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Impact of lockdown on cardiovascular disease hospitalizations in a Zero-COVID-19 country

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ABSTRACT

Objectives: There are concerns about the potential effect of social distancing used to control COVID-19 on the incidence of cardiovascular diseases (CVD).
Study design: Retrospective cohort study.
Methods: We examined the association between lockdown and CVD incidence in a Zero-COVID country, New Caledonia. Inclusion criteria were defined by a positive troponin sample during hospitalization. The study period lasted for 2 months, starting March 20, 2020 (strict lockdown: first month; loose lockdown: second month) compared with the same period of the three previous years to calculate incidence ratio (IR). Demographic characteristics and main CVD diagnoses were collected. The primary endpoint was the change in incidence of hospital admission with CVD during lockdown compared with the historical counterpart. The secondary endpoint included influence of strict lockdown, change in incidence of the primary endpoint by disease, and outcome incidences (intubation or death) analyzed with inverse probability weighting method.
Results: A total of 1215 patients were included: 264 in 2020 vs 317 (average of the historical period). CVD hospitalizations were reduced during strict lockdown (IR 0.71 [0.58–0.88]), but not during loose lockdown (IR 0.94 [0.78–1.12]). The incidence of acute coronary syndromes was similar in both periods. The incidence of acute decompensated heart failure was reduced during strict lockdown (IR 0.42 [0.24–0.73]), followed by a rebound (IR 1.42 [1–1.98]). There was no association between lockdown and short-term outcomes.
Conclusions: Our study showed that lockdown was associated with a striking reduction in CVD hospitalizations, independently from viral spread, and a rebound of acute decompensated heart failure hospitalizations during looser lockdown.

Introduction

Since the beginning of the SARS-CoV-2 pandemic, strict social distancing and healthcare reorganization measures have been adopted worldwide to contain transmission and address the surge

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of critically ill patients in acute care settings.[1] These measures along with border closing and contact tracing contributed to an efficient control of the spread of SARS-CoV-2 in certain isolated territories such as New Caledonia.[2–4] Restrictions related to COVID-19 remain debatable because of their social and economic consequences. Consequently, elimination strategies, which aim to fully prevent any viral circulation, represent a high level of social restrictions. Their impact on healthcare systems and diseases unrelated to COVID-19 remains to be elucidated.[5,6]

New Caledonia, a territory of the French Republic in the Pacific region, has a multicultural and inclusive population with Melanesian, Oceanian, Asian, and European cultures characterized by a high incidence of obesity.[7] New Caledonia benefits from a health system and medical infrastructure that meet the highest international standards, guaranteeing safe and efficient care. Early in the COVID-19 pandemic, New Caledonia issued a Zero-COVID strategy starting with complete border closure.[4] Indeed, after the detection of a first local case of COVID-19 in March 2020, a strict 1-month lockdown was applied. During this period, no local COVID-19 cases were detected. The strict lockdown was followed by a second month of looser restrictions and social distancing strategies.[4] Eventually, New Caledonia was declared a Zero-COVID country by the end of May 2020 and maintained this status until March 2021.[8]

After the introduction of the first lockdown measures, local healthcare workers in New Caledonia soon reported changes in hospitalization patterns with a specific signal on acute decompensated heart failure (AHF), acute coronary syndrome (ACS), and acute heart rhythm and conduction disorders as observed elsewhere in the world.[9] Few data on lockdown-related healthcare consequences and patient outcomes have been published despite the fact that it represents the untold toll of the pandemic. The unique setting of New Caledonia during the first lockdown in the absence of viral spread of SARS-CoV-2 represents an exceptional opportunity to analyze the consequences of this healthcare policy. Therefore, we studied the impact of lockdown on the incidence of cardiovascular hospitalizations.[10]

