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# Enhancing patient outcomes: Integrating electronic cardiology consultation in primary care for cancer patients

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## Abstract

**Background:** The prevalence of cancer patients with concomitant cardiovascular (CV) disease is on the rise due to improved cancer prognoses. The aim of this study is to evaluate the long-term outcomes of cancer patients referred to a cardiology department (CD) via primary care using e-consultation.

**Methods:** We analysed data from cancer patients with prior referrals to a CD between 2010 and 2021 ($n = 6889$) and compared two care models: traditional in-person consultations and e-consultations. In e-consultation model, cardiologists reviewed electronic health records (e-consultation) to determine whether the demand could be addressed remotely or necessitated an in-person consultation. We used an interrupted time series regression model to assess outcomes during the two periods: (1) time to cardiology consultation, (2) rates of all-cause and CV related hospital admissions and (3) rates of all-cause and CV-related mortality within the first year after the initial consultation or e-consultation at the CD.

**Results:** Introduction of e-consultation for cancer patients referred to cardiology care led to a 51.8% reduction (95%CI: 51.7%–51.9%) in waiting times. Furthermore, we observed decreased 1-year incidence rates, with incidence rate ratios (iRRs)

[IC95%] of .75 [.73–.77] for CV-related hospitalizations, .43 [.42–.44] for all-cause hospitalizations, and .87 [.86–.88] for all-cause mortality.

**Conclusions:** Compared to traditional in-person consultations, an outpatient care program incorporating e-consultation for cancer patients significantly reduced waiting times for cardiology care and demonstrated safety, associated with lower rates of hospital admissions.

**KEYWORDS**

cancer, cardio-oncology care, cardiovascular outcomes, inter-clinician electronic consultation

## 1 | INTRODUCTION

The incidence of cancer cases has steadily increased over the past few decades, primarily due to advancements in cancer diagnosis and treatment. Consequently, individuals with a history of cancer are at an elevated risk of developing cardiovascular (CV) diseases.[1]

Managing healthcare for cancer patients poses a growing challenge, characterized by an expanding group of patients with multiple conditions, particularly CV diseases, exhibiting a higher risk profile.[1]

Notably, the European Society of Cardiology published its first guideline on cardio-oncology, aiming to provide guidance to healthcare professionals in delivering care to oncology patients, encompassing their CV health through the cancer treatment continuum.[2]

Within the framework of public health systems, primary care physicians (PCPs) play a central role in the prevention, diagnosis, treatment, and follow-up for patients with both cancer and CV diseases. Consequently, various hospital departments, including oncology, internal medicine, and cardiology, need to organize healthcare services effectively to manage referrals from PCPs, thereby minimizing waiting times for care. This is particularly important for cancer patients with suspected CV pathology.[3] Timely access and effective communication between clinicians are essential to ensuring quality, efficiency, and safety in patient care. Nevertheless, obtaining appointments for PCP referrals remains a persistent challenge, particularly with specialized departments like cardiology department (CD). Insufficient access to care is a major contributor to healthcare disparities, leading to higher rates of disability, chronic disease sequelae, and death.[4] The outbreak of the SARS-CoV-22,019 (COVID-19) pandemic caused disruptions in outpatient CV and oncology care, potentially affecting patient outcomes.[5,6] Moreover, it accelerated the development of digital health technologies as a means to manage the surge in COVID-19 cases and ensure continued care delivery to patients in need.[7,8]

Clinician-to-clinician electronic consultation programs, known as e-Consult, are an emerging healthcare innovation designed to mitigate prolonged wait times for specialist care. They enable PCPs to seek expert opinion from specialists in a timely manner.[9] E-Consult services have proven effective in providing faster access to specialist advice, characterized by short response times from participating specialists and resulting in a substantial reduction in face-to-face referral visits. This care model is deemed safe, correlating with favourable outcomes, including lower rates of emergency department visits, hospital admissions and mortality within the first year, compared to face-to-face consultations for all referrals.[9,10]

The hypothesis of our study was that integrating e-consultation into the outpatient care process of cancer patients referred to a CD would improve healthcare accessibility and positively influence health outcomes, such as hospitalization and mortality, for individuals with a history of cancer referred to a CD by PCPs. Additionally, our study aimed to assess the impact of the COVID-19 pandemic on the outcomes of this patient population.

## 2 | METHODOLOGY

### 2.1 | Patients

The study was conducted in the health area of Santiago de Compostela, located in Galicia, northwest Spain, which provides care through 301 PCPs for a population of 446,603 individuals. This health area comprises three urban hospitals and one local hospital, all managed by a single CD.

For our analysis, we included 6889 patients previously diagnosed with cancer, selected from a total of 68,518 patients, who were referred to the CD between the years 2010 and 2021 (see Figure 1).

This study received approval from the local ethics committee on March 23, 2022, under reference number 2021/496.

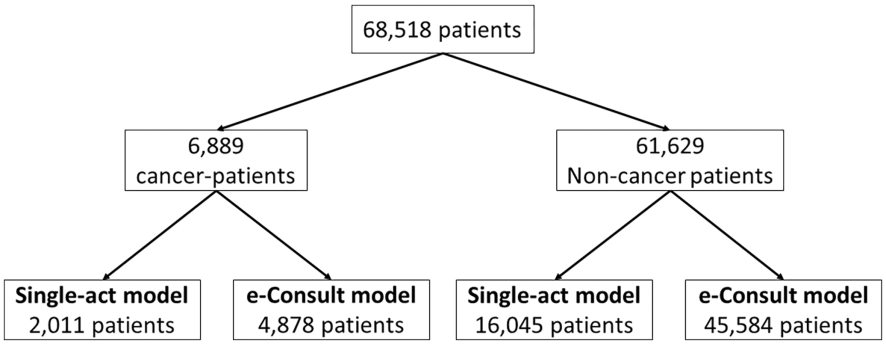


**FIGURE 1** Flow diagram: Patient demographics, prior cancer diagnosis and care delivery model.

## 2.2 | Consultation models

We compared two distinct time periods, using the beginning of the e-consult program on 1 January 2013, serving as the starting point for all PCP referrals: single-act face-to-face consultations from 2010 to 2012, and electronic consultations (e-consults), from 2013 to the present.

