April 30, 2020

**Abstract—Recommendations of the Interuniversity Committee for the Formulation of a Coronavirus Crisis Exit Plan**(Presented to the Mossad on April 6, 2020)

**Composition of the Committee**

Prof. Ariel Porat, Law, and President of Tel Aviv University—Chair of the Committee

Prof. Dan Blumberg, Remote Sensing and Vice President for Regional and Industrial Development, Ben-Gurion University

Prof. Yoav Binyamini, Statistics, Tel Aviv University

Dr. Baruch Barzel, Complex Networks Mathematics, Bar-Ilan University

Prof. Eyal Gottlieb, Medicine, The Technion

Prof. Manfred Green, Epidemiology, Haifa University

Prof. Alon Chen, Brain Science and President, Weizmann Institute of Science

Prof. Jacob (Kobi) Moran-Gilad, Epidemiology, Ben-Gurion University

Prof. Orli Manor, Public Health and Biostatistics, The Hebrew University of Jerusalem

Prof. Yaron Oz, Quantum Physics and Rector, Tel Aviv University

Prof. Roee Ozeri, Quantum Physics, Weizmann Institute of Science

Prof. Adi Pozner, Economics, Tel Aviv University

Prof. Nir Friedman, Computational Biology and Data Science, The Hebrew University of Jerusalem

Prof. Jacob (Koby) Rubinstein, Mathematics and Executive Vice President for Research, The Technion

Prof. Ronit Sarid, Virology, Bar-Ilan University

Prof. Amos Tanay, Mathematics, Computer Science, and Biology, Weizmann Institute of Science

**Assistants to the Committee**

Prof. Eran Bacharach, Virology, Tel Aviv University

Prof. Irad Ben-Gal, Engineering, Tel Aviv University

Prof. Omri Yadlin, Law, Tel Aviv University

Prof. Dan Yamin, Engineering, Tel Aviv University

Prof. Nira Lieberman, Computer Science, Tel Aviv University

Prof. Muli Safra, Computer Science, Tel Aviv University

Prof. Faisal Azaiza, Dean of Welfare and Health Science, Haifa University

**General Remarks**

**Purpose of the proposed plan:** to hold the epidemic to a low level of diffusion while keeping the healthcare system functioning and activating the largest possible segments of the economy at once.

**Principles of the plan:** Divide the country into areas in accordance with level of risk, differentiated by rules of internal movement and work; define safe workplaces; activate a system for control of travel to work within and between areas; and employ passive and active monitoring systems that will make it possible to relax the lockdown in areas where morbidity falls and forewarn about areas where morbidity rises before it surpasses the range within which the healthcare system can function.

**For this purpose,** we assume that the healthcare system has a specific allocation of beds for intensive care and ventilation of COVID-19 patients and balances the need for regular care of the population’s health. We also assume the ability to allocate tests by means of the existing method for monitoring the extent of morbidity. Below we invoke several assumptions about these values (as were made on the date of publication of the first report) that give an indication of their applicability. These assumptions, however, should be reassessed as close as possible to the activation of the plan and practical conclusions should be drawn on their basis.

**Before we proceed to the main provisions of the plan,** we wish to stress the need to perform a concurrent serology survey as soon as possible, even if it is inaccurate. The purpose here is to test the basic assumptions that underlie the current plan of holding the epidemic to the lowest level of diffusion. If the survey shows that the lethality of the disease is low, a transition to alternatives that are less burdensome to the economy and the population should be considered.

**a. Apportioning the country into areas differentiated by level of risk and behavior**

 An area shall be defined as a spatial continuum that is homogeneous both in its current level of morbidity and in its rate of morbidity change, as well as its ability to sustain life independently in terms of food, schools, and community medicine. The smallest area that can be demarcated is a quarter. Quarters conjoin into neighborhoods, neighborhoods into localities, and localities into clusters. The number of areas into which the country shall be divided will also depend on the ability to monitor changes in area morbidity. Therefore, the number of areas may grow as the possible number of tests increases.

