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Impact of nationwide COVID-19 lockdown on the workload and injury patterns of major trauma cases in a regional trauma centre in Singapore

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ABSTRACT

Introduction: Singapore instituted lockdown measures from 7th February 2020 to 1st June 2020 in response to the COVID-19 pandemic.

Methods: Retrospective analysis of cases from the national trauma registry was carried out comparing the lockdown period (7th February 2020 to 1st June 2020) to the pre-lockdown period (7th February 2019 to 1st June 2019). Data extracted included the volume of Tier 1 (ISS >15) and Tier 2 (ISS 9-15) cases and epidemiology. Subgroup analysis was performed for Tier 1 patient outcomes.

Results: Trauma volume decreased by 19.5% with a 32% drop in Tier 1 cases. Road traffic and workplace accidents decreased by 50% ($p<0.01$) while interpersonal violence showed an increase of 37.5% ($p=0.34$). There was an 18.1% decrease in usage of trauma workflows ($p=0.01$), with an increase in time to intervention for Tier 1 patients from 88 to 124 minutes ($p =0.22$). Discharge to community facilities decreased from 31.4% to 17.1% ($p < 0.05$). There was no increase in inpatient mortality, length of stay in critical care, or length of stay overall.

Conclusion: There was an overall decrease in major trauma cases during the lockdown period, particularly road traffic accidents and worksite injuries and a relative increase in interpersonal violence. Redeployment of manpower and hospital resources may have contributed to decreased usage of trauma workflows and community facilities. In the event of further lockdowns it is necessary to plan for trauma coverage and maintain use of workflows to facilitate early intervention.

Keywords: COVID-19, trauma surgery, trauma volume, trauma workload

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (COVID-19) was first identified in December 2019 in Wuhan, China.[1] The first case of COVID-19 was reported in Singapore on 23rd January 2020,[2] and subsequent increases in community transmission led the Ministry of Health to declare a progressive lockdown and closure of non-essential services beginning on 7th February 2020 to reduce public movements and interactions.[3,4] The lockdown was lifted on 2nd June 2020 with gradual opening of schools and other public areas.[5]

Khoo Teck Puat Hospital (KTPH) is an acute restructured hospital and top regional trauma centre, receiving the second highest volume of Tier 1 or ISS (Injury Severity Score) >15 trauma patients nationwide. The majority of trauma patients present after blunt trauma from road traffic accidents or falls from height. The hospital's trauma activation protocols consist of a first-line trauma activation that is initiated on presentation for patients who have suspected multisystem polytrauma or high speed injury, and a second-line trauma activation protocol initiated for patients who are haemodynamically unstable and mandate immediate attention by consultant specialists for intervention.[6]

There is limited information available on the impact of widespread community lockdown on the volume of trauma cases seen in public hospitals, and the patterns and trends of injury that may be seen during such a lockdown. There is also no previous literature on the clinical outcomes of major trauma patients undergoing treatment during a pandemic period.

METHODS

Data was extracted from the Singapore National Trauma Registry, which is maintained and prospectively collected by the KTPH Department of General Surgery. The periods under study were 7th February 2020 to 1st June 2020 (lockdown group) versus the

month-matched historical cohort from 7th February 2019 to 1st June 2019 (pre-lockdown group). All Tier 1 (ISS > 15) and Tier 2 (ISS 9-15) trauma patients that presented to KTPH during this period were included. There were no missing records.

The data extracted included the volume of trauma cases, epidemiological data, mechanism of injury, and outcomes such as activation of first- or second-line trauma protocols, time taken to intervention, length of hospital stay, length of critical care stay, mortality, and discharge facility. Institutional Research Board approval was sought and obtained. Analysis of these outcomes was performed with Pearson's chi-squared test and Student's t-test where appropriate. $P < 0.05$ was considered a significant difference.

RESULTS

Table 1 shows the demographics and injury pattern of Tier 1 and 2 trauma patients compared between the pre-lockdown and lockdown groups. There was a total of 349 patients in the pre-lockdown group and 281 in the lockdown group with a 19.5% decrease in overall caseload. There was a more pronounced drop of 32% in Tier 1 trauma cases from 122 to 83 cases. There was a 12.8% decrease in Tier 2 trauma cases from 227 to 183 cases. The month-to-month comparisons are shown in Figure 1 and Figure 2. There were no large differences between the pre-lockdown and lockdown groups with regards to gender.

