

# Impact of COVID-19 pandemic on the characteristics of paediatric emergency room visits in a tertiary centre in Northern Italy

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## Research

**Keywords:** COVID-19, newborn, child, paediatric emergency department, triage code

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# Abstract

## Introduction

The ongoing COVID-19 pandemic is heavily affecting healthcare services worldwide. We investigated the impact of a lockdown policy on the characteristics of patients attending a Paediatric Emergency Department (PED), in one of the first areas of COVID-19 outbreak in Europe.

## Methods

We retrieved data of all PED visits in March-April 2020 (COVID-19) and March-April 2019 (non-COVID-19), comparing volume and characteristics of PED accesses in the two periods.

## Results

In COVID-19 period, total visits reduced by 67% if compared to 2019. White codes decreased from 45.8–35%. Green codes raised from 45.9–52.2%, while yellow and red codes were comparable. As a percentage, accidents increased during COVID-19, being the first cause of PED access (29.7%) ( $p < 0.0001$ ), while infections and fever category dropped from 49.1–27.7%. ( $p < 0.001$ ). Within the neonatal population, minor conditions raised from 56.4% to 81.3. ( $p < 0.001$ ). Hospitalisation rate slightly increased, while Paediatric Intensive Care Unit (PICU) admission rate was comparable in the two periods.

## Conclusions

The lockdown due to COVID-19 had a substantial impact on volume and features of patients accessing our PED in Verona. PED visits abruptly decreased, mainly for a reduction of white codes. As a percentage, despite the stay-at-home order, accidents such as injuries, burns and wounds significantly increased, suggesting that home safety measures should be reinforced by parents during any lockdown. Finally, the increased accesses for minor neonatal conditions should prompt primary care services to be more efficient and easily available, in case of lockdown, to reduce unnecessary PED visits and risk of contagion for these infants and their families.

# Introduction

On January 30th, 2020 the World Health Organization (WHO) declared the outbreak of the novel coronavirus SARS-CoV-2 as a “public health emergency of international concern” and on March 11th as a global pandemic. [1]. Italy was the first Country reporting cases of COVID-19 in Europe, starting from the Northern regions. [2, 3] Since February 23rd, school closure and restriction of social activities were imposed in outbreak areas, to avoid the spread of SARS-CoV-2 and other viral infections mimicking COVID-19. Since March 1st, progressively restrictive measures for social contacts were extended all over the Country, up to the national lockdown established on March 9th and strictly maintained until April 27th. Since the first days of COVID-19 emergency, due to high risk of contagion, visits to hospital and Emergency Departments (ED) were discouraged, unless for urgent reasons. As a consequence, many

Italian Paediatric Emergency Departments (PED) experienced a marked reduction of visits during the pandemic (-73% and - 88% compared to same periods in 2019 and 2018, respectively). [4] Furthermore, cases of delayed access to PED were reported, even in severely ill children. [4] At the same time, medical assistance by primary care physicians was abruptly limited to phone consultation, especially for children with any suspected infectious disease. Currently, it is barely known the real impact the lockdown had on patient influx to the hospital in a COVID-19 epidemic area. In particular, few data are available about the reasons and characteristics of paediatric accesses to PEDs during the lockdown period.

The aim of this study was to analyse the variation in terms of volume, typology and triage code severity of paediatric access to our PED during the lockdown period, compared to the figures observed during the same period in the previous year, in a COVID-19 outbreak area in Northern Italy.

## Methods

### Study design

We performed a retrospective observational study in the Paediatric Emergency Department (PED) of the Verona University Hospital, during the ongoing outbreak of COVID-19, started in February 2020. The PED in Verona is a tertiary centre providing care to about 20.000 children per year, for any pathological conditions but major trauma. In our centre, according to patients' symptoms and vital signs, urgency at triage code severity is defined by colour codes (white, green, yellow and red).

Following any PED access, patients may be discharged home or admitted, either to a paediatric ward or to the paediatric intensive care unit (PICU).

We analysed data of all patients who accessed our PED from March 1st to April 30th, 2019 (non COVID-19 period) and from March 1st to April 30th, 2020 (COVID-19 period), when national restrictive policies for social distancing and other mitigation procedures were established.

We also retrieved the number of PED visits observed in a two-month span (January and February) in 2019 and 2020, to compare the trend of PED accesses before the COVID-19 season.

Data were retrieved from our electronic PED database, including details on number of visits, age and sex distribution, urgency at triage, discharge diagnosis and outcome.

According to age, patients were split into seven categories, from below 28 days of life up to more than 14 years.

Newborns (< 28 days of life) were subdivided in two categories, including infants with pathological conditions or with minor issues (e.g. breastfeeding issues, umbilical care), respectively.

Discharge diagnoses were subdivided in 9 categories: 1) fever and infections (e.g. aspecific fever, respiratory and gastrointestinal infections); 2) gastrointestinal and genitourinary diseases (e.g.

abdominal pain, stipsis, urinary tract infections); 3) seizures, epilepsy and neurological conditions; 4) headache; 5) accidents (e.g. head injury, other traumatic injuries, burns, wounds, foreign body ingestion or inhalation and musculoskeletal pain); 6) dermatological pathologies; 7) psychiatric disorders; 8) acute surgical conditions; 9) other conditions.

Outcome of patients was classified in three categories: discharge home, admission to a paediatric ward or to the PICU.

We compared all figures between the non COVID-19 period (2019) and COVID-19 period (2020).

## **Statistical analysis**

Descriptive statistics were reported as median and range, or mean and standard deviation, for continuous variables and proportion and percentage for categorical variables. The Mann Whitney U test was used for group comparison analysis of continuous variables and Chi-squared and Fisher's exact tests for categorical. When the p-value was  $< 0.05$ , the difference was regarded as statistically significant. All statistical tests were 2-tailed. All statistical analyses were performed using Stata Version 13.0 (StataCorp, College Station, TX)

## **Results**

A total of 4.198 visits were registered in the two study periods. The number of PED visits markedly decreased in the COVID-19 period (1039, 524 in March, 515 in April) as compared to the non COVID-19 one (3159, 1605 in March and 1554 in April). (Table 1) Differently, the number of PED visits registered in January-February 2019 was nearly identical to that observed in the same period in 2020 (3.891 vs 3.842). (Fig. 1)

Table 1

Demographical characteristics and triage code severity of the population accessing the Verona PED in March – April 2019 (non COVID-19 period) compared with the same 2020 period (COVID-19 period). (d = days; y = years)

	2019	2020	p-value
<b>Number of visits, n</b>	3159	1039	
<b>Visits per day, n (SD)</b>	51.62 (10.44)	17.03 (6.76)	<b>&lt; 0.001</b>
<b>Sex (n, %)</b>	1418 (44.88)	437 (42.05)	ns
Female	1741 (55.12)	602 (57.94)	ns
Male			
<b>Age group (n, %)</b>	78 (2.7)	59 (5.68)	<b>&lt; 0.001</b>
< 28 d	544 (17.22)	203 (19.54)	ns
28 d < 1y	583 (18.46)	241 (23.20)	<b>0.001</b>
1 y < 3 y	860 (27.22)	194 (18.67)	<b>&lt; 0.001</b>
3 y < 6 y	436 (13.80)	162 (15.59)	ns
6 y < 10 y	402 (12.73)	136 (13.09)	ns
10 y < 14 y	256 (8.10)	44 (4.23)	<b>&lt; 0.001</b>
≥ 14 y			
<b>Priority tags at triage</b>			
White (n,%)	1447 (45.81)	364 (35.03)	<b>&lt; 0.001</b>
Green (n,%)	1450 (45.9)	574 (55.25)	<b>&lt; 0.001</b>
Yellow (n,%)	261 (8.26)	100 (9.62)	ns
Red (n,%)	1 (0.03)	1 (0.1)	ns
<b>Outcome</b>			
Discharge	2893 (91.57)	930 (89.51)	<b>0.04</b>
Hospital admissions	266 (8.42)	109 (10.49)	<b>0.04</b>
PICU admissions	27 (10.15)	11 (10.09)	ns

Mean PED visits per day was significantly lower in the COVID-19 period (17.03, DS ± 6.76), compared to the non COVID-19 period (51.62, DS ± 10.44).to (p < 0.001).

Sex distribution was comparable, with a predominance of males in both epochs.

The most represented age group were 3 < 6 years (27.22%) and 1 < 3 years (23.2%) in March – April 2019 and 2020 respectively. When compared to non COVID-19 period, we noticed a significant reduction in the groups 1 < 3 years, 3 < 6 years and  $\geq 14$  years ( $p < 0.001$ ), while neonatal population increased from to 2.7–5.68% ( $p < 0.001$ ).

At triage, the percentage of white codes significantly decreased in the “COVID-19 period”, as compared to the non COVID-19 period (35% vs 45.8%,  $p < 0.001$ ). Differently, green codes significantly increased, from 45.9–55.25% ( $p < 0.001$ ), while yellow codes and red codes did not vary. (Table 1)

As for the neonatal population, the number of newborns accessing PED for pathological conditions significantly decreased, falling from 34 (non COVID-19) to 11 (COVID-19) ( $p < 0.001$ ). Conversely, visits for minor neonatal conditions significantly increased, from 44 (56.41%) in 2019 to 48 (81.3%) in 2020 ( $p < 0.001$ ). (Table 2)

Table 2  
Newborns (age < 28 days) accessing Verona PED in March – April 2019 (non COVID-19) compared with the same period in 2020 (COVID-19).

	<b>2019</b>	<b>2020</b>	<b>p-value</b>
Total visits, n	78	59	
Newborns with pathological conditions, n (%)	34 (43.5)	11 (18.6)	<b>&lt; 0.001</b>
Newborns with minor conditions, n (%)	44 (56.41)	48 (81.3)	<b>&lt; 0.001</b>

Diagnosis at discharge are shown in Table 3. In March-April 2019, the three most frequent diagnoses at discharge were infections and fever ( $n = 1552$ , 49.13%), accidents ( $n = 535$ , 16.94%) and gastrointestinal and genitourinary diseases ( $n = 371$ , 11.74%). (Fig. 2)

Table 3

PED diagnosis at discharge in March – April 2019 (non COVID-19) compared with the same period in 2020 (COVID-19).

Diagnosis at discharge, % (n)	2019	2020	p
Infections and fever	1552 (49.13)	288 (27.72)	< 0.001
Lower airways infections	255 (16.43)	54 (18.75)	ns
Upper airways infections	796 (51.29)	160 (55.56)	ns
Aspecific fever	123 (7.93)	32 (11.11)	ns
Gastroenteritis	378 (24.36)	42 (14.58)	< 0.001
Gastrointestinal and genitourinary diseases	371 (11.74)	159 (15.3)	0.003
Seizures, epilepsy and other neurological conditions	74 (2.34)	51 (4.91)	< 0.001
Headache	65 (2.06)	7 (0.67)	0.003
Accidents	535 (16.94)	309 (29.74)	< 0.001
Head injury	132 (24.67)	71 (22.98)	ns
Other traumas – burns – wounds	237 (44.3)	183 (59.22)	< 0.001
Foreign body ingestion/inhalation	53 (9.91)	30 (9.71)	ns
Musculoskeletal pain	113 (21.12)	25 (8.09)	< 0.001
Dermatological pathologies	247 (7.82)	65 (6.26)	ns
Psychiatric disorders	30 (0.95)	8 (0.77)	ns
Acute surgical conditions	26 (0.82)	21 (2.02)	0.001
Others	259 (8.19)	131 (12.6)	ns
Total	3159	1039	

In March-April 2020, the most frequent diagnoses at discharge were accidents (n = 310, 29.74%) followed by infections and fever (n = 288, 27.72%) and gastrointestinal and genitourinary diseases (n = 159, 15.3%). (Table 2).

As compared to March-April 2019, in the COVID-19 period there was a significant increase of accidents (p < 0.001), gastrointestinal and genitourinary diseases (p = 0.003), seizures, epilepsy and other neurological conditions (p < 0.001), and acute surgical conditions (p = 0.001). Conversely, there was a significant decrease of PED visits for infections and fever (p < 0.001) and headache (p = 0.003). In particular, visits for headache fell from 65 accesses in the non COVID-19 period to 7 in the COVID-19 (p < 0.003). Dermatological and psychiatric disorders were comparable in the two periods. (Table 3)

Within the “infections and fever” diagnostic category, the percentage of visits for gastroenteritis significantly declined during the COVID-19 period, from 24.36% in 2019 to 14.58% in 2020 ( $p < 0.001$ ). (Table 3)

We also observed a significant increase for “other traumatic injuries, burns and wounds” ( $p < 0.001$ ), while head injury and foreign body ingestion or inhalation remained stable. Conversely, musculoskeletal pain markedly diminished ( $p < 0.001$ ). (Table 3)

In terms of outcome, children accessing our PED in March-April 2020 were more frequently hospitalized in a paediatric ward if compared to March-April 2019, [109 hospital admissions in 2020 (10.4%) vs 266 in 2019 (8.4%), respectively;  $p = 0.04$ ]. Differently, admission rate in the PICU was comparable in the two epochs [11 (10.09%) in 2020 vs 27 (10.15%) in 2019;  $p = ns$ ]. (Table 4)

Table 4  
Outcome of the paediatric population accessing the Verona PED in March – April 2019 (non COVID-19) compared with the same period in 2020 (COVID-19).

Outcome, n (%)	2019	2020	p
Discharge	2893 (91.57)	930 (89.51)	<b>0.04</b>
Admissions	266 (8.42)	109 (10.49)	<b>0.04</b>
PICU admissions	27 (10.15)	11 (10.09)	ns

## Discussion

Our study aimed to explore the impact of a strict lockdown policy on attendance of patients to an urban PED, in one of the first areas of COVID-19 outbreak in Europe. Indeed, COVID-19 outbreak in 2020 had a marked impact on volume and characteristics of visits in our PED in Verona. Mean daily PED accesses dropped to one third of those registered in the same period in 2019, with reduced percentage of white codes and a slight increase of green codes, while yellow and red codes did not vary. Of note, “accidents” were the most frequent cause for PED visits during COVID-19, overcoming the “infections and fever” category, which had ranked first in the previous year. As another important finding, we observed a marked increase of PED visits for minor neonatal conditions, which nearly tripled in percentage if compared to 2019. Hospitalization rate slightly increased during COVID-19 period, while admissions to the PICU remained at 10% in both epochs.

After COVID-19 became pandemic, a drastic decrease in number of patients presenting to adult EDs was noticed. [5] Similar data were recently highlighted also for children [6] and are confirmed by our study, that reported a drop of PED visits by 67% during the “COVID-19 period”, if compared to the same period in 2019. This dramatic change was clearly linked to the pandemic, as in two previous months (January and February 2020) the number of PED visits was equivalent to the previous winter season.



As for classification at triage, white, green and yellow codes showed a marked reduction in terms of absolute numbers during the COVID-19 period. However, the overall drop of PED visits was mainly due to a large decrease in children with less urgent problems, e.g. those classified as white codes, which decreased from 45 to 35%, while percentage of green codes slightly increased. We may argue that parents of children with minor problems (white codes) were more reluctant of taking them to the hospital, given the risk of contagion. Furthermore, access to hospital for non-urgent problems was discouraged by restriction on private and public transport, which limited travels for urgent reasons and essential services only. Instead, reassuringly, the proportion of children presenting to our PED with urgent or emergent conditions (yellow or red codes), was nearly the same in the two epochs.

Unexpectedly, accidents were the first reason for accessing our PED during the COVID-19 period. Specifically, we found a marked increase in injuries, burns or wounds, mimicking the rise of traumatic events typically observed in children during summer or holidays seasons. This finding suggests that home remains a frequent place for accidents in children. [7]

In line with a recent finding in a large paediatric population [8], we observed a marked reduction of children presenting to our PED with infections or fever (from 49–28%). Possibly, avoidance of social interactions, school closure, suspension of all non-essential services and sport activities, may have limited the spread of other viral infections usually seen in previous winter seasons. [5, 9]

Nonetheless, infections and fever ranked as the second most represented category in our PED during the COVID-19 period. Several studies suggest that infectious diseases are the main cause for PED visits all over the year, and signs and symptoms like fever, cough, respiratory distress, vomiting and diarrhoea are frequently found in the paediatric population. [10–12] Indeed, the population had become quickly aware that respiratory symptoms and fever could be warning signs for possible COVID-19, thus prompting caregivers to seek PED consultation for their children, despite the opposite recommendation by the national health service to stay at home and the low involvement of the paediatric age. [13–16] Conversely, PED visits for gastroenteritis showed a significantly fall in the COVID-19 period, probably because gastrointestinal symptoms were not known yet as a possible manifestation of COVID-19 by caregivers, particularly in the first weeks of the outbreak.

PED visits for headache, abdominal and musculoskeletal pain significantly decreased during COVID-19. These data may be partly related to the frequent functional etiologic cause of these symptoms, more frequently observed during school attendance. [10, 17]

As a novel information, during the COVID-19 period we observed a much larger proportion of otherwise healthy newborns, who were brought to our PED for minor neonatal conditions, such as breastfeeding or umbilical care related problems. This somewhat surprising data may be primarily explained by the restricted access to primary care services. Forced home isolation may also have limited the possibility for inexperienced parents to seek advice from relatives and friends, raising anxiety and worries about the best management for their infant. The need for help on routine care of their baby may have offset parents' fear of contagion, prompting them to reach out the PED despite the limitations imposed by the

lockdown. This data should be carefully taken into account should another lockdown had to be re-instituted. Indeed, neonates are a vulnerable population, that in a COVID-19 context could be exposed inappropriately to a higher risk of infection while visiting the PED. Furthermore, inappropriate access to PED for minor neonatal issues may pose an unnecessary burden to healthcare providers and the hospital system, as well as a higher risk of contagion also for other family members. More efficient territorial services should be made easily available for the neonatal population in the future, to limit incongruous access of these fragile subjects to the PED.

Finally, in terms of outcome we observed a moderate although significant increase of hospitalization rate during the COVID-19 period. This may be coherent with the marked reduction of white codes in 2020, suggesting the population visiting our PED was generally sicker during COVID-19, thus requiring hospital care more frequently. However, as percentage of yellow and red codes were not different, and the need for PICU admission did not change in 2019 and 2020, we speculate that the risk of delayed access to PED during the COVID-19 period was negligible in our population, differently from that reported in other studies. [4, 18]

This study has some limitations. First, the retrospective study design and the relatively small sample size do not allow to draw robust conclusions. Second, it is a single centre study, thus it may not fully reflect the diversity of care provided in other paediatric emergency departments, in Italy and other countries. Nonetheless, it provides information on the characteristics of more than one thousand PED visits in a third-level urban centre, during the early phase of a unique situation, such as that caused by the COVID-19 pandemic. These data may be useful for comparing figures from other PEDs, as well as for guidance in adapting healthcare policies for possible future outbreaks.

In conclusion, our data point out the abrupt reduction and reveal some distinct characteristics of PED visits in Verona during the COVID-19 pandemic, if compared with the same period in 2019.

The strict and prolonged national lockdown policy had a strong impact on volume and features of patients accessing our PED, with a marked reduction in percentage of white codes. Of note, one third of visits was accident-related, emphasizing the need of implementing strategies to raise public awareness of child safety at home, particularly during a mandatory stay-at-home policy. We report an unexpected marked increase of PED visits for minor neonatal conditions, which nearly tripled in percentage if compared to 2019. This finding highlights the need for primary care services to be more efficient and easily available, should another lockdown had to be re-established, to reduce unnecessary PED visits and the inherent risk of contagion for these infants and their family members. Hospitalization rate slightly increased during COVID-19 period, while admission rate to the PICU remained equal in the two epochs, suggesting an overall judicious use of hospital resources despite the inevitable pressure PED healthcare providers had to face during the pandemic.

## Abbreviations

COVID-19, COronaVirus Disease 19

ED, Emergency Department

PED, Paediatric Emergency Department

PICU, Paediatric Intensive Care Unit

WHO, World Health Organization

## **Declarations**

# **Ethics approval and consent to participate**

Ethics approval and consent to participate waived for the retrospective observational nature of the study.

### **Consent for publication**

Not applicable.

### **Availability of data and materials:**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no competing interests.

## **Funding:**

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## **Authors' contributions:**

Dr. DS, Dr. LB and PB conceived the study design and analyzed the data. Dr. DS and Dr. LB drafted the initial manuscript. Dr. PS, Dr. SI, Dr. PLT, Dr. GLF and Dr. CB participated in the literature search and data collection. Dr. PB reviewed the manuscript. All authors interpreted the data, contributed to the intellectual content, reviewed the manuscript, and approved the final version.

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## Figures

Figure 1

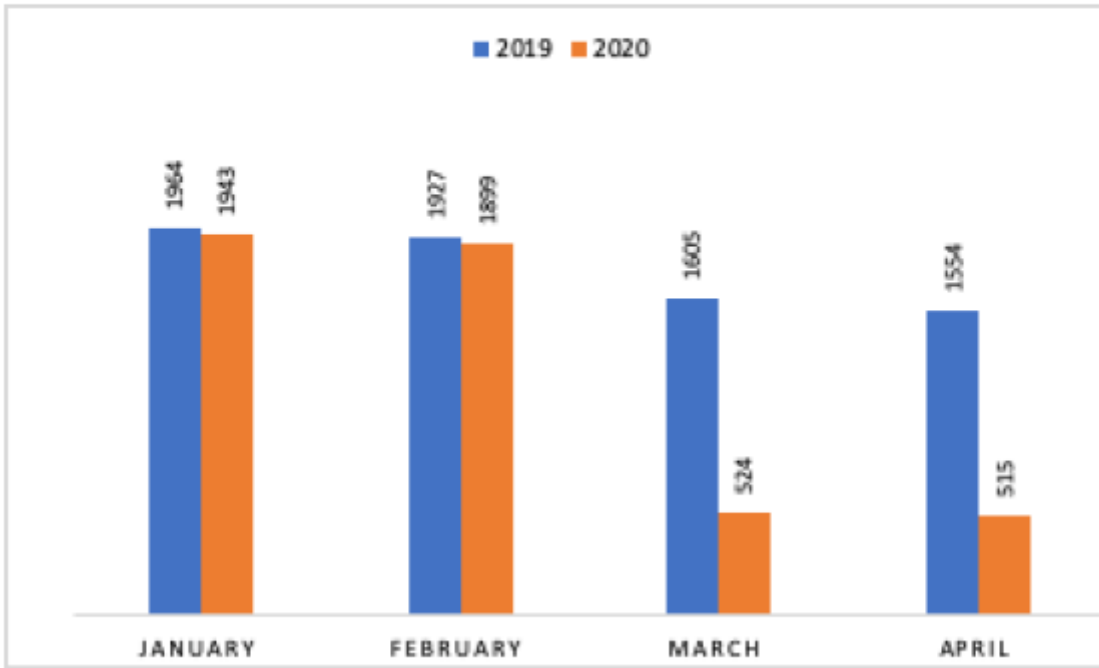


Figure 1

Monthly visits to the Verona PED from January to April, in 2019 and 2020, respectively.

Figure 2

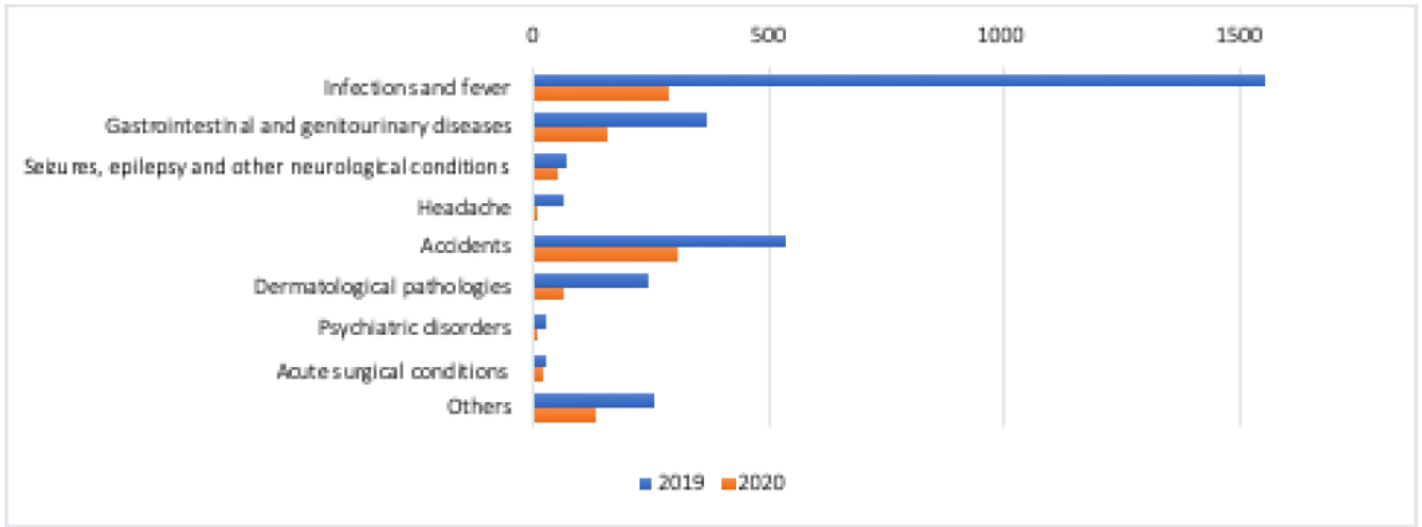


Figure 2

Diagnosis at discharge in the two study periods [March – April 2019 (non COVID-19) vs March - April 2020 (COVID-19)]