Acta Anaesth. Bel., 2023, 74 | Suppl. 1: *39-45*

Master thesis | Original study

Predicting hospital readmission and 90-day mortality in patients presenting at the emergency department during the first COVID-19 wave in Belgium

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Abstract

Background: **During the early stages of the COVID-19 pandemic, emergency departments (EDs) faced large numbers of patients suspected to be infected with a new pathogen for which no guidelines existed. The emergency physician's gestalt was appealed to more than ever to prevent health care system breakdown.**
Methods: **This retrospective observational study analyzed the data from the first COVID-19 wave in a nonacademic tertiary hospital in Belgium to identify risk factors for mortality and ED readmission rates. Second, the performance of the physicians' gestalt was assessed. The main outcome measures were the hospital readmission rate within 90 days and mortality rate at 90 days in patients who presented with suspected COVID-19 symptoms at our ED and were discharged according to the attending physician's gestalt.**
Main results: **A total of 2140 patients presented to the ED for suspected COVID-19 symptoms. A total of 1163 patients were discharged home the same day. 12/1163 (1.03%) died within 90 days after initial discharge from the ED. Age was the main risk factor for mortality after discharge. 298/1163 (25.6%) patients needed hospital readmission within 90 days after initial discharge from the ED. Lower hemoglobin and C-reactive protein (CRP) are associated with a higher risk of readmission.**
Conclusions: **When facing an unknown and overwhelming pandemic, the physician's gestalt could be an important and reliable tool to guide clinical practice in the ED. Older patients and patients with low hemoglobin and CRP should warrant close follow-up after discharge from the ED for respiratory problems, as they are at risk for mortality and readmission, respectively.**

Keywords: **Emergency Department, COVID-19, physician's gestalt.**

Introduction

The COVID-19 pandemic exposed healthcare systems to unprecedented challenges[1]. Emergency departments (EDs) faced overwhelming demands for evaluating and treating potential or confirmed COVID-19 patients[2]. During the first COVID-19 wave in Belgium from March to June 2020, ED physicians were confronted with scarce testing modalities to identify the new virus, rationed use of personal protective equipment (PPE) and reduced patient access to general practitioners. The natural course of COVID-19 disease was also unknown.

At the beginning of the COVID-19 pandemic, no validated tools were available to guide clinical decision making in the early discharge of a patient with suspected COVID-19. Therefore, the decision of whether to discharge patients home from the ED was based on clinical experience, patient characteristics and biochemical variables to substantiate this decision, even though their significance was unknown. An assertive approach was taken at the ED to avoid unnecessary

Ethical approval: Ethics committee approval was provided by the clinical trial unit of Ziekenhuis Oost-Limburg on 27/10/2022 (internal reference number Z-2022036).

overcrowding on the regular ward and certainly on the intensive care unit (ICU) to prevent the collapse of the healthcare system. However, the risk of early ED discharge may have led to a readmission to the hospital due to progressive respiratory failure or premature death.

In the meanwhile, existing scoring systems for respiratory diagnosis have been validated, and new COVID-19-specific tools have arisen[3,4].

Risk stratification tools can play an important role in identifying those patients at risk for readmission or mortality. Therefore, this study aimed to identify risk factors for readmission after initial discharge from the ED and for 90-day mortality in patients presenting with suspected COVID-19. Second, this study verified the performance of physician's gestalt during this overwhelming and unknown pandemic.

Methods

Study design

This retrospective observational study was performed in a Belgian nonacademic tertiary care hospital during the first COVID-19 outbreak from 13 March 2020 to 21 May 2020. All patients aged 15 years or older who presented to the ED of Hospital Oost-Limburg Genk, Belgium, with suspected COVID-19 symptoms or polymerase chain reaction (PCR) confirmed COVID-19 were included. COVID-19 suspected symptoms were defined as follows:

- Cough OR
- Shortness of breath OR
- Flu-like symptoms OR
- Sore throat OR
- Loss of smell and taste

During the study period, the ED was divided into a non-COVID-19 and a COVID-19 zone. All patients presenting with at least one of the suspected COVID-19 symptoms or PCR-confirmed COVID-19 were diverted to the COVID-19 zone. The COVID-19 zone was only medically staffed with emergency physicians. All personnel in the COVID-19 zone were equipped with FFP-3 masks, face shields, gowns, and gloves. The indication for PCR testing during the first COVID-19 wave was imposed by the Belgian Department for Public Health and was initially limited to patients returning from holiday from Lombardia, Italy, partially due to the lack of testing capacity.

