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Research Article

SARS-CoV-2 Seroprevalence among Solid Tumor Outpatients in a Spanish Hospital

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Abstract

Background: Cancer patients are highly vulnerable to SARS-CoV-2 infection and the risk-benefit of active cancer treatment should be evaluated if infection occurs. Thus, it was of interest to assess the SARS-CoV2 infection prevalence among cancer outpatients (by means of serology), and to evaluate if appropriate treatment modifications are taking place according to serological status.

Patients and Methods: An observational, ambispective study was conducted in the Medical Oncology unit of Basurto University Hospital to assess the seroprevalence of SARS-Cov2 among adult outpatients with solid tumors who visit the unit for active treatment or follow-up. In addition, the possible implications of seropositivity on oncologic care were also assessed. Total antibodies were assessed by Chemiluminescence Immunoassay (CLIA), and when positive, followed by IgG and IgM Enzyme Linked Immunosorbent Assay (ELISA), at baseline and serially up to 12 months, and SARS-CoV-2 RT-PCR was performed at baseline, and for those patients on treatment, also at 24-48 hours before treatment cycle initiation.

Results: Out of 515 eligible patients, 31 were positive for SARS-Cov2 infection (seroprevalence: 5.6%). Contact with a COVID-19 positive patient, history of smoking and hypertension were risk factors for the infection. Five (23.8%) patients underwent a modification of their treatment plan (3, treatment delay and 2, treatment suspension).

Conclusion: Serology by CLIA and ELISA is a sensitive and specific method for establishing SARS-Cov2 infection status in the oncologic population. Prevalence of infection is 6% among solid tumor outpatients. Antineoplastic therapy is modified in more than a quarter of patients positive to the infection.

INTRODUCTION

Cancer patients are highly vulnerable to Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) infection, not only due to their weakened immune system, caused by tumor growth and neoplastic treatment, but also due to greater exposure, considering the nosocomial transmission of the virus and the need of these patients for frequent hospital visits [1]. These risk factors lead to at least a two-fold increase of the risk of contracting the infection among cancer patients as compared to the general population [2-4]. In addition to the higher SARS-CoV-2 infection rate, once infected, cancer patients are more likely to have higher morbidity and mortality than the general population [2]. The WHO-China Joint Mission on Coronavirus Disease 2019 estimated the crude fatality ratio (CFR) for cancer patients in 7.6%, while that for patients with no comorbid conditions was 1.4% [5]. Cancer patients also have a higher risk of severe events [admission to intensive care unit (ICU) with invasive ventilation or death], as compared to patients without cancer [4], and the risk increases in those patients submitted to surgery or antineoplastic treatment within the last 14-30 days [4,6]. In addition, time to develop severe events is significantly shorter in cancer patients than in those without cancer [4], translating into a faster deterioration of the patient.

The prevalence of COVID-19 infection has been estimated in the overall Spanish population. From April 27 to May 11, 2020, a nationwide study showed a seroprevalence of 5% [7]. As of June 29th, 2021, and according to the Spanish Health Ministry, there had been 3,799,733 confirmed cases and 80,829 deaths due to COVID-19 [8]. However, the prevalence in the Spanish cancer population has not yet been established, while among COVID-19 deceased patients, higher cancer prevalence has been observed than in the general population [9].

Due to the special characteristics of cancer patients, different scientific societies have issued recommendations for their care during the pandemic. Some of the recommendations include, clear communications and education about hygiene and infection control measures, minimizing outpatient visits, and considering the risk-benefit of active cancer treatment on a case-by-case basis [2]. However, whether measures have been implemented and their impact is unknown.

Detection of antibodies may complement and improve infection diagnosis by antigen detection by reverse transcription

polymerase chain reaction (RT-PCR) [10], and it has been shown that the sensitivity of detection of total antibodies by Enzyme Linked Immunosorbent Assay (ELISA) overtakes that of RNA test since day 8 after symptoms onset [11].

