


ORIGINAL PAPER

Therapy area: Other

Smart Check – COVID-19 triage system: Evaluation of the impact on the screening time and identification of clinical manifestations of SARS-CoV-2 infection in a public health service

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Abstract

Introduction: Most patients with COVID-19 have mild or moderate manifestations; however, there is a wide spectrum of clinical presentations and even more severe repercussions that require high diagnostic suspicion. Vital sign acquisition and monitoring are crucial for detecting and responding to patients with COVID-19.

Objective: Thus, we conducted this study to demonstrate the impact of using a tool called Smart Check on the triage time of patients with suspected COVID-19 and to identify the main initial clinical manifestations in these patients.

Methodology: We assessed triage times before and after the use of Smart Check in 11 466 patients at Hospital Nossa Senhora da Conceição in Porto Alegre, Brazil, from 1 June to 31 July 2020. In this group, we identified 220 patients for the identification of COVID-19 clinical manifestations in a case-control analysis.

Results: Smart Check was able to decrease the triage time by 33 seconds on average ($P < .001$), with 75% of the exams being performed within 5 minutes, whereas with the usual protocol these steps were performed within 6 minutes. A range of clinical presentations made up the COVID-19 initial manifestations. Those with the highest frequency were dry cough (46.4%), fever (41.3%), dyspnoea (35.8%), and headache (31.8%). Loss of appetite was the manifestation that had a statistically significant association with the SARS-CoV-2 presence (univariate analysis). When analysed together, loss of appetite associated with dyspnoea and/or ageusia and/or fever was related to the diagnosis of COVID-19.

Conclusions: Smart Check, a simple clinical evaluation tool, along with the targeted use of rapid PCR testing, can optimise triage time for patients with and without COVID-19. In triage centres, a number of initial signs and symptoms should be cause for SARS-CoV-2 infection suspicion, in particular the association of respiratory, neurological, and gastrointestinal manifestations.

1 | INTRODUCTION

A new coronavirus (CoV) with a high virulence and capable of infecting humans (HCoV) is currently holding much of the world's population hostage. This virus, known as coronavirus 2, responsible for the severe acute respiratory syndrome (SARS-CoV-2) and coronavirus 2019 (COVID-19) disease, emerged in late 2019 in China and is currently affecting the population in more than 210 countries and territories worldwide. On 30 January 2020, the WHO declared it a Public Health Emergency of International Concern and on 11 April 2020, it was declared a pandemic.¹ At the time of this article's writing, the WHO estimates that COVID-19 has been diagnosed in 108 579 352 people from 210 countries worldwide, causing about 2 396 408 deaths.² In Brazil, there have been more than 9.8 million patients and about 240 000 deaths.²

SARS-CoV-2 belongs to a family of viruses that can cause various symptoms, such as pneumonia, fever, difficulty breathing and pneumonitis.³ Clinical manifestations include fever, cough, dyspnoea, myalgia, fatigue, headache, diarrhoea, hemoptysis, anosmia and ageusia.^{4,5} Most patients with COVID-19 have mild to moderate symptoms, but approximately 15% may progress to critical pneumonia and eventually develop severe acute respiratory syndrome (SARS), septic shock, multiple organ failure and death.⁴ Once the infection sets in, it requires a high degree of suspicion for a correct diagnosis and the institution of appropriate therapeutic and restrictive measures because of the enormous manifestations spectrum.

Vital sign acquisition and monitoring are crucial for detecting and responding to deteriorating patients; however, it is known that during routine vital sign acquisition and recording, many of the vital sign records in medical records are incomplete or inconsistent, which can compromise patient safety.⁶ Thus, we propose this study to demonstrate the impact of using a tool called Smart Check on the triage time of patients with suspected COVID-19 and identify its main clinical manifestations.

