

COVID-19: Africa's Challenge and the Need for a Paradigm Shift on the Use of Ventilators

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Abstract

Background: The December 2019 Chinese epidemic of Corona Virus Disease [COVID-19], which erupted in Wuhan, South China, was declared a pandemic, by the World Health Organization [WHO], on 12th January 2020. The worldwide spread from China was rapid, but Africa was the last port-of-call. Her first diagnosed case was two months after China's, on 14th February, 2020 in Egypt. The morbidity and mortality rates have, however, remained lower in Africa than in the developed world, and analysts believe that it was more of a temporary respite, since Africa's poor health infrastructure will become her eventual albatross. **Methodology:** Data were collected on COVID-19 and records of the socio-economic capacity of Africa by accessing the relevant previous and current peer-reviewed publications from multiple search engines on internet. The data were, then, collated and comparatively analyzed. **Results:** The available data revealed that Africa had, mostly, the milder forms of COVID-19, and so, morbidity and mortality were low. Her shrinking elderly population and hot climate were believed to be contributory, but lately, as the pandemic spread, the role of these factors was not exactly predictive. Being low on healthcare infrastructure, Africa could tenaciously leverage on the supportive and preventive measures prescribed by WHO, while the world awaited a vaccine. The role of ventilators in the care of critically ill patients, also, came under scrutiny as some workers were questioning the underlying pathology, and advocating a paradigm shift from high-tech positive end expiratory pressure ventilation to plasmapheresis and packed cell transfusion. **Conclusion:** Africa faces a huge challenge with COVID-19, but the predicted heavy mortalities may be reduced by some local confounding factors, control

of spread and re-focusing of critical care away from the expensive and unavailable ventilators.

Keywords

Blood Failure, China, Confirmed Cases, Cytokine Storm, Deaths, Egypt, Interleukin-6 as Biomarker, Packed Cell Transfusion, Respiratory Failure, Plasmapheresis, SARS-CoV-2, USA

1. Introduction and Overview of COVID-19

Background

The 2019 Chinese epidemic of Corona Virus Disease [COVID-19], which erupted in a local Seafood Market in Wuhan, South China, at the end of 2019, was declared a pandemic by the World Health Organization [WHO], on 12th January 2020 [1] [2] [3]. The causative organism was identified and code-named SARS-CoV-2, by WHO [4].

Spread

The spread from China was rapid, all around the world, but Africa was the last port-of-call, recording her first confirmed case in Egypt on 14th February, followed by Nigeria 25th February, Morocco 3rd March and South Africa 5th March, 2020.

Tissue Concentration of the Virus

When the virus gains entry into the human body, it concentrates mostly in the respiratory system, and saliva. On account of this, any of four secretions are useful in screening for SARS-CoV-2: sputum, throat swab, respiratory tract secretions and saliva [5]. The focus of the treatment of COVID-19 is, logically, on the respiratory tract, where it concentrates.

Interleukin-6 as a Biomarker for Poor Prognosis

In critically ill patients, the inflammatory cytokine, interleukin-6 [Il-6], levels increase significantly, to almost 10 times the normal levels. This high rise is correlated to the detection of RNAemia. Remarkably, also, all cases of death exhibited high levels of Il-6, suggesting that it as an important biomarker for poor prognosis [6].

Classification

There are two classes of COVID-19, based on the effects on the respiratory system, where it predominantly manifests. These are: Asymptomatic and Symptomatic, both of which are contagious and can transmit the disease. The symptomatic COVID-19 is sub-classified into: 1) Mild 2) Moderate 3) Severe 4) Critical; based on the intensity of hypoxaemia and progression to multiple organ dysfunction syndrome [MODS].

Post-mortem Findings

Sharif Sultan, recently, reported that, based on the observations from post-mortem studies done on deceased COVID-19 patients, there was a consistent

finding of pulmonary thrombosis, which was not typical of Acute Respiratory Distress Syndrome [ARDS]. Also, that the hypoxaemia found in the patients did not respond to PEEP ventilation, but to high oxygen flow [7]. And so, he advised that patients be started early on maximum oxygen flow, until ventilation becomes inevitable.

