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High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in healthcare workers: results of the CoV-CONTACT prospective cohort

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Original article

2 Title

3 High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in
4 healthcare workers: results of the CoV-CONTACT prospective cohort

5

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64 **Abstract**

65 **Objective:** We aimed to estimate the risk of infection in Healthcare workers (HCWs) following a high-
66 risk exposure without personal protective equipment (PPE).

67 **Methods:** We conducted a prospective cohort in HCWs who had a high-risk exposure to SARS-CoV-2-
68 infected subject without PPE. Daily symptoms were self-reported for 30 days, nasopharyngeal swabs
69 for SARS-CoV-2 RT-PCR were performed at inclusion and at days 3, 5, 7 and 12, SARS-CoV-2 serology
70 was assessed at inclusion and at day 30. Confirmed infection was defined by positive RT-PCR or
71 seroconversion, and possible infection by one general and one specific symptom for two consecutive
72 days.

73 **Results:** Between February 5th and May 30th, 2020, 154 HCWs were enrolled within 14 days following
74 one high-risk exposure to either a hospital patient (70/154; 46.1%) and/or a colleague (95/154;
75 62.5%). At day 30, 25.0% had a confirmed infection (37/148; 95%CI, 18.4%; 32.9%), and 43.9%
76 (65/148; 95%CI, 35.9%; 52.3%) had a confirmed or possible infection. Factors independently
77 associated with confirmed or possible SARS-CoV-2 infection were being a pharmacist or
78 administrative assistant rather than being from medical staff (adjusted OR (aOR)=3.8,
79 CI95%=1.3;11.2, p=0.01), and exposure to a SARS-CoV-2-infected patient rather than exposure to a
80 SARS-CoV-2-infected colleague (aOR=2.6, CI95%=1.2;5.9, p=0.02). Among the 26 HCWs with a SARS-
81 CoV-2-positive nasopharyngeal swab, 7 (26.9%) had no symptom at the time of the RT-PCR positivity.

82 **Conclusions:** The proportion of HCWs with confirmed or possible SARS-CoV-2 infection was high.
83 There were less occurrences of high-risk exposure with patients than with colleagues, but those were
84 associated with an increased risk of infection.

85

86 **Main text**

87 **Introduction**

88 Since December 2019, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which causes
89 COVID-19, rapidly spread around the globe [1, 2]. The difficulty to control its rapid propagation is
90 related to many factors, including the fact that infectiousness can precede the symptoms onset,
91 thereby complicating the identification and isolation of infected individuals before they can transmit
92 the virus [3, 4].

93 Healthcare workers (HCWs) can be infected following a contact with a patient, but also after
94 interactions with colleagues, or in the community [5-12]. The use of personal protective equipment
95 (PPE) was rapidly implemented in departments hosting suspected or identified SARS-CoV-2-infected
96 subjects. However, the atypical presentation of the infection favors high risk contacts between HCW
97 and unidentified patients in other departments [3], and the large circulation of the virus increases
98 the risk of infection during interactions with colleagues, during which the use of PPE or social
99 distancing may be less strictly followed [13].

100 We conducted a prospective cohort study to estimate the risk of infection in HCWs following high-
101 risk exposure in the hospital, and to evaluate the virological, immunological and clinical outcomes
102 following exposure.

103

104 **Methods**

105 ***Study design and participants***

106 The CoV-CONTACT study is an ongoing prospective multicenter cohort study including HCWs with
107 exposure to an “index” SARS-CoV-2-infected person (either a patient or a colleague) whose infection
108 was virologically proven by a nasopharyngeal RT-PCR and whose exposure was considered at high-
109 risk of SARS-CoV-2 transmission. HCWs were included in the study in the 14 days following the last
110 identified high-risk exposure. The present analysis focuses on “contact” subjects enrolled at the

111 >1000 bed Bichat Claude Bernard University Hospital (Paris, France) [14] between March, 3rd 2020
112 and April, 27th 2020.

113 ***Ethics and regulatory issues***

114 The study was approved by the French National Data Protection Commission (approval #920102),
115 and the French Ethics committee (CPP-Ile-de-France-6, #2020-A00280-39) and was registered on the
116 Clinicaltrial.gov registry (NCT04259892). All subjects provided written informed consent.

117 ***Definition of high-risk exposure***

118 Exposure was considered to be at high-risk of SARS-CoV-2 transmission if it occurred i) face-to-face,
119 within one meter and without protective surgical or FFP2/N95 mask, and ii) during a discussion or
120 while the index had an episode of coughing or sneezing, and iii) in the 72 hours prior to, or following
121 the virological diagnosis, or during the symptomatic period of the index.

122 ***Data collection***

123 Collected characteristics of the index included age, date of the diagnostic nasopharyngeal RT-PCR
124 and the SARS-CoV-2 viral load [15].

125 The collected characteristics of the contacts included medical history, weight, height, current
126 medications, and smoking status. The date of the last high-risk exposure, D0, with the index were
127 also recorded, as well as the cumulative exposure duration.

128 Contacts were followed up for 30 days following D0. Nasopharyngeal swabs were performed at
129 inclusion, and then at D3, D5, D7 and D12. As inclusion could occur up to 14 days after D0, a
130 maximum of five nasopharyngeal swabs could be collected. Blood samples were drawn at inclusion
131 and D30±7d for SARS-CoV-2 serology.

132 A set of general symptoms (fever >38°C, fatigue, myalgia, headache) and specific symptoms (cough,
133 breathing difficulties, sore throat, nasal congestion, anosmia, diarrhea) was recorded daily from D0
134 to D30 using self-administered questionnaires. Results of any additional nasopharyngeal swab were

135 collected, as well as the occurrence of hospitalization, or the existence of household contacts
136 hospitalized for a SARS-CoV-2 infection between D0 and D30.

