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Strategies to Prevent Suicide and Attempted Suicide in New South Wales (Australia): Community-Based Outreach, Alternatives to Emergency Department Care, and Early Intervention

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Abstract: Background: This study describes the development of a system dynamics model to project the potential impact of a series of proposed suicide prevention interventions in New South Wales (NSW, Australia) over the period 2016 to 2031. Methods: A system dynamics model for the NSW population aged $\geq$ 20 years which represented the current incidence of suicide and attempted suicide in NSW was developed in partnership with a consortium of stakeholders, subject matter experts, and consumers with lived experience. Scenarios relating to current suicide prevention initiatives were investigated to identify the combination of interventions associated with the largest reductions in the projected number of attempted suicide and suicide cases for a 5-year follow-up period (2019–2023). Results: The largest proportion of cases averted for both suicide and attempted suicide over the intervention period was associated with community-based suicide prevention outreach teams and peer-led drop-in facilities (6.8% for attempted suicide, 6.4% for suicide). A similar proportion of potential cases averted of both attempted suicide and suicide (6.4%) was evident for targeted interventions focusing only on those in the population with suicidal thoughts and a previous history of attempted suicide. Conclusion: Initiatives that are characterised by the short-term stabilisation of suicidal distress at the point of crisis, averting the need for a hospital encounter, and the referral of individuals to non-acute community-based care were associated with the largest potential reductions in suicidal behaviour in NSW.

Keywords: suicide prevention; suicide; self-harm; systems modelling; simulation

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1. Introduction

Suicide and self-harm are major public health issues worldwide. Suicide is the leading cause of death among Australians aged 15–44 years. In 2019, over 3318 people died by suicide in Australia, 29% of which were from New South Wales (NSW), Australia's most populous state [1,2]. Despite consistent efforts to reduce suicide in Australia, the suicide rate has remained relatively stable over the last two decades, with evidence of a recent increase [3].

Within Australia, there has been growing attention to and investment in suicide prevention. The Prime Minister's National Suicide Prevention Advisor has led a new focus on a whole-of-government approach for suicide prevention to comprehensively address the social, economic, health, cultural, and environmental factors contributing to suicide risk in the population [4]. Within NSW, targeted suicide prevention investments have been made in order to reach the goal of a 20 per cent reduction in the rate of suicide [5]. As part of this initiative, vulnerable populations including rural communities and those who

have previously self-harmed and/or are in suicidal crisis have been identified as priority populations for intervention.

Suicide prevention strategies for priority populations are typically classified as selective interventions or indicated interventions. Selective interventions are directed towards individuals who are at greater risk for suicidal behaviour and may include training frontline workers and gatekeepers for the early detection of suicide risk or tailored psychosocial or peer support [6]. Indicated interventions are targeted towards individuals who are already displaying signs of suicidal behaviour. These interventions are more timely and assertive in managing suicide risk through active follow-up, often referred to as "aftercare" following a suicide attempt. Aftercare typically includes case management, referral to psychiatric treatment, psychosocial support, and skill-building exercises [6].

Evidence for selective and indicated interventions is still emerging. Existing data suggest that psychosocial treatment and management and aftercare interventions are effective in reducing suicidal behaviour [7–9]. There is also a growing body of evidence showing that gatekeeper training could prevent suicides [8,10]. More recently, peer support groups led by people with lived experience have also emerged as an alternative non-clinical strategy for suicide prevention; however, evidence to date on their effectiveness is limited [11]. Collectively, a "systems approach" to suicide prevention, one that delivers a combination of evidence-based interventions simultaneously, spanning the spectrum of prevention, is recognised internationally as having the best chance to reduce population suicide rates [12,13]. However, measuring the impact of multiple interventions over time and in varying contexts presents a challenge, and identifying which interventions have the most impact is also difficult.

