Conference Proceedings of the
2008 International Conference of the System Dynamics Society
July 20 – 24, 2008, Athens, Greece
ISBN 978-1-935056-01-0
http://www.systemdynamics.org/conferences/2008/proceed/abstracts/456.html

# Linking clinical workforce skill mix planning to health and health care dynamics

Geoff McDonnell, David Lyell, Keith Masnick, Ime Asangansi and John Dewdney

Centre for Health Informatics, University of New South Wales, Kensington, Australia

***Abstract**: Current health workforce planning methods are inadequate for the complexity of the task. Most approaches treat the workforce supply of individual health professions in isolation and avoid quantifying the impact of changes in skills mix, either planned or unplanned. The causes and consequences of task delegation and task substitution between or within health professions is particularly important in handling workforce shortages in developing countries and understanding and planning possible responses to both rapid catastrophic health demands and slower background trends in their social and political environment. As well as the contextual environment, interactions and delays in supplying and balancing health resources and configuring clinical services are required to address the geographic, profession-specific and quality imbalances. These supply side resources include knowledge and research, skills and attitudes of clinicians, buildings and equipment, medications and medical technologies, information and communications technologies and any other methods and models to improve the provision of clinical services. The interaction between demand and supply could adjust for feedbacks of health services outcomes, policies and governance on population expectations, funding, political and social supports and explicitly link these to clinical workforce supply in a useful, rigorous and relevant tool. The challenge is capture the relevant essence of the dynamic complexity of health and healthcare for this purpose.*

**Introduction**

The current health workforce planning literature is much concerned with discussion and suggestions as to the optimal composition of a health workforce, but there is remarkably little by way of tools to assist the planner in actually determining what might be an optimal mix. We have been attempting to devise a simple do-it-yourself tool which would help in drawing up and examining the staffing, service and costing implications of alternative skill mix scenarios. The scenarios would reflect different mixes of personnel categories, the shifting of tasks from one category of personnel to another, the substitution of one type of worker with another and the possible creation of new categories of health worker where this appeared to be desirable. The planner would then have a repertory of alternative scenarios from which to select the most appropriate choice.

Our quest for such a tool has taken us well beyond the simple 'stock and flow' type planning approach which has been widely used in health workforce planning, generally focussed on one or other particular category of health service personnel, most commonly doctors or nurses, and less frequently on dentists, pharmacists, laboratory and medical imaging personnel, physiotherapists, speech therapist, community health workers, other clinical personnel groups or occasionally on workers in managerial, administrative, engineering, housekeeping and other support personnel categories. We realized that we not just thinking about a 'workforce problem' rather we were confronting a 'dynamic system' problem. This paper presents a picture of that system.

**Basic components**

We started modelling a system with three basic components – the population to be served, the clinical workforce to serve it, and the workload generated by both the population and the clinical workforce.

The population, ever changing in numbers and composition through the interplay of births, deaths and migration, is the source of people with 'health conditions', or more precisely 'ill-health conditions', some with disabilities, and some with disease, thus generating the need for clinical health care. For a range of reasons including personal choice, fears and prejudice, geographic and financial accessibility,

perceived quality and acceptability of available services, some of that need will be manifest in demand for care and so constitute part of the 'clinical workload' confronting the clinical workforce.

The clinical workload we are concerned with is the workload made up of the four essential functions of personal health service delivery - detection, identification, diagnosis and treatment of health conditions - involving person-to-person interaction between the affected person and one or more persons trained in at least one, but usually more of these four essential functions. The trained personnel in this interaction make up what we have called, and are generally recognised as, the 'clinical workforce'. Some readers may be uneasy with the absence of the word 'prevention' from our listing of clinical workload activities. The reason for this omission is our view that the preventive activities of clinicians in their face-to-face interaction with their patients, covering as they do all three levels of prevention – primary, secondary and tertiary - can well be subsumed under the broad heading 'treatment".

Although health system policy makers, planners and managers are faced with issues extending well beyond concerns relating to the clinical workforce, we have chosen to concentrate our attention on
this composite group because clinical personnel, those who participate on a one-on-one basis with the detection, identification, diagnosis and treatment of people with health conditions, constitute the most numerous personnel group and the most financially costly element in virtually every national health care delivery system across the world.

