

Impact of ICU bed availability on ovarian cancer surgical hospitalization rates during the first wave of the coronavirus disease 2019 pandemic

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SUMMARY

OBJECTIVES: The coronavirus disease 2019 pandemic, which began in 2020, disrupted healthcare services. Reports of changes in surgical activities coincide with the outbreak period. We aimed to identify if changes could be determined in hospitalization rates of ovarian cancer patients from 2016 to 2020, comparing pre-pandemic and pandemic levels.

METHODS: Aggregated data were obtained from the State of São Paulo Secretary of Health regarding ovarian cancer clinical and surgical hospitalization, both Coronavirus disease-specific ICU and infirmary bed occupation rates, average social distancing rates, coronavirus disease 2019 incidence, mortality, and lethality rates. We performed the joinpoint analysis to verify if there were changes regarding hospitalization rates during this period. We also calculated hospitalization rate ratios and tested if they were correlated with pandemic-related variables.

RESULTS: Hospitalization rates in the state fell, coinciding with the pandemic. Surgical hospitalization rate ratios were inversely correlated with Coronavirus disease-specific ICU bed occupation rates during the third trimester of 2020, with a Pearson's correlation coefficient of -0.50 (95%CI -0.78 to -0.05, $p=0.03$).

CONCLUSION: These results demonstrate the impact of the coronavirus disease 2019 pandemic on the treatment of conditions that compete for the same healthcare resources.

KEYWORDS: Intensive care units. Ovarian neoplasms. COVID-19. Hospitalization.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) was declared a global pandemic by the World Health Organization (WHO) on March 11, 2020¹. In Brazil, the first case was registered on February 26, 2020, in São Paulo. By March 20, 2020, Brazil's Ministry of Health recognized COVID-19 community transmission in country². Spatiotemporal analysis indicated the disease spread quickly in the country for multiple reasons, including disparities in health resources³.

The pandemic's impact is far more significant than COVID-19's incidence and mortality rates. The population's health-care-seeking behavior and service provision have changed since the outbreak began⁴. These changes have been demonstrated even among conditions such as acute myocardial infarction⁵ and cerebrovascular events⁶, reducing hospitalization rates compared to pre-pandemic levels.

Regarding specifically surgical activity, initial reports indicated a decrease in the number of elective surgeries following the pandemic's start^{7,8}. As the pandemic progressed, the following reports stated a reduction in surgery incidence, followed by an increase in surgery rates and waiting times⁹. As for oncological surgery, in Finland, oncological surgery did not see changes during the outbreak compared to pre-pandemic levels, which might reflect healthcare service reorganization toward prioritizing oncological surgeries¹⁰.

In ovarian cancer, surgery plays a significant role in staging and treating both initial and advanced diseases. Several patients will necessitate platinum-based chemotherapy to improve recurrence-free and overall survival¹¹.

In this study, we aimed to assess the clinical and surgical hospitalization rates for ovarian cancer in the state of São Paulo before and during the pandemic, and whether there is any correlation between these data and pandemic-related variables.

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Conflicts of interest: the authors declare there is no conflicts of interest. Funding: This project was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) – Programa CAPES EPIDEMIAS (grant number 88887.506852/2020-00). FJCR (grant number 310262/2021-6) was funded by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

Received on June 30, 2022. Accepted on August 01, 2022.

METHODS

This study is an ecological analysis. Our main hypothesis was whether there was any change in the rate of hospital admissions for ovarian cancer during the first wave of the COVID-19 pandemic, and if possible, changes were correlated with variables associated with the COVID-19 outbreak progression in the state. This research encompasses 19 trimesters, from the first trimester of 2016 to the third trimester of 2020. The first trimester of 2020 is considered the beginning of the pandemic.

Data regarding hospital admissions for ovarian cancer were publicly available on the São Paulo State Secretary of Health website. It contained the total number of clinical and surgical hospital admissions per trimester having the primary diagnosis of ovarian cancer, both at the state level and by one of 17 numbered state subdivisions known as the Regional Departments of Health (RDH). This information is aggregated from the Authorization for Hospital Admission (AHA) documents. The inclusion criteria were the primary *International Disease Code (ICD)* be C56 and the main procedure being either clinical or surgical treatment.

We obtained from Brazil's Ministry of Health the female population and the total population. We obtained from the National Supplementary Health Agency the female population who had private medical insurance. We calculated the exclusively public-insured female population from these data.

