


The effect of national public health interventions for COVID-19 on emergency general surgery in Northland, New Zealand

Matthew J. McGuinness * and Christopher Harmston*†

*Department of General Surgery, Northland District Health Board, Whangarei, New Zealand and

†University of Auckland, Auckland, New Zealand

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Correspondence

Dr. Matthew J. McGuinness, Department of General Surgery, Whangārei Hospital, Manu Road, Whangārei 0148, New Zealand.
Email: matt@mcguinness.net.nz

M. J. McGuinness MBChB; **C. Harmston** FRCS (Eng), FRACS.

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Introduction

New Zealand (NZ) joined the global fight against the COVID-19 pandemic on 28 February 2020.¹ Within weeks it was evident the NZ epidemic curve was following the same exponential trajectory as seen in Asia and Europe.² In response, the NZ government enacted public health interventions aimed at ‘flattening the curve’. Coinciding with the first case of COVID-19 community transmission on 21 March 2020, the government announced a four-tier alert-system and moved from a strategy of ‘flattening the curve’, to elimination.³ The alert-system comprises escalating public health restriction and ranges from level 1 with minimal restriction to level 4 which requires the NZ population isolate at home with exemptions for interactions with essential services.³ The elimination strategy was successful with 8 June marking the announcement that the last active case had recovered.⁴

During this time of progressively restrictive public health interventions urgent planning at a hospital level was difficult given no prior pandemic experience, the unclear trajectory of the NZ

Abstract

Background: The New Zealand government instituted escalating public health interventions to prevent the spread of COVID-19. There was concern this would affect health seeking behaviour leading to delayed presentation and worse outcomes. The aim of this study was to examine the effects of these interventions on rate and severity of acute general surgical admissions in Northland, New Zealand.

Methods: A retrospective comparative cohort study was performed. Two cohorts were identified: 28 February to 8 June 2020 and same period in 2019. Data for surgical admissions and operations and emergency department (ED) presentation were obtained from the hospital data warehouse. Three index diagnoses were assessed for severity.

Results: There were 650 acute general surgical admissions in 2019 and 627 in 2020 (P 0.353). Operations were performed in 226 and 224 patients respectively (P 0.829). ED presentations decreased from 11 398 to 8743 (P < 0.001). No difference in severity of acute appendicitis (P 0.970), acute diverticulitis (P 0.333) or acute pancreatitis (P 0.803) was detected. Median length-of-stay, 30-day mortality and admission diagnosis were comparable.

Conclusion: Despite a significant reduction in ED presentations, interventions for COVID-19 did not result in a difference in the rate or severity of acute general surgical admissions.

epidemic and limited knowledge of the effect the pandemic and the public health interventions would have on health seeking behaviours. The downstream ramification and delayed implication of COVID-19 and the consequent public health interventions are only now starting to be discovered. Concern has been raised that COVID-19 affected health seeking behaviour possibly leading to delayed presentation and worse outcomes for patients with acute medical and surgical problems.⁵

The aim of this study was to examine the effects public health interventions for COVID-19 had on the rate and severity of acute general surgical admissions in Northland, NZ.

Methods

Setting

Northland District Health Board (NDHB) is NZ’s northernmost DHB. It services the population of Northland which was 179 076 on the 2018 census spread over an area of 13 286 km².⁶ Compared to the national average, Northland has a larger Māori population,

higher unemployment, lower median income and higher amenable mortality.^{6,7} Whangārei Hospital is NDHB's largest hospital and provides secondary specialist care to all of Northland. It serves as a secondary referral centre for four regional hospitals and has the only acute general surgical service.

Design

A retrospective comparative cohort study was performed. Data were collected from the hospital's data warehouse which was searched to identify all general surgery admissions and emergency department (ED) presentations between 28 February and 8 June in 2019 and 2020. The hospital electronic medical records were accessed to review diagnosis and operations when this was unclear from the hospital coding and to assess disease severity.

Outcomes of interest

The primary outcomes of interest were the difference in rate of acute general surgical admissions, interventions and severity. Secondary outcomes of interest were mortality, length of stay, type of operation and admission diagnosis.