System dynamics modelling has recently emerged as one means of addressing the complexities of evaluating multi-component public health interventions, particularly with respect to suicide prevention [14,15], and it provides policymakers with decision support tools to consider the likely impacts of interventions within complex social and health systems. Using the best available evidence, system dynamics modelling allows for an assessment of the potential impacts of different interventions at a population level, and for the identification of those interventions likely to have the greatest impact in reducing suicidal behaviour [15]. Unlike traditional analytic approaches that are typically static and independent, systems modelling can identify drivers of population-level outcomes, including changes in service interactions, workforce capacity, and the combined effects of multiple interventions [14].

Accordingly, using population-based data for NSW, we developed a system dynamics model to project the impact of a series of suicide prevention interventions on suicidal behaviour in NSW in order to assist policy decision making. Specifically, the objectives of this study were to: (1) identify suicide prevention activities likely to deliver the greatest reductions in self-harm hospitalisations and suicide deaths for NSW and (2) identify system-level factors driving population-level changes in suicide and self-harm outcomes following the implementation of suicide prevention interventions.

2. Methods

2.1. Study Context

New South Wales is the most populous state in Australia, with a population of 8,072,163 according to the 2021 Census, and represents approximately one third of the Australian population [16]. In 2017, the age-standardised rate of suicide in NSW was 10.6 per 100,000, and 76.8 per 100,000 for hospital-treated self-harm [17]. These rates are below national rates, which, in 2021, were 12.0 per 100,000 for suicide and 116.3 per 100,000 for hospital-treated self-harm [17]. Targeted suicide prevention investments have been made in NSW [5,18], and the current study focuses on a selection of these initiatives and related investments, as outlined in detail below.

2.2. Model Development

A participatory approach was adopted to develop the dynamic simulation model iteratively in partnership with NSW Health and in collaboration with a consortium of stakeholders with knowledge of or experience with suicide and/or suicide prevention in the local context. The consortium consisted of government and non-government health service providers, health policy agencies, academics, and consumers with lived experience. A core team with expertise in dynamic modelling, systems thinking, and research facilitated and provided oversight of model development. This process was informed by published research, administrative data, two participatory online workshops, out-of-session stakeholder consultations, and two demonstration forums held between October 2020 and June 2021.

Two online workshops were held via Zoom using Group Model Building techniques [19–22] adapted for the online environment with the use of a cloud-based visual collaboration platform (https://miro.com/ accessed on 25 September 2020). The first workshop (held over two days in October 2020) introduced the consortium of stakeholders to system dynamics modelling methodology and included the conceptual mapping of and collaborative discussion on the population-level factors contributing to the increasing rate of suicide over time. The stages of the lived experience of suicide were identified and mapped, noting critical points of potential intervention in preventing suicidal thinking and suicide attempt and re-attempt. Stakeholders mapped key existing suicide and mental health services and support pathways available in NSW and factors influencing the flow of the population along these pathways, and considered gaps and limitations in the system.

The second online workshop (held over two days in February 2021) focused on participants' feedback on the model structures included in a first draft of the conceptual model, and they hypothesised effects of the selected suicide prevention initiatives in the system (Table 1, and as described below). A conceptual diagram based on these participatory mapping exercises and discussions undertaken by the consortium of stakeholders was subsequently developed (Supplementary Figure S1), with model sub-sectors relating to "Stages of Suicidal Behaviour" (Supplementary Figure S2a), "Non-acute Community Support" (Supplementary Figure S2b), and "Crisis and Acute Care" (Supplementary Figure S2c).

Table 1. Suicide prevention interventions included in the system dynamics model.

