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A student during a COVID-19 quarantine in St Petersburg, Russia.

Mental health: build predictive models to steer policy

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Combine economic, social and medical data to forecast need and design services to address the growing crisis.

A crisis is growing in mental health as the widespread impacts of the COVID-19 pandemic and the economic hardship it has brought bites deeper. In Japan, suicides rose by 16% during the second wave of the pandemic, from July to October 2020, compared with the rate in previous years[1]. In the United States, 25% of people aged 18–24 surveyed in June 2020 reported increased substance use to cope with pandemic-related stress[2]. This year, the flagship report of the United Nations children's charity UNICEF, *The State of the World's Children*, focused on child and adolescent mental health and well-being for the first time. If urgent and effective action is not taken, the protracted and global scale of the pandemic disruption will cast a long shadow on mental health, particularly that of young people.

Decades of research suggests that the response must be all-encompassing and long term. The fact that this is neither feasible nor affordable in many contexts gives rise to two types of response. Some governments or agencies allocate available resources over too broad a range of evidence-based programmes and services; without the scale and intensity needed, these cannot achieve real and

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A food-bank worker in California: economic programmes must be part of the mental-health policy toolkit.

sustained impact. An example is Australia's struggle, over three decades, to shift the needle on many mental-health conditions. Other governments and agencies take a reactive and ad hoc approach – as exemplified by the US response to the synthetic-opioid overdose epidemic. Neither approach will be adequate to tackle today's mental-health crisis.

Instead, policymakers must account for how the pandemic has fundamentally changed the state of mental health across society. It is time to examine preconceptions about what interventions are effective.

Lessons can be learned from infectious-disease research. Systems models allowed researchers to rapidly predict the spread of COVID-19 (see *Nature* **580**, 316–318; 2020), integrating contact-tracing data based on commuting patterns and mobile-phone location trackers. Although imperfect, in some places these models provided a virtual testing ground for alternative assumptions and for the timing and scale of mitigation strategies, including lockdowns, mask wearing, school closures and vaccination. The models also accounted for the changing likelihood of people complying with such measures as the pandemic persisted. Where decision makers worked closely and cooperatively with modellers, as in Australia, New Zealand (see go.nature.com/3kiw79n) or Taiwan, models were used to inform timely, decisive and effective responses to the pandemic[3].

We argue that a similar systems-modelling approach should be used to tackle the mental-health challenge. Drawing together qualitative and quantitative evidence and data, models should capture changes triggered by the pandemic – such as education loss, job loss, domestic violence, social isolation, fear and uncertainty. Models should forecast demand for community mental-health services and acute care, including emergency-department presentations and psychiatric hospitalizations, as well as outcomes such as suicidal behaviour (see 'Mental-health forecast').

> **"Analysing risk factors independently fails to account for their interactive effects."**

Credible projections of population mental-health outcomes are needed to stress-test new policies and mitigation strategies, from employment programmes to helplines and investments in education and retraining. Before allocating significant investments, alternative scenarios should be simulated to reveal the combination, scale, targeting, timing and duration of health, social and economic policies and initiatives that will deliver the greatest impacts. Understanding which combinations of interventions work best at which stage is key to reducing harm.

As experts in mental health and systems modelling, we outline here five challenges and four priorities to ensure that models are used to reliably guide policy and allocate resources.

Five challenges

Closing the care gap. In most societies, mental-health systems were underfunded and fragmented even pre-pandemic[4]. The gap between those that need care and those that receive it is widest in countries where there is conflict, such as Afghanistan, and in countries with higher rates of unemployment, unequal wealth distribution and budget cuts, such as Greece. Across low-, middle- and high-income countries there are significant treatment gaps between the most privileged people and those who are most marginalized, such as Indigenous populations in Canada, New Zealand, the United States and Australia[5].

Allocating resources. Interest and investment in mental health is growing. Witness the work of the World Health Organization (WHO), UNICEF and global civil-society organizations such as the World Economic Forum's Global Shapers Community (see

go.nature.com/3tpbtrz). In May 2020, the UN secretary-general António Guterres called for more urgent action on the issue[6], and the elevation of mental health and suicide prevention in the global development agenda in recent years will be important to the COVID-19 mental-health response[7]. Up to US$160 billion has been committed by the World Bank Group to help developing countries tackle the health, social and economic impacts of the pandemic, and governments around the world are committing trillions to social and economic aid packages. However, without good planning tools, decision makers will continue to be challenged by the complexity of causal drivers, the quagmire of the known and the unknown, and the kaleidoscope of voices and choices.

Expanding the toolkit. The predominant approach to research on mental illness and suicidal behaviour uses retrospective data to identify independent risk factors, such as unemployment, substance abuse or childhood trauma. Half a century of such study has brought only partial progress towards population-level impact, as a recent meta-analysis noted[8]. In addition, analysing risk factors independently fails to account for their interactive effects. This makes robust projections of population mental-health outcomes difficult, if not impossible.