Severity

Appendicitis was confirmed if a patient scored one or greater on the Anatomic Severity of Appendicitis Grading System.⁸ This system was subsequently used to assess appendicitis severity. Pancreatitis was confirmed if a patient had at least two out of the following: characteristic pain, a lipase great than three times the upper limit of normal or radiological evidence of pancreatitis. Disease severity was assessed with the Revised Atlanta Classification.⁹ Diverticulitis was confirmed if a consultant radiologist had confirmed diverticulitis on a computerized tomography scan and severity was assessed using the Hansen Stock classification.¹⁰

Classification of five time periods

Patients were classified into five time periods based on the NZ government's public health interventions. The first period (16 days), 'no interventions', was from the first case of confirmed COVID-19 in NZ on 28 February until 15 March. During this time no public health interventions were in place. The second period (9 days), 'early interventions', was from 16 March to 24 March. During this period there was escalating intervention. On 16 March the government introduced border restrictions, compulsory self-isolation for all arriving passengers except from pacific islands, prohibited cruise ships and banned non-essential outdoor gatherings >500 people. On 19 March NZ borders closed to all but NZ citizens and residents, indoor events with more than 100 people were banned with exemptions for workplaces, schools, supermarkets, and public transport. On 21 March NZ moved to level 2 and on 23 March level 3. The third period (33 days), 'level 4 lockdown', was from 25 March to 26 April. The fourth period (16 days), 'level 3', from 27 April to 12 May marked the de-escalation from level 4 lockdown to level 3. The fifth period (27 days), 'level 2', from 13 May to 8 June was the duration of level 2. 8 June marked the transition to level 1.

Statistical analysis

Data were entered into IBM SPSS for analysis. Scale data were tested for normality with a Shapiro–Wilk test. Non-parametric data including age, acute general surgery admissions, acute general surgery operations and length of stay was tested with a Mann–Whitney *U*-test. Parametrically distributed data including ED presentations and age were tested using a Student *t*-test. Nominal data including ethnicity, gender and disease severity were tested using a chi-squared or Fischer exact test.

Ethics

This study was deemed out-of-scope by the NZ Health and Disability Ethics Committee.

Table 1 Basic demographics and primary outcomes of interest

	Total		No intervention		Early intervention		Level 4 lockdown		Level 3		Level 2	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Age												
Median	57	57	57	59	61	54	55.5	60	60	57	57	55
IQR	40	39	39	33	38	53	41	32	45	42	37	39
Ethnicity (% of group)												
European	443 (68)	390 (63)	79 (69)	75 (66)	39 (64)	24 (73)	150 (70)	109 (63)	74 (71)	76 (59)	101 (65)	107 (60)
Māori	187 (29)	215 (34)	32 (28)	32 (28)	21 (34)	24 (24)	58 (27)	59 (34)	28 (27)	49 (38)	48 (31)	67 (38)
Other	20 (3)	22 (3)	4 (3)	7 (6)	1 (2)	1 (3)	6 (3)	5 (3)	2 (2)	3 (4)	7 (4)	4 (2)
Gender (% of group)												
Female	336 (52)	300 (48)	56 (49)	59 (52)	30 (49)	15 (45)	113 (53)	75 (43)	53 (51)	60 (46)	84 (54)	91 (51)
Male	314 (48)	326 (52)	59 (51)	55 (48)	31 (51)	18 (55)	101 (47)	57 (57)	51 (49)	69 (54)	72 (46)	87 (49)
General surgery admissions												
Total	650	627	115	114	61	33	214	173	104	129	156	178
Median per day	6	6	7	7	6	4	6.5	5	6.5	7.5	6	6
Emergency department presentations												
Total	11 398	8743	1867	1809	1044	851	3638	2294	1738	1317	3111	2472
Median per day	113	84	113	113	117	95	113	70	110	82	115	92

Results

Basic demographics

During the study period 1277 general surgical admissions were identified, 650 in 2019 and 627 in 2020. Basic demographics are outlined in Table 1. There was no significant difference in mean age ($P = 0.901$), ethnicity ($P = 0.910$) or gender ($P = 0.169$) between years. There was no significant difference between time periods for 2019 and 2020 in age ($P = 0.503, 0.774$), ethnicity ($P = 0.895, 0.444$) or gender ($P = 0.912, 0.553$).

