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The Patterns and Changes of General Surgical Presentations during the First Wave COVID-19 Pandemic at a Metropolitan Sydney Hospital

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Abstract

Background: The impact of SARS-CoV-2 virus (COVID-19) has been well documented in international settings with a reduction in overall emergency presentations both influenced by social distancing and lockdowns. This study focuses on several common acute general surgical pathologies exploring differences in presentations and clinical outcomes for appendicitis, cholecystitis, and incarcerated hernias during the first wave.

Methods: A retrospective review of medical records of all patients was analyzed in two groups: The non-COVID-19 group (combined 2017-2019) and the COVID-19 group (2020).

Results: There were 3,316 acute emergency surgical presentations with an 8.2% decrease in total presentations in 2020. There were 477 appendicectomies, 224 cholecystectomies, and 121 repair of incarcerated hernias. All general surgical procedures demonstrated significant differences between non-COVID and COVID cohorts, including Length of Stay (LoS) (2.7 *vs.* 2.1, p=0.009) and onset of symptoms (1.6 *vs.* 2.2, p=0.018) for those aged less than 25 years. Patients with appendicitis aged less than 25 years had a significantly longer onset of symptoms before hospital presentation and shorter LoS in the COVID group (1.7 *vs.* 2.5, p=0.002; 2.9 *vs.* 2.3, p=0.016). Likewise, patients with cholecystitis had a significantly longer onset of symptoms in the COVID-19 cohort compared to their counterparts (2.0 *vs.* 3.0 days, p=0.025). There were no significant differences in biochemical, clinical or postoperative outcomes.

Conclusion: The first wave of the COVID-19 pandemic significantly reduced acute general surgical presentations. For those less than 25 years in the COVID-19 cohort, overall LoS was shorter despite indicating significantly delayed presentations.

Keywords: COVID-19; Physical distancing; Appendicitis; Cholecystitis; Length of stay

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Abbreviations

ASA: American Society of Anesthesiologists; PS: Physical Status; CRP: C-Reactive Protein; CT: Computed Tomography; ICU: Intensive Care Unit; LoS: Length of Stay; NSW: New South Wales; qSOFA: Sequential Organ Failure Assessment; US: Ultrasound; WCC: White Cell Count

Introduction

COVID-19, a contagious disease, known as the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), was declared a pandemic by the World Health Organization on March 11th, 2020 [1]. The Australian Government introduced "social distancing" five days later and significant changes in the public health system were progressively implemented [2]. European counterparts recognized a reduction in emergency presentations between March and April 2020 ranging from 13.0% to 46.3%, compared to the previous year [3,4]. On March 25th, 2020 following the National Cabinet announcement and acting on the advice of the Australian Health Protection Principal Committee, New South Wales (NSW) state public hospitals suspended all non-urgent elective surgery [2].

With scientific communities working to better understand the nature of the disease and to develop prevention protocols [5], the provision of acute surgery services inevitably had to continue