**The population and people with health conditions**

***Determinants of population numbers and composition***

Population numbers and composition – commonly described in terms of age, sex and ethnicity – are, at the first level of analysis, the outcome of three processes, birth, death and migration. These processes reflect the dynamic interaction of many factors, some relating to human genetics and human behaviour, others being responses to environmental influences beyond human control. Our particular interest is focussed on a particular group within a population at large, the group of people with what we have referred to as 'health conditions'.

***People with health conditions***

Listings of classifiable and classified diseases and disabilities which may affect human beings – for example the entities listed in the items listed in the International Statistical Classification of Diseases and Related Health Problems,10th Revision, Version for 2007 – run into thousands of items. For workforce planning purposes very basic groupings such as acute, chronic, life threatening, requiring short-term or long-term institutional or ambulatory care are generally sufficient. Many of the people with health conditions need clinical care, but, as we noted earlier, not all of them seek such care – we are concerned in our modelling here with those who do, since this expressed demand for care determines the size and nature of the 'clinical workload'.

***Impact of 'non-clinical' preventive activity and 'alternative medicine'***

Of course 'non-clinical' preventive activity in its many and varied forms will have an important role in determining the number of people with health conditions, and the nature of those conditions.

Substantial numbers of people in the 'with health conditions' group may seek or receive 'clinical care' from practitioners of 'alternative medicine' and other forms of clinical intervention. Our model does not take these factors into account, since we are concerned with planning relating to the size and composition of what we have chosen to regard as the 'professional' clinical health workforce.

**The clinical workload**

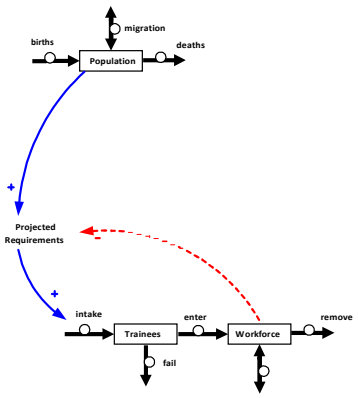
We have discussed the determinants of the size and composition of the expressed demand for clinical care, we now need to express that demand in workload terms – what are the nature and volume of the inputs and processes, required to meet the demand?

Previously we identified the essential processes involved in clinical care as detection, identification, diagnosis and treatment of disease and disability. The essential inputs to these processes can be identified as people expressing their demand for clinical care, the clinical health workforce and medical technology. Together these three elements determine the output and subsequent outcome of the service provided by the clinical sector of the health system.

**The clinical workforce**

The clinical workforce of our concern is comprised principally of 'doctors' – medical practitioners who have graduated from a medical school on the completion of generally 4 to 6 years training followed by one or more years of internship, and in the case of specialists several more years of advanced specialist training; second tier medical practitioners referred to variously by such titles as assistant medical officers, auxiliary medical officers, clinical officers, health officers, health extension officers, non-physician clinicians – generally having completed at least three years training.

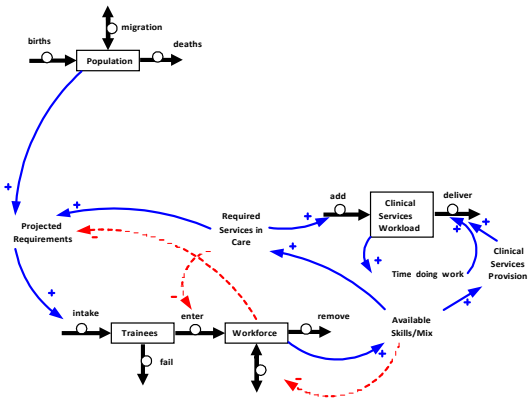
**Current mental and spreadsheet stock-flow models**