The Spanish Society of Medical Oncology (SEOM, by its Spanish acronym) recommends the detection of IgG and IgM by means of rapid antibody tests [or lateral flow immunochromatographic assays (LFIAs)] in asymptomatic cancer patients previous to the initiation of immunosuppressive chemotherapy [12]. However, the Spanish Society for Infectious Diseases and Clinical Microbiology (SEIMC, by its Spanish acronym) states that ELISA and Chemiluminescence Immunoassay (CLIA) have higher specificity and sensitivity than the rapid tests [13]. In fact, using a marketed ELISA kit, Zhao et al. showed that the median seroconversion time was 11 days from symptoms onset for total antibodies, 12 days for IgM, and 14 days for IgG, and that from day 15 of onset, the sensitivities of total antibodies, IgM and IgG were 100.0%, 94.3% and 79.8%, respectively [11].

Therefore, it was of interest to assess the serologic status of cancer patients, by highly specific and sensitive methods, to know the incidence of the infection in the Spanish cancer population, and to assess the different modifications of the indicated antineoplastic treatments in order to improve individual patient management.

METHODS

An observational, ambispective study was conducted in Medical Oncology and the Microbiology Departments of the Basurto University Hospital, to assess the seroprevalence of SARS-CoV2 among the adult outpatients with solid tumors who visit the unit for active treatment or for follow-up. In addition, the putative implications of seropositivity on the oncologic care of these patients were also evaluated.

The study clinical data were retrospectively gathered from the electronical medical records of the patients, while specific IgM and IgG were prospectively assessed in the recruited patients.

Adult patients with a diagnosis of solid malignant tumor of any type and stage, histologically confirmed, were consecutively recruited during a period of 4 months (from June to September 2020) after signing the informed consent. Patients participating in clinical trials or whose follow-up in the center during the study duration was not guaranteed were excluded.

Demographic and clinical characteristics were gathered, including tumor´s characteristics, comorbidities [hypertension, diabetes mellitus, obesity, chronic renal disease, chronic obstructive pulmonary disease (COPD) or asthma, cardiovascular disease, neurological disease, hepatopathy, chronic corticosteroids, living in a residential care facility], smoking status, hospital admissions during the previous two months and specific data that might be related to SARS-CoV-2 infection, such as COVID-19 contact, previous COVID-19 diagnosis, symptoms and time since the epidemic outbreak in Spain, which was March 15th 2020. In addition, the current oncologic treatment, and laboratory test results, including those of serology and RT-PCR were also collated.

The blood for antibody detection was drawn, whenever possible, at the same time that the extraction for the patients´ normal check-up during their hospital visit; and thus, in patients on active antineoplastic treatment, a greater number of serological determinations were made than in those patients on follow-up.

Anti- SARS-CoV-2 total antibodies (IgG+IgM+IgA) targeting a recombinant nucleocapside antigen (N) were assessed by CLIA (Elecsys® Anti- SARS-CoV-2) at time of study inclusion (baseline), and at 1 and 3 months. If total antibodies were positive, additional tests were performed to assess IgG and IgM separately by ELISA, targeting recombinant nucleocapside and spike antigens (N and S) (Coronavirus-SARS-2-IgM ELISA Dia-Pro® and Coronavirus-SARS-2-IgG ELISA Dia-Pro®). In seropositive patients, sequential blood samples were obtained at 6, 9 and 12 months to assess the evolution of the antibodies.

A SARS-CoV-2 RT-PCR (RNA extraction using STARMag Universal Cartridge kit and PCR using Allplex™ 2019-nCoV assay-Seegene, Werfen) in nasopharyngeal sample, was performed for every patient at baseline, and for patients on treatment, also 24-48 hours before treatment initiation.

Patients were categorized by microbiological results (antibodies and PCR tests) in 6 different groups: Susceptible, window period, active early phase, recent phase/false negative PCR/false positive IgM, late infection and resolved infection (**Table 1**).

After patients´ classification, the protocol recommendations were as follow:

A) *Susceptible*: Antineoplastic treatment could be administrated. Before each cycle, patients should have been microbiologically assessed.

Table 1: Putative serological and PCR scenarios.