Primary outcomes of interest

General surgical admissions and ED presentations across time periods are graphed in Figure 1 with raw numbers in Table 1. There was no difference between the median number of acute general surgery admissions per day in 2019 and 2020 ($P = 0.353$). Comparison of median number of acute general surgical admission per day between 2019 and 2020 by time period found no significant difference between the no intervention period ($P = 0.642$), level 3 ($P = 0.134$) and level 2 ($P = 0.273$). However, a significant decrease was found

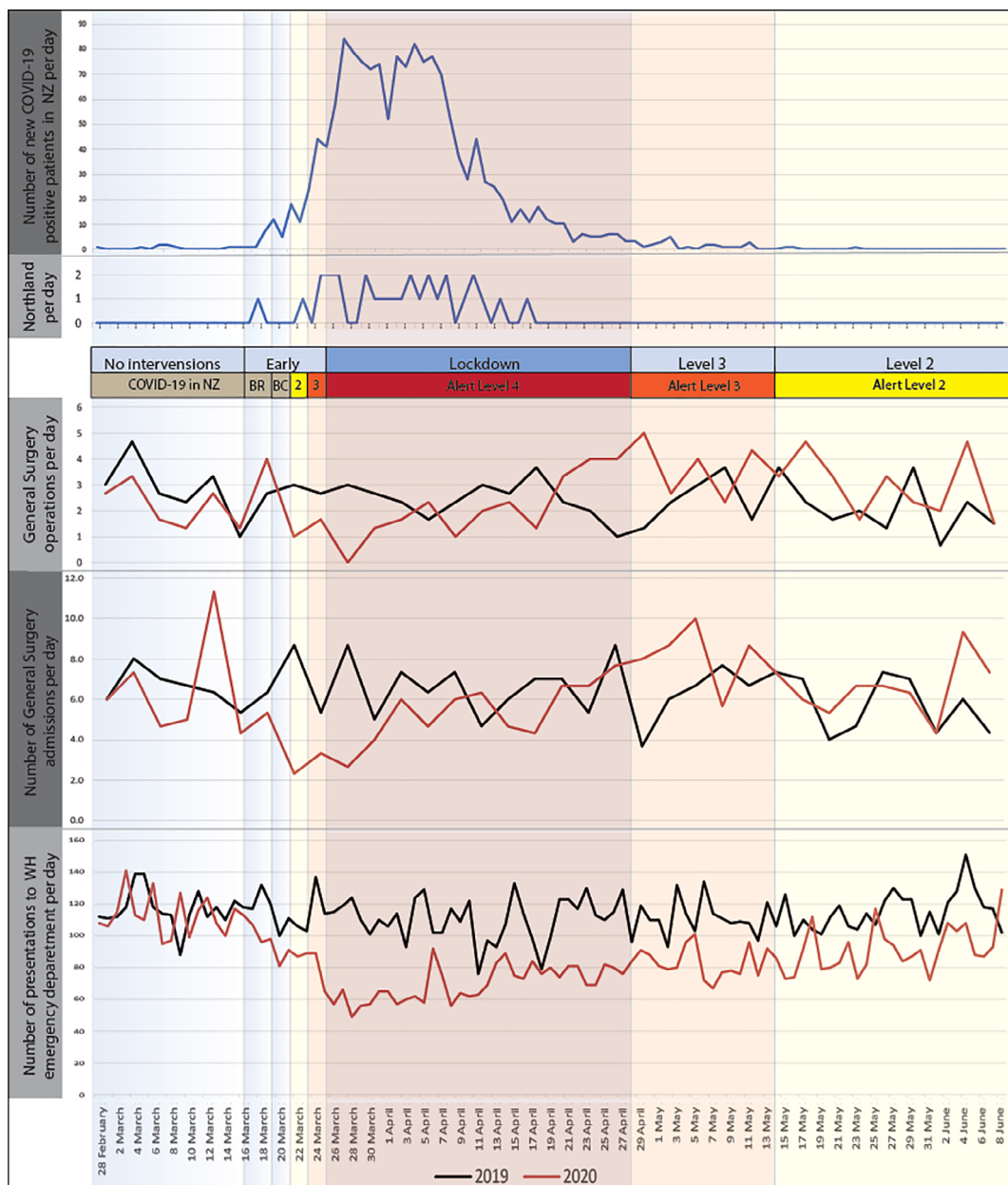


Fig 1. General surgery operations, general surgery admissions and ED presentations in 2020 compared with 2019 in relationship to the number of new COVID-19 patients in NZ and Northland and the level of public health restriction.