During the first period (2010–2012), all patients referred by PCPs underwent in-person consultations, during which the cardiologist conducted necessary complementary tests and determined the need for follow-up cardiology visits. In contrast, during the e-consult period (2013–present), we introduced e-consults as the initial step, enabling triage of all referrals to determine the necessity of an in-person consultation.[9] Following the in-person consultation in both models, certain patients were identified for follow-up in dedicated cardiology consultations.

The e-consult system is anchored in the sharing of patient information sourced from primary care and hospitals across the Spanish region of Galicia, integrated into our electronic health record system. PCP e-consults must include all clinically relevant information, subsequently reviewed by a cardiologist a few days later, along with any additional tests performed in primary care (PC) (e.g., electrocardiograms, chest x-rays, blood tests) and relevant information regarding the patient's disease history (e.g., prior hospitalizations for heart failure and their respective diagnosis dates). Based on this information, the cardiologist can address the e-consultation without the need for a face-to-face consultation or schedule the patient for an in-person visit.

## 2.3 | Variables

We collected the following data for all patients: sex, age at the time of the first e-consultation, date of the e-consultation, any diagnosed CV risk factors, history of previous CV diseases, date of cardiology consultation, number of follow-up consultations, and whether a face-to-face consultation was conducted after the e-consultation. For the follow-up period, we also assessed: (1) emergency department visits, (2) hospital admissions (both overall and due to CV reasons) and (3) mortality (both overall and CV related) during the first year after the initial consultation or e-consultation to the CD.[9,10]

We obtained epidemiological and administrative data from the healthcare database, while clinical data were obtained from the electronic clinical record using International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes for cancer-related information and hospitalizations, and International Classification of Primary Care (ICPC-2) codes for personal medical histories. Mortality causes were obtained from hospital records for in-hospital deaths or civil records for out-of-hospital deaths, both using ICD-10 codes.

Information regarding cancer was obtained from clinical histories, documented with ICPC-2 codes in PC, ICD-10 codes for hospitalized patients, and also from ambulatory assistance in the oncology and radiotherapy departments. However, our administrative and clinical databases did not allow us to obtain information on clinical status (e.g., in treatment, stable, or palliative care) or previous surgical treatments.

In addition to the descriptive analysis mentioned earlier, we conducted a temporal trend analysis for four outcomes in both groups (patients with a previous cancer diagnosis and patients without a cancer diagnosis): (1) waiting times for CD consultation after the PCP referral, (2) incidence of emergency department visits, (3) hospital admissions (both overall and CV related), and (4) mortality (all-cause and CV related) during the first year after consultation, comparing the in-person consultation and post e-consultation periods.

## 2.4 | Statistical analysis

Qualitative variables were expressed as percentages (%), and continuous quantitative variables were presented as mean ± standard deviation (SD). The chi-square test was used to assess significant associations between

qualitative variables, while Student's *t*-test was employed to investigate associations between quantitative variables, after confirming normal distribution assumptions in both groups. Statistical significance was established at $p < .05$.

To evaluate the impact of the e-consultation program on delays in care, hospital admissions, and mortality in both groups, we conducted an interrupted time series (ITS) regression analysis.[11] The predictors included in the model were the time elapsed from the beginning of the study (in months), consultation type (0 for in-person consultation; 1 for e-consultation), and the interaction between time and type of consultation. Overdispersion was considered and controlled for, and we calculated the incidence relative risk (RR) with the corresponding 95% confidence interval [95%CI] for each outcome across three distinct periods. Additionally, we estimated the incidence of hospitalizations and mortality over time, represented as cases per 100 patients per month.

A multivariate logistic regression was performed for each outcome, estimating the odds ratio (OR) with the corresponding 95% confidence interval [95%CI] for each variable associated with the four outcomes. Variables included in the model were those that could potentially influence prognosis, such as personal characteristics (age, gender), comorbidities (arterial hypertension, diabetes mellitus, ischemic heart disease, heart failure, cerebrovascular disease, peripheral arterial disease), previous cancer diagnosis, the COVID-19 period, and factors related to disease management (time delay until cardiologist evaluation, consultation model, and number of emergency department visits during the first year after the e-consultation).

Data analysis was performed using SPSS version 25.0 (SPSS Inc., United States), and ITS analyses were conducted using R version 3.5.1 and the open-source BayesX software.

## 3 | RESULTS

### 3.1 | Overview of baseline clinical characteristics, co-morbidities and outcomes in both patient groups

We analysed a total of 6889 PCP referrals for patients with cancer from 2010 to 2021 (see Figure 1). Tables 1 and 2 provides an overview of the baseline epidemiological characteristics, comorbidities, and healthcare data for patients with a history of cancer.

In both groups (PCP referrals of patients with and without cancer), compared to patients seen in single-act consultation, those in e-consultation period were older ($p < .001$, $p = .001$, respectively). The cancer group showed a higher prevalence of men with an increasing proportion of women after the e-consult model implementation ($p = .001$). Additionally, all analysed comorbidities were more common in the cancer group ($p < .001$), with a reduced prevalence after e-consult model implementation ($p < .001$); only the proportion of patients with atrial fibrillation increased in the non-cancer group ($p < .001$).

Following the implementation of e-consultations, there was a significantly higher need for in-person visits among patients with cancer ($p < .001$). The elapsed time to receive cardiology care was similar in both patient groups ($p = .899$), with an important reduction in both groups, compared with the previous in-person consultation period ($p < .001$). Over 60% of referrals were resolved in less than 8 days, with this proportion significantly higher, in both groups, after the e-consultation program was introduced ($p < .001$).

Patients with cancer required more complementary tests ($p < .001$) and had a greater need for emergency department visits ($p < .001$); which were reduced after the e-consultation implementation in cancer and non-cancer patients ($p < .001$, in both groups).

Tables 3 and 4 summarizes the 1-year follow-up outcomes (hospitalization and mortality rates) after PCP referral for both patient groups. Patients with cancer exhibited higher rates of all-cause hospitalizations ($p < .001$), CV related hospitalizations ($p = .044$), and all-cause mortality ($p < .001$). The four analysed outcomes were significantly reduced after e-consultation implementation both in cancer and non-cancer patients ($p < .001$).

Cancer was identified as the leading cause of death within the 1-year timeframe in both groups, accounting for 57.8% of all deaths in the cancer group compared to 9.5% in the group without a cancer history. In both groups, heart failure and ischemic heart disease were the primary causes of CV-related deaths.

