Patient-Led COVID-19 Triage Systems and Case Fatality Rates: A Comparative Study Between Singapore, Japan, Norway, the USA and the UK.

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Abstract
Introduction: The case fatality rate from COVID-19 differs markedly around the world. There are likely a number of factors one can attribute to such disparity, not least of which is differing healthcare models and approaches. Here, we examine the COVID-19 related health advice issued by six different countries, specifically examining the patient-led triage pathways in each country.

Methods: A simulation study was conducted on current, nationwide, patient-led triage systems from three countries with low case fatality rates (Singapore, Norway and Japan) and two countries with high case fatality rates (the USA and the UK). 36 case scenarios were designed to imitate common presentations of COVID-19 with varying degrees of severity. These scenarios were then fed into each country’s patient-led triage system. The advice for each scenario was recorded and then compared.

Results: Patient-led triage systems from Singapore, Japan and Norway maintained a low threshold for advising clinical contact for patients with possible COVID-19 (88 to 100% of cases were referred). Patient-led triage systems from the USA and the UK maintained high thresholds for advising contact with either call centre support or clinical contact (28 and 33% of cases were referred, respectively), and triaged the majority of cases home with no further healthcare input. There was a strong inverse correlation between percentage of cases referred and the nation’s case fatality rate (Pearson’s Correlation = -0.642, p = 0.01).

Conclusion: In this simulation study, countries with low case fatality rates - Singapore, Norway and Japan -, performed well, successfully identifying severe COVID-19 and triaging such cases to medical care. The USA triage system (CDC’s ‘Coronavirus Self-Checker’) and the UK’s triage system (NHS ‘111’ online) performed poorly, failing to identify Severe COVID-19 infection and sepsis in the case simulations, and triaging the majority of cases to self-care with no further healthcare input. Such poorly performing triage systems are likely to be contributing to the high case fatality rates in the US and the UK.
Introduction
COVID-19 is a new infection in humans. The symptom profile, disease progression and complication rates are still unknown\(^1\). Whilst the true mortality rate may be lower when accounting for milder cases, over a period of four months COVID-19 has led to more than 200,000 confirmed deaths\(^2\).

The Case Fatality Rate (CFR) between countries varies greatly\(^2\). Initially this was thought related to the method of recording deaths or the total number of tests conducted (i.e the detection of the milder cases)\(^3\). As the pandemic spreads across the globe it is becoming increasingly clear that how society responds to the infection impacts the number of deaths their locality will experience\(^4,5\).

Patient-led triaging has become popular. Early on the crisis China implemented ‘symptom-checkers’ as part of their disease surveillance and control efforts. Similar applications have been adapted by a number of countries to attempt triaging of patients with minimal expenditure of resources.

Triaging of patients during a pandemic is arguably the most central activity of any response. Evidence must feed into it as it arises, particularly when it is an infectious disease never before encountered. Changing resource availability will determine the limits and boundaries of such triage systems. Public information will centre around the key symptoms feeding into the triage system. The criteria for triaging is a critical factor in mortality\(^6\).

The ideal triage system is developed when there is a reasonably plentiful supply of beds and staff available. The triage system can then seek the ideal outcome: identifying patients who will become severely unwell before they become severely unwell. From the available evidence it appears that a number of countries have streamlined this approach, and perhaps achieved a triage system approaching the ‘ideal’.

The World Health Organisation (WHO) have provided guidelines for both primary care triaging\(^7\), and triaging in low resource settings\(^8\).

Different countries have taken different approaches to the triage process. Singapore, Norway and Japan appear to have implemented a triaging system along the lines recommended by the WHO.

Singapore
Singapore appears to have streamlined their response to the outbreak\(^9\). All patients with suspicion of COVID-19 were initially seen and assessed. All positive cases or cases where suspicion was high were admitted to an isolation ward. Best supportive care was implemented\(^10\). At this time, the case numbers were well contained and case fatality rate was less than 1%\(^11\).