2 | METHODOLOGY

We performed data collection of the time of risk classification and signs and symptoms of suspected COVID-19 patients at the COVID-19 Triage Center of the Hospital Nossa Senhora da Conceição (HNSC) in Porto Alegre, in the southern region of Brazil, from 1 June 1 to 31 July 2020. HNSC is a public health service of reference to care for COVID-19. This triage centre has a reception and waiting area, a registration and triage area, two boxes for exam collection, three consulting rooms, a stabilisation room, and a specific environment for the professionals' paramentation and deparamentation. It is open daily, from 8 AM to 10 PM, with a team of one administrative assistant, three nurses, three doctors, and four nursing technicians. Nursing technicians were responsible for the classification—COVID-19 screening. In addition, it has three

What's known

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What's new

It is important to be assertive and quick in identifying patients of COVID-19; the Smart Check tool can assist in this sorting. The main signs and symptoms related to SARS-CoV-2 infection are referenced in the literature and exhibit a wide variety of clinical presentations; here we bring the comparison of these initial signs and symptoms with those presented in an acute respiratory syndrome or cold without COVID-19.

professional hygienists strategically distributed to keep the environment constantly disinfected. The COVID-19 triage centre sees patients with influenza syndrome and identifies patients with potential symptoms for COVID-19, referring those with severity signs to the HNSC emergency room. The time to check vital signs (temperature, blood pressure, blood saturation, heart and respiratory rates) was considered as a classification time (Table 1). The clinical manifestations were collected in anamnesis and categorised as listed in Table 2.

In the period from 1 July to 31 July 2020, we introduced the Smart Check tool (multiparametric monitor from the company Toth Life Care®; certificate of conformity TÜV 17.1492 dated 24 April 2018), a compact multiparametric vital signs monitor, into that triage centre's care routine. Through Smart Check there is the possibility to quickly acquire vital signs (systolic, diastolic, and non-invasive mean arterial pressure and pulse rate, functional oxygen saturation, body temperature, blood glucose level) and, in triage mode, store and display the history of the triages performed. This triage tool communicates with external devices via *Bluetooth*, it has a bar code reader that allows quick identification of patients wearing identification bracelets, and *ethernet* and *wireless* communication with the transmission in HL7 protocol for integration with Hospital Information Systems. In this study, we used accessory Risk Classification software (SMART RISK®) for Emergency management.

To determine the impact of Smart Check on COVID-19 triage time, we conducted a before-and-after type study (n = 11 466). After the screening performed, the patients were submitted to medical evaluation when some, clinically stable and in good health, were instructed and maintained specific care, with no indication to perform the RT-PCR test. Thus, not all 11 466 screened patients underwent RT-PCR examinations.

TABLE 1 Classification time of patients with suspected COVID-19 x Smart Check at the COVID-19 Triage Center of the Hospital Nossa Senhora da Conceição (HNSC) in Porto Alegre, Brazil, 2020

Classification without Smart Check	
N = 4799	Min
Average	4.30
Median	3.00
Standard deviation	2.822
Minimum	1
Maximum	26
Percentiles	
25	2.00
50	3.00
75	6.00
Classification with Smart Check	
N = 6667	Min
Average	3.74
Median	3.00
Standard deviation	2.425
Minimum	1
Maximum	21
Percentiles	
25	2.00
50	3.00
75	5.00

Note: n = 11 466; min, minutes; $P < .001$.

To identify the characteristic clinical manifestations of COVID-19, we developed a descriptive study and a case-control analysis, where the first 110 patients who presented a real-time polymerase chain reaction (RT-PCR) test of nasopharyngeal smear specimens positive for SARS-CoV-2 were included in the case group and matched 1:1 with another 110 patients in the control group who sequentially presented negative RT-PCR for SARS-CoV-2 (n = 220). Nasopharyngeal swab samples in a single tube of viral transport medium were obtained under transmission-based precautions from all patients presenting to the triage centre and comprised the descriptive case-control type study. All biological samples were sealed and transferred to the laboratory in strict accordance with standard protocol.

This study was approved by the Research Ethics Committee of the Grupo Hospitalar Conceição according to opinion no. 3 968 873 on 14 April 2020 and by the National Research Ethics Commission of Brazil through opinion no. 3 990 822 on 26 April 2020.

Considering an expected sensitivity of 95%, expected specificity of 80%, with a margin of error of 10% and a prevalence of 5.8% of COVID-19 in our population, our sample would be estimated at 210 individuals.