Intervention	Description
Early identification and intervention	
Community-based suicide prevention outreach teams	A service provided in a community-based setting using clinical and non-clinical models of care. Mobile teams made accessible to people in suicidal crisis who would not usually contact mental health services for help. The primary purpose is the stabilisation of individuals experiencing suicidal crisis and provision of onward referral to suicide-specific community-based care.
Peer-led drop-in facilities	Peer-led drop-in facilities based in the community in proximity to emergency departments to provide a non-clinical alternative to presenting to an emergency department for people experiencing suicidal crisis. The facilities to be staffed by peer workers with lived experience of suicide and/or self-harm and supported by mental health clinicians. The service to include crisis risk assessment/screening, psychosocial support, and safety planning for suicidal behaviours to aid de-escalation and recovery.
Gatekeeper training	Provision of evidence-based suicide prevention training in the NSW community to increase the number of key community members with the skills and confidence to safely speak with and support individuals at increased risk of suicidal ideation and behaviour.
Post-attempt indicated intervention	
Post-suicide attempt aftercare support	Immediate and assertive follow-up with individuals discharged from hospital to increase access to and engagement with community-based treatment services to prevent repetition of suicidal behaviour. To include the provision of safety planning, non-clinical psychosocial support and encouragement to adhere to treatment, and problem-solving counselling with links to practical support including housing, finances, relationships. The average duration of support is assumed to be 3 months post-discharge.

Table 1. *Cont.*

Intervention	Description
Peer support groups	Provision of appropriate peer-facilitated support for people experiencing suicidal ideation and/or for people who have attempted suicide. Encourages empathetic talking about suicide combined with exploring alternative coping strategies, facilitated by people with lived experience of suicide.
Selective mental health intervention	
Expansion of clinical counselling workforce in rural communities	Expansion of clinical counselling workforce in rural and remote NSW that would provide wider access to appropriate psychological and emotional support for people at high risk of suicidality (suicidal thoughts and behaviours) in regional areas.

2.3. Model Structure

The construction, quantification, calibration, and validation of the computational model (main structure in Figure 1; see Supplementary Materials for further detail) was undertaken using standard approaches for system dynamics models [19,23–27], and developed using Stella Architect® software (version 2.1.1) (www.iseesystems.com/ accessed on 27 November 2020). The system dynamics model was initialised using 2016 local administrative data and model time units are in years, and projects to 2031.