As numbers have increased, Singapore Ministry of Health have initiated a symptom checker application to keep uncomplicated, low-risk cases at home or sign-posted to the nearest Public Health Preparedness Clinic (PHPC). The app effectively gives three outcomes: advise to self-isolate for 2-3 days and if no better or if they get worse then to contact their nearest PHPC; make an appointment with their PHPC; or go straight to the emergency department\(^12\).
The Singapore COVID-19 patient-led triage application has a low threshold for referral. Anyone of any age or medical history who self-reports difficulty breathing is advised to go straight to the emergency department.

Norway
Norway has maintained a low CFR. Patients with mild illness are advised to self-isolate and contact their GP if symptoms worsen or are unresolved by day 7. All patients with shortness of breath are advised to contact their GP or go to the emergency department.

Norway have recently implemented a symptom-checker app. It is accessible only to Norwegian residents.

Japan
Japan follows a similar approach to Singapore, with a default position of clinical assessment of patients and clinician led triaging. Any patient with symptoms suggestive of COVID-19 are directed through an on-line interactive pathway finder to a specialist clinic for further assessment. CFR in Japan has remained low (<3%). Out of 12,240 confirmed cases, 10,469 cases have been admitted to hospital.
Methodology

Five countries were selected for analysis. Three (Singapore, Japan and Norway) had maintained low case fatality rates despite a demonstrable surge of cases in the preceding three months. Two countries (UK and USA) were selected due to concern regarding high case fatality rates and/or incidence rates.

Public Health Guidelines from each country were reviewed. Access was obtained to any available government sponsored online patient-led triage systems (Singapore, Japan, USA (CDC) and UK (NHS ‘111')). Case Scenario’s were designed to test the public health advice and where available patient-led triage systems in relation to COVID-19. The results were tabulated for comparison between countries.

Results

The key population and testing data are presented in Table 1. Notably, the highest rate of testing was by Norway with the lowest being Japan. CFR’s were similar for both. Norway had the highest reported physicians per capita. From the available statistics the UK had the highest CFR currently. All data was extracted from WHO as of 26.04.2020.

| Total Tests (per million) | Singapore | Norway | Japan | USA | UK |
|---------------------------|-----------|--------|-------|-----|----|
| Total Tests               | 122,000   | 155,000| 147,000| 5,500,000 | 669,000 |
| Population (millions)     | 5·8       | 5·4    | 126·5 | 331 | 67·9 |
| Confirmed COVID-19 Positive | 12,693   | 7,467  | 13,182| 899,281 | 148,381 |
| Case Fatality Rate (%)    | 0·1       | 2·7    | 2·7   | 5·6 | 13·6 |
| Physicians per 10,000 head of capita | 24 | 46 | 24 | 25 | 28 |

Table 1 - Population and Testing Data for the Six Countries Studied.

In total 216 scenarios were tested, 36 per country. Norway triaged 29 out of 36 pseudo-patients to either doctor or hospital, Singapore triaged 33 out of 36 to specialist clinics or hospital, and Japan triaged all pseudo-patients to specialist medical centres. The UK triaged 10 pseudo-patients to a national call centre and 4 pseudo-patients to hospital, recommending the other 22 to stay at home without any further healthcare contact. The USA system triaged 6 patients to a ‘medical provider within 24 hours’ and 4 patients to hospital, recommending the other 26 patients to remain at home with no further healthcare contact. The results for each scenario are presented in tabulated format (Table 2 to Table 7).
| Singapore | Norway | Japan | USA | UK |
|-----------|--------|-------|-----|----|
| **Scenario 1A - Cough + Fever for 4 days** | | | |
| 12 yr old with cough and fever for 4 days | Stay Home | Stay Home | Medical Centre | Stay Home | Stay Home |
| 32 yr old with cough and fever for 4 days | Stay Home | Stay Home | Medical Centre | Stay Home | Stay Home |
| 52 yr old with cough and fever for 4 days | Stay Home | Stay Home | Medical Centre | Stay Home | Stay Home |
| 72 yr old with cough and fever for 4 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| **Scenario 1B - Cough and Fever for 7 days** | | | |
| 12 yr old with cough and fever for 7 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| 32 yr old with cough and fever for 7 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| 52 yr old with cough and fever for 7 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| 72 yr old with cough and fever for 7 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| **Scenario 1C - Cough and Fever for 10 days** | | | |
| 12 yr old with cough and fever for 10 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| 32 yr old with cough and fever for 10 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| 52 yr old with cough and fever for 10 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |
| 72 yr old with cough and fever for 10 days | PHCC or GP | GP | Medical Centre | Stay Home | Stay Home |