We performed an age-adjusted joinpoint regression analysis for clinical, surgical, and overall ovarian cancer hospitalization rates during the study period using the Joinpoint Trend Analysis software. The population was exclusively public-insured women. We used the WHO standard population in this analysis. We identified the last trimester before the pandemic in which there was a change in the hospitalization rates and calculated average pre-pandemic hospitalization rates. We calculated an average from the whole pre-pandemic period when the above method was not possible.

We calculated the hospitalization rate ratio (HRR) by comparing each trimester during the COVID-19 pandemic and the baseline period before the pandemic, utilizing the exact Poisson test. We also calculated the COVID-19-specific ICU and infirmary bed occupation percentage, COVID-19 incidence and mortality rate, and the social distancing average percentage in both state and RDH populations per trimester using publicly available data obtained from the State of São Paulo government. Data for ICU and bed availability were not available before May 19, 2020. We used Pearson's correlation tests to assess if there was any correlation between HRR in a given trimester and pandemic-related variables.

We compared expected and observed hospitalizations. Expected hospitalizations were obtained by applying the quarterly percentual change, which was identified in the last trimester before the pandemic began, calculated in the joinpoint regression, and applied these to the observed hospitalizations identified in the last trimester before the pandemic.

We also calculated the proportion of the state's female population exclusively public-insured during the same period and performed a Pearson's correlation test.

Data manipulation and statistical analysis were conducted using the RStudio software, version 1.4.1717 (2021-05-24).

Temporal series analysis was performed as a joinpoint regression using the Joinpoint Trend Analysis software, version 4.9.0.0. We allowed from zero up to five joinpoints. We used the minimal number of two observations from a joinpoint to either end of the data and between two joinpoints.

The study followed the Declaration of Helsinki. According to Resolution 510/2016 of the National Health Council of Brazil, studies that use publicly available data without patient identification do not require approval from an ethics committee.

RESULTS

A total of 12,856 hospital admissions were analyzed during the study period. Of these, 6,597 were classified as surgical, and 6,259 were identified as clinical. Overall hospitalization rates for ovarian cancer declined during the pandemic period, reversing the previous upward trend. Among all RDH which demonstrated changes in their tendencies, none presented an increase during the COVID-19 outbreak period. Clinical hospitalizations demonstrated a continuous decline during the study. Surgical hospitalizations showed a downward trend during the pandemic, and none of the RDH showed an increase during the outbreak.

Surgical HRR displayed an inverse correlation with COVID-specific ICU bed occupation rates during the third trimester of 2020. We identified a Pearson's correlation coefficient of -0.50 (95%CI -0.78 to -0.05 , $p=0.03$). This is represented in Figure 1. Overall clinical and surgical HRR did not display a correlation with any of the other studied variables in each trimester.

Regarding the third trimester of 2020, Table 1 displays the calculated HRR for each RDH and the state and the values of pandemic-related variables.

Overall hospitalizations showed a 15% decrease compared to expected values. These results can be found in Table 2.

The proportion of exclusively public-insured women in the state has demonstrated an increase in the study. The Pearson's correlation coefficient is 0.95 (95%CI $0.88-0.98$, $p<0.001$).

DISCUSSION

We found a decrease in the hospitalization rates for ovarian cancer in the public health system during the pandemic and an inverse correlation between HRR and COVID-specific ICU

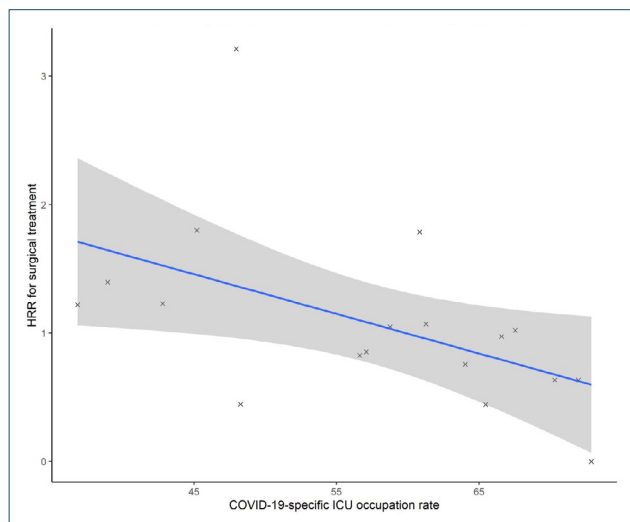


Figure 1. Relationship between hospitalization rate ratio for ovarian cancer treatment and the ICU occupation rate in the state of São Paulo in the third trimester of 2020.

bed occupation rates among RDH during the third quarter of 2020. This supports our primary hypothesis that the pandemic impacted ovarian cancer care in the state of São Paulo. It suggests ICU bed availability could have limited ovarian cancer surgical activity.