Molecular Findings, Cytokine Storm and Failure of Haemoglobin

The viral structural protein, was discovered to stick to haeme, displacing oxygen releasing iron-free ion, and leading to toxicity at the pulmonary bed with inflammation of alveolar macrophages. The virus attacks the beta chain of haemoglobin, dissociates haeme and removes the iron converting it to porphyrin, and leading to “failure of blood” to carry oxygen. The underlying pathology, therefore, is not “failure of respiration”.

The oxidative iron released from the haemolysed blood cells damages the lungs, leading to an abnormal rise in levels of Il-6 which becomes the hallmark and driving force of the associated Cytokine Storm, that leads to MODS [7]. The final common pathway, therefore, is the metabolic hypoxia from blood organ failure.

The physiological implication of this is that an invasive ventilation will not be of the best benefit, rather, frequent plasmapheresis and transfusions, to replace the compromised haemoglobin and boost the oxygen-carrying capacity, will be more beneficial in ameliorating the Cytokine Storm [7].

This study evaluates the current status of COVID-19 around the world and the challenges facing the resource-poor African nations. It, then, suggests a paradigm shift from mandatory mechanical ventilation to mandatory plasmapheresis and packed cell transfusion in the management of COVID-19.

Data were collected on the available body of knowledge on COVID-19 and socio-economic capacity of African countries, from multiple search engines on internet. The results collected from all the sources were collated and presented in prose, tables and a graph and analyzed.

2. Methodology

Data were collected on COVID-19 and records of the socio-economic capacity of African countries by accessing the relevant previous and current peer-reviewed publications from multiple search engines on internet. The data were, then, collated and comparatively analyzed.

3. Results

Statistics on SARS-CoV-2 Infection around the World

Within the first 4 months of the pandemic, [30th April, 2020], some 160 [of 212] countries around the world had been infected, with a total of 3,304,309 cases confirmed COVID-19 positive. Out of those, 1,980,404 were mild [97%] and 50,950 [3%] severe/critical infections. There were 233,839 deaths, and 1,039,104 recoveries [8] [9] [10]. China, the source of the coronavirus, had 82,874 confirmed cases, 4633 deaths and 77,642 recoveries [11]. And, there were the 300

million non-infected pupils worldwide, who were taken off schools and asked to stay at home, until the pandemic came under control.

The USA topped the world list with 1,095,019 confirmed cases, 1,039,136 recoveries and 63,856 deaths; followed by Spain with 239,639 cases, 137,984 recoveries and 24,543 deaths; Italy 205,463 cases, 75,945 recoveries and 27,967 deaths; UK 171,253 cases and 26,771 deaths; France 167,178 cases, 49,476 recoveries, 24,376 deaths; and Germany 163,009 cases, 123,500 recoveries and 6623 deaths [12]. As the UK and French figures rose rapidly, the German figures rose less rapidly, just as her comparative death rates, as well. Surprisingly, China, with the largest population in the world [1.4 billion], came a distant 11th, and did not even make the Top-10; see **Table 1**.

Impact on Africa

In Africa, by the end of April, 52 out of her 54 countries were already infected, with 39,713 confirmed cases, 13,070 recoveries, and 1,638 deaths. Out of these, South Africa was the worst hit with 5647 confirmed cases, followed by Egypt with 5537 cases and Morocco 4423 cases.

But, Algeria with 4006 cases, 1779 recoveries and 450 deaths, had the worst outcome amongst the African nations. Ghana was 5th with 2074, cases; Nigeria was 6th with 1932 cases, and Cameroon 7th with 1832 cases; see **Table 2** [13].

Table 1. World's top 10 countries with COVID-19 [16] [30th April, 2020].

