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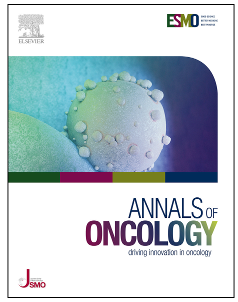

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Seroconversion in patients with cancer and oncology healthcare workers infected by SARS-CoV-2

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Highlights

- Patients with cancer have high risk for severe complications and poor outcome to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-related disease (coronavirus disease 2019 [COVID-19]).
- No difference in terms of anti-SARS-CoV-2 immunoglobulin-G (IgG) positivity rates by rapid qualitative membrane-based immunoassay was observed between cancer patients and health workers
- Median time from SARS-CoV-2 diagnosis to IgG detection was comparable between cancer patients and health workers
- Our data showed that SARS-CoV-2-specific IgG antibody detection is not different between cancer patients and healthy subjects

Abstract

Background

Patients with cancer have high risk for severe complications and poor outcome to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-related disease (coronavirus disease 2019 [COVID-19]). Almost all subjects with COVID-19 develop anti-SARS-CoV-2 immunoglobulin-G (IgG) within three weeks after infection. No data are available on the seroconversion rates of cancer patients and COVID-19.

Material and methods

We conducted a multicenter, observational, prospective study that enrolled: 1) patients and oncology health professionals with SARS-CoV-2 infection confirmed by real time polymerase chain reaction (RT-PCR) assays on nasal/pharyngeal swab specimens; 2) patients and oncology health professionals with clinical or radiological suspicious of infection by SARS-CoV-2; and 3) patients with cancer who are considered at high risk for infection and eligible for active therapy and/or major surgery. All enrolled subjects were tested with the 2019-nCoV IgG/IgM Rapid Test Cassette, which is a qualitative membrane-based immunoassay for the detection of IgG and IgM antibodies to SARS-CoV-2. The aim of the study was to evaluate anti-SARS-CoV-2 seroconversion rate in patients with cancer and oncology healthcare professionals with confirmed or clinically suspected COVID-19.

Results

From March 30 to May 11, 2020, 166 subjects were enrolled in the study. Among them, cancer patients and health workers were 61 (36.7%) and 105 (63.3%), respectively. Overall, 86 subjects (51.8%) had confirmed SARS-CoV-2 diagnosis by RT-PCR testing on nasopharyngeal swab specimen, while 60 (36.2%) had a clinical suspicious of COVID-19. Median time between symptom onset (for cases not confirmed by RT-PCR) or RT-PCR confirmation to serum antibody test was 17 days (interquartile range, 26). In the population with confirmed RT-PCR, 83.8% was IgG positive. No difference in IgG positivity was observed between cancer patients and health workers (87.9% vs 80.5%; $P = 0.39$).

Conclusions

Our data indicate that SARS-CoV-2-specific IgG antibody detection do not differ between cancer patients and healthy subjects

Keywords: cancer; healthcare workers; COVID-19; SARS-CoV-2; coronavirus; antibody response; seroconversion

Introduction

Since its first reported case in late December of 2019, the outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-related disease (coronavirus disease 2019 [COVID-19]) has rapidly spread around the world. As of July 29, 2020, more than 16 million confirmed cases and 650,000 deaths related to COVID-19 have been reported worldwide [1]. Since the beginning of the epidemic, subjects with chronic diseases such as cancer have been shown to have an increased risk of severe complications and poor outcomes with COVID-19 [2-5]. Patients with cancer are more susceptible to infection than general population because of their systemic immunosuppressive state [6]. Accordingly, some studies reported that patients with cancer have a higher risk of severe outcomes related to COVID-19, including death, intensive care unit (ICU) admission, development of severe/critical symptoms, and utilization of invasive mechanical ventilation, compared with patients without cancer [7, 8]. Several factors, including increased age, male sex, active or former smoking, poor performance status and active cancer, have been associated with high thirty-day mortality rate in patients with cancer and COVID-19 [9]. Moreover, patients with cancer who underwent chemotherapy or surgery seem to be at high risk of clinical severe events [7, 8, 10], although other studies did not confirm this observation [9, 11] On the other hand, patients with cancer and COVID-19 can also experience a spectrum of asymptomatic or *pauci*-symptomatic infections with subclinical courses [12], being managed at home and referred to the telemedicine systems or primary healthcare network [13].

