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Risk Stratification in COVID-19: A Review

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Abstract

Following the first few reports of a novel coronavirus affecting a large number of Chinese residents in the city of Wuhan, it was rapidly clear that the disease did not affect everyone to the same degree. Often this is based on socio-political factors, leadership and resilience of the public health infrastructure. The predicted surge in infections due to high viral transmission rates threatened to overwhelm every healthcare system in the world. However it has become clear that the experience of different population groups or subsets with variable characteristics was not the same. This review assesses pre-existing conditions that were identified as pathophysiological or sociodemographic risk factors of COVID-19. This will allow policy makers to decide what mitigation is needed to reduce those risks and protect the public from infections.

Keywords; COVID-19, risk stratification, socio-economic factors

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Full Text

Introduction

Following the first few reports of a novel coronavirus affecting a large number of Chinese residents in the city of Wuhan, it was rapidly clear that the disease did not affect everyone to the same degree. It emerged that whilst infected children were virtually symptom-free, older male patients with specific underlying co-morbid conditions were more likely to suffer from a severe form of the disease and to die of it as a result. When the disease assumed pandemic proportions, these disparate outcomes were also reflected in clinical data obtained from other parts of the world.

In response to data related to disparate outcomes, it became important for countries to identify groups within the population that were more vulnerable to adverse outcomes of the disease. This was done so that targeted risk mitigation intervention for uninfected persons and treatment escalation for infected persons could be adopted. One group of people at high risk of infection were healthcare and other essential workers who were at continuous risk of occupational exposure to the virus despite widespread restriction in economic activity in other sectors.

Countless reviews and meta analyses have identified a number of risk factors for adverse outcomes due to COVID-19 within the population. With emergence of large-scale population-based data, it became apparent that not all disparities in outcome in some high-income countries could be explained by the well-established risk factors based on gender, age and co-morbidity alone. This review assesses pre-existing conditions that were identified as pathophysiological or sociodemographic risk factors of COVID-19. This will allow policy makers to decide what mitigation is needed to reduce those risks and protect the public from infections. We will have a particular emphasis on risk among healthcare workers and will outline areas where future work is needed to establish causality of some of the identified risk factors. Clinical and laboratory features of patients with confirmed COVID-19 that are associated with high risk of death will not be discussed in this review.

Demographic risk data from China

Early analysis of patient characteristics among 113 deceased patients in China indicated that people who died were more likely to be significantly older, of male gender and with a history of cardiovascular disease including hypertension[1]. Subsequently, two meta-analyses of Chinese studies involving over 1500 patients each identified that hypertension, chronic obstructive pulmonary disease, cardiovascular disease and cerebrovascular disease were significant risk factors for COVID-19 patients[2,3]. A much larger nationwide cohort of >44,000 confirmed cases was reported by the Chinese Centre for Disease Control (CCDC), where co-morbid risk factors for death were age, hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer[4]. Reports from other Chinese groups also identified smoking[5] and obesity[6] as independent risk factors for poor outcome.

Several studies indicated that children were largely unaffected. In the largest population based study from China, children under 10 accounted for 1% of over 72,000 confirmed cases[4] and those with co-morbid conditions such as active cancer therapy were at risk[7].

Analysis of COVID-19 in healthcare workers (HCW) in the large CCDC study showed that HCW infections accounted for 3.8% of >44,000 confirmed cases. Other reports have indicated that 90% of HCW infections in China occurred in the Hubei Province and HCW were infected during the early stages of the pandemic (January to mid-February 2020) when transmission dynamics were not sufficiently understood[8,9]. The greatest risk of dying of COVID-19 among Chinese HCW included working in community hospitals in the Hubei Province and being of male gender. Several interventions were put in place once HCW death risks were apparent. This included improving shift patterns to allow more rest, improving the availability of personal protective equipment and supporting psychological health of HCW in the community. Incidentally, road traffic accidental deaths among HCWs also reduced following implementation of these measures[9].

Demographic risk data from outside China

Some of the largest population-based data have emerged from the UK, which have mostly mirrored clinical risk of death by COVID-19 that had emerged from the early work in China. UK data have been addressed by the rapid deployment of several large multi-centre observational studies. One such study of hospital admissions with COVID-19 was the ISARIC4C study involving over 16,500 patients [10]. Pre-print data from this study have indicated that male gender, age above 50, presence of chronic cardiovascular, pulmonary or renal disease, obesity and dementia were independent risk factors for death. Surprisingly, data from another multi-centre observational study, the Intensive Care National Audit and Research into

COVID-19 study indicated that patients from minority ethnic backgrounds represented over a third of the patients admitted to UK critical care units despite census data from 2011 indicating that minorities constitute about 11% if the total UK population[11]. The proportion of minority ethnic patients admitted to critical care units with COVID-19 were far higher than those admitted in preceding years with seasonal influenza[11]. The reason for this disparity is not known and may become clearer once more prospective data is accrued over time.

