

Getting to Zero: Stopping COVID in Ireland

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WHY SHOULD IRELAND GET TO ZERO?

If the transmissions in a day are higher than zero, we will always have either rapid growth in cases or strong restrictions on what we can do. If we have zero new cases, then we can relax restrictions. There might still be a case or two, but we can stop them using “fire-fighting,” local actions that don’t affect most of the country. What we don’t want to do is to leave a fire burning that will grow as soon as we go back to normal activities.

HOW LONG WILL IT TAKE?

How long it will take to get to zero depends on what actions are taken. At the level of restriction of the previous strong Ireland lockdown, the time that it would take to get to zero is 8 weeks. Any softer action will take much more time. The restrictions that are in place now are not enough to get to zero in forever. We would have to take stronger action even to get to zero in a year.

GREEN ZONE STRATEGY

Using a green zone strategy we can relax restrictions in parts of the country much sooner because individual areas don’t have to wait for the entire country to get to zero. Parts of the country can get back to normal within a few weeks, because the outbreak is not as strong. Restrictions would only hold in areas that have active transmission if we limit travel between regions to prevent new outbreaks. Social and economic impacts of restrictions are much reduced. Those communities that take strong action would be the ones that would benefit from it. Members of a community are closely connected to the consequences of their actions. Transmission within a community justifies strong local actions.

A green zone strategy is the optimal strategy to rapidly reduce the number of cases and enable maximum economic activity without disease and loss of life. This approach was used effectively but often only partially in multiple countries, including New Zealand, China, Switzerland, and Argentina as well as Ireland. These countries imposed restrictions on non-essential travel between localities in order to control the outbreak, resulting in rapid elimination of the disease and enabling them to open economic activity in most of the affected area within a few weeks.

For Ireland, the first step is to implement a short strong lockdown of 14 days (the incubation period to reveal many of the cases) to gain control of the outbreak. During this time, it is also key to reestablish the travel restrictions and identify Zones where there are and are not cases. Ideally an additional level of zones would be established for rural towns and cities, and suburbs and neighborhoods of Dublin.

At the finer scale, the areas that are Green zones after the first 2 week period should include large parts of the country. This will include some rural areas and perhaps certain urban neighborhoods. In subsequent weeks, only areas with community transmission will have strong restrictions. Core urban areas will likely require an additional 3rd or 4th week. At the county level, most counties will require 4 weeks. By the 4th week most of the country will be COVID free and the remaining areas can be cleared by 5 weeks. The opening of economic activity can be successfully done by locality, cautiously allowing an additional margin of safety, and then rapidly expanded across the country, rather than by sector.

This strategy is also a preparation for rapid response to any new cases that are subsequently discovered. Any individual case or localized outbreak can be stopped with contact tracing and, at worst, highly localized lockdowns only as needed with minimal economic impacts.

IMPROVED TESTING

As part of the improved effort, testing should be accelerated using new testing options. In addition to swab tests, ramp up saliva testing, chest imaging (CT-scans, ultrasound) for rapid results, as well as sewage testing for neighborhoods. Provide options for immediate isolation of individuals away from family and housemates. Let people know that they should protect their families and household members from being infected so we can get to zero.

WHY WILL PEOPLE LISTEN?

Everyone is tired of COVID, give them a clear goal and a certain time to get out of it.

This enables one to drive the disease to elimination. Elimination has been achieved or nearly achieved in almost 50 countries and is the best exit from this disease. Achieving this in Ireland will enable Ireland to serve as a model for Europe and the world.



Fig. 1. Time line of Green Zone strategy. Stage 1: Two week strong lockdown to identify cases and bring outbreak under control while establishing zones and regulating travel, Stage 2: Two week period of slowly relaxing restrictions in COVID-free Green zones, while maintaining strong action in areas with ongoing transmission. Stage 3: Residual action in progressively smaller areas as the green zones expand to cover the country. Total time till normal is 4-6 weeks with residual action (fire fighting) in very localized areas.

APPENDIX A: ACTIONS DETERMINE THE TIME TO NORMAL

A key question is what should we anticipate in the dynamics of the outbreak in Ireland. More than anything else, this depends on what actions people choose. The overall behavior is controlled by the transmission rate from individual to individual, this is often characterized by the value of R , which is the typical number of individuals who are infected by an individual. For COVID-19 all over the world, the value of R is in the range 2-4. There is an easier way to understand the outbreak in terms of the change in number of new infections from day to day. If we call this Q , the baseline value of Q is between 1.2 and 1.4, which means there are 20% to 40% more new cases per day, a factor of 4 – 10 per week, a very rapid growth.

Once people take action, restricting what they do in order to reduce transmission, Q and R go down. When $R = 1$ the number of cases remains fixed as each person leads to one new case, so also $Q = 1$. If we want to stop the outbreak, which is necessary to relax those restrictions without going back to the rapid growth, we have to have R less than 1, which also means Q is less than 1, and wait long enough for the number of cases to get to zero.