Methods

We conducted this study at the regional hospital of New Caledonia Centre-Hospitalier-Territorial Gaston-Bourret (CHT), the only tertiary hospital in New Caledonia. Unscheduled hospitalizations represented the nearly unique reason for hospital admissions in 2020 in the CHT, which is the referral hospital for major surgeries and life-threatening emergencies in non-pandemic time. In the present analysis, all adult patients with a positive troponin plasma sample at hospital admission were included. The threshold was >15.6 pg/mL for women and >32.4 pg/mL for men (Alinity I STAT high-sensitive troponin I kit, Abbott, Chicago, USA).[10] Patients who underwent cardiac surgery during the index hospitalization, imported COVID-19-related myocarditis, patients presenting with post-traumatic myocardial injury, as well as patients admitted for a scheduled dialysis or ambulatory care facilities were excluded. To limit bias due to migration and tourism in the historical group, residents from outside of New Caledonia were excluded because of the border closure during lockdown. The study period lasted from March 20, which was the day of the international border closure, to May 20, 2020. The lockdown period was compared with the same period of the three previous years (i.e. historical period) to minimize a potential seasonal epidemic effect.

Sensitivity analyses were also conducted. First, time effect was assessed by comparing the two lockdown periods vs the historical period. Period A comprised the 4 weeks when **strict lockdown** policies were enforced in New Caledonia and period B, the following month, when **loose lockdown** and social distancing policies were implemented. Second, the incidence of different cardiovascular diseases during lockdown was compared with their incidence during the historical period, such as the hospitalizations for AHF, ACS, acute rhythm and conduction disorders, sepsis, and surgical emergencies. Third, an analysis was conducted in the subgroup of intensive care unit (ICU) admissions. Finally, we analyzed the association of lockdown to a composite outcome (intubation and all-cause in-hospital death).

This study was approved by the local ethics committee (identification number 2020-001) and performed in accordance with the declaration of Helsinki.

Data on hospitalizations in ICU, specialty wards, and emergency department visits were collected. Chronic and acute diagnosis associated with the index hospitalization were collected according to the French coding system (CIM-10). Demographic data were recorded on age, gender, billing address, medical history of cancer, neurovascular disease, arterial hypertension, coronary artery disease, chronic heart failure, and chronic kidney failure. Clinical characteristics and biological data were extracted from the CHT clinical database (DX Care). ZIP codes were used to define two types of urbanicity (see supplementary materials).

Outcome variables included all-cause in-hospital death, the need for mechanical ventilation, a coronary angiography, ICU admission, and Simplified Acute Physiology Score 2 (SAPS2) score. The main diagnosis of cardiovascular disease included type 1 myocardial infarction (MI; ACS with and without ST-elevation [ST-segment elevation myocardial infarction (STEMI) and ST-segment elevation myocardial infarction (NSTEMI)]), AHF, as well as acute rhythm and conduction disorders. Data on myocardial injury were also collected, as defined by type 2 MI due to sepsis, acute neurovascular disease, or surgery.

The maximal troponin measured on plasma sample and the time from admittance to the troponin peak were noted.

The primary endpoint was the incidence of hospital admissions with a positive troponin sample during the 2020 lockdown compared with previous years and the incidence of the main CVD diagnoses, including ACS, AHF, and acute rhythm and conduction disorders.

The secondary endpoints included the effects of strict and loose lockdown on primary endpoint, change in incidence of hospitalization for each cardiovascular diagnosis, and effects of lockdown on the occurrence of the composite outcome of all-cause in-hospital death and the need of invasive ventilation.

We calculated bivariate frequencies of hospitalization rates, main diagnoses, outcome, and preadmission characteristics. Categorical variables are presented as number and percentage. Continuous variables are presented as means and 95% confidence interval (CI). The ZIP codes were used to provide a mapping of patients included in the analysis and to adjust the statistics according to the geographical localization.

The incidence ratios (IRs) were calculated as the proportion of related events from the study period in 2020 to the historical period. The incidence of events in the population of New Caledonia was calculated as the proportion of disease for 100,000 inhabitants. The interaction between periods A and B was also tested.