137 ***Virology***

138 The SARS-CoV-2 RT-PCR was performed blinded to contact characteristics and reported symptoms
139 (see Supplementary appendix).

140 In contacts with clinical signs suggestive of COVID-19 but a negative SARS-CoV-2 RT-PCR and a
141 negative SARS-CoV-2 serology at D30, a multiplex RT-PCR (QIAstat-Dx Respiratory Panel; Qiagen,
142 Germany) was retrospectively performed on available aliquots to detect other respiratory pathogens
143 (see Supplementary appendix).

144 ***Serology***

145 SARS-CoV-2 serology was performed blinded to contacts' characteristics and reported symptoms. We
146 used two methods targeting different SARS-CoV-2 antigens: LuLISA N, an in-house Luciferase-Linked
147 Immunosorbent assay designed to detect IgG targeted toward SARS-CoV-2 N antigen (unpublished
148 results) and EuroIMMUN, a commercial immunoassay used for the detection of IgG targeted toward
149 the SARS-CoV-2 recombinant Spike protein subunit (S1) [16]. A serum was considered as positive for
150 SARS-CoV-2 antibodies when the signal exceeded the threshold set at 13,402 relative light units per
151 second (RLU/s) for LuLISA or a 1.1 ratio for EuroIMMUN.

152 For each method, we defined SARS-CoV-2 seroconversion as the apparition of a positive SARS-CoV-2
153 serology at the D30 visit, or as an at least two-fold increase of the LuLISA signal or EuroIMMUN ratio
154 between inclusion and D30, in the case of a positive serology at inclusion.

155 ***Definition of SARS-CoV-2 infection***

156 Three definitions of SARS-CoV-2 infection were used: (i) "clinically-suspected infection", when the
157 contact reported at least one general symptom and one specific symptom during two consecutive
158 days during the 30-day follow-up; (ii) "virologically-proven infection", if the contact had at least one

159 SARS-CoV-2-positive nasopharyngeal swab during the 30-day follow-up; (iii) “immunologically-proven
160 infection” if the contact exhibited a SARS-CoV-2 seroconversion in any of the two methods.

161 SARS-CoV-2 infection was considered as confirmed if it was virologically or immunologically-proven,
162 and considered as possible in case of clinically-suspected infection only.

163 The primary endpoint was confirmed or possible SARS-CoV-2 infection, thereafter referred to as
164 SARS-CoV-2 infection.

165 ***Statistical methods***

166 Categorical variables are expressed as counts (percentage) and continuous variables are expressed as
167 median (IQR). We first estimated the prevalence of SARS-CoV-2 infection among HCWs, with its 95%
168 confidence intervals computed using the binomial distribution. For the primary endpoint, in case of
169 missing data for one of the components, the subject was considered as infected if one of the
170 available components of the endpoint fulfilled the definition of infection, and considered missing
171 otherwise.

172 We searched for risk factors associated with SARS-CoV-2 infection among HCWs. Variables achieving
173 a p-value <0.20 in univariate logistic regression analysis were entered into a multivariate logistic
174 regression analysis. Using a backward selection method, we obtained a final model in which all risk
175 factors had a p-value <0.05.. A sensitivity analysis was performed after exclusion of the
176 subpopulation who only met the definition of a possible SARS-CoV-2 infection.

177 We then studied the kinetics of the SARS-CoV-2 infection in participants with virologically-proven and
178 clinically-suspected infection. We analyzed the SARS-CoV-2 viral load as a function of time from
179 symptom onset using a quadratic regression model..

180 Analyses were performed with R v3.5 (R Foundation for Statistical Computing, Vienna, Austria). All
181 tests were two-sided with a type-I error fixed to 0.05.

182

183

184 **Results**

185 ***Contacts characteristics and type of exposure***

186 Overall, 154 HCWs exposed to 44 COVID-19 index subjects were included. The median age of these
187 contacts was 35 years (IQR 29.0; 46.8), 35/154 were male (22.7 %). High-risk exposure occurred prior
188 to the widespread use of masks in the hospital (on March, 18th) in 88/154 contacts (57%). In contrast,
189 the exposure to colleagues increased from 31.8% (28/88) before March, 18th to 88.2% (60/68) after
190 March, 18th (2 contacts with combined exposures). Overall 28/154 contacts (18.2%) had a high-risk
191 exposure with more than one index subject.

192 The median duration of the high-risk exposure period was two days (IQR 0; 3.8), and contacts were
193 enrolled at a median time of 6.5 days (IQR 4; 8) after D0. Table 1 presents the characteristics of the
194 included contacts; 51/154 (33.1%) were medical doctors, midwives, or residents; 77/154 (50.0%)
195 were nurses, nursing assistant, physiotherapists or hospital students.

196 Contacts were exposed to patients (70/152, 46.1%) or colleagues (95/152, 62.5 %) of whom 13/152
197 (8.6%) were exposed to both patients and colleagues.

198 While the exposure to patients represented 68.2% (60/88) of high-risk exposure before March 18th,
199 this number dropped to only 11.8% (8/68) after March 18th. Most contacts had a cumulated exposure
200 of more than 30 minutes (102/151, 67.5%). In the 95 contacts exposed to an index colleague,
201 exposure was related to face-to-face discussion (89/95, 93.7%), meetings (26/95, 27.4%), lunch
202 sharing (20/95, 21.1%), and other (10/95, 10.5%).

203 ***Virological, immunological and clinical outcomes***

204 Overall, 26/154 contact subjects (16.9%, 95%CI [11.3%;23.8%]) had at least one SARS-CoV-2-positive
205 nasopharyngeal swab (see details in supplementary appendix). When positive, the median
206 nasopharyngeal SARS-CoV-2 viral load was 8.7 log₁₀ copies/ml (IQR 6.5; 9.4).