If it is higher than zero, we will always have either rapid growth or strong restrictions. If we have zero new cases, then we can relax restrictions. There still might be a case or two, but that is something we can deal with using “fire-fighting:” local actions that don’t affect most of the country.

The key to doing this is to get $R < 1$ and then recognizing how long we have to wait to get to zero. The situation in Ireland on August 23 is shown in Fig. 2. It shows the current state and several future courses based upon possible actions. In order to get to zero by the last week of September (5 weeks) the value of R would have to be 0.59 ($Q = 0.89$, a reduction of 11% in new cases per day). To get to zero by the middle of October (8 weeks) a value of $R = 0.72$ would be needed, $Q = 0.93$, a 7% reduction day to day, similar to the most rapid reduction previously in Ireland.

In Fig. 3 we show a plot that is useful to see the value of Q . In this “logarithmic” plot, equal intervals are equal percentage changes so that the change is a straight line for a fixed value of R and Q . Early in the outbreak in Ireland, the growth was very rapid. The growth rate was reduced at the end of March to 7.5% per day. During the first lockdown it went down to a reduction of 7% per day. After relaxing the restrictions, it went back up to an increase of 5% per day, corresponding

to the second outbreak, showing the impact of using partial restrictions as compared to the lockdown. If Ireland is to get out of the outbreak within 2 months it must adopt a strategy of achieving $Q = 0.93$ or less, like the first lockdown. We note that if CT-scans are implemented (Appendix C) an additional reduction in R by 0.2 is attainable, leading to $Q = 0.89$, reducing the time to 5 weeks.

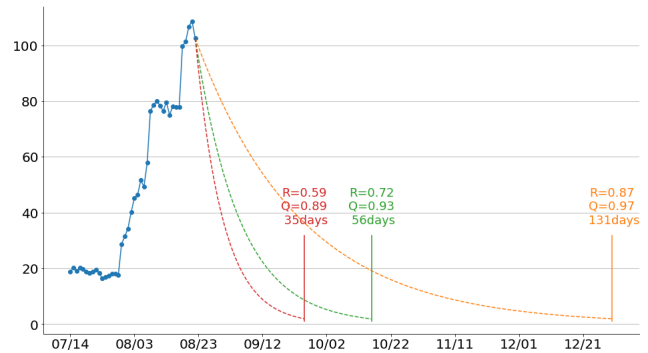


Fig. 2. Current state of the COVID-19 outbreak in Ireland in terms of daily new cases with several possible futures based upon what action Ireland takes. Curves show how long it takes to get to zero and the ability to relax the restrictions without going back to rapid growth. Note that a Green Zone strategy allows opening up in green zones earlier than this indicates.

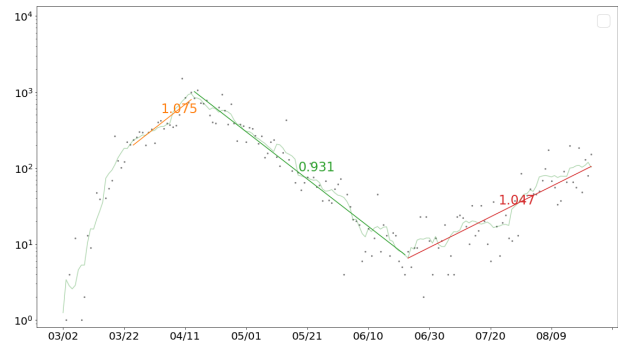


Fig. 3. Blue dots show daily new cases in Ireland on a logarithmic plot equal vertical axis intervals are equal percentage changes. Lines with values of Q for different intervals of time since the beginning of the outbreak in Ireland. During the first outbreak, after the first rapid increase, the number of cases increased at $Q = 1.075$ or 7.5% per day. During the lockdown it decreased at a rate $Q = .93$ or -7% per day. In the second outbreak the growth was $Q = 1.047$ or 5% per day. If Ireland is to get out of the outbreak within 2 months it must adopt a strategy of achieving $Q = 0.93$ or less.

APPENDIX B: GREEN ZONES FOR IRELAND

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A Green Zone strategy, one that selectively imposes restrictions within a country, e.g. at county level, is the optimal strategy to rapidly reduce the number of COVID-19 cases and accelerate the return to normal social, health, education, and business activity—as each county, province or state becomes clear—without disease and loss of life.

This approach has already been used effectively, but often not completely, in multiple countries, including Ireland, New Zealand, China, Switzerland, and Argentina. Many European countries are now applying Green Zone style approaches, both to allow for response to localized outbreaks and for selective easing of restrictions on travel to neighbouring countries with similar or lower disease rates. Countries that imposed restrictions on non-essential travel, both internationally and between localities within their borders, have achieved very rapid contraction of their epidemics and local, or even national, elimination of the disease. This enabled them to reopen economic activity in most of the affected area within a few weeks, while the most stringent control measures were selectively maintained only in areas with ongoing community transmission (Red Zones).

