple area chart), 'Ansteckungsfähiger Zeitraum für Einzelfälle' (a red area chart), 'Vorhersage von Erkrankungen für Gruppen' (a red bar chart), and 'Risikoabschätzung Quarantäne für Gruppen' (a bar chart with multiple categories). Below this is an 'Über diese Applikation' section with a disclaimer: 'Diese Webapplikation ist ein Demonstrator zu Forschungszwecken. Die Entwicklung wurde zum Ende der Projektlaufzeit am 30.08.2022 eingestellt. Interne Parameter für die Modellierung der Fragestellungen basieren auf Ergebnissen einer Literaturrecherche, die zuletzt am 03.02.2022 geupdatet wurde. Das Infektionsgeschehen kann sich aber weiterhin ändern. Die Korrektheit der Auswertungen wird daher nicht garantiert!'. It also lists the development and research partners: Fraunhofer ITWM, Fraunhofer MEVIS, and Leibniz-Institut für Präventionsforschung und Epidemiologie BIPS, along with contact information for Dr. Stefanie Grimm.