Interpretation	RT-PCR	Total antibodies (CLIA)	Ig M (ELISA)	Ig G (ELISA)
Susceptible	-	-	-	-
Window period	+	-	-	-
Active early phase	+	+	+	-
Recent phase/False negative PCR/ False positive Ig M	-	+	+	-
Late infection	- (+)	+	- (+)	+
Resolved infection	-	+	-	+

Ig: Immunoglobulin; **RT-PCR:** Reverse transcription-Polymerase chain reaction; **CLIA:** Chemiluminescence immunoassay; **ELISA:** Enzyme-linked immunosorbent assay

B) *Active early phase, recent phase/false negative PCR/false positive IgM* or *window period*: PCR had to be performed in 3-4 weeks. Treatment administration should be delayed until results were compatible with past infection, and subsequently serial serological tests had to be performed.

C) *Late or resolved infection*: Antineoplastic therapy could be administered and serial serological tests had to be performed to assess the evolution of acquired immunity (every 3 months).

Statistics

A descriptive analysis of the sociodemographic and clinical characteristics was performed using measures of central dispersion for the continuous variables and frequencies for the categorical variables. A multivariant bilateral logistic regression was used to assess the putative relationship between different categorical variables and having a positive serological test. Nagelkerke R square (R2) was used to estimate the variability defined by the logistic regression model.

Data analysis was performed with the statistical program SPSS (version 23.0, IBM Corporation). A significance level of 0.05 was used.

The study was conducted in agreement with the Helsinki declaration (Fortaleza, Brazil, October 2013), the good clinical practice guidelines (CPMP / ICH / 135/95), and local legislation, including data protection laws. The study was approved by the Ethics Committee of the OSI (Integrated Sanitary Organization, by its Spanish acronym) Bilbao-Basurto. Every recruited patient signed an informed consent.

RESULTS

Out of 1,599 cancer patients who visited the outpatient ward of medical oncology of the Basurto University Hospital between May 29th and September 30th 2020, a total of 522 met inclusion and exclusion criteria. Out of these, 7 patients did not undertake any serological or PCR analysis, and thus, 515 were eligible for analysis (**Figure 1**).

The population median age was 65 years and it was divided into half men and half women. 430 patients (82.4%) were on active antineoplastic treatment; 24.3% with curative intention.

Chemotherapy (CT) and targeted therapy (included hormonal treatment) were the most frequent treatments (35.8% and 23.2% respectively). 83 patients (16%) received immunotherapy (as monotherapy 14%). Only 33 patients (6.3%) had locally advanced disease on concomitant CT and radiotherapy (RT) treatment, and 7 patients (1.3%) were exclusively receiving RT. Regardless of cancer, 348 pts (67.6%) had at least one risk factor for SARS-CoV-2 infection. Patients' characteristics are shown in [**Table 2].**

Prevalence of SARS-CoV-2 infection among cancer patients and characteristics of positive patients

In our series, 31 out of 515 patients were positive for an active or past SARS-CoV2 infection (prevalence: 6.02%). Infection diagnosis was obtained by PCR and serology in 9 patients (29%), only by serology in 20 patients (64.5%), and only by PCR in 2 patients (6.4%). These last 2 patients died shortly after infection

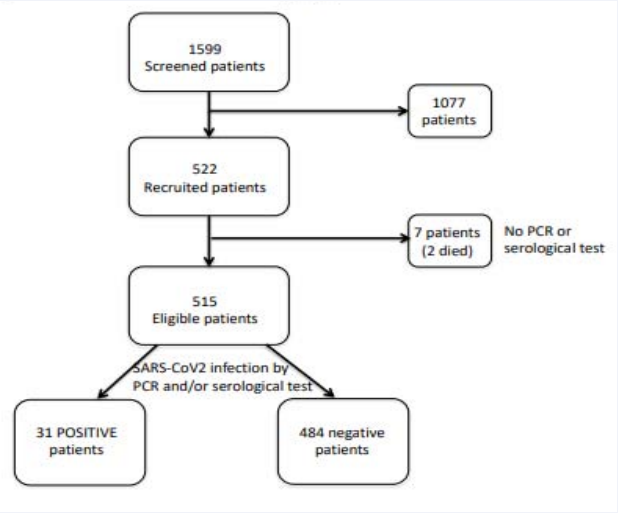

Figure 1 Flow chart of the study population.

and serological testing could not be performed.