Data for patients' outcome were censored on September 1, 2020. We conducted a multivariable logistic regression analysis to estimate the association between the lockdown and the composite endpoint (all-cause in-hospital death or invasive ventilation). We conducted a propensity score–matched analysis to reduce the bias of confounding factors in the analysis. The individual propensities

to be hospitalized with a positive troponin sample in 2020 were calculated with a multiple regression model using the same covariates as previously described. The association between the lockdown period and outcomes was first assessed by a logistic regression analysis (i.e. crude analysis), then by three different analyses using a propensity score. First, we used the propensity score as an additional covariate in the multiple logistic regression analysis with all potential cofounders as covariates. Second, we applied the nearest neighbor propensity score matching. Caliper value was 0.25 of the standard deviation of the logit of the propensity score. Finally, we used inverse probability weighting (IPW). Death and mechanical ventilation were studied as separate outcomes with the same methodology. Odds ratios (ORs) and their 95% CIs were calculated.

The subgroup analysis included ICU admissions. Patients with missing data on SAPS2 were considered random and excluded from the analysis.

Results

A total of 1399 patients were admitted with a positive troponin sample during the 2-month period from March 20 to May 20 in 2017, 2018, 2019, and 2020. Thirty-two patients were excluded because they underwent cardiac surgery, 104 for non-admittance to hospitalization, 19 for traumatic injuries, 17 because they were not New Caledonia residents, eight patients for chronic dialysis, and three due to missing ZIP codes. The final study cohort included 1215 patients (an average of 152 patients per month). The evolution of emergency department visits, as well as hospitalizations in ICU and non-ICU ward, are described in Fig. 1. The median troponin concentration on inclusion was 142 pg/mL (52–1078) and observed at the median day 1 after admission (0–2).

Baseline characteristics of the study population are presented in Table 1. The median age of patients included in the study during the 2020 lockdown was 67 years. Compared with the historic cohort, patients included in 2020 had more comorbidities, including neurovascular disease (10.2% vs 5.4%, $P = 0.01$) and chronic kidney disease (32.2% vs 23.6%, $P = 0.01$).

Concerning the primary endpoint, there were 264 hospitalizations with a positive troponin sample in 2020 vs 951 during the historical period (mean value of 317 patients over 2 months). This amounted to an 18% absolute reduction in hospitalizations in 2020 (see Fig. 1), with an IR of 0.83 (0.72–0.95). This reduction in the incidence was exclusively seen during the first month with strict lockdown (IR 0.72 [0.58–0.88]) and not during the second month of loose lockdown (IR 0.93 [0.78–1.12]), $P = 0.005$.

The incidence of hospitalization according to urbanicity is illustrated in Supplementary Fig. 1.

The incidence of main cardiovascular diagnoses during the study period is described in Supplementary Fig. 2. The number of hospitalizations for Type 1 MI did not vary significantly during periods A and B whether it was for an STEMI or an NSTEMI (P interaction 0.5; Fig. 2). However, the incidence of hospitalizations for AHF dropped significantly during the period A with a decrease of −42% compared with previous years and increased during period B at +41% above the usual rate (Supplementary Fig. 3; P interaction <0.001). Similarly, the hospitalizations for acute rhythm and conduction disorders decreased during period A and nearly doubled during period B (P interaction 0.002).

Concerning the diagnosis associated with type 2 MI, the number of hospitalizations for acute neurovascular events, sepsis, or surgical emergencies with a positive troponin sample did not vary over time.

During the period A, defined as the month of March 2020 when the strict lockdown measures were implemented, a 28.3% decrease

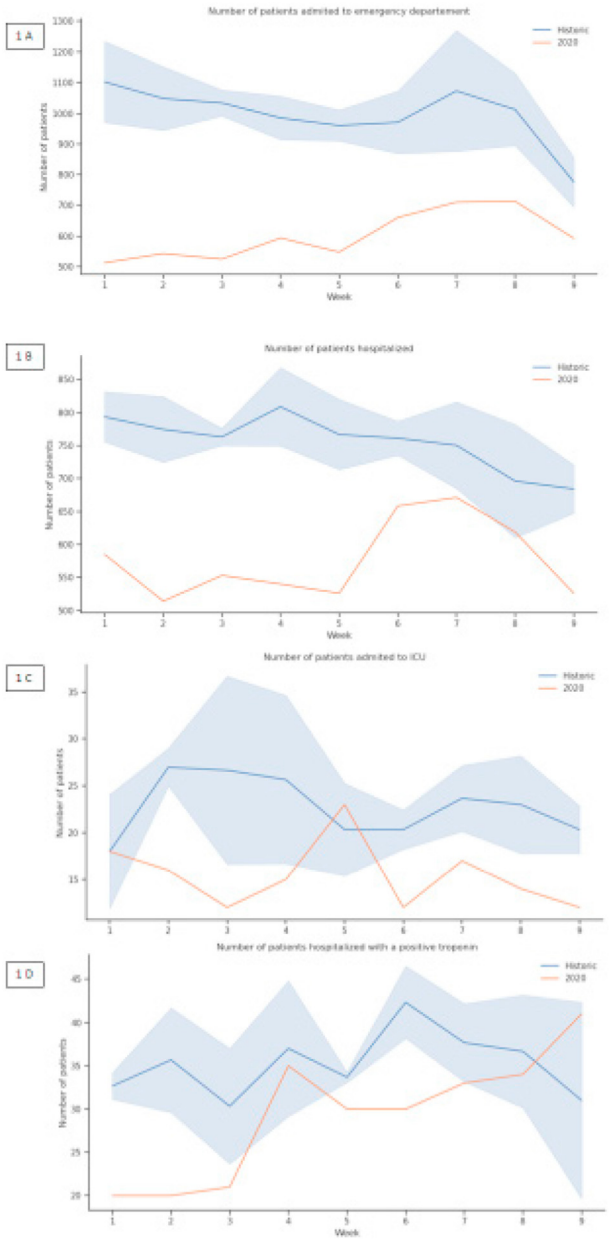

Fig. 1. Number of hospital admissions in Centre-Hospitalier-Territorial according to the study period and the historical cohort. (A) Emergency department admissions. (B) The number of hospital admissions. (C) Intensive care unit (ICU) admissions. (D) The number of patients with a positive troponin sample included in the study. Data were collected from the March 20 till May 20, 2020, and were compared with the same period of the three previous years (i.e. historical period).

in hospital admissions was observed, with 109 hospitalizations compared with a mean of 152 hospitalizations per month during the historical period of the three previous years, with an IR of 0.72 (0.58–0.88), $P = 0.002$. During the period B, defined as the second month of lockdown (April 2020) when restrictions were loosened and social distancing policies were applied, a 6.5% decrease in admissions was observed, with 155 patients hospitalized vs an average of 165 patients during the same month of previous years, with unchanged IR of 0.93 (0.78–1.12), $P = 0.452$.

During the inclusion period in 2020, the composite outcome of all-cause in-hospital death and mechanical ventilation was observed in 19.3% of patients vs 18.4% of patients of the historical cohort ($P = 0.74$).

Table 1
Patient characteristics and outcomes according to the period of inclusion.

Characteristics	Unmatched patients		*P*-value	Matched patients		*P*-value
	2020 ($N = 264$)	Historical period ($N = 951$)		2020 ($N = 261$)	Historical period ($N = 261$)	
Age (years)	66 (15)	66 (16)	0.89	66 (15)	65 (15)	0.70
<40	16 (6.1)	70 (7.4)	0.55	16 (6.1)	13 (5.0)	0.70
40–59	80 (30.3)	229 (24.1)	0.05	77 (29.5)	81 (31)	0.78
60–79	113 (42.8)	479 (50.4)	0.04	113 (43.3)	119 (45.6)	0.66
≥80	55 (20.8)	173 (18.2)	0.38	55 (21.1)	48 (18.4)	0.51
Female sex	128 (48.5)	453 (47.6)	0.86	126 (48.3)	116 (44.4)	0.43
Geographical region						
Grand Noumea	179 (67.8)	637 (67.0)	0.86	176 (67.4)	176 (67.4)	1.0
Medical history						
Oncology	29 (11.0)	103 (10.8)	0.97	29 (11.1)	34 (13)	0.59
Neurovascular	27 (10.2)	51 (5.4)	0.01	26 (10)	31 (11.9)	0.57
Cardiovascular	186 (70.5)	646 (67.9)	0.48	183 (70.1)	173 (66.3)	0.40
Hypertension	134 (50.8)	464 (48.8)	0.62	131 (50.2)	132 (50.6)	1.00
Coronary artery disease	85 (32.2)	253 (26.6)	0.09	83 (31.8)	71 (27.2)	0.29
Chronic heart failure	68 (25.8)	228 (24.0)	0.61	68 (26.1)	61 (23.4)	0.54
Chronic respiratory diseases	9 (3.4)	59 (6.2)	0.11	9 (3.4)	12 (4.6)	0.66
Chronic kidney disease	85 (32.2)	224 (23.6)	0.01	82 (31.4)	90 (34.5)	0.52
Active smoking	50 (18.9)	212 (22.3)	0.28	50 (19.2)	60 (23)	0.33
Metabolic syndrome	125 (47.3)	443 (46.6)	0.88	122 (46.7)	120 (46)	0.93
Associated diagnoses and procedures, *n* (%)						
STEMI	29 (11.0)	77 (8.1)	0.18	27 (10.3)	33 (12.6)	−0.49
NSTEMI	26 (9.8)	86 (9.0)	0.78	26 (10)	25 (9.6)	1.00
Acute heart failure	63 (23.9)	204 (21.5)	0.45	63 (24.1)	57 (21.8)	0.60
Acute neurovascular disease	33 (12.5)	80 (8.4)	0.06	32 (12.3)	29 (11.1)	0.79
Acute arrhythmia and conduction disorders	91 (34.5)	262 (27.5)	0.03	91 (34.9)	92 (35.2)	−1.00
Sepsis	44 (16.7)	128 (13.5)	0.22	44 (16.9)	44 (16.9)	1.00
Coronary angiography	70(26.5)	260(27.3)	0.85	70 (26.8)	71 (27.2)	1.00
Surgery	34 (12.9)	99 (10.4)	0.31	33(12.6)	30 (11.5)	0.79
ICU admission	68 (25.8)	256 (26.9)	0.77	68 (26.1)	71 (27.2)	0.84
Outcome						
Composite outcome	51 (19.3)	175 (18.4)	0.8	51 (19.5)	46 (17.6)	0.65
All-cause death	36 (13.6)	115 (12.1)	0.57	36 (13.8)	27 (10.3)	0.28
Mechanical ventilation	32 (12.1)	109 (11.5)	0.85	32 (12.3)	32 (12.3)	1.0

ICU, intensive care unit; NSTEMI, non-ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction.
The composite outcome is defined as the occurrence of death or mechanical ventilation. The results are expressed as mean and standard deviation or number and percentage.

The OR and 95% CI for the outcome endpoint and its two determinants (i.e. death and mechanical ventilation) were calculated for each characteristic studied (Supplementary Table 1). In the crude unadjusted analysis, there was no difference in the composite outcome of all-cause in-hospital death or mechanical ventilation during the lockdown period compared with the historical cohort (OR 1.01 [0.96–1.06]). No influence was found for the strict vs loose lockdown (*P* interaction 0.888). No significant differences in the composite outcome were observed after adjustment for propensity score (OR 1.01 [0.97–1.05]), neither after propensity score matching (OR 1.02 [0.97–1.08]) or after inverse probability weighting (OR 1.01 [0.97–1.05]), with no significant interaction of strict vs loose lockdown. No significant differences were observed when analyzing each outcome separately (see Table 2).

Additional sensitivity analysis comparing the influence of the strict lockdown month vs looser lockdown month demonstrated that neither strict nor loose lockdown was associated with an increased rate of in-hospital death or mechanical ventilation (see Supplementary Table 2).

The subgroup analysis of ICU admissions during lockdown showed that there was no significant impact on the composite outcome (see Supplementary Table 3). Interestingly, patients who were admitted to the ICU during the lockdown period had a higher SAPS2 score when compared with the previous years (median 55 [24–96] vs 44 [19–95], $P = 0.01$).

Sensitivity analyses according to the admission diagnosis (ACS, AHF, acute rhythm and conductions disorders, acute neurovascular diseases, sepsis, and surgical emergencies) and ubranicity were also conducted according to the outcome (Supplementary Table 4). No associations were detected between the diagnosis on admission and the composite outcome.

Discussion

This study describes the incidence of cardiovascular hospitalizations and their outcomes during a lockdown period in a territory where implemented restrictions successfully prevented the spread of SARS-CoV-2. The overall incidence of hospitalizations for CVD with increased myocardial injury biomarkers was lower during lockdown, especially during the first month of strict lockdown when compared with the following month of looser restrictions. However, although the admissions for ACS remained similar during lockdown when compared with a historical cohort, the admissions for AHF decreased during the period of strict lockdown and rebounded with a dramatic increase during the period of looser lockdown. Interestingly, there was no association of the composite endpoint (all-cause in-hospital mortality and intubation) in patients hospitalized during lockdown.

Our study is unique, given the specific setting of New Caledonia, where early border closure and an implementation of strict lockdown resulted in a total control of the outbreak. No COVID-19 cases were detected in the population during the first wave of the SARS-CoV-2 pandemic. Our results provide a valuable insight into the impact of lockdown *per se*, without the confounding of direct effects of SARS-CoV-2. Until March 2021, all COVID-19 cases were diagnosed during quarantine with no local transmission.[8] Analysis of the hidden toll of lockdown is critical to identify patients at risk and to prevent any malfunction of the healthcare system.

	IR [95%CI] Strict Lockdown	IR [95%CI] Loose Lockdown	p-value
Hospitalization	0.71 [0.58 - 0.88]	0.93 [0.78 - 1.12]	0.06
Heart Failure	0.42 [0.24 - 0.73]	1.41 [1.00 - 1.98]	<0.001
Acute Coronary Syndrome	1.26 [0.82 - 1.93]	0.81 [0.52 - 1.26]	0.17
STEMI	1.39 [0.72 - 2.68]	0.98 [0.55 - 1.71]	0.43
NSTEMI	1.18 [0.67 - 2.07]	0.63 [0.30 - 1.28]	0.17
Acute Neurovascular event	0.97 [0.51 - 1.86]	1.46 [0.87 - 2.46]	0.34
Arrhytmias & Conduction diseases	0.74 [0.50 - 1.10]	1.31 [0.97 - 1.77]	0.002
Sepsis	0.83 [0.49 - 1.39]	1.23 [0.78 - 1.95]	0.26
Surgery	1.18 [0.65 - 2.14]	0.92 [0.55 - 1.53]	0.56
Coronarography	0.77 [0.52 - 1.14]	0.84 [0.59 - 1.20]	0.74
ICU admission	0.68 [0.46 - 1.02]	0.90 [0.63 - 1.29]	0.31

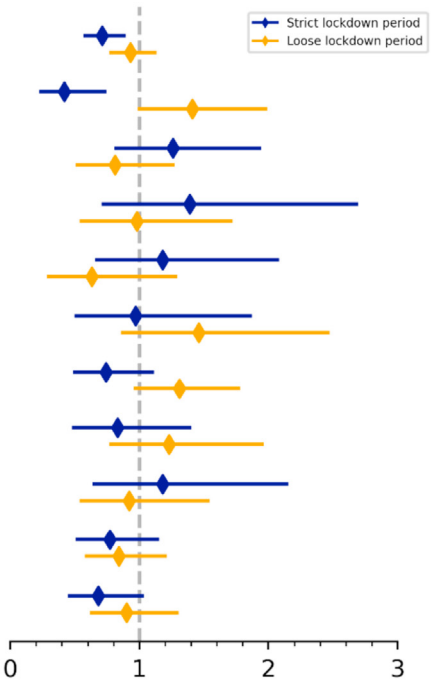

Fig. 2. Incidence of hospitalizations with a positive troponin sample and associate diagnosis during the strict lockdown month of the study period in 2020 (blue line) and during the looser lockdown (yellow line) compared with their historical counterpart of the three previous years. The results are expressed as incidence ratios (IRs) and 95% confidence interval. A *P*-value of interaction between the strict lockdown and the loose lockdown period was considered as significant when <0.05. ICU, intensive care unit; IR, incidence ratio; NSTEMI, non-ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction; 95% CI, 95% confidence interval. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 2
Association between lockdown and patient outcomes.

Outcomes	*N*	Odds ratio	95% CI	P-value
Composite endpoint of death and mechanical ventilation				
Crude analysis	1215	1.06	[0.75–1.49]	0.87
Adjusted for propensity score	1215	1.07	[0.66–1.72]	0.83
Matched on propensity score	322	1.29	[0.69–2.41]	0.58
IPW stabilized	1215	1.07	[0.66–1.72]	0.87
Death				
Crude analysis	1215	1.15	[0.76–1.70]	0.29
Adjusted for propensity score	1215	1.15	[0.71–1.85]	0.38
Matched on propensity score	322	1.70	[0.88–3.26]	0.99
IPW stabilized	1215	1.16	[0.71–1.86]	0.35
Mechanical ventilation				
Crude analysis	1215	1.07	[0.69–1.60]	0.96
Adjusted for propensity score	1215	1.11	[0.60–2.03]	0.60
Matched on propensity score	322	1.18	[0.52–2.70]	0.99
IPW stabilized	1215	1.11	[0.60–2.03]	0.63

CI, confidence interval; IPW, inverse-probability-weighted.
Data are presented as odds ratio (95% confidence interval).

In other regions of the world, the effect of lockdown on diseases unrelated to COVID-19 is difficult to interpret because of the confounding factors caused by the viral spread in the population.[11] Our findings confirm a decrease in admissions for cardiovascular disease during lockdown, which was comparable to those observed in countries with an active spread of SARS-CoV-2, including Italy, United Kingdom, and France.[9,12,13]

Most of the included patients were at risk of severe COVID-19. They presented a number of cardiovascular risk factors, such as metabolic syndrome and hypertension.[22,23] Also, patients hospitalized during lockdown had more comorbidities when compared with a historical cohort. Having in mind the reduced incidence of hospitalizations, higher rates of comorbidities demonstrate that only the most severely ill patients presented to the hospital during lockdown. This finding also emphasizes the importance of prevention policies for community medicine and continuity of essential health care for patients with chronic illnesses.[14]

Further key insights can be highlighted when looking closely at the admission diagnosis.[15] We hypothesized that specific factors might have had an influence on CVD presentation, such as a decrease in ACS admissions during lockdown, possibly due to a change in lifestyle or reluctance to seek medical help. A previous study reported significant lifestyle changes during lockdown in relation to NSTEMI incidence.[17] On the contrary, the hospitalizations for ACS during the lockdown period in New Caledonia did not change significantly when compared with other countries where the spread of SARS-CoV-2 was high.[12,16] ACS patients may have been compelled to consult hospitals because of the severity of their symptoms. Our data support the hypothesis that ACS rates were not influenced by the lower degree of physical exertion and other lifestyle changes during lockdown.[13] Furthermore, there was no increase in hospital workload related to COVID-19, so ACS patients were not underdiagnosed or undertreated, in contrast to countries with active viral spread.[18] Our study shows that there were no negative effects of early lockdown on the incidence of hospitalizations for ACS.

The incidence of hospitalizations of patients presenting with type 2 MI was not influenced by lockdown, in accordance to

previous studies.[19] No significant difference was found in outcomes associated with type 2 MI in patients hospitalized during lockdown vs the historical period.

Acute heart failure patients with a positive troponin sample are considered as high risk because of the increased risk of in-hospital mortality. Our study demonstrated a dramatic decrease in AHF hospitalizations during lockdown, with a rebound phenomenon after the restrictions were lifted. Our results are consistent with previously published findings in countries with active SARS-CoV-2 circulation.[20–22] Our study was underpowered to analyze the specific reasons why heart failure patients did not present to the hospital or if they avoided preventive care. Notably, the New Caledonia residents strongly believed in the active circulation of SARS-CoV-2. We may thus hypothesize that the psychological aspect of lockdown was a prominent factor that prevented heart failure patients from seeking medical care during the initial phase of the pandemic. The rebound phenomenon that was observed during the looser lockdown illustrates the importance of ambulatory management of chronic heart failure.

It is challenging to identify the direct effect of healthcare policies, such as early strict lockdown in the setting of a pandemic. However, in our study, we were able to control for bias from the confounding factors, as our results are free from the influence of the direct effects of SARS-CoV-2. Other strengths of this study include an extensive overview of different causes of myocardial injury during lockdown. We used a composite outcome of all-cause in-hospital death and intubation clinically relevant during the pandemic.[23,24] We acknowledged that these outcomes can be unevenly affected by both the severity of underlying conditions and quality of care. Our results confirmed a preserved quality of care in the acute setting, as although the incidence of hospital admissions decreased, short-term outcomes remained unaffected. Therefore, the study provides information on the resilience of healthcare system rather than disease-specific factors.[25] It was important to verify this hypothesis when considering the restrictions initially applied to curb the spread of SARS-CoV-2 down to zero detection. Border closure might negatively affect patient care delivery in New Caledonia, as the healthcare system relies on medical evacuations to France or Australia as well as specialized visiting medical or surgical missions. Aside from hospital overload, Pacific islands as well as other remote territories had to face specific challenges in their healthcare systems due to the SARS-CoV-2 pandemic.

Several limitations of the present study must be acknowledged. First of all, the retrospective design of the study accounted to a small amount of missing data due to the potential inaccuracy of electronic medical records. Second, due to lack of randomization, there might be residual bias of the outcome analysis. However, the propensity score matching and the inverse probability weighting (IPW) method allowed us to minimize selection bias and provided consistent in line with a recent meta-analysis focused on the incidence of STEMI during lockdown.[26] Furthermore, our study included both unscheduled and planned hospitalizations, only outpatients were excluded to minimize the selection bias. Third, the results are based only on in-hospital outcomes without extended follow-up. On the one hand, the Zero-COVID-19 strategy with complete border closure might have direct implications on the incidence of COVID-19–related myocarditis. On the other hand, general stress and lack of medical care in patients with chronic diseases could have led to an increase in morbidity and mortality in the long term. Unfortunately, our study was underpowered to assess the long-term effects of Zero-COVID strategy. Finally, our study relies on data from a single center, which could limit the generalizability of the findings. However, the studied site has the only ICU, cardiology ward, and angiography facilities for the whole territory.

We feel that it is important to emphasize that the results of this study should not lead to a conclusion that the lockdown had no negative consequences. The fall in the incidence of hospitalization leads to the hypothesis that a significant number of patients did not consult and stayed home with a myocardial injury. Further studies should focus on the sociological and psychological aspects of the reluctance to seek medical care during the pandemic. Moreover, the rebound phenomenon of AHF hospitalizations emphasizes a major public health issue. At the time of study completion, New Caledonia succeeded in a Zero-COVID-19 strategy, but the pandemic consequences such as anxiety or other psychological aspects were most likely present. Policy makers should consider these aspects to enhance outpatient care during lockdown periods.

Author statements

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Ethical approval

This study was approved by the local ethics committee (identification number 2020-001) and performed in accordance with the declaration of Helsinki.

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Competing interests

A.M. received honorarium for lectures from Novartis, Roche, Abbott, Orion, Servier, consultation fees from Corteria and Windtree, and research grant from 4TEEN4, Adrenomed, Roche, Abbott.

Author contributions

P.H.M., J.B.B., and M.D.R. conceived the study and its design, had full access to the data, and take responsibility for the integrity of the data and accuracy of the analysis. P.H.M., V.C., and S.G. organized and entered data. P.H.M., N.O., and M.M. contributed to data analyses. P.H.M., V.C., M.S., E.C., and A.M. contributed to data interpretation. P.H.M. and N.O. drafted the article. All authors critically revised the drafted article and approve of the submitted manuscript.

Disclosure

None.

Data sharing

The authors are prepared to share their data according to French and New Caledonian laws on health data on specific request to P.H.M.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2023.01.029.

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