By contrast, infectious-disease epidemiology has matured into a robust interdisciplinary field through methodological expansion that makes routine use of the analytic techniques of complex-systems science. At the outset of the COVID-19 pandemic, this enabled global research teams to rapidly deploy and customize existing systems models. Researchers could analyse and forecast transmission trajectories under different conditions, allowing uncertainty to be quantified. As new information and data about the virus and its transmissibility became available, models were refined and provided governments with critical tools for testing and weighing the impact of responses, from mask wearing to travel quarantines.

Embracing ideas. Discourse on mitigating the mental-health impacts of COVID-19 has focused largely on mental-health education programmes, crisis helplines, improved access to virtual services, and tinkering with existing arrangements to enhance access to emergency care. This health-sector view fails to recognize that the most potent mental-health interventions can be social and economic. These could include employment support, eviction moratoriums, subsidized education and training, or increased unemployment insurance[9,10]. For instance, an income supplement that moved 14% of Native American households out of poverty in North Carolina saw a 32% decrease in psychiatric symptoms among children of those households[11].

Huge questions. It is not at all clear what combination of policies, initiatives or reforms are needed to respond effectively to the mental-health crisis. What impact will that combination have across different outcomes? Will the most effective combination be similar across different contexts? What targeting, timing, scale, frequency and intensity of investments are necessary? Will there be rebound effects when temporary mitigation strategies such as income support or eviction moratoriums are removed? What are the consequences of delayed actions? Will unintended consequences arise from well-meant but ill-designed or ill-timed mitigation measures?

The scale of these challenges behoves us to take a more progressive research path[8,12]. We must recognize the feedback loops, threshold effects, non-independence and non-linearity that characterize our subject of study[13,14]. For example, an increase in unemployment increases both the prevalence of psychological distress (which can lead to increased substance misuse and suicidal behaviour) and domestic violence. Domestic violence increases rates of adverse childhood exposures and psychological distress, further driving up rates of substance misuse and so on[14]. Modelling and simulation can help us get a handle on such complexity.

Opportunity in crisis

A paradigm shift in population mental-health research is emerging at just the right time. The complexity and global scope of the crisis requires it, and the computational tools are sufficiently advanced and accessible to make it feasible. The past two decades have seen substantial investments in the data systems of low- and middle-income countries (LMICs), covering civil registration — the collection of statistics such as births, marriage, divorce, cause of death — and health information such as service coverage and capacity, and medical records[15,16]. A 2021 report by the WHO[17] on 183 of its member states highlighted that 86 have suicide data that are considered good quality (49 are high-income countries, and 37 are LMICs). And countries including India, China and the United Arab Emirates are collecting data that will contribute to estimating the burden of mental ill-health through national and regional surveys. These could be used as model inputs. Hence, the advanced modelling tools to support decisions are no longer the exclusive domain of high-income countries.

During the COVID-19 crisis, the Brain and Mind Centre at the University of Sydney, Australia, leveraged years of experience to develop a series of models to inform policy and planning for the country's regional, state and national mental-health systems. In youth and in the population as a whole, the models project the likely trajectories for a range of outcomes including the prevalence of psychological distress, rates of help-seeking, wait times, emergency-department presentations, self-harm hospitalizations, and suicide deaths as a result of the pandemic[10,18]. Such projections provide a test bed for probing the trade-offs and potential synergies of economic and social measures, among other strategies.

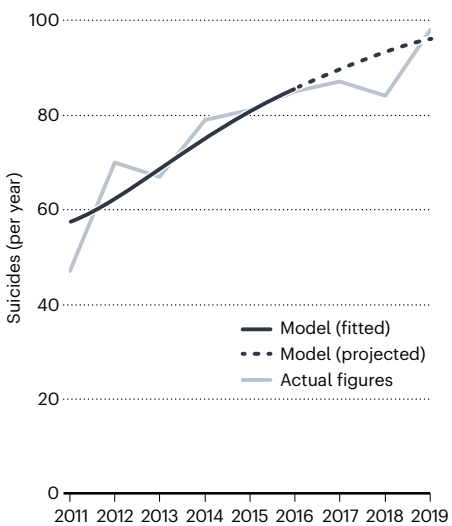
For example, models from the Brain and Mind Centre suggested that among the smart choices for Australia in the recovery period (2021–25) were investments in childcare, employment programmes and job creation (particularly for women), active follow-up after suicide attempts, and expansion of digitally coordinated specialist mental-health services. These were forecast to prevent an estimated 6% of self-harm hospitalizations and 4.1% of emergency-department presentations relating to mental health[10]. Investing in more psychiatric-hospital beds, awareness campaigns, helplines or stand-alone primary-care or specialist services were projected to deliver little impact, despite being considered 'evidence based'.