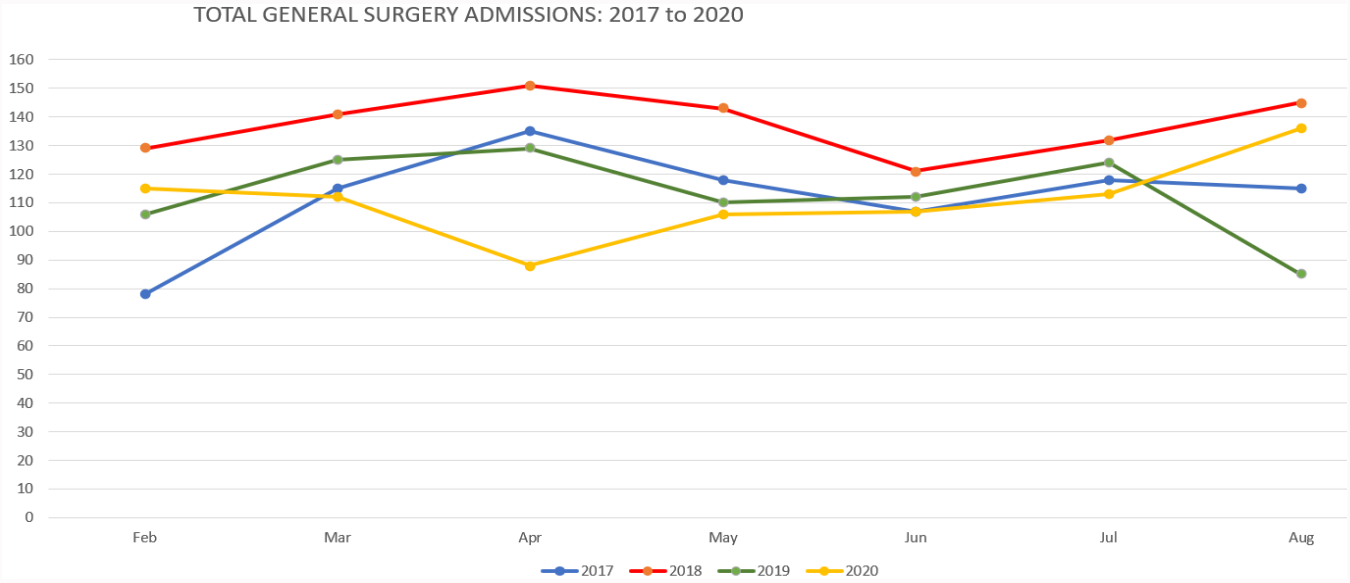

Figure 1: Total general surgery admissions 2017 to 2020.

to function including for potential life-threatening pathologies such as cancer with hospitals reorganizing their infrastructure within a socially distance manner. During the first wave of the pandemic, countries internationally reported patients were severely affected by the disease and these results directly influenced surgical outcomes [6-8]. In comparison our local health districts have sparsely analyzed the effect those initial public health measures had with respect to delayed presentations to ED or advert short- and long-term clinical outcomes. This project aims to specifically study the impact of those restrictive measures had during the first wave of COVID-19 pandemic on several common general surgical presentations at a Sydney metropolitan hospital.

Methods

A retrospective review was conducted for all emergency general surgical presentations at Bankstown-Lidcombe Hospital, NSW, Australia from 2017 to 2020 between February to August. Ethics approval was granted from the South Western Sydney Human Research and Ethics Committee [2021/PID00924]. The study was conducted using STROBE guidelines. The inclusion criteria were any patients admitted to the general surgical unit with an acute surgical pathology. The primary objective was to determine any differences in presentations for all acute general surgical admissions. The secondary objective was to further determine any changes in clinical outcomes in a refined subgroup of the most common pathologies, including appendicitis, cholecystitis, and incarcerated hernias.

The data collected included

- Demographic information: Sex, age, age groups (<25, 25-40, 40-55, 55-70, 70+), body mass index (kg/m^2), onset of symptoms to hospital presentations (days)

- Sepsis: Two or more of quick Sequential Organ Failure Assessment (qSOFA) criteria consisting of respiratory rate ≥ 22 breaths/min, Glasgow coma scale <15, and systolic blood pressure ≤ 100 mmHg.

- Biochemical parameters: White Cell Count (WCC), C-Reactive Protein (CRP), hemoglobin, platelets, creatinine, urea, albumin, liver function tests, and lactate

- Imaging: Ultrasound (US) and Computed Tomography (CT) scan and associated CT findings.

- Management: American Society of Anesthesiologists (ASA) physical status, operative management.

- Outcomes: Operative time (total time including anesthetic and surgical, hours), Length of Stay (LoS, days), Intensive Care Unit (ICU) admission and ICU LoS, post-operative complications (surgical and medical), and in-hospital mortality.