The largest decrease was in the group of patients presenting with road traffic accidents and workplace accidents, which decreased significantly by 50% ($p<0.01$) during the lockdown period across all types of vehicles. The only mechanism of injury that showed an increase was interpersonal violence with a non-significant increase by 37.5% ($p=0.34$) from 8 cases in pre-lockdown to 11 cases during lockdown. Trauma that occurred on the road decreased by 38.4%, in public places by 21.5%, and in the workplace by 29.4%. There was minimal change to the number of trauma cases that occurred in the household.

Subgroup analysis of patient outcomes for Tier 1 trauma cases is described in Table 2. Audit of usage of trauma workflows showed that there was a significantly reduced use of first-line trauma activation protocol, from 43.4% pre-lockdown to 25.3% during lockdown, and a non-significant reduction in use of second-line trauma activation protocol, from 9.0% pre-lockdown to 2.4% during lockdown. There was a corresponding increase in time taken to intervention from a pre-lockdown average of 88 minutes to 124 minutes during lockdown, however it was not statistically significant. ($p=0.22$)

There was no significant difference in mortality pre-lockdown (11.5%) and during lockdown (7.2%) with a p value of 0.44. The number of days that patients spent in critical care pre-lockdown (5.7 days) versus lockdown (3.5 days) was not statistically significant.

There was no significant difference in length of stay for patients in pre-lockdown or lockdown periods, however at the point of data extraction 30 days post lockdown, there were 2 patients who remained in the general ward pending discharge, 1 from either period under assessment. This factor might also have had implications on the total cost of hospitalisation.

The breakdown of discharge facility disposition for those patients who had been discharged from hospital showed that there was a significantly larger proportion of patients that were discharged to their own homes (46.3% pre-lockdown vs 61.0% during lockdown, $p < 0.05$) and a significantly lower proportion that were discharged to stepdown community facilities or nursing homes. (31.4% pre-lockdown vs 17.1% during lockdown, $p < 0.05$)

DISCUSSION

The substantial decrease in overall major trauma admissions in Singapore was congruent with the epidemiological statistics of other countries who have gone through a similar lockdown phase due to the COVID-19 pandemic. Grant et al described an overall drop of 43% of all injury-related admissions in a Level I trauma centre in New Zealand,[7]

while Forrester et al described a 4.8-fold drop in trauma activations in two Level I trauma centres in Santa Clara County, California.[8] Yang et al described a 39.2% reduction in major trauma patients presenting to Level I trauma centres in Hangzhou, China.[9]

The downtrend in rates of traffic-related and workplace trauma can be attributed to the direct effects of the nationwide lockdown decreasing traffic flow[10] as well as the closure of work sites. While the decrease in traffic volume seems promising, there have been concerns raised by the UK Metropolitan Police that reduced volume of traffic might lead to a paradoxical increase in number of speeding vehicles.[11] This has been alluded to in the local setting with figures from the Singapore Traffic Police, who noted in May 2020 that average road trips had fallen from 201 million per month to 80.4 million after the introduction of lockdown measures, while the percentage of speeding violations had risen from 75 to 187 violations per million trips.[12]

The rise in interpersonal violence has also been reported in other articles such as the aptly named *Trauma Does Not Quarantine* by Hatchimonji et al.[13] While it is not within the scope of this paper to elucidate the cause of the increase, other countries have also seen records of increased partner violence[14] as well as increasing trends of self-harm[15,16] during this period of enforced social isolation, corresponding to an overall increase in anxiety and depression in the general public.[17]