Total antibodies were positive in 29 patients (seroprevalence 5.6%), and it was confirmed by IgM or IgG determination by ELISA in 100% of them. Out of the 29 seropositive patients, 19 were positive at baseline and 10 became positive during the study period; no reinfections were observed.

A total of 1,953 serological tests were performed, with 383 SARS-CoV-2 positive results, with median 5.5 test per patient (**Suppl. Table 1**). Out of the 29 seropositive patients, at least 74% maintained their seropositivity during 6 months or more from their first seropositive test (**Figure 2**). Eight of these patients died during follow-up (**Figure 2)**.

Characteristics of the 31 infection-positive patients can be seen in **table 2.** Positive patients had a mean age of 66 years, 16 were male, 51.6% had a history of smoking, and 4 patients (12.9%) lived in a residential care facility. In addition to cancer, seventy-one percent had at least one risk factor for Sars-Cov-2 severe infection. The most frequent tumors were lung (29%) and breast (22.6%), and 61% of patients had advanced disease. Seventeen patients were asymptomatic for COVID-19, while 14 (45.2%) showed related symptoms. Four (12.9%) patients died due to COVID-19.

Risk factors for seropositivity

In the univariant analysis of possible risk factors for a positive serologic test, the only significant results were: Contact with a COVID-19 positive patient ($p \leq 0.0001$), history of smoking ($p = 0.020$), and hypertension ($p = 0.082$), which were also significant in the regression analysis ($p<0.001$, $p=0.033$, and $p=0.014$, respectively) (**Table 3**).

No relation was found for age (< or ≥65 yrs.), diabetes mellitus, obesity, COPD or asthma, cardiovascular disease, neurological disease, hepatopathy, chronic corticosteroids, living in a residential care facility, lung cancer, chemotherapy or active treatment.

Nagelkerke R2 value was 19.4%; thus, the regression model

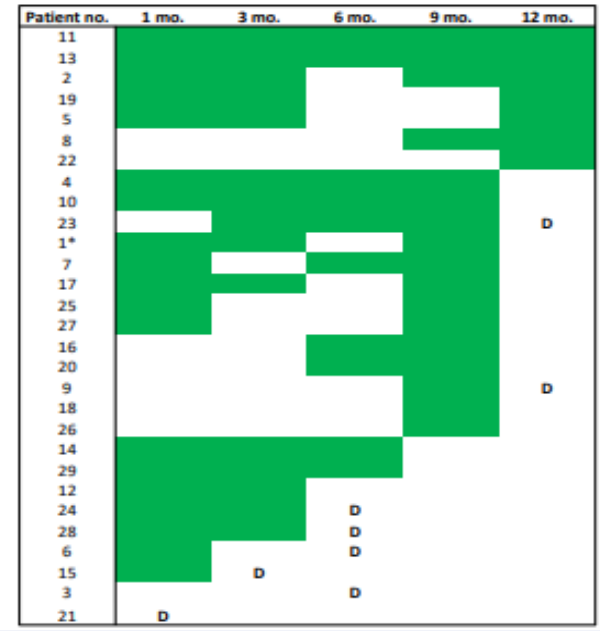

Figure 2 Mantenance of seroprevalence; N=29.
Green: Test performed and positive result; White: Test not performed; D: Death.

explained 19.4% of the variation of the dependent variable (i.e., the positivity of the serological test).

Implications of a positive test in oncologic care

Out of the 31 positive patients, 27 patients (87.1%) were receiving active antineoplastic treatment (66.7% with palliative intention), and chemotherapy was the most common therapy (44.4%) (**Table 2**). Two (7.4%) patients were on immunotherapy treatment.

Twenty-four (77.4%) patients were classified as "late or resolved infection" and thus, required no change in their oncologic care. Seven (22.6%) patients were categorized as "active infection", and five of them underwent a modification of their established treatment plan: Treatment was delayed in three patients, who had advanced disease, and stopped in two patients with advanced adenocarcinoma (**Table 4**).

The three patients with advanced disease, in whom, treatment was delayed had the following diagnosis: One had pancreas adenocarcinoma (treatment was delayed 10 days), the second one had breast carcinoma (treatment was delayed 15 days), and the third one had ALK+ lung adenocarcinoma (treatment was delayed 12 days).

One of the two patients in whom treatment was suspended had a diagnosis of advanced lung adenocarcinoma and the other,

Table 2: Baseline characteristics of the overall population (N=522) and the infection-positive patients (N=31).

Characteristics	Overall *N* =522	Infection+ *N* =31
Sex: Male	262 (50.2%)	16 (51.6%)
Age, years	65 [27-94]	65 [39-93]
Time since cancer diagnosis, months	12 [0-365]	14 [0-241]
Time since outbreak, days	100 [76-199]	97 [76-163]
[a]**Risk factors and comorbidities**	353 (67.6%)	22 (71.0%)
Previous diagnosis of COVID-19 infection	5 (1.0%)	3 (9.7%)
COVID-19 contact	26 (5.0%)	8 (25.8%)
Current or past smoker	359 (68.8%)	16 (51.6%)
Hypertension	197 (37.7%)	17 (54.8%)
DM	74 (14.2%)	5 (16.1%)
Obesity	109 (21.2%)	8 (26.7%)
Chronic renal disease	11 (2.1%)	0 (0%)
COPD or asthma	53 (10.2%)	1 (3.2%)
CVD	83 (15.9%)	8 (19.4%)
Neurologic disease	17 (3.3%)	1 (3.2%)
Hepatopathy	16 (3.1%)	0 (0%)
Chronic corticosteroids	171 (32.8%)	9 (29.0%)
Residential care facility	46 (8.8%)	4 (12.9%)
Tumor stage		
I	33 (6.3%)	1 (3.2%)
II	53 (10.2%)	4 (12.9%)
III	85 (16.3%)	7 (22.6%)
IV	351 (67.2%)	19 (61.3%)

Tumor type		
Lung	166 (31.8%)	9 (29.0%)
Breast	117 (22.4%)	7 (22.6%)
Digestive (No colon)	77 (14.8%)	4 (12.9%)
Urologic	72 (13.8%)	6 (19.4%)
Colon	29 (5.6%)	1 (3.2%)
Gynecologic	19 (3.6%)	2 (6.5%)
Head and Neck	15 (2.9%)	-
Sarcoma	14 (2.5%)	1 (3.2%)
CNS	11 (2.1%)	-
Melanoma	2 (0.4%)	1 (3.2%)
Active anticancer treatment	430 (82.4%)	27 (87.1%)
Adjuvant	64 (12.3%)	4 (14.8%)
Neoadjuvant	34 (6.5%)	2 (7.4%)
Concomitant radical RT	29 (5.6%)	3 (11.1%)
Palliative	303 (58.0%)	18 (66.7%)
[b]**Type of treatment**		
QT	174 (33.3%)	8 (29.6%)
Targeted therapy	76 (14.6%)	9 (33.3%)
Immunotherapy	75 (14.4%)	2 (7.4%)
RT/QT	33 (6.3%)	3 (11.1%)
HT	27 (5.2%)	1 (3.7%)
HT + Targeted therapy	18 (3.4%)	2 (7.4%)
QT/targeted therapy	13 (2.5%)	1 (3.7%)
Immunotherapy/QT	8 (1.5%)	-
RT	7 (1.3%)	1 (3.7%)
Previous thoracic RT	117 (22.4%)	6 (20.0%)
Infection acquired during study period	-	10 (32.3%)

CNS: Central nervous system, **CVS:** Cardiovascular disease, **DM:** Diabetes Mellitus, **COPD:** Chronic obstructive pulmonary disease, **QT:** Chemotherapy, **RT:** Radiotherapy

Data presented as no. (%) for categorical variables or median [range] for continuous variables.

a. One patient can have more than one risk factor

b. One patient can have more than one treatment

Table 3: Bilateral logistic regression to assess the putative dependency of having antibodies on sociodemographic and clinical characteristics.