2.1 | Statistical analysis

We expressed continuous variables as medians and interquartile ranges or simple intervals, as appropriate. We summarised categorical variables as counts and percentages, and we calculated associations with Student's *t* test, chi-square and Mann-Whitney tests. We made no imputation for missing data. We performed all analyses using SPSS 22.0.

3 | RESULTS

For the Smart Check tool time analysis, we collected data from 4799 patients before and 6667 patients after the introduction of Smart Check in triage for COVID-19. The group's average age was 41.4 years (18-98 years) and 58.3% were women. 2258 (19.7%) had some comorbidity, among which hypertension (45.8%), diabetes mellitus (20.8%), asthma (20%) and heart disease (6.2%) were the most frequently reported, followed by obesity and dyslipidemia (4.7%), arthritis (4.3%), smoking (4.2%), alcoholism (4.2%) and hypothyroidism (3.9%). The average time from symptoms to seeking the COVID

TABLE 2 Clinical manifestations of COVID-19

Clinical manifestations	SARS-CoV-2		P-value
	Positive	Negative	
Flu symptoms	9 (8.2%)	11 (10.0%)	.639
Dizziness	5 (4.5%)	6 (5.5%)	.757
Sore throat	20 (18.2%)	39 (35.5%)	.004
Nausea	13 (11.8%)	9 (8.2%)	.369
Loss of appetite	7 (6.4%)	0 (0.0%)	.007
Fatigue	15 (13.6%)	9 (8.2%)	.194
Otagia	3 (2.7%)	6 (5.5%)	.307
Coryza	23 (20.9%)	27 (24.5%)	.520
Headache	35 (31.8%)	43 (40.9%)	.161
Dyspnoea	39 (35.8%)	30 (27.3%)	.191
Wheezing	1 (0.9%)	1 (0.9%)	1.00
Dry cough	51 (46.4%)	49 (44.5%)	.787
Productive cough	5 (4.5%)	7 (6.4%)	.553
Myalgia	29 (26.4%)	28 (25.5%)	.878
Ageusia	5 (4.5%)	1 (0.9%)	.098
Anosmia	4 (3.6%)	3 (2.7%)	.702
Chills	8 (7.3%)	10 (9.1%)	.623
Fever	45 (41.3%)	32 (27.5%)	.066
Diarrhoea	13 (11.8%)	10 (9.1%)	.509
Constipation	1 (0.9%)	0 (0.0%)	.316
Abdominal pain	3 (2.7%)	2 (1.8%)	.651
Chest pain	11 (10.0%)	10 (9.1%)	.819
Tremors	0 (0.0%)	1 (0.0%)	.316
Mental confusion	1 (0.9%)	0 (0.0%)	.316
Total	110 (100%)	110 (100%)	

Note: n = 220.

triage centre was 4.4 days, with 64% of patients seeking care within 3 days of the onset of complaints. In Table 1 we identified 4799 patients who underwent COVID-19 triage in the usual manner with a mean time to risk classification of 4.3 minutes (6 minutes at the 75th percentile). On the other hand, while using the Smart Check with 6667 patients, the rating time was 3.74 minutes on average (5 minutes at the 75th percentile). With the use of the Smart Check screening tool, there was an average reduction of 33 seconds ($P < .001$) in the time it took to classify patients with the respiratory syndrome.

We performed an analysis of 220 patients, who had diagnostic testing for COVID-19 (RT-PCR by nasopharyngeal swab) to identify the clinical manifestations that led them to seek triage for COVID-19. In Table 2, we show these signs and symptoms and their relationship to the presence of SARS-CoV-2 infection. Dry cough (51 patients [46.4%]), fever (45 patients [41.3%]), dyspnoea (39 patients [35.5%]) and headache (35 patients [31.8%]) were the most frequent signs and symptoms. Loss of appetite was the manifestation that showed a statistically significant association with the presence of SARS-CoV-2. If we analyse the loss of appetite in association with other clinical manifestations such as dyspnoea

and/or fever and/or ageusia (loss of taste) when combined with any of the last three clinical manifestations, we observe a statistical relationship with the presence of SARS infection-CoV-2 (Table 3).