Reverse transcription-polymerase chain reaction (RT-PCR) has demonstrated to be a sensitive methodology and can effectively confirm SARS-CoV-2 infection [14]. Studies on severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) showed that virus-specific antibodies were detectable in 80-100% of patients at 2 weeks after symptom onset [15-17]. Similarly, almost all patients with COVID-19 are tested as positive for anti- SARS-CoV-2 immunoglobulin-G (IgG) within 19 days after symptom development [18]. Furthermore, combining viral RNA by RT-PCR and antibody detections significantly improves the sensitivity of pathogenic diagnosis for COVID-19 [19]. However, very limited information on the antibody responses against SARS-CoV-2 in patients with cancer is currently available, with two retrospective analyses on small populations of cancer patients that reported lower detection rates of SARS-CoV-2 antibodies [20, 21].

This article reports the first analysis of a prospective observational study aimed to evaluate the antibody response in cancer patients and oncology healthcare workers presenting with confirmed or clinically suspected COVID-19.

Material and methods

Study design

This study was a multicenter, observational, prospective study conducted at five Italian Institutions. At time of this interim analysis, a total of 166 subjects were enrolled in this study from one general hospital and one comprehensive cancer center in Lombardy Region, which was the epicenter of the COVID-19 epidemic in Italy [22, 23]. Study population included three different categories: 1) patients or health professionals already confirmed to be positive for SARS-CoV-2 by RT–PCR assays on nasal/pharyngeal swab specimens; 2) patients or health professionals who are suspected of being infected with SARS-CoV-2, defined as history of contact with confirmed cases before the onset of illness or subjects with at least one clinical manifestation or imaging characteristics of COVID-19 in the last week before accrual in the trial; 3) patients with cancer who are considered at high risk for infection and eligible for active therapy and/or major surgery. Subjects diagnosed with bacterial or viral pneumonia in previous three months were excluded from the study. **Figure S1** graphically represents a flow chart with the enrolled subjects.

Institutional review board and Ethics committee approval was obtained from all participating Institutions. The study was conducted in accordance with the Declaration of Helsinki. All patients provided written informed consent before any study-related procedure.

Detection of SARS-CoV-2 RNA by RT-PCR

Presence of SARS-CoV-2 on nasopharyngeal swab specimens was determined by means real-time RT-PCR. GeneFinder^{TM} COVID-19 Plus RealAmp Kit (Elitech, Milan, Italy) or Allplex™ 2019 n-CoV Assay (Seegene Inc, Seoul, South Korea) were used to detect SARS-CoV-2 by amplification of RdRp gene, E gene and N gene according to the World Health Organization (WHO) recommendations and as previously described [24].

Overall, 836 specimens obtained from nasopharyngeal swab were tested by RT-PCR.

Detection of IgG and IgM against SARS-CoV-2

To evaluate the presence of IgG and IgM against SARS-CoV-2, all enrolled subjects were tested with the *2019-nCoV IgG/IgM Rapid Test Cassette®* (PRIMA Lab SA, Balerna, Switzerland), which is a qualitative membrane based immunoassay for the detection of IgG and IgM antibodies to SARS-CoV-2 in whole blood, serum or plasma specimen. For this purpose, capillary blood was obtained from each subject by fingerstick. After a droplet was formed, capillary blood was captured in a capillary tube until filled to approximately 20 µL. The whole blood was then dispensed to the specimen well of the test cassette. Lastly, two drops of diluent were added to the specimen well of the test cassette.

The *2019-nCoV IgG/IgM Rapid Test Cassette®* consists of two components, an IgG component and an IgM component. In the IgG component, anti-human IgG is coated in IgG test line region. During testing, the specimen reacts with 2019-nCoV antigen-coated particles in the test cassette. The mixture then migrates upward on the membrane chromatographically by capillary action and reacts with the anti-human IgG in IgG test line region, if the specimen contains IgG antibodies to 2019-nCoV. Anti-human IgM is coated in IgM test line region and if specimen contains IgM antibodies to 2019-nCoV, the conjugate-specimen complex reacts with anti-human IgM. If the specimen contains 2019-nCoV IgG antibodies, a colored line appears in IgG test line region as a result of this. Similarly, a colored line appears in IgM test line region, if the specimen contains 2019-nCoV IgM antibodies. If the specimen does not contain 2019-nCoV antibodies, no colored line appears in either of the test line regions, indicating a negative result.

To serve as a procedural control, a colored line always appears in the control line region, indicating that the proper volume of specimen has been added and membrane wicking has occurred. **Figure S2** displays three possible results and interpretation of the rapid test. Overall, 166 (one for each enrolled subject) serological rapid tests were performed.

Aim of the study

Primary endpoint of the study was to evaluate anti-SARS-CoV-2 seroconversion rates in cancer patients and cancer health professionals with confirmed or clinically suspected COVID-19.