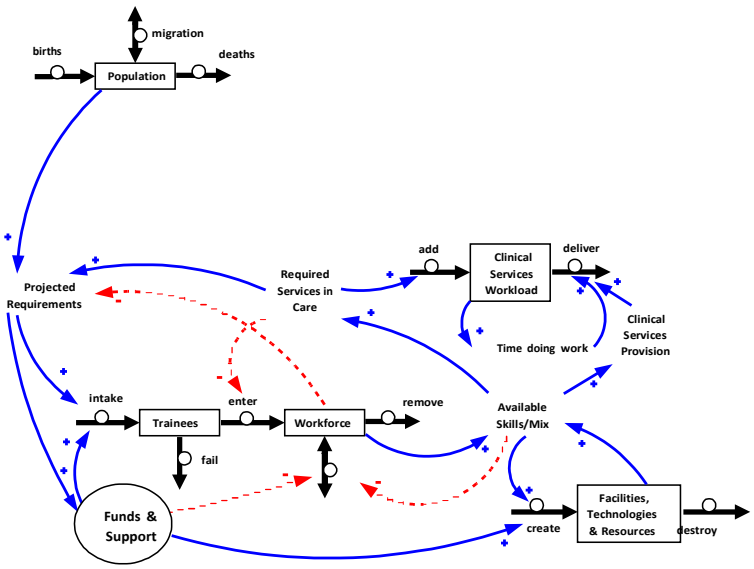
A stock-and-flow approach to clinical workforce planning within a health system is essentially a numbers game. On the input side, contributing to the workforce stock, we have the number of students taken into training and their number subsequently employed in the health system, the number of clinicians previously trained but currently outside the health system recalled back into employment will take into account, and the number of personnel trained elsewhere but imported to fill posts within the health system. On the exit side we have personnel who resign, retire, are invalided out or are dismissed from the system, and those who die while in employment.

Projected requirements are based on an agreed number of doctors, nurses and midwives per population and the difference between current workforce and requirement results in a change in intake of trainees, if the funds and support are available.

But planning for an effective and efficient clinical workforce calls for attention not simply to numbers, but to skill mix within the workforce, retention of trained personnel, worker productivity, and appropriate deployment of staff.



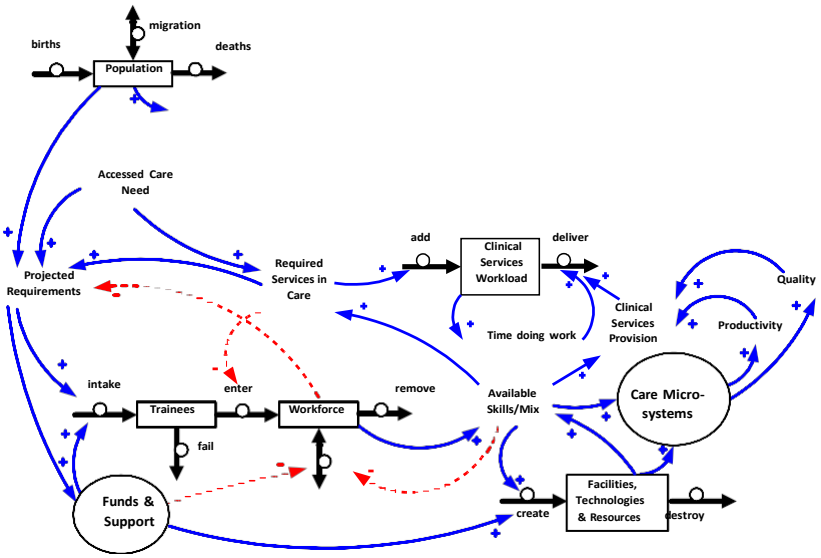

Our stated purpose of creating a useful tool for planning and managing skills mix in developing countries led us to the above conceptual model scope. This appeared to be a starting point for modelling the impacts of task transfer, substitution and creation of new categories. However, it quickly became apparent that we needed to consider further determinants of workforce effectiveness and efficiency – retention, productivity (incentives, effective and perverse), deployment, technology and the like. This led to a more complete supply side picture which includes all technologies and funds and political support which affect the clinical professional's ability to provide clinical care.