Table 2 Disease severity

	2019 n (%)	2020 n (%)
Anatomic severity of appendicitis		
1	25 (45)	21 (39)
2	15 (27)	17 (31)
3	7 (13)	7 (13)
4	5 (9)	6 (11)
5	3 (5)	3 (6)
Total	55	54
Hansen Stock classification of diverticulitis		
Complicated	14 (35)	7 (24)
Uncomplicated	26 (65)	22 (76)
Total	40	29
Revised Atlanta classification of pancreatitis		
Mild	22 (81)	24 (75)
Moderate	4 (15)	5 (16)
Severe	1 (4)	3 (9)
Total	27	32

Table 3 Admission diagnosis and general surgery operations

	2019 n (%)	2020 n (%)	P-value
Admission diagnosis			
Drainage of abscess	44 (7)	49 (8)	0.981
Appendicitis	55 (8)	54 (9)	0.736
Biliary pathology	40 (5)	16 (3)	0.599
Cholecystitis	54 (8)	45 (7)	0.285
Diverticulitis	40 (6)	29 (5)	0.505
Gastroenteritis	19 (3)	24 (4)	0.203
GI bleed	16 (2)	15 (2)	0.279
Hernia	21 (3)	28 (4)	0.351
Malignancy	32 (5)	39 (6)	0.253
Non-specific abdominal pain	60 (9)	43 (7)	0.083
Pancreatitis	27 (4)	32 (5)	0.188
SBO	25 (4)	28 (4)	0.856
Trauma	76 (12)	60 (10)	0.198
Other	151 (23)	165 (27)	0.960
General surgery operations			
Abscess drainage	36 (16)	36 (15)	0.888
Appendectomy	45 (20)	47 (20)	0.945
Cholecystectomy	25 (11)	27 (12)	0.859
Diagnostic laparoscopy	6 (3)	5 (2)	0.722
Endoscopy	45 (20)	45 (20)	0.429
Hernia	10 (4)	16 (7)	0.258
Laparotomy	22 (10)	20 (9)	0.669
Wound management	19 (8)	12 (5)	0.165
Other	18 (8)	25 (11)	0.309
Total	226	233	

between the early intervention ($P = 0.019$) and level 4 lockdown periods ($P = 0.043$), comparing 2019 and 2020.

ED presentations decreased between 2019 and 2020 ($P = 0.000$). There was a significant decrease in median presentations per day during the early intervention period ($P = 0.001$), level 4 lockdown ($P < 0.001$), level 3 ($P < 0.001$) and level 2 ($P < 0.001$) but not for the no intervention period ($P = 0.421$).

Severity

Severity of index disease is outlined in Table 2. There was no significant difference between 2019 and 2020 in severity of disease in

patients with acute appendicitis ($P = 0.970$), acute diverticulitis ($P = 0.333$) or acute pancreatitis ($P = 0.803$).

Diagnoses

There was no significant difference in admission diagnosis between 2019 and 2020 ($P = 0.472$). As seen in Table 3, analysis by individual diagnosis found no significant differences.

Operative interventions

The number of operations is graphed in Figure 1. Two hundred and twenty-six operations were performed in 2019 and 233 in 2020. There was no difference in the number of operations performed between years ($P = 0.829$) or the type of operations performed as seen in Table 3. There was no significant difference in number of operative interventions in any period when comparing 2019 and 2020. Operative interventions were performed in 39% versus 30% of patients in the no intervention period ($P = 0.128$), 38% versus 39% in the early intervention period ($P = 0.730$), 33% versus 40% during level 4 lockdown ($P = 0.059$), 37% versus 40% during level 3 ($P = 0.390$) and 32% versus 38% during level 2 ($P = 0.350$).

Mortality

30 and 60 day mortality of patients admitted in general surgery was 3% and 5% respectively in the 2019 cohort and 4% and 5% respectively in the 2020 cohort ($P = 0.877$ and 0.795).

Length of stay

The median length of stay was 2.16 in 2019 and 2.22 in 2020 ($P = 0.760$). There was no difference found between 2019 and 2020 for the no intervention period 4.04 versus 3.0 ($P = 0.756$), the early intervention period 3.96 versus 3.17 ($P = 0.965$), level 4 lockdown 3.83 versus 4.32 ($P = 0.069$), level 3 3.99 versus 3.76 ($P = 0.193$) and level 2 3.16 versus 3.07 ($P = 0.500$).

