Department of Health

Alcohol Improvement Partnership

Dynamic Whole System Modelling for Alcohol Harm Reduction

Project Report

Developed by: Symmetric^{sd}

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Contents

1. Background

Latest estimates[1] have indicated that the annual cost of alcohol misuse to the NHS in England is approximately £2.7 billion (at 2006/07 prices).

Symmetric[sd] was commissioned by the DH, on behalf of the Alcohol Improvement Programme, to develop a dynamic, whole system model for use in supporting work on Alcohol Harm Reduction. There were 2 phases to the work:

- Phase 1 - developing a model that would simulate the impact of strategies for reducing harm, using alcohol related admissions to hospital as the key impact measure[2]
- Phase 2 – facilitating the use of the model at a local level.

Work on Phase 1 began in April 2009 and is now complete. Work on Phase 2 has now begun and will be complete by June 2010.

The model uses a System Dynamics method, which enables the impact of complex, inter-dependent change to be demonstrated over time. A similar piece of work was commissioned by Blackpool PCT (also undertaken by Symmetric[sd]) and was completed last year. Both projects have shared information on their insights and approaches.

This report provides an overview of the work on the national project, sets out the key findings and makes some recommendations about next steps.

[1] Health Improvement Analytical Team, *The cost of alcohol harm to the NHS in England: An update to the Cabinet Office (2003) study* DH, 2008 http://www.dh.gov.uk/en/Publichealth/Healthimprovement/Alcoholmisuse/DH_085387

[2] The project adopted hospital admissions as a proxy measure; this is explored further in Section 3 below.

2. Working method

System Dynamics is the well-established, practical and theoretical underpinning of Systems Thinking. System Dynamics uses powerful 'stock and flow' process mapping and quantitative computer simulation modelling to enable stakeholders to test alternative or new policies for consistency and robustness before implementation and without risk. In particular, System Dynamics is capable of highlighting some of the unintended consequences of decision-making as well as giving greater confidence in the achievability of intended consequences.

We work with an expert group to inform the development of the model and source appropriate data. Details of the membership of the group for the Alcohol project are attached at Appendix 1.

The group met on 6 occasions. There were additional meetings with individuals and smaller sub-groups to review specific issues and ensure robust testing of the model. The emerging findings were presented to the January 2010 meeting of the AIP Management Board and were discussed with Regional Alcohol Managers and DH data specialists during the Spring of 2010.

3. Frame of reference

In parallel with the development of the model, the project reviewed the evidence available to inform the design of the model, the choices made about behaviour of the model and the data used to test it. In addition, a range of reference material was reviewed.

The creation of a System Dynamics model is an iterative process and the review of evidence and wider reference material continued to inform the development of the Alcohol model as the project developed. The final frame of reference adopted comprised the following:

a. The key performance measure used would be the impact on hospital admissions. Reducing the rate of increase in alcohol related admissions had already been proposed as a PSA target[3] and around 70% of PCTs had adopted it. Whilst inter-agency working was acknowledged as a key component of an effective Alcohol Harm Reduction Strategy, the modeling project would be aligned with the PSA target and so focused on NHS based organisations. The model itself would be capable of subsequent adaptation.

b. Whilst hospital admissions remained the key performance measure, the cost impact was widened to take account of Accident and Emergency attendances. This enabled a more balanced position to be represented for Commissioners in relation to the impact of the various service initiatives tested

c. Three specific initiatives were selected for testing within the model. They were part of the group of High Impact Changes previously suggested by the Alcohol Improvement Partnership but were the ones for which evidence of impact was most robust, as follows:

    - Identification and Brief Advice in Primary Care
    - Alcohol Health Workers
    - Specialised Treatment

d. The model itself would cover the adult population (age 18 and over) and use a previously agreed structure of four alcohol 'risk' groups based on consumption levels, as follows;