Note in the above diagram 'Funds & Support' is represented as a circle rather than a stock. The circle is used to depict the fact that this is a collection of individual payers and link the model to the vast literature that depicts the health system as a contested arena of conflicting interests. The agents involved in this contest are usually referred to as payers, providers and patients. In addition, regulators or "governors", people who use policies, power or other governance mechanisms (including managers and administrators), can be considered as another individual "player" in the contest.

**Clinical Care Microsystems**

The basis of clinical care is the healing interactions among patients, healers and carers. This is often described in a more technical sense as the clinical microsystem, the way the care team, including the patient, work together to perform clinical work. This is now seen as a complex socio-technical system with great potential for both superior results and catastrophic errors. This is represented in the following diagram, again with a circle to represent the clinicians as individual agents. The clinical tasks of informing, deciding, acting and communicating are performed by interactions among the agents, who are constrained or enabled by the structural environment.



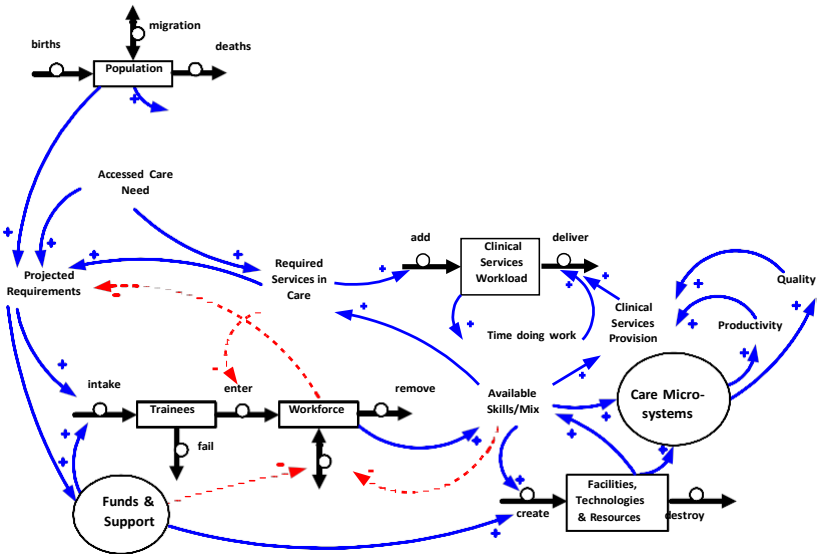

**Linking Clinical Work to the Rest of Healthcare**

Clinical work is performed by health professionals in institutional patient care settings. These include hospitals, doctors' offices, primary health and community care clinics, residential care, and patients' homes. Patients in care enter and exit the various institutions of care that are provided in the facilities, service configurations and "models of care" provided at the macro-level through the sectoral structure of health care.

Based on previous work on both patient flows and access and demand for care, we added the two additional stocks of people with health conditions and patients in care between population and clinical workload.

The people with health conditions links in with extensive published work on chronic disease progression and also be expanded to embrace the epidemiological SIR and related models of acute infectious disease.

The 'patients in care' stock depicts those people contracted to a care institution to receive clinical services. Here they are considered as patient care episodes, since this is the way health outputs or service activity is measured. In a continuum of care, these episodes can last from brief care institution interactions between patient and healer/carer to a lifetime of chronic care, depending on the purpose
of the model.