Statistical analyses were performed using IBM SPSS Statistics version 27.0. Patients were divided into two groups: Non-COVID-19 (2017-2019) and COVID-19 (2020) with a focused analysis on appendicectomy, cholecystectomy, and hernia. Continuous variables assessed the relationship between linear data and correlation based on a level of significance set at p value of 0.05. Data were analyzed with respect to each division of data including demography, biochemical, imaging, management and outcomes. The differences between proportions between the COVID-19 and non-COVID-19 groups derived from categorical data were analyzed using Pearson chi and student *t* test for continuous variables, respectively.

Results

Total study period

During the whole study period, there were a total of 42,225 emergency presentations to hospital with 3,316 emergency surgical admissions. There was an overall decrease in the total number of emergency general surgical presentations by 8.2% between the two study periods (846.3 *vs.* 777, p=0.171, Figure 1). The total cohort had an average age of 40.0 (± 22.3) years with a negative skewed distribution [0-25 years (31.9%), 26-40 years (25.9%), 40-55 years (17.2%), 55-70 years (12.2%), 70+ years (12.9%)]. There was an approximately equal distribution of men and women (51.3% *vs.* 48.7%). The three most common ethnicities included Caucasian (45.1%), middle eastern (35.9%), and Asian (16.2%). The average BMI was 27.6 (± 6.9) kg/m^2.

For all general surgical procedures and clinical outcomes for

Table 1: Comparative analysis between the COVID-19 cohort and the control cohort for appendicitis.

	Control Cohort (2017-2019)	COVID-19 Cohort (2020)	P value
Demographic Information			
Age [years], mean (SD)	29.2 (17.2)	30.2 (17.3)	0.607
Sex			
Male	199 (54.5%)	63 (56.3%)	0.748
Female	166 (45.5%)	49 (43.8%)	
Body mass index (BMI) [kg/m^2], mean (SD)	26.0 (6.6)	24.6 (5.5)	0.096
Months			
February	43 (11.8%)	12 (10.7%)	0.791
March	61 (16.7%)	18 (16.1%)	
April	48 (13.2%)	18 (16.1%)	
May	51 (14.0%)	13 (11.6%)	
June	43 (11.8%)	17 (15.2%)	
July	69 (18.9%)	16 (14.3%)	
August	50 (13.7%)	18 (16.1%)	
Onset of symptoms (days)	2.0 (3.3)	2.4 (2.9)	0.214
Aged less than 25 years	1.7 (1.2)	2.5 (2.5)	0.002*
Biochemical Parameters [normal range], mean			
White cell count (× 10^9/L) [4.0-10.0]	12.9	13.2	0.59
C reactive protein (mg/L) [<4.9]	39	30.3	0.205
Hemoglobin (g/L) [130-170]	141.6	141.6	0.987
Creatinine (µmol/L) [60-110]	70.6	70.9	0.872
Urea (mmol/L) [4.0-9.0]	4.6	4.6	0.799
Albumin (g/L) [33-48]	43.3	41.2	<0.001*
Lactate (mmol/L) [<1.9]	1.5	1.7	0.174
Sepsis	6 (1.6%)	1 (0.9%)	0.563
Imaging			
US	97 (26.6%)	19 (17.0%)	0.038*
CT scan	153 (41.9%)	40 (20.7%)	0.242
CT findings:			
Abscess	364 (99.7%)	112 (100.0%)	0.579
Phlegmon	0 (0.0%)	0 (0.0%)	-
Free gas	2 (0.5%)	0 (0.0%)	0.432
Operative management			
ASA status			
ASA 1	223 (61.1%)	73 (65.2%)	0.256
ASA 2	119 (32.6%)	32 (28.6%)	
ASA 3	23 (6.3%)	6 (20.7%)	
ASA 4	0 (0.0%)	1 (0.9%)	
Operative time [hours], mean (SD)	1.5 (0.5)	1.6 (0.6)	0.082
Aged 55-70 years	1.8 (0.6)	2.3 (1.0)	0.048*
Perforation	44 (12.1%)	9 (8.0%)	0.236
Postoperative Outcomes			
Postoperative complications	14 (3.8%)	3 (2.7%)	0.563
Return to theatre	19 (5.2%)	1 (0.9%)	0.046*
ICU			
Admission	5 (1.4%)	2 (1.8%)	0.749
Mean length of stay (SD)	0.1 (0.5)	0.1 (0.6)	0.56