Statistical analyses

Descriptive statistics were used to analyze and report patients' characteristics. Clinical and biological variables were stratified into categories whenever reasonable, to preserve statistical power and feasibility of data collection. Continuous variables are expressed as the median (interquartile range, IQR) and were compared with the Mann-Whitney U-test. Categorical variables are expressed as numbers and proportions (%) and were compared by Fisher's exact test or Chi-square test, as appropriate. All tests were performed 2-sided at a significance level of $\alpha=0.05$. Statistical analyses were performed using SAS (version 9.4) and R Studio (version 1.1.463).

Results

From March 30, 2020 to May 11, 2020, 166 subjects were enrolled in the study. Among them, cancer patients and health workers were 61 (36.7%) and 105 (63.3%), respectively. Median age was 46 years (IQR, 21) and 118 (71.1%) were females. Health workers were younger than patients (median age 41 vs 62 years; P <0.001). Patients with cancer were more frequently diagnosed with hypertension (26.2% vs 2.9%; P <0.001) and type 2 diabetes (8.2% vs 1.0%; P = 0.01) as compared to healthcare workers. Conversely, healthcare workers were more frequently carriers of autoimmune diseases (12.4% vs 3.3%; *P* = 0.04), mainly chronic autoimmune thyroiditis and rheumatoid arthritis (data not showed). Patients' characteristics are reported in **Table 1**.

Among 61 cancer patients, breast carcinoma was the most frequent diagnosed tumor (55.7%), followed by lung cancer (13.1%). Thirty-three (54.1%) had metastatic disease. Forty-one (67.2%) patients were receiving active antitumoral therapies, that included systemic chemotherapy (14.8%), immunotherapy (8.2%), targetted therapy (9.8%), and hormonal therapy +/- targetted therapy (6.6% and 29.5%, respectively). Main characteristics of enrolled patients with cancer are described in **Table S1.**

Overall, 86 subjects (51.8%) had confirmed SARS-CoV-2 diagnosis by prior RT-PCR testing on nasopharyngeal swab specimen, while 60 (36.2%) and 20 (12.0%) were clinically suspected or at high risk for SARS-CoV-2 infection, respectively. The majority (79.2%) were diagnosed with mild COVID-19 condition, according to the *Italian Society for Anesthesia, Analgesia, Resuscitation and Intensive Care* (SIAARTI) clinical classification, while 11.7% and 9.1% as moderate and severe, respectively.

Median time between symptom onset (for cases not confirmed by RT-PCR) or RT-PCR confirmation to serum antibody test was 17 days (IQR, 26), while median time to symptom resolution or viral RT-PCR negativization was 22 days (IQR, 33). Of note, 9 subjects (5.4%) still had RNA viral detection by RT-PCR on swab specimen at time of this analysis.

Detection of IgG against SARS-CoV-2 in subjects with positive RT-PCR

In the overall population, 69 (41.6%) and 3 (1.8%) participants were IgG and IgM positive, respectively. Considering the population with confirmation by RT-PCR, 62 (83.8%) was IgG positive (**Table 2**). No difference in terms of IgG positivity was observed between cancer patients and health workers (87.9% vs 80.5%; *P* = 0.39) (**Figure 1**). Furthermore, no differences were observed in time from SARS-CoV-2 diagnosis to IgG detection between cancer patients and health workers (23.0 vs 28.0 days; *P* = 0.21) (**Table 3; Figures 2** and **3**). Age, gender, comorbidities, and symptom intensity did not significantly influence rate and time of IgG antibody response.

Discussion

According to the European Commission recommendations [25], timely and accurate SARS-CoV-2 laboratory testing is an essential part of the management of COVID-19 for slowing down the pandemic, supporting decisions on infection control strategies and patient management at healthcare facilities, and detecting asymptomatic cases that could spread the virus further if not isolated.

Rapid tests are non-automated procedures and have been designed to give a fast result. For COVID-19, rapid tests may take around 10-15 minutes until giving a result compared with about four hours for molecular tests [26]. These rapid tests are relatively simple to perform and interpret and therefore require limited test operator training. They may be intended either for use in hospital for particular situations or in other social needs, allowing rapid screening of symptomatic and asymptomatic SARS-CoV-2 carriers.

Our findings suggest that patients with cancer infected with SARS-CoV-2 tend to have an antibody response comparable to healthy subjects, who in our population were represented by healthcare workers. Understanding the duration of potential infectiousness and the time to IgG antibody response are critical to the containment of SARS-CoV-2 spread, especially in cancer patients and healthcare workers who are in constant exposure to high-risk populations. Moreover, monitoring previously infected subjects is essential to optimize the adequate individual protection diapositives, the clinical management and the administration of oncological treatments.