207 Overall, 147 of the 154 contacts had both inclusion and D30 sera samples. At inclusion, 15/147 (10%)
208 contacts had a positive serology by one of the two methods. At D30, 31/147 (21.1%, 95%CI [14.8%;
209 28.6%]) contacts exhibited a seroconversion. Results obtained by the two serological methods are
210 presented in Table S1.

211 Based on self-administered questionnaires, 61/151 (40.4%, 95%CI [32.5%; 48.7%]) contacts met the
212 definition of a clinical infection (see details in supplementary appendix). The median duration of
213 symptoms was 5.5 days (IQR 3; 9.2).

214 The Figure 1 presents the combination of virological, immunological and clinical outcomes; 28
215 contacts fulfilled only the clinical definition of infection. In these subjects, the prevalence of
216 symptoms dropped at day 10, whereas it persisted elevated until day 30 in those with confirmed
217 infection (Figure 2).

218 ***Proportion of contacts with SARS-CoV-2 infection***

219 At D30, among the 148 contacts with available data, 65 met the criteria of confirmed or possible
220 SARS-CoV-2 infection (43.9%, 95%CI [35.9%; 52.3%]), confirmed in 37 (25.0%, 95%CI [18.4%; 32.9%]),
221 and possible (*i.e.*, only clinically-suspected) in 28 (18.9%, 95%CI [13.2%; 26.5%]). Figure S1 presents
222 the different clusters of exposure from the 44 index subjects. Among the 28 contacts with possible
223 SARS-CoV-2 infection, multiplex RT-PCR for other respiratory viruses could be performed in 21 and
224 was negative for 19 patients and positive for two (one bocavirus and one rhinovirus). During follow-
225 up, one contact with confirmed SARS-CoV-2 infection was hospitalized. There was no hospitalization
226 for SARS-CoV-2 infection reported in their household contacts.

227 ***Factors associated with SARS-CoV-2 infection***

228 In the multivariable analysis, the variables associated with SARS-CoV-2 infection were being a
229 pharmacist or administrative assistant (OR=3.8, CI95%=1.3; 11.2, p=0.01) and having a contact with a
230 SARS-CoV-2-infected patient (OR=2.6, CI95%=1.23; 5.9, p=0.02).

231 The results of the sensitivity analysis excluding contacts having only a possible SARS-CoV-2 infection
232 provided similar results except for pharmacist or administrative assistants' function (Table S2).

233 ***Viral dynamics in infected contacts***

234 The viral load as a function of time since symptom onset reached a maximum at 8.8 log₁₀ copies/ml 4
235 days after symptom onset followed by a decline afterwards (Figure 3). Of note, 7/25 subjects had a
236 positive SARS-CoV-2 nasopharyngeal swab before the symptoms onset and the first positive
237 nasopharyngeal swab was observed as early as six days before symptoms onset. In eight subjects, the
238 positive swab was preceded by one negative swab and in two of them, the negative swab was done
239 after the symptom onset.

240

241

242 **Discussion**

243 In this prospective cohort of high-risk exposed HCWs, between 25% and 44% of subjects acquired
244 SARS-CoV-2 infection at day 30, depending on the definition used to assess infection. Viral shedding
245 occurred before symptoms onset in 27% of the SARS-CoV-2-positive subjects. The majority of HCWs
246 were exposed to a SARS-CoV-2-infected colleague (62.5%), and a substantial proportion had a high-
247 risk contact with a patient (46.1%). Exposure with a SARS-CoV-2-infected patient was significantly
248 associated with SARS-CoV-2 infection ($p=0.023$).

249 The HCWs included in our analysis reflected the diversity of the hospital workers, [17] offering an
250 ideal perspective to analyze the risks of infections encountered in a hospital. Following universal
251 masking for HCWs on March, 18th in our hospital, high-risk exposure to SARS-CoV-2-positive patients
252 dropped from 68.2% to 11.8%, and high-risk exposure to SARS-CoV-2-positive colleagues became
253 predominant, increasing from 31.8% to 88.2% and making colleagues-to-colleagues transmission a
254 potentially major route of infection [7]. The profession of the contact subject was associated with
255 infection, but we did not find any association with the type of activities of the HCWs. Although it is

256 likely that activities involving a close contact with patients favor infection, such association might
257 have been masked as HCWs could also be infected by colleagues.

258 One of the strengths of our study is its prospective design, with daily self-questionnaire to
259 characterize symptoms onset and evolution, as well as repeated nasopharyngeal swabs to capture
260 the time of infection after exposure, and serological assessments at inclusion and at day 30. The 10%
261 seropositivity of HCWs at inclusion corresponds to the seroprevalence reported in the Paris area in
262 the general population during this period, [18] and it is plausible that these subjects had been
263 infected prior to the high-risk exposure identified in the study. Seroconversion was observed in about
264 a third of exposed HCWs classified as infected, while their nasopharyngeal swabs were negative;
265 most of these HCWs were symptomatic. Inversely a quarter of the HCWs with a SARS-CoV-2-positive
266 nasopharyngeal swabs had no detectable antibodies at day 30, despite the use of two serological
267 techniques. The prospective nature of our analysis allowed us to characterize the time to viral
268 positivity in the 26 subjects with SARS-CoV-2-positive nasopharyngeal swabs and the relationship
269 between the viral load and the time since symptom onset. Nasopharyngeal viral load could be
270 positive before symptom onset, with the first positive viral load obtained as early as six days before
271 symptom onset, consistent with the estimated 6-day incubation period previously reported [19, 20].