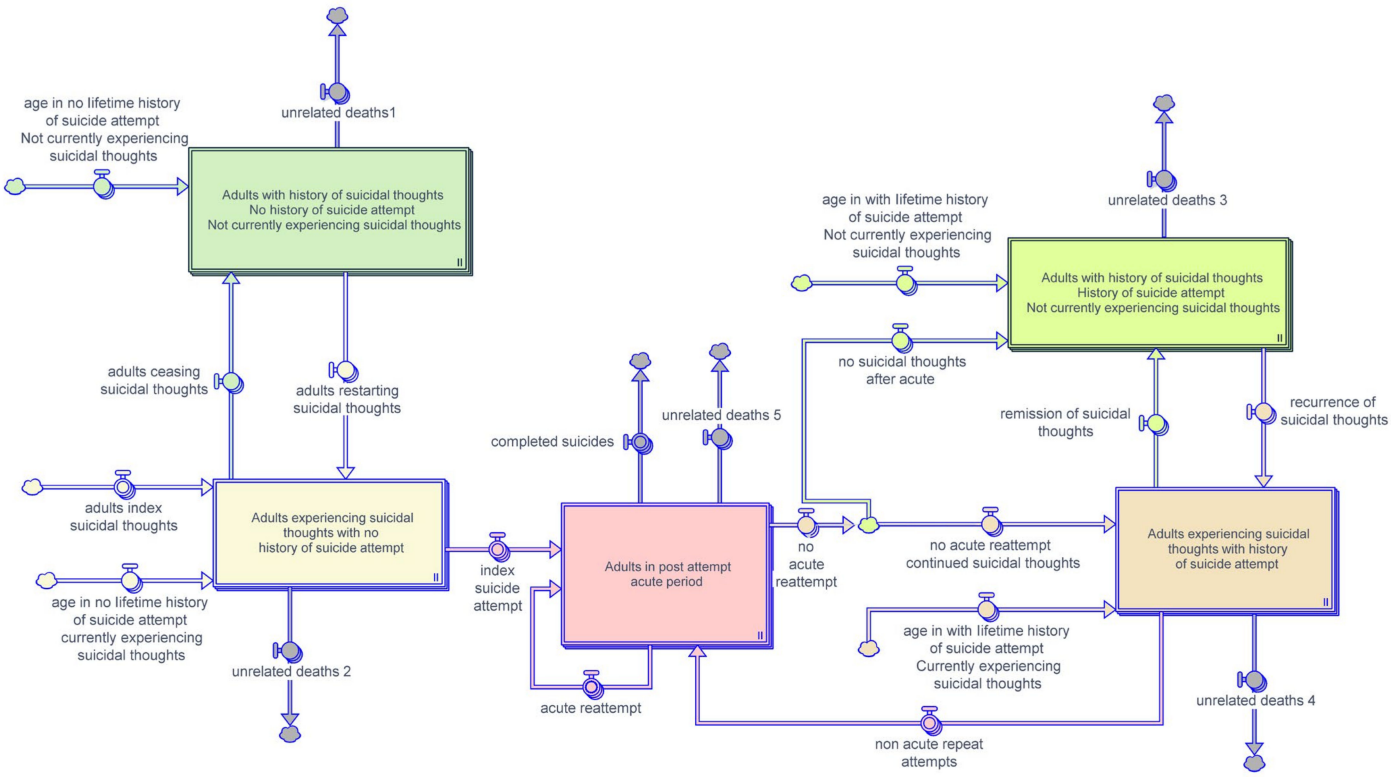

Figure 1. Main model structure representing stages of suicidal thoughts and behaviour.

The model consists of the following interacting components: (a) population dynamics; (b) stages of suicidal thoughts and behaviour (including incidence of suicidal thoughts, suicidal crisis, suicide attempt, and suicide); (c) crisis and acute care (including occurrences of acute formal stabilisation and/or social support); (d) non-acute community support and service access (including occurrences of non-acute community-based care and service access); (e) non-acute community support and service effects (relating to the probability of transition to remission from suicidal thoughts, given service access and ability of service to meet consumer's perceived needs); and (f) initiatives and scenarios (further detail on each of the core components is provided in Supplementary Materials).

Parameter values for the model were informed by published research, local administrative data, and expert consensus (Supplementary Table S1). The model is based on the population of NSW aged $\geq$ 20-years, and the model validity was tested by comparing outputs from 2016 to 2021 with trends in routinely reported suicide deaths and hospital presentations for suicide attempt/non-fatal suicide behaviour in NSW (obtained from the NSW Suicide Monitoring System death data, NSW Combined Admitted Patient Epidemiology Data, and ABS population estimates).

The model also allowed for time to scale up to achieve targets for intervention uptake and population reach. Due to the limited evidence base for some of the proposed intervention activities, services, and programmes, the model incorporated the ability to change intervention parameters to reflect new evidence on the effectiveness of specific interventions in the future. Thus, the final model allows for "what-if" analyses of the potential impact of combinations of key suicide prevention interventions to inform priority areas for future investment and public health programmes.

2.4. Suicide Prevention Interventions Modelled

Six identified interventions were included in the model (Table 1). These interventions were: (i) post-suicide attempt aftercare support, (ii) gatekeeper training, (iii) peer-led drop-in facilities, (iv) expansion of clinical counselling workforce in rural communities, (v) community-based suicide-prevention outreach teams, and (vi) broader enhancements in peer support and peer-led initiatives. Interventions were identified on the basis of current policy priorities identified by stakeholders during the participatory design phase of the model, and related to suicide prevention initiatives that are currently being implemented as part of the "Towards Zero Suicide" initiatives [18] and other population-based multicomponent interventions, such as the Lifespan initiative [28] and the National Suicide Prevention Trial [29,30]. All interventions were simulated for the period of calendar year 2019 to 2023 (inclusive), in line with an evaluation time frame of the NSW Towards Zero Suicides Initiative [18], and then onto 2031. Effects of interventions were assessed as differences between outcomes from simulated scenarios (i.e., one initiative or combinations of initiatives were run) and a "business as usual" comparator. Descriptions, default values, and assumptions for the base-case are further detailed in the Supplementary Materials.

