NHS Improvement

ACT Academy

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Modelling and simulation

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Modelling and simulation

What is it?

Modelling and simulation tools enable you to understand the potential impact of any proposed service changes or developments. Using them enables you to evaluate the potential impact of changes that are made to both the service and the wider system. This helps to reduce time, energy and resources in implementing changes that lead to unforeseen results.

Those responsible for the delivery of healthcare services can also use modelling and simulation tools to help examine variation in the supply and demand of services and understand how emergency and elective workloads can be delivered more effectively. There are various different types of tools, eg health system simulation tools, care pathway analysis tools (eg Map of Medicine), benchmarking tools and forecasting tools.

Simulation and modelling software have both been used in healthcare to model and explore different options for service reconfiguration across the organisation or health system:

- **Patient flow** – a precise measure of pressure in the system. If the flow of patients in is not matched by the flow of patients out, this increases pressure on the system.
- **Length of stay** – one of the main causes of pressure in a hospital. All patients are expected to have an estimated date of discharge (EDD) on the day of admission and this is to be determined by the multi-disciplinary team (MDT) and reviewed daily (see **reducing length of stay**).
- **Inpatient occupancy** – the number of patients that are currently in the hospital and the number forecast.
- **Real-time status** – shows the current operational status of the hospital so managers have an understanding of the pressures that the hospital is subject to.

When to use it

These tools are particularly useful if you are considering making long term or significant changes, the impact of which can be difficult to predict. Using modelling and simulation tools before you initiate change will help you to plan and implement more effective service improvements. They can also enable you to understand what the demand for services may be like in the future, to ensure that any service developments are 'future proofed'. Using these techniques enables the prediction of potential peaks in emergency care workload during the winter months. This information can then be used to better plan elective workload and avoid cancellations.

A very practical use for these tools is to understand the demand for beds within a hospital or specialty. We know there is significant variation in both the demand for services and also the capacity of those services. Because of this variation, it is not appropriate to use averages (eg average length of stay, or average bed occupancy) when investigating demand and capacity. A good way to understand the picture of the relationship between capacity, demand and the bed pool is through using a simulation based approach.

For example, critical care services generally operate small bed pools (especially when compared to the whole organisation). The historical pattern of demand and capacity can be modelled and then this model can be used to simulate the effect of adding in more beds.

There always needs to be consideration of what is practically achievable, ie if it was deemed that a critical care bed had to be available 100% of the time, the number of beds would have to increase exponentially and the occupancy rates of the unit would likely need to be around 50% (so that the natural variation in demand can be dealt with). If a more practical approach was taken, ie that a critical care bed should be available 95% of the time, this can be modelled and far fewer beds would be required (as opposed to the 100% availability).

How to use it

Modelling and simulation techniques generally work by using historical data to create a mathematical model of a healthcare service or system. This then enables a prospective analysis of the pressures on the system if the current trends continue into the future.

Because a model has been created, it is possible to understand the potential impact of different changes to the supply of services or the demand for them. The model can also be extended to incorporate data from other sources, eg weather forecasts and flu watching (where there are known links to healthcare demand). This addition of more information can further help to predict a variation in demand for healthcare.

The results can help you to understand and plan for scenarios that would place significant pressure on healthcare systems. For example, if there was a significant flu outbreak, some parameters can be predicted that can be added into a model to help understand the impact on service delivery. As well as extra demand for services, a flu outbreak would also affect healthcare staff, so the supply of services would also be affected.

Modelling and simulation helps to ask the 'what if' questions that can then be analysed to help ensure that resilient services are developed.

Different types of tools are appropriate for different situations.

1. Health system simulation tools can develop a virtual health system that allows new systems of care to be tested in a simulated context. You can use this to evaluate the potential impact of changes in population, demand and the burden of disease.
2. Care pathway analysis tools allow health systems to map out the patient's healthcare journey as a process map. You can then modify the pathway to show the potential impact of new ways of working or the effects of new technology and practice.
3. Benchmarking tools allow you to compare the current performance of a health system with the performance of similar health systems. When combined with simulation, you can also test the impact of changing performance to that of another health system or group of health systems.

4. Forecasting tools allow operational and strategic service planners to predict short and long term changes in healthcare demand. This means they can design services that will be able to cope with this new pattern of demand. Many systems provide a single point forecast with a reliable picture of how demand will change over hours and days. If used in conjunction with simulations to model a range of future scenarios. This provides a powerful decision support tool for the health service planner who is forecasting over longer timescales.

Examples

Many 'off the peg' simulation packages have been used within the NHS to test future service changes, model the impact of disease outbreaks or forecast the impact of population growth.

- A simulation approach was used by the NHS in Ayrshire and Arun to model the benefits of different options for acute reconfiguration. This process highlighted some major potential problems with the existing configuration's ability to cope with clinical shortages, changes in working times and the requirements of new technology. It also helped inform the decision on the best option for reconfiguration. During public consultation, the sponsors of change were able to demonstrate the impact of different models of care live to public audiences.
- The NHS has developed its own web-based benchmarking software known as SHAPE (Strategic Health Asset Planning Evaluation). The software allows providers and commissioners to compare costs and activity by condition, to look at length of stay, day surgery and outpatient rates. They can then identify future service and asset requirements, based on the top quartile performance. SHAPE is currently free to all NHS professionals and Local Authority professionals with a role in public health or social care. Access to the application is by formal registration and licence agreement via Public Health England (www.shape.dh.gov.uk).

What next?

Simulation and modelling can be a useful add-on to existing **demand and capacity management** approaches. Much of the data that is needed to build mathematical models will need to be collected and existing process understood by using tools such as **process mapping**. Simulation and modelling is a specialist area and external advice, support or expertise is likely to be required.