Impact of nationwide COVID-19 lockdown on 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 7 February 2020 to 1 June 2020 in response to the coronavirus disease 2019 (COVID-19) pandemic.

Methods: A retrospective analysis of cases from the national trauma registry was carried out comparing the lockdown period (from 7 February 2020 to 1 June 2020) to the pre-lockdown period (from 7 February 2019 to 1 June 2019). Data extracted included the volume of Tier 1 (injury severity score [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 min ($P = 0.22$). 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 the use of workflows to facilitate early intervention.

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

INTRODUCTION

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

Khoo Teck Puat Hospital (KTPH) is an acute restructured hospital and a top regional trauma centre that receives the second highest volume of Tier 1 or injury severity score (ISS) >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]

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There is limited information available on the impact of widespread community lockdown on the volume of trauma cases seen in public hospitals, as well as the patterns and trends of injury that may be seen during a lockdown. There is also no previous literature on the clinical outcomes of major trauma patients undergoing treatment during a pandemic. This study aimed to describe the impact of community lockdown on the volume and injury patterns of major trauma cases in a single regional hospital in Singapore.

METHODS

Data was extracted from the Singapore national trauma registry, which is maintained and prospectively collected by the Department of General Surgery, KTPH. The periods under study were from 7 February 2020 to 1 June 2020 (lockdown group) versus the month-matched historical cohort from 7 February 2019 to 1 June 2019 (pre-lockdown group). All Tier 1 (ISS >15) and Tier 2 (ISS 9–15) trauma patients who 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. The study was approved by the institutional research board (reference no. 2020/00567). Analysis of these outcomes was performed with Pearson's chi-square test and Student's *t*-test where appropriate. A P value < 0.05 was considered as statistically significant.

RESULTS

Table 1 shows a comparison of demographics and injury pattern of Tier 1 and Tier 2 trauma patients between the pre-lockdown and lockdown groups. There were 349 patients in the pre-lockdown group and 281 in the lockdown group,

Table 1. Epidemiology of Tier 1 and Tier 2 trauma patients.

Variable	*n*			Change (%)	*P*
	Total	Pre-lockdown	Lockdown		
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 (yr)					
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 ≤0.5 m	416	214	202	−5.6	<0.01*
Fall from height >0.5 m	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[a]	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

[a]Other mechanisms of injury include sports injury, asphyxiation by hanging and charcoal burning. *Statistically significant. ISS: injury severity score, PMD: personal mobility device

with a 19.5% decrease in the 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 Figures 1 and 2. There were no large gender differences between the pre-lockdown and lockdown groups.

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

Subgroup analysis of patient outcomes for Tier 1 trauma cases is presented 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 min to 124 min during lockdown; however, this was not statistically significant (*P* = 0.22).

There was no significant difference in mortality between pre-lockdown and during lockdown (11.5% vs. 7.2%, *P* = 0.44). The number of days that patients spent in critical care pre-lockdown and during lockdown (5.7 vs. 3.5 days) was also not statistically significant. There was no significant difference in length of stay for patients in pre-lockdown and lockdown periods; however, at the point of data extraction (30 days post-lockdown), there were two patients who remained in the general ward pending discharge, one from either period under assessment. This factor might also have had implications on the total cost of hospitalisation.

Breakdown of discharge facility disposition for those patients who had been discharged from hospital showed that there was a significantly larger proportion of patients who were discharged to their own homes (46.3% pre-lockdown vs. 61.0% during lockdown, *P* < 0.05) and a significantly lower proportion
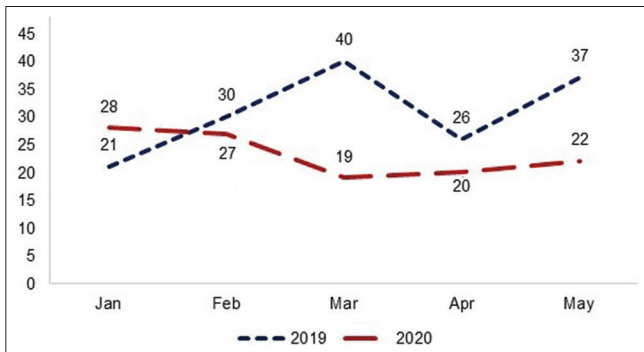

Figure 1: Graph shows the number of Tier 1 cases in 2019 and 2020.
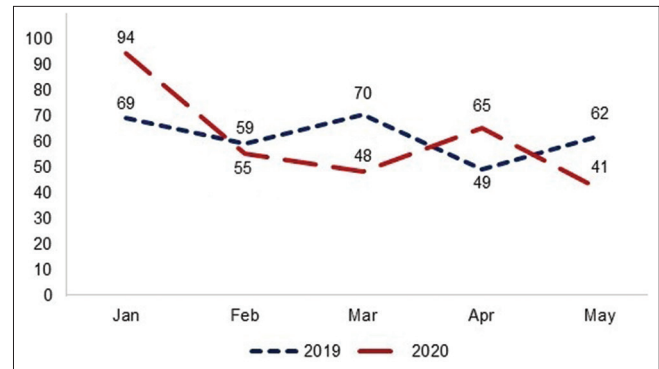
Figure 2: Graph shows the number of Tier 2 cases in 2019 and 2020.

Table 2. Outcomes of Tier 1 cases.			
Outcome	**n (%)/mean±SD**		**P**
	Pre-lockdown (*n*=122)	**Lockdown (*n*=83)**	
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 (min)	88±45 (*n*=10)	124±62 (*n*=5)	0.22
Length of hospital stay[a] (day)	17.2±29.2	11.1±14.4	0.06
Length of stay in HD/ICU (day)	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[a]	*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 hospitalisation[a] (SGD)	18,620±31,671	7,831±12,013	0.01*

[a]Two patients pending discharge from hospital at the point of data extraction. *Statistically significant. HD: high-dependency unit, ICU: intensive care unit, SD: standard deviation, SGD: Singapore dollar

of patients who were discharged to step-down 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 that had gone through a similar lockdown phase due to the COVID-19 pandemic. Christey *et al*.[7] reported an overall drop of 43% for all injury-related admissions in a Level I trauma centre in New Zealand, while Forrester *et al*.[8] reported a 4.8-fold drop in trauma activations in two Level I trauma centres in Santa Clara County, California, USA. Yang and Fu[9] reported a 39.2% reduction in major trauma patients presenting to Level I trauma centres in Hangzhou, China. 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] and the closure of work sites. While the decrease in traffic volume seems promising, there were 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 was aligned with the local context. Figures from the Singapore Traffic Police showed that in May 2020, the average road trips had fallen from 201 million to 80.4 million per month 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 the 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 those with acute respiratory infections (ARI).[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 introduction, if any, 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 less supervision of junior staff in both ED and surgical teams. The additional psychological burden of working on the frontline of a pandemic with ARI patients may also have taken a toll on even 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 Tier 1 polytrauma patients, who can be at risk of (a) undertriaging of the mechanism of injury and failure to activate trauma protocols, (b) missing significant injuries, especially in obtunded patients, and (c) delay in review by overstretched medical staff and delay in intervention within the 'golden hour' before clinical deterioration. The immediate effects of this can be seen in the increase in time to intervention, which was almost doubled in this study, 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 in the lockdown period showed no significant change compared to the pre-lockdown period, although 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 measure that may have contributed to maintaining an equivalent length of inpatient stay was the presence of a discharge team actively linking up patients with community-based outpatient rehabilitation programmes, although the outcomes of rehabilitation after those alternative programmes have not yet been studied.

At the time of this study, the future of the COVID-19 pandemic was fluid, with some countries reinstituting lockdowns due to the much-dreaded second wave previously forecasted.[20] It may not be possible for Singapore, 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 the 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 during the pandemic have been consolidated in the European Society of Trauma and Emergency Surgery recommendations.[21] Drawing from this paper, the key tenets particularly pertinent to the issues raised above are as follows: (a) care should be taken to maintain the quality of interventions and limit delay of interventions while considering COVID-19 guidelines, and (b) the shift of staff due to necessary redeployment should not have a negative impact on the ability to provide timely care for trauma and emergency surgery patients.
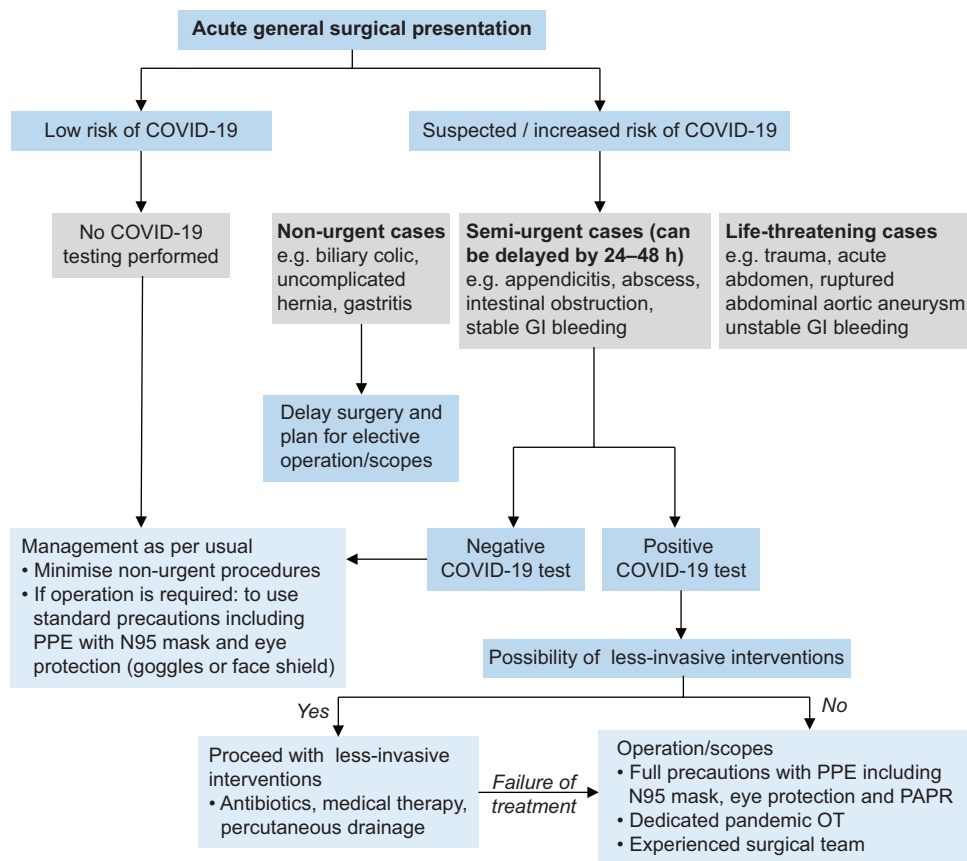
Figure 3: Chart shows the workflow for patients presenting with acute general surgical conditions and trauma during COVID-19 at Khoo Teck Puat Hospital. GI: gastrointestinal, OT: operating theatre, PAPR: powered air-purifying respirator, PPE: personal protective equipment

The ability to continue to provide quality care and appropriate intervention hangs on the presence and utilisation of robust institutional workflows. 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 utilisation of primary healthcare providers to attend to ARI and COVID-19 testing may also offload a surge in cases presenting to 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 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 increasing outreach to vulnerable groups are issues that have been raised in other countries, such as having 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 the 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 is 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.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, *et al*. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497-506.
2. Ministry of Health, Singapore. Confirmed imported case of novel coronavirus infection in Singapore; multi-ministry taskforce ramps up precautionary measures. Available from: https://www.moh.gov.sg/news-highlights/details/confirmed-imported-case-of-novel-coronavirus-infection-in-singapore-multi-ministry-taskforce-ramps-up-precautionary-measures. [Last accessed 2021 Sep 28].
3. Ministry of Health, Singapore. Risk assessment raised to DORSCON Orange. Available from: https://www.moh.gov.sg/news-highlights/details/risk-assessment-raised-to-dorscon-orange. [Last accessed on 2021 Sep 28].
4. Ministry of Health, Singapore. Circuit Breaker to minimise further spread of COVID-19. Available from: https://www.moh.gov.sg/news-highlights/details/circuit-breaker-to-minimise-further-spread-of-covid-19. [Last accessed on 2021 Sep 28].
5. Ministry of Health, Singapore. Roadmap ahead to phase two. Available from: https://www.moh.gov.sg/news-highlights/details/roadmap-ahead-to-phase-two. [Last accessed on 2021 Sep 28].
6. Kang ML, Goo JTT, Lee DJK. CHOP Protocol: Streamlining access to definitive intervention for major trauma victims. Singapore Med J 2021;62:620-2.
7. Christey G, Amey J, Campbell A, Smith A. Variation in volumes and characteristics of trauma patients admitted to a level one trauma centre during national level 4 lockdown for COVID-19 in New Zealand. N Z Med J 2020;133:81-8.
8. Forrester JD, Liou R, Knowlton LM, Jou RM, Spain DA. Impact of shelter-in-place order for COVID-19 on trauma activations: Santa Clara County, California, March 2020. Trauma Surg Acute Care Open 2020;5:e000505.
9. Yang F, Lu X. The effect of COVID-19 on trauma system in one city of China. Scand J Trauma Resusc Emerg Med 2020;28:57.
10. Thornton J. Covid-19: A&E visits in England fall by 25% in week after lockdown. BMJ 2020;369:m1401.
11. Park C, Sugand K, Nathwani D, Bhattacharya R, Sarraf KM. Impact of the COVID-19 pandemic on orthopedic trauma workload in a London level 1 trauma center: The "golden month". Acta Orthop 2020;91:556-61.
12. Tan C. Roads become more free-flowing and safer but speeding cases surge. In: The Straits Times 2020 May 13. Available from: https://www.straitstimes.com/singapore/transport/roads-become-more-free-flowing-and-safer-but-speeding-cases-surge. [Last accessed on 2021 Sep 28].
13. Hatchimonji JS, Swendiman RA, Seamon MJ, Nance ML. Trauma does not quarantine: Violence during the COVID-19 pandemic. Ann Surg 2020;272:e53-4.
14. Kofman YB, Garfin DR. Home is not always a haven: The domestic violence crisis amid the COVID-19 pandemic. Psychol Trauma 2020;12(Suppl 1):S199-201.
15. Iob E, Steptoe A, Fancourt D. Abuse, self-harm and suicidal ideation in the UK during the COVID-19 pandemic. Br J Psychiatry 2020;217:543-6.
16. Henry N, Parthiban S, Farroha A. The effect of COVID-19 lockdown on the incidence of deliberate self-harm injuries presenting to the emergency room. Int J Psychiatry Med 2021;56:266-77.
17. Tng XJJ, Chew QH, Sim K. Psychological sequelae within different populations during the COVID-19 pandemic: A rapid review of extant evidence. Singapore Med J 2022;63:229-35.
18. Hartnett KP, Kite-Powell A, DeVies J, Coletta MA, Boehmer TK, Adjemian J, *et al*. Impact of the COVID-19 pandemic on emergency department visits - United States, January 1, 2019-May 30, 2020. MMWR Morb Mortal Wkly Rep 2020;69:699-704.
19. Chew QH, Chia FL, Ng WK, Lee WCI, Tan PLL, Wong CS, *et al*. Perceived stress, stigma, traumatic stress levels and coping responses amongst residents in training across multiple specialties during COVID-19 pandemic-A longitudinal study. Int J Environ Res Public Health 2020;17:6572.
20. Cacciapaglia G, Cot C, Sannino F. Second wave COVID-19 pandemics in Europe: A temporal playbook. Sci Rep 2020;10:15514.
21. Coimbra R, Edwards S, Kurihara H, Bass GA, Balogh ZJ, Tilsed J, *et al*. European Society of Trauma and Emergency Surgery (ESTES) recommendations for trauma and emergency surgery preparation during times of COVID-19 infection. Eur J Trauma Emerg Surg 2020;46:505-10.
22. Neil J. Domestic violence and COVID-19: Our hidden epidemic. Aust J Gen Pract 2020;49. doi: 10.31128/AJGP-COVID-25.
23. Gunnell D, Appleby L, Arensman E, Hawton K, John A, Kapur N, *et al*. Suicide risk and prevention during the COVID-19 pandemic. Lancet Psychiatry 2020;7:468-71.