3. Results

3.1. Baseline Estimates of Suicide and Attempted Suicide

Between 2019 and 2023, under a "business-as-usual" baseline scenario, the model projected that the number of people in NSW who attempted suicide was expected to increase by 13% to approximately 32,300 over the 5-year period, and it projected the number of people who died by suicide to increase by 11%, to approximately 930 persons per annum. Over the same time period, the model projected an 11.8% increase in annual suicide-related hospital encounters, and a 10.6% increase in the annual number of people engaged in community-based care due to suicidality. The projections for suicide equate to a projected age-standardised rate of 12.1 per 100,000 people for suicide-related deaths in NSW at the end of 2023. At the same rate over 10 years, 2019–2030, the model projected that the cumulative number of suicide-related deaths would be 11,520, a 29% increase in annual suicide attempts, and 25% increase in annual suicide-related deaths.

3.2. Impact of Targeted Interventions

The potential impact of early and indicated interventions suggested that 6.3% of cases of attempted suicide and 6.8% of cases of suicide could be averted (Table 2). The largest potential contributions of individual interventions were for community-based suicide prevention outreach teams and peer-leddrop-in facilities, for both attempted suicide and suicide (Table 2). A similar number of potential cases averted for both attempted suicide and suicide (6.4%) was evident for targeted interventions focusing on only those in the

population with suicidal thoughts and a previous history of attempted suicide (Table 2, Figures 2 and 3).

Table 2. Modelled cumulative cases of averted suicide and attempted suicide from 2019 to 2023.

	Suicide Attempts			Suicides		
	Cumulative Cases	**Cases Averted**	**% Reduction**	**Cumulative Cases**	**Cases Averted**	**% Reduction**
Early identification and intervention						
Base run	148,831			4354		
Suicide prevention outreach teams	144,960	3871	2.6	4230	124	2.8
Peer-led drop-in facilities	144,344	4488	3.0	4212	142	3.3
Gatekeeper training	148,530	301	0.2	4348	6	0.1
Post-attempt indicated interventions						
Expanding aftercare	148,462	370	0.2	4346	8	0.2
Expanding peer support	148,249	582	0.4	4338	16	0.4
Expanding rural counsellors	148,196	636	0.4	4337	17	0.4
Aftercare and expanding rural counsellors	148,103	729	0.5	4332	22	0.5
Early and indicated interventions combined	139,504	9327	6.3	4059	295	6.8
Targeted interventions for people with suicidal thoughts (a)						
No history of suicide attempts (b)	145,539	3293	2.2	4268	86	2.0
No history of suicide attempts (c)	147,790	1041	0.7	4310	44	1.0
Previous suicide attempt (last 12 months)	141,148	7683	5.2	4096	258	5.9
Previous suicide attempt	139,273	9558	6.4	4077	277	6.4

(a) Targeting people with suicidal thoughts with suicide prevention outreach and peer-led drop-in facilities. (b) For index year of suicidal thoughts. (c) For non-index year of suicidal thoughts.

