RESEARCH ARTICLE

The COVID-19 pandemic impact on gross income and utilization of radiologic services in a Philippine COVID-19 public tertiary referral hospital

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ABSTRACT

Background: The global economy has been severely affected by the COVID-19 pandemic which proved to be more than a public health crisis. Volume and gross income have also declined in the health service sector including the diagnostic imaging and radiotherapy divisions of the radiology departments in other countries.

Objective: This study determined the change in volume and gross income of the Radiology Department of a tertiary hospital which was designated as a COVID-19 referral center in the Philippines.

Methodology: Monthly records of the profit centers of the Radiology Department were reviewed noting the volume and gross income one year before and during the first year of the pandemic.

Results: Records were successfully retrieved for the volume of procedures and revenue for each profit center from one year before the pandemic (from March 1, 2019 to February 28, 2020) and the first year of the pandemic (from March 1, 2020 to February 28, 2021). There was a total reduction of 120,046 procedures conducted and Php 84,837,614.16 in revenues generated between the two periods. This is equivalent to a 61.98% (range: 47.92% to 83.37%) decrease in the volume of procedures and a 45.02% (range: 31.08% to 77.86%) decrease in revenue. These changes were found to be statistically significant.

Conclusion: The COVID-19 pandemic caused a decline of all profit centers in the Radiology Department. The decline was associated with changes in quarantine restrictions. Data from this study may help the administration of the institution or other institutions to conduct their own studies and cope with future pandemics of similar magnitude or further surges of the current pandemic on decisions regarding budget and resource allocation.

Keywords: *COVID-19 pandemic, radiology department, hospital profit centers, volume and gross income, radiology and imaging*

Introduction

The radiology department remains one of the most profitable cost centers in hospitals globally [1]. Outpatient radiology is "the biggest contributor to the profit margin of U.S. hospitals, costing Medicare $14 billion" and "imaging services accounted for $24.1 billion, or 37 percent of hospitals' profit. That is about three times greater than cardiology, the next closest service line" [1]. In the institution where this study was performed, the Radiology Department consistently ranked number three in revenue generation for the past five years according to the Departmental Report of Income from the accounting services division.

All these have changed when the COVID-19 pandemic occurred. The global economy has been severely affected and almost all known health service providers have suffered a decline in the volume provided and, consequently, revenue. Studies in the US reveal a significant decline in imaging volume in large healthcare systems and community hospitals [2,3,4]. According to the special report from the Radiological Society of North America (RSNA) on COVID-19, the pandemic brought about marked decreases in case volumes of up to 80% in some cases [5]. In a survey conducted by members of the American College of Radiology, there was a decline in

volume and gross charges with respondents also applying for financial relief [6]. In a survey from the UK but with more than 70% of the respondents from India, 80% reported a drastic decrease in workload [7].

In 2014, the Philippine government created the Inter-Agency Task Force for the Management of Emerging Infectious Diseases (IATF-EID) to protect and promote the right to health of the people against emerging infectious diseases acknowledged by the global community to cause potential public health emergencies and international concern [8]. During the COVID-19 pandemic, the Task Force issued memoranda concerning two kinds of community lockdown: the General Community Quarantine (GCQ) and Enhanced Community Quarantine (ECQ) [9,10]. The ECQ is the stricter of the two, which is a total lockdown where residents are ordered to stay at home with travel restricted to what are deemed essential personnel and for emergencies. The GCQ, with its lighter restrictions, would make mobility easier with public transportation now operational but with a reduced capacity [9,10].

Online literature search did not reveal any published studies on the impact of the pandemic on radiology services in the Philippines. Communication with the Chair of the Research Committee of the Philippine College of Radiology (specialty society for radiology) revealed that there are no current proposals, ongoing studies, or submitted papers on this topic.

A study was therefore made with the aim of documenting the change in volume and gross income of the Radiology Department of a tertiary hospital in the Philippines which was designated as a COVID-19 referral center [11]. The site of the study is one of the largest general hospitals in the country with a comprehensive repertoire of specialties.