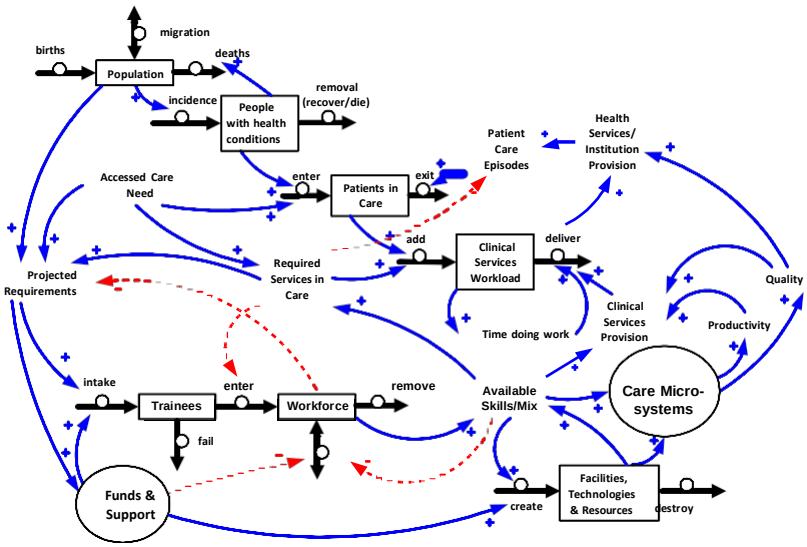

**Linking Clinical Work to the Rest of Healthcare**

Clinical work is performed by health professionals in institutional patient care settings. These include hospitals, doctors' offices, primary health and community care clinics, residential care, and patients' homes. Patients in care enter and exit the various institutions of care that are provided in the facilities, service configurations and "models of care" provided at the macro-level through the sectoral structure of health care.

Based on previous work on both patient flows and access and demand for care, we added the two additional stocks of people with health conditions and patients in care between population and clinical workload.

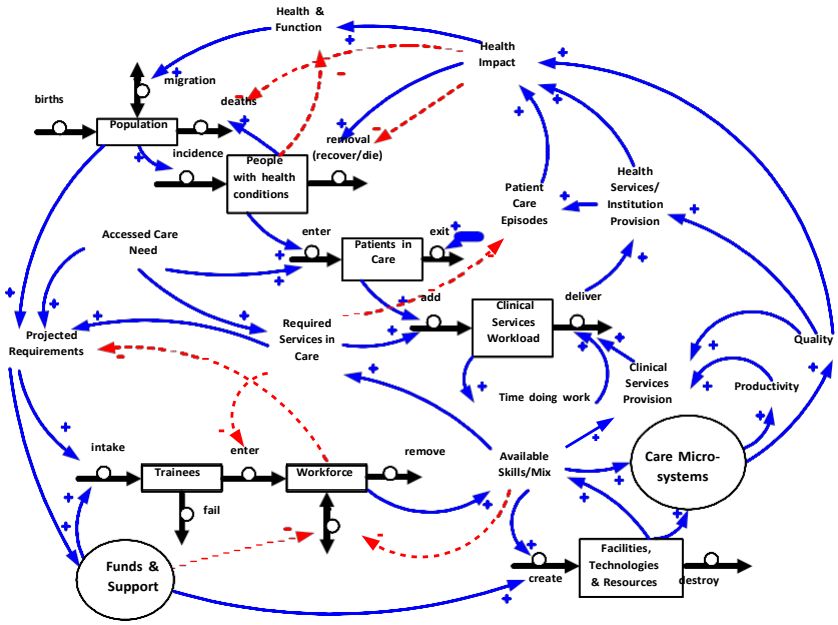
The people with health conditions links in with extensive published work on chronic disease progression and also be expanded to embrace the epidemiological SIR and related models of acute infectious disease.

The 'patients in care' stock depicts those people contracted to a care institution to receive clinical services. Here they are considered as patient care episodes, since this is the way health outputs or service activity is measured. In a continuum of care, these episodes can last from brief care institution interactions between patient and healer/carer to a lifetime of chronic care, depending on the purpose
of the model.


migration
births
deaths
Population
incidence
People with health conditions
removal (recover/die)
Patient Care Episodes
Health Services/ Institution Provision
Accessed Care Need
enter
Patients in Care
exit
add
Clinical Services Workload
deliver
Projected Requirements
Required Services in Care
Quality
Clinical Services Provision
Time doing work
Productivity
intake
enter
Trainees
Workforce
remove
Available Skills/Mix
Care Micro-systems
fail
Funds & Support
create
Facilities, Technologies & Resources
destroy