The decrease in use of first- and second-line trauma activation protocols was audited by an interdepartmental trauma committee and some of the common factors involved included an increased workload presenting to the Emergency Department (ED), particularly acute respiratory illnesses.[18] This was particularly prominent in the early pandemic period, when COVID-19 testing was not widely available to primary care practitioners. There was also widespread redeployment of physicians from other departments to ED, often at short notice and with an abbreviated, if any, introduction to trauma protocols and workflows. The

overall increase in workload and the need to segregate staff in case of COVID-19 exposure may have contributed to lesser supervision of junior staff in both the Emergency Department and surgical teams. The additional psychological burden of working on the frontline of a pandemic with ARI patients may also have taken a toll even on veteran staff, in the form of anxiety, depression, and other adverse psychological responses culminating in physician burnout and reducing individual efficiency.[19]

The effect of decreased workflow use was most significant in the Tier 1 polytrauma patients, who can be at risk of a) under-triaging of the mechanism of injury and failure to activate trauma protocols, b) missing significant injuries, especially in obtunded patients, c) delay in review by over-stretched medical staff and delay in intervention within the "golden hour" prior to clinical deterioration. The immediate effects of this can be seen in the increase in time to intervention, which was almost doubled in this paper, although the effect was not statistically significant due to small patient numbers.

The downstream outcomes of length of stay, duration of stay in critical care units, mortality, and cost of hospitalisation showed no significant change as compared to the pre-lockdown period, though the utilisation of community hospitals as facilities for step-down rehabilitation decreased. This can be attributed to community hospital facilities within the institute being converted to wards for COVID-19 patients, as well as limitation in transfer to external rehabilitation facilities due to nationwide restrictions in cross-institute transfer of patients. Possible measures that may have contributed to maintaining an equivalent length of inpatient stay were the presence of a discharge team actively linking up patients with community-based outpatient rehabilitation programmes, though the outcomes of rehabilitation after those alternative programmes have not yet been studied.

The future of the COVID-19 pandemic is fluid, with some countries starting to re-institute lockdowns due to the much-dreaded second wave previously forecasted.[20] It may

not be possible for Singapore, being a population-dense and globally connected country, to avoid this phenomenon altogether, despite aggressive contact tracing, stringent home quarantine for travellers, and other public health measures.

Forward planning in event of further lockdown should utilise data from previous trends to project the needs of the future. The capacity to maintain high standard care despite resource scarcity in a pandemic is essential for acute surgical conditions and even more so for trauma, where timely intervention is counted in minutes rather than hours.

The guidelines for trauma care in during the pandemic have been consolidated in the European Society of Trauma and Emergency Surgery (ESTES) recommendations.[21] Drawing from this paper, the key tenets particularly pertinent to the issues raised above are: firstly, that care should be taken to maintain quality of interventions and limit delay of interventions, while considering COVID-19 guidelines; and secondly that the shift of staff due to necessary redeployment should not have a negative impact to the ability to provide timely care for trauma and emergency surgery patients.

The ability to continue to provide quality care and appropriate intervention hangs on the presence of robust institutional workflows, and emphasis on utilisation of the same. This can be reinforced by departments planning early for a second lockdown by earmarking a number of staff to be redeployed, with early debriefing and dissemination of preparatory materials. This can be performed via intranet electronic resources and virtual meetings rather than physical gatherings. On a larger scale, the utilization of primary healthcare providers to attend to ARIs and COVID-19 testing may also offload a surge in cases presenting to the ED.

The same vehicles for information can be used within the General Surgery department to familiarise staff with trauma processes and reinforce usage of workflows, as well as raise the awareness of possible pitfalls and lapses that may occur during the initial redeployment of staff. This would form a “safety net” to reduce the chance of adverse outcomes. The use of

COVID-19 guidelines should also be disseminated widely. Figure 3 provides guidance for the management of acute surgical conditions and trauma in patients with suspected COVID-19 within the local context, which takes into account community prevalence of COVID-19 infection, availability of resources, and national guidelines for COVID-19 screening. It clearly defines that intervention should be based on the acuity of clinical need, so that provision of high quality trauma care may be maintained while ensuring judicious use of resources.