This study has several strengths. It includes a large number of hospitalizations during a significant period. It is also based on AHA records, which are mandatory in the public health system. Furthermore, our pandemic-related variables encompassed different pathways that could correlate to healthcare disruption.

Limitations are inherent to retrospective and ecological analysis. Hospitalization could not be classified further than “clinical” or “surgical” treatment. COVID-specific bed occupations, both infirmary and ICU data, were absent for the first trimester and partially available for the second trimester of 2020. However, these do not seem to invalidate the conclusions presented above.

Similar research regarding surgical activity during the COVID-19 pandemic shows convergence and divergence points. A decrease in surgery incidence has been reported during restrictive periods in Finland, followed by an increase compared to the reference years, as an attempt to address the accumulated elective surgery backlog⁹. Another Finnish

Table 1. Hospitalization rate ratio for each type of hospitalization and pandemic-related variables in the third trimester of 2020.

RDH	Overall HRR	Surgical HRR	Clinical HRR	COVID-19 Incidence	COVID-19 mortality	COVID-19 Lethality	Average social distancing rate	Infirmary bed occupation rate	ICU occupation rate
State	0.86	0.85	0.88	104.56	3.96	3.78	42.48	42.57	57.09
1	0.91	0.83	0.99	10.42	0.35	3.35	43.1	43.53	56.63
2	1.09	0.45	1.38	55.12	1.61	2.91	40.07	32.72	48.26
3	1.32	1.4	1.24	303.33	11.96	3.94	43.12	32.69	38.94
4	0.98	1.22	0.72	24.46	0.71	2.91	44.21	30.84	36.83
5	0.92	0.97	0.67	63.94	1.13	1.76	42.54	28.43	66.57
6	0.46	0.44	0.5	86.16	2.18	2.53	39.71	37.34	65.46
7	0.86	0.76	0.92	13.31	0.31	2.32	40.26	46.21	64.04
8	0	0	0	61.67	0.65	1.05	42.09	33.19	72.87
9	1.14	1.8	0.54	13.28	0.33	2.49	39.41	26.45	45.2
10	0.81	1.07	0.59	1824.61	79.53	4.36	39.92	44.88	61.28
11	1.18	1.02	1.3	168.55	4.39	2.6	36.24	55.41	67.54
12	0.88	1.23	0	370.34	6.77	1.83	40.9	42.89	42.8
13	0.76	0.63	0.81	138.13	4.1	2.97	44.17	57.94	71.97
14	2.31	3.21	1.73	29.66	0.81	2.73	45.95	24.29	47.96
15	0.91	0.63	1.01	136.4	3.71	2.72	40.63	50.7	70.31
16	1.9	1.79	2.13	16.9	0.49	2.92	40.39	36.25	60.84
17	0.85	1.05	0.67	68.86	1.71	2.48	44.53	38.42	58.75

Table 2. Difference between observed and expected ovarian cancer hospitalizations in the state of São Paulo during the first three trimesters of the coronavirus disease 2019 pandemic and pre-pandemic levels.

RDH	Fourth trimester of 2019	First trimester of 2020	Second trimester of 2020	Third trimester of 2020	Pre-pandemic trimestral percentage change rate	Expected value for first trimester of 2020	Expected value for second trimester of 2020	Expected value for third trimester of 2020	Difference between observed and expected hospitalizations in first trimester of 2020	Difference between observed and expected hospitalizations in second trimester of 2020	Difference between observed and expected hospitalizations in third trimester of 2020	Sum of the difference between observed and expected hospitalizations during the pandemic period	Relationship between observed and expected hospitalizations
State	750	745	615	617	1.63	762.23	774.65	787.28	-17.23	-159.65	-170.28	-347.15	0.85
1	312	328	290	267	1.42	316.43	320.92	325.48	11.57	-30.92	-58.48	-77.83	0.92
2	2	6	4	8	-2.64	1.95	1.9	1.85	4.05	2.1	6.15	12.31	3.16
3	19	11	9	20	0.19	19.04	19.07	19.11	-8.04	-10.07	0.89	-17.22	0.7
4	15	13	17	17	-1.24	14.81	14.63	14.45	-1.81	2.37	2.55	3.11	1.07
5	69	51	42	44	8.81	75.08	81.69	88.89	-24.08	-39.69	-44.89	-108.66	0.56
6	73	68	39	36	-2.9	70.88	68.83	66.83	-2.88	-29.83	-30.83	-63.54	0.69
7	58	73	60	46	-0.21	57.88	57.76	57.64	15.12	2.24	-11.64	5.73	1.03
8	3	8	4	0	1.63	3.05	3.1	3.15	4.95	0.9	-3.15	2.7	1.29
9	9	9	5	12	0.88	9.08	9.16	9.24	-0.08	-4.16	2.76	-1.48	0.95
10	13	17	11	13	1.13	13.15	13.3	13.45	3.85	-2.3	-0.45	1.11	1.03
11	19	17	7	11	3.82	19.73	20.48	21.26	-2.73	-13.48	-10.26	-26.47	0.57
12	4	4	1	4	-5.8	3.77	3.55	3.34	0.23	-2.55	0.66	-1.66	0.84
13	21	29	22	28	-15.78	17.69	14.9	12.54	11.31	7.1	15.46	33.87	1.75
14	11	13	6	11	1.63	11.18	11.36	11.55	1.82	-5.36	-0.55	-4.09	0.88
15	46	38	46	31	-11.66	40.64	35.9	31.71	-2.64	10.1	-0.71	6.75	1.06
16	26	22	25	29	3.92	27.02	28.08	29.18	-5.02	-3.08	-0.18	-8.28	0.9
17	50	38	27	40	-2.32	48.84	47.71	46.6	-10.84	-20.71	-6.6	-38.15	0.73