Right now, Ireland can achieve safety, with consistently normal local activity in many counties, with perhaps the occasional need for more intensive local responses to local outbreaks. To do this, a key policy is a more consistent Green Zone strategy, using international and inter-county travel restrictions to prevent and control larger outbreaks. This will serve as a foundation for a return to comparatively normal domestic economic activities and social life. Partnering with other Green Zone countries will enable international travel, fostering a broader effort to get to zero.

The current conditions in Ireland remain favourable for adopting such a COVID-19 elimination policy due to the success of the previous strong actions taken. County level conditions on July 12 and Aug 3 are shown in Fig. 4 and Fig. 5. However, it should be noted that the scale of that challenge and length of time required to see it through grows with every day that the existing plan to “live with the virus”—which is already failing and allowing the national epidemic to re-expand at an alarming rate—persists. Looking forward to a COVID-free island, we can learn a lot from the successful way Ireland tackled and progressively shrunk the epidemic all the way up until late June, notably including the earlier county-level travel restrictions that rendered several counties COVID-free for as long as those travel limits lasted. If the ongoing new outbreaks scattered across the country are to be contained and snuffed out, and further outbreaks are to be prevented, it is essential to build upon these experiences of success by restoring and supplementing control measures which allow opening up of the economy in counties that achieve elimination. The key is preventing a new chance for rapid growth in cases, and then unconstrained geographic spread, as has been seen repeatedly in Italy, Japan, Israel, the UK and the USA.

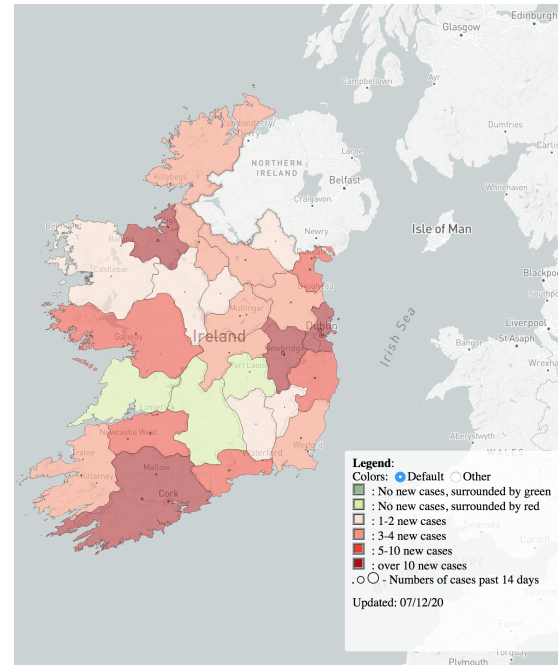


Fig. 4. County status in Ireland including five levels of zone distinction, by number of cases in the past 14 days, on July 12, 2020. Three counties have no cases in the last 14 days but don't qualify for green zone status because of neighboring red zones, i.e. they are yellow zones.

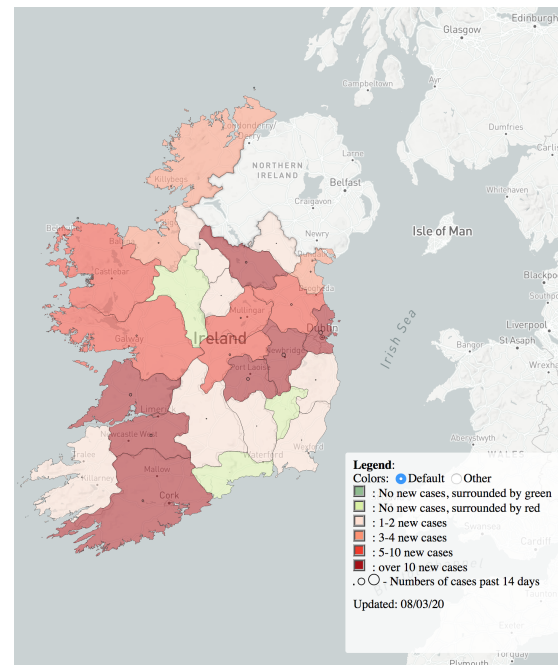


Fig. 5. Similar to Fig. 4 on August 3, 2020. The yellow zones have shifted but there are still three of them. Overall severity is worse.

The way forward is to get to zero new cases in at least the most recent 14 day period county by county. Reinstating the inter-county travel restrictions on non-essential travel (and not the other restrictions) from phase II of Ireland's national plan is key. The restrictions from phase I may also be useful for

selectively clamping down hard and fast on intransigent foci of persistent, uncontrolled transmission in specific localities, with extra caution and patience so as not to open up prematurely. Simultaneously there is a need to develop decentralized, fine-scale routine surveillance systems with sufficient sensitivity to detect any new outbreaks while they are still small enough to contain and extinguish as they arise. This is akin to firefighting. Just as we don't leave an uncontrolled fire burning in a home but prepare for new fires if they occur, so should be our strategy for fighting COVID-19.