Patients with cancer are at higher risk of developing infections for several factors that include advanced age, underlying immunosuppressive status, and treatment-related factors such as chemotherapy, radiation, and surgical procedures [27]. Accordingly, several works reported that patients with cancer have a higher risk of severe outcomes related to COVID-19 [7-11].

In contrast to prior literature [20, 21], our experience showed that more than 85% of the cancer patients who had laboratory documented SARS-CoV-2 infection or high clinical suspicious developed IgG antibodies using our rapid assay. Notably, no differences in terms of antibody formation and time to seroconversion were observed in cancer patients as compared to healthcare workers. Given that cytotoxic agents are able to dampen immune response and interfere with antibody formation [28], it could be expected that patients on chemotherapy have lower rates of antibody positivity [20]. Of note, more than 60% of our patients were receiving active treatments, but only a minority (about 10%) chemotherapy. Accordingly, such association needs to be confirmed in larger cohorts of patients with cancer and COVID-19.

Additionally, our findings suggest that IgG antibodies develop over a median period of 17 days from symptom onset or RT-PCR confirmation. This suggests that the ideal time frame for antibody testing is at least two weeks after symptom onset and no more than three/four weeks after symptom resolution or RT-PCR negativization. As reported by Long et al. [18], antibody testing should be performed as early as possible, because about 12% of the patients had already plateaued in IgG titer within seven days of symptom onset. For patients who were not sampled during the ideal window or are tested at later stages, repeated serological tests would be needed to confirm an antibody response against SARS-CoV-2 infection. Comparable data were recently reported in a preprint paper summarizing the results of a study conducted in the New York region (United States) [29]. Moreover, considering that many infected patients remain asymptomatic and fully capable of transmitting SARS-CoV-2 [30, 31], combining antibody testing and RT-PCR on swab specimen can potentially increase COVID-19 diagnosis.

Although scant information on the immunity conferred by IgG and its duration, previous experiences in other viral infections, such as SARS and MERS, suggest that IgG may confer some level of immunity [32, 33], while it seems to wane over the time. Similar data have been reported for other coronaviruses were immunity can confer limited protection [34]. In order to study the duration of IgG antibody response to SARS-CoV-2, we planned to prospectively follow our patient population and retest for IgG by both quantitative and qualitative assays after three and six months in order to measure time and level of immunization. Moreover, blood samples from each enrolled subject will be analyzed to evaluate also quantitative IgG and IgM levels in the peripheral blood. At time of the present analysis, data on antibody titer were available only for 16.9% of the overall population (data not shown).

Among subjects who had not a confirmed infection by RT-PCR, but were considered as clinical suspected or high risk, including those with symptoms consistent with COVID-19, highly suggestive radiological imaging or close contact with patients with confirmed SARS-CoV-2 infection, we found that only 8.8% of this population had IgG antibodies. This finding suggests that a majority of participants suspected for COVID-19 actually were not infected with SARS-CoV-2. In addition, recent evidences suggested weaker immune responses and a more rapid reduction in the IgG titer for asymptomatic individuals infected by SARS-CoV-2 as compared to symptomatic subjects [35]. On the other hand, the low rates of IgG positivity in subjects without a confirmed diagnosis of SARS-CoV-2 infection by RT-PCR may be related to a false negative rate of our assay or insufficient time for participants to mount an IgG antibody response detectable by means rapid test. This remarks the importance of harmonize and validate proper methodologies for SARS-CoV-2 detection to improve diagnosis and reduce false negative rates.

Notably, nine subjects (5.4%) remained RT-PCR positive despite full resolution of symptoms and IgG seroconversion. This had relevant implications regarding the real duration of viral transmission. Although other viral genomes can be detected even months after resolution of clinical infection [36], additional research on SARS-CoV-2 is need to determine if nasopharyngeal RT-PCR positivity is related to transmission and the duration of the viral shedding [37].

We are aware that our study presents some limitations. About 90% of participants had mild disease, and thus these data may not reflect antibody response in moderate or severe COVID-19. Furthermore, we did not collect rigorous data regarding symptom severity which could potentially be related to the timeline and strength of IgG antibody response to SARS-CoV-2. As aforementioned, further studies are needed to understand the magnitude and duration of the IgG response in patients recovered from SARS-CoV-2. In addition, the antibody titer that is necessary to protect individuals from reinfection is currently unknown. Lastly, the clinical significance of prolonged positive SARS-CoV-2 nasopharyngeal PCR in the absence of clinical evidence requires additional clarification.