Data from this study can help the current hospital administration to reallocate resources and prepare the budget for the coming years while the pandemic is still ongoing. This can also serve as a template for studies in other institutions whose category (non-COVID centers and smaller hospitals) is different and those which are not publicly funded or receiving government support.

Methodology

Study Design

This is a single institution retrospective review of monthly records of the volume of procedures and gross income from these procedures for each profit center which is defined as the different diagnostic and therapeutic sections of the Radiology Department.

Study Setting

The site of this research is the Radiology Department of a large government-funded hospital in the Philippines. It is a tertiary referral hospital situated in the National Capital Region receiving patients not just from its locality but also from various provinces in the country.

Data Sources

The records of the different profit centers of the Radiology Department were obtained. These were: X-ray (plain and contrast studies including mammography); CT scan (both imaging and biopsies); MRI; Ultrasound (diagnostic and therapeutic procedures); Interventional Radiology (angiography, fistulograms, sialograms, hysterograms, and various therapeutic procedures); External Beam Radiotherapy or EBRT (Linear Accelerator and Cobalt-60 treatments); and Brachytherapy (low-dose-rate (LDR) and high-dose-rate (HDR) procedures). These profit centers were treated in this paper as separate, stand-alone businesses responsible for generating their own income.

The records for the year before the pandemic (from March 1, 2019, to February 28, 2020) and the first year of the pandemic (from March 1, 2020, to February 28, 2021) were consolidated and compared. Monthly census of the different profit centers in the Department were mined from two sources: the logbook kept in each profit center and the hospital's information technology platform – the Open-ERP (Enterprise Resource Planning). The pay and charity procedures were not separated and neither were the inpatient and outpatient procedures. Data was only evaluated per profit center and for the Radiology Department as a whole.

Variables

The volume of procedures, a discrete variable, operationally defined as the amount of each kind of procedure done per profit center, was gleaned from the census. Another variable, the gross income, a continuous variable, operationally defined as the sum of all profits/ earnings of each profit center, was also culled from the monthly census.

Statistical Methods

Data was thoroughly checked for completeness and consistency prior to analyses. Shapiro Wilk test was performed to determine the normality of data.

Discrete (volume of procedures) and continuous (gross income) data were summarized using medians and interquartile ranges and were compared using Wilcoxon signed-rank test for Before Pandemic (March 2019 – February 2020) versus During Pandemic (March 2020 – February 2021). P-values less than 0.05 were considered significant. STATA 15 (StataCorp, Texas, USA) was used in all analyses.

Results

Records were successfully retrieved for the volume of procedures and revenue for each profit center from one year before the pandemic (from March 1, 2019 to February 28, 2020) and the first year of the pandemic (from March 1, 2020 to February 28, 2021). This totaled 24 months of data with no missing values.

Section A. Volume Changes Before and During the Pandemic

The volume of each profit center was compared before the pandemic *vis-a-vis* during the pandemic.

Based on Table 1, there is a statistically significant decrease in the volume of procedures for all profit centers from before and during the pandemic. This is graphically shown in Figure 1.

Computing for the percent decrease in the procedures of the entire Department from before the pandemic and during the pandemic showed a 61.98% decrease or a decrease of 120,046 total procedures. Detailed in Table 2 is the percentage decrease for each profit center.

As can be seen from Table 2, all profit centers in the Department experienced a decrease of more than 45 percentage points, the lowest drop was for the CT scan section (47.92%) while the highest drop was seen for the Ultrasound section with a decrease of 83.37%.

As seen in the line graph (Figure 2), there is a general fall in the volume of procedures across all profit centers. This drop is very notable in the X-ray profit center from March 2020 to April 2020. There was then a gradual increase in the number of procedures from May to June 2020 to the end of the study period during the pandemic year.

Section B. Gross Income Changes Before and During the Pandemic

Based on Table 3, there is a statistically significant decrease in the gross income for all profit centers from before and during the pandemic, visually shown in Figure 3.