272 In addition to these confirmed infections, we also considered possible infections, as defined by the
273 presence of one general and one specific symptoms for two consecutive days in subjects with neither
274 a positive PCR nor seroconversion. Our definition is stricter than what was done in other studies [17,
275 21-23]. Interestingly we found that the kinetics of symptom onset was very similar in confirmed and
276 possibly infected subjects, with 20-35% of subjects presenting symptom between day 4 and day 15
277 after their last high-risk exposure. The possibly infected patients had a lower prevalence of
278 symptoms as time went by, with a rapid reduction of prevalence around day 15, while subjects with
279 confirmed infection had a prevalence of symptoms that remained larger than 20% until day 30. The
280 faster clearance of symptoms in possible infections suggests that these patients had a milder disease,
281 which would be consistent with the fact that their nasopharyngeal swabs remained negative and that

282 they did not exhibit detectable antibodies. Future analyses, that will include the probabilistic analysis
283 of their serial negative nasopharyngeal swab results, as well as the study of the immune cellular
284 response, will provide more conclusive evidence on their infection status [24].

285 A major limitation of our study is the absence of whole genome sequencing comparing the virus of
286 the index subject and SARS-CoV-2-infected HCW. Therefore, the network of exposures and infection
287 only suggests that the infection in a subject is the consequence of a high-risk exposure. However,
288 sequencing would be restricted to RT-PCR positive subjects, which only represent 40% (26/65) of our
289 population of confirmed and possible infections. Another limitation was that the type of contacts
290 observed in the study has been modified by universal masking implemented on March, 18th, 2020.
291 After this date, most at risk contacts were between two HCWs, which were less likely, but not
292 unlikely, to result in SARS-CoV-2 transmission.

293 All together, the rate of transmission observed in HCWs after high-risk exposure, which could be as
294 large as 44%, and close to a recent report [25], strengthens the conclusion that universal masking of
295 HCW, both during contacts with patients and colleagues, and at all times, is essential to prevent
296 HCWs infection and maintain hospital capacities during outbreaks [26].

297 **Contributors**

298 ST, CB, XD, YY, JCL, JB, PB and BL designed the experiments. ST, MT, LA, AL and XD included subjects.
299 NH, CC, DD, SvW and BL performed the biological analyses. ST, CB, PM, FB, JG and XD analyzed the
300 data. ST, CB, PM, FB, JG CC, DD, SvW, BL and XD interpreted the results. ST, CB, FB, and XD wrote the
301 Article. All authors reviewed and approved the manuscript before submission.

