

Digital health and precision prevention: shifting from disease-centred care to consumer-centred health

Oliver J. Canfell ^{1,2,3,4,6,7} BExNuSc, MDietSt, PhD, APD, Research Fellow – Digital Health Transformation

Robyn Littlewood⁴ BSc, PGDipNutrDiet, GCELead, MMedSci, PhD, FDA, Chief Executive Officer, Adjunct Professor

Andrew Burton-Jones³ BCom(Hons), MInfSys, PhD, Professor – Business Information Systems

Clair Sullivan^{1,4,5} MBBS(Hons), MD, FRACP, FAIDH, CHIA, Clinical Informatics Director – Research, Consultant Endocrinologist, Associate Professor of Clinical Informatics

¹Centre for Health Services Research, Faculty of Medicine, The University of Queensland, Brisbane, Qld, Australia. Email: c.sullivan1@uq.edu.au

²Digital Health Cooperative Research Centre, Australian Government, Sydney, NSW, Australia.

³UQ Business School, Faculty of Business, Economics and Law, The University of Queensland, Brisbane, Qld, Australia. Email: abj@business.uq.edu.au

⁴Health and Wellbeing Queensland, Queensland Government, Brisbane, Qld, Australia. Email: hwqld_exec@hw.qld.gov.au

⁵Metro North Hospital and Health Service, Department of Health, Queensland Government, Brisbane, Qld, Australia. Email: clair.sullivan@health.qld.gov.au

⁶Present address: Level 5, Health Sciences Building, Faculty of Medicine, The University of Queensland, Herston, Qld, Australia.

⁷Corresponding author. Email: o.canfell@uq.edu.au

Abstract. Digital disruption and transformation of health care is occurring rapidly. Concurrently, a global syndemic of preventable chronic disease is crippling healthcare systems and accelerating the effect of the COVID-19 pandemic. Healthcare investment is paradoxical; it prioritises disease treatment over prevention. This is an inefficient break–fix model versus a person-centred predict–prevent model. It is easy to reward and invest in acute health systems because activity is easily measured and therefore funded. Social, environmental and behavioural health determinants explain ~70% of health variance; yet, we cannot measure these community data contemporaneously or at population scale. The dawn of digital health and the digital citizen can initiate a precision prevention era, where consumer-centred, real-time data enables a new ability to count and fund population health, making disease prevention ‘matter’. Then, precision decision making, intervention and policy to target preventable chronic disease (e.g. obesity) can be realised. We argue for, identify barriers to, and propose three horizons for digital health transformation of population health towards precision prevention of chronic disease, demonstrating childhood obesity as a use case. Clinicians, researchers and policymakers can commence strategic planning and investment for precision prevention of chronic disease to advance a mature, value-based model that will ensure healthcare sustainability in Australia and globally.

Keywords: eHealth, preventive medicine, public health, public health informatics, medical informatics, noncommunicable diseases, childhood obesity, healthcare systems.

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A system under pressure

Chronic disease is the leading cause of ill health, disability and death in Australia.¹ More than one-third (38%) of this burden is preventable.¹ There are at least two healthcare models for addressing this burden: break–fix (current) and predict–prevent. Predict–prevent is the most efficient; every prevention dollar

invested saves approximately US\$27 long term.² The break–fix (disease-centred, acute care) system only explains ~20% variance in population health.³ Australia’s healthcare investment logic is paradoxical: 40% (A\$74 billion) is necessary to fuel break–fix healthcare but only 9.6% (A\$17.9 billion) supports disease prevention.⁴ This inequitable investment model is