Data collection and outcome measures

Demographic data, presenting vital signs, laboratory results, and hospital admission data were collected from the electronic medical records (E.H.). Survival status at 90 days after ED admission was obtained from the Belgian death registry. The main outcomes were hospital readmission within 90 days and mortality at 90 days in patients who presented with suspected COVID-19 symptoms and were discharged the same day. Survival status was assessed in the longer term as patients could have been admitted to the ICU, requiring prolonged hospitalization.

Additional analyses were performed to evaluate the predictive value of demographic data, vital signs and, if available, screening lab results.

All patients were included in the analysis, regardless of whether they had later-on proven COVID or not. Additionally, patients in whom no diagnostic examinations (laboratory, chest X-ray) were performed remained in the analysis.

Statistical analysis

Continuous variables were presented as the means with standard deviation when normally distributed and median with interquartile range (IQR) when showing a skewed distribution. Categorical variables were described as counts plus percentages.

In the univariate analyses, normally distributed continuous variables were compared using Student's t test, and non-Gaussian continuous data were compared using the Mann–Whitney U test. Proportions were compared using a chi square (Fisher exact) test.

Nominal logistic multivariable regression analysis models for the binary outcomes, hospital readmission and 90-day mortality were built. Included variables were selected either on clinical relevance (known factors from severity of illness in the emergency department) or from the univariate analysis (p value <0.1). The missingness of the variable also had to be less than 80%. Given the exploratory nature of this retrospective analysis a strict event-per-variable ratio was not predefined. Nevertheless, the number of variables included in the models were kept low as statistical significance of individual predictors and the predictive value of the model itself was the aim of this study. Nonnormally distributed data were log-transformed and checked for normality before being included in the logistic regression model. Statistical analyses were performed using JMP version 15.0.0 (SAS Institute, Cary, NC, USA). P values < 0.05 were considered significant.

Ethical approval

Ethics committee approval was provided by the clinical trial unit of Ziekenhuis Oost-Limburg on 27/10/2022. Given the observational retrospective design of the study using routine clinical data only, the need for informed consent was waived.

Results

Patient characteristics

During the study period, 2140 patients were admitted to the COVID zone.

The mean age was 53.6 years (SD ±25), and there was an equal gender distribution (Table I). In 985 patients (46%), a minimum blood count (hemoglobin, white blood cells, thrombocytes) was available. A CRP level was requested in 961 patients (45%).

A total of 977 patients (45.7%) were admitted to the hospital. Of all included patients, 188 (8.8%) patients died within 90 days after their ED presentation. Of the 1163 patients who were discharged home after their ED presentation, 12 patients (1.03%) died within the 90-day period.

90-day mortality

Univariate analyses

Sixty percent of the deceased were males, and the mean age was 79.7 (SD ±11.5) years, compared to 51.1 (SD ±24.5) years in the survivor group (p <0.0001). Those who died had a lower mean hemoglobin and worse renal function, 12.5 (SD ±2.4) mg/dl and 46.0 (SD ±22) ml/min/1,73 m2, respectively, compared to 13.0 (SD ±2.2) mg/dl and 57.7 (SD ±22.4) ml/min/1,73 m2 (p 0.0073 and p <0.0001), respectively. Survivors had a higher oxygen saturation, 95.2 (SD ±5.2) % compared to 90.9 (SD ±7.1%) (p <0.0001), and a higher mean arterial pressure of 101 (SD ±17.5) mmHg compared to 95 (SD ±22.9) mmHg (p 0.0004). The heart rate was lower in the 90-d mortality group, 90 (SD ±25.8) compared to 94 (SD ±23.3) beats per minute (BPM) (p 0.0168). The other variables tested did not differ (Table II).