1. **Red area:** total lockdown, resembling the situation today. Only the most essential workers shall receive work permits, subject to especially frequent testing.
2. **Yellow area:** partial relaxation of lockdown and the possibility of working within the area only—a decrease in the risk that an outbreak in this area will infect other areas. The possibility of shift labor (week on/week off) in such an area may be considered.
3. **Green area:** more meaningful relaxation of lockdown and permission to work also in a **“green workplace,”** one located in another green area or in a yellow or red area that is physically isolated from the green area and employs only “green” workers.

 **Exceptions** to these rules of behavior shall be made for (a) people who have been declared in need of isolation or who have symptoms that are identified with the coronavirus, and (b) those who have recovered from COVID-19 and developed antibodies to it, who will be allowed to circulate freely.

b. **Workplaces**

1. Regulatory conditions shall be laid down for the opening of workplaces in a way that will mitigate the likelihood of infection. Workplaces that are reached by workers from different areas, even if located in a green area, shall be subjected to special stringency. The conditions shall include employer inspection of travel permits, body-temperature checks, density among workers, and so on, as well as passing periodic sample tests of workers (pooled). For enclosed places tenanted by several employers (e.g., office buildings), additional conditions relating to the enclosed place itself shall be set forth.

2. The government shall assure, in advance, an adequate supply of protective devices that are needed for the opening of workplaces (thermometers, masks, etc.). Enforcement vis-à-vis workplaces shall be carried out mainly by way of legal liability (civil and criminal) for violation. A workplace that honors the regulatory rules shall be absolved of liability toward any person who becomes infected (be it a worker or a person infected by a worker).

3. Workplaces that deal with vulnerable population groups (e.g., seniors’ homes) or are social hubs that may spread infection among service recipients (e.g., a clinic or a grocery store) shall be subjected to special stringency.

4. Employers, including those of the public sector, shall be encouraged to have employees work from home.

**c. Management of authorization to travel**

Individuals’ authorization to travel shall be managed by means of an application that allows them to prove their area of origin and to confirm that they are allowed to enter the places for which they are authorized.

1. A green workplace shall be entered only after application proves that the person belongs to a green area.
2. The application shall generate a daily statement about the absence of symptoms.
3. The issuance of area-wide visas for travel and use of public facilities such as parks or beaches, by means of the application, may be considered.

**d. Monitoring and control system**

Any situation in which an area is expected to overload the healthcare system beyond the established threshold must be identified at the earliest possible time, because seven to fourteen days may pass from the moment of infection to the stage at which a person with COVID-19 may need a ventilator. Accordingly, the areas must be monitored continually in terms of the number of ventilators that patients in the area are expected to need relative to the limit allocated by the healthcare system, with safety margins provided. The number of infected persons and the morbidity trend shall be monitored in real time.

1. The forecast for a given area may be improved by gathering additional data about the area, such as housing density, each composition, and extent of compliance with instructions.
2. Control shall be applied by means of a monitoring system that integrates various mathematical models that are fed with daily outcomes of population sampling.

**e. Sampling to monitor carriers and its impact on the number of areas**

The decision about how many areas to designate is complex and may vary over time. On the one hand, a large number of small areas allows for a focused response in the event of an outbreak in the area and limits the impact of the outbreak on the system at large. On the other hand, since the total number of sampling operations corresponds in almost linear proportion to the number of areas, the potential number of samples that can be taken at any time is the main determinant of the number of areas. It is best to begin with a few areas—from ten to twenty—and to determine smaller areas insofar as greater sampling ability is attained.

Monitoring may be based on (1) confirmed patients, (2) the group of people in contact with confirmed patients, (3) people with symptoms who approach Magen David Adom or community physicians, (4) the population of the area, (5) social hubs such as workplaces, schools, and so on. Apart from confirmed patients whose number is known, sampling should be used for the monitoring of groups. However, the requisite sample size depends on the expected morbidity rate in each such group. Data released last week show that the rate of persons ill is 1–10 percent in both the contact group and in the group of persons presenting symptoms.