Ideally, two levels of geographic zones should be developed. In addition to the county level zones, a second, finer scale set of zones should be developed for towns and rural communities, and neighbourhoods in larger urban centres. Using current infection data Green Zones can be identified and include large parts of the country. If implemented today, this might already include many rural and suburban areas and even some neighbourhoods in big cities. Community members should be alerted to local transmission events so that actions to stop transmission can be focused where it matters most in areas that are not yet green zones, meaning that either they have ongoing community transmission (Red zones) or borders with neighbouring zones that do (Yellow zones). Social distancing, hand hygiene, face masks, limited essential services, and extensive testing should be used to shrink local transmission down to zero.

By taking strong action in those targeted areas, only a month should be needed in counties with only a few new cases per day presently to get to zero. Once the condition of zero new cases is achieved, including a period of vigilance to rule out residual cases, a process of opening up safely can be started. In subsequent weeks, only areas with persisting community transmission will require these actions to be extended until zero incidence is achieved and sustained. Where areas have persistent cases, strong action can be mounted to eliminate it as the resources of the country can be focused there. The reopening of near-full economic activity across all sectors should then be carried out on a locality by locality and county by county basis and rapidly expanded across the country, rather than attempting to do so nationally on a sector-by-sector basis. This decentralized strategy also lays down solid foundations for fine-scale, near-real-time routine surveillance system that enables rapid responses to any new cases that are subsequently discovered or imported from outside these green zones. Any individual case or localized outbreak may be identified early and then tackled decisively with contact tracing and, as necessary, selective re-imposition of local restrictions.

While local travel restrictions are recognized as key to the solution, conversely, the alternative of allowing free mobility to rapidly spreading outbreaks across the country makes containing them impossible without sustaining severe social and economic restrictions until the whole country is virus free.

The Green Zone approach combining local travel restrictions with rapid and decisive but localized reactive measures if local transmission reoccurs, enables one to drive the disease to extinction relatively rapidly. Local extinction has been achieved or at least approached in almost 50 countries, where reproductive numbers of significantly less than one were achieved, so elimination clearly represents a viable exit strategy. Ireland is also capable of achieving and sustaining its

position as a COVID-free green zone, this represents the most positive form of soft power internationally, with advantages for trade and travel.

The first example of a country applying a Green Zone strategy was China, which eliminated the outbreak within 4-5 weeks, and in the epicenter of Wuhan in 5-6 weeks (Fig. 6). Recent comparatively small outbreaks there are examples of firefighting in this context. For as long as Ireland imposed county-level travel restrictions, it consistently achieved a rapid decline in cases (Fig. 7). Missing from its arsenal is the use of CT-scans that could accelerate the decline in cases due to eliminating the false negative rates of RT-PCR tests as widely recognized and recently reported in the *New England Journal of Medicine* [?]. Switzerland achieved a similar geographical contraction but then eased off and has allowed the residual tail of the outbreak to begin growing again (Fig. 8). In contrast, Italy did not use the green-zone geographic strategy except in limited ways, so after 4 months of lockdown cases continued not only in the original epicentres but also across the entire country (Figs. 9, 10). In contrast, Argentina has confined the outbreak to the epicenter in Buenos Aires, and while having difficulties addressing the outbreak there, has otherwise maintained an almost COVID-free country with only a few small outbreaks outside the capital (Fig. 11). Russia, the longest country in the world, allowed the disease to propagate all along the Siberian railway without imposing any travel restrictions (Fig. 12).

Islands have a tremendous advantage in achieving a COVID-free exit from the pandemic. This is apparent from New Zealand, Iceland, and elsewhere. The Republic of Ireland, in collaboration with North Ireland, can also deploy this strategy to exceptional effect. We note that even for countries with widespread cases, it is possible to achieve outbreak control in a few weeks using a Green Zone strategy. To rapidly gain control of the outbreak, the first step is to apply a brief but stringent restrictions of at least 2 weeks to prevent most transmissions and to properly identify the locations where outbreaks are ongoing. This has already been shown to be both possible and successful in Ireland. During this initial highly restricted containment phase, sub-county-level boundaries should be established for restricting travel between towns and neighborhoods in urban areas. These restrictions will then enable the most rapid relaxation of restrictions according to the green zone process. Where there is persisting transmission directed efforts that engage the affected community will be effective. Community members will better recognize the consequences of their own actions for stopping their outbreak. Thus, the last embers of the epidemic can be stamped out with vigour.

A few brief weeks ago, Ireland was closer to zero COVID than it is today, and things are now headed rapidly in the wrong direction. However, there is no inevitability to a second wave, or all the associated costs that come with it. The main drivers of both health and economic harm are new cases of infection and the responses required to stop them from spiraling out of control. Decisiveness is key to minimizing the damage caused by COVID-19. If a second wave is allowed to develop on the island of Ireland, all those avoidable additional costs, not to mention deaths and disabilities, will be borne.