Multivariable analysis

Based on the nominal logistic regression, age, temperature, CRP, thrombocyte count, and renal function were the most important significant factors predicting 90-d mortality.

90-day readmission

Univariate analyses

Of the 1163 patients discharged from the ED, 298 patients (25.6%) were readmitted. Of these, 59,4% were male, with a mean age of 62.8 (SD ±20.9) years. In comparison, the mean age of patients who were not readmitted was 52.1 (SD ±25.3) years (p < 0.0001). The mean hemoglobin, oxygen saturation and heart rate were 12.4 (SD ±2.5) mg/dl, 94 (SD ±7.7) % and 91 (SD ±21.9) BPM, respectively, in the readmission group compared to 13 (SD ±2.2) mg/dl, 95 (SD ±5.1) % and 94 (SD ±23.8) BPM, respectively, in the readmission-free group (p 0.001, p 0.0086 and p 0.0256). Unlike mortality, renal function and mean arterial pressure were not correlated with the risk of readmission. Furthermore, in the readmission group, CRP, alanine transaminase (ALT), aspartate transaminase (AST), ferritin and

Table I. — Baseline characteristics.

	Total (n=2140)
Sex, male (n, %)	1081, 51 (n=2140)
Age, years (mean ± SD)	53,6 ± 25 (n=2140)
Hemoglobin, g/dl (mean ± SD)	12,9 ± 2,2 (n=985)
WBC, x1000/mm³ (mean ± SD)	9,8 ± 5,9 (n=985)
Thrombocytes, x100/mm³ (mean ± SD)	250,6 ± 125,9 (n=984)
CRP, mg/L (median(IQR))	43,2 (10,7-106,9) (n=961)
ALT, U/L (median(IQR))	23 (16-34) (n=966)
AST, U/L (median(IQR))	29 (22-45) (n=965)
Total bilirubin, mg/dl (median(IQR))	0,51 (0,35-0,71) (n=919)
Conjugated bilirubin, mg/md (median(IQR))	0,28 (0,22-0,37) (n=570)
Ferritin, µg/L (median(IQR))	265,6 (127,4-728,8) (n=312)
LDH, U/L (mean ± SD)	331,1 ± 175,3 (n=921)
D-dimers, µg fib eq./ml (mean ± SD)	1,3 ± 0,9 (n=512)
eGFR, ml/min/1.73m² (mean ± SD)	55,2 ± 22,8 (n=756)
SpO2, % (mean ± SD)	94,8 ± 5,6 (n=1947)
SpO2<92%, (n,%)	316, 14 (n=1947)
MAP, mmHg (mean ± SD)	100 ± 18,2 (n=1823)
Temperature, °C (mean ± SD)	37 ± 1,1 (n=1991)

Table II. — 90-day mortality univariate and multivariable analyses.

	90-day mortality	90-day survival	P value
Sex, male n, (%)	109 (60)	972 (49,8)	0,032
Age, years (mean ± SD)	79,7 ± 11,5	51,1 ± 24,5	<0,0001
Hemoglobin, g/dl (mean ± SD)	12,5 ± 2,4	13 ± 2,2	0,0073
WBC, x1000/mm³ (mean ± SD)	11 ± 8,1	9,5 ± 5,4	0,98
Thrombocytes, x100/mm³ (mean ± SD, (median))	245 ± 128	251,7 ± 125,5	0,26
CRP (median(IQR))	60,6 (23,1-130,7)	40,1 (9,6-99,2)	<0,0001
ALT (median(IQR))	21 (15-35)	23 (16-34)	0,43
AST (median(IQR))	32 (22-57)	29 (22-44)	0,15
Total bilirubin (median(IQR))	0,51 (0,35-0,75)	0,51 (0,34-0,70)	0,56
Ferritin (median(IQR))	417 (171-962)	234 (124-615)	0,029
LDH, U/L (median(IQR))	316 (230-417)	275 (214-372)	0,9997
D-dimers, µg fib eq./ml (mean ± SD)	1,6 ± 0,9	1,3 ± 0,9	0,0035
eGFR, ml/min/1.73 m² (mean ± SD)	46 ± 22	57,7 ± 22,4	<0,0001
SpO2, % (mean ± SD)	90,9 ± 7,1	95,2 ± 5,2	<0,0001
MAP, mmHg (mean ± SD)	94,7 ± 22,9	100,6 ± 17,5	0,0004
Temperature, °C (mean ± SD)	37 ± 1,4	37 ± 1	0,6473
Heart rate, BPM (mean ± SD)	89,5 ± 25,8	93,7 ± 23,3	0,0168

lactate dehydrogenase (LDH) were significantly lower than those in the readmission-free group (Table III).