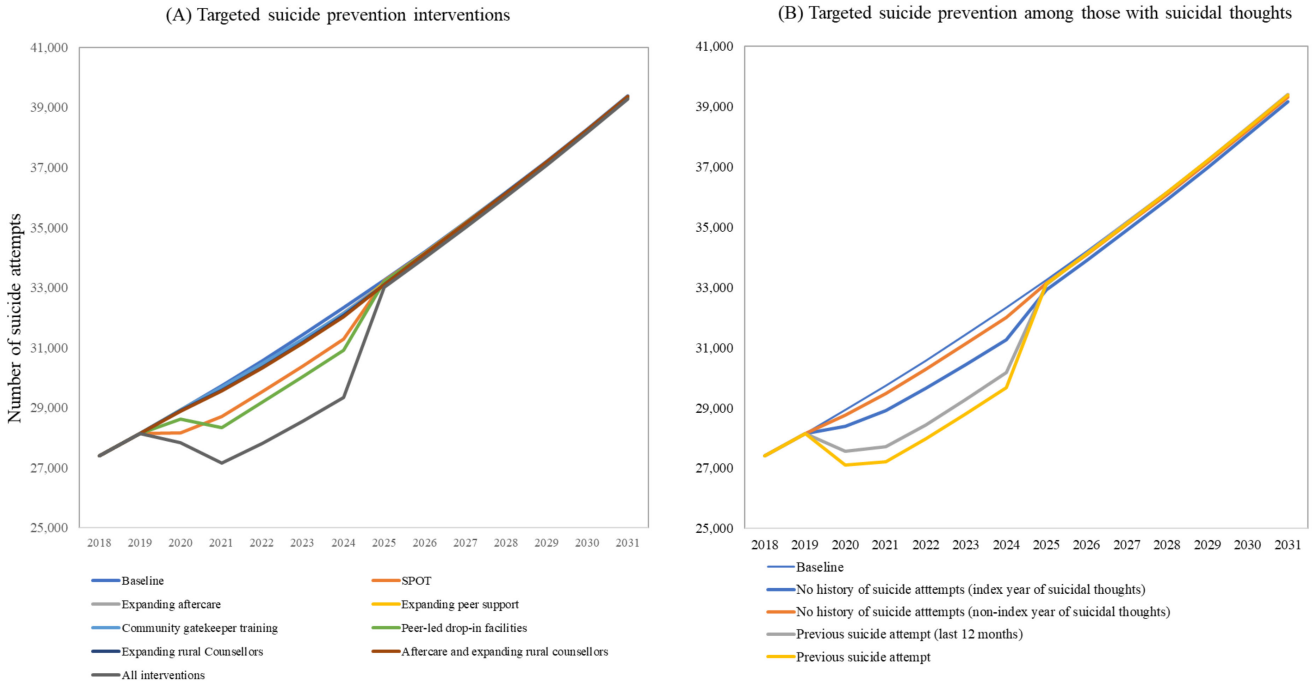

Figure 2. Modelled impact of targeted suicide prevention interventions on NSW suicide attempts (2019–2023) for (**A**) the general population, and (**B**) those with suicidal thoughts. See Table 1 for description of suicide prevention interventions included in this figure.