Country	Confirmed Cases	Recoveries	Deaths
1. USA	1,095,023	152,324	63,856
2. Spain	239,639	137,984	24,543
3. Italy	205,463	75,945	27,967
4. United Kingdom	171,253	N/A	26,771
5. France	167,178	49,476	24,376
6. Germany	163,009	123,500	6623
7. Turkey	120,204	48,886	3174
8. Iran	94,640	70,933	6028
9. Russia	106,498	11,619	1073
10. Brazil	87,187	35,935	6006
11. China	84,338	77,474	4642

Table 2. Africa's top 10 countries with COVID-19 [8] [13] [17] [18] [19] [20] [30th April, 2020].

Countries	Confirmed Cases	Recoveries	Deaths
1. South Africa	5647	2073	103
2. Egypt	5537	1381	392
3. Morocco	4423	984	170
4. Algeria	4006	1779	450
5. Ghana	2074	212	17
6. Nigeria	1932	319	58
7. Cameroon	1832	934	61
8. Cote d'Ivoire	1164	499	14
9. Guinea	1495	329	7
10. Djibouti	1089	846	2

The Nigerian Centre for Disease Control [NCDC] equally reported a total of 13,500 tests done by this time, and a plan to increase testing capacity to 3500 tests daily; while South Africa led Africa with 60,000 tests already done, and an existing capacity for 10,000 tests, daily [14] [15].

4. Discussion

Africa appeared lucky with her much lower incidence and mortality rates than the rest of the world; and the worst hit African country was South Africa with 5647 cases, though Algeria had the highest mortality rate, followed by Egypt; see **Table 2**.

The Infamous “Bleak Situation” in Our Continent

Being that massive resources are required for the diagnosis and treatment of patients, protection of the care givers and community, as well as research, with a hope to developing a cure, or, vaccine, Africa’s capacity to cope with this pandemic appears to be, unarguably, sub-optimal. Observers believed that the African situation was like a ticking time-bomb, and that, it was just a matter of time before the pandemic will overrun the continent. A few disagree on account of some observed factors.

Immunity by Default?

At the outbreak of the pandemic, there appeared to be in Africa:

- 1) a lytic hot climate, adverse to the survival of SARS-CoV-2, which showed a predilection to the cold regions;
- 2) a viral strain, Type B mostly, which was less toxigenic;
- 3) the factor of low population of elderly persons, due to her lower life expectancy, from poverty and disease.

Perhaps, these 3 variables explained the lower morbidity and mortality rates in Africa; but, may well be confounding factors, only.

Capacity for the Care of the Severely Ill Cases in Africa

In Africa [*population 1.2 billion*], the total number of COVID-19 cases was 39,713 confirmed cases, which was 3.63% the figure for USA [*population 331 million*] [20] [21] [22]. Yet, it is noteworthy that in Africa, the volume and quality of essential expertise, equipment and infrastructure, for the intensive care of critically ill persons, are grossly inadequate.

Kenya, for example, had 200 intensive care [ICU] beds for her 50 million citizens, *i.e.* a ratio of one ICU bed to 250,000 citizens; whereas, the USA had 34 ICU Beds [*could be up to 45*] per 100,000 persons [23]. The ICU bed ratio of USA translated to 85 - 100 times disparity against Kenya.

African Initiatives

Learning from the experiences of their forebears in the COVID-19 pandemic in USA, Asia and Europe, many African states adopted some indigenous measures to contain COVID-19 [24]. Madagascar produced an organic drink from the antimalarial, artemisia, which was reported to reduce the mortality from COVID-19 [25]. Senegal, with UK government and Bill and Melinda Gates Foundation, adapted the screening kit originally used for Dengue Fever to a

cheap \$1 COVID-19 quick diagnostic kit [26]. The Senegalese researchers, also, designed an affordable ventilator, costing \$60 each, as against \$16,000 for each imported unit in the country which had only 50 ventilators for her 16million population [27].