Multivariable analysis

Male sex, older age, lower hemoglobin, lower oxygen saturation and slower heart rate were associated with a higher risk of readmission. When using nominal logistic regression, only hemoglobin and CRP appeared to be independent predictors for the risk of readmission.

Mortality after ED discharge

A total of 12 patients (1.03%) died after initial discharge from the ED. Five of them had extensive therapeutic limitations and were discharged for supportive care at home or at a nursing home. Two patients were admitted to the hospital within one week and died during their hospitalization. Three patients died more than one month after their index visit to the ED. One patient presented with a traumatic injury after a fall in the nursing home but was triaged to the COVID-19 zone because of a confirmed COVID-19 positive status. One patient died at home four days after his ED visit. All patients were 71 years of age or older.

Discussion

During the early stages of the COVID-19 pandemic, EDs were confronted with an unknown pathogen and disease course. Shortages in PPE, overcrowded hospital wards and ICUs, and strict and ever-changing testing strategies made the task even more difficult. The physician's gestalt was used to guide clinical practice while knowledge on the virus was growing. This study showed that 25.6% of the patients who were initially discharged from our ED were readmitted to the hospital within 90 days. Of these, 1% of patients died after initial ED discharge.

When analyzing the 90-day mortality data, age was the main risk factor. Other risk factors, such as temperature, CRP, thrombocytes, renal function, and oxygen saturation, contributed only to a very small portion of the risk of mortality. Interestingly, the heart rate was lower in the nonsurvivors. This seems counterintuitive since tachycardia can be an early sign of distress[5]. The use of beta blockers could play a role in explaining this phenomenon. Tan et al[6] found that 38% of the patients included in their study had premorbid beta blocker exposure, highlighting that the use of beta blockers is common in the general population.

In the readmission group, age was not an independent risk factor. In contrast to mortality, low hemoglobin and CRP were the main risk factors predicting the need for readmission. We hypothesize that a low CRP as a risk factor can be explained by the fact that those patients presented in an early stage of the disease. However, for both biochemical parameters, no clear cutoff could be defined, which was useful in clinical practice. Most studies focus on risk factors predicting readmission after hospitalization instead of emergency department discharge. One study confirms the correlation between a low hemoglobin and an

Table III. — 90-day readmission univariate and multivariable analyses.

	Readmission	No readmission	P value
Sex, male n, (%)	177 (59,4)	904 (49,1)	0,0011
Age, years (mean ± SD)	62,8 ± 20,9	52,1 ± 25,3	<0,0001
Hemoglobin, g/dl (mean ± SD)	12,4 ± 2,5	13 ± 2,2	0,001
WBC, x1000/mm³ (mean ± SD)	9,8 ± 5,9	9,8 ± 5,9	0,49
Thrombocytes, x100/mm³ (mean ± SD)	254 ± 137	250 ± 124	0,62
CRP (median(IQR))	31 (9-85)	47 (13-110)	0,030
ALT (median(IQR))	20 (13-33)	23 (17-35)	0,0029
AST (median(IQR))	26 (19-38)	31 (22-46)	0,0004
Total bilirubin (median(IQR))	0,50 (0,36-0,73)	0,51 (0,34-0,71)	0,55
Ferritin (median(IQR))	208 (86-618)	287 (141-769)	0,051
LDH, U/L (median(IQR))	267 (214-368)	288 (218-397)	0,068
D-dimers, µg fib eq./ml (median(IQR))	1,16 (0,74-2,05)	0,99 (0,6-1,68)	0,030
eGFR, ml/min/1.73² (mean ± SD)	53,7 ± 21,8	55,6 ± 23	0,17
SpO2, % (mean ± SD)	93,8 ± 7,7	94,9 ± 5,1	0,0014
MAP, mmHg (mean ± SD)	99,3 ± 17,7	100,1 ± 18,2	0,24
Temperature, °C (mean ± SD)	37,1 ± 0,9	37,0 ± 1,1	0,62
Heart rate, BPM (mean ± SD)	90,9 ± 21,9	93,7 ± 23,8	0,025