The percent decrease in the gross income of the Radiology Department from before the pandemic and during the pandemic is at 45.02% or a total loss of PhP 84,837,614.16. Detailed in Table 4 is the percentage decrease in each profit center.

Table 1. *Comparison of the volume of procedures for different profit centers before and during the pandemic*

PROFIT CENTER	VOLUME				
	BEFORE PANDEMIC March 2019 - February 2020 (n=72)		DURING PANDEMIC March 2020 - February 2021 (n=72)		P-VALUE
	Median (IQR)	True Value	Median (IQR)	True Value	
XRAY	1366 (2354)	125,065	312 (835)	46,807	**<0.0001**[a]
CT SCAN	213 (458)	19,016	90 (239)	9,904	**<0.0001**
MRI	22 (38)	1,867	0 (4)	959	**<0.0001**
ULTRASOUND	238 (321)	23,481	4 (55)	3,906	**<0.0001**
IR	1 (11)	453	0 (2)	164	**<0.0001**
EBRT	69 (339)	22,788	14 (139)	11,502	**<0.0001**
BRACHYTHERAPY	0 (33)	1,029	0 (3)	411	**<0.0001**

[a]Wilcoxon signed-rank test. Note: The Shapiro-Wilk test was used to assess the normality assumption of the student's t-test. All of the p-values of the Shapiro-Wilk test were significant, indicating they were all non-normally distributed, hence, the t-test cannot be used. A non-parametric counterpart, the Wilcoxon test, was used instead.