Similar approaches are also under way in the United States. The US National Institute of Mental Health (NIMH) recently launched the Advanced Laboratories for Accelerating the Reach and Impact of Treatments for Youth and Adults with Mental Illness (ALACRITY) research-centres programme. These centres harness systems science, computational approaches, behavioural economics and digital health to test methods to synthesize data.

Still, there is progress to be made on several fronts. Pandemic modelling benefited from unprecedented levels of intergovernmental and intersectoral cooperation on the exchange of data and crucial information, for instance about movement patterns, that were shared across telecommunication, transport and health agencies. Unfortunately, similar cooperation is rare around the ethical sharing

MENTAL-HEALTH FORECAST

The predictions of a model developed at the University of Sydney, Australia, to inform public-health decisions were close to the suicide rate for a region of New South Wales in the years before the COVID-19 pandemic.



SOURCE: AUSTRALIAN INST. HEALTH AND WELFARE NATL MORTALITY DATABASE

of data that would benefit efforts to model mental health during COVID, for instance across health, education, social services and the economic sector.

Four priorities

Several Australian members of the World Economic Forum's Global Future Council on Mental Health (for details, see Supplementary information) have spent five years applying systems modelling to mental health. This experience has highlighted the following four priorities for rapid and successful deployment of models to improve population mental health and prevent suicide. It is key to:

Use a technical blueprint. To construct systems models in diverse contexts, a clear picture of how social, economic and health factors interact to drive psychological distress and mental-health outcomes is needed. An exemplar blueprint will be released this year[19], based on COVID-19 research by the Brain and Mind Centre and supported by the World Economic Forum. It details how to develop a national or regional system-dynamics model of mental health, including key inputs, outputs and processes. The blueprint includes guidelines for analysing the projections of population mental-health outcomes. It also offers guidance on modelling the impact of policies such as investing in jobs, childcare, education or social connectedness.

Build multidisciplinary teams. Expertise in computational and systems science, epidemiology, psychology, psychiatry, social science, policy and economics will ensure that models have valid, robust, interdisciplinary underpinnings, and limit bias. The COVID-19 international modelling consortium (CoMo) is a notable example, drawing on a broad range of disciplines and contextual knowledge to provide relevant, trusted and tailored tools to more than 30 countries[20].

Strengthen data systems. Improving the range, quality and timeliness of data collected and continuously reappraisng models as fresh data emerge will reduce uncertainty bounds, expand the insights that can come from systems modelling and improve decision making. In addition, a commitment to transparency and multidisciplinary co-design, and presenting the results of alternative assumptions helps to guard against the politicization of model outputs for public policy.

The data that are needed depends on the scope of the model and the outcome indicators of interest. These should be determined by national priorities, stakeholder inputs and the research question being posed. Time-series data used for model calibration range from demographic and labour-force statistics such as births, mortality, migration and unemployment rates, to estimates of the prevalence of distress and mental disorder and related data such as emergency-department presentation, hospitalization and intentional-self-harm rates. Adjustments will need to be made depending on the local context. In Australia, for example, self-harm hospitalizations are recorded, but not data on suicide attempts; in Colombia, suicide attempts are reported. Model parameterization also draws on research evidence (including systematic reviews, randomized controlled trials and cohort studies) and expert consensus.

Commit to co-design. Models that are created with multidisciplinary stakeholders and, crucially, those with lived experience of mental ill-health have better credibility and validity. A participatory approach helps to identify the key referral pathways of the service system, bottlenecks and barriers. It highlights users' experiences of delay, disengagement, service gaps and interruptions to continuity of care[14]. Self-harm survivors, for example, identified that long wait times made it more likely that they would stop seeking care, prolonging their distress and increasing the likelihood of suicidal behaviours. Qualitative data, triangulated with quantitative service data, help to customize and ground models.

> **"What helps the privileged might not aid the disadvantaged."**

Recognize limitations

Of course modelling is no policy panacea – just look at the snail's pace of climate-change mitigation. There is necessary scepticism about the gulf between generalizations and granular detail. Useful forecasts in high-income countries might not work in low-income ones; and what helps the privileged might not aid the disadvantaged. Critics point out that if the social determinants of physical health aren't being addressed – as has been so obvious from disparate COVID-19 death and disability rates – it is naive to imagine they will suddenly be addressed for mental health once a good model is available. Critics also note that outputs are only as good as inputs, cautioning about a paucity of data and the perils of incorrect assumptions.

Nonetheless, as the pandemic rages on, alongside so many other global challenges, there has never been a more important time to strive for what we describe here.

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