### 3.2 | Results of interrupted time series regression analysis

#### 3.2.1 | Delay from PCP referral to cardiology consultation

The interrupted temporal trend regression analysis revealed a reduction in the delay between PCP referral and CD assistance over the observation period, with a particularly pronounced decreased following the introduction of e-consultations for both patient groups. Overall, compared to the preceding period, the implementation of e-consultation was associated with a significant ($p < .001$) reduction in delay by 51.8% (95%CI: 51.7%–51.9%). Furthermore, during the e-consultation period, there was

**TABLE 1** Epidemiological characteristics, personal history and healthcare data at 1 year follow-up in patients with cancer.

| | Total | Single-act consultation | e-consultation | *p*-value |
|---|---|---|---|---|
| *N* | 6889 | 2011 | 4878 | |
| Age (mean [SD]) (years) | 71.9 (11.0) | 69.5 (10.7) | 72.9 (10.9) | <.001 |
| Women (%) | 38.6% | 36.3% | 39.5% | .011 |
| Personal history | | | | |
| Arterial hypertension (%) | 64.7% | 69.2% | 62.9% | <.001 |
| Diabetes mellitus (%) | 24.7% | 27.9% | 23.3% | <.001 |
| Ischaemic heart disease (%) | 12.2% | 15.4% | 10.9% | <.001 |
| Heart failure (%) | 8.7% | 13.3% | 6.8% | <.001 |
| Atrial fibrillation (%) | 28.3% | 27.7% | 28.6% | .498 |
| Cerebrovascular disease (%) | 2.9% | 6.8% | 1.4% | <.001 |
| Peripheral arterial disease (%) | 6.1% | 6.6% | 5.8% | .223 |
| Consultation model | | | | |
| Single act model | 81.2% | 83.2% | 79.6% | .258 |
| E-consult model | 18.8% | 16.8% | 20.4% | |
| E-consult | | | | |
| e-consult solves (%) | - | - | 36.0% | <.001 |
| Single act solves (%) | 43.3% | 54.1% | 38.9% | |
| Follow-up consultations (%) | 31.2% | 45.9% | 25.1% | |
| Delay consultation | | | | |
| Delay in cardiology consultation (mean [SD]) (days) | 14.9 (28.1) | 35.8 (44.5) | 6.2 (6.4) | <.001 |
| <8 days (%) | 61.3% | 27.8% | 75.1% | <.001 |
| 8–14 days (%) | 14.5% | 15.0% | 14.2% | |
| 15–30 days (%) | 13.0% | 20.6% | 9.9% | |
| >30 days (%) | 11.2% | 36.5% | .8% | |
| Cardiology assistance | | | | |
| Cardiology tests first year (mean [SD]) | 1.14 (1.8) | 1.59 (2.52) | .94 (1.30) | <.001 |
| Emergency department visit first year (mean [SD]) | 2.58 (4.63) | 6.11 (6.60) | .99 (1.87) | <.001 |
| Emergency department visit first year (%) | 58.7% | 91.8% | 43.9% | <.001 |

Abbreviation: SD: standard deviation.

a reduction of .48 (.07) days per month for patients with cancer and .50 (.07) days per month for patients without cancer (see Figure 2).

### 3.2.2 | Hospital admissions at 1-year after consultation

The rate of all-cause hospital admissions at 1 year was higher for patients with a prior cancer diagnosis during the observation period. For both patient groups, a downward trend was observed during the e-consultation period. All-cause hospital admissions, in the in-person consultation phase, were higher for patients without cancer and decreased similarly for both groups (−2.8 [2.6–3.0] per month for the cancer group, $p < .001$, and −2.6 [2.5–2.7] per month for patients without cancer, $p < .001$). However, after the introduction of the e-consultation program, the reduction in total hospitalizations was more pronounced for patients without cancer (−1.7 [1.6–1.7] per month, $p < .001$) compared to those with cancer (−1.2 [1.1–1.3] per month, $p < .001$). For both groups, the inception of the e-consultation program marked a decline in total hospitalizations (iRR: .43 [.42–.44], for patients with cancer and iRR: .64 [.63–.65] for patients without cancer) as shown in Figure 2A. The COVID-19 pandemic brought about a shift in these trends, leading to an increase in both groups, with a significantly higher increase in patients with cancer: iRR 2.28 [2.21–2.38] and 1.346 [1.35–1.3], respectively (see Figure 3A).

The incidence of CV hospital admissions was also higher for patients without cancer during the third period, as indicated in Figure 3B. This outcome showed a

**TABLE 2** Epidemiological characteristics, personal history and healthcare data in patients without cancer.

| | Total | Single-act consultation | e-consultation | *p*-value |
|---|---|---|---|---|
| *N* | 61,629 | 16,045 | 45,584 | |
| Age (mean [SD]) (years) | 63.3 (18.8) | 62.9 (19.1) | 63.4 (18.7) | .001 |
| Women (%) | 50.6% | 51.1% | 50.4% | .160 |
| Personal history | | | | |
| Arterial hypertension (%) | 51.9% | 53.2% | 51.5% | <.001 |
| Diabetes mellitus (%) | 17.9% | 19.8% | 17.2% | <.001 |
| Ischaemic heart disease (%) | 10.0% | 12.3% | 9.2% | <.001 |
| Heart failure (%) | 7.1% | 12.6% | 5.2% | <.001 |
| Atrial fibrillation (%) | 21.3% | 20.2% | 21.7% | <.001 |
| Cerebrovascular disease (%) | 2.5% | 5.9% | 1.3% | <.001 |
| Peripheral arterial disease (%) | 3.5% | 3.5% | 3.4% | .482 |
| Consultation model | | | | |
| Single act model | 76.4% | 72.7% | 79.6 | <.001 |
| E-consult model | 23.6% | 27.3% | 20.4 | |
| E-consult | | | | |
| e-consult solves (%) | - | - | 37.1% | <.001 |
| Single act solves (%) | 46.4% | 61.2% | 41.2% | |
| Follow-up consultations (%) | 26.1% | 38.8% | 21.7% | |
| Delay consultation | | | | |
| Delay in cardiology consultation (mean [SD]) (days) | 14.9 (29.2) | 40.5 (47.6) | 5.9 (6.3) | <.001 |
| <8 days (%) | 63.9% | 25.5% | 77.4% | <.001 |
| 8–14 days (%) | 13.0% | 13.2% | 12.9% | |
| 15–30 days (%) | 11.9% | 20.6% | 8.8% | |
| >30 days (%) | 11.2% | 40.7% | .8% | |
| Cardiology assistance | | | | |
| Cardiology tests first year (mean [SD]) | .96 (1.6) | 1.29 (2.33) | .84 (1.23) | <.001 |
| Emergency department visit first year (mean [SD]) | 1.71 (3.75) | 4.59 (5.99) | .64 (1.31) | <.001 |
| Emergency department visit first year (%) | 47.1% | 82.3% | 34.0% | <.001 |