    - Abstainers
    - Drinking at Lower Risk
    - Drinking at Increasing Risk
    - Higher Risk Drinking

e. Each service initiative had a known impact on reducing consumption and each consumption group had a known propensity for hospital

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3 http://www.hm-treasury.gov.uk/d/pbr_csr07_psa25.pdf

admission. The model simulates the impact of these initiatives on reducing risk and so then on reducing hospital admission. The change in consumption group would not necessarily take effect immediately due to potential underlying health problems related to prior consumption levels; the model takes this time-lag into account

f. The project's start point had been an assumption of increasing growth in the rate of hospital admissions. Part way through the project, national data became available[4] indicating that the rate of growth in alcohol consumption had reached a plateau. By implication, the level of risk would reduce and so would the rate of growth in hospital admission. However, these would be only relative reductions against an already high level of admission. The project proceeded on the basis that additional action, such as that described in the AIPs High Impact Changes, and specifically the three initiatives tested in the model, would still be useful. So, the model tests the impact of these changes against this underlying flattening of consumption. Where local data indicates a different underlying position, the model is flexible enough to accommodate such changes.

[4] Health Improvement Analytical Team, Department of Health, 2009. The projection is based in part on General Household Survey estimates showing that the percentage of the population in higher and increasing risk categories had remained largely unchanged since 2003; and estimates of average consumption by Her Majesty's Revenue and Customs, which have also remained reasonably constant since that time

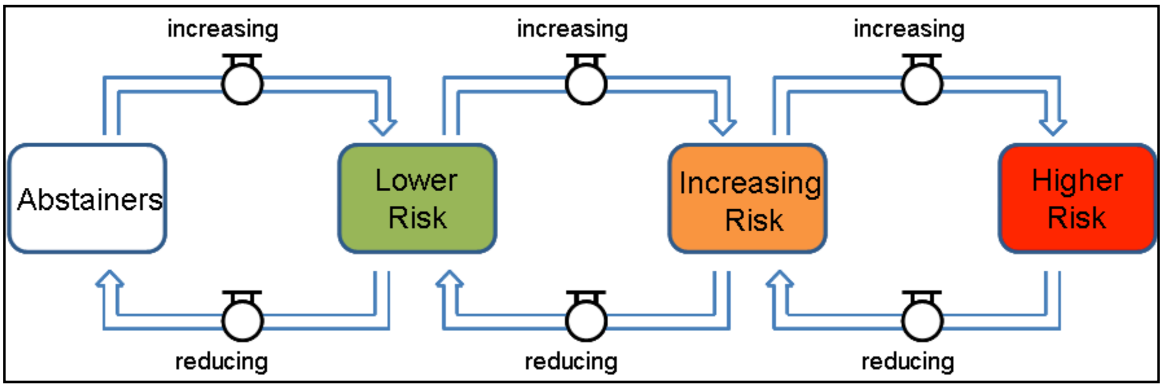
4. Overview of the model

4.1 Model Structure

The model represents a geographical area equivalent to a PCT or Local Authority, with an adult population of 250k (and rising). It is however, capable of scaling to cover a regional or national picture if required.

At the heart of the model is its Stock and Flow structure and, as indicated above, this splits the population between four consumption groups – ‘Abstainers’, ‘Lower Risk’, ‘Increasing Risk’ and ‘Higher Risk’. At any time, the entire adult population is in one, and only one. consumption group. At all times, people are moving up and down the consumption scale. A simplified version of the main Stock and Flow structure is shown in Figure 1.