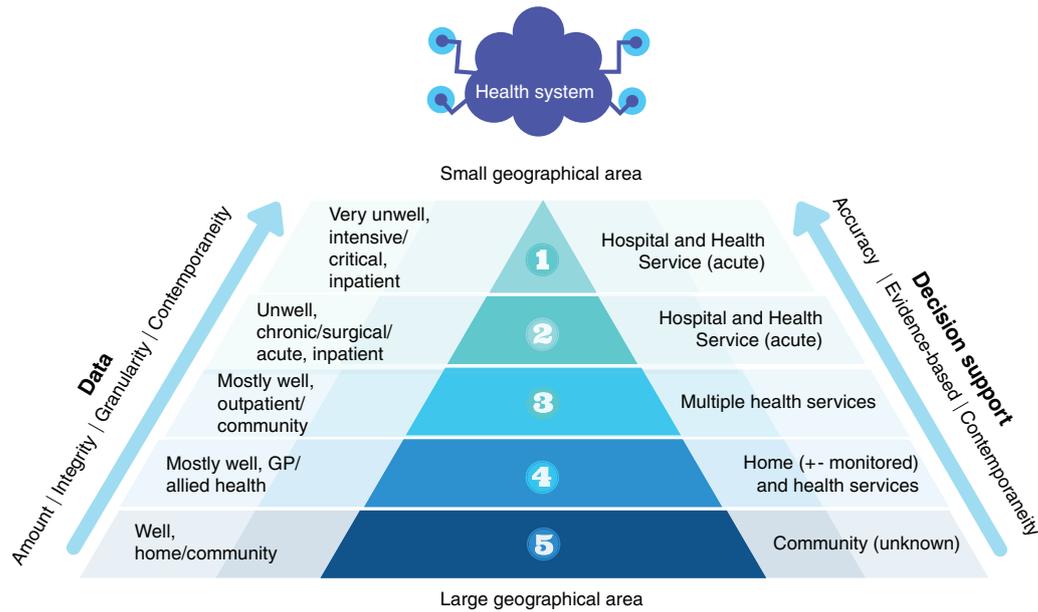


Fig. 1. Population health data pyramid from a health system perspective in Australia.

unsustainable considering our ageing population and growing burden of chronic disease.

Perversely, Australia's health services are rewarded for failing to keep populations well; every sick patient treated is counted as activity and funded, and there is minimal incentivisation to reduce hospitalisations. It is difficult to incentivise and reward improvements to population health in Australia when it is not measured in a contemporaneous, actionable way to enable funding. Measurement of populations currently comprises retrospective point prevalence surveys, clinical research and disease registries. The maxim 'what is measured, matters'⁵ is missing in population health but certainly holds true for acute care; this underpins the current paradoxical investment model favouring break-fix.

Digital health and precision prevention

Digital health enables measurement of health care delivery for every patient in real time. Social, environmental and behavioural health indicators explain ~70% of health variance, yet are not measured meaningfully, and so are poorly funded.⁶ A solution for measuring population health and making disease prevention 'matter' is digital health. Digital transformation has resulted in 22.68 million My Health Records¹ and 65% of public hospitals using an electronic medical record (EMR) platform to manage clinical information.⁷ Digital health has yielded significant data availability, decision support, clinical informatics and innovative benefits (e.g. precision medicine, artificial intelligence) to the break-fix system.⁸ These have improved acute health outcomes and system monitoring but at significant cost (\$1.26 billion in Queensland)⁹ and with minimal effect on overall population health.

Digital health applied to the prevention sector could leverage real-world evidence (RWE), i.e. health information derived from contemporaneous, dynamic and consumer-centred sources, such as EMRs, electronic health records (EHRs), mobile health (mHealth) applications and digital wearables.¹⁰ Aggregation

and meaningful presentation of this preventive data enables: (1) advancement from static and retrospective to accurate and real-time measurement of population health; (2) precision prevention interventions, targeting precise, at-risk groups or communities by tailoring interventions to unique characteristics, modifying care delivery systems or implementing targeted policy or macroenvironmental changes that are customised to each group based on *risk* and *need*;¹¹ and (3) monitoring population health intervention and 'counting' improvement (via near real-time changes in health determinants, chronic disease risk factors and prevalence, and wellbeing indicators) to create deliverables to justify the necessary funding shift to enable an efficient predict-prevent model.

Demonstrating childhood obesity as a use case, we highlight three barriers to this funding shift and propose three digital horizons¹² to guide health system, organisational and policy decision makers towards precision prevention.

Barriers to digital investment for disease prevention

Investment myopia

Investment in digital health has exploded. Australia's digital health market was valued at US\$1.599 billion in 2018 and US\$1.851 billion in 2020.¹³ Globally, strategic publications in digital health have likewise surged, reflecting years of iterative, multi-national investments and rapidly advancing technologies.¹⁴⁻¹⁶ Despite this growth, the acute sector and disease treatment remain the focus. Prevention is discussed in abstract, conceptual and future-focused terms with little concrete commitment to preventive investment and transformation, likely because there is limited ability to measure prevention delivery and outcomes. This myopic investment strategy that enables break-fix over predict-prevent is explainable from an institutional perspective. Policymakers invest in a system that is easily measurable by counting care delivery in acute health services, a behaviour explained by a complex mix of habits, norms,

Table 1. Three horizons framework for digital health transformation towards precision prevention of chronic disease in Australia