Total length of stay in hospital [days]			
mean (SD)	2.9 (2.1)	2.5 (1.5)	0.027*
Aged less than 25 years	2.9 (1.7)	2.3 (1.3)	0.016*
40-55 years	3.3 (2.3)	2.1 (0.9)	0.008*
In-hospital mortality	0 (0.0%)	0 (0.0%)	-

Table 2: Comparative analysis between the COVID-19 cohort and the control cohort for cholecystitis.

	Control Cohort (2017-2019)	COVID-19 Cohort (2020)	P value
Demographic Information			
Age [years], mean (SD)	50.2 (19.9)	51.2 (20.1)	0.593
Sex			
Male	67 (42.9%)	22 (32.4%)	0.136
Female	89 (57.1%)	46 (67.6%)	
Body mass index (BMI) [kg/m^2], mean (SD)	30.4 (6.8)	29.6 (7.3)	0.49
Months			
February	13 (8.3%)	6 (8.8%)	0.453
March	23 (14.7%)	9 (13.2%)	
April	33 (21.2%)	10 (14.7%)	
May	19 (12.2%)	14 (20.6%)	
June	24 (15.4%)	7 (10.3%)	
July	24 (15.4%)	15 (22.1%)	
August	20 (12.8%)	7 (10.3%)	
Onset of symptoms (days)	2.0 (2.8)	3.0 (3.8)	0.025*
Aged less than 25 years	1.1 (0.5)	6.9 (7.0)	0.006*
Biochemical Parameters [normal range], mean			
White cell count (× 10^9/L) [4.0-10.0]	12.1	11.2	0.286
C reactive protein (mg/L) [<4.9]	43.9	39.2	0.681
Haemoglobin (g/L) [130-170]	137.6	159.1	0.098
Creatinine (µmol/L) [60-110]	80.5	76.3	0.499
Urea (mmol/L) [4.0-9.0]	5.5	5.2	0.457
Albumin (g/L) [33-48]	40.2	38.4	0.061
Lactate (mmol/L) [<1.9]	1.7	1.9	0.216
GGT	184.6	174.1	0.798
ALP	113.9	117.3	0.796
ALT	137.6	153	0.678
AST	114.8	125.8	0.77
Bilirubin	18.8	21.2	0.476
Sepsis	9 (5.8%)	6 (8.8%)	0.4
Imaging			
US	102 (65.4%)	31 (45.6%)	0.006*
CT scan	78 (50.0%)	36 (52.9%)	0.686
CT findings:			
Thickened gallbladder wall >3 mm	40 (54.8%)	3 (9.1%)	<0.001*
Free fluid	9 (12.3%)	5 (15.2%)	0.691
Operative management			
ASA status			
ASA 1	32 (20.6%)	10 (14.7%)	0.675
ASA 2	74 (47.7%)	39 (57.4%)	
ASA 3	43 (27.7%)	17 (25.0%)	