Public health measures that might contribute to further primary prevention of trauma in the community include further reinforcement of speed limits during and after pandemic lockdowns to stem a surge in high-velocity accidents. Addressing the mental health of the general public and especially increasing outreach to vulnerable groups is a topic that has been raised in other countries, such as telehealth visits focusing on domestic violence by primary care providers in Australia,[22] as well as development of remote assessment and care pathways for patients at risk of self-harm.[23]

In conclusion, the COVID-19 lockdown period showed a decrease in major trauma admissions and a change in injury trends. There should be adequate pandemic preparedness planning locally in event of a second wave of lockdowns, which should highlight that there is still a substantial need for the provision of full trauma services within hospitals, unless resource limitations make it unavoidable. The need to reinforce and maintain workflows for major trauma patients are key to maintaining high standards of treatment. There should be increased awareness of mental health within the community of healthcare workers as well as outreach to the general public during these troubling times to maintain a positive narrative.

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Figure 1. Number of Tier 1 cases in 2019 and 2020

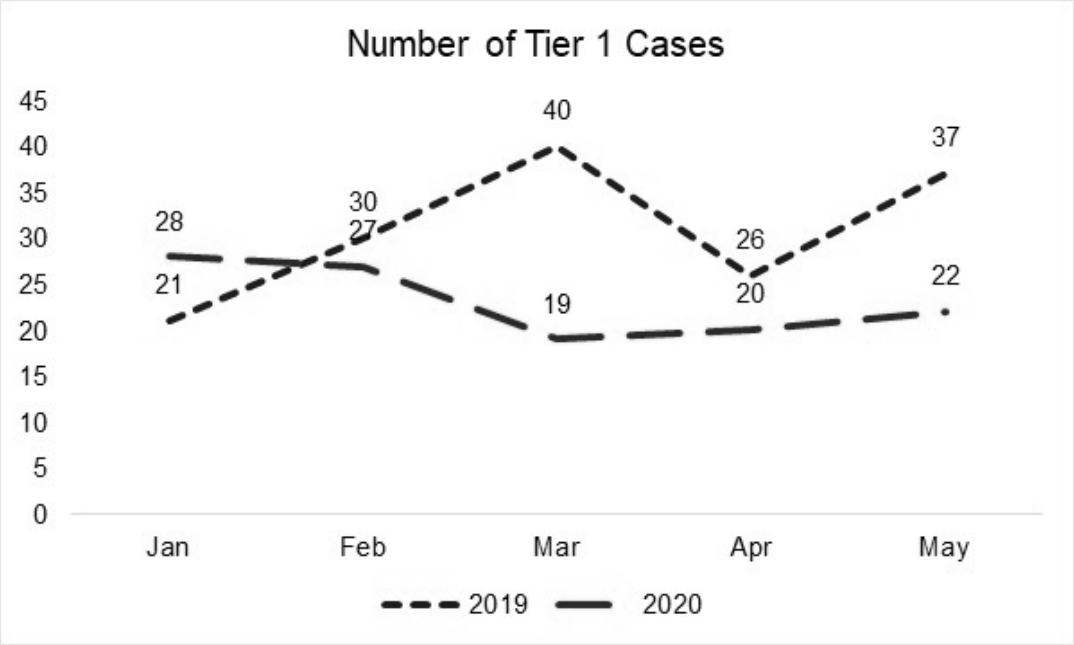


Figure 2. Number of Tier 2 cases in 2019 and 2020

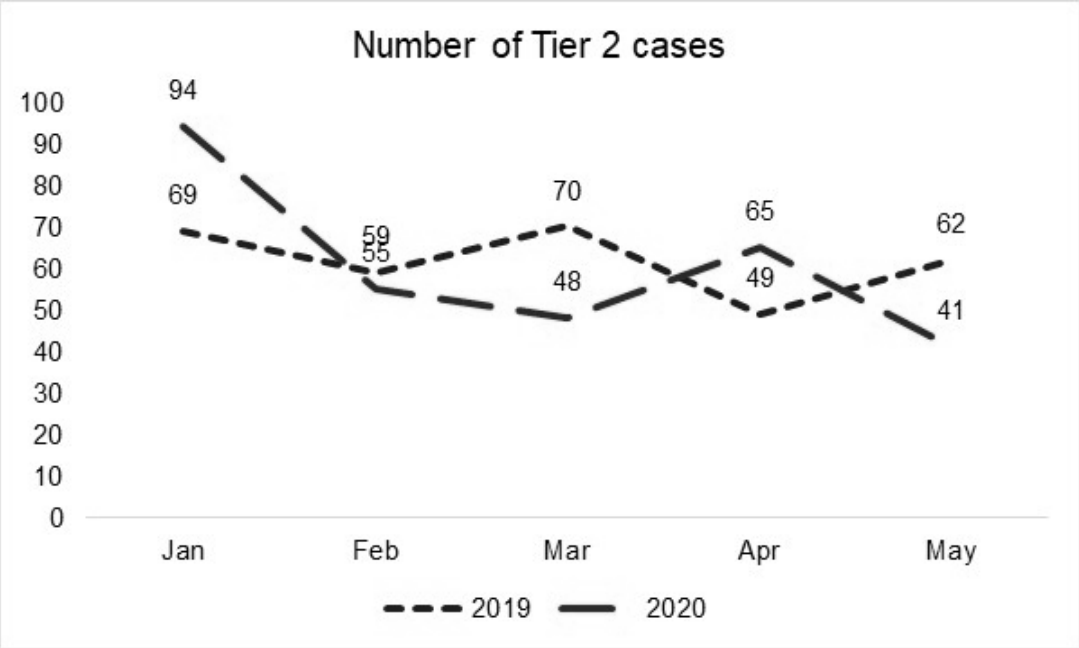
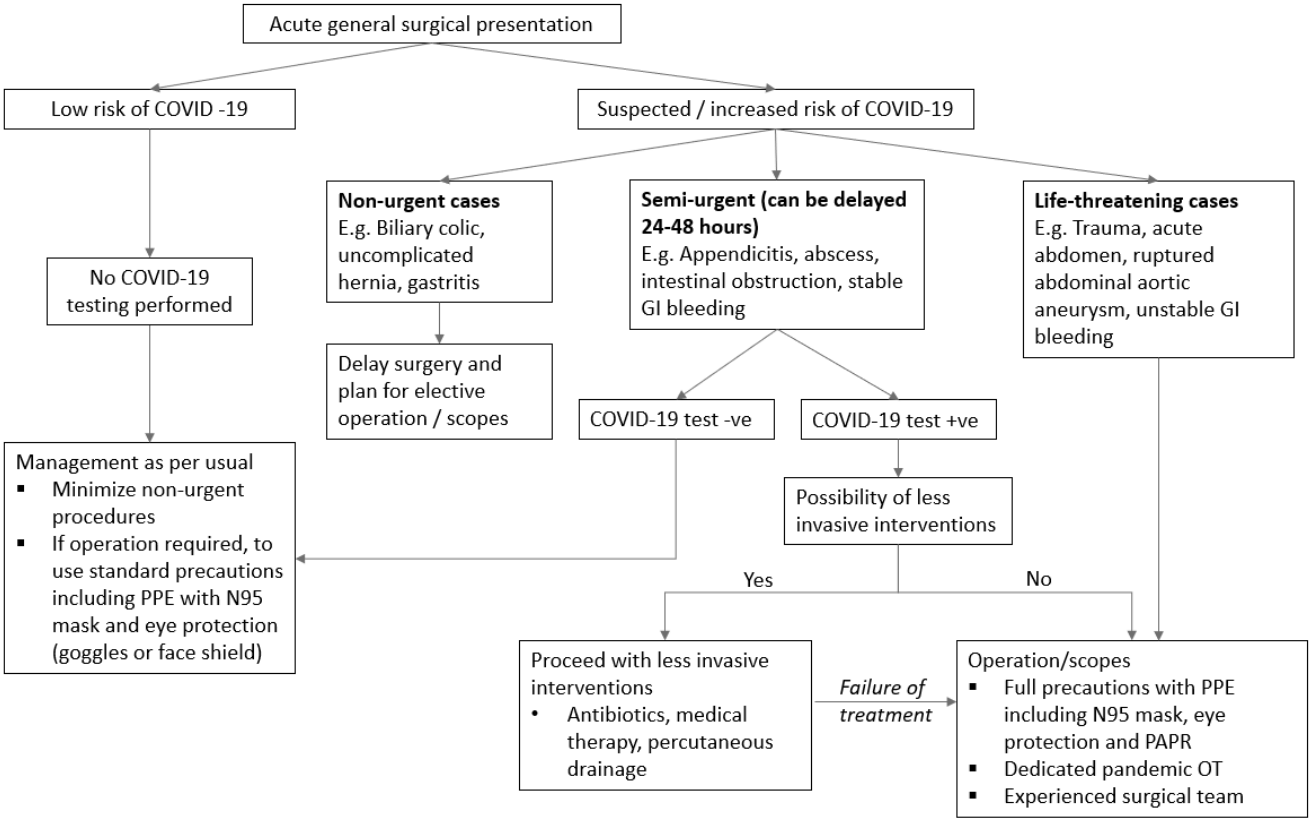