study did not identify decreases in the oncologic surgery rate, suggesting prioritization of these cases¹⁰. Similarly, an Italian study did not identify any decreases in oncological surgical activity during the pandemic¹². These divergences might be attributable to the fact that these studies included several different oncological conditions, each of which could behave differently.

In Austria, a study reported a decrease of 49% in diagnosing new ovarian cancers during the first 2 months of the pandemic¹³. Notably, the study cites a maximum ICU occupation rate of 26%. In France, one report identified a 13% decrease in gynecological oncology cases in an unicenter study¹⁴. Another French study reported that 32.7% of patients with ovarian cancer had their surgeries postponed or suspended¹⁵. These results highlight the importance of further research to better comprehend the role of restrictive measures, ICU occupation rate, and different healthcare systems in ovarian cancer care during the pandemic.

Some studies tried to determine more accurately possible correlations and causes for changes in surgical activity during the pandemic. A Japanese case series of patients with confirmed or suspected gynecological malignancies suggests COVID-19 overdiagnosis might have played a role in treatment delay¹⁶. Another research from India identified longer waiting times from diagnosis to the start of treatment among epithelial ovarian cancer patients, and travel restrictions during lockdown might have acted as a factor limiting treatment¹⁷.

Our data suggest ICU beds could be a bottleneck for ovarian cancer treatment during the pandemic. It is possible that these so-called “COVID-specific ICU beds” were established using previously existing ICU structures. Thus, both conditions compete for the same resources. We cannot exclude other factors that could be associated with higher ICU occupation and surgical activity decreases, such as sedative drug and personal protective equipment shortage and prioritization. Available data do not allow us to discuss how patient referral and exam availability might have impacted these results; however, the absence of correlation with other COVID-19-related variables

is a possible indicator that different pathways might not have contributed to the surgical activity decline.

Cancer treatment centralization has been the subject of research¹⁸. Evidence indicates that ovarian cancer patients benefit from surgical treatment being performed in high-volume hospitals¹⁹. In São Paulo, ovarian cancer has demonstrated high rates of centralization²⁰. Disruptions to healthcare services challenge this centralized model since patient treatment could be impacted if resources in a region become suddenly unavailable.

Exploratory analysis indicates a higher proportion of patients being exclusively dependent on public healthcare insurance. Thus, we do not expect a high proportion of these treatments might have happened in private healthcare services.

CONCLUSION

Ovarian cancer hospitalization rates in São Paulo decreased by 15% during the pandemic, when comparing expected and observed hospitalizations. Among different RDH, a lower HRR was determined among regions with higher COVID-specific ICU bed occupation. These findings indicate a possible delay in treatment, which could impact disease curability. They also point to ICU bed availability as a possible limiting factor for ovarian cancer surgical activity during the first wave of the COVID-19 pandemic. Additional studies are required to better understand which resources act as treatment bottlenecks and to better direct investments in similar future scenarios.

AUTHORS' CONTRIBUTIONS

VCM: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review and editing. **FJCR:** Conceptualization, Formal Analysis, Funding acquisition, Methodology, Project administration, Supervision, Writing – review and editing. **FFP:** Methodology, Validation, Writing – review and editing. **NJWMJ:** Methodology, Validation, Writing – review and editing.

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