Abuja Declaration on Health Budgets of African Nations

At the April 2001 Abuja Declaration, African Heads of Government under the auspices of the WHO, agreed to allot, at least, 15% of total annual budgets to health [28]. After the first decade following that Declaration, only one African country met that target, and 11 actually reduced their budgets. Nigeria's health budget range, very embarrassingly, averaged at 4% - 6% since the Abuja Declaration [29].

WHO Recommendations on Healthcare Personnel and Equipment

The WHO recommends 1 doctor to 1000 persons; 1 nurse to 1 patient in ICU [1 nurse to 2 or 3 acutely ill but stable patients]; and 1 nurse to 500 persons; see **Table 3** and **Figure 1** [28] [29] [30]. Other WHO recommendations include: one ICU bed/10,000 persons, and a 50-bed hospital/100,000 persons. On none of these counts do the African countries meet the recommendations, whereas all the World Top-5 COVID-19 countries exceeded the WHO benchmarks.

Amongst the Top-5 African COVID-19 affected countries, only Algeria [1.8-per-1000] met the WHO recommendation of 1 doctor per 1000 persons, whereas all the World's Top-5 affected countries had more than double the recommendation. This is a further illustration of the low manpower capacity of Africa in healthcare services.

Curiously, the world's Top-5 had the highest infection and death rates globally, demonstrating the massive impact on their resources. It can best be imagined how the African countries could cope if the infection rates rise to those of the developed economies.

Table 3. Comparison of doctor-to-patient ratio [Physician Density per 1000 Persons] between Top-5 COVID-19 infected nations in the World and Top-5 of Africa [31] [32].

Country	Population [million]	Confirmed COVID-19 Cases	Doctor/1000 Pop
Africa's Top-5			
1. South Africa	60	5647	0.9 [2017]
2. Egypt	102	5537	0.814 [2014]
3. Morocco	40	4423	0.7 [2017]
4. Algeria	44	4006	1.8 [2016]
5. Ghana	31	2074	0.2 [2017]
World's Top-5			
6. USA	331	1,000,000	2.6 [2016]
7. Spain	47	220,000	4.1 [2016]
8. Italy	60	199,000	4.021 [2016]
9. Germany	84	158,000	4.191 [2015]
10. UK	68	153,000	2.825 [2017]

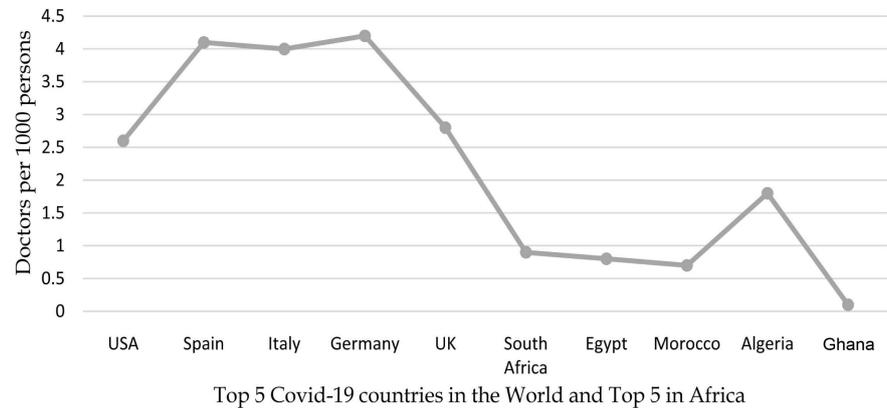


Figure 1. Graphic representation of doctors-per-1000-persons ratios in the World's top-5 and Africa's top-5 COVID-19 infected countries.

Evaluating the availability of ventilators, Nigeria had an estimated 370 units for 206 million citizens; an average of 1 to 560,000 persons, compared to USA with 150,000 ventilators for 331 million citizens, a ratio of 1 per 2200 persons [15] [33] [34] [35] [36] [37]. Meanwhile, with COVID-19, the ventilator is a major respiratory back up, in severe stages, against failing respiration and death [30] [35]. The disparity between Africa and the developed nations is very scandalous; see **Table 4**.