Figure 3: KTPH workflow for patients presenting with acute general surgical conditions and trauma during COVID-19



NB: GI: gastrointestinal; PPE: personal protective equipment; OT: operating theatre, PAPR: powered air-purifying respirator

TABLE 1. Epidemiology of Tier 1 and 2 trauma patients					
	Total	**Pre-lockdown**	**Lockdown**	**% Change**	***P***
Overall	630	349	281	-19.5%	-
Severity					
Tier 2 (ISS 9 – 15)	425	227	198	-12.8%	*0.17*
Tier 1 (ISS > 15)	205	122	83	-32.0%	
Gender					
Male	351	202	149	-26.2%	*0.25*
Female	279	147	132	-10.2%	
Age Range *(years)*					
16 - 64	248	147	101	-31.3%	*0.13*
≥ 65	382	202	180	-10.9%	
Injury Mechanism					
Fall	450	233	217	-6.9%	***<0.01***
Same level fall ≤ 0.5m	416	214	202	-5.6%	***<0.01***
Fall from height > 0.5m	34	19	15	-21.1%	*0.95*
Vehicular accident	138	92	46	-50.0%	***<0.01***
Pedal cyclist/PMD[+]	29	20	9	-55.0%	*0.19*
Motor car driver/passenger	12	10	2	-80.0%	*0.08*
Motorcycle rider/pillion	79	50	29	-42.0%	*0.16*
Pedestrian	18	12	6	-50.0%	*0.46*
Interpersonal violence	19	8	11	+37.5%	*0.34*
Tools/Objects/Machinery	12	8	4	-50.0%	*0.56*
Others*	11	8	3	-62.5%	*0.36*
Place of Injury					
Home/Residential institutions	342	177	165	-6.8%	*0.054*
Road	139	86	53	-38.4%	*0.10*
Public places	116	65	51	-21.5%	*0.96*
Workplace	29	17	12	-29.4%	*0.87*
Unknown	4	4	0	-100.0%	*0.13*

[+]PMD: personal mobility device.
*Other mechanisms of injury include sports injury, asphyxiation by hanging, charcoal burning

Table 2. Outcomes of Tier 1 cases			
	n (%) / mean ± SD		
	Pre-lockdown	**Lockdown**	***P***
First-line trauma activation	53 (43.4%)	21 (25.3%)	***0.01***
Second-line trauma activation	11 (9.0%)	2 (2.4%)	*0.08*
Time to intervention *(mins)*	88 ± 45 *(n=10)*	124 ± 62 *(n=5)*	*0.22*
Length of hospital stay (LOS) *(days)* *	17.2 ± 29.2	11.1 ± 14.4	*0.06*
Length of stay in HD/ICU *(days)*	5.7 ± 7.4 *(n=58)*	3.5 ± 3.3 *(n=24)*	*0.07*
Mortality	14 (11.5%)	6 (7.2%)	*0.44*
Discharge disposition*	*n=121*	*n=82*	
Home	56 (46.3%)	50 (61.0%)	***0.04***
Other acute hospital	3 (2.5%)	2 (2.4%)	*1.00*
Community hospital/Nursing Home	38 (31.4%)	14 (17.1%)	***0.03***
Cost of hospitalization *(SGD)^**	18,620 ± 31,671	7,831 ± 12,013	***0.01***

*LOS, discharge disposition, bill size: two patients pending discharge from hospital at point of data extraction
^ SGD: Singapore dollar