Figure 1 – Stocks and Flows of Adult Population by Consumption Group



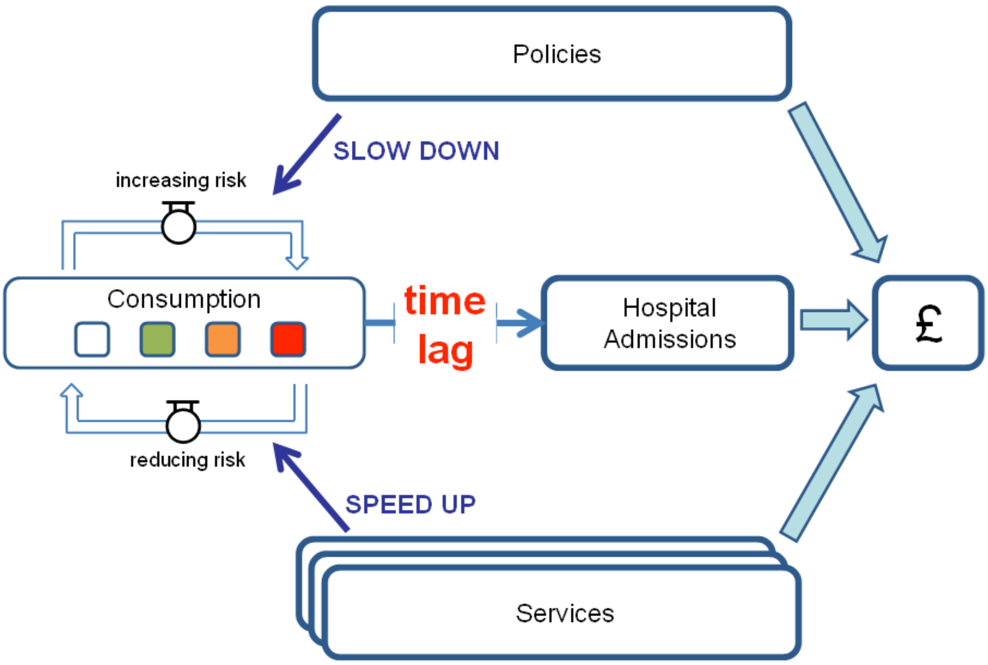
In addition, the model accommodates changes in the population as a result of people joining (by reaching age 18 or moving into the area) or leaving (by dying or moving out of the area). As the model runs, so people move between the groups. Almost everything that the model subsequently shows hinges on this.

The model also covers two other aspects of Alcohol policy concern – ‘binge’ drinking and ‘dependent’ drinking. These are not shown explicitly in the consumption groups diagram. Binge drinkers form a subset of the ‘Lower Risk’, ‘Increasing Risk’ and ‘Higher Risk’ groups; dependent drinkers are a subset of the ‘Increasing Risk’ and ‘Higher Risk’ groups.

Beyond the Stock and Flow chain, the model incorporates a range of other features. Figure 2, below, summarises how the different parts of the model interconnect and, most importantly, the main causal links and time delays.

‘Services’, such as the High Impact Changes, mainly serve to move people down the consumption chain (i.e. to speed up the ‘reducing risk’ flows). It is also possible to model policy initiatives (such as pricing) that might both slow down the rate at which people increase consumption and also speed up the rate of reduction; this option was not fully explored but the model is capable of showing such an effect.

Figure 2 – Whole Model Structure (simplified)



So, the model shows alcohol-related hospital admissions as a function of alcohol consumption; and there are different rates of admission from each consumption group. For many types of admission, though, there is a time delay between the change in consumption and the health improvement. This time delay varies by type, e.g. accident-related admissions depend more on present consumption whereas chronic conditions are a function of historical consumption.

There are two main outputs of interest:-

- Alcohol-related hospital admissions
- Costs

The model enables a user to experiment by "commissioning" varying amounts of new service and observing the impact on hospital admissions and costs over time.