[1] S. Woloshin et al, False Negative Tests for SARS-CoV-2 Infection, *NEJM* 2020; 383:e38, <https://www.nejm.org/doi/full/10.1056/NEJMp2015897>

China: COVID-19 Outbreak

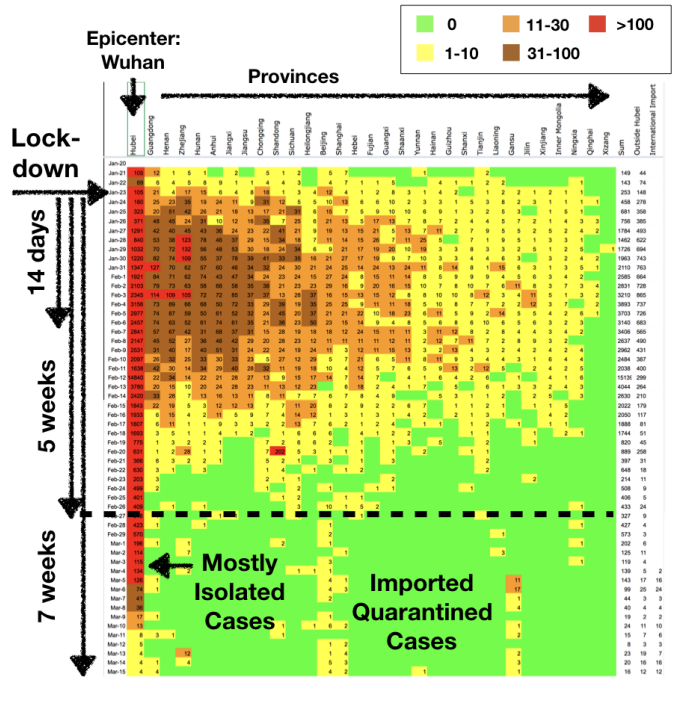


Fig. 6. Outbreak control in China. Horizontal axis is the provinces, higher number of cases are on the left and are closer to the epicenter in Wuhan. Outside of the epicenter provinces had no more than 21 identified cases per day at the time of lockdown. The trajectory of growth and decline led to a 4-5 week elimination. In Wuhan 5-6 weeks were needed, not including a period in which essentially all cases that arose were already quarantined due to contact tracing of close contacts, often of housemates.

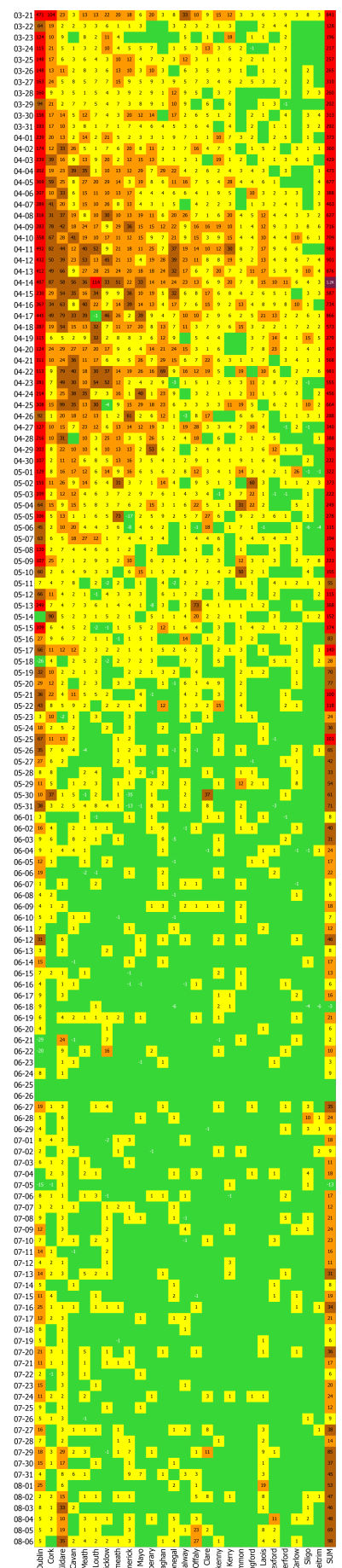


Fig. 7. Outbreak control in Ireland showing significant geographical contraction and recent increases (compare Switzerland and Italy below).