Abbreviation: SD: standard deviation.

slight downward trend in patients with cancer during the in-person consultation phase (−2.9 [2.7–3.1] per month, $p < .001$), and for patients without cancer (−2.7 [2.6–2.8] per month, $p < .001$). However, following the introduction of e-consultation, this incidence showed an upward trend to 2.2 (95%CI: 2.1–2.3) per month for patients with cancer and a downward trend to −2.3 (95%CI: 2.3–2.4) per month for patients without cancer. Nonetheless, in both groups, the implementation of e-consultations led to a reduction in the incidence of CV related hospitalizations (iRR (cancer): .75 [.73–.77] and iRR (non-cancer): .87 [.86–.88]) as displayed in Figure 2B. The COVID-19 pandemic was associated with an increased rate of CV admissions in both groups: iRR 1.34 [1.28–1.39] and 1.08 [1.07–1.08], respectively; but experienced a decreasing trend during the COVID-19 period (−2.0 [1.8–2.2], in cancer patients and −2.2 [2.2–2.3], in non-cancer patients) as shown in Figure 3B.

### 3.2.3 | Mortality at 1-year after consultation

The 1-year all-cause mortality rates after cardiology consultation were higher for patients with cancer during the third period as illustrated in Figure 4A. In both patient groups, there was an upward trend in all-cause mortality (3.1 [2.9–3.3] and 3.2 [3.1–3.3] for cancer and non-cancer patients, respectively) during the in-person consultation phase. However, after the implementation of e-consultations, both incidences saw a reduction, with an upward trend observed for patients without (3.7 [3.6–3.7]) and a slight downward trend for patients with cancer (2.7

**TABLE 3** Hospital admissions, mortality and causes of mortality at 1 year follow-up in patients with cancer.

| | Total | Single-act consultation | e-consultation | *p*-values |
|---|---|---|---|---|
| *N* | 6889 | 2011 | 4878 | |
| Hospitalizations | | | | |
| Total hospitalizations (%) | 16.3% | 20.8% | 5.3% | <.001 |
| CV-hospitalizations (%) | 6.9% | 7.8% | 4.7% | <.001 |
| Deaths | | | | |
| All-cause death (%) | 5.8% | 6.4% | 4.4% | .002 |
| CV-death (%) | .8% | 1.0% | .4% | .011 |
| Cause of death | | | | |
| Cancer (%) | 57.8% | 64.8% | 52.5% | <.001 |
| Ischemic heart disease (%) | 3.2% | 3.5% | 2.8% | |
| Heart Failure (%) | 3.0% | 3.1% | 3.0% | |
| Respiratory infection (%) | 1.2% | 1.2% | 1.2% | |
| COVID-19 (%) | 1.2% | - | 1.2% | |
| Ischemic stroke (%) | 1.1% | 1.3% | 1.0% | |
| COPD (%) | 1.1% | 1.7% | .6% | |
| Atrial fibrillation (%) | 1.1% | 1.3% | 1.0% | |
| Valvular heart disease (%) | 1.0% | 1.0% | 1.0% | |
| Kidney failure (%) | .7% | .9% | .5% | |
| Haemorrhagic stroke (%) | .3% | .3% | .2% | |
| Others (%) | 46.2% | 28.5% | 50.7% | |

Abbreviations: COPD, chronic obstructive pulmonary disease; COVID-19: SARS-CoV-2; CV, cardiovascular.

[2.6–2.9]). The introduction of e-consultations resulted in a reduction in total mortality for both groups (RR: .88 [.86–.91] for cancer patients and RR: .87 [.86–.88] for patients without cancer) as depicted Figure 4A.

The 1-year CV mortality was higher for patients without cancer in both periods, except during the COVID-19 period, as shown in Figure 4B. Both groups displayed a downward trend in 1 year CV-related mortality (−5.5 [4.8–6.2] for cancer patients and −3.9 [3.8–3.9] for non-cancer patients). During the e-consultation period, CV-related mortality showed a declining trend for cancer patients (−4.6 [4.3–4.9]) but an upward trend for non-cancer patients (4.5 [4.4–4.6]). In both groups, the implementation of e-consultations led to a reduction in CV-related mortality (RR: .83 [.78–.89] for cancer patients, and RR: .87 [.86–.88] for non-cancer patients), as illustrated in Figure 4B.

The COVID-19 pandemic was associated with an increased all-cause mortality for patients without cancer (iRR: 1.06 [1.05–1.06]) and a reduced mortality for patients with cancer (iRR: .80 [.79–.81]), but with an upward trend over the period (2.4 [2.2–2.6]). CV-related mortality during the COVID-19 period showed a downward trend in both groups (−3.9 [3.5–4.3] for cancer patients and −4.3 [4.1–4.5] for patients without cancer). However, this period showed a reduction in incidence for patients without cancer (RR: .83 [.78–.89]) and an increase for patients with cancer (RR: 1.16 [1.15–1.17]).

In the multivariate analysis, the delay in receiving cardiology care was significantly associated with an independent increase in 1-year mortality and hospital admission for both groups of patients. Furthermore, the implementation of the e-consult model was associated with a reduction in mortality and hospital admission rates (refer to Tables 3 and 4). The COVID-19 pandemic was independently associated with an increase in mortality and hospitalizations for both patient groups (see Tables 5 and 6).