Discussion

This study found that public health interventions for COVID-19 in NZ did not result in a difference in the rate or severity of acute general surgical admissions in Northland. This was despite a significant reduction in ED presentations during the same period.

This data shows acute general surgery admission initially fell by 46% in the early intervention period continuing at lower levels through the first half of level 4 lockdown, compared with 2019. This initial decrease, coinciding with the early government public health interventions, did not continue throughout the study period and did not result in lower general surgical admissions overall. The early intervention period with decreased admissions was likely the period of greatest uncertainty and fear. The return to normal was at a time when the epidemic curve had reversed with new COVID-19 cases per day decreasing and few COVID-19 hospitalizations likely restoring public confidence in the health system. Despite fears from clinicians and the NZ media, no increase in severity of acute surgical disease was observed.^{5,11} These findings will help future

pandemic response planning and guide public awareness campaigns. It is likely that stronger messaging regarding health seeking behaviour is needed in the early stages of restrictive public health measures. The data also suggests that controlling numbers of COVID-19 patients in the populations allows a return to normal health seeking behaviour before population restrictions are lifted. This is particularly important in Northland; an area of NZ with a population already suffering from poorer health outcomes compared to the majority of NZ.^{6,7}

The findings of our study differ to those seen in multiple UK, Italian and Spanish studies which found large decreases in general surgical admissions, ranging from 14% to 86%.^{12–18} Taken in isolation the early intervention period is in line with international literature. The subsequent return to normal rates has not previously been reported. There is substantial heterogeneity in this international literature including variation in comparison group, variation in length of the study and likely most significantly, variation in contemporaneous public health interventions and rates of COVID-19 in the studied regions. Several of these studies compared short time periods before and during the region's equivalent restrictive public health intervention periods.^{13,15,16} Two studies did employ similar methodology to our study; comparing longer time periods and using the previous year as a comparison cohort. Dick *et al.* found a 59% reduction over two and a half months and Perez-Rubio *et al.* found a 14% reduction over 2 months.^{12,18} Assessing this study in the context of these international findings suggests the strongest factor influencing a return to normal acute general surgical admissions is not the de-escalation in public health restrictions but instead the effective control of COVID-19 in the population.

Concern has been raised that patients are presenting with increased disease severity in the COVID-19 threatened climate. Literature from the UK, China, Spain, Australia and Colombia has shown increased severity of appendicitis in patients presenting in the COVID-19 era compared to prior.^{12,19–22} This study did not demonstrate an increased severity in patients presenting with diverticulitis, appendicitis or pancreatitis. This finding is particularly important in the context of a decrease in general surgical admission in the early intervention period and the first half of level 4 lockdown. Concern has been raised that this decrease was due to patients who required hospitalization staying at home due to fear of COVID-19 exposure at hospital or because of government message on health seeking behaviour. It is reassuring that this initial decrease was not associated with an increase in severity in the subsequent studied periods.

The authors accept that the retrospective nature of this study limits its reliability. Disease severity was assessed retrospectively possibly introducing an element of misclassification bias. The limited period of 3 months means possible significant trends outside of this period were not included. This study was confined to Northland which had low levels of COVID-19 throughout the studied period, limiting the wider applicability. Contrary to many hospitals, no change to surgical management of acute general surgical patients was implemented in Northland in response to the possible increased risk of exposure to COVID-19 from laparoscopic surgery.²³ This study's findings should also be interpreted through the lens of NZ's unique global situation with a comparatively rapid reversal of the

epidemic curve following intense public health restrictions. Despite these limitations we believe that the data are of relevance and will inform future planning.

In the continuously changing landscape of the ongoing global COVID-19 pandemic it is important to continue to investigate the downstream ramifications. Further studies, including of larger populations and from regions within NZ that had a greater COVID-19 patient burden, would be useful.

This is the first study in NZ that has described the relationship between population interventions for COVID-19 and the number and severity of acute general surgical admissions. There was no overall change in number or severity of acute surgical disease across the period of public health interventions.

Author contributions

Matthew McGuinness: Formal analysis; methodology; visualization; writing-original draft; writing-review and editing. **Christopher Harmston:** Conceptualization; methodology; supervision; writing-review and editing.

Conflicts of interest

None declared.

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