If the \$16,000 cost per unit, of an imported ventilator in Senegal, is used as benchmark, it becomes a herculean task for any of the African Top-10 affected countries, whose highest income per capita [Algeria \$15,293] is 25% of that of USA [\$59,928], to procure enough ventilators to match the ratio of any of the World's Top-10 affected countries; see **Table 5**.

And so, what are the options available to Africa?

By April 2020, Senegalese researchers had begun the production of very cheap ventilators at \$60 per unit [cc: \$16,000/imported unit], and, if these can be mass-produced, Africa will improve on her current ventilator/100,000 persons ratios, to a good extent [27]. But those may be reserved for just the critical cases.

Sultan had in his report clearly enunciated the pathological basis for the respiratory difficulties and Il-6 Cytokine Storm in COVID-19, and gone ahead to proffer the solution of plasmapheresis and packed cell transfusion, with maximum oxygen flow, as more effective than PEEP ventilation [7].

At the average cost of \$40 per unit of blood and \$400 for 10units in the African countries, it appears that multiple transfusions will even be 400 times cheaper [\$400 vs. \$16,000] than the hardware of a mechanical ventilator. It, therefore, behooves the African nations to adopt the Sultan prescription along with existing management protocols which may be more cost-effective, pragmatic and efficient for them, even on an experimental basis, than investing their little income-per-capita on just a few ventilators at the critical stage of COVID-19.

Table 4. Comparison of ventilator-to-persons ratio between African countries and USA [38] [39].

Country	Population [millions]	Total No. of Ventilators	Ventilator Ratio/100,000
1. Senegal	16	200	1.25/100,000
2. Nigeria	206	370	0.184/100,000
3. South Africa	59	6000	10/100,000
4. Egypt	102	6000	6/100,000
5. USA	331	150,000	45/100,000

Table 5. Distribution of income per capita of the Top-10 COVID-19 affected countries in Africa and the world [40].

Country	Income Per Capita [\$]	Country	Income Per Capita [\$]
1. South Africa	13,526	1. USA	59,928
2. Egypt	11,608	2. Spain	39,037
3. Morocco	8225	3. Italy	40,924
4. Algeria	15,293	4. United Kingdom	44,920
5. Cameroon	3722	5. France	44,033
6. Ghana	4502	6. Germany	52,556
7. Nigeria	5887	7. Turkey	28,002
8. Cote d'Ivoire	3945	8. Iran	20,885
9. Guinea	2247	9. Russia	25,763
10. Djibouti	N/A	10. Brazil	15,553

In the long term, nevertheless, the more impacting factors like poverty, malnutrition, corruption and endemic diseases, which pre-dated COVID-19, along with the poor healthcare infrastructure, have to be resolutely addressed by all African nations, as a priority.

5. Conclusions

With COVID-19, Africa is going to face harder times ahead, because of the protracted negligence of the health infrastructure of her countries over the decades; and so, despite the initial low morbidity and mortality rates, there is a possibility that these figures may rise astronomically.

Developing countries need to adopt home-grown indigenous hygienic and health promotional measures to successfully fight COVID-19.

If, however, the lockdown remains imperative, appropriate measures should be taken to avert both food and economic crises, by ensuring that food supply lines and essential businesses are sustained.

Africa should immediately explore the prospects of plasmapheresis and packed cell transfusion as a cheaper and more efficient treatment protocol for critically

ill COVID-19 patients. The absolute dependence on mechanical ventilators, which are both expensive and in short supply, should be reserved for the critical cases.

Disclosures

I have nothing to disclose; I have no commitment whether financial, intellectual or philanthropic to any of the references or institutions or companies cited and I have no form of payment or gratification to any individual or group, whatsoever.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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