Another large dataset obtained from primary care health records of over 17 million UK NHS patients was recently available as pre-print. This showed that ethnic minority status and social deprivation scores were independent risk factors for in-hospital death from COVID-19[12]. Similarly, reports from the US media indicate that disproportionately higher number of people from ethnic minorities and economically deprived communities are dying of COVID-19[13]. Social determinants of health are a much- researched subject, and countless data exist to demonstrate differential health outcomes based on poverty, lack of education and opportunity, poor access to healthcare and health prevention [14]. Inter-racial disparities among minorities have also been reported. For example, UK data indicate that Afro-Caribbean people are at the highest risk of COVID-19 deaths, followed by Asians, mixed racial backgrounds and 'other' non-white races[12]. The cause for these disparities is not known.

Healthcare Worker deaths in the UK

Several high-profile reports in England during this pandemic highlighted the disproportionately large representation of black African males among those doctors who died after contracting COVID-19. Further media reports, including one from the *Health Services Journal*[15] reported that over 90% doctors who died were from minority ethnic backgrounds, mainly African and South Asian. Minorities were also over-represented among COVID-19 deaths among nurses and other allied healthcare professions. This raised significant concerns among trade unions, professional groups, charities and others, who highlighted the need for enhanced risk analysis and mitigation.
The role of personal protective equipment (PPE) in protecting essential workers from occupational exposure has been widely discussed. Protection from droplet infections by masks, respirators, eye shield, skin protectors and gloves should ideally be graded according to risk of exposure[16]. Data from China and elsewhere have demonstrated that enhanced PPE use reduces healthcare worker death from COVID-19[8]. However, amidst a worldwide shortage of such PPE equipment, many countries, including England, have resorted to rationing and reuse of equipment[17], with more enhanced protection offered to those at highest risk of exposure, such as in intensive care[18].

It is not entirely clear why a disparate group of minority ethnic professionals is so highly represented among HCW deaths. Whilst population based socio-demographic factors that lead to health inequalities can be explained by poverty, malnutrition, poor housing, large inter-generational households increasing transmission risk, lack of knowledge of English to clearly understand risk reduction guidance from government agencies[19], none of these economic and educational deprivation factors are applicable to HCW with well paid jobs and post graduate professional qualifications. Further research is vital in understanding these risks, so that measures to mitigate these risks can be urgently put in place.

The UK government has advised that NHS trusts implement further occupational risk assessments among HCW in frontline, patient-facing roles. It has recommended that the additional high risk of death among those from minority ethnic backgrounds are taken into consideration when such risk assessments are undertaken. However, due to lack of evidence, this has been difficult to implement in practice. Several

individual hospitals have pro-actively initiated mitigation of risk among their staff from minority ethnic backgrounds, with Somerset NHS Foundation Trust being among the first to introduce this[20]. Some early guidance based on available data on COVID-19 hospital deaths are beginning to emerge with proposed risk stratification scores[21]. However, these scoring systems are yet non-validated and requires further prospective work.

It is proposed that other, more systemic factors may contribute to the differential outcome in COVID-19 death among minority ethnic HCW. Among others, these may be due to perceived racial inequalities leading to chronic changes in physiology that may lead to disease susceptibility[22], inability to address inequalities in access to PPE, lack of ability to speak up against institutional injustices, lack of ethnic minority representation in positions of higher strategic power within organisations[23]. A recent online survey of over 1500 UK HCW indicated that those from minority backgrounds were unable to access PPE or undertake social distancing at work, and the latter was found to have significant association with the risk of COVID-19 among respondents[24]. Future research should focus on validating culturally sensitive and nuanced risk tools that take into account systemic, personal and organisational factors that compound the known pathophysiological risks. Ultimately, effective pandemic preparedness at national level, adequate availability of PPE, evidence-based use of pandemic control measures will result in lives being saved, as is evidenced in many countries who were able to implement this with more success than others.

The prevalence of COVID-19 deaths among social care workers is not fully known. However, recent data from the UK clearly demonstrate high death rates among care home residents during this pandemic compared to matched data from previous years[25]. It is very likely that care workers in this sector will also be at a high risk of occupational exposure, and further research is needed in this area.

Conclusions

COVID-19 has resulted in a unique set of clinical features which do not mimic any known zoonoses in humans. Many of its pathology remains yet unexplained. For example, it is unclear why children are spared from its severe consequences, males are more affected, some co-morbid conditions are more risk-prone than others. However, this pandemic has also demonstrated disparities that transcend a simple biological premise. Further work is urgently needed to explore those disparities, particularly in the HCW context.

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