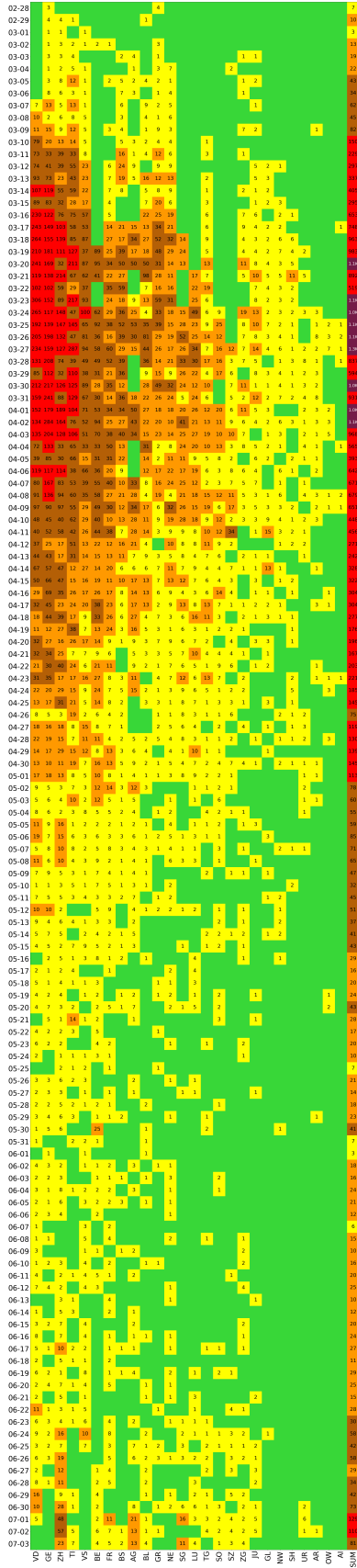


Fig. 8. Outbreak control in Switzerland showing improved contraction compared to Italy, but not quite getting to zero and the reopening later leading to new transmission.

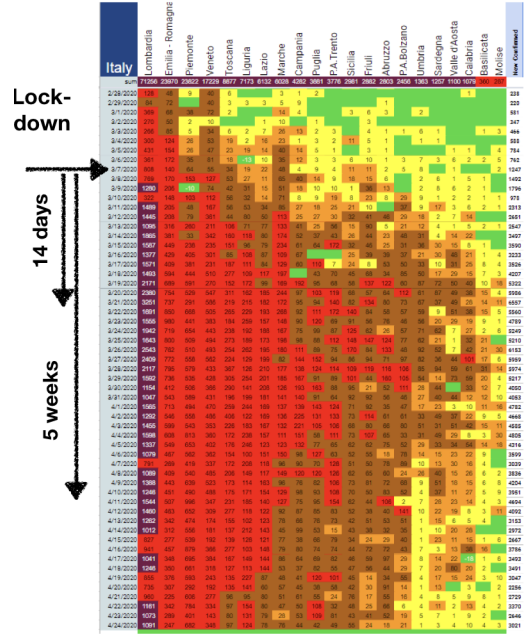


Fig. 9. Outbreak control in Italy (see also Fig. 10). While the lockdown occurred with more cases outside the epicenter than in China, what is striking is the much longer time to control the outbreak and the absence of clear geographical contraction until much later. The reasons for this may include additional transmission due to (1) Not isolating sick individuals away from home, (2) use of RT-PCR with a high false negative rate instead of the extensive screening use of CT-scans used in China, (3) absence of strong travel restrictions between provinces as well as to local communities.

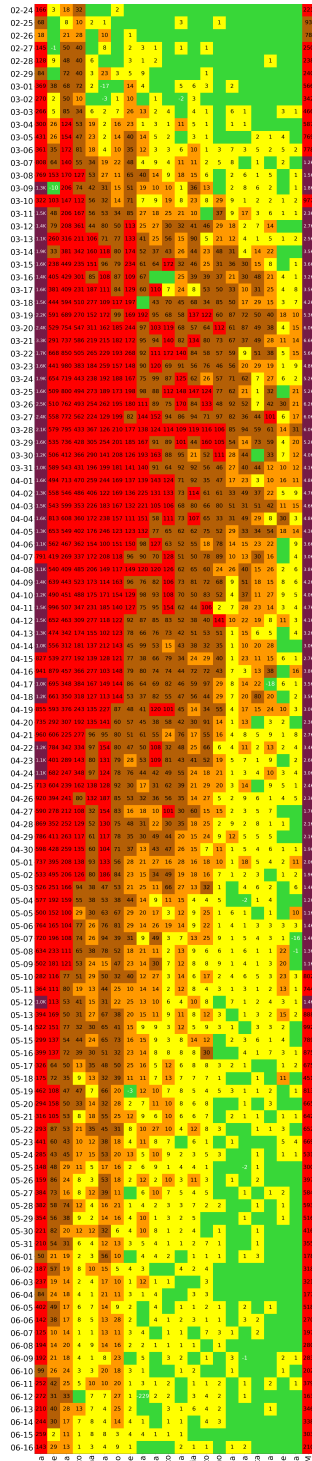


Fig. 10. Outbreak control in Italy including expanded view showing that the control of the outbreak took over 3 months and has not been completed even after 4 months (see also Fig. 9).

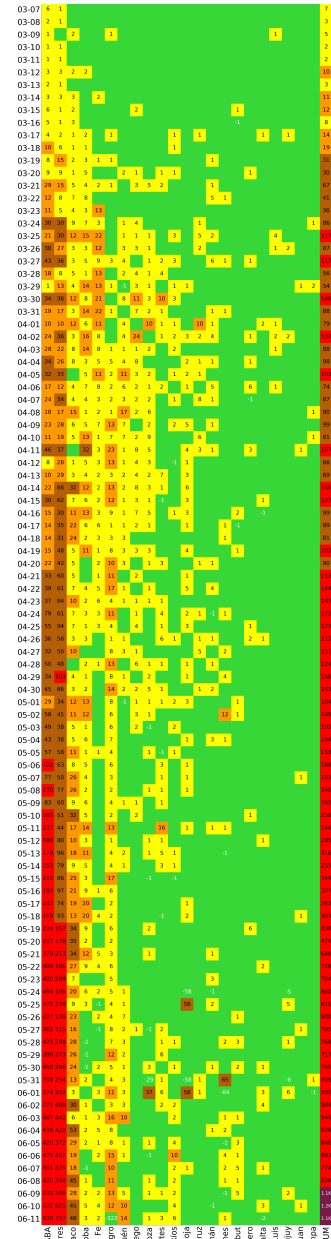


Fig. 11. Outbreak control in Argentina showing that the outbreak was restricted to the epicenter in Buenos Ares early on, but the effort to contain it there has not yet been successful due to high population density and other factors. The solution is to use a more local model for travel restrictions between neighborhoods and to refine other aspects of the response efforts.