ASA 4	6 (3.3%)	2 (2.9%)	
Operative time [hours], mean (SD)	2.8 (0.9)	2.8 (1.1)	0.999
Aged less than 25 years	2.6 (0.8)	2.0 (0.6)	0.046*
Perforation	4 (2.6%)	3 (4.4%)	0.465
Gangrene	22 (14.1%)	9 (13.2%)	0.863
Postoperative Outcomes			
Post-operative complications	14 (3.8%)	3 (2.7%)	0.563
Return to theatre	3 (1.9%)	1 (1.5%)	0.814
ICU			
Admission	14 (9.0%)	11 (16.2%)	0.115
Mean length of stay (SD)	0.5 (2.3)	0.7 (1.9)	0.486
Total length of stay in hospital [days], mean (SD)	7.2 (11.4)	5.0 (5.7)	0.127
Aged 25 to 40 years	4.1 (3.0)	2.5 (1.0)	0.003*
Aged 40 to 55 years	5.1 (4.2)	3.4 (1.7)	0.048*
In-hospital mortality	2 (1.3%)	0 (0.0%)	0.348

the COVID-19 group, sex did not show any significant difference for onset of symptoms (2.1 days male *vs.* 2.8 days female, p=0.190), operative time (1.6 h male *vs.* 1.7 h female, p=0.597), postoperative complications (11.2% male *vs.* 5.1% female, p=0.113), return to theatre (1.0% males *vs.* 1.0% females, p=0.994), LoS (2.4 male *vs.* 2.6 female, p=0.462), mortality (1.0% male *vs.* 0.0% female, p=0.314). However, there were significant differences in the total LoS (2.7 *vs.* 2.1, p=0.009) for all patients, similarly for 40 to 55 years (2.7 *vs.* 1.9, p=0.029), and those aged 70 years and older (6.2 *vs.* 3.2, p=0.018). There was also a significant difference of 0.6 days from onset of symptoms to presentation to ED (1.6 *vs.* 2.2, p=0.018) for those aged less than 25 years.

Appendicectomy

There were 477 appendectomies recorded with the average age and sex ratio similar between both cohorts. There was no overall difference from onset of symptoms to presentation at hospital (2.0 *vs.* 2.4 days, p=0.214, Table 1), but patients aged less than 25 years old had a significantly longer onset of symptoms before hospital presentation (1.7 *vs.* 2.5, p=0.002) and shorter LoS (2.9 *vs.* 2.3, p=0.016) in the COVID-19 group. Biochemical parameters at presentation did not show any statistical differences except for albumin (43.3 *vs.* 41.2, p<0.001). The use of US showed a significant reduction of 9.4% in the COVID-19 cohort compared to their counterparts (97 *vs.* 19, p=0.038), whereas CT usage showed no difference (153 *vs.* 40, p=0.242). There was no significant difference in CT findings, sepsis, or rate of perforated appendicitis. The operative time was approximately 1.5 h for both groups with those aged 55 to 70 years old in the COVID-19 cohort having a significantly longer operative time (1.8 *vs.* 2.3 h, p=0.048). The non-COVID-19 cohort showed a significantly higher rate of unplanned return to theatre compared to their counterparts (5.2% *vs.* 0.9%, p=0.046). The total COVID-19 cohort demonstrated a significantly shorter LoS by 0.4 days compared to their counterparts (2.9 *vs.* 2.5 days, p=0.027); furthermore, those aged 40 to 55 years old had a 1.2-day shorter LoS (3.3 *vs.* 2.1 days, p=0.008).

Cholecystectomy

There were 224 cholecystectomies included with the average age, proportion of sex, and biochemical parameters similar between both cohorts (Table 2). There was a significant difference of one day delay, from onset of symptoms to hospital presentation, for the COVID-19 cohort compared to their counterparts (2.0 *vs.* 3.0 days, p=0.025). Furthermore, those aged less than 25 years in the COVID-19 group had a significant difference of 5.8 days in presentation compared to their non-COVID-19 counterparts (1.1 *vs.* 6.9 days, p=0.006). The use of US showed a significant reduction of 19.8% in the COVID-19 cohort compared to their counterparts (102 *vs.* 31 p=0.006). CT findings of a thickened gallbladder wall was significantly higher in the non-COVID cohort compared to their counterparts (54.8% *vs.* 9.1%, p<0.001). There was no difference in sepsis, perforation, or gangrenous gallbladder rates. The operative time was 2.8 h for both groups with a significant difference of 0.6 h for those aged less than 25 years (2.6 *vs.* 2.0 h, p=0.046). There were no significant differences in post-operative complications (3.8% *vs.* 2.7%, p=0.563). Those aged between 25 to 40 and 40 to 55 years had a significantly shorter LoS in the COVID-19 cohort compared to their counterparts (4.1 *vs.* 2.5, p=0.003; 5.1 *vs.* 3.4, p=0.048).