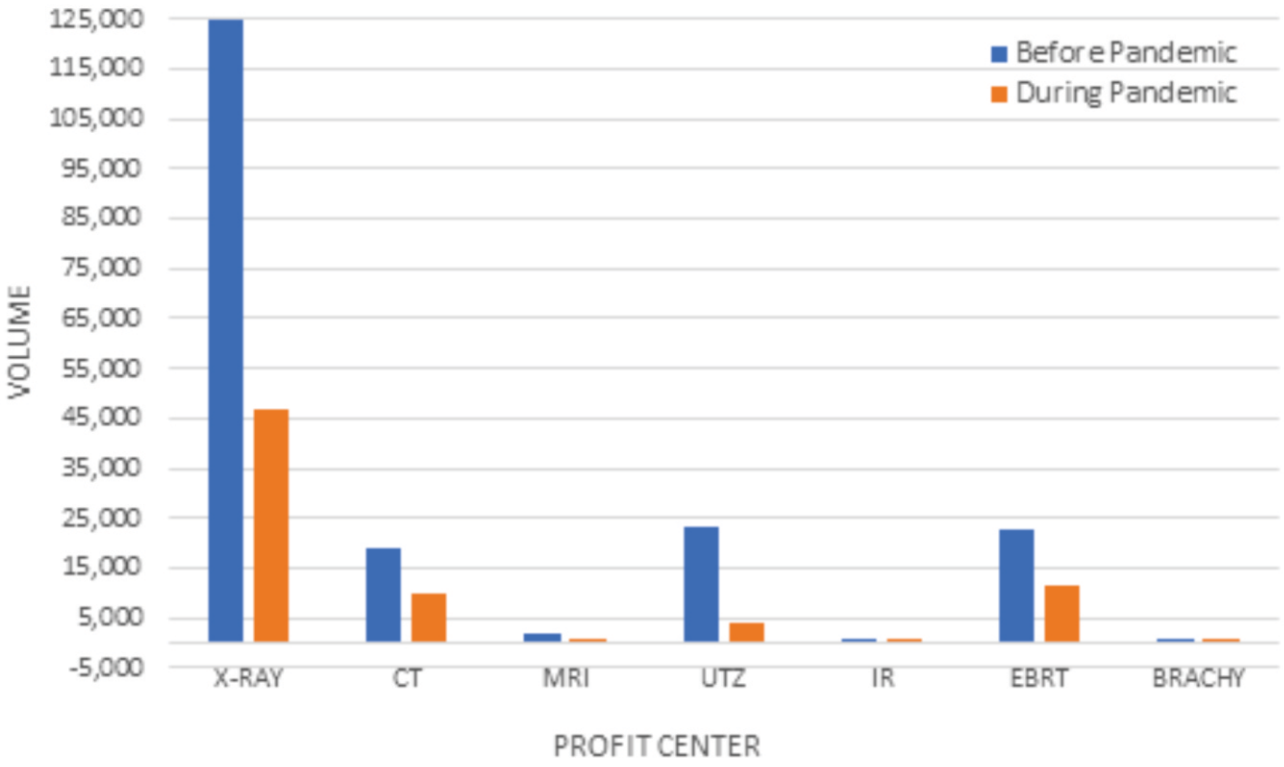

Figure 1. *Volume of procedures before and during the pandemic*

Table 2. *Percentage change in the volume of procedures before and during the pandemic in each profit center*

Profit Center	Before the Pandemic	During the Pandemic	Decrease in volume of procedures	% Change
X-ray	125,065	46,807	78,258	62.57
CT	19,016	9,904	9,112	47.92
MRI	1,867	959	9,081	48.63
UTZ	23,481	3,906	19,575	83.37
IR	453	164	289	63.80
EBRT	22,788	11,502	11,286	49.53
Brachytherapy	1,029	411	618	60.06
Total	193,699	73,653	120,046	61.98

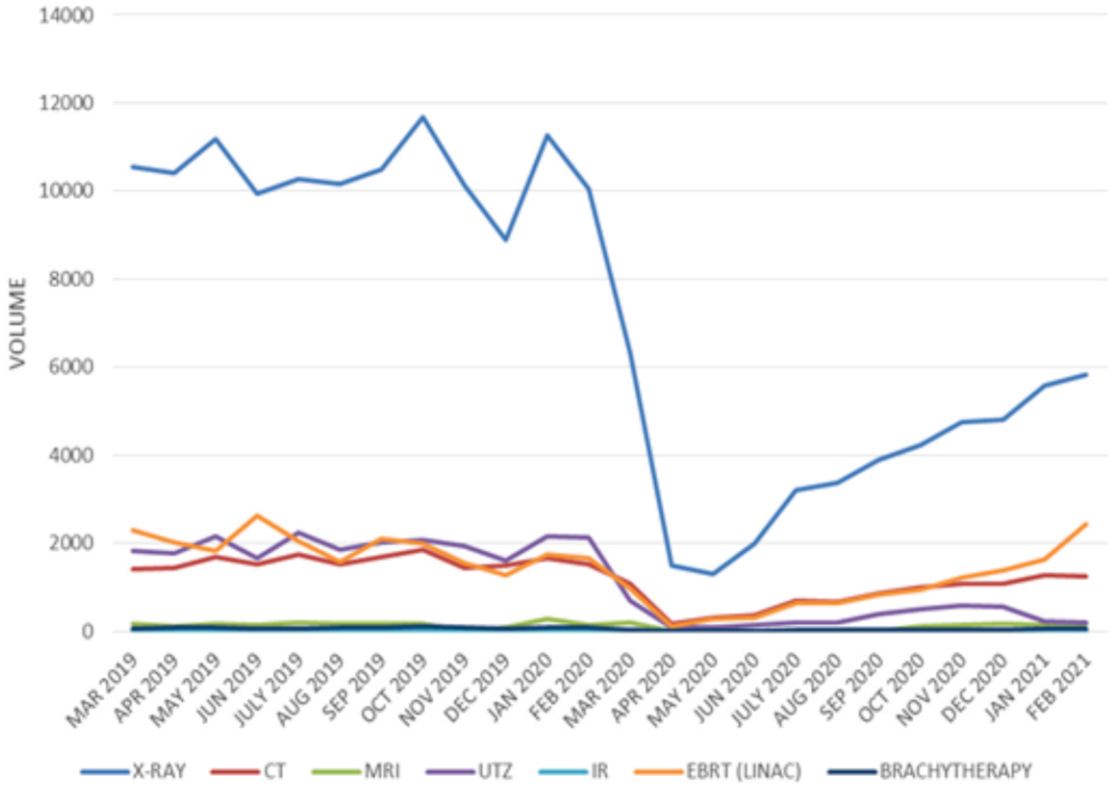

Figure 2. *Volume of procedures per profit center per month from March 2019 to February 2021*