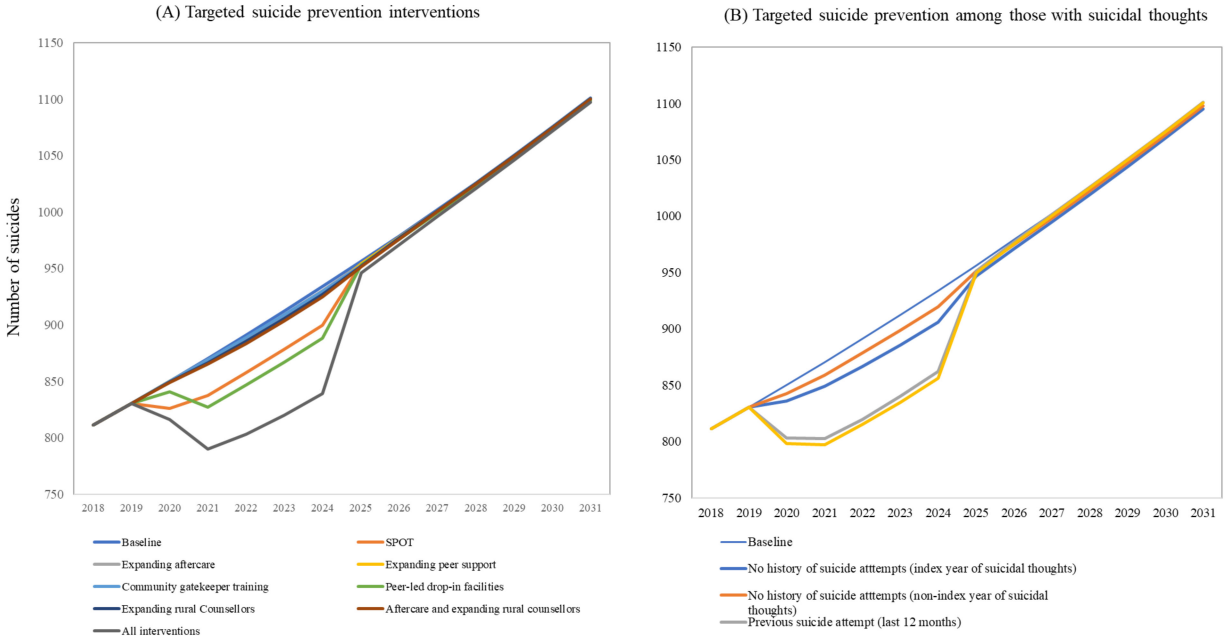

Figure 3. Modelled impact of targeted suicide prevention interventions on NSW suicide (2019–2023) for (**A**) the general population, and (**B**) those with suicidal thoughts. See Table 1 for description of suicide prevention interventions included in this figure.

If a target of a 20% reduction in suicide-related deaths is used for the NSW population aged $\geq$ 20 years, then the model projects that these initiatives would contribute 48% toward this reduction (an equivalent rate per 100,000 of 12.7 by 2023). In combination, these two interventions would also divert approximately 8.7% of individuals away from hospital encounters, and an additional 1.3% of individuals would be referred to non-acute community-based care (compared to the business-as-usual scenario over the five-year period).

4. Discussion

This study describes the co-design, development, and application of a system dynamics model that aims to inform the optimal combination of suicide prevention activity in New South Wales (Australia). Of the range of initiatives included in the model, the two initiatives projected to be the most effective at preventing suicide-related deaths and suicide attempts were community-based suicide prevention outreach teams and peer-led drop-in facilities. Community-based outreach was estimated to avert 2.6% of attempted suicides and 2.8% of suicides over the 5-year projection period. Peer-led drop-in facilities were estimated to avert 3.0% of attempted suicides and 3.3% of suicides over the 5-year projection period. Both these types of initiatives are characterised by the short-term stabilisation of suicidal distress at the point of crisis, averting the need for a hospital encounter and the referral of individuals to non-acute community-based care. The combined potential effect of all early and indicated interventions was estimated to avert ~6% of attempted suicides and ~7% of suicides over the intervention period.

Importantly, model findings also suggest that while greater short-term reductions in suicide-related deaths were demonstrated when interventions target individuals at high risk of experiencing a suicide re-attempt (i.e., post-suicide aftercare support), this will be at the expense of potential longer-term reductions in suicide that could be achieved by targeting interventions towards individuals who have yet to experience a suicide attempt, particularly those in the index year of experiencing suicidal thoughts. The implication of this finding is that modifying intermediary risk factors associated with subsequent suicidal behaviour (psychological distress, mental disorder, and social and economic stressors)

among those in the general community may be an additional strategy for early intervention to prevent hospital-treated self-harm and suicide.

There are a number of limitations for consideration when interpreting the findings of this paper. Firstly, the system dynamics model described in the current study models populations in aggregate and is limited in providing insights into individual-level impacts, or for specific population subgroups. The model captures population and behavioural dynamics that impact mental health service capacity, and the uptake and scaling of suicide prevention activity. However, agent-based models are better placed to capture complex individual-level behaviours and sociodemographic characteristics [31]. A system dynamics modelling approach is perhaps more appropriate in the current context, given the need for policymakers to understand the likely population-level impacts of proposed interventions to prevent suicide, and the need for timely insights for responsive decision making.