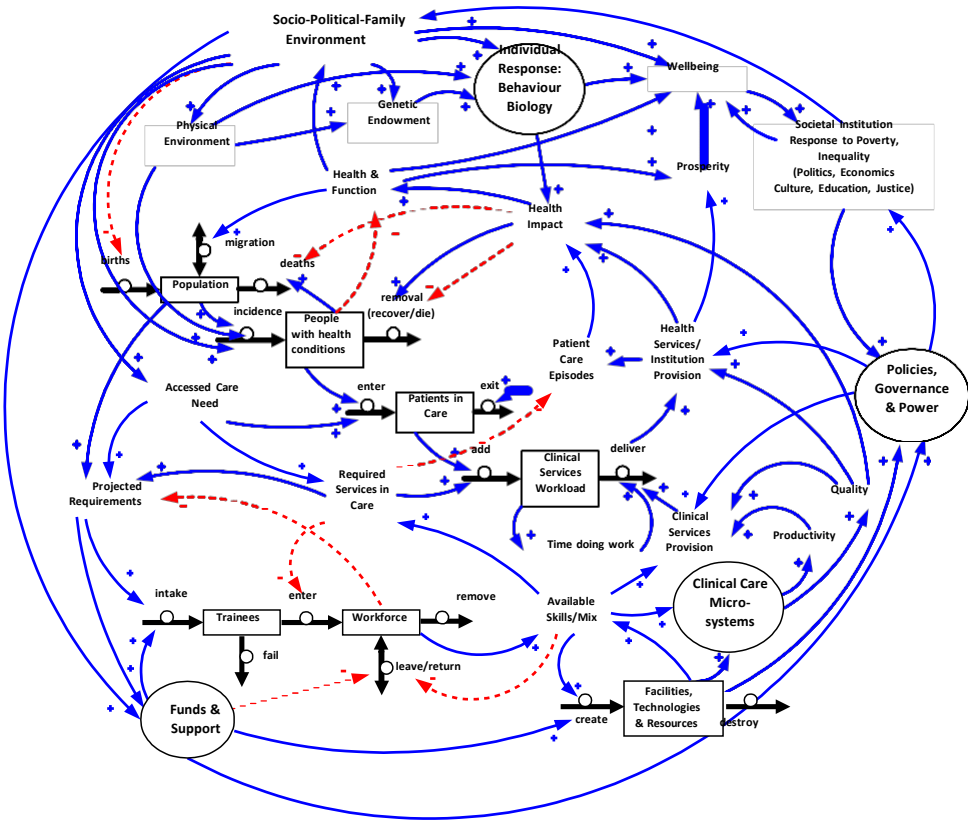
**Impacts of Healthcare Outputs on the Population**

Patient care episodes should have measurable impacts on the health and function (that is, disease and disability prevalence) of the population. Closing the loop to affect the inflows and outflows of 'population' stock are included below. These effects can be mediated by recovery, change in mortality and morbidity or in functional status, or any other factor which can affect health-related
quality of life.




The many other factors that affect health and function include the whole of our human and physical environment, including the social determinants of health. A popular framework for representing the dynamics of health and wellbeing is the Evans, Barber, Marmor Field Theory of Health. To complete the link from healthcare to the rest of the social system, we also need to add the broader governance structures that link health care values to the rest of the social institutional structures that affect citizens. The representation used here borrows heavily from the Structure-Agency Sociology theory popularised more recently in the UK by Giddens and identified as the philosophical foundation of the system dynamics method by David Lane. The addition of the concept of power explicitly links the scope of the dynamics of health and health care to the political process within and outside healthcare.

The completed scope of the dynamic complexity of health and healthcare is depicted below.




Again the individual person is represented here as a circle, an individual agent. Much of the new work in systems biology and systems medicine occurs within the body of this agent. In this area of research, the person is represented as a dynamic network of genetic information interacting with the environment through multiple scales, from the protein molecule to the cell to the organ to the body to the external world. Future management of health may involve preventing and managing the perturbation of these networks by disease.

