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Isolation precautions cause minor delays in diagnostics and treatment of non-COVID patients

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SUMMARY

Background: Isolation precautions are essential prevent spread of COVID-19 infection but may have a negative impact on inpatient care. The impact of these measures on non-COVID-19 patients remains largely unexplored.
Aim: This study aimed to investigate diagnostic and treatment delays related to isolation precautions, the associated patient outcome, and the predisposing risk factors for delays.
Methods: This observational study was conducted in seven Helsinki region hospitals during the first wave of the COVID-19 pandemic in Finland. The study used data on all non-COVID-19 inpatients, who were initially isolated due to suspected COVID-19, to estimate whether isolation precautions resulted in diagnostic or treatment delays.
Results: Out of 683 non-COVID-19 patients, 33 (4.8%) had delays related to isolation precautions. Clinical condition deteriorated non-fatally in seven (1.0%) patients. The following events were associated with an increased risk of treatment or a diagnostic delay: more than three ward transfers ($P = 0.025$); referral to an incorrect speciality in the emergency department ($P = 0.004$); more than three SARS-CoV-2 RT-PCR tests performed ($P = 0.022$); and where cancer was the final diagnosis ($P = 0.018$). In contrast, lower respiratory tract symptoms ($P = 0.013$) decreased the risk.
Conclusions: The use of isolation precautions for patients who did not have COVID-19 had minor negative effects on patient outcomes. The present study underlines the importance of targeting diagnostic efforts to patients with unspecified symptoms and to those with a

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negative SARS-CoV-2 test result. Thorough investigations to achieve an accurate diagnosis improves the prognosis of patients and facilitates appropriate targeting of hospital resources.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has had a multidimensional impact on both the population's well-being as well as the function of healthcare systems worldwide [1]. During outbreaks, hospitals need to concentrate on a surge of confirmed and suspected COVID-19 patients, while simultaneously providing clinical care for patients with other diseases [2]. This causes unprecedented needs to adapt rapidly to the changing demands on healthcare, while ensuring that patients are cohorted and isolated appropriately [3].

Isolation precautions are used for hospitalised patients with a known or suspected infection or due to colonisation with certain pathogens. These precautions are necessary to prevent spread, especially for a highly transmissable respiratory infection such as COVID-19 [4]. Previous studies suggest that isolation precautions can have negative effects on patient safety and psychological well-being [5]. It has been reported that isolated patients may have half as much contact with a treating physician and fewer investigations compared to patients without isolation [6]. In addition, isolation can lead to longer hospital stays, and thus increased costs of care [7,8].

Reverse transcriptase-polymerase chain reaction (RT-PCR) is the gold-standard for detecting severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA in clinical practice [9,10]. However, the turnaround time for this diagnostic test is a minimum of several hours, which means that the majority of suspected cases need to be isolated in the emergency departments (EDs) and cohort wards or areas to protect other patients and healthcare workers from potential virus transmission [3]. The sensitivity and specificity for RT-PCR assays are excellent but a number of preanalytical factors decrease their clinical sensitivity [11—13]. False negative results are a concern, since undetected cases could further spread the disease. Thus, if COVID-19 suspicion is high, clinicians are advised to continue isolation and obtain several diagnostic samples regardless of an initially negative swab test result [9,12,13].

For patients who are subsequently identified to be COVID-19 positive, the isolation and multiple testing during hospitalisation were appropriate actions. For patients who were later confirmed COVID-19 negative, isolation and ongoing COVID-19 suspicion could be considered unnecessary. We hypothesised that the use of isolation precautions for non-COVID-19 patients may have resulted in diagnostic or treatment delays, and adverse effects on patient outcome.

The present study aims to investigate the delays in diagnostics and treatment due to the isolation precautions used for non-COVID-19 patients in the Hospital District of Helsinki and Uusimaa (HUS) during the first wave of the COVID-19 pandemic in March—April 2020 in Finland. Further details that contributed the most to these potential delays in inpatient care were studied.

Methods

Study design and population

The HUS district has a catchment population of 1.6 million and consists of 25 hospitals, out of which 7 were involved in treating adult COVID-19 patients during the first wave of the pandemic. COVID-19 patients were centralised into specific cohort wards. Suspected COVID-19 patients, who were awaiting test results were mainly isolated and treated in individual hospitals as before the pandemic.

This retrospective observational study investigated patients admitted to HUS region hospitals during the first wave of the COVID-19 pandemic between March 4 to April 15 in 2020 [14]. Initially, all hospitalised patients who had undergone a SARS-CoV-2 RT-PCR test either at the admission or during the inpatient period were included. A more detailed description of the initial patient recruitment and SARS-CoV-2 testing at that time in our hospital district has been published before [12]. Subsequently, patients with a laboratory confirmed COVID-19 infection, and patients with a high clinical suspicion for COVID-19 infection despite a negative SARS-CoV-2 RT-PCR where COVID-19 was a discharge diagnosis were excluded from the present study. The final study population included all hospitalised non-COVID patients who were initially isolated. This study was approved by the local Institutional Review Board (HUS/141/2020).

Data collection and study outcomes

Clinical data reported in this study were collected from electronic medical records. The baseline clinical data included the following: age, sex, body mass index (BMI), medical comorbidities, immunosuppression (disease or medication), and smoking status. Duration of both hospital stay and isolation; the number of ward transfers; the number of RT-PCR tests conducted during the hospital stay; the presence of acute kidney injury (serum creatinine increase over 27μmol/L or 1.5-fold from baseline); and the following symptoms prior to admission were included: fever, sore throat, rhinitis, breathlessness, cough, muscle pain or weakness, headache, delirium, dizziness, hemiparesis, diarrhoea, nausea, and abdominal pain. At discharge, the final main diagnosis of the inpatient period was recorded. The medical specialty in the ED was compared with the final diagnosis, and the patients were categorised based on whether they were correctly distributed at the ED and the isolation wards.

The main study outcome was an estimation on whether isolation precautions resulted in either diagnostic or treatment related delays in non-COVID-19 patients. These delays were observed upon the start of the isolation precautions. The patient charts were reviewed by one of the authors, and a separate second review was conducted for all patients with a potential delay in treatment or diagnostics due to COVID-19 suspicion. We only considered delays caused by COVID-19 isolation, and not diagnostic delays such as laboratory or radiological turnaround time. Furthermore, we noted whether a possible delay was solely diagnostic or treatment related, and if the delay resulted in the decline of the patient's condition. The investigations or procedures that were delayed due to isolation precautions were quantified.

Statistical analysis

Patients with diagnostic or treatment related delays due to COVID-19 suspicion were compared to patients with no delays. Continuous variables were presented as medians with interquartile range (IQR). Categorical variables were expressed as number of patients (percentage). The comparisons were determined by Mann-Whitney U-test for continuous variables, and the Chi-squared test or Fisher exact test was used for categorical variables. Univariate and multivariate logistic regression was performed to explore the association of clinical characteristics and the risk for diagnostic or treatment delay. If multiple comparisons were made, the *P*-values were adjusted by the Bonferroni correction for multiple tests. Statistical analyses were performed using SPSS version 25.0 (IBM SPSS Statistics, Chicago, IL).

Results

From March 4 to April 15, 2020, a total of 1,194 patients with suspected or confirmed COVID-19 were referred to HUS district hospitals. Out of these, 328 (27%) were positive for SARS-CoV-2 RT-PCR and 91 (8%) had high COVID-19 clinical suspicion with negative RT-PCR test. In addition, 92 (8%) were only treated at the ED or were treated at hospitals which were not part of HUS. Therefore, data from 683 (57%) non-COVID-19 inpatients were included in this study.

Baseline characteristics

A total of 33 (4.8%) patients were evaluated to have either a diagnostic or a treatment delay. Table I shows the demographic and clinical characteristics of all the study patients. The patients with a diagnostic or treatment delay had a longer duration of hospital stay ($P < 0.001$), more SARS-CoV-2 RT-PCR tests done ($P = 0.008$), and more ward transfers ($P = 0.001$) compared with patients who had no delays. In contrast, patients with no delays were more likely to have been referred to the correct specialty both in the ED ($P < 0.001$) and in the cohort wards ($P = 0.003$). Furthermore, compared to patients with no delay, patients who had delays were more likely to have cancer ($P < 0.001$) or to be surgical ($P = 0.005$) based on the main discharge diagnosis, and less likely to have an infectious disease ($P < 0.001$). In addition, a previous cancer diagnosis was more common in patients with a delay ($P = 0.012$), while lower respiratory symptoms were the only symptoms that differed significantly between the study groups ($P = 0.003$). Detailed information on the final diagnosis is shown in Supplementary Table I.

Table II shows the detailed information of patients with diagnostic or treatment related delay. Five (15%) patients had a treatment delay alone, five (15%) a diagnostic delay alone, and twenty-three (70%) patients had both. The median delay for both diagnostic test (IQR 2–4 days) and treatment (IQR 1–4 days) was three days. The most frequently delayed investigation was radiological examination (n = 20, 61%), while systemic corticosteroids (n = 6, 18%) was the most common delayed treatment.

Patients whose condition deteriorated during delay

The clinical condition was estimated to have deteriorated in seven (1.0%) patients during isolation (shown in Figure 1). Two of these patients died but the deaths were not related to the delays in diagnostics or treatment. All the clinical deteriorations were due to worsening respiratory failure leading to either invasive (n = 2) or non-invasive (n = 2) ventilation, or increased oxygen requirements (n = 3). The underlying cause for acute respiratory failure was either cardiac insufficiency (n = 3), lung cancer (n = 2), bacterial pneumonia (n = 1), or pulmonary fibrosis (n = 1).

Associations and risk factors for diagnostic or treatment delay

Table III summarizes the associations and risk factors for diagnostic and treatment related delays. The univariate analysis revealed that the duration of hospital stay over five days ($P < 0.001$), number of ward transfers ($P < 0.001$) and the number of RT-PCR tests done ($P = 0.008$), incorrect speciality in the ED ($P < 0.001$) or isolation ward ($P = 0.004$), final diagnosis ($P < 0.001$), and lower respiratory tract symptoms ($P = 0.028$) associated with the risk for delay. After adjustments, over three ward transfers ($P = 0.025$), incorrect speciality in the ED ($P = 0.004$), over three SARS-CoV-2 RT-PCR tests performed ($P = 0.022$), and malignant final diagnosis ($P = 0.018$) increased the risk of treatment or diagnostic delay, while having lower respiratory tract symptoms ($P = 0.013$) decreased the risk.

Discussion

The ongoing COVID-19 pandemic has had a widespread global impact on healthcare, including possible detrimental effects on non-COVID-19 patients [1]. While hospitals encounter a surge of COVID-19 patients, providing healthcare for non-COVID-19 patients cannot be dismissed [1,3]. Infection control precautions are necessary to control the spread of infections in healthcare, and their use is widely implemented throughout healthcare settings [4,15]. However, despite the widespread use of isolation precautions during a pandemic, the impact of their effects on patients' outcomes remains largely unexplored. In the present study, we investigated the use and impact of isolation precautions in non-COVID-19 patients, and their association with diagnostic or treatment delays and clinical consequences. The most important observation was that the use of isolation precautions had infrequent and relatively minor harmful effects on patients' outcomes.

Due to the COVID-19 pandemic, the WHO advises to use infection prevention and control measures on all patients with fever, respiratory symptoms, or recent exposure to SARS-CoV-2

Table I
Baseline characteristics of study patients

Characteristics	Total (n=683)	Delay (n=33)	No delay (n=650)
Age, years, median (IQR[a])	71 (55–80)	72 (62–80)	70 (55–80)
Sex, male, n (%)	373 (55%)	18 (55%)	355 (55%)
Duration of hospital stay, days, median (IQR)	5 (3–8)	10 (5–12)	5 (3–7)
Specialty in the emergency department			
Internal medicine	430 (63%)	19 (58%)	411 (63%)
Surgery	16 (2%)	1 (3%)	15 (2%)
General medicine	47 (7%)	5 (15%)	42 (7%)
Respiratory medicine	28 (4%)	1 (3%)	27 (4%)
Emergency medicine	153 (22%)	6 (18%)	147 (22%)
Miscellaneous	9 (1%)	1 (3%)	8 (1%)
Correct specialty in the emergency department, yes	380 (72%)	8 (30%)	374 (74%)
Correct isolation ward according to final diagnosis, yes	559 (82%)	20 (63%)	539 (83%)
SARS-CoV-2 RT-PCR[b] tests done, n (%)			
One	515 (75%)	19 (58%)	496 (76%)
Two	133 (20%)	8 (24%)	125 (19%)
More than two	33 (5%)	6 (18%)	28 (4%)
Duration of isolation, days, median (IQR)	2 (1–3)	2 (1–3)	2 (1–3)
Ward transfers during hospital stay, n (%)			
None	351 (52%)	3 (9%)	348 (54%)
One	237 (35%)	17 (52%)	220 (34%)
Two	68 (10%)	7 (21%)	61 (9%)
$\geq$ Three	24 (3%)	6 (18%)	18 (3%)
Final main diagnosis group, n (%)			
Infectious	399 (58%)	9 (28%)	390 (60%)
Malignancy	31 (5%)	6 (18%)	25 (4%)
Cardiovascular	111 (16%)	7 (21%)	104 (16%)
Respiratory (non-infectious)	38 (6%)	2 (6%)	36 (6%)
Surgical	44 (6%)	6 (18%)	38 (6%)
Psychiatry	17 (3%)	1 (3%)	16 (2%)
Miscellaneous	43 (6%)	2 (6%)	41 (6%)
Comorbidities, n (%)			
Hypertension	363 (53%)	16 (49%)	347 (53%)
Respiratory disease	161 (24%)	4 (12%)	157 (24%)
Heart disease	201 (29%)	6 (18%)	195 (30%)
Diabetes	64 (9%)	3 (9%)	61 (9%)
Liver disease	28 (4%)	0	28 (4%)
Kidney disease	109 (16%)	4 (12%)	105 (16%)
Cancer	103 (15%)	10 (30%)	93 (14%)
Immunodeficiency or immunosuppressive medication, yes, n (%)	72 (11%)	6 (18%)	66 (10%)
Smoking, n (%)			
Smoker	143 (28%)	4 (17%)	139 (29%)
Ex-smoker	159 (32%)	12 (50%)	147 (31%)
Never-smoker	199 (40%)	8 (33%)	191 (40%)
Body mass index (kg/m^2), median (IQR)	27.2 (23.0–31.9)	25.4 (23.7–29.6)	27.3 (23.0–32.0)
Symptoms, n (%)			
Fever	386 (57%)	19 (58%)	367 (57%)
Upper respiratory tract	184 (27%)	6 (18%)	178 (27%)
Lower respiratory tract	470 (69%)	15 (46%)	455 (70%)
Muscle	311 (46%)	14 (42%)	297 (46%)
Kidney injury	103 (15%)	3 (9%)	100 (15%)
Gastrointestinal tract	178 (26%)	10 (30%)	168 (26%)
Central nervous system	157 (23%)	8 (24%)	149 (23%)

[a] IQR, interquartile range.
[b] RT-PCR, Reverse transcriptase-polymerase chain reaction.

Table II
Detailed information on patients with diagnostic or treatment related delay (n = 33)

Delay from the emergency department, days, median (IQR[a])	
Diagnostic delay	3 (2–4)
Treatment delay	3 (1–4)
Condition drawback due to diagnostic or treatment delay, yes, n (%)	8 (24%)
Diagnostic investigation or procedure delayed, n (%)	
Radiology	20 (61%)
Angiography	2 (6%)
Endoscopy	2 (6%)
Laboratory	2 (6%)
Small diagnostic procedure	2 (6%)
Delayed treatments, n (%)	
Medication	
Anticoagulation	2 (6%)
Antibiotic	5 (15%)
Corticosteroid	6 (18%)
Antipsychotic	1 (3%)
Procedure	
Pleural puncture	3 (9%)
Ascites puncture	1 (3%)
Coronary angioplasty and stent	1 (3%)
Gastroscopy and stent	1 (3%)
Surgical operation	4 (12%)
ERCP[b]	1 (3%)
Non-invasive ventilation	2 (6%)
Dialysis	1 (3%)
COVID-19 suspicion, n (%)	
Clinical	23 (70%)
Radiological	10 (30%)

[a] IQR, interquartile range.
[b] ERCP, endoscopic retrograde cholangiopancreatography.

virus [9]. In addition, some procedures and investigations are recommended to be postponed until the SARS-CoV-2 infection is confidently ruled out, which leads to incremental use of isolation precautions [16]. In line with the previous studies from the pre-COVID era [5–7], we observed that a proportion of patients had adverse effects, mainly respiratory deterioration, related to delays associated with isolation precautions. Due to the wide spectrum of differential diagnosis and non-specific COVID-19 symptoms, clinicians must consider several diagnostic options when managing patients with acute respiratory symptoms. The results of this study highlight that rigorous diagnostic investigations should be pursued simultaneously, especially if an initial SARS-CoV-2 sample proves to be negative. Radiological examination, mainly thoracic CT scans, were the most commonly delayed investigations, while corticosteroids were the most frequently delayed treatment. The latter could be explained by the general recommendation at the beginning of the pandemic to avoid systemic corticosteroids for COVID-19 infection [9].

The patients with diagnostic or treatment related delays had a longer hospital stay when compared to patients with no delays. However, perhaps surprisingly, no difference in isolation duration between the study groups existed, although the number of RT-PCR tests was higher in patients with a delay. Even after adjusting for confounders, the odds of diagnostic or treatment related delay was over six times higher if over three or more tests was done. The clinical sensitivity for RT-PCR for inpatients in our institution was previously reported to be 67.5 % (95 CI 62.9–71.9%) [12], which supports repeat-testing strategy if clinical suspicion is high. In practice, the likelihood of other diagnoses increases after several negative RT-PCR tests.

Referral of patients to the correct specialty in the ED reduces mortality, length of stay, and readmission rates [17]. We observed similar adverse effects if patients were referred to an incorrect specialty in the ED. Likewise, an association

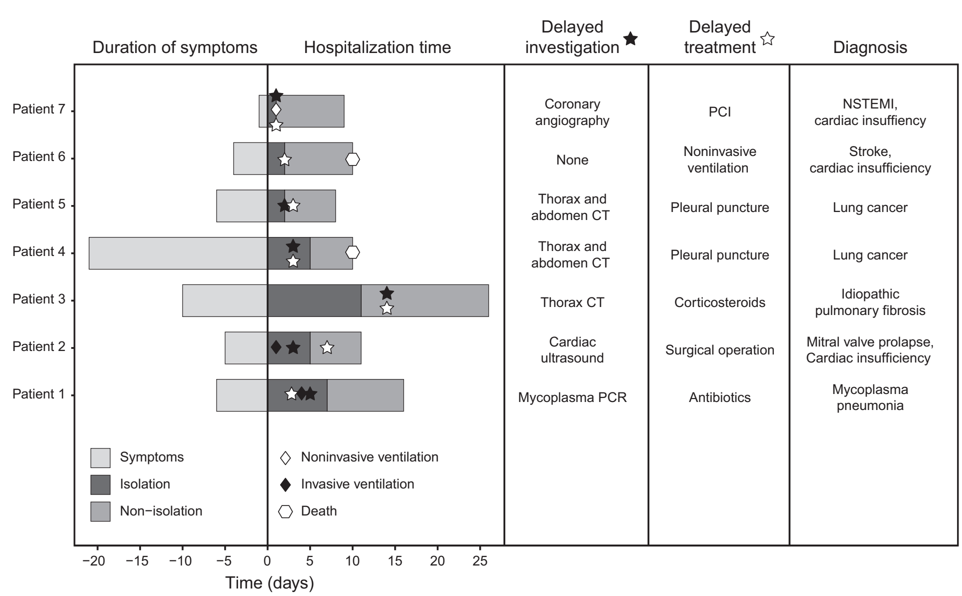

Figure 1. Timeline and information on patients whose condition declined due to COVID-19 suspicion (PCI, percutaneous coronary intervention; NSTEMI, non-ST segment elevation myocardial infarction; CT, computed tomography; PCR, polymerase chain reaction).

Table III
Analysis of risk factors associated with treatment or diagnostic delays

	Univariate model			Multivariate model	
	OR[a] (95% CI[b])	P-value		OR (95% CI)	P-value
		Unadjusted	Adjusted*		
Age, ≥ 70 years	0.97 (0.48–1.95)	0.923	NA[c]		
Sex, male	0.99 (0.49–2.01)	0.989	NA		
Hospital stay, ≥ 5 days	6.68 (2.32–19.26)	<0.001	NA	1.39 (0.39–4.97)	0.609
Duration of isolation, ≥ 2 days	0.80 (0.36–1.75)	0.573	NA		
Ward transfers during hospital stay					
None	0.09 (0.03–0.28)	<0.001	<0.001	0.05 (0.01–0.46)	0.008
One	2.06 (1.02–4.16)	0.043	0.172		
Two	2.59 (1.08–6.21)	0.033	0.132		
≥ Three	7.77 (2.85–21.13)	<0.001	<0.001	5.46 (1.24–24.04)	0.025
Specialty in the ED[d]					
Internal medicine	0.79 (0.39–1.60)	0.513	1.000		
Surgery	1.32 (0.17–10.33)	0.790	1.000		
General medicine	2.59 (0.95–7.04)	0.063	0.378		
Respiratory medicine	0.72 (0.10–5.48)	0.752	1.000		
Emergency medicine	0.76 (0.31–1.88)	0.552	1.000		
Miscellaneous	2.51 (0.30–20.66)	0.393	1.000		
Incorrect specialty in the ED, yes	6.80 (2.91–15.90)	<0.001	NA	5.30 (1.71–16.47)	0.004
Incorrect isolation ward, yes	2.99 (1.41–6.25)	0.004	NA	1.71 (0.55–5.32)	0.355
Number of SARS-CoV-2 RT-PCR[e]					
One	0.45 (0.22–0.94)	0.033	0.099		
Two	1.39 (0.61–3.17)	0.432	1.000		
≥ Three	4.13 (1.48–11.52)	0.007	0.021	6.59 (1.31–33.26)	0.022
Main final diagnosis group					
Infectious	0.24 (0.11–0.52)	<0.001	<0.001	0.55 (0.17–1.78)	0.322
Malignancy	5.60 (2.12–14.84)	0.001	0.007	6.91 (1.40–34.21)	0.018
Cardiovascular	1.41 (0.59–3.33)	0.440	1.000		
Respiratory (non-infectious)	1.10 (0.25–4.80)	0.895	1.000		
Surgical	3.61 (1.40–9.29)	0.008	0.056	1.06 (0.21–5.38)	0.948
Psychiatry	1.24 (0.16–9.67)	0.836	1.000		
Miscellaneous	0.96 (0.22–4.17)	0.960	1.000		
Symptoms					
Fever	1.04 (0.51–2.11)	0.918	1.000		
Upper respiratory tract	0.59 (0.24–1.46)	0.256	1.000		
Lower respiratory tract	0.36 (0.18–0.72)	0.004	0.028	0.27 (0.09–0.76)	0.013
Muscle	0.88 (0.43–1.78)	0.718	1.000		
Kidney injury	0.55 (0.17–1.85)	0.336	1.000		
Gastrointestinal tract	1.25 (0.58–2.67)	0.573	1.000		
Central nervous system	1.07 (0.47–2.43)	0.866	1.000		
Comorbidities					
Hypertension	0.83 (0.41–1.66)	0.590	1.000		
Heart disease	0.51 (0.21–1.27)	0.148	1.000		
Respiratory disease	0.44 (0.15–1.26)	0.125	0.875		
Diabetes	0.97 (0.29–3.27)	0.961	1.000		
Kidney disease	0.72 (0.25–2.09)	0.546	1.000		
Liver disease	NA	0.998	1.000		
Cancer	2.62 (1.21–5.68)	0.015	0.105		
Immunosupression, yes	1.98 (0.79–4.96)	0.147	NA		
Body mass index, ≥ 27 kg/m^2	0.66 (0.28–1.51)	0.321	NA		
Smoking					
Current	0.49 (0.16–1.46)	0.199	0.597		
Ex-smoker	2.26 (0.99–5.15)	0.052	0.156		
Never-smoker	0.74 (0.31–1.77)	0.498	1.000		

**P*-values adjusted with Bonferroni correction if multiple comparisons were made.
[a] OR, Odds ratio.
[b] CI, Confidence interval.
[c] NA, Not applicable.
[d] ED, Emergency department.
[e] RT-PCR, Reverse transcriptase-polymerase chain reaction.

with delays was observed if patients were cohorted to a wrong speciality ward, although this association diminished after adjustments. It was especially apparent in patients with surgical patients who were cohorted incorrectly into non-surgical areas. The number of ward transfers mirrors the same patter, and we observed that the likelihood of delay rose as the number of ward transfers increased. Similarly, previous studies have shown that both interhospital and intrahospital transfers are associated with a higher likelihood of adverse outcomes as well as increased costs, longer length of stay, and lower odds of discharge to home [18,19].

We reviewed the final diagnosis associated with delays when diagnoses were grouped according to specialty. Diagnosis was delayed especially in patients with either previous cancer or a cancer diagnosis on discharge. Specifically, lung cancer as a comorbidity predisposed to a delay in diagnosis, possible due to COVID-19-like symptoms. In addition, post hoc analyses showed that patients with cancer final diagnoses had more ward transfers during hospital admission compared to other diagnoses. However, we believe that the brief delay in hospital had only a minimal effect on patient outcomes, since the majority of cancer related diagnostic delays are prehospital [20,21]. In contrast to cancer, infectious diseases seemed to protect from delays and lower respiratory tract symptoms alone seemed to reduce the risk for diagnostic or treatment related delays. The most probable explanation for this is the empiric antibiotic usage when patients are hospitalised for unknown infectious aetiology. In addition, patients with lower respiratory tract symptoms were mostly correctly cohorted in respiratory wards, which could lead to better outcomes compared to inappropriate cohorting.

This study contains information from the start of the pandemic during the first wave [22]. At that time, while the laboratory capacity was overwhelmed [14], in Finland the hospital beds were sufficient to treat both COVID-19 and non-COVID-19 patients. This is largely due to simultaneous national restrictions, shutdown of elective surgery, and a decrease of the amount of non-COVID-19 patients. For example, the influenza season ended rapidly in Spring 2020 [23], and the number of patients with pneumococcal bacteraemia decreased substantially in 2020 [24]. Thus, the patient volumes remained near normal, even if the proportion of patients needing isolation precautions increased substantially. Furthermore, the implementation of the isolation precautions was facilitated by a relatively new hospital infrastructure, with mostly single-person rooms.

A considerable amount of education needed to be implemented in a short period of time as a result of the pandemic, but this focused on the treatment of COVID-19 patients. In addition, relocation of the staff was able to be flexible because of the large number of employees in the national public healthcare system. Thus, adequate numbers of appropriately skilled staff took care of non-COVID-19 wards, and according to our data, no major problems were encountered during isolation precautions under those circumstances.

The main limitations of this study are its retrospective and its observational nature. The effects of isolation precautions and the causal relationship between the isolation and the observed delays are difficult to interpret and quantify retrospectively. Hence the number of observed delays may be overestimated, and some delays may have gone undetected. In addition, some potential confounders might not be fully reported due to the retrospective design. The study period was limited to the first wave of the COVID-19 pandemic and the previously unknown nature of the disease may have had an impact both on diagnostic pathways and clinicians' decisions. Furthermore, during the study period, the turnaround time for RT-PCR was much longer than currently and newly available point-of-care (POC) tests, may reduce the need for unnecessary isolation precautions [25]. However, laboratory RT-PCR test is still the current standard of care and should be performed repeatedly in patients with high clinical suspicion despite the initially negative test results. Finally, due to differences in hospital districts and patient distributions, these results might not be generalisable to other countries with different healthcare systems.

Conclusions

COVID-19 related isolation precautions caused minor delays in diagnostics or treatment of hospitalised non-COVID-19 patients. The delays lead to clinical deterioration in only a small proportion of patients, and no fatal outcomes as a result of COVID-19 delays occurred. However, our findings indicate that some of these delays could be avoidable. The risk for delays were particularly associated with the number of ward transfers during hospitalisation, referral to incorrect specialties in the ED, several RT-PCR tests being performed, and cancer as the discharge diagnosis. These results highlight the importance of targeting diagnostic efforts to patients with unspecified symptoms and to those with a negative SARS-CoV-2 test results. Continuous review to elicit the correct diagnosis improves the prognosis of patients and facilitates appropriate targeting of hospital resources.

CRediT author statement

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Appendix A. Supplementary data

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