4.2 Model Input Data

The main data inputs to the model are, for the population of interest:-

- Total size of the adult population, and how that is projected to change over time

- Distribution of that population between the four consumption groups, and how that has changed, and is projected to change, over time
- Distribution of binge drinkers across the three consumption groups
- Distribution of dependent drinkers across the highest two groups
- Assumptions about the 'normal' rates of movement between consumption groups
- Rates of alcohol-related hospital admission
- Service capacities for:-
  - Specialist alcohol treatment services
  - Alcohol health workers
  - GPs offering brief advice
  - Up to five types of service to be added by local users
- Impact of each service on consumption
- Costs of:
  - Each type of service
  - Each type of hospital admission and A&E attendance

Some of these data categories were readily available in existing data sets. Others were new and required some secondary analysis. For example, the model required the rates of alcohol related hospital admissions to be expressed for each consumption group[5]. This was a different approach to the concept of an Alcohol Attributable Fraction, previously used in this field. Using the dynamic method, if the distribution across consumption groups changes, so will the numbers of admissions.

Another new piece of analysis estimated the current rates of movement across consumption groups. To our knowledge, no comparable measures of this phenomenon had existed prior to this project[6].

For each consumption group, we wanted to know how many people would be in a different consumption group in one year's time. These estimated percentages are shown in Figure 3.

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[5] With acknowledgment to the work led by the Health Improvement Analytical Team, Department of Health

[6] Calculated by Health Improvement Analytical Team, Department of Health, being a longitudinal analysis of General Household Survey data

Figure 3 – Base Rates of Movement between Consumption Groups (Percentage of each group that will be in another group in one year)

To / From	Abs	Lower	Inc.	Higher
Abstinent		25	0	0
Lower Risk	5		8	0
Increasing Risk	1	21		11
Higher Risk	1	10	19	

4.3 Model Outputs and Scenarios

The model simulates change over a 20-year period, with every model variable recalculated for each day within the model. The model is therefore capable of providing a large number of output measures and analysis.

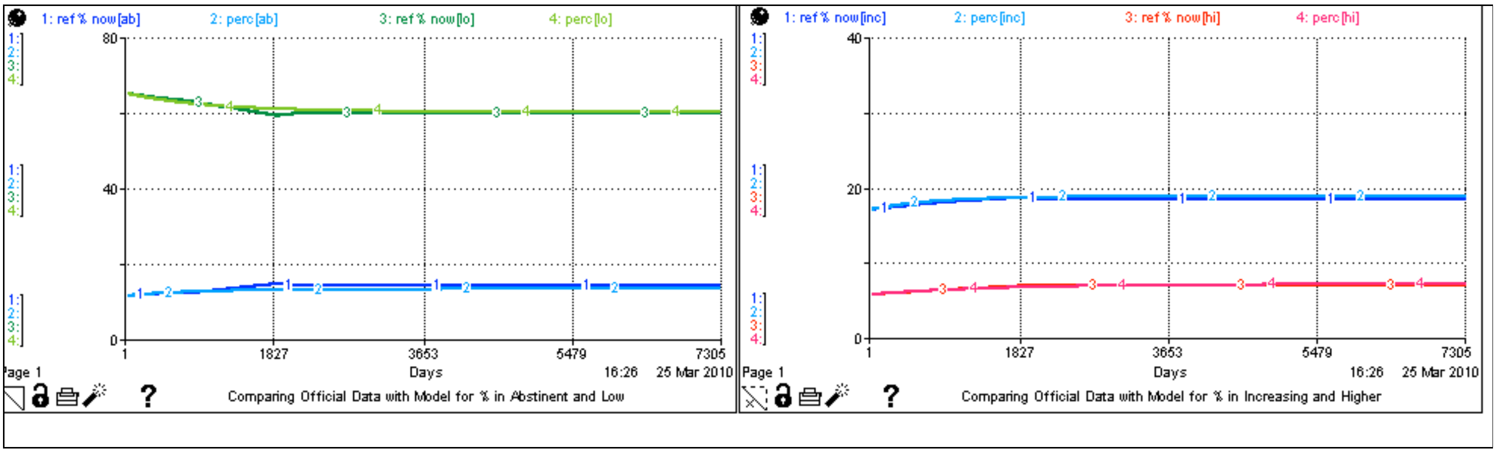
The base run of the model demonstrates the pattern of existing trends and relationships. This was then compared with a range of scenarios, introducing different combinations and amounts of new services relating to Alcohol Harm Reduction.