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308

309 **Declaration of interests**

310 The authors have no commercial or other associations that might pose a conflict of interest.

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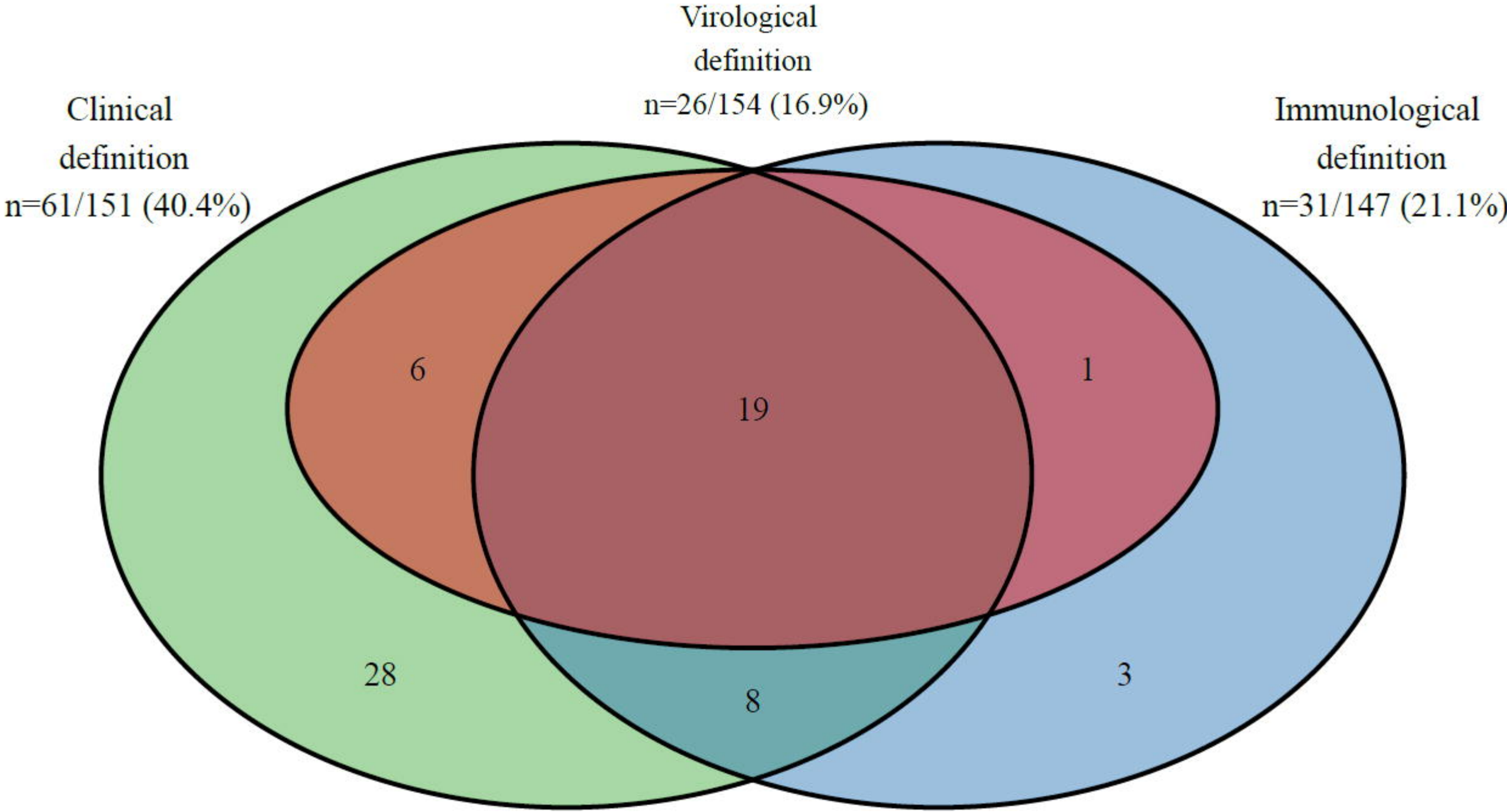
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354 **ClinicalTrial. Gov identification number:** NCT04259892
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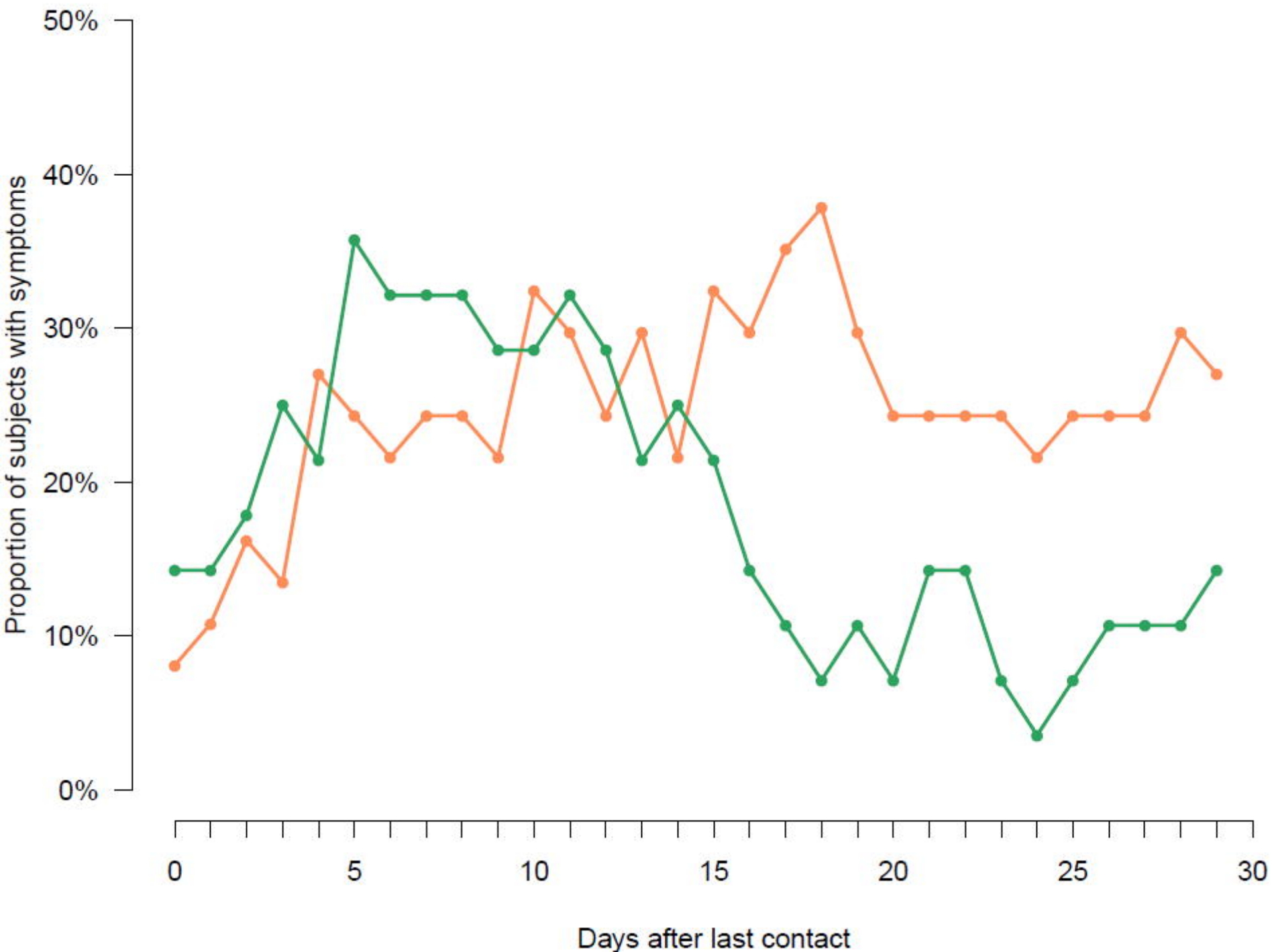
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TOTAL INFECTED: N=65/148 (44%)



Viral load (\log_{10} copies / mL)