Table 2 - Scenario 1. Cough and Fever in various age groups with varying durations.
Table 3- Scenario 2 - Co-morbidity with Possible COVID-19. Co-morbidity was applied to mean a congenital heart condition in relation to the 12 year old, and hypertension in relation to the adults.

| Age          | Co-morbidities | Healthcare Provider | Decision 1 | Decision 2 |
|--------------|----------------|---------------------|------------|------------|
| 12 yr old    | cough and fever| PHCC or GP          | GP         | Medical Centre | Call medical provider within 24 hours | Call 111 |
| 32 yr old    | cough and fever| PHCC or GP          | GP         | Medical Centre | Stay Home                          | Stay Home |
| 52 yr old    | cough and fever| PHCC or GP          | GP         | Medical Centre | Stay Home                          | Stay Home |
| 72 yr old    | cough and fever| PHCC or GP          | GP         | Medical Centre | Stay Home                          | Stay Home |

Table 4 - Scenario 3. Cough and Fever in varying ages of patients with significant immunosuppression e.g. recent chemotherapy or a transplant patient.

| Age          | Co-morbidities | Healthcare Provider | Decision 1 | Decision 2 |
|--------------|----------------|---------------------|------------|------------|
| 12 yr old    | cough and fever| PHCC or GP          | GP or Emergency Dept. | Medical Centre | Call medical provider within 24 hours | Call 111 & Speak to a Nurse |
| 32 yr old    | cough and fever| PHCC or GP          | GP or Emergency Dept. | Medical Centre | Call medical provider within 24 hours | Call 111 & Speak to a Nurse |
| 52 yr old    | cough and fever| PHCC or GP          | GP or Emergency Dept. | Medical Centre | Call medical provider within 24 hours | Call 111 & Speak to a Nurse |
| 72 yr old    | cough and fever| PHCC or GP          | GP or Emergency Dept. | Medical Centre | Call medical provider within 24 hours | Call 111 & Speak to a Nurse |
Table 5 - Scenario 4. Shortness of Breath and Fever for five days duration in varying age groups.

| Age          | Action                  |
|--------------|-------------------------|
| Singapore    | Norway                  | Japan | USA | UK          |
| 12 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Stay Home |
| 32 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Stay Home |
| 52 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Stay Home |
| 72 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Stay Home |

Table 6 - Scenario 5. Moderate Shortness of Breath and Fever for five days in various age ranges.

| Age          | Action                  |
|--------------|-------------------------|
| Singapore    | Norway                  | Japan | USA | UK          |
| 12 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Call 111 & speak to a Nurse |
| 32 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Call 111 & speak to a Nurse |
| 52 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Stay Home | Call 111 & speak to a Nurse |
| 72 yr old with shortness of breath and fever | Emergency Department | GP or Emergency Department | Medical Centre | Emergency Department | Call 111 & speak to a Nurse |
Table 7 - Scenario 6. Severe Shortness of Breath and Fever for 8 days in varying ages.

Of the three distinct presentations (cough + fever, co-morbidity or shortness of breath), the UK and US triaged to further healthcare no patients with cough and fever regardless of duration; 25% of those with COVID-19 symptoms + co-morbidities and less than or equal to 75% of patients with shortness of breath + fever (Figure 1). Percentage of distinct presentations triaged to further care (versus no care) was strongly inversely correlated with national case fatality rates (Pearson’s Correlation = -0.642, p = 0.01).

Figure 1. Percentage referred versus distinct presentations.
Interpretation
The UK and USA national, patient-led triage systems failed to triage cases with signs of severe COVID-19 infection or cases with signs of sepsis to appropriate medical care.