Horizon	Action
Horizon 1: Building digital health prevention foundations	<ul style="list-style-type: none"> • Map data required to inform preventive decision making for chronic disease prevention – for patients, communities, priority populations, health system and government sectors. • Integrate existing and generate new data infrastructure to support aggregation, hosting and operationalising of data to inform preventive decision making, especially to unite health, education, social and environmental sectors. • Curate digital citizens, where consumer-owned data on determinants of health (social, biomedical, behavioural) is securely collected in real time via digitally validated apps/wearables (in partnership with industry), aggregated around the consumer themselves for trust and ownership and not siloed in government departments or vendors. This data is visible in real time to inform clinical and public sector decision making. Data richness is enabled by partnering with mHealth, wearable and digital health behaviour change interventions to support continuous data flow. • Build interoperability between fragmented data systems across sectors and the continuum of care. • Deploy change making and organisational readiness initiatives to support funding and subsequently policy shifts towards preventive digital transformation. • Develop digital literacy in the context of prevention; (1) adopt a multi-modal and multi-strategy hub-and-spoke model of digital literacy education to reach underserved, priority areas (communities) and integrate into workforce education and training (tertiary); (2) incentivise participation for priority populations (e.g. culturally and linguistically diverse peoples) and communities. • Embed sectoral prevention divisions, high-level digital health champions (Board/Executive) and conjoint positions to drive partnership, system interoperability and a shared vision.
Horizon 2: Transforming preventive care using data and analytics	<ul style="list-style-type: none"> • Optimise existing digital workflows with preventive clinical decision support systems to optimise preventive care. • Redesign old and build new clinical and community workflows that ensure routine and standardised collection of actionable preventive data on the determinants of health. • Integrate high-value predictive analytics for disease across the life course, supported by localised referral pathways, actionable, evidence-based preventive intervention, practitioner training and iterative validation and evaluation to drive continuous improvement. • Develop digital infrastructure to aggregate real-world data from social, biomedical, environmental and behavioural determinants of health and analyse this data in real time with innovative analytics (decision support, artificial intelligence and prediction) to support targeted prevention decisions and funding at a community and population scale.
Horizon 3: A learning system of precision prevention	<ul style="list-style-type: none"> • Hub and spoke digital models of care that are underpinned by centralised, interoperable data systems that are state/nationally owned rather than organisationally owned and shared by healthcare and prevention service providers. • Prevention transcends individual diseases – it is systemic. All data captured contributes to a real time, learning healthcare system driven by prevention. • Use shared population data infrastructure to precisely deliver preventive interventions for specific chronic diseases based on collective social, biomedical, environmental and behavioural risk. • Genomics screening drives preventive decision making across the life course – for populations (precision health) and individuals (precision medicine). • Map existing and pilot new digital interventions in emerging areas – artificial intelligence, machine learning, medical robotics, remote monitoring, virtual care – across the prevention continuum to achieve a learning system of prevention. • Evidence-based digital models of care are synthesised into digital clinical practice guidelines and inform future workforce education and training. • Policy is strengthened to include incentivisation for health services and communities curating well consumers, and reward for reducing hospitalisations related to chronic disease.

assumptions and interest.¹⁷ The investment strategy reinforces the status quo rather than transforming it.

Disease-centred data and health care

Rapid digital health transformation has enabled RWE in acute clinical care. In hospitals, an unwell patient, and treatment of disease, forms the epicentre of data collection. Rich clinical data is necessary for every patient, every time, in real time. This disease-centred data drives contemporaneous, accurate and risk-based decision making to improve patient care. The amount, integrity, granularity and contemporaneity of this data evaporates as the ‘well’ patient is discharged and isolated from the system (and from real-time data collection)^{8,18} (see Figure 1).

In contrast, data currently used for disease prevention is often years old and captured as point prevalence snapshots. RWE for preventive health (i.e. social, environmental and behavioural)

exists in pockets of data excellence; data is rich and plentiful but severely fragmented, aged and static across sectors.¹⁸ To realise precision prevention, consumers (well patients) must be the epicentre of real-time data collection and aggregation for preventing chronic disease.

Consumer privacy

Privacy concerns around the secondary use of data have underpinned a lack of strategic use of data for population disease prevention. Consumers understand the benefits of secondary use of health data if a balance between individual privacy and public benefit is maintained.¹⁹ We hypothesise that the COVID-19 pandemic may contribute to slowly dissolving public fear around secondary data usage in coming years. Trust, transparency, open public dialogue, consumer feedback loops and robust policies are crucial.