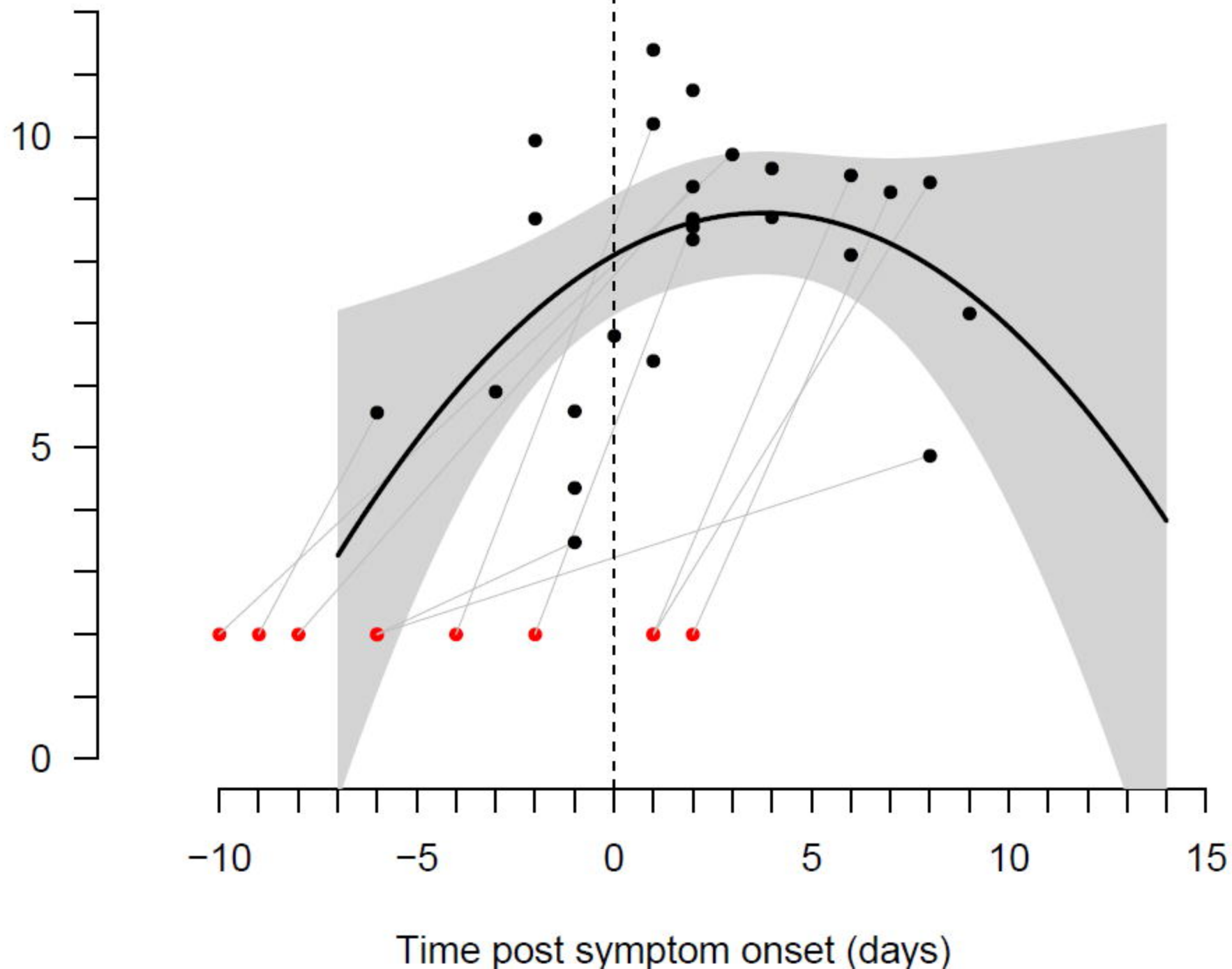


Figure Legends

Figure 1

Venn diagram of the clinical, virological and immunological outcomes among the 154 contacts included in the CoV-CONTACT cohort.

SARS-CoV-2 infection could be determined for 148/154 contacts (missing data for immunological and clinical outcomes (n=2), missing data for clinical outcome (n=1), missing data for immunological outcome (n=3).

Figure 2

Proportions of symptomatic contact subjects among the 154 contacts included in the CoV-CONTACT cohort.

The orange curve corresponds to contacts subjects with confirmed SARS-CoV-2 infection (*i.e.*, virologically- or immunologically-proven, n=37). The green curve corresponds to contacts subjects with possible SARS-CoV-2 infection (*i.e.*, clinically-suspected without viro-immunological confirmation, n=28).

Figure 3

SARS-CoV-2 viral load in the first positive SARS-CoV-2 nasopharyngeal swab as a function of time since symptom onset, in the 25 healthcare workers with a positive RT-PCR and who met the definition of clinical infection.

The first day when a specific symptom and a general symptom had been reported for two consecutive days was considered as the time of symptom onset.

The black dots show the viral loads at the first positive RT-PCR for each subject. The red dots show the time of the previous negative RT-PCR when present (8 subjects). The black curve is the best fitting second-order polynomial for viral load as a function of time since symptom onset, and the shaded area is the 95% confidence interval.

Supplementary material for : High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in healthcare workers: results of the CoV-CONTACT prospective cohort, by Tubiana *et al.*

Supplementary Methods

Data collection

In the case of exposure between colleagues working together, the beginning of the exposure period was fixed to 72 hours before the diagnosis of the SARS-CoV-2 infection of the index or the onset of the symptoms in the index, whichever occurred first.

SARS-CoV-2 RT-PCR

Nasopharyngeal swabs were drawn by trained practitioners using Sigma Virocult® swabs (Medical Wire Instrument, UK) and processed within four hours after sampling. Nasopharyngeal swabs were manually discharged in conservation fluid according to the manufacturer recommendations. Viral RNA was extracted from 200 µL of discharge fluid with the MagNA Pure LC Total Nucleic Acid Isolation Kit - Large Volume (Roche Diagnostics) and eluted in 50 µL. Then, SARS-CoV-2 RT-PCR was performed using the RealStar® SARS-CoV-2 RT-PCR kit 1.0 (Altona Diagnostics) according to the manufacturer's instructions. This assay allows the detection and differentiation of lineage B-betacoronavirus (B-βCoV), by targeting the E gene from B-βCoV, and SARS-CoV-2 specific RNA, by targeting the S gene. PCR assays were performed on an ABI 7500 platform (Applied Biosystems®).

A signal with a cycle threshold value above 40 was considered as negative.

Other respiratory pathogens RT-PCR

Detection of other respiratory pathogens was performed using the QIAstat-Dx Respiratory Panel (Qiagen), designed for the detection of adenovirus, bocavirus, coronavirus 229E (CoV 229E), CoV HKU1, CoVNL63, CoV OC43, human metapneumovirus A and B, influenza A (FLU A), FLU A H1, FLU A H3, FLU A H1N1/2009, influenza B, parainfluenza virus 1 (PIV 1), PIV2, PIV 3, PIV 4, human rhinovirus/enterovirus, respiratory syncytial virus A and B, *Bordetella pertussis*, *Chlamydomphila pneumoniae*, and *Mycoplasma pneumoniae*. Approximately 300 µL of discharge fluid was tested according to the manufacturer's instructions.