In Scenario 1, a 72 year old patient with a fever and cough lasting 7 or even 10 days would, if using either NHS ‘111’ COVID app or CDC ‘Coronavirus Self-Checker’, be advised to stay at home, and would not be directed towards any medical care.

In Scenario 2, a 72 year old with a five day history of fever and cough with a history of hypertension would also have been advised to stay at home and not seek medical care. In the UK ‘111’ COVID app, even if the 72 year old with possible COVID-19 infection had diabetes, moderate asthma, ischaemic heart disease, congestive cardiac failure and a history of stroke, the patient would not have spoken to a nurse or been directed to a clinician.

In Scenario 3, a patient with possible neutropenic sepsis would have been advised by the USA triage system to contact medical care within 24 hours. The UK system would have advised the patient to call 111 and ask for a nurse.

In Scenario 4, a patient with suspected COVID-19 gives symptoms of shortness of breath. In Singapore, Japan and Norway, all patients in all age groups complaining of any difficult breathing or shortness of breath would be advised to contact a doctor or attend an Emergency Department (ED) immediately. In the UK and USA, the advice is to self-isolate and no contact with healthcare is needed.

In Scenario 5, - moderate shortness of breath with possible COVID-19, the US model advised all patients except the 72 year old to stay at home. The UK discriminated better with a question relating to feeling short of breath at rest, although this would likely have missed the mild to moderate shortness of breath in an otherwise healthy person.

In Scenario 6, patients presented with respiratory failure due to COVID-19, and all countries successfully triaged to the ED.
Discussion
There were specific areas the NHS ‘111’ COVID-19 patient-led triage system (UK), and CDC ‘Coronavirus Self-Checker’ (USA) failed in the simulation cases. From best practice the following is recommended:

The main utility in a patient-led triage system is to detect potential cases. Workload may be offset to some degree by advising to ‘stay at home’ to clear low-risk patient groups, provided clear instructions and safety-net advice are given.

Neither the UK nor the US national triage systems appear to be following any international guidelines or consensus. Indeed, neither the US nor UK would even meet the recommended triaging efforts required for low resource settings\(^8\). The WHO advises that a small proportion of potential COVID-19 cases can be triaged to ‘home’. The advice is to screen patients with
potential COVID-19 - an unknown and potentially fatal disease -, in a clinic or hospital specific for that purpose.

**Conclusion**

Following review of the public health policies and patient-led triage systems of five countries, it seems quite likely patient-led triage systems have an impact on case fatality rates in COVID-19 infection.

In the present study, when tested, the UK system discriminated too early and failed to pick up clear signs of severe COVID-19 infection or other serious, life-threatening conditions. The US system failed in a similar regard, although may have been slightly protected by the different provisions and guidelines issued on a state by state basis. For example, New York City issued their own guidelines encouraging people with symptoms to contact medical professionals earlier, after data revealed a high number of patients dying from COVID-19 at home.\textsuperscript{16}

The most critical aspect of the societal response to COVID-19 is the correct triaging of patients. Few issues are as important during the outbreak of a new pathogen than identifying those who need medical attention. In most critical incidents the highest level of expertise is deployed for triaging. It is the place where the most experienced and astute direct the fate of individuals.\textsuperscript{6,14}

The importance of getting the triage system correct becomes more urgent as many nations move towards the uncertainty of relaxing restrictions and increasing population exposure. To do so without a clear and working triage system may well be carrying unnecessary risk into an already high-risk situation.

In this simulation study, the UK and USA patient-led triage systems performed poorly. Even if such triage systems were considered within a context of severe shortages of staff and hospital beds, the systems would still have performed poorly. Particular concerns were advising no medical contact for elderly patients with COVID-19 related symptoms or patients who had developed shortness of breath or any patient with persistent fever. There was a strong inverse correlation between triage performance and national case fatality rates (Pearson’s Correlation = -0.642, \( p = 0.01 \)). The quality of a localities triage system is likely to significantly affect the total number of deaths from COVID-19 infection.

**Conflict of Interests**

Authors declare no conflicts of interest.
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