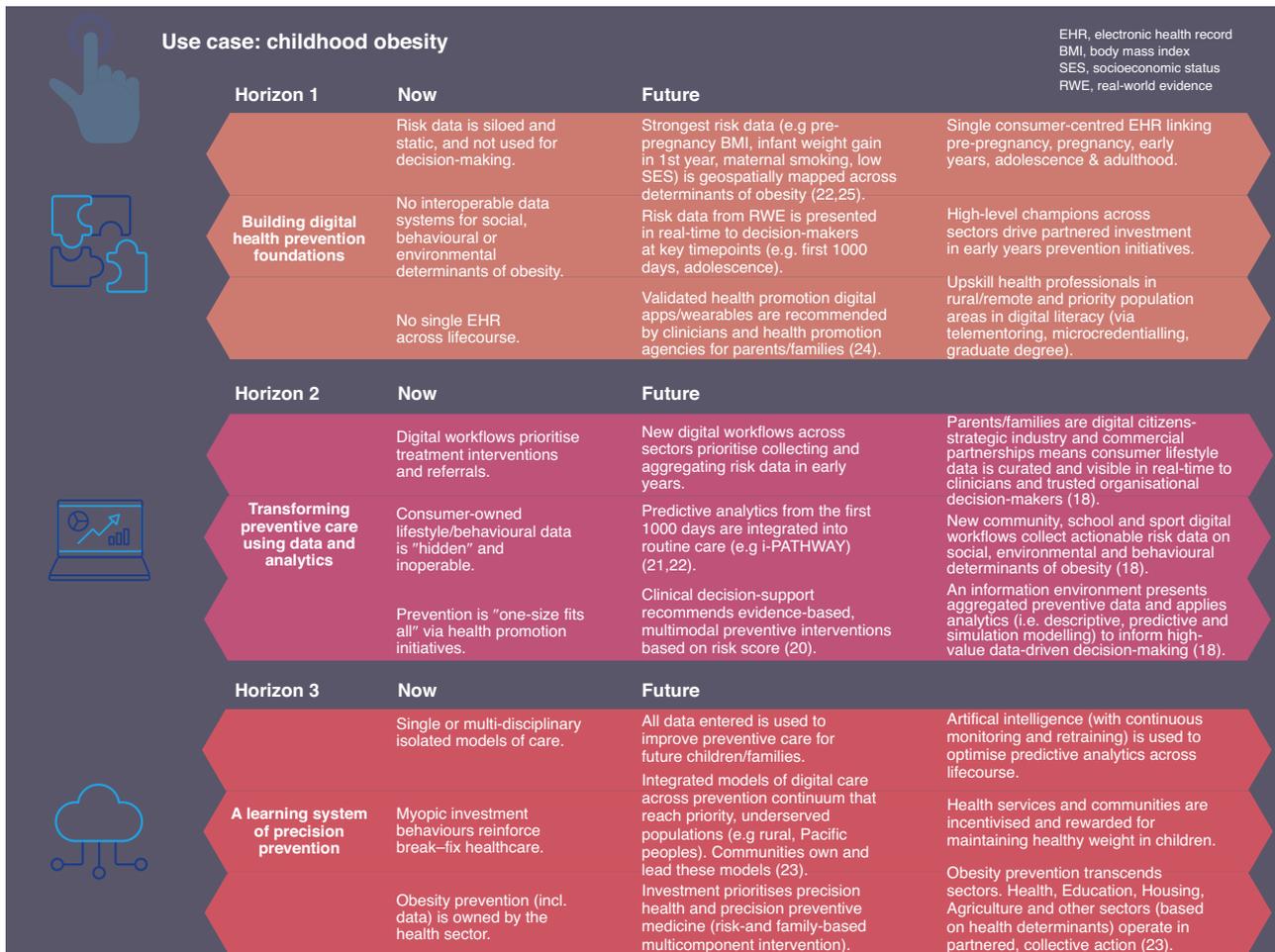


Fig. 2. Childhood obesity: a use case of the three horizons framework¹² for digital health transformation towards precision prevention of chronic disease.^{18,20-25} BMI, body mass index; SES, socioeconomic status.

A new direction

Real-time, consumer-centred aggregation of data on determinants of health is critical for building the digital foundations for precision prevention. New global strategy is aligned with this direction; the World Health Organization Global Strategy on Digital Health outlines a strategic priority to ‘advocate people-centred health systems that are enabled by digital health’¹⁶.

Several state jurisdictions in Australia (Queensland, New South Wales, Western Australia) are pivoting their information systems from disease-specific registries to consumer-centred EMRs. For this perspective, we leveraged the Queensland Digital Health Clinical Charter and its three horizons¹² for digital transformation of acute hospital care to propose three new horizons for precision prevention of chronic disease (Table 1).

Figure 2 presents a use case of precision prevention for childhood obesity mapped to our three horizons. The purpose is to provide a pragmatic foundation to guide digital health investment, decision making and research for precision prevention in Australia.

Australia’s opportunity

Digital health transformation is difficult and lengthy. The greatest challenges for precision prevention will be securing societal unity and support, transforming investment behaviours and digitally uniting a fragmented public sector to measure and make population health ‘matter’. Beginning with (a) mapping preventive data points and data assets and (b) engaging with multi-sectoral prevention stakeholders to co-produce a roadmap for advancing the three horizons for precision prevention, Australia can shift from low-value break-fix to high-value predict-prevent for chronic disease to ensure healthcare sustainability.

Data availability

Data sharing is not applicable as no new data were generated or analysed during this study.

Competing interests

The authors declare that they have no competing interests.

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