1. Sampling of persons in contact has the advantage of detecting change earlier than sampling of symptoms would; it is also important for the clinical requirements of full isolation. Sampling of contacts imposes an onerous operating load, whereas the symptom group is already partly monitored today by Magen David Adom and by clinics. It also bears emphasis that, according to existing information, almost all people who need ventilation have symptoms; thus, it is important to monitor morbidity among members of this group. The number of samples that are needed in each area is around 225; this may be divided among contacts and symptoms, yielding a total of 2,250 samples in ten areas. In these groups, once the number of areas climbs to fifty, the number of samples that a small area will have to perform will come to around 170, but their total number, of course, will climb to 8,500.
2. There is an advantage in sampling the entire population in terms of forewarning time because it takes around five days after infection for symptoms to appear and several days to track down persons in contact. The share of carriers in the population at large, however, is much smaller. In areas where the carrier rate is 0.1 percent or below, thousands of tests would be needed to monitor changes and the number of tests per area would not change with a decline in area size. We cannot recommend this for the time being. Only if morbidity in the area surpasses 0.2 percent is it worth switching over to sampling of an area’s entire population; in this case, some 500 samples per area would be needed.
3. The requisite sampling should be performed on a daily basis because the infection rate may increase perceptibly within a few days.
4. Sampling of social hubs: workplaces and schools.

Workplaces bring together people who are classified as “green” and come from different areas. Therefore, they, too, should be monitored in order to estimate morbidity, in the manner of national sampling (scaled to size). This sampling may be done at the lower frequency of once every ten days.

Schools: If and when schools are allowed to reopen and in the absence of meaningful social distancing between children, it will also be necessary to sample the population of children with pooling at the class level, at a frequency of at least once every ten days per school.

1. The population at large, persons with symptoms, and social hubs may be tested on a pooling basis (samples of several people combined into a one laboratory test) of 10–50 persons tested, commensurate with the expected rate in the group.
2. Serological survey: The availability of serological test kits in large numbers will yield information that can be used to improve the area-level models; it will also provide a general overview of the characteristics of the epidemic in the population, on the basis of which other ways to cope with it may be tested. Serology and carrier tests for the same person will give the survey a knowledge multiplier, e.g., by allowing it to calibrate serology tests that are not yet accurate.

**f. Applied testing simulations**

To examine the viability of implementing the plan at once, a check was performed with the help of physical diffusion models. For the purpose of the models, we adopted, **as an example only,** several values that seemed reasonable on the day the plan was formulated.

1. The percent of seriously ill persons in need of hospital admission as a share of total persons infected is 2–3 percent on average (this is an assumption that may be relaxed once additional information arrives). Note that these figures depend on the age distribution of the area’s population.
2. Say, for example, that there are some 2,000 inpatient / ventilation units.
3. An ill person occupies such a unit for approximately 20 days.

The conclusion adduced from Assumptions 2 and 3 is that the system can treat 50–100 new seriously ill persons per day.

1. We assume that a green area is one in which the diffusion coefficient has recently fallen to less than 8 percent per day

Below are initial conclusions from running physical models for epidemic diffusion with area-level isolation maintained:

1. A step-by-step release from lockdown may be applied.
2. Mathematical models show that the data on the rate of virus infection do not allow full release from lockdown even in green areas because the infection parameter has to be lowered by a factor of 2–3 by the rules of social distancing and hygiene.
3. Areas with diffusion coefficients of up to 8 percent per day may be opened (for work purposes).

4. As of April 4, 2020, some 900,000 people live in such areas (a 10 percent threshold yields some 1,500,000 persons). After Passover, this number will grow.

1. An intermittent lockdown (week on/week off) as a way to lower the diffusion coefficient may be considered.

We emphasize the need to re-estimate and make a decision on these parameters and to run the simulations anew shortly before the plan is activated.