4 | DISCUSSION

One strategy for fighting the COVID-19 pandemic was rapid diagnosis and care in these specific environments, with segregation of patients with the disease's most severe and characteristic symptoms. Even in such environments, patients who seek care for suspected infection may be exposed to the infection itself if they stay longer than necessary in triage centres. Nosocomial transmission of COVID-19 puts patients with other medical problems at risk of serious illness and death. In this study, we observed that 19.7% of patients with suspected COVID-19 had some comorbidity, which potentially put them at greater risk for serious illness.

Wake et al demonstrated that from the total of nosocomial SARS-CoV-2 infections, 88% of patients had shared a ward with a confirmed COVID-19 case. In that study, the implementation of a triage system combining clinical evaluation with rapid testing for SARS-CoV-2 facilitated the cohort so that fewer susceptible patients were exposed to COVID-19 in shared environments. With the possibility of future waves of COVID-19-related hospitalisations, strategies to prevent nosocomial transmission are essential.⁷ With the use of the Smart Check screening tool, there was an average reduction, statistically significant, of 33 seconds in the time it took to classify patients with the respiratory syndrome. Considering the 75th percentile of the classification time, we can observe a reduction of 1 minute in it. Point-of-care diagnostics can complement clinical evaluation to quickly identify patients with COVID-19 and reduce the risk of transmission within triage centres and hospitals.

If we take the decrease in the average time for classification with Smart Check and assess the number of cases classified in the month of use—July 2020—it is possible to state that there was a

TABLE 3 Group of clinical manifestations in the COVID-19 diagnosis

Dyspnoea and/or ageusia and/or fever and/or loss of appetite	SARS-CoV-2	
	PositiveS	Negative
Without these signs/symptoms	37 (33.6%)	58 (52.7%)
With 1 of these signs/symptoms	51 (46.4%)	41 (37.3%)
With 2 of these signs/symptoms	21 (19.1%)	11 (10.0%)
With 3 of these signs/symptoms	1 (0.9%)	0 (0.0%)
Total	110 (100%)	110 (100%)

Note: n = 220; P value: .002.

reduction of 62 hours in the classification time/month. This reduction represents 1/3 of the average workload of the nursing technician per month; translating into man-hour gain. In this way, every 3 months, we can estimate the gain of 1 salary for a nursing technician involved in the screening. Considering the Brazilian public health service reality, in one year the return on the amount invested in Smart Check equipment is achieved. Thus, we can state that the Smart Check tool can contribute to the classification of patients with suspected Covid-19, bringing celerity to this screening moment, in addition to having a gain in man-hours of screening. Since Smart Check quickly characterises patients' signs and symptoms with accurate records, we can reduce the risk of transmission and profile clinical manifestations.

Most patients with COVID-19 exhibit mild to moderate symptoms, but approximately 15% progress to critical pneumonia and 5% eventually develop acute respiratory distress syndrome, multiple organ failure, septic shock, and death.^{4,8} Once the infection sets in, the spectrum of clinical presentations ranges from asymptomatic infection to critical respiratory failure. Most commonly reported symptoms are fever, cough, myalgia, fatigue, pneumonia, dyspnoea, as well as loss of smell and taste, while less commonly reported symptoms, such as diarrhoea, hemoptysis and coryza.^{4,5}

We found a range of clinical manifestations that comprised the diagnosis of SARS-Cov-2 infection, among which dry cough, fever, dyspnoea and headache were the most frequent. However, this clinical presentation is similar to other respiratory diseases such as influenza, which makes us need some degree of suspicion for the COVID-19 diagnosis. Since the clinical manifestations were collected by direct anamnesis at the time of screening, we compete with the risk of measurement bias. Patients, subjects of the research, could not remember related signs or symptoms or overestimate those who would have them perform COVID-19 screening tests. Fever seems to be one of the initial events, after 2-3 days of infection, followed by pulmonary manifestations.⁹ Loss of appetite, fever and ageusia (loss of taste) were the manifestations that formed a statistically significant association with the presence of SARS-CoV-2 in our study. Loss of appetite, when in conjunction with dyspnoea, fever or ageusia, has also shown an association with the presence of SARS-CoV-2 infection. The presence of more than one symptom, especially when we identify the search for care after 3 days of symptoms, has been pointed out as characteristic of COVID-19, when we can observe, besides respiratory manifestations (dyspnoea, cough), some neurological manifestations such as ageusia, fatigue, anosmia, headache and myalgia, and other gastrointestinal manifestations such as loss of appetite, diarrhoea and abdominal pain.¹⁰

