

УДК 001.891.573

Брутман А.Б.

канд. екон. наук, доц. НУ «Запорізька політехніка»

### **ON THE INFORMATIVENESS OF STATISTICAL MORTALITY INDICATORS DURING THE EPIDEMICS**

The novel coronavirus has killed tens of thousands of people around the world since it first emerged in China last December. It has compelled many governments to lock down their populations to a degree unimaginable until recently. It will probably cause the most brutal recession in living memory. In order to improve the forecast of COVID-19 coronavirus pandemic development, the following aspects have been studied, based on the methods of statistical analysis, mathematical modeling and forecasting.

In statistical practice there are generally accepted indicators (coefficients) of mortality, calculated by formulas as follows:

$$I(\text{WHO}) = D / \text{TC} \quad (1)$$

$$I(\text{CC}) = D / (D + R) \quad (2)$$

where: I - index (mortality rate); WHO - World Health Organization; D – Death; TC - Total Cases (total number of infected); CC - Closed Cases (closed cases: recovered + dead); R - Recovered (recovered)/

During the epidemics the above stated indicators are calculated on a daily basis. The correct use of these indicators requires an understanding of what kind of information they provide. Logical analysis of the epidemic spread structure allows to distinguish two main qualitatively different components (subsystems) in it: (1) spread of infection and (2) provision of medical care to the infected (patients). The input of the first subprocess is population of the region. The output forms a flow of infected people, which enters the second subsystem and is an input from systemic positions. The recovered and dead are an output of the second subsystem.

The number of infected people depends on various mechanisms of the virus transmission from person to person, as well as on measures taken by the state and the population to curb the spread of the virus. At this stage, it is necessary to distinguish between latent (hidden) and detected infected. The relationship between them depends, inter alia, on measures to diagnose the population. Official statistics deal with the number of infected.

Considering these ideas, the semantic content of I(WHO) indicator becomes clear. The value of this indicator depends on the number of infected people (output of the first subsystem) and the number of deaths (one of the two outputs of the second subsystem). It follows that, in order to “lower” the mortality rate, it is “enough” to speed up the process of detecting the number of infected. This is an obvious nonsense. The reason is systemic. The mentioned indicator links the result of the activity of one subsystem to only one of two results of the second subsystem, which operates according to its own laws. This leads to significant underestimation of the mortality rate at the initial stages of the epidemics development, when an increase in the number of detected infections prevails. That is why WHO has to adjust the mortality rate of coronavirus COVID-19 daily.

### Outcome of Cases (Recovery or Death) in China

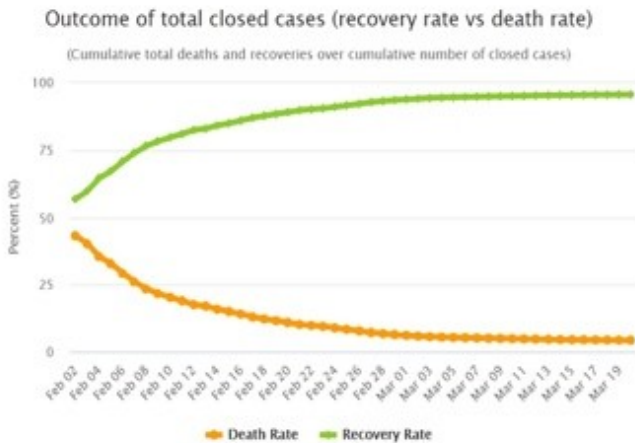


Figure 1 – Outcome of Cases (Recovery or Death) in China

Indicator I(CC) is internally consistent and characterizes the health care efficiency (the effectiveness of the second subsystem), showing the proportion of failures in providing treatment for patients (deaths) in total number of closed cases.

Again, however, this indicator is not without certain disadvantages as an indicator of mortality at initial stages of the epidemic. The main one is that rate of the deaths number at the first stages exceeds the rate of the recovered number. That is to say, the characteristic time of transition from the state of the cases identified to the state of recovered and deceased is different. Therefore, when comparing on a daily basis the recovered and the dead, essentially different entities are compared. As a result, the mortality rate  $I(CC)$  at the initial stages of the epidemic is often higher than at the final stages.



Figure 2 - Outcome of Cases (Recovery or Death) in Spain

This is clearly evidenced by the trend in the indicator values as exemplified by the COVID-19 epidemic (see examples below). The second example, due to an abrupt and unpredictable change in values, directly indicates the inability of meaningful application of  $I(CC)$  indicator at the initial stages of the epidemic.

The results of research are as follows:

- information level of WHO mortality indicator to characterize the epidemics status and development at the early stages is unsatisfactory;
- epidemic progress indicator is developed based on WHO’s mortality indicator, its scientific feasibility and high informative value is proved.

**REFERENCES**

1. <https://www.worldometers.info/coronavirus/#countries>
2. <https://www.facebook.com/MATHMODELCOVID19>
3. <https://t.me/mathmodelcovid19>