The Five Problems of the "Corona Numbers"
Analysis and Remedy

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Large numbers of corona "positives" are presently seen alongside relatively few persons who fell seriously ill. Some of the ill die from the virus sars-cov-2, mostly those having a pre-existing heart or lung disease.

So, is covid19 markedly less frequent than initially suggested? ... or is there something wrong with the "numbers"? … or both?

Problem No. 1: The "covid-dead" are ill-defined.

The "covid-dead" reported on a daily basis comprise in fact two classes,

A. those who died from the virus, i.e. from bilateral cov-2-induced pneumonia and
B. those for whom the virus was not the cause of death.

Class A are the real covid-dead their number being important to estimate the mortality or sars-cov-2. Grouping class A and B clearly feigns a higher mortality than actually justified by class A. So the number of the real covid-dead is certainly smaller than the numbers usually reported, but nobody knows how much smaller.

Problem No. 2: The absolute number of "positives" depends on the number of tests carried out.

Taking more tests is likely to lead to more "positives". This well-known link did often not make its way into major TV news outlets. While a few media sources[1] report the positive rates, i.e., the numer of positives over the number of tests, some larger ones such as the major German TV News has not been reporting the positive rates along with the absolute numbers.

Problem No. 3: "Positives" and "Positive" rates depend on the specific test ensembles

In one setting, in which PCR-tests were carried out as a screening on ensembles representative for the entire population, the results would be useful for understanding the dynamics of the pandemic and for estimating morbidity and mortality[2].

In another setting, tests would be carried out only on suspected cases and under specific circumstances, e.g. prior to hospitalization. This would yield useful information of practical importance. Here the positive rates could easily be much higher than in the population as a whole.

Unfortunately, however, specific testing and general screening are usually mixed up, and the resulting totals have virtually no informative value or explanatory power.

Problem No. 4: The PCR test does not detect all "positives" (type II error).

Under common test conditions, the corona PCR tests have sensitivities in the range of 70 %[3].
Example: Let 1000 persons in a larger test ensemble be positive, then the typical PCR test yields approx. 700 positives. The remaining 300 go undetected and may infect others.

Problem No. 5: Some tested persons result as positive although they do not have the virus (type I error). This effect can vary from test to test and from country to country.

This is because the frequency with which the test detects precisely the target virus is always less than 100 %.
In other words, in some cases the test erroneously yields a positive result although the analyzed sample did not contain the virus (so-called false-positive results).
Given the different PCR tests on the market, the frequency of giving false positives varies from test to test. This

easily explains why there could be less false positives, say, in New Zealand than in other countries.

False positives can also result from the test procedure itself: a high number of amplification cycles of the PCR test notoriously leads to false results.

Suggested solutions:

Solution to problem no. 1: **Stop the improper counting of "corona-associated" dead.**
Distinguish whether the corona virus-induced disease or some other disease caused the death, albeit in the presence of sars-cov-2.

Patients who had the virus – which naturally happens in the course of a pandemic - but died from the effects of a car accident, from stroke or any other severe disease, must not be taken into account as covid-dead.

This was not always handled correctly. Reporting the "corona-associated" dead (ie, classes A and B) instead of the real covid-dead (class A) is confusing and misleading. Misleading because, this way, the "corona-associated" dead are known, while the important correct death toll caused by sars-cov-2 is unknown.
The improper counting of "corona-associated" dead must therefore immediately stop.

Solution to problem no. 2: **Indicate the positive rates along with the positive numbers.**

Solution to problem no. 3: **Keep the numbers of specific testing and general screening apart.**
Otherwise, the lumped numbers of testings and screenings are virutally uninterpretable. They neither provide meaningful information to the general public, nor are they suited to serve as a basis for far-reaching administrational measures.

Solution to problem no. 4: **Test repetitions.**
This problem concerns the test itself. What is the point in testing a million persons per week and putting the "positives" under quarantine, while being aware that almost half the number of those positively tested remains undetected and could infect others.

Tracing apps and address tracking after restaurant visits are relatively ineffective under such conditions; it resembles holding water in a reservoir but letting 30 % of it escape.

This drawback can be largely removed by repeating the PCR test once or twice on the same day and independently. This way one could detect 90 % or even 97 %, instead of 70 %, of virus carriers.
Carrying out all tests repeatedly is unfeasible due to the large outlay required.
But repeated tests in specific cases and cases of suspected disease would easily be feasible.

Solution to problem 5: **Test repetitions with safe cycle number.**
This problem, too, concerns the test itself, since every PCR test has a false-positive probability (p_{fp}).
However low the value of this probability is, at a certain stage of a fading pandemic, the occurrence or prevalence of the virus in the population is in the same range, say p_{fp}= 0.1 %, as the false-positive probability, or lower. At this point, the result "positive" has virtually no significance, and testing does not make sense beyond this point.

An example may clarify this point: Assume the frequency of false-positives is 0.1 % (some say it's higher, some say it's lower; but that does not matter for this argument). Now, if during the decay of a pandemic 1 out of 1000 has the virus, a PCR test applied to 100000 persons would yield 200 positive results, namely 100 real positives and 100 false-positives[1]. In every specific person it is, however, not known whether the result "positive" means really positive or false-positive; the information given to the person is random; and with equal probability true or false, the consequence being that half of the persons would be unnecessarily put under quarantine. Worse: with the pandemic fading away, persons will increasingly often get a wrong result.

Could this effect be avoided? Yes, at least to a certain extent and under two conditions. First, tests need to be carried out with PCR cycle numbers that lead to reliable results[4]. Second, persons with a positive test result should be tested again and maybe – should the second test outcome be negative - even a third time. If two of the tests are positive, the person is really positive, since the probability for two subsequent false-positive tests is extremely low (e.g., if p_{fp} is 0.1 %, the probability for two subsequent false-positive results is as low as one out of a million cases, and thus negligible).

Conversely, if a positive test cannot be reproduced by repetitions, the test outcome was false-positive.

Recognizing false-positives by repeated testing would have a number of important consequences: for instance, if a teacher is tested positive, but the result turns out to be false-positive, there would be no reason to put all students and teachers as well as the relatives etc. under quarantine. Same for crèches, kindergartens, institutions, etc. The point that false-positives are not important because they are rare, is thus nonsense.
As a side effect, this way one could get a good guess of the false-positive probability.
Taken together, it is hard to understand why tests are not carried out repeatedly.

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Taken together, the following five points can or must thus be improved:

1. PCR-Tests should be carried out only on well-defined ensembles with suspected diagnosis (dunned by the minister of health; to no avail)

2. Do not report non-representative results as if they were representative.

3. covid-dead and others where sars-cov-2 was not the cause of death must be distinguished (should be good practice in any case).

4. Always report positive-rates along with positives.

5. Repeat tests on positively tested persons, to confirm positiveness or detect false-positives thereby avoiding unnecessary quarantine.

[1] RSI, Switzerland; IlSole24Ore: https://lab24.ilsole24ore.com/coronavirus/# , Italy.

[2] Screening: https://en.wikipedia.org/wiki/Screening : a strategy used in a population to identify an unrecognised disease in individuals without signs or symptoms

[3] *BMJ 2020;369:m1808*

[4] Die Süddeutsche Zeitung berichtete am 7.10.2020 von Philipp Traxel, der im Abstand von vielen Monaten positiv getestet worden und beim ersten Mal krank war. Der zweite positive Test beruhte auf 40 PCR-Zyklen; das zweite positive Ergebnis war also mit ziemlicher Sicherheit false positiv.

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