Of note, only 19% of healthcare workers in our study population reported having received seasonal flu vaccine. Although WHO and national agencies identify health workers as a priority target group and recommend for vaccination, influenza vaccination coverage rates of healthcare workers are significantly variable in Europe, ranging from 15.6% to 63.2% [38]. In Italy, the coverage rate is very low (less than 20%), as showed in a multicenter cross-sectional study conducted in ten Italian cities [39]. These observations have relevant implications related to the current COVID-19 pandemic, especially considering the overlapping between seasonal flu- and COVID-19-related symptoms. In order to plan organization and management of future COVID-19 waves, it might be to guarantee influenza vaccination coverage for all healthcare workers. **Conclusions**

Our data indicate that SARS-CoV-2-specific IgG antibody detection is not different between cancer patients and healthy subjects. As a result, rapid test for antibody detection can be a complement to RNA RT-PCR testing for the diagnosis of COVID-19, especially in those situations where the knowledge of the COVID-19 status is rapidly mandatory for specific clinical decisions. In vulnerable population such as cancer patients, confirming suspected COVID-19 cases as early as possible with the help of serological testing could reduce exposure risk and help optimizing diagnostic and therapeutic algorithms. The key for success in COVID-19 and cancer is to implement diagnostic and therapeutic methodologies, maybe with a high sensitivity/sensibility and rapidity of execution/resulting that allow to ensure a continuum of the healthcare during pandemic.

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Statement of potential conflicts of interest: DG reports personal fees for consulting, advisory role and speakers' bureau from Novartis, Pfizer, Lilly; fees for travel and accommodations from Novartis, Pfizer, Lilly. GC reports personal fees for consulting, advisory role and speakers' bureau from Roche/Genentech, Novartis, Pfizer, Lilly, Foundation Medicine, Samsung, and Daichii-Sankyo; honoraria from Ellipses Pharma; fees for travel and accommodations from Roche/Genentech, and Pfizer. Other authors have no potential conflicts of interest to disclose. Other authors have no potential conflicts of interest to disclose

Author's contribution: Study concept and design: GC, DG, AM. Acquisition, analysis, and interpretation of data: AM, SG, PZ, DG, GC. Drafting of the manuscript: AM and GC. Statistical analysis: SG and AM. Administrative, technical, or material support: All authors. Study supervision: GC. All the authors read and approved the final version of the manuscript.

Ethics approval and consent to participate: Institutional review board and Ethics committee approval was obtained from all participating Institutions. The study was conducted in accordance with the Declaration of Helsinki. All the patients provided written informed consent before any study-related procedures.

Availability of data and material: All data generated or analyzed during this study are included in the published article. Additional supporting data are available from the corresponding author on reasonable request. All requests for raw and analyzed data and materials will be reviewed by the corresponding author to verify whether the request is subject to any intellectual property or confidentiality obligations.

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Table 1. Patients' characteristics. Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blockers; ICU, intensive care unit; IgG, immunoglobulin G; IgM, immunoglobulin M; IQR, interquartile range; NA, not applicable; RT-PCR, reverse transcriptase-polymerase chain reaction.

	Health workers (N=105)	Cancer patients (N=61)	Total (N=166)	*P* value
Age				**<0.001**
Median (IQR)	41 (14)	62 (21)	46 (21)	
Gender				0.629
Female	76 (72.4%)	42 (68.9%)	118 (71.1%)	
Male	29 (27.6%)	19 (31.1%)	48 (28.9%)	
Seasonal flu vaccine				0.548
No	85 (81.0%)	47 (77.0%)	132 (79.5%)	
Yes	20 (19.0%)	14 (23.0%)	34 (20.5%)	
Comorbidities				
Cardiovascular	3 (2.9%)	2 (3.3%)	5 (3.0%)	0.878
Pulmonary	0 (0.0%)	2 (3.3%)	2 (1.2%)	0.062
Asthma	7 (6.7%)	2 (3.3%)	9 (5.4%)	0.353
Diabetes	1 (1.0%)	5 (8.2%)	6 (3.6%)	**0.016**
Autoimmunity	13 (12.4%)	2 (3.3%)	15 (9.0%)	**0.049**
Hypertension	3 (2.9%)	16 (26.2%)	19 (11.4%)	**<0.001**
Concomitant drugs				
ARB	1 (1.0%)	3 (4.9%)	4 (2.4%)	0.108
ACE inhibitor	2 (1.9%)	4 (6.6%)	6 (3.6%)	0.122
Inclusion criteria				**<0.001**
Confirmed	56 (53.3%)	30 (49.2%)	86 (51.8%)	
High Risk	0 (0.0%)	20 (32.8%)	20 (12.0%)	
Suspected	49 (46.7%)	11 (18.0%)	60 (36.2%)	
Contact with infected subject				**<0.001**
NA	39	27	66	
No	16 (15.2%)	22 (36.1%)	38 (22.9%)	
Yes	50 (47.6%)	12 (19.7%)	62 (37.3%)	
Presentation				0.226