The key output variables used were the number of hospital admissions and costs. Each variable is plotted over time. Other outputs of interest are the population analysis, showing both the number and the percentage of the population in each consumption group.

In the base run, the model was set to start running in 2005. Given little more than the initial number of people in each consumption group, combined with the data from Figure 3 on rates of change, the model's estimates of the percentage of people in each consumption group compare well with the Department's current assumption that consumption has reached a plateau.

Unlike other model runs shown in this report, Figure 4 below shows the period 2000 – 2020. Each graph plots two consumption groups, comparing the model-generated output variable (*perc*) against the DH assumption (*ref%).* There is a close match between both sets of figures (indeed the two lines frequently merge into one).

Figure 4 – Model Outputs Compared with DH Assumptions about Population Distribution across Consumption Groups (Covering Period 2000 – 2020)



But this plateau in consumption still produces a projected increase in alcohol related admissions, for three reasons, the first being most significant.

1. The plateau is a percentage figure. If the population in any area is rising (in the model population, it rises from 250,000 to 280,000 over 20 years) then the absolute numbers in each consumption group must also be rising, and so must the alcohol related admissions
2. There is a time delay between a change in consumption resulting in a reduction in admissions
3. The rise in the elderly population also produces a rise in alcohol-related admissions, and this is represented in the model with a simple ratio.

Scenarios

The outputs from the Base Run were compared to four alternative scenarios. In each scenario, a policy change is implemented from 1 April 2010, and the impact plotted on a series of graphs.

Scenario 1: Base Run

The model runs, as indicated, based on the core assumptions and data fed into it

Scenario 2: GP Brief Advice

In this scenario, we added the impact of a GP Identification and Brief Advice (IBA) service. The basic assumptions are;

- The IBA service is implemented by 25% of GP practices
- 65% of the population visits their GP at least once per annum

This service is costed at the following rates:-

- Each patient visiting the GP is screened once in the course of a year at a cost of £1

- Some patients are offered lower level advice costing £8
- Some are offered higher level advice costing £32
- The distribution of these costs reflects the population consumption group distribution (this assumes that GPs offer the appropriate level of advice in accordance with the patient's consumption)
- 12.5% of people in the two higher groups receiving this service reduce their consumption by one group

Scenario 3: Alcohol Health Worker (AHW)

In this scenario, we reset the model and added the impact of employing AHWs. The assumptions about impact are based largely on work undertaken in Liverpool[7] related to a nurse-led service. The model contains

- A range of inputs about the workload constraints of a typical AHW
- The range and types of interventions offered (including brief advice; brief advice and intervention; outpatient detox combined with brief advice and intervention)
- The effectiveness of these interventions (in terms of reduced consumption).

In the scenario modelled, a service employing four whole time equivalent (WTE) AHWs is introduced at the intervention point. The service is costed at £36,400 per annum per AHW plus a total of £11,000 of "other" costs.

Scenario 4: Specialist Services

For Scenario 4, we used a service classification adopted by the National Treatment Agency for Substance Misuse. Specialised Service provision is not new and services already exist at a variety of levels across the country; so, for the Base run, we incorporated a typical range of provision. Scenario 4 incorporates a change in one component of this range of services - Specialised Structured Intervention.

In the table below we show the full range of Specialised Services; current typical service levels represented by the number of commissioned episodes per annum; and the cost per episode. We also show the change in volume of Specialised Structured Intervention fed into the model from April 2010:

[7] For further details see http://www.alcohollearningcentre.org.uk/Topics/Browse/HIC/AHW/

Service	Commissioned episodes pa		Cost per Episode (£)
	From 2005	From 2010	
Community Prescribing	35	35	2,000
Inpatient Detox	50	50	1,200
Residential	40	40	6,000
Specialised Structured Int.	200	800	221
Specialised Day Service	35	35	1,500
Other Structured Int.	220	220	800

Scenario 5: Scenarios 2, 3 and 4 combined

This scenario combines all of the interventions so that GP Brief Advice, AHWs and Increased Specialist Services are all implemented.