## 4 | DISCUSSION

Our study encompassed a substantial cohort of patients referred by PCPs for cardiology consultation, revealing that approximately 10% of these patients (6889 individuals) had a previous history of cancer. This group exhibited a higher prevalence of comorbidities and experienced less favourable 1-year outcomes compared to a much larger cohort of patients without cancer (60,630 patients). Our findings suggest that introducing e-consultation into the cardiology outpatient care model for cancer patients is associated with improved healthcare accessibility for

**TABLE 4** Hospital admissions, mortality and causes of mortality at 1 year follow-up in patients without cancer.

| | Total | Single-act consultation | e-consultation | *p*-value |
|---|---|---|---|---|
| *N* | 61,629 | 16,045 | 45,584 | |
| Hospitalizations | | | | |
| All-cause hospitalizations (%) | 11.3% | 13.1% | 5.9% | <.001 |
| CV-hospitalizations (%) | 6.2% | 6.5% | 5.4% | <.001 |
| Deaths | | | | |
| All-cause death (%) | 2.9% | 4.1% | 2.5% | <.001 |
| CV-death (%) | 1.3% | 2.1% | 1.1% | <.001 |
| Cause of death | | | | |
| Cancer (%) | 9.5% | 10.9% | 8.2% | <.001 |
| Heart failure (%) | 9.3% | 9.6% | 8.9% | |
| Ischemic heart disease (%) | 8.9% | 9.5% | 8.3% | |
| Ischemic stroke (%) | 5.3% | 6.0% | 4.6% | |
| Valvular heart disease (%) | 3.3% | 4.2% | 2.3% | |
| Respiratory infection (%) | 3.3% | 3.5% | 3.1% | |
| COPD (%) | 3.1% | 4.7% | 1.6% | |
| Atrial fibrillation (%) | 2.8% | 3.7% | 1.9% | |
| Hemorrhagic stroke (%) | 1.7% | 2.1% | 1.3% | |
| Kidney failure (%) | 1.6% | 2.1% | 1.0% | |
| COVID-19 (%) | 1.1% | - | 1.1% | |
| Others (%) | 46.2% | 28.5% | 50.7% | |

Abbreviations: COPD, chronic obstructive pulmonary disease; COVID-19: SARS-CoV-2; CV, cardiovascular.

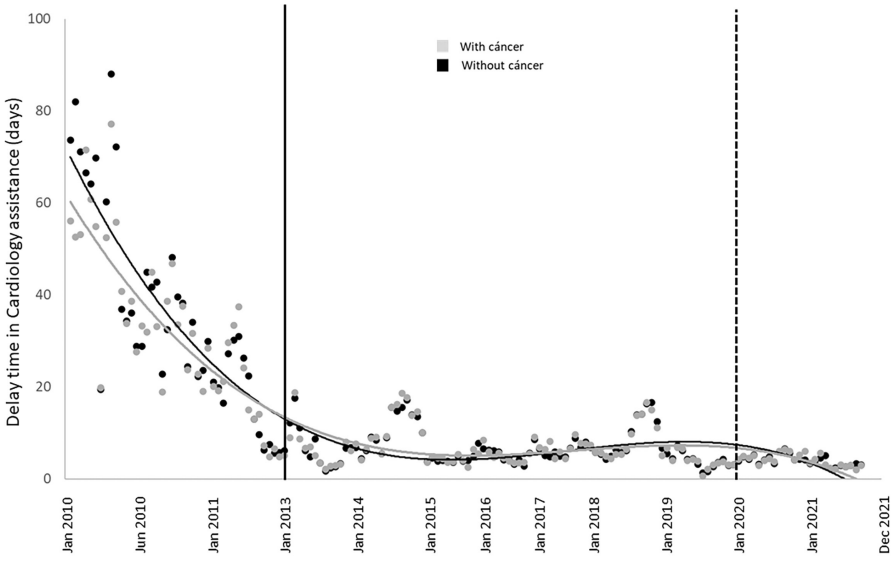


**FIGURE 2** Analysis of the interrupted temporal trends in elapsed time to cardiology care in both groups (with cancer and without cancer).

a significant patient population. Furthermore, this approach was proven to be safe, as it correlated with a significant reduction in all-cause and CV hospital admissions during the e-consultation period, though the associations with mortality reduction did not achieve statistical significance. However, it is noteworthy that CV outcomes were greater among non-cancer patients, whereas all-cause outcomes were greater among cancer patients during the e-consultation period.

To the best of our knowledge, our study is the first to describe the characteristics, 1-year outcomes, and the results of an e-consultation initiative for cancer patients referred for cardiology care by PCPs, while also considering the influence of the COVID-19 pandemic. We believe that our experience in managing the healthcare demands of this highly vulnerable patient group, with an integrated electronic medical record spanning all healthcare levels, can enhance accessibility to