LuLISA

The LuLISA N assay makes use of a nanobody fused to luciferase for the detection of IgG antibodies binding to the SARS-CoV-2 nucleoprotein (N). Sera were used at a 1:200 dilution. The luciferase signal was measured and expressed in Relative Light Units per second (RLU/s). The threshold of positivity (13,402 RLU/s) was based on the analysis of 231 pre-pandemic sera and defined as the mean + two standard deviations

Supplementary material for : High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in healthcare workers: results of the CoV-CONTACT prospective cohort, by Tubiana *et al.*

Supplementary Results

Virological, immunological and clinical outcomes

The median number of nasopharyngeal swabs performed per contact was two (IQR 1;3), and the median time between the last high-risk exposure and the first SARS-CoV-2-positive nasopharyngeal swab was 6.5 days (IQR 4; 8).

Based on self-administered questionnaires, the most frequent symptoms being tiredness (74/151; 49.0%), headache (72/151; 47.7%) and myalgia (48/146; 32.9%) among general symptoms, and nasal congestion (52/148; 35.1%) and cough (51/149; 34.2%) among specific symptoms. The median duration of symptoms was 5.5 days (IQR 3; 9.2).

The median number of symptoms was 5 (IQR 4; 6) among the 28 contacts with possible SARS-CoV-2 infection and was 6 (IQR 4; 10) among those with confirmed SARS-CoV-2 infection.

Factors associated with SARS-CoV-2 infection

Exposure to a SARS-CoV-2-infected patient was at higher risk of SARS-CoV-2 infection than exposure to a SARS-CoV-2 colleague ($p=0.023$, Table 1). Nurses, nurse assistants, physiotherapists and hospital students had a higher risk than medical staff ($p=0.04$), as did pharmacists and administrative assistants ($p=0.033$). In the multivariable analysis, the c-statistic of this final model was 0.67 (95%CI=0.58; 0.76) and the p-value of the Hosmer-Lemeshow test was 0.99, showing no model misspecification.

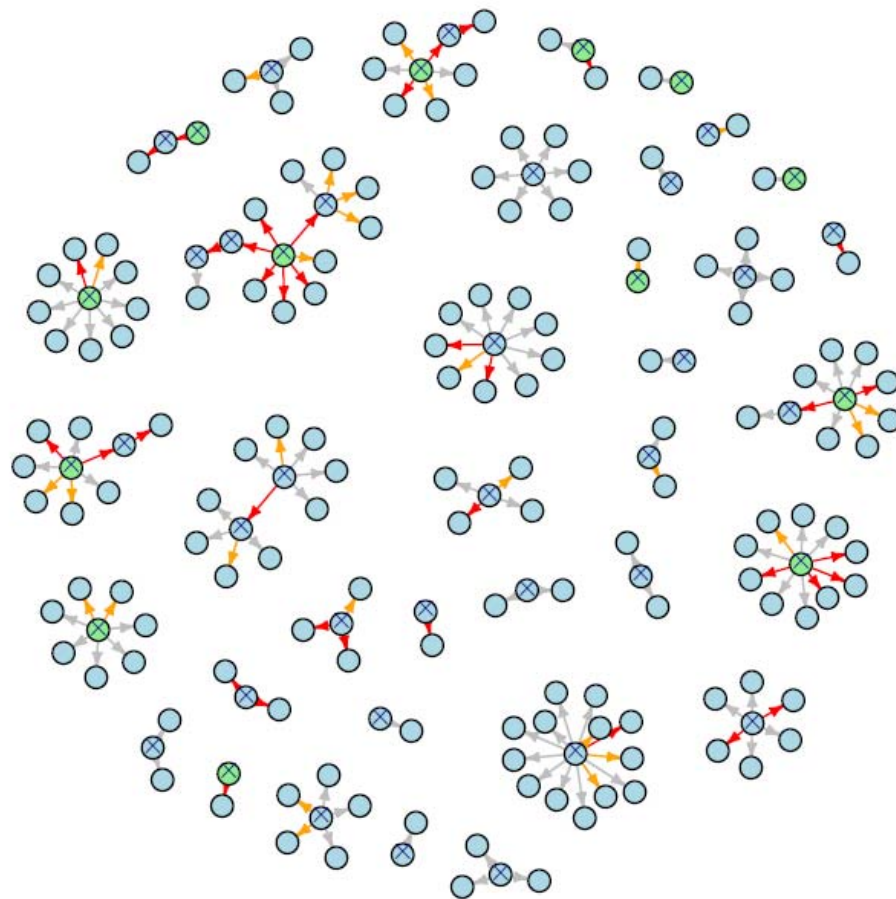
Supplementary material for : High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in healthcare workers: results of the CoV-CONTACT prospective cohort, by Tubiana *et al.*

Supplementary Figure S1

Structure of the contact network between the 44 index subjects and the 154 healthcare workers contact subjects with high-risk exposure to SARS-CoV-2 included in the CoV-CONTACT cohort.

Blue circles are health-care workers (either index or contact subjects), green circles are SARS-CoV-2 infected index patients. Circles with crosses represent the COVID-19 index subjects.

The arrows are the exposures; the red ones are the confirmed infections (*i.e.*, virologically- or immunologically-proven, n= 37), the orange ones are the possible infections (*i.e.*, clinically-suspected without viro-immunological confirmation, n=28).



Supplementary material for : High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in healthcare workers: results of the CoV-CONTACT prospective cohort, by Tubiana *et al.*

Supplementary Table S1

Immunological results obtained by the two serological methods (Lulisa N and EuroIMMUN) in the 147 healthcare workers contact subjects with available data, following a high-risk exposure to SARS-CoV-2 included in the CoV-CONTACT cohort.