Incarcerated hernias

There were 121 incarcerated hernias recorded with the average age, proportion of sex, and biochemical parameters similar between both cohorts (Table 3). The three main types of incarcerated hernias included inguinal, ventral/umbilical and intra-abdominal. There was no difference in onset of symptoms to presentation at hospital (1.9 *vs.* 2.2 days, p=0.656). The use of CT imaging was employed more often in the COVID-19 group than their counterparts (79.8% *vs.* 94.1%, p=0.156). Features of bowel obstruction on CT were demonstrated in 38.5% of the non-COVID-19 cohort compared to 47.1% in the COVID-19 group (p=0.502). Bowel involvement within the hernia sac was evident in 54.5% of the total cohort and mesh was used in 61.1% with no significant differences between groups. The most common surgical approach for the COVID-19 group was laparoscopic (58.8%) versus open for the control cohort (51.9%). No patients had unplanned returned to theatre in the COVID-19 group (0.0% *vs.* 7.7%, p=0.237). There was no significant difference in operative time between the two groups (2.3 *vs.* 2.4, p=0.902). Furthermore, the COVID-19 cohort aged 55 to 70 years experienced significantly shorter operative times by 0.9 h (2.5 *vs.* 1.6, p=0.020) and shorter LoS by 5.4 days (6.7 *vs.* 1.3, p=0.019).

Discussion

Our findings demonstrated a reduction in the total volume of

Table 3: Comparative analysis between the COVID-19 cohort and the control cohort for incarcerated hernia.

	Control Cohort (2017-2019)	COVID-19 Cohort (2020)	P value
Demographic Information			
Age [years], mean (SD)	61.9 (19.1)	59.5 (14.9)	0.629
Sex			0.108
Male	58 (55.8%)	13 (76.5%)	
Female	46 (44.2%)	4 (23.5%)	
Body mass index (BMI) [kg/m^2], mean (SD)	29.1 (6.5)	27.7 (7.4)	0.45
Months			
February	6 (5.8%)	2 (11.8%)	0.21
March	18 (17.3%)	7 (41.2%)	
April	17 (16.3%)	0 (0.0%)	
May	18 (17.3%)	2 (11.8%)	
June	17 (16.3%)	2 (11.8%)	
July	18 (17.3%)	2 (11.8%)	
August	10 (9.6%)	2 (11.8%)	
Onset of symptoms	1.9 (2.1)	2.2 (1.6)	0.656
Biochemical Parameters [normal range], mean			
White cell count (× 10^9/L) [4.0-10.0]	10.6	9.8	0.531
C reactive protein (mg/L) [<4.9]	19.3	22.3	0.784
Haemoglobin (g/L) [130-170]	139.5	143.1	0.487
Creatinine (µmol/L) [60-110]	94.8	101.1	0.701
Urea (mmol/L) [4.0-9.0]	7.2	7.4	0.893
Albumin (g/L) [33-48]	40.3	38.6	0.21
Lactate (mmol/L) [<1.9]	1.5	1.4	0.643
Type of hernia			
Inguinal	37 (35.6%)	8 (47.1%)	0.339
Ventral / umbilical	57 (54.8%)	9 (52.9%)	
Intra-abdominal	10 (9.6%)	0 (0.0%)	
Sepsis	0 (0.0%)	0 (0.0%)	
Imaging			
US	3 (2.9%)	2 (11.8%)	0.088
CT scan	83 (79.8%)	16 (94.1%)	0.156
CT features of bowel obstruction	40 (38.5%)	8 (47.1%)	0.502
Operative management			
ASA status	10 (9.6%)	4 (23.5%)	0.128
ASA 1	43 (41.3%)	5 (29.4%)	
ASA 2	44 (42.3%)	5 (29.4%)	
ASA 3	7 (6.7%)	3 (17.6%)	
ASA 4			
Operative time [hours], mean (SD)	2.3 (1.2)	2.4 (1.1)	0.902
Aged 55 to 70 years	2.5 (1.5)	1.6 (0.3)	0.020*
Bowel involvement in hernia	55 (52.9%)	11 (64.7%)	0.364
Mesh used	66 (63.5%)	8 (47.1%)	0.198
Surgical approach			0.646
Open	54 (51.9%)	7 (41.2%)	
Laparoscopic	46 (44.2%)	10 (58.8%)	
Laparoscopic converted to open	1 (1.0%)	0 (0.0%)	
Hybrid	3 (2.9%)	0 (0.0%)	

Postoperative Outcomes			
Post-operative complications	25 (24.0%)	4 (23.5%)	0.964
Return to theatre	8 (7.7%)	0 (0.0%)	0.237
ICU			
Admission	21 (20.2%)	3 (17.6%)	0.807
Mean length of stay (SD)	0.8	0.6	0.229
Total length of stay in hospital [days], mean (SD)	6.9 (9.2)	4.8 (4.5)	0.348
Aged 55 to 70 years	6.7 (11.2)	1.3 (0.6)	0.019*
In-hospital mortality	3 (2.9%)	1 (5.9%)	0.522

general acute surgical presentations consistent with the international literature [9-11]. Our experience was congruent with the overall decline in emergency department visits between March and May 2020 in Western Sydney Local Health District and Australia, with a drop of 25% and 38%, respectively [12,13]. It is well documented that delayed presentations of common general surgical pathologies such as appendicitis and cholecystitis may lead to higher rates of complications and LoS [14,15]. The expectation was that the pandemic and lockdown may have contributed to delayed diagnoses, directly impacting clinical outcomes and LoS. However, this assumption was heavily galvanized by international experiences who reported delayed presentations and detrimental clinical outcomes. For instance, a Scottish study reported a significant increase in severe appendicitis resulting in greater proportion of emergency surgery and operative time [16]. Additionally, a regional New Zealand study reported patients with appendicitis were 15.1 years younger their counterparts (21.5 *vs.* 36.6, p<0.01), had a longer onset of symptoms to presentation (2.82 *vs.* 1.77 days) and shorter LoS, albeit not statistically significant [17].

During the first wave, Bankstown-Lidcombe hospital was a relatively spared center like many other major Australian hospitals as resources were re-allocated towards major COVID-19 hospitals for expectant management of cases. This study identified that there were few significant overall clinical differences in outcomes of common acute general surgical pathologies as most procedures were even more heavily driven by consultants and/or fellows. We identified that those less than 25 years old had a significantly longer onset of symptoms before hospital presentation for appendicitis of 0.8 days (1.7 *vs.* 2.5 days, p=0.002) and 5.8 days for cholecystitis (1.1 *vs.* 6.9 days, p=0.006) compared to their counterparts. Surprisingly, for both pathologies, the LoS was overall significantly shorter in the COVID-19 group by 0.6 days (2.9 *vs.* 2.3 days, p=0.016) for appendicitis and one day for cholecystitis (2.0 *vs.* 3.0 days, p=0.025) compared to their counterparts (Table 1, 2). Our experience recognizes that the younger age group seemed to have more delayed presentations overall, which may be due to the lockdown, social media access and fear of hospital exposure adversely affecting earlier presentation. We also believe that surgeons' experience and prompt hospital discharge during the pandemic wave may have contributed.

The investigations of choice were different and likely influenced by the potential respiratory transmission of COVID-19 with safe distancing protocols in place. The use of US had a significant reduction by 9.4% and 19.8% for appendicitis and cholecystic, respectively. Ultrasound use was impacted by safe distance protocols in place and physicians likely aware of the potential transmission thereby selecting alternative measures. Interestingly, CT findings of a thickened gallbladder wall was significantly higher in the non-COVID-19 cohort compared to their counterparts (54.8% *vs.* 9.1%, p<0.001). This study did not distinguish between acute and chronic cholecystitis features as a factor in the above findings, but Yeo's radiological study has reported specific radiological findings based on gallbladder distension, pericholecystic haze, and liver enhancement [18]. An American study reported a different experience with CT use demonstrating a significant decrease in CT abdomen and pelvis (33.6% *vs.* 31.1%), but increase in US abdomen (15.7% *vs.* 20.3%) during the pandemic period, except for an increase in CT chest [19]. Whilst reductions in presentations account for this change, Hoshiyar Attributes this as multifactorial relating to regional differences in disease prevalence, magnitude and scope of social distancing mandates, variable adoption of these measures by members of the public, and existing image ordering practices and resources [20].

Despite the absence of reported cases of COVID-19, the general surgical unit did not identify any clinically significant differences in biochemical parameters, operative management, or major clinical outcomes between both groups. Our previous work identified that those with necrotizing fasciitis in the COVID-19 group had a significantly longer mean onset of symptoms till hospital presentation of 4.1 days, longer mean operative time, more likely to be admitted to ICU and not survive compared to their counterparts [21]. A Melbourne based study who experienced different restrictions compared to Sydney reported those who had operations after-hours in the COVID-19 period were more likely to present with severe cholecystitis [22]. An Israeli study who had similar experiences with lockdowns, but at the time overall better vaccination rates compared to Australia reported significant delays of presentation from onset of symptoms resulting in worse biochemical and clinical parameters compared to the control cohort. In contrast to our findings, their COVID-19 cohort underwent significantly higher rates of urgent surgery and greater LoS [23]. The increase LoS was also attributed by worse clinical conditions, delayed PCR testing and fear of hospital exposure [24,25]. Acting within resource limitations and preparation for the wave, the LoS was significantly shorter for appendicitis and cholecystitis in the COVID-19 cohort (2.9 *vs.* 2.5, p=0.027). The Auckland experience similarly reported fewer operations, albeit non-significant, with a total median LoS difference of 0.5 days between the groups (1.8 *vs.* 1.3, p=0.031) [26]. The shorter LoS may have been attributed by resource limitations, pressures to discharge and create COVID-19 wards as well as more senior consultant driven care.

Australia experienced a lesser magnitude of the first wave compared to other countries with a total of 28,381 cases of COVID-19 by the end of 2020, including 909 deaths [27]. With an established telehealth service pre-pandemic, the introduction of government subsidized telehealth services across Australia largely facilitated the management of non-COVID-19 health conditions

[28]. Our unit remained as a 'clean center' during the first wave and our response in addressing common surgical pathologies were overall sound. Evidently, the access to these services and social restrictions contributed to the reduction in presentations and delayed presentations. Limitations of the study are attributed to the retrospective design with potential selection bias due to coding of the disease, which may not have captured all patients. Surveillance and informed data decision processes are paramount to the provision of good service in achieving adequate patient care.

Conclusion

The first wave of the COVID-19 pandemic significantly reduced acute general surgical presentations during the lockdown period. Patients aged less than 25 years old were most likely to present later for common surgical pathologies. Despite significantly delayed overall presentations for appendicitis and cholecystitis, sound clinical outcomes were satisfactorily met with overall shorter LoS.

Authors' Contribution

All authors contributed to the conception and design of the manuscript, revised it critically for important intellectual content, approved the final version to be published and agreed to be accountable for all aspects of the work.

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