**Conclusion**

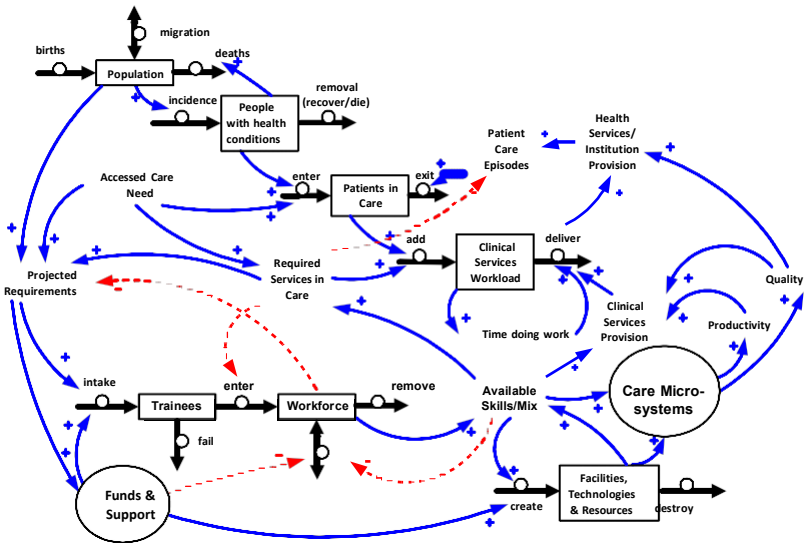
John Muir remarked, "When we try to pick something out, we find it hitched to everything else in the universe."

Here we briefly chronicle the journey of a group focussed on the skills mix of the clinical workforce and how this has led to a broad endogenous model of the dynamic complexity of health and healthcare. We believe this provide a basis for making sense of the world of healthcare among the many disciplines involved in learn to take effective action in this complex world.

**Next Steps**

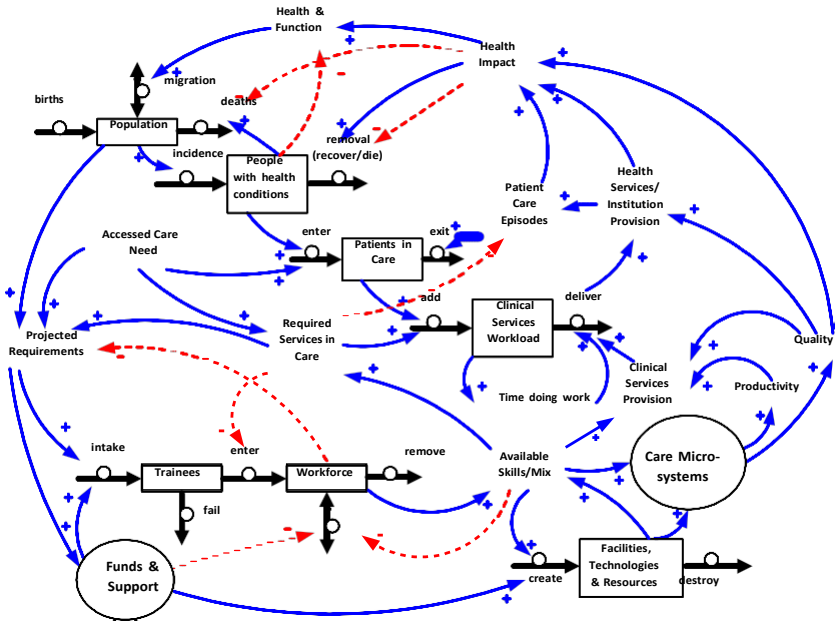
We plan to develop a quantitative simplified model of 5-8 stocks at the national level, with a focus on training new clinical professionals,

**References to follow**


migration
births
deaths
Population
incidence
People with health conditions
removal (recover/die)
Patient Care Episodes
Health Services/ Institution Provision
Accessed Care Need
enter
Patients in Care
exit
add
Clinical Services Workload
deliver
Projected Requirements
Required Services in Care
Quality
Clinical Services Provision
Time doing work
Productivity
intake
enter
Trainees
Workforce
remove
Available Skills/Mix
Care Micro-systems
fail
Funds & Support
create
Facilities, Technologies & Resources
destroy