		Euroimmun technique		
		No seroconversion	Seroconversion	Total
Lulisa N technique	No seroconversion	116	2	118
	Seroconversion	3	26	29
	Total	119	28	147

Supplementary material for : High-risk exposure without personal protective equipment and infection with SARS-CoV-2 in healthcare workers: results of the CoV-CONTACT prospective cohort, by Tubiana *et al.*

Supplementary Table S2

Characteristics of the 123 healthcare workers contact subjects with confirmed SARS-CoV-2 infection and without infection following a high-risk exposure included in the CoV-CONTACT cohort.

	All contacts (N=123)	Contacts with confirmed SARS-CoV-2 Infection* (N=37)	Contacts without SARS-CoV-2 infection (N=83)	OR [95%CI]	P-value
Contacts characteristics					
Age (year)	35 [29;47.5]	35 [29;48]	35 [30;47]	1 [0.97;1.03]	0.95
Male gender	33/123 (26.8%)	9/37 (24.3%)	22/83 (26.5%)	0.89 [0.35;2.14]	0.80
HCW functions					
- Medical doctor / Resident / Midwife	47/121 (38.8%)	11/36 (30.6%)	35/83 (42.2%)	1 (ref)	
- Registered Nurse / Certified nurse assistant / Physiotherapists / Hospital students	62/121 (51.2%)	23/36 (63.9%)	38/83 (45.8%)	1.93 [0.83;4.64]	0.13
- Pharmacist / Administrative assistants	12/121 (9.9%)	2/36 (5.6%)	10/83 (12%)	0.64 [0.09;2.91]	0.59
Coexisting conditions					
- Obesity (BMI>30Kg/m ²)	21/122 (17.2%)	7/37 (18.9%)	14/83 (16.9%)	1.15 [0.4;3.06]	0.78
- Tobacco use	27/123 (22%)	7/37 (18.9%)	19/83 (22.9%)	0.79 [0.28;2]	0.63
- Cardiopathy	6/122 (4.9%)	3/37 (8.1%)	3/83 (3.6%)	2.35 [0.42;13.28]	0.31
- Chronic respiratory disease	17/122 (13.9%)	3/37 (8.1%)	14/83 (16.9%)	0.43 [0.1;1.44]	0.21
- Chronic kidney disease	1/122 (0.8%)	1/37 (2.7%)	0/83 (0%)	NE	0.99
- Diabete	1/122 (0.8%)	0/37 (0%)	1/83 (1.2%)	NE	0.99
- Immunosuppressive therapy	4/122 (3.3%)	1/37 (2.7%)	3/83 (3.6%)	0.74 [0.04;6.01]	0.80
- Current pregnancy	1/89 (1.1%)	0/28 (0%)	1/61 (1.6%)	NE	0.99
Type of exposition					
Inclusion after the French lockdown	55/123 (44.7%)	13/37 (35.1%)	40/83 (48.2%)	0.58 [0.26;1.28]	0.19
Contact with more than one index	22/123 (17.9%)	9/37 (24.3%)	13/83 (15.7%)	1.73 [0.65;4.48]	0.26
Types of index subjects					
- Contacts with SARS-CoV-2-infected HCW(s) only	66 (54.5%)	12 (33.3%)	53 (63.9%)	1 (ref)	
- Contacts with SARS-CoV-2-infected patient(s) only	45 (37.2%)	19 (52.8%)	25 (30.1%)	3.36 [1.43;8.16]	0.0061
- Contacts with SARS-CoV-2-infected HCW(s) and patient(s)	10 (8.3%)	5 (13.9%)	5 (6.0%)	4.42 [1.08;18.39]	0.036
Maximal SARS-CoV-2 viral load in the index subject	9.3 [7.5;10.8]	10.2 [7.5;10.8]	8.7 [7.5; 10.9]	1.09 [0.91;1.3]	0.36
Cumulated length of exposure > 30 min	86/120 (71.7%)	25/35 (71.4%)	60/82 (73.2%)	0.92 [0.39;2.28]	0.85
Exposure to a SARS-CoV-2-infected patient (N=70)					
- Care during an aerosol-generating procedure	4/55 (7.3%)	0/24 (0%)	3/30 (10%)	NE	0.99
- Care without aerosol-generating procedure	45/55 (81.8%)	20/24 (83.3%)	25/30 (83.3%)	1 [0.23;4.51]	>0.99
- Presence in the patient's room during an aerosol-generating procedure	18/55 (32.7%)	9/24 (37.5%)	9/30 (30.0%)	1.4 [0.45;4.43]	0.56
- Other type of contact	9/55 (16.4%)	7/24 (29.2%)	2/30 (6.7%)	5.76 [1.23;41.82]	0.041
Exposure to a SARS-CoV-2-infected HCW (N=95)					
- Face-to-face discussion	72/76 (94.7%)	16/17 (94.1%)	55/58 (94.8%)	0.87 [0.1;18.31]	0.91
- Joint meeting	22/76 (28.9%)	6/17 (35.3%)	16/58 (27.6%)	1.43 [0.43;4.45]	0.54
- Lunch sharing	17/76 (22.4%)	3/17 (17.6%)	14/58 (24.1%)	0.67 [0.14;2.45]	0.58
- Other type of contact	7/76 (9.2%)	1/17 (5.9%)	6/58 (10.3%)	0.54 [0.03;3.51]	0.58

* Contacts subjects with a possible SARS-CoV-2 infection (*i.e.*, clinically-suspected without viro-immunological confirmation, n=28) were excluded.

SARS-CoV-2 infection could be determined for 120/123 exposed contacts (missing data for immunological outcome n=3).

** Corticoids, chemotherapy, anti-rejection medication, etc.

Data are presented as n (%) or median [IQR]. NC, not estimable.