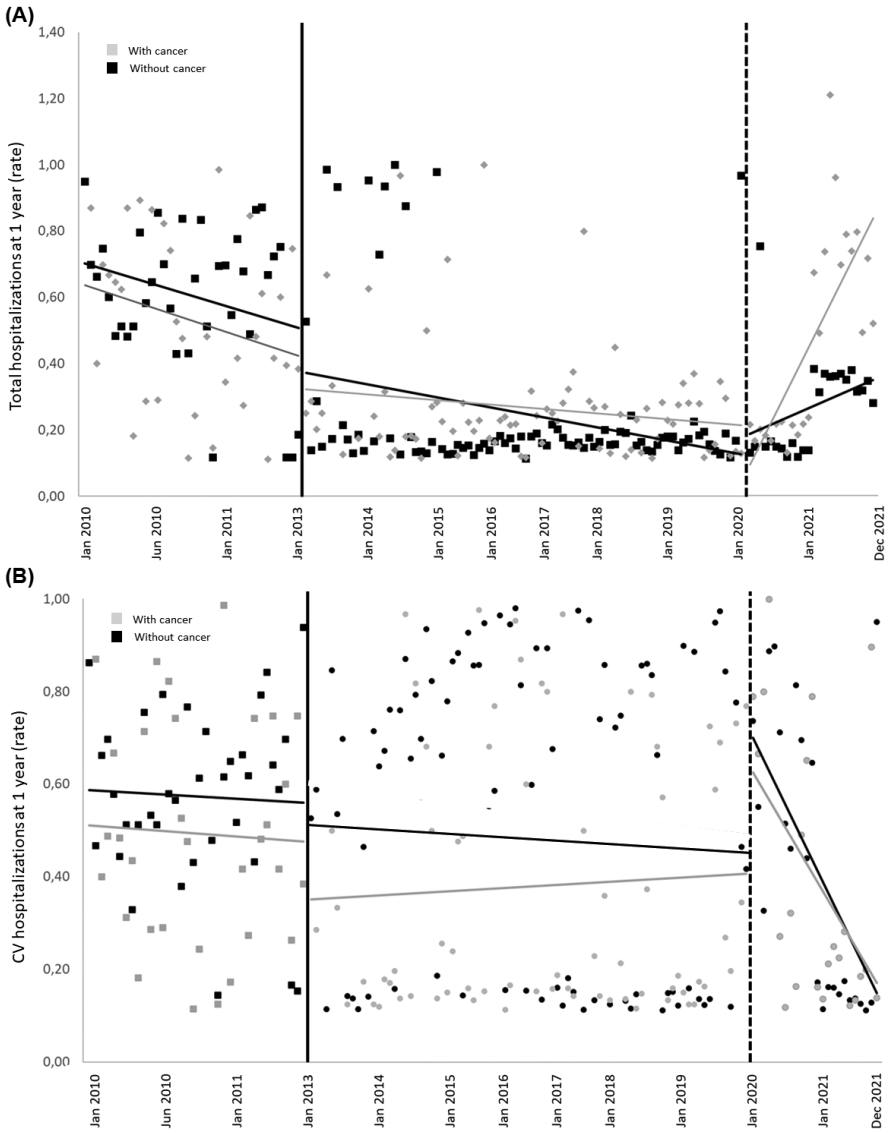


**FIGURE 3** Analysis of the interrupted temporal trends in all-cause hospital admissions (A), and cardiovascular disease hospital admissions (B), in the first year after consultation in both groups (with cancer and without cancer). The rate of hospitalization was measured in 100 persons per month.

cardiology care for patients with complex clinical conditions characterized by a high prevalence of comorbidities, advanced CV pathologies, and limitations in healthcare accessibility.[12] Our study notably reveals an increased rate of 1-year hospitalizations and mortality after the onset of the COVID-19 pandemic, particularly among cancer patients, despite the reduction in time taken to access cardiology care. The disruptive effects of the COVID-19 pandemic on healthcare transitions across all levels of the healthcare system, including limited access to care and complementary tests, may help explain these results.[13]

Our outpatient management model may be of interest to healthcare organizations in other regions, especially those with extensive geographical dispersion and patient populations facing difficulties in accessing healthcare services. Implementing such a model can expedite care delivery for patient groups at high risk of CV complications and frequent decompensations, such as those with heart failure.[14–16] A single electronic medical record is available for all the health professionals in our region including all the patient clinical information. After an e-consult, the cardiologist may resolve the request without the need for an in-person visit, including a specific comment in the patient medical record. The remaining patients are scheduled for a face-to-face visit; after this in-person consultation, the patient may be referred back to their PCP, or may be also followed up in a specific cardiology care program.

Patients with cancer are at higher risk of developing CV complications compared to their counterparts without cancer, and conversely, patients with CV disease have a greater risk of developing cancer. This interplay is attributed to shared mechanistic pathways between tumour growth and CV physiology. Furthermore, overlaps also exist between pathways necessary for normal CV physiology and those required for tumour growth.[17–20] These shared mechanisms explain the frequent referrals for cardiology consultation in

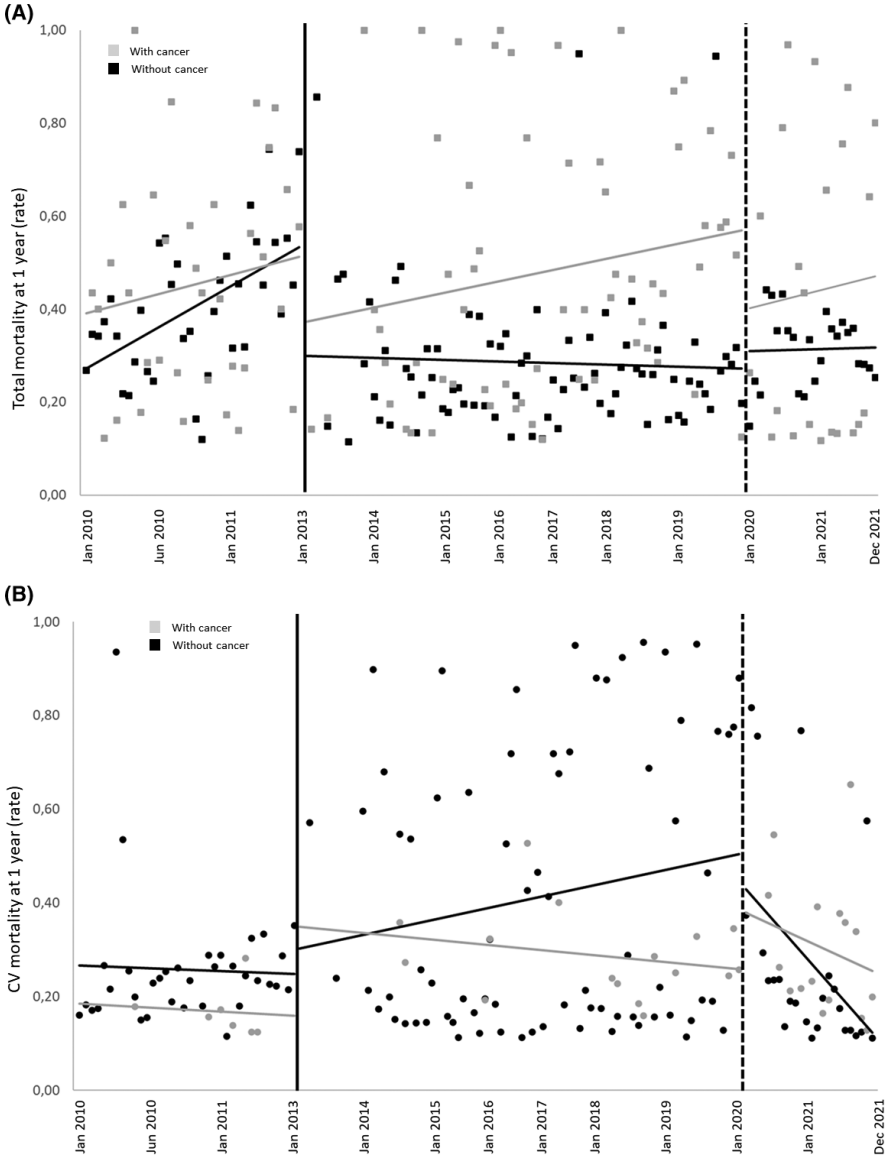


**FIGURE 4** Analysis of the interrupted temporal trends in all-cause mortality (A), and cardiovascular disease mortality (B), in the first year after consultation in both groups (with cancer and without cancer). The rate of hospitalization was measured in 100 persons per month.