increased risk of readmission after hospitalization[7]. As far as we know, we are the first to describe the correlation between low CRP and hemoglobin and the risk for hospital readmission after emergency department discharge and no existing scoring systems focusing on safe emergency department discharge (e.g. CHOSEN, ACEP,…) include those variables[8,9].

The necessity of hospital readmission could have implied an underestimation of the severity of a patient's COVID-19 disease. Readmission has also been linked with ED crowding, higher healthcare costs and lower patient safety[10] and has been proposed as a quality assurance tool[11].

Comparing our readmission rates to those during nonpandemic states was difficult, as most studies in the general ED population focus on three-day readmission rates[11], with one study reporting readmission rates up to 22,4% within one month[12]. During the COVID-19 pandemic, reported ED revisit rates varied from 14,6% to 24,3%, of which 7,6% to 11,5% needed hospitalization[13-18].

In this study, 12 (1.03%) patients died after ED discharge, which is similar to previously reported mortality rates of 0.05 to 1.8% in the general population[19,20] and up to 3% in the eldery[21]. An in-depth analysis of these 12 patients revealed that one patient died shortly after ED discharge following a reassuring clinical evaluation at that time. Other deaths could be explained by an established DNR policy or occurred later in time, making it less likely that these deaths could be linked to the complaint of the index ED visit.

Our relatively high readmission rate of 25,6% could be explained by the assertive discharge approach to prevent health care collapse. However, the readmission rate was still in line with those reported in nonpandemic situations.

Physicians' gestalt was of utmost importance in the early stages of the pandemic. With the arrival of validated scoring systems, ED physicians received tools to support clinical decision making. However, physicians' gestalt was found to be equally performant as COVID-19 mortality scoring systems[22]. PCR testing in combination with physician's gestalt outperformed PCR testing only in ruling out COVID-19[23]. Since our mortality rates after ED discharge did not differ from nonpandemic mortality rates[19-21], it can be concluded that the physician's gestalt was a valuable tool during the early stages of the pandemic. We must emphasize though that the COVID-19 zone was staffed with emergency physicians only who had multiple years of experience after graduation and their emergency physician interns working under their supervision. This is important as it has been reported that the severity of illness is estimated lower in emergency physicians with little experience[24] and triage performance and pretest probability, for example for pulmonary embolism, increases with clinical experience[25]. The COVID-19 pandemic was not the first and will not be the last pandemic emergency physicians will encounter. It will be important to keep in mind that the emergency physician's gestalt can be trusted as a reliable tool to guide clinical decision making in the ED.

This study has some limitations. The data in our study were collected in a single hospital, implying that our study population might not represent the general population. Second, because of the retrospective analysis of data, medical records might have been incomplete, resulting in missing data. Third, our study population consisted mostly of suspected COVID-19 cases. Because of the lack of testing capacity, this diagnosis could not be confirmed by PCR.

In summary, we can conclude that during the first wave of the COVID-19 pandemic, the physician's gestalt, an important and reliable tool, was to guide clinical practice in the ED. Older patients and patients with low hemoglobin and CRP should warrant close follow-up after discharge from the ED for respiratory problems, as they are at risk for mortality and readmission, respectively.

Ethics approval and consent to participate: Ethics committee approval was provided by the clinical trial unit of Ziekenhuis Oost-Limburg on 27/10/2022. Given the observational retrospective design of the study using routine clinical data only, the need for informed consent was waived.

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: Support was provided solely from institutional and/or departmental sources.

Acknowledgements: Not applicable.

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doi.org/10.56126/75.S.13