Univariate analysis				**Multiple regression analysis**		
	value	**d.f.**	***p-value***	**Exp(B)**	***p-value***	**CI 95%**
Time since epidemic outbreak	0.026	1	0.873	1.000	0.998	0.98-1.01
Age (< vs. ≥ 65 yrs.)	0.501	1	0.479	0.521	0.170	0.20-1.32
Smoking (previous or current vs. never)	5.438	1	**0.020**	2.615	**0.033**	1.08-6.32
Contact with COVID- 19 patients	31.37	1	**≤ 0.0001**	12.594	**<0.001**	4.07-38.92
Hypertension	4.528	1	**0.082**	3.171	**0.014**	1.26-7.95
DM	0.211	1	0.646	0.823	0.749	0.25-2.70
Obesity	0.508	1	0.476	0.688	0.476	0.24-1.92
COPD or asthma	1.590	1	0,207	0.330	0.311	0.03-2.81
CVD	0.290	1	0,590	1.298	0.637	0.44-3.83
Neurological disease	0.001	1	0.969	1.354	0.786	0.15-12.00
Hepatopathy	1.060	1	0.303	0.000	0.998	0

Chronic corticosteroids	0.108	1	0.742	0.826	0.673	0.33-2.01
Residential care facility	0.717	1	0.397	1.495	0.530	0.42-5.25
Lung Cancer	0.407	1	0.524	1.289	0.605	0.49-3.37
Chemotherapy	0.518	1	0.472	0.700	0.425	0.29-1.68
Active treatment	0.346	1	0.556	1.740	0.380	0.50-5.99

DM: Diabetes mellitus, **COPD:** Chronic obstructive pulmonary disease, **CVD:** Cardiovascular disease, **COVID-19:** Coronavirus disease 2019, **d.f.:** degrees of freedom, **Bold p-values:** Statistically significant

Table 4: Treatment modifications and status at study end for infection-positive patients.

*Treatment modification (*N* =21)	5 (23.8%)
Treatment delayed	3 (14.3%)
Treatment suspension	2 (9.5%)
Status at study end (*N* =31)	
Alive with disease	20 (64.5%)
Alive with no disease	2 (6.5%)
Dead due to tumor	5 (16.1%)
Dead due to COVID19	4 (12.9%)

COVID-19: Coronavirus disease 2019 Data expressed as n (%)
***N* = 21** patients in active antineoplastic treatment with available data

of advanced prostate adenocarcinoma, and they both died due to tumor progression after the COVID infection had been resolved.

DISCUSSION

The current study shows an infection rate among solid tumor patients from June to September 2020 of 6%.

Cancer patients have a higher rate of infection by SARS-CoV-2 and are more likely to suffer the infection with higher morbidity and mortality than the general population [3,14]. A retrospective study conducted at a tertiary cancer institution in Wuhan reported an infection rate of SARS-CoV-2 in patients with cancer of 0.79%, which was higher than the cumulative incidence of all diagnosed COVID-19 cases reported in Wuhan over the same time period (0.37%) [3]. In a study conducted in over 1.8 million individuals from the general population of U.K., U.S. and Sweden, 0.67% (155 out of 23266) of cancer patients reported a positive COVID-19 test, while the percentage was 0.57% for the patients without cancer [14]. In an Austrian study conducted between March 21 and May 4, 2020, SARS-CoV-2 was detected in 0.4% of cancer patients (4 of 1,016), although this time the prevalence seemed to be similar to that of the overall population (also 0.4% or 6 of 1,544 non-hospitalized individuals of a cohort from the overall population) [15].

Our study shows an infection rate among solid tumor patients (6%), which is much higher than those shown in the three mentioned studies.

Spain was one of the most affected countries during the first wave of COVID-19 [7,16], as of May 10th of 2020, there had been 250,273 confirmed SARS-CoV-2 infection cases [17], and, as of September 30th of 2020, 533,857 additional cases had been reported [18], adding up to a total of 784,130 cases, which represents an infection rate of ~1.7% of the Spanish general population (47,332,614 at January 1st, 2020) [19]. A study conducted in cancer outpatients of another hospital in Madrid region (Spain), from June 1st to June 19th 2020, showed a much higher seroprevalence than our study at 31.4% [20].

A seroprevalence study conducted in households from the 50 provinces and the two autonomous cities of Spain, between April 27th and May 11th of 2020, had shown a 4.6% seroprevalence assessed by CLIA with great differences among regions [7]. The seroprevalence of the overall population in Madrid, at 11.5%, was much higher than that in the Basque region (2.9%) [7], and should explain, at least partially, the higher seroprevalence in cancer patients in Madrid [21,10].