NA	60	29	89	
Mild	38 (84.4%)	23 (71.9%)	61 (79.2%)	
Moderate	5 (11.1%)	4 (12.5%)	9 (11.7%)	
Severe	2 (4.4%)	5 (15.6%)	7 (9.1%)	
Setting of care				0.084
NA	59	29	88	
Home	45 (97.8%)	27 (84.4%)	72 (92.3%)	
Hospital	1 (2.2%)	4 (12.5%)	5 (6.4%)	
ICU	0 (0.0%)	1 (3.1%)	1 (1.3%)	
Ventilation				0.273
No	103 (98.1%)	58 (95.1%)	161 (97.0%)	
Yes	2 (1.9%)	3 (4.9%)	5 (3.0%)	
Complications				**<0.001**
None	101 (96.2%)	47 (77.0%)	148 (89.2%)	
Pneumonitis	4 (3.8%)	14 (23.0%)	18 (10.8%)	
Outcome				0.229
Ongoing	4 (3.8%)	5 (8.2%)	9 (5.4%)	
Recovered	101 (96.2%)	56 (91.8%)	157 (94.6%)	
IgG				**0.030**
Negative	68 (64.8%)	29 (47.5%)	97 (58.4%)	
Positive	37 (35.2%)	32 (52.5%)	69 (41.6%)	
IgM				0.902
Negative	103 (98.1%)	60 (98.4%)	163 (98.2%)	
Positive	2 (1.9%)	1 (1.6%)	3 (1.8%)	
RT-PCR testing				**<0.001**
No	21 (20.0%)	0 (0.0%)	21 (12.7%)	
Yes	84 (80.0%)	61 (100.0%)	145 (87.3%)	
RT-PCR result				0.529
NA	21	0	21	
Negative	43 (51.2%)	28 (45.9%)	71 (49.0%)	
Positive	41 (48.8%)	33 (54.1%)	74 (51.0%)	

Table 2. IgM and IgG seroconversion in overall population, cancer patient and health workers. Abbreviations: IgG, immunoglobulin G; IgM, immunoglobulin M; RT-PCR, reverse transcriptase-polymerase chain reaction.

			RT-PCR-negative (N=71)	**RT-PCR-positive (N=74)**	**Total (N=145)**	***P* value**
Overall	**IgG**					**<0.001**
		Negative	65 (91.5%)	12 (16.2%)	77 (53.1%)	
		Positive	6 (8.5%)	62 (83.8%)	68 (46.9%)	
	IgM					0.535
		Negative	69 (97.2%)	73 (98.6%)	142 (97.9%)	
		Positive	2 (2.8%)	1 (1.4%)	3 (2.1%)	
Cancer patients	**IgG**	Negative	25 (89%)	4 (12%)	29 (20%)	**<0.001**
		Positive	3 (11%)	29 (88%)	32 (22%)	
Health workers	**IgG**	Negative	40 (93%)	8 (20%)	48 (33%)	**<0.001**
		Positive	3 (7%)	33 (80%)	36 (25%)	

Table 3. Median time to IgG positivization. Abbreviations: IQR, interquartile range; Q1, 1st quartile; Q3, 3rd quartile.

		Median (IQR)	Q1	Q3	*P* value
Category	Health workers	23.0 (13.0)	17	29	0.208
	Patients	28.0 (19.2)	16	35	
Gender	Female	25.0 (16.5)	16	34	0.761
	Male	27.0 (17.7)	16	34	

Figure legends

Figure 1. Comparison between IgG positivity rate between healthcare workers (red) and patients with cancer (blue) according to the result of reverse transcriptase-polymerase chain reaction (RT-PCR) test for SARS-CoV-2. *P* value refers to the Fisher's exact test. Abbreviations: HCWs, healthcare workers; RT-PCR, reverse transcriptase-polymerase chain reaction

Figure 2. Comparison between time to IgG seroconversion and subject category (health workers vs patients, panel a) and gender (female vs male, panel b). On each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles, the whiskers extend to the most extreme data points not considered outliers, and outliers are plotted individually. *P* value refers to the Mann-Whitney U-test.