Secondly, there is potential measurement bias in the secondary data used to parameterise the model, and the extent to which estimates identified from the literature, or sourced from other populations, may be generalisable to the NSW context. Population-based data relating to mental health services (such as hospitalisations, workforce information, and service capacity), population-level psychological distress, and suicidal behaviour (suicide and hospital-treated intentional self-harm) were based on routinely collected datasets. It is acknowledged that there is potential under-enumeration of suicide and attempted suicide, due to misclassification (for events of "undetermined intent"), and attempted suicides represent only those cases that present to services (and not the total population burden associated with suicidal behaviour). Some estimates for parameters were not available from secondary datasets, and in these instances, a combination of estimation and stakeholder consensus was used to establish parameter values. Additionally, the model interface incorporated a series of "sliders" for a selection of parameters to allow for stakeholders to investigate the impact of alternative assumptions for parameters on the model projections of suicide and attempted suicide.

Thirdly, the model considered a limited set of interventions and scenarios. Selected interventions were based on stakeholder priorities in the context of current prominent suicide prevention initiatives such as the NSW Health Towards Zero Suicide initiatives [18], and related initiatives relating to population-level multi-component interventions [28–30]. Other potentially relevant interventions, for example, relating to social determinants associated with suicidal behaviour [32] and the provision of psychosocial or economic interventions to modify intermediary risk factors [33], may also be important for consideration. Alternative scenarios and combinations of interventions may result in a different set of findings.

Fourthly, the model was developed for the NSW population, which may affect the generalisability of the findings. However, while the model was developed for a specific population, the insights are based upon generically framed suicide prevention initiatives that are not based on a specific prescribed approach to design, implementation, and resourcing. The findings are likely applicable to other high-income country contexts with a similar epidemiology of suicide, and where there are coordinated aftercare strategies that are planned for those at suicidal risk in publicly funded health systems that provide (nominally) universal healthcare.

A key strength of the modelling approach in the current study was the quantitative approach to capture the complexity of suicidal behaviour and the mental health system, in combination with the participatory approach that involved stakeholders and subject matter experts in mapping the underlying structure of the system, and in the critical appraisal of model inputs. This is distinct from the more qualitative, non-evidence-based approaches that can sometimes be associated with the prioritisation of suicide prevention policies and interventions.

This study suggests that the combination of community-based suicide prevention outreach teams and peer-led drop-in facilities was associated with the greatest potential reductions in both suicides and attempted suicides over the selected 5-year intervention period. However, model findings also suggest that while short-term reductions in suicide

can be achieved by focusing on individuals at high risk of experiencing a suicide re-attempt (that is, via aftercare support services), this will be at the expense of potential longer-term reductions in suicide that could be achieved by targeting interventions towards individuals who have yet to experience a suicide attempt. These findings emphasise the immediate and longer-term benefits of targeting early intervention among individuals who may be experiencing psychological distress in the general community, as well as those at higher risk, in order to achieve the greatest reductions in suicides and attempted suicides and optimise mental health services for the NSW population.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/systems11060275/s1, Figure S1: Conceptual model of the stages of suicidal behaviour; Figure S2: Refined conceptual diagram of proposed model sectors; Description of system dynamics model components available with Figures S3–S7; Figure S3: Population Dynamics Sector; Figure S4: Stages of suicidal behaviour sector; Figure S5: Crisis and acute care sector; Figure S6: Non-acute community support sector; Figure S7: Non-acute community support and service effect sector; Table S1: Numerical Input and Data Sources.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: The authors declare no conflict of interest that are relevant to the content of this article. This research is based on a system dynamics model developed as part of work commissioned by the Health Administration Corporation for and on behalf of NSW Health undertaken by the Sax Institute. The NSW Ministry of Health specified the scope and objectives of the model, and the model structure was developed by Dr Danielle Currie, Senior Systems Dynamic Modeller, Sax Institute, on the basis of inputs and content expertise as part of a participatory-design model-building process facilitated by the Sax Institute. The funder had no role in the collection, analyses, or interpretation of data reported in this manuscript, in the writing of the manuscript, or in the decision to publish the results.

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