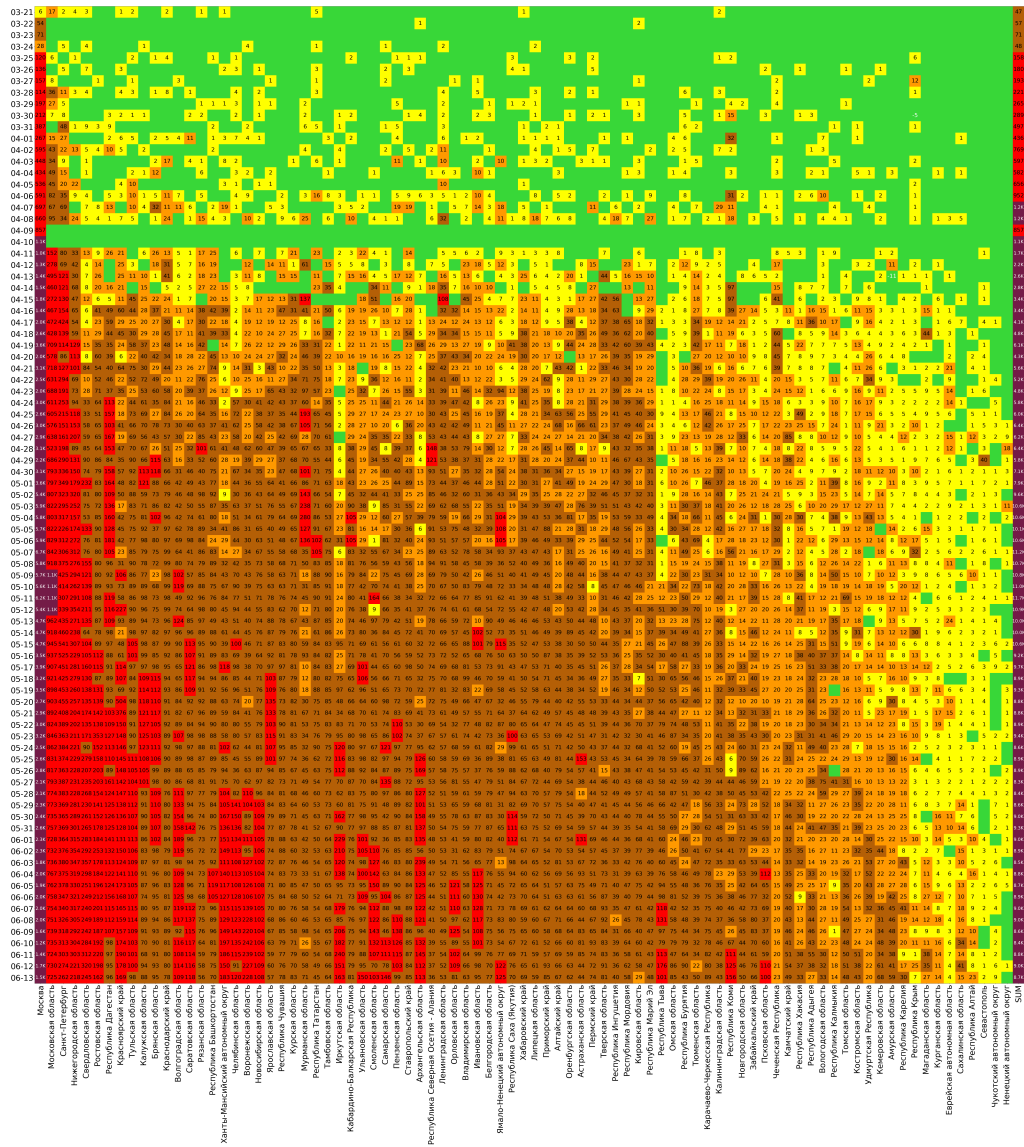


Fig. 12. Outbreak control in Russia showing that without travel restrictions the outbreak propagated from end to end of the longest country in the world and led to major outbreaks and dramatically extended the time to control the outbreak. While the outbreak is being reduced in the epicenter in Moscow by end of this period, it continues to grow in other areas.

APPENDIX C: CT SCANS FOR COVID-19

To contain the spread of the COVID-19 pandemic, early detection and isolation are essential. We have to know who is infected as soon as possible and with the best accuracy possible. Currently, laboratory RT-PCR tests are the primary detection method. However, these tests suffer from several drawbacks, including long report times, limited availability, and a 30% false-negative rate, as recently reviewed in the New England Journal of Medicine <https://www.nejm.org/doi/full/10.1056/NEJMp2015897>.