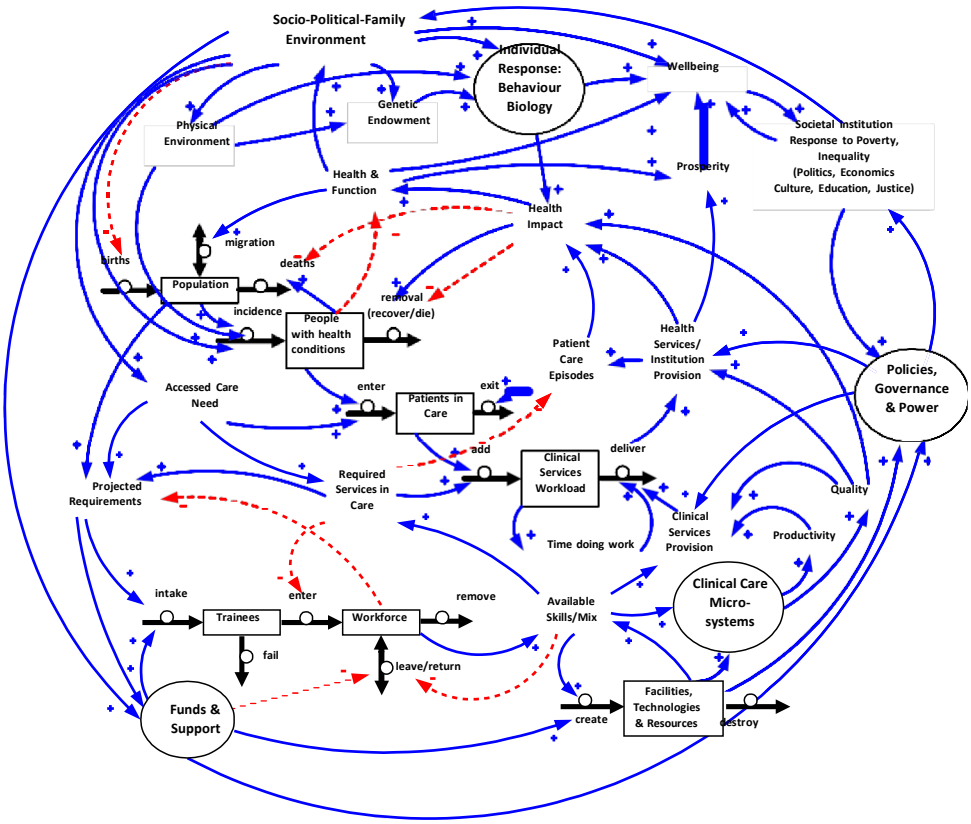
**Impacts of Healthcare Outputs on the Population**

Patient care episodes should have measurable impacts on the health and function (that is, disease and disability prevalence) of the population. Closing the loop to affect the inflows and outflows of 'population' stock are included below. These effects can be mediated by recovery, change in mortality and morbidity or in functional status, or any other factor which can affect health-related
quality of life.




The many other factors that affect health and function include the whole of our human and physical environment, including the social determinants of health. A popular framework for representing the dynamics of health and wellbeing is the Evans, Barber, Marmor Field Theory of Health. To complete the link from healthcare to the rest of the social system, we also need to add the broader governance structures that link health care values to the rest of the social institutional structures that affect citizens. The representation used here borrows heavily from the Structure-Agency Sociology theory popularised more recently in the UK by Giddens and identified as the philosophical foundation of the system dynamics method by David Lane. The addition of the concept of power explicitly links the scope of the dynamics of health and health care to the political process within and outside healthcare.

The completed scope of the dynamic complexity of health and healthcare is depicted below.




Again the individual person is represented here as a circle, an individual agent. Much of the new work in systems biology and systems medicine occurs within the body of this agent. In this area of research, the person is represented as a dynamic network of genetic information interacting with the environment through multiple scales, from the protein molecule to the cell to the organ to the body to the external world. Future management of health may involve preventing and managing the perturbation of these networks by disease.

**Conclusion**

John Muir remarked, "When we try to pick something out, we find it hitched to everything else in the universe."

Here we briefly chronicle the journey of a group focussed on the skills mix of the clinical workforce and how this has led to a broad endogenous model of the dynamic complexity of health and healthcare. We believe this provide a basis for making sense of the world of healthcare among the many disciplines involved in learn to take effective action in this complex world.

**Next Steps**

We plan to develop a quantitative simplified model of 5-8 stocks at the national level, with a focus on training new clinical professionals,