Figure 3. Cumulative incidence of seroconversion of IgG antibodies against SARS-CoV-2 among COVID-19 healthcare workers (red line) and cancer patients (blue line).

Figure S1 graphically represents a flow chart with the enrolled subjects.

Figure S2 displays three possible results and interpretation of the rapid test.

Table 1. Patients' characteristics. Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blockers; ICU, intensive care unit; IgG, immunoglobulin G; IgM, immunoglobulin M; IQR, interquartile range; NA, not applicable; RT-PCR, reverse transcriptase-polymerase chain reaction.

	Health workers (N=105)	Cancer patients (N=61)	Total (N=166)	*P* value
Age				**<0.001**
Median (IQR)	41 (14)	62 (21)	46 (21)	
Gender				0.629
Female	76 (72.4%)	42 (68.9%)	118 (71.1%)	
Male	29 (27.6%)	19 (31.1%)	48 (28.9%)	
Seasonal flu vaccine				0.548
No	85 (81.0%)	47 (77.0%)	132 (79.5%)	
Yes	20 (19.0%)	14 (23.0%)	34 (20.5%)	
Comorbidities				
Cardiovascular	3 (2.9%)	2 (3.3%)	5 (3.0%)	0.878
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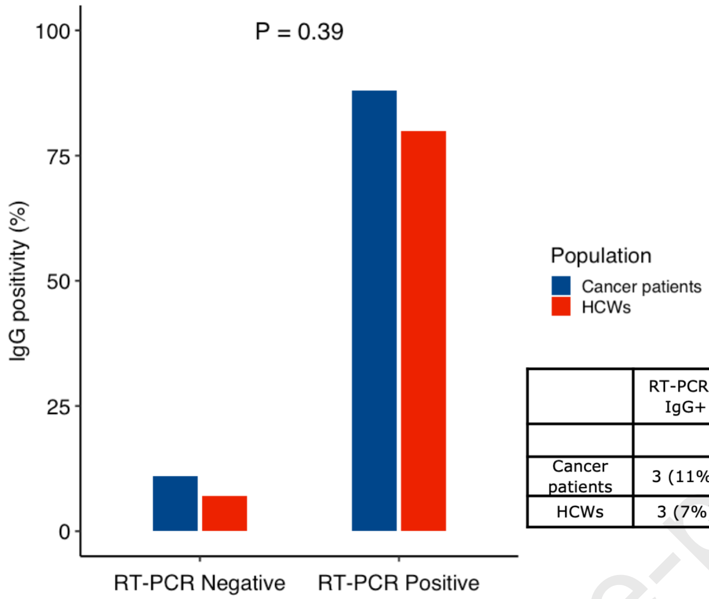
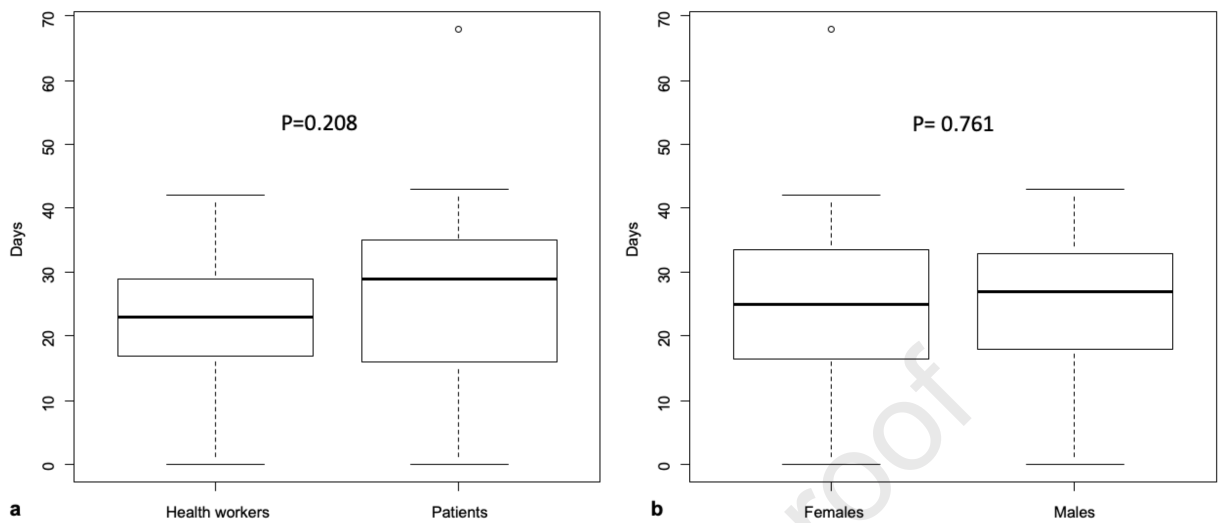
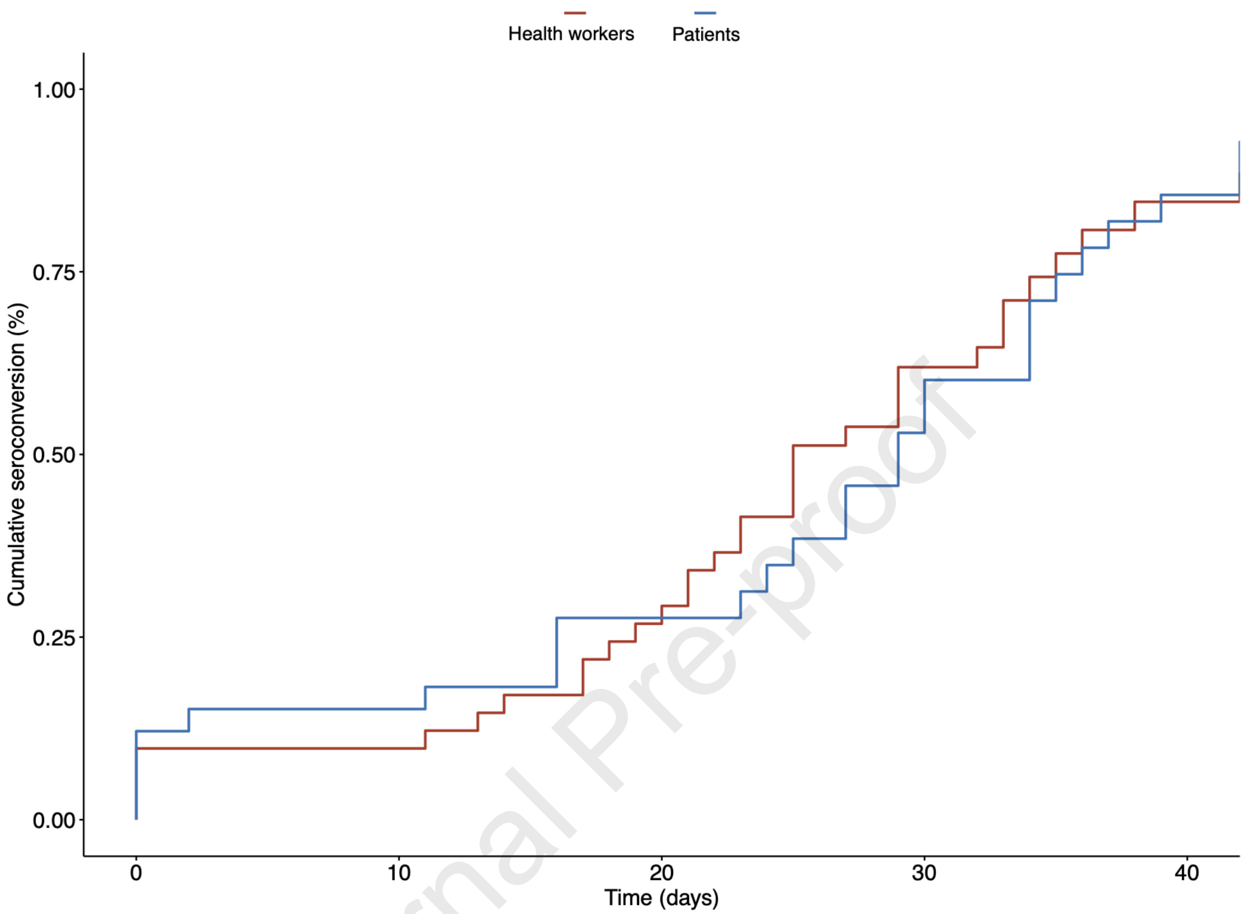


	RT-PCR-/ IgG+	RT-PCR+/ IgG+	*P* value
			0.39
Cancer patients	3 (11%)	29 (88%)	
HCWs	3 (7%)	62 (80%)	



70
60
50
40
30
20
10
0
Days
P=0.208
a
Health workers
Patients
b
P= 0.761
Females
Males


Health workers
Patients
1.00
0.75
0.50
0.25
0.00
Cumulative seroconversion (%)
0
10
20
30
40
Time (days)