One way to break free from this testing deadlock: CT imaging.

Computerized tomography (CT) scans provide a 3-D view of the lungs, including the number of damaged sites and the extent of their damage. They can show an infection even before a patient reports symptoms (presymptomatic) or when they have mild symptoms. This gives a snapshot of the condition of the lung early in the disease and can also monitor symptoms as they progress.

COVID-19 patients, often even when asymptomatic, have characteristic patchy shadows and ground-glass opacities visible on chest scans. CT devices are an existing resource within medical systems. Appointments can be completed within 12 minutes or less and results can be available immediately, if protocols are optimized. Thus, the use of CT for pre-screening can expand testing capacity dramatically, as was seen in Hubei province in China, Spain, Belgium and France. Egypt is using CT-scans as the primary diagnostic method and has dramatically reduced the number of new cases in the country recently.

The impact of obtaining results immediately upon testing and the lower false negative rates motivate more effective isolation, leading to a decrease in transmission rate and reducing the value of R by 0.2 <https://www.endcoronavirus.org/ct-scans>. If the number of transmissions is constant over time, $R=1$, then this would reduce the transmission daily by 5% for a reduction by 50% in 10 days. This has been the recent rate of reduction in Egypt (see Fig. 13).

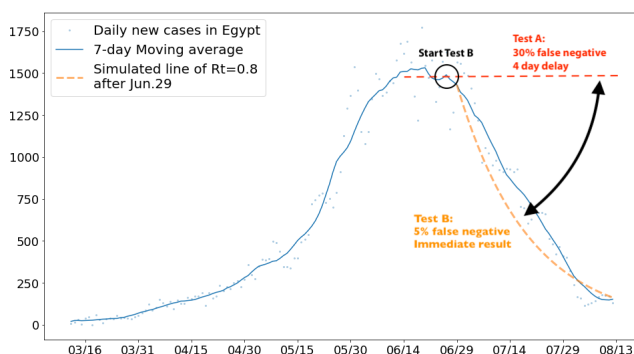


Fig. 13. Daily new cases in Egypt which has adopted CT-scans for initial diagnostic testing of COVID-19. The value of $R = 0.8$ since mid June may be compared to the just previous $R = 1$, consistent with calculations of the impact of using CT and PCR relative to PCR by itself due to rapid test results and reduced false negative rates.

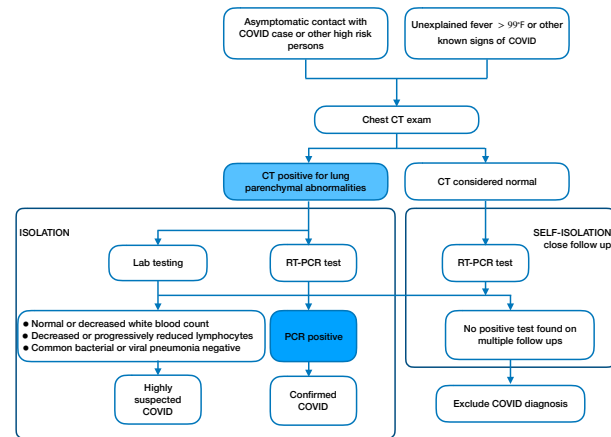


Fig. 14. Diagnosis flow chart using chest CT as part of the clinical diagnosis for COVID-19 to improve and speed up treatment of patients, and their isolation for control of the entire epidemic.

We estimate the benefits from the use of CT scans in conjunction with RT-PCR for diagnosis of COVID-19 in symptomatic individuals. Our calculation shows that for 10,000 CT-scans 124 lives are saved this year (within months), 2,074 diagnosed cases are prevented, 415 hospitalizations are prevented and subsequent short-term and long-term disability are also prevented. <https://www.endcoronavirus.org/ct-scans>

There are some considerations to adopting widespread CT testing, but the benefits far exceed the risks. The population to be screened includes symptomatic and some high-risk individuals (see Fig. 14). These are not high-cost scans as they are low-dose non-contrast CT. False negative rates are about 5% <https://tinyurl.com/y74bec79>, even automated algorithms have achieved 15% <https://www.nature.com/articles/s41467-020-17971-2>. Combining CT and PCR tests provide significant advantages. In particular, scans can mistake other lung disease and viral pneumonias for COVID-19, so RT-PCR tests should be used for confirmation. Additional precautions will be needed to sanitize CT equipment, and protocols for sanitization have been developed. Patients are exposed to a low dose of radiation during a low-dose CT scan, but it does not pose a significant risk for cancer.

Thoracic CT scanning has been demonstrated to reliably detect early symptom COVID-19 cases and monitor and predict disease progression. While extended studies are continuing, the demonstrated capabilities more than justify rapid adoption in the face of a pandemic. If the use of CT scans can be rapidly expanded, it will have an immediate and powerful effect on COVID-19 detection and containment.