The main impacts from all 4 scenarios are plotted on the graphs in Figure 5 below, with the actual values summarised in Appendix 2.

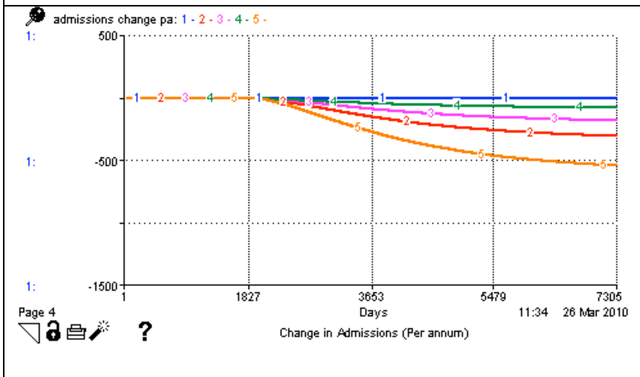
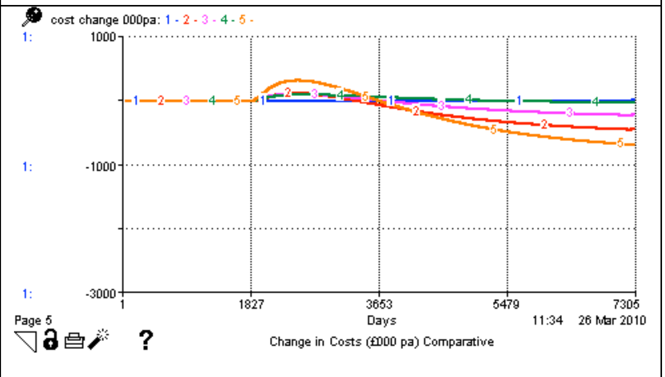
In Fugure 5, the specific runs of the model associated with each scenario are numbered – so Scenario 1, the base run, equates to line 1 in the graphs; Scenario 2 equates to line 2, and so on, through to line 5.

The graphs plot the relative difference between Scenario 1, the base run, and the new service initiative described in Scenarios 2 to 5. The actual number of admissions and associated costs may still be rising, mainly due to the increasing population. However, showing the relative change provides a more obvious indication of the impact resulting from the level of investment made.

Each scenario has a similar effect, but to a differing degree. There is a slight delay before the reduction in admissions shows on the graph. As indicated earlier, for many conditions, there is a time lag between a reduction in consumption and an improvement in health and so a delay in seeing a reduction in admissions.

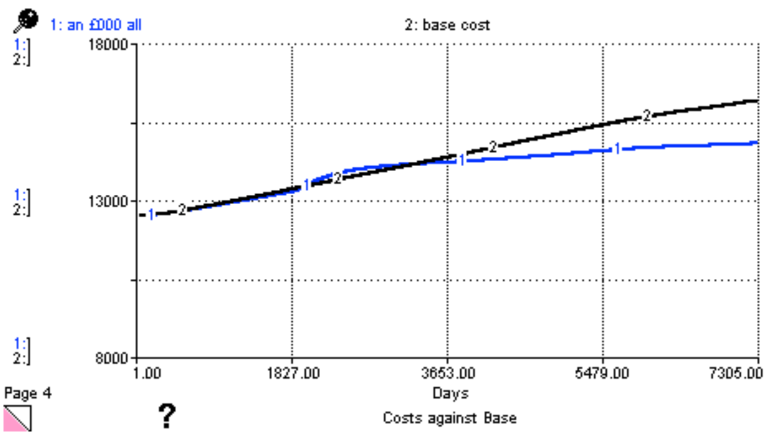
The time lag effect is most obvