



Impact of Covid-19 on gastrointestinal cancer surgery: A National Survey

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Abstract

Purpose To understand the actual impact of the Covid-19 pandemic and frame the future strategies, we conducted a pan India survey to study the impact on the surgical management of gastrointestinal cancers.

Methods A national multicentre survey in the form of a questionnaire from 16 tertiary care gastrointestinal oncology centres across India was conducted from January 2019 to June 2021 that was divided into a 15-month pre-Covid era and a similar period of active Covid pandemic era.

Results There was significant disruption of services; 13 (81%) centres worked as dedicated Covid care centres and 43% reported suspension of essential care for more than 6 months. In active Covid phase, there was a 14.5% decrease in registrations and proportion of decrease was highest in the centres from South zone (22%). There was decrease in resections across all organ systems; maximum reduction was noted in hepatic resections (33%) followed by oesophageal and gastric resections (31 and 25% respectively). There was minimal decrease in colorectal resections (5%). A total of 584 (7.1%) patients had either active Covid-19 infection or developed infection in the post-operative period or had recovered from Covid-19 infection. Only 3 (18%) centres reported higher morbidity, while the rest of the centres reported similar or lower morbidity rates when compared to pre-Covid phase; however, 6 (37%) centres reported slightly higher mortality in the active Covid phase.

Conclusion Covid-19 pandemic resulted in significant reduction in new cancer registrations and elective gastrointestinal cancer surgeries. Perioperative morbidity remained similar despite 7.1% perioperative Covid 19 exposure.

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic impacted all the aspects of cancer care worldwide [1, 2]. The reorganisation and necessary reallocation of the healthcare in response to the pandemic coupled with the uncertainty, fear, nationwide lockdowns, and the absence of the guidelines regarding safe surgical care pathways during the initial part of the pandemic severely impacted the cancer care [3, 4]. The notion of delaying the surgical cancer care was further potentiated by the observational studies that reported unusually high 30-day post-operative mortality [5, 6]. However, the delay in initiation of the cancer care means increasing cancer-related deaths; there is evidence to suggest an absolute increase of 6.8% mortality with a 30-day delay in the cancer related surgery [7–9]. The oncologists soon realised the need for providing safe Covid-19-free surgical pathways and restoration of the cancer care given the low case fatality rate of the Covid-19 infection and published relevant guidelines regarding the same [10–15].

By the end of 2021, India has reported more than 34.9 million Covid-19 cases with a case fatality rate of 1.36% [16]. The timeline included two major peaks and two major nationwide lockdowns. Although some centres reported continuation of the cancer care during the Covid-19 pandemic with outcomes comparable to pre-Covid era, the results were heterogeneous and could not be generalised [17–21]. Gastrointestinal cancers represent 20% of all the malignancies in India, out of which nearly 20% would need early surgery [22]. Moreover, there was about 80% decrease in endoscopic procedures worldwide in the early part of Covid-19 pandemic that seriously impacted the number of newly diagnosed gastrointestinal cases [23, 24]. In a study by Sud et al., a 30% reduction of survival was seen in patients with stage II and III gastrointestinal cancers with every 6 months of delay in the surgical care [25]. Similarly there was approximately 50% decrease in curative liver resections and liver transplant surgeries in a survey from 76 cancer care centres across the world [26]. In order to understand the actual impact of the Covid-19 pandemic and frame the future strategies, we need to analyse objective and comparative data of organ specific malignancies from the major referral centres across the country. Given the paucity of this data, we conducted a pan India survey to

study the impact of the Covid-19 pandemic on the surgical management of gastrointestinal cancers.

Methods

The Tata Memorial Centre, Mumbai, initiated a national multicentre survey by circulating a document in the form of a questionnaire to 19 tertiary care gastrointestinal oncology centres across India. High volume gastrointestinal and hepatopancreatic biliary cancer referral centres across all the four zones of the country were included in the study. The questionnaire was sent in June 2021 and all the replies were collected by September 2021. The data was shared by the participating centres from the institutional registries maintained as prospective databases at the respective centres. The study was approved by the institutional ethical committee (OIEC/3843/2021/00001).

This survey was conducted from January 2019 to June 2021 (30 months) which was divided into a 15-month pre-Covid era till the end of third week of March 2020 and a similar period of active Covid era starting from the third week of March 2020. Apart from the basic demographic details, the questionnaire included three main sections; first section included five questions that addressed the details about the hospital bed proportion that was allocated to Covid-19 care and whether hospital made an exception about cancer surgeries. Second section included details about the hospital registration and gastrointestinal cancer surgeries performed across different organ systems in pre-Covid and Covid era including palliative and minimal access surgeries along with morbidity and mortality during that period. The third section included the details about the Covid-19 status of the operated patients. Overall, potentially comparable variables indicating impact of Covid-19 on GI cancer care at each institution were requested for the pre Covid and Covid period (Supplementary material: Questionnaire).

Statistical analysis

Nonparametric data were summarised with medians and interquartile ranges and differences between groups were tested using the Mann–Whitney *U* test. Parametric data were summarised with mean average and standard deviation. Differences between groups were explored using two-tailed Student's *t*-test (two comparator groups) or one-way analysis of variance (ANOVA, three or more comparator groups). The χ^2 test was used for categorical data.

Table 1 Centre-specific pre-Covid and active Covid phase data along with duration of suspension and beds lost

Designated Covid-19 centre	Duration of suspension	Proportion of beds lost	Total registrations		Total surgeries performed		Morbidity (grade III and above)		Mortality			
			Pre-Covid	Active-Covid	Pre-Covid	Active-Covid	Pre-Covid	Active-Covid	Pre-Covid	Active-Covid		
					Percentage decrease	Percentage decrease/increase						
Tata Memorial Centre (Mumbai), WEST	YES	nil	10%	21890	23823	9	2318	2212	15%	11%	3%	3%
Dr B Borooah Cancer Institute (Gauhati), EAST	YES	-	-	-	-	-	327	264	17%	16%	4%	5%
Homi Bhabha Cancer Hospital (TMC) (Sangrur), NORTH	NO	nil	nil	826	1035	25	90	131	10%	10%	2%	2%
Homi Bhabha Cancer Hospital (TMC) (Varanasi), NORTH	YES	-	-	4030	4916	22	239	454	7%	7%	6%	3%
Sanjay Gandhi PGI of Medical Sciences (Lucknow), NORTH	YES	-	-	493*	269*	-45	343	154	13%	11%	5%	3%
Sher-I-Kashmir Institute of Medical Sciences (Srinagar), NORTH	YES	nil	>60%	120*	111*	-7.5	72	58	10%	10%	2%	3%
Tata Medical Centre (Kolkata), EAST	NO	nil	nil	22715	21877	-4%	648	554	12%	7%	2%	2%

Table 1 (continued)

	Designated Covid-19 centre	Duration of suspension	Proportion of beds lost	Total registrations		Total surgeries performed		Morbidity (grade III and above)		Mortality	
				Pre-Covid	Active-Covid	Pre-Covid	Active-Covid	Pre-Covid	Active-Covid	Pre-Covid	Active-Covid
All India Institute of Medical Sciences (Bhubaneswar), EAST	YES	-	-	-	123	94	-23	15%	15%	3%	3%
Amrita Institute of Medical Sciences and Research Institute (Kochi), SOUTH	YES	< 1 month	nil	21903	16951	-22	-6.6	11%	12%	3%	2%
Basavata-rakam Indo American Cancer Hospital (Telangana), SOUTH	YES	< 1 month	nil	9237	7837	-15	-14	5%	5%	1%	1%
Manipal Hospital (Bangalore), SOUTH	YES	1-6 months	> 60%	990	405	-59	-48%	9%	41%	4%	7%
Asian Institute of Gastroenterology (Telangana), SOUTH	NO	nil	nil	435*	263*	-39	-47	11%	9%	1%	1%
King Edwards Medical College (Mumbai), WEST	YES	> 6 months	> 60%	5031	1552	-69	-31	3%	2%	1%	1%

Table 1 (continued)

	Designated Covid-19 centre	Duration of suspension	Proportion of beds lost	Total registrations		Total surgeries performed		Morbidity (grade III and above)		Mortality	
				Pre-Covid	Active-Covid	Pre-Covid	Active-Covid	Pre-Covid	Active-Covid	Pre-Covid	Active-Covid
Stanley Medical College (Madras), SOUTH	YES	1–6 months	> 60%	3908	2025	284	185	23%	<u>31%</u>	2%	<u>4%</u>
Lakeshore Hospital and Research Centre (Kochi), SOUTH	YES	< 1 month	-	10975	6646	881	504	8%	8%	1%	<u>2%</u>
Jawahar Lal Institute of Post-graduate Medical Education and Research (Puducherry), SOUTH	YES	> 6 months	> 60%	-	-	496	239	25%	<u>22%</u>	3%	<u>8%</u>

* Outpatient data not available

Figures marked in bold signify percentage decrease; Figures underlined signify increase in morbidity/mortality

Results

Nineteen centres were contacted across the country out of which 16 (84%) centres responded and replied to the survey. The participating centres represented all the zones of the Country (Table 1).

Reallocation of beds and quantification of the impact

Out of 16 participating centres, 13 were designated Covid-19 centres. Regarding the proportion of beds lost to Covid-19 care, information was available from 11 centres; four centres had more than 60% of beds designated for Covid-19 care and six centres had less than 20% beds designated for Covid-19 care. Most 84% (11 out of 13) of the designated Covid-19 centres made exceptions to continue essential cancer surgeries after the initial total lockdown phase was over in May 2020. Though GI cancer care and surgeries in particular were affected to a variable extent at each centre, complete suspension of cancer care over a variable time period was reported by 7 centres with 4 centres reporting suspension of more than 6 months.

Registrations (in-patient and out-patient)

Details regarding the registrations were available from 13 centres, out of which 10 (77%) reported decrease in both in and out-patient registrations. In the active Covid period, a total of 87,710 registrations were reported compared to 102,553 registrations in pre-Covid phase and 70% of these were reported from five centres. When average number of registrations were considered; 7889 (range 120–22,715) in pre-Covid phase and 6746 (range 111–23,823) in active Covid phase, there was a 14.5% decrease in active Covid phase, and the proportion of decrease was highest in the centres from South zone (22%). Tata Memorial Centre at Mumbai and associated centres at Varanasi and Sangrur reported 11.3% increase in the number of registrations during active Covid period.

Individual organ systems (Fig. 1)

In the second section of the questionnaire, surgeries performed on individual organ systems were analysed. The participating centres reported a total of 9856 oncosurgical procedures for different gastrointestinal cancers including palliative procedures as compared to 8204 procedures in active Covid phase with percentage decrease of 17%. This decrease was seen across the organ systems with maximum decrease in hepatic resections (33%) followed by

oesophageal and gastric resections (31 and 25% respectively) with the lowest decrease in colorectal resections (5%).

The information about oesophageal cancer surgeries was available from 15 centres, out of which 12 (80%) centres reported decrease in the number of surgeries performed. In the active Covid period, a total 421 oesophageal resections were reported when compared to 607 resections in pre-Covid phase. Considering the average number of oesophageal cancer surgeries performed, 43 (range: 2–213) in pre-Covid phase and 30 (range: 2–154) in active Covid phase, there was 31% decrease during the active Covid phase. Similarly, 14 centres reported decrease in gastric cancer operations with average percentage decrease of 25% (range: 18–63%) in the active Covid phase. All the centres uniformly reported decrease in minimally invasive upper gastrointestinal surgeries with average percentage decrease of 22%.

Majority 87% (13 out of 15) participating centres reported decrease in the pancreatic cancer surgeries performed in the active Covid phase, with overall average decrease of 24% (range: 2–63%). However, when we selectively considered the centres that operated more than 50 cases/year in the pre-Covid era, the average percentage decrease of cases was higher at 35% (range: 2–63%). Eight and 10 centres reported decrease in surgical procedures for biliary and liver cancers respectively, with an average percentage decrease of 9% (range: 34–58%) and 33% (range: 0–58%) respectively. Out of 10 centres who reported data on minimally invasive hepatopancreatic biliary procedures, seven (70%) reported increase with average percentage increase of 71% during active Covid phase. Amrita Institute and research Centre, Kochi, reported 100% increase in minimally invasive hepatopancreatic biliary procedures during active Covid phase.

The average decrease of colorectal cancer surgeries in active Covid-19 phase was 5% (range: 11–69%), with 1.7% decrease in minimally invasive procedures performed. Tata Memorial Centre at Mumbai and associated centres at Varanasi and Sangrur reported an average increase of 22% (range: 24–77%). Regarding miscellaneous procedures which included retroperitoneal sarcomas, small bowel cancers, and palliative surgeries, the average decrease of 21% (range: 8–51%) was noted in the active Covid phase.

Morbidity and mortality

All the centres reported data on morbidity and mortality. The average pre-Covid (Major Clavien-Dindo Grade IIIA and beyond) morbidity was 11.7% (range: 2.7–24%) and the mortality was 2.1% (range: 1–5.5%). In the active Covid phase, the morbidity was 11.8% (range: 3–30%) and mortality was 2.8% (range: 1.3–7%). Only three (18%) centres reported higher morbidity in active Covid phase, while the rest of the centres reported similar or lower morbidity rates

when compared to pre-Covid phase; however, 6 (37%) centres reported higher mortality in the active Covid phase with percentage increasing in mortality ranging from 18%–338%. Three out of these 6 centres reported higher mortality in post-operative Covid-19-positive patients. The overall mortality in the active Covid phase was higher than pre-Covid phase.

Peri-operative Covid-19 exposure/status

Information regarding this was available from 14 centres. Out of 8204 operations performed in active Covid phase, a total of 584 (7.1%) patients were operated who either had active Covid infection or developed Covid-19 in the post-operative period or had recovered from Covid-19 infection. Perioperative active Covid-19 infection was noted in 158 (1.9%) patients. Fifty-nine (10%) patients with active Covid-19 infection were operated whereas 99 (16.9%) patients developed Covid-19 infection in post-operative period. Out of these 584 patients, 426 (73%) patients had recovered from the previous Covid-19 infection.

Centre-specific data

In the analysis of the centre-specific data, 3 (17%) out of 16 centres reported increase in number of surgical procedures performed. Amrita Institute Kochi (7%) and Tata Memorial Centres at Sangrur and Varanasi (46% and 90%) reported increase in gastrointestinal surgeries performed. In the pre-Covid phase, Tata Memorial Centre Mumbai, Amrita Kochi, and Indo-American Telangana commutatively performed 50% of total number of gastrointestinal cancer surgeries, while in active Covid phase these three centres were responsible for 59% of all the gastrointestinal cancer surgeries

reported in the survey. Five centres reported a percentage fall of 43–55% in gastrointestinal cancer surgeries when compared to pre-Covid era (SGPGI Lucknow, Lakeshore Kerala, Manipal Bangalore, JIPMER Puducherry, and Asian Institute of Gastroenterology Hyderabad).

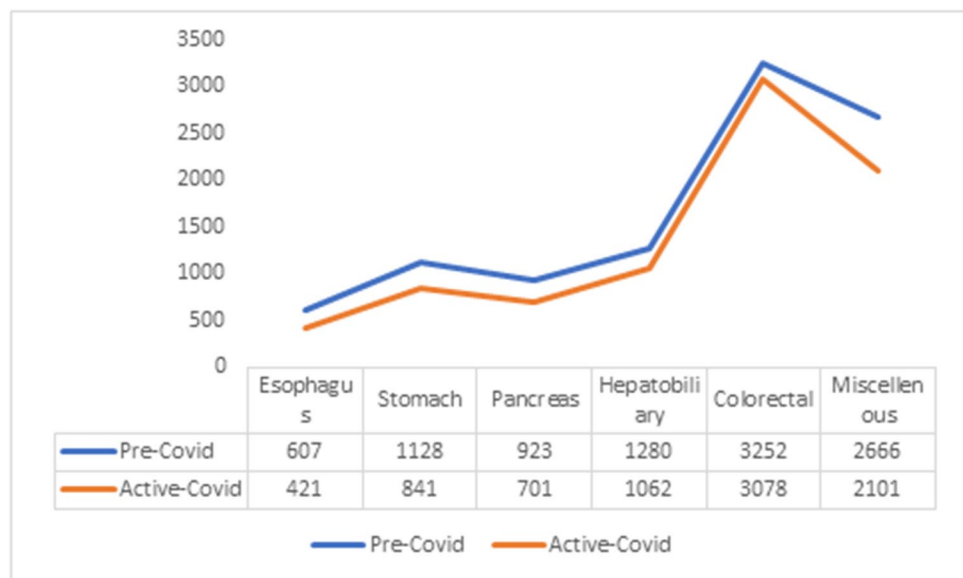
Mitigation strategies adopted

In the second wave, many centres adopted different mitigation strategies to minimise the impact of Covid-19 pandemic. Objective data was available only from Amrita Institute Kochi and Tata Memorial Centres at Mumbai, Sangrur, and Varanasi. Various mitigation strategies adopted included use of tele clinics for consultations and follow-up services, FastTrack recruitment of dedicated Covid-19 staff to minimise disruption of healthcare personnel allocation, setting up of temporary establishments away from hospital premises for dedicated Covid care, segregation of care pathways, dedicated non-Covid zones, pre-operative Covid-19 testing, adaptation of national and international guidelines, and continuation of multidisciplinary clinics using virtual modes.

Discussion

The Covid-19 pandemic resulted in significant disruption of cancer care worldwide [1, 2]. In India where the majority (up to 70%) of the tertiary care cancer centres are in the urban areas, the challenges of the cancer care delivery were complex [27]. During the pandemic, multiphasic nationwide lockdowns severely limited the access of the rural population to tertiary care centres. In addition to that, reallocation of major health care resources, financial restrains, and earlier reports of poorer outcomes in cancer patients post Covid-19

Fig. 1 Individual organ-system comparison between pre-Covid and active Covid period



infection resulted in catastrophic disruption of cancer care which may have substantial implications in future [28, 29]. Although all the aspects of cancer care were impacted from screening to research, current study focusses on the disruption of surgical services across major gastrointestinal cancer centres in India.

Although majority of centres in our study made an exception for essential cancer surgeries, 81% centres worked as dedicated Covid care centres with 43% of the centres reporting complete suspension of essential care extending up to 6 months. This reallocation of the health services in the form of theatre space, ventilators, and cancer care staff resulted in suspension of elective cancer care in these centres [28, 29]. In addition to this, suspension of multidisciplinary clinics, clinical trials, and academic activity needs to be highlighted given the long-term impact of these on present and future of gastrointestinal cancer care [3, 4, 20, 28, 29].

In this study, the new patient registrations saw a cumulative decrease of 14% in the active Covid phase. Pramesh et al. in a nationwide survey of 41 cancer centres reported 54% decrease in new registrations [29]. The decrease in new registrations implies delay in diagnosis and initiation of the treatment that severely impacts the outcome of the gastrointestinal malignancies as treatment timeline has considerable impact on these malignancies. Tata Memorial Centre at Mumbai and associated Centres in Varanasi and Sangrur reported an increase in new registrations. Increase in number of operations and registrations reported by TMC Sangrur and Varanasi may be explained by major augmentation of hospital services in these centres just prior to the active Covid phase. Moreover, cancer care was prioritised at standalone cancer centres when compared to other centres. There was no suspension of cancer care services and the allocation to the dedicated Covid care was minimal in these centres. This may also reflect the impact of the publication by Shrikhande et al. regarding the continuation of cancer care at Tata Memorial Centre, Mumbai during early part of first wave of the Covid-19 pandemic that was widely circulated in the national newspapers [17]. This also reflects early adoption of segregated safe cancer care pathways by these institutions [2, 3, 14].

There was 17% decrease in the gastrointestinal and hepatopancreatic biliary oncological procedures during the active Covid phase. This study also highlighted that up to 60% of these surgeries were performed in 5 of the 16 centres. The disruption is lower as compared to other nationwide studies that reported up to 50% decrease in the number of major cancer surgeries [30–33]. This reflects the mitigation strategies adopted by the cancer care specialists in the form of segregation of Covid care and adopting best practice guidelines for cancer treatment during the pandemic as prescribed by Indian Association of Surgical Oncology (IASO) COVID-19 guidelines and

the Tata Memorial Centre COVID-19 working group and redesignate oncological surgeries as essential rather than elective [14, 34–36].

This study highlighted the maximum disruption in esophagogastric and hepatopancreatic cancer surgeries ranging from 25 to 33%. Some of the centres in Japan reported 50% decrease in the number of gastrectomies performed in the active Covid phase [31]. The disruption of optimal management of upper gastrointestinal cancers has been uniformly reported across the countries as the endoscopic services were largely discontinued in the early part of the Covid-19 as they were considered as high aerosol generating procedures. This disruption was further potentiated by the fact that alternative treatment options like chemoradiotherapy were substituted for surgically resectable diseases [37]. Similarly, regarding pancreatic cancer surgeries, the optimal care was seriously restricted in view of the reduced endoscopic and radiological services. In our study, the high-volume centres reported about 35% decrease in pancreatic surgeries when compared to average decrease of 24%. English centres reported a decrease of 40% in oncological pancreatic resections during active Covid phase [38, 39]. Similarly a large multicentre study on the impact of Covid-19 on liver cancer management reported 50% decrease in curative resections [40]. Major liver resections are resource exhaustive surgeries and alternative non-surgical modalities are readily available. This major disruption in the surgical resection of liver tumours may be explained by the adoption of non-surgical modalities like ablation, neo-adjuvant chemotherapy, and stereotactic radiotherapy as the preferential treatment modalities during the active Covid phase. This trend was evident from many international hepatobiliary centres and highlighted in Society of Surgical Oncology guidelines [41–44]. The disruption was minimal in colorectal surgeries across the participating centres with some centres reporting an increase of up to 22% in colorectal cancer resections including minimally invasive resections. Although the initial concern regarding the enhanced viral transmission related to aerosolisation associated with minimally invasive surgery was rapidly allayed by different societal guidelines, however, there have been reports of up to 20% decrease in minimally invasive surgeries for rectal cancer from some Chinese centres [45]. However, some European and American centres reported no difference in minimally invasive colorectal surgeries during Covid-19 pandemic with strict adherence to the societal guidelines [46, 47]. Increase in minimally invasive colorectal surgeries during the Covid-19 era in our study may be explained by strict adherence to the precautionary measures adopted in these centres and benefits related to enhanced postoperative recovery and

decreased respiratory complications. Apart from that, the recruitment of newly appointed laparoscopic colorectal surgeons at Tata Memorial Centres in Varanasi and Sangrur may have led to increase in volume of minimally invasive colorectal surgeries in these centres during the active Covid-19 phase.

This study highlighted comparable morbidity in active Covid-19 phase with relatively higher mortality when compared to pre Covid-19 phase. The study also highlighted that only 1.12% patients became Covid-19 positive in the post-operative period which was lower than nationwide infectivity rate. The comparable morbidity reflects the importance of the cumulative impact of scientific approach, administrative will, and the stringent pre-operative measures to ascertain the safe performance of the elective surgeries. Regarding increase in mortality in active Covid-19 phase, the data available is insufficient to draw any conclusions. However, in three centres, it was related to higher mortality in post-operative Covid-positive patients. These results are concurrence with international collaborative study that demonstrated higher mortality in post-operative Covid-19 patients [48, 49]. However, since the data about associated factors like comorbidities and age is not available, so definite conclusions cannot be made.

The present survey also highlights the importance of the continuation of cancer care. Most of the centres were designated Covid care centres; however, different mitigation strategies were adopted for continuation of the care. Hospitals developed standard operating procedures in the form of segregation of care, dedicated non-Covid zones, pre-operative Covid-19 testing, adaptation of national and international guidelines, and continuation of multidisciplinary clinics using virtual modes and segregating designated health care personnel [12–15, 36].

Since this was a survey, questionnaire only included the objective data-based queries; no details regarding patient demographics, procedural details, tumour-based outcomes, hospital policies, details of complications, and causes of mortality were available. Hence, detailed conclusions could not be drawn. However, this survey highlighted the behaviour of different tertiary care hospitals in response to Covid-19 pandemic and provides insight into the administrative and scientific mitigation strategies that were adopted by different hospitals across India in dealing with complex gastrointestinal malignancies. This study provides an opportunity to analyse the strategies adopted by centres that performed comparatively better and use them to framework future strategies.

This survey has helped us to identify a range of strategies to enhance the cancer care in the post-pandemic era and enhance the delivery of value-based health care. Development of the models allowed enhanced delivery

of out-patient and home-based oncological care utilising virtual platforms like telehealth, e-prescriptions, e-ordering of investigations, and home-based nursing care. In addition to this, the pandemic paved the way for enhanced acceptance of virtual Multidisciplinary Team meetings as the standard components of oncological workflow. Development of segregated and flexible workflow systems in terms of hospital design and staff would allow better response to future pandemics.

This short-term impact of the Covid-19 pandemic on the cancer care may only represent the tip of the iceberg. Luo et al. in a study from Australia have put forward some alarming statistics. In their prediction model, they have predicted approximately 1719 additional deaths in colorectal cancer patients in Australia between 2020 and 2044 that may be attributed to a 26-week treatment delay related to Covid-19 pandemic [50]. Data from Canadian Cancer Survivor Network highlighted the elevated risk of death in colorectal cancer patients associated with 6 weeks of treatment delay [51]. Prediction models have highlighted the estimated increase in cancer-related deaths along with the reversal of the ongoing decreasing trend of certain cancers. In addition to that, pandemic has significantly affected the cancer research resulting in significant hiatus in the therapeutic development and an anticipated 18-month delay in research breakthroughs [24]. Understanding these implications may help in appropriate planning and resource allocation to mitigate this anticipated long-term impact. National and international collaborative efforts along with the administrative support for cancer care and research are needed to minimise the disparities in cancer care and prepare for a relatively higher burden of later stage cancers in the post-pandemic era.

Conclusion

This National Survey gives an objective outlook about the performance of high-volume referral centres across India dealing with complex gastrointestinal malignancies. Most (81%) centres did resource allocation to provide Covid-19 care and 43% centres had complete cessation of non-Covid care for more than 6 months during the active pandemic phase. New registrations and surgical procedures decreased in the active Covid phase. Upper gastrointestinal, pancreatic, and hepatic procedures were impacted the most. Although, perioperative morbidity remained similar, relatively higher perioperative mortality was noted in the active Covid phase in this study. Given the limitations of the data available, definitive conclusions may not be possible for this observation. Despite catastrophic impact of the Covid-19 pandemic, most of the centres adopted guidelines-based mitigation

strategies to reduce the magnitude of the impact. There is a need for nationwide standardised safe surgical pathways to address further Covid peaks and need for reinforcement to deal with the higher anticipated backlog in the post-Covid phase.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00423-022-02675-6>.

Authors' contributions Amir Parray—data compilation and analysis and manuscript drafting Vikram A Chaudhari, Manish S Bhandare, Shailesh V Shrikhande—concept and final framework of manuscript Madhabananda K, Dilip K Muduly, Sudhindran S, Johns S Mathew, Pradeep R, Subramanyeshwar R, Amal K, Debashish C, Jitender R, Durgatosh P, Amar P, Prasanth P, Kalayarasan R, Chetan V Kantharia, Sharvari P, Ramesh H, Somashekhar S P, Aaron Fernandes, Rajneesh K Singh, Rajan Sexena, Mohd R Lattoo, Omar J Shah, Jeswanth S, Manas Roy, Robin Thambudurai—centre-specific data contribution and analysis

Data availability On request from the corresponding author

Declarations

Ethics approval The study was approved by institutional ethical committee of Tata Memorial Centre, Mumbai (OIEC/3843/2021/00001). Waiver of consent was granted since this is a retrospective study.

Conflict of interest The authors declare no competing interests.

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