cancer patients and the need for outpatient management models that expedite care for this high-risk patient group.[2]

The COVID-19 pandemic had a profound impact on routine outpatient care worldwide, resulting in delayed and disrupted care that can adversely affect patient outcomes, healthcare utilization, and patient experience.[21] Timely access to care has become a key performance indicator for healthcare systems. Many studies have reported significant increases in overall waiting times during the COVID-19 pandemic, and the effects of this disruption have persisted.[22–24] However, the prognostic impact of COVID-19 on patient outcomes following disrupted outpatient care for those referred by PCPs for cardiology consultation has not been systematically evaluated.

E-consultations represent a promising technology to address these challenges. They improve communication and information exchange between clinicians and offer timely access to efficient, high-quality care for patients. E-consultations involve asynchronous, non-face-to-face interactions between PCPs and specialists using a secure electronic communication platform, usually integrated with the patient's electronic medical record.[25,26] In many cases, the clinician can manage the care demand with guidance from the specialist provided via e-consultation, reducing the need for in-person visits.[27] Several studies have demonstrated the potential of e-consultations to reduce waiting times for specialty care and improve healthcare for vulnerable patients. They can also significantly reduce the need for face-to-face consultations, with reductions ranging from 8.9% to 51%, depending on the clinical setting and specialty.[28]

Our group has previously reported the benefits of implementing an e-consultation program as the first step for all PCP referrals to our CD. This initiative improved 1-year outcomes compared to a previous period of in-person consultation for all referrals.[9,10,12]

**TABLE 5** Multivariate analysis of factors linked to hospital admissions and death, in patients with cancer.

| | CV-hospitalizations OR (95%CI) | All-cause hospitalization OR (95%CI) | CV-mortality OR (95%CI) | All-cause mortality OR (95%CI) |
|---|---|---|---|---|
| Age | **1.013 (1.003–1.024)** | **1.012 (1.005–1.019)** | **1.126 (1.081–1.172)** | **1.055 (1.042–1.068)** |
| Comorbidities | | | | |
| Arterial hypertension | 1.04 (.83–1.29) | 1.08 (.93–1.26) | **.53 (.29–.94)** | **.71 (.56–.88)** |
| Diabetes mellitus | 1.22 (.98–1.52) | 1.06 (.90–1.24) | 1.28 (.69–2.37) | 1.19 (.94–1.50) |
| Ischemic heart disease | **1.40 (1.07–1.83)** | 1.08 (.88–1.34) | 1.02 (.47–2.25) | .99 (.72–1.35) |
| Atrial fibrillation | 1.03 (.82–1.30) | 1.05 (.89–1.23) | 1.02 (.56–1.86) | 1.18 (.93–1.49) |
| Heart failure | **1.81 (1.36–2.40)** | **1.43 (1.13–1.79)** | **2.18 (1.09–4.39)** | 1.25 (.91–1.73) |
| Cerebrovascular disease | 1.18 (.67–2.09) | .99 (.62–1.59) | - | .58 (.27–1.26) |
| Peripheral arterial disease | **1.93 (1.40–2.65)** | **1.62 (1.26–2.10)** | **2.99 (1.39–6.45)** | **1.52 (1.05–2.21)** |
| COVID-19 periods | | | | |
| PreCOVID-19 (ref) | 1 | 1 | 1 | 1 |
| PostCOVID-19 | 1.13 (.90–1.43) | **1.92 (1.65–2.23)** | **2.31 (1.19–4.47)** | **1.53 (1.19–1.96)** |
| Healthcare activity | | | | |
| Number of visits to the emergency department (1 year follow-up) | **1.04 (1.01–1.06)** | **1.07 (1.06–1.09)** | .97 (.88–1.08) | 1.01 (.98–1.04) |
| Waiting time to cardiology care | | | | |
| 0–7 days (ref) | 1 | 1 | 1 | 1 |
| 8–14 days | **1.30 (1.01–1.68)** | **1.25 (1.02–1.52)** | **4.27 (1.44–12.69)** | **1.39 (1.06–1.83)** |
| 15–30 days | **1.52 (1.05–2.20)** | **1.35 (1.01–1.82)** | 3.69 (.69–19.94) | 1.11 (.73–1.68) |
| >30 days | 1.47 (.88–2.46) | **1.58 (1.01–2.47)** | .924 (.06–15.29) | .83 (.49–1.41) |
| Consultation model | | | | |
| Single act (ref) | **1** | **1** | **1** | **1** |
| E-consult | **.57 (.41–.79)** | **.19 (.14–.25)** | **.49 (.17–1.38)** | **.94 (.66–1.34)** |

*Note*: The bold values correspond to statistical significative diffence.

Abbreviation: 95%CI, 95% confidence interval; OR, odds ratio.

Our current results extend these findings to patients with a history of cancer in who were referred for cardiology care by PCPs. Despite the higher CV risk of this patient group compared to patients without cancer, the introduction of the e-consultation program was associated with a reduced time to care and improved 1-year outcomes, including a reduction in the rate of CV hospital admissions and mortality. The multivariate analysis revealed that a shorter time to resolve the e-consultation and the absence of a need for face-to-face visits were associated with improved 1-year outcomes.

During the first year of the COVID-19 pandemic, we observed a significant drop in patient referrals through e-consultation by PCPs to our CD, followed by a subsequent recovery in demand for care. Importantly, the pandemic's initial year (2020) was associated with poorer health outcomes compared with the immediately preceding pre-pandemic period. In our analysis, we documented a delayed, significant increase in the 1-year rate of CV and total hospital admissions for patients referred in 2021 with assessments in 2022.[29] These findings suggest that delayed or disrupted care within our public healthcare system may explain our results and can serve as quality control indicators to guide healthcare professionals and policymakers in implementing changes to enhance healthcare system performance.