The fact that we have two samples with different sizes, the largest after the introduction of the technology to be evaluated, may be a limitation to the study. In this case, a larger sample size can be considered both a confounding factor because of the faster handling of classification by the experience acquired by the team, and a residual confounding factor in the opposite direction. In the latter case, measuring the result of time with fewer individuals to be screened could lead to a faster classification than what we found.

5 | CONCLUSION

We demonstrated how a simple clinical evaluation tool—the Smart Check—along with the targeted use of rapid PCR testing, can optimise triage time for patients with and without COVID-19. The Smart Check screening tool there was an average reduction, statistically significant, of 33 seconds in the time it took to classify patients with the respiratory syndrome. This reduction represents 1/3 of the average workload of the nursing technician per month in our service; translating into man-hour gain. In addition, a number of early signs and symptoms, such as loss of appetite, dyspnoea, ageusia and fever, should be cause for suspicion of SARS-CoV-2 infection, in particular the association of respiratory, neurological and gastrointestinal manifestations. Further studies are needed to corroborate these findings.

DISCLOSURES

Authors Marcos Luiggi Lemos Sartori, Jéferson Cardoso do Rosário, José Francisco Secorun Inácio, Maicon Diogo Much, Eduardo Marckmann and Sandro Pinheiro have commercial conflicts of interest, which is why their participation in this project only occurred with the donation and guidance on the use of Smart Check equipment to the institution of this research.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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REFERENCES

1. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Biomed.* 2020;91:157-160.
2. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report – 98. 2020. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/>. Accessed February 11, 2021.
3. WMHC. Wuhan municipal health and health commission's briefing on the current pneumonia epidemic situation in our city. 2020. <http://wjw.wuhan.gov.cn/front/web/showDetail/2019123108989>. Accessed February 1, 2021.
4. Xu Z, Shi L, Wang Y, et al. Pathological findings of COVID-19 associated with acute respiratory distress syndrome. *Lancet Respir Med.* 2020;8:420-422. [https://doi.org/10.1016/S2213-2600\(20\)30076-X](https://doi.org/10.1016/S2213-2600(20)30076-X)
5. He F, Deng Y, Li W. Coronavirus disease 2019 (COVID-19): what we know? *J Med Virol.* 2020;92:719-725. <https://doi.org/10.1002/jmv.25766>
6. Stevenson JE, Israelsson J, Nilsson GC, Petersson GI, Bath PA. Recording signs of deterioration in acute patients: the documentation of vital signs within electronic health records in patients who suffered in-hospital cardiac arrest. *Health Informatics J.* 2016;22(1):21-33.
7. Wake RM, Morgan M, Choi J, Winn S. Reducing nosocomial transmission of COVID-19: implementation of a COVID-19 triage system. *Clin Med.* 2020;20(5):e141-e145. <https://doi.org/10.7861/clinmed.2020-0411>

8. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395:497-506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5)
9. Awadasseid A, Wu Y, Tanaka Y, Zhang W. Initial success in the identification and management of the coronavirus disease 2019 (COVID-19) indicates human-to-human transmission in Wuhan, China. *Int J Biol Sci*. 2020;16(11):1846-1860. <https://doi.org/10.7150/ijbs.45018>
10. Hu B, Guo H, Zhou P, Shi ZL. Characteristics of SARS-CoV-2 and COVID-19. *Nat Rev Microbiol*. 2021;19(3):141-154. <https://doi.org/10.1038/s41579-020-00459-7>

How to cite this article: Anschau F, Worm PV, Kopittke L, et al. Smart Check – COVID-19 triage system: Evaluation of the impact on the screening time and identification of clinical manifestations of SARS-CoV-2 infection in a public health service. *Int J Clin Pract*. 2021;75:e14610. <https://doi.org/10.1111/ijcp.14610>