Increased sensitivity of antibody tests has been shown to be associated with increased seroprevalence [22], and the current study used very sensitive tests. In addition, the infection prevalence in the general population (1.7%) was also higher. Methods to estimate seroprevalence also differed between the Madrid and the current study; while the current study used high sensitive and specific methods, rapid tests were used in Madrid, which, especially at low viral loads, may miss the infection [23]; thus, if any, the prevalence in Madrid might have been underestimated.

The SEIMC recommends ELISA and CLIA as the SARS-CoV-2 tests with higher specificity and sensitivity [13], and using these tests we were able to identify 29 patients out of 515 (5.6%) as infected at some point along the study course, and at least 74% of them maintained their seropositivity during 6 months or more. This fact is important, since although the presence of antibodies has not yet been confirmed to be immunologically protective against reinfection in humans, some studies suggest an association between seropositivity and protection from infection, even if protection may wane over time, and between seropositivity and protection from severe infection [24,25]. A study conducted at a National Clinical Laboratory in the United States reported loss of detectable IgG seropositivity over weeks or months, and found an association with age and severity of disease (falling faster in younger adults and milder infections) [26]. In another study conducted in UK health care workers, anti-nucleocapsid IgG levels waned fast with an estimated half-life of 85 days (and levels also fell faster in younger adults and following asymptomatic infections), while anti-spike IgG levels remained stably above the threshold for a positive result in 94% of patients up to six months [27].

The total antibodies assessed by CLIA at baseline, 1 and 3 months targeted a recombinant nucleocapside antigen, while the antibodies IgG and IgM, independently assessed by ELISA for confirmation and follow-up, targeted N and S proteins and

lasted at least 6 months in all patients that were assessed at that time point. In agreement with our results, a study conducted in Spanish health care workers showed that 97% of non-vaccinated individual patients were seropositive up to 10-12 months after onset of symptoms (IgG 95%, IgA 83%, IgM 25%) [28].The current work adds onto the knowledge of the maintenance of seropositivity in cancer patients, and it is to note that 87% of the 31 positive patients were on active immunosuppressive oncologic treatment.

The regression model showed that seropositivity was associated to contact with COVID-19 positive patients ($p < 0.001$), which has already been associated with seropositivity in previous studies conducted among healthcare workers [22,29], and with two additional factors: A history of smoking ($p=0.033$) and hypertension ($p=0.014$). Other study in cancer patients had shown pneumonia as a risk factor for seropositivity [20], and lung cancer has been recently shown to be one of the two cancers with greater susceptibility for SARS-CoV2 infection [30].

Although lung cancer was not significant in our model, smoking, as a factor affecting the respiratory system, was. It is known that patients with chronic conditions such as diabetes, hypertension or cardiopulmonary disease are at higher risk of severe disease complications and death [31,32], and the current study shows that these conditions (at least hypertension) in cancer patients are also risk factors for getting the infection, and thus, becoming seropositive.

Among the 31 positive patients, treatment was delayed in 3 and suspended in 2. Kutikov *et al* [33] had proposed to categorize patients into low, medium or high risk of disease progression with cancer treatment delay for management of these patients. They considered safe to delay treatment for >3 months in patients with chronic hematologic cancers, nonmelanoma skin cancer, nonlocally advanced breast cancer, and other low-risk cancer diseases, while treatment delay was not recommended in patients with high grade or aggressive cancers. All treatment delays and suspensions in our series were of patients with metastatic disease, since treatment management was based on serology.

The study has the limitations inherent to real-world studies generated during routine clinical practice, and since part is retrospective, it is even more likely to be subjected to bias and confounding factors. In addition, the regression model only explains 19.5% of the variability of being seropositive. However, this is one of the few studies conducted in cancer patients in Spain, and provides valuable information for their care in SARS-CoV2 pandemic times.

In conclusion, serology by CLIA and ELISA is a sensitive and specific method for establishing SARS-CoV2 infection status in the oncologic population. Prevalence of infection is 6% among solid tumor outpatients in our series, and antineoplastic therapy is modified in more than a quarter of patients positive to the infection.

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