Table 3. *Comparison of the gross income for different profit centers before and during the pandemic*

PROFIT CENTER	VOLUME				
	BEFORE PANDEMIC March 2019 - February 2020 (n=72)		DURING PANDEMIC March 2020 - February 2021 (n=72)		P-VALUE
	Median (IQR)	True Value	Median (IQR)	True Value	
XRAY	625,411.00 (706,448.50)[a]	33,696,765.03	22,315.50 (198,167.00)	14,019,417.00	**<0.0001**[b]
CT SCAN	1,268,100.00 (1,234,305.00)	73,500,941.00	448,945.00 (1,037,771.00)	48,680,900.00	**0.0002**
MRI	127,520.00 (277,878.00)	12,122,573.50	0.00 (16,625.00)	8,354,321.50	**<0.0001**
ULTRASOUND	104,195.00 (119,005.40)	7,567,472.70	3,177.50 (26,460.75)	1,675,708.30	**<0.0001**
IR	0.00 (60,969.35)	6,635,763.23	0.00 (17,092.80)	2,881,379.30	**0.0106**
EBRT	171,130.00 (917,905.00)	43,005,397.00	27,185.00 (336,350.00)	23,350,615.00	**<0.0001**
BRACHYTHERAPY	0.00 (335,123.90)	12,531,331.21	0.00 (36,022.00)	4,660,287.78	**0.0037**

[a] Median (Interquartile Range), [b] Wilcoxon signed-rank test

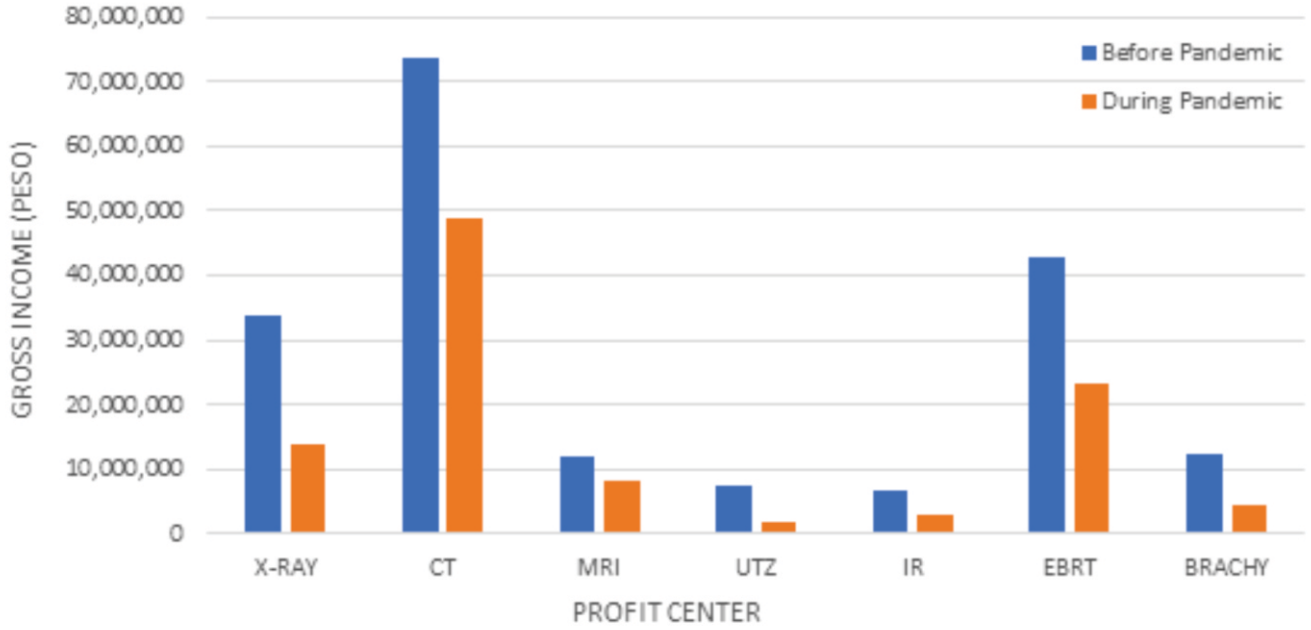

Figure 3. *Gross income from procedures before and during the pandemic*

Table 4. *Percentage change in the gross income of procedures before and during the pandemic in each profit center*

Profit Center	Before the Pandemic	During the Pandemic	Decrease in volume of procedures	% Change
X-ray	33,696,765.03	14,019,417	19,677,348.03	58.4
CT	73,500,941	48,680,900	24,820,041	33.77
MRI	12,122,573	8,354,321.50	3,768,251.50	31.08
UTZ	7,567,472.7	1,675,708.30	5,891,764.4	77.86
IR	6,035,763.23	2,881,379.30	3,154,383.93	52.26
EBRT	43,005,397	23,350,615	19,654,782	45.7
Brachytherapy	12,531,331	4,660,287.70	7,871,043.30	62.81
Total	188,460,242.96	103,622,628.8	84,837,614.16	45.02

As indicated in Table 4, all profit centers in the Department experienced a decrease of more than 30 percentage points. The highest loss in gross income was for the Ultrasound profit center which showed a decrease of 77.86%.

As compared to Figure 2, there was a marked dip in the income of most of the profit centers, more pronounced in CT scan, EBRT, and X-ray. The greatest downturn also occurred during the month of April. Most of the profit centers also

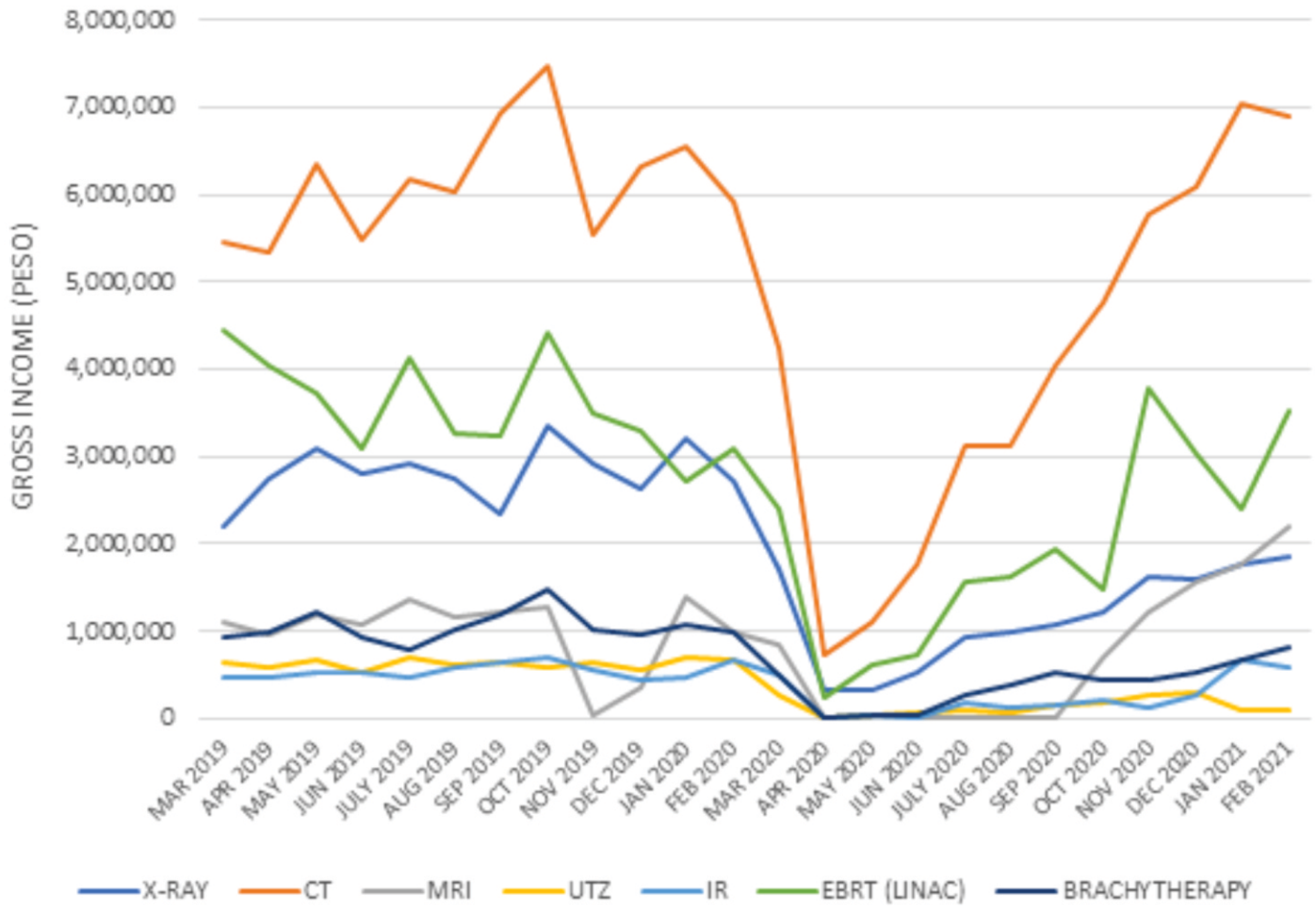

Figure 4. *Gross income per profit center per month from March 2019 to February 2021*

showed a gradual increase from the month of June 2020 except for the MRI profit center which had no procedures and income from June to September 2020.

Discussion

As seen from the results, there was significant decrease in the volume of procedures and gross income in all profit centers in the Department of Radiology. There was a total of 61.98% decrease in the volume of procedures and a 45.02% decrease in revenue during the pandemic. The data gleaned from this study is not directly comparable to any current published data as the available literature pertained to health care systems composed of several hospitals and none were specifically for COVID referral centers. However, these studies showed a similar decline in both the volume and gross income.

The decrease in volume of procedures from a large health system in Ohio showed a 55% decrease in imaging utilization [2]. In a parallel finding, case volumes fell 57% during the pandemic surge on March 1 – May 12, 2020, in another large academic health system within the greater New York City area [12]. Another study in Massachusetts showed that the average weekly imaging volume decreased 54% at the main hospital campus and by 64% in its affiliated imaging centers [13].

When questionnaires were given to members of the American College of Radiology (ACR) regarding their practice, a decline (56.4-63.7%) in the volume of practice and collections (by 46.4-53.9%) was experienced during the initial part of the COVID-19 pandemic in April [6]. There was also a decline in the gross charges with nearly 70% of respondents applying for financial relief [6].

At the beginning of the pandemic outbreak when details of the COVID -19 transmission and virulence are still being established, procedures were limited to emergency room and inpatient emergent cases only. Because doing ultrasound procedures requires close contact with the patient, the risk of exposure to COVID-19 is likewise higher, and therefore the option of doing non-contact imaging modalities like X-ray and CT scans were prioritized over ultrasonography. It is not surprising that in this study, the ultrasound profit center experienced the greatest drop in both volume of procedures (83.37% decrease) and gross income (77.86% decrease) which can be attributed to limited acceptance and referral of patients for ultrasound examination. These figures are much lower when compared to other published data. The healthcare system in Ohio showed a 58% decrease in ultrasound procedures [2]. A survey of radiologists mostly from India showed that COVID-19 pandemic had a drastic impact on the workload with reports of almost 60%–70% reduction in imaging procedures, more marked in ultrasound [14].

The therapeutic section of the Radiology Department is composed of the EBRT and Brachytherapy profit centers. In this study, there was a 49.53% decrease in volume of procedures, a 45.7% decrease in gross income from EBRT, a 60.06% decrease in volume of procedures, and a 62.81% decrease in gross income from Brachytherapy. Radiation oncology practice leaders from the US were surveyed and it also showed declines in volume of treatment. It was stated in that study that "on average, practices reported treating 68% of their usual volume" which showed a 32% decrease [15]. From the same survey, 71% of their practices approximated a revenue decrease of 20% or more [15]. A similar decreasing trend was also observed in the EBRT and Brachytherapy volume and gross income in the studied institution. This was due to limited operations treating only emergency cases in April 2020 and delays related to complying with new stricter infection control guidelines and requiring a negative COVID-19 RT-PCR (reverse transcriptase – polymerase chain reaction) test for the patients.

The decline in both the volume of procedures and gross income starting in March and hitting its bottom at the end of April 2020 is attributable to the implementation of the ECQ in the middle of March. During the first two weeks of March, a regular number of patients was still seen at the Department. There were still pre-scheduled procedures for the remainder of March which were still carried out if the patient was able to reach the hospital. April showed the least numbers because the entire month was in ECQ with the implementation of strict procedures [9,10]. Volume and gross income started to increase in May although there was still no public transportation, biking, and other non-motorized transport that were encouraged [9,10]. The subsequent gradual increase of volume and gross income corresponded to the implementation of less stringent regulations during the GCQ [9,10] when public transportation was resumed, albeit at a decreased capacity.

Several factors other than the imposition of the different quarantine restrictions also influenced the observations. The earlier increase in X-ray and CT procedures in May 2020 maybe attributed to their utilization in managing COVID-19 cases. MRI, on the other hand, had limited use for COVID-19 and thus, had limited procedures requested. The MRI volume of procedures and gross income further decreased because the machines were not operational from June to September 2020 due to hardware breakdown.

Although the study was done in a government/publicly-funded hospital, the decline in both volume and revenue can be a guide in reallocating resources, especially for private institutions. The operation of low-volume/low revenue profit centers can be reduced to minimize operation costs. Resources, particularly manpower, can be transferred to profit centers which are highly critical in the care of COVID-19 patients such as x-rays & CT scans. This is particularly true for manpower which is scarce during the pandemic. The data from this study can determine how much the operation of the other profit centers can be scaled down to meet the needs of the institution.

All in all, as with other published studies, it will be beneficial to keep abreast or anticipate government announcements on restrictions (like quarantine status) to anticipate the change in patient influx and, therefore, change in volume, utilization pattern, and gross income of health services in the hospitals.

There are several limitations in this study which may provide future research opportunities. First, the study is retrospective and since the pandemic is still ongoing and evolving, it can be continued. Second, aggregated data were ulitized which did not separate patient characteristics (e.g., pay or service, in-patient, or out-patient), procedure urgency (emergent or elective), and specific procedures within each profit center (e.g., mammography under X-ray and biopsies under CT). Delving into these categories may provide a more detailed analysis of how different profit center subcomponents were affected. Third, the setting is a publicly funded tertiary hospital and the results may not be applicable to private institutions reliant on their income for operation, non-COVID centers, and primary and secondary hospitals. Therefore, further studies can be performed for these specific instances.

Conclusion

The imaging volume and gross income at the hospital studied showed a decline in all profit centers with not all the profit centers being affected to the same degree. The decline in volume and gross income was greatest with Ultrasound and the least with CT and MRI. The decline in volume of procedures and gross income coincided with the declaration by the government of the quarantine restriction which is congruent with what happened in the available literature for North America and the limited surveys from Indian radiologists.

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