Our results may be of interest to other healthcare regions and national healthcare services. Evaluating the impact of the COVID-19 pandemic on the quality of care and implementing necessary changes when similar findings are observed is crucial for maintaining high standards of patient care.

## 4.1 | Study limitations

While our study provides valuable insights, several limitations must be considered. The robustness of our findings

**TABLE 6** Multivariate analysis of factors linked to hospital admissions and death, in patients without cancer.

| | CV-hospitalizations OR (95%CI) | All-cause hospitalization OR (95%CI) | CV-mortality OR (95%CI) | All-cause mortality OR (95%CI) |
|---|---|---|---|---|
| Age | **1.019 (1.017–1.022)** | **1.021 (1.019–1.022)** | **1.107 (1.098–1.117)** | **1.109 (1.102–1.115)** |
| Comorbidities | | | | |
| Arterial hypertension | **.89 (.83–.97)** | **.90 (.85–.96)** | .86 (.73–1.01) | **.67 (.60–.75)** |
| Diabetes mellitus | **1.47 (1.36–1.59)** | **1.38 (1.29–1.47)** | **1.36 (1.16–1.61)** | **1.42 (1.27–1.59)** |
| Ischemic heart disease | **1.82 (1.66–1.99)** | **1.44 (1.33–1.55)** | **1.36 (1.12–1.66)** | **1.20 (1.04–1.38)** |
| Atrial fibrillation | **1.23 (1.14–1.34)** | **1.16 (1.09–1.24)** | **.80 (.67–.95)** | **.83 (.74–.93)** |
| Heart failure | **1.81 (1.64–2.00)** | **1.67 (1.54–1.83)** | **3.20 (2.72–3.78)** | **2.65 (2.35–2.99)** |
| Cerebrovascular disease | **1.24 (1.03–1.49)** | **1.28 (1.09–1.50)** | .92 (.64–1.31) | **.72 (.55–.95)** |
| Peripheral arterial disease | **1.52 (1.32–1.75)** | **1.43 (1.27–1.61)** | **1.53 (1.15–2.05)** | **1.59 (1.30–1.95)** |
| COVID-19 periods | | | | |
| PreCOVID-19 (ref) | 1 | 1 | 1 | 1 |
| PostCOVID-19 | .98 (.90–1.06) | **1.23 (1.16–1.30)** | **.72 (.59–.88)** | .91 (.80–1.04) |
| Healthcare activity | | | | |
| Number of visits to the emergency department (1 year follow-up) | **1.06 (1.05–1.06)** | **1.09 (1.08–1.10)** | **.86 (.83–.89)** | **.92 (.91–.94)** |
| Waiting time to cardiology care | | | | |
| 0–7 days (ref) | 1 | 1 | 1 | 1 |
| 8–14 days | **1.38 (1.26–1.51)** | **1.34 (1.24–1.44)** | **1.87 (1.56–2.23)** | **1.76 (1.55–1.99)** |
| 15–30 days | 1.11 (.97–1.28) | **1.23 (1.10–1.38)** | **1.46 (1.11–1.93)** | **1.23 (1.01–1.50)** |
| >30 days | **1.20 (1.02–1.43)** | **1.25 (1.07–1.46)** | .75 (.53–1.07) | .97 (.77–1.23) |
| Consultation model | | | | |
| Single act (ref) | 1 | 1 | 1 | 1 |
| E-consult | **.65 (.57–.72)** | **.28 (.25–.31)** | **.31 (.25–.38)** | **.37 (.32–.43)** |

*Note*: The bold values correspond to statistical significative diffence.

Abbreviation: 95%CI, 95% confidence interval; OR, odds ratio.

is strengthened by the examination of a large patient cohort over an extended period, incorporating comprehensive demographic, clinical and prognostic information integrated within an electronic medical record. However, bias may be introduced through the analysis of retrospective data, with constraints on access to the specific causes of mortality. Information on evolution of cancer, such as whether patients were in remission, receiving active treatment, or under palliative care; as well as types of cancer is not shown as this was not the main objective of the study, which is to assess whether the implementation of an e-consultation program had a consistent impact on reducing delay times and improving outcomes in patients with cancer, independent of these variables.

Over the course of our observations, it is possible that various factors, such as changes in the care model or treatment approaches, might have influenced outcomes. However, it is highly unlikely that the introduction of e-consultation coincided with changes in cancer treatment leading to such rapid shifts in patient outcomes. Furthermore, we were unable to identify the reasons behind PCP referrals, as this information was not available in our databases. Nevertheless, our primary aim in this manuscript is to present the health outcomes of patients with cancer referred by PCPs for cardiology consultation, regardless of the underlying causes.

## 5 | CONCLUSIONS

Our study underscores the importance of considering patients with a history of cancer when analysing the demand for cardiology consultation among referrals from PCPs. These individuals often present with a higher burden of comorbidities and experience less favourable 1-year outcomes compared to those without cancer. After

implementing the e-consult program and comparing it with the previous period of in-person visits, we observed a significant reduction in waiting times to access cardiology care for the entire population. This approach proved to be safe, as evidenced by the significant association with the reduction in the need for hospital admissions following the implementation of the e-consultation program; however, the associations with mortality reduction did not achieve statistical significance. Nevertheless, it is essential to highlight that the all-cause outcomes were notably worse, especially in patients with cancer, in the aftermath of the COVID-19 pandemic, despite the reduced time to access cardiology care.

## AUTHOR CONTRIBUTIONS

SCS has designed research/study, performed research/study, collected data, analysed data, wrote paper and reviewed the last version; PMR has designed research/study, performed research/study, collected data, analysed data, wrote paper and reviewed the last version; DRA designed research/study, analysed data, wrote paper and reviewed the last version; DGV has performed research/study, collected data and reviewed the last version; AMM: has performed research/study, collected data and reviewed the last version; MPR designed research/study, analysed data, wrote paper and reviewed the last version; MRM has performed research/study, collected data and reviewed the last version; MSF has reviewed the last version; RLF has performed research/study and reviewed the last version; RLL: has performed research/study, collected data and reviewed the last version; JGJ has designed research/study, performed research/study, collected data, analysed data, wrote paper and reviewed the last version.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

## DATA AVAILABILITY STATEMENT

The data supporting this article are accessible through RUNA (https://runa.sergas.gal/) but can be accessed via the following DOI link: (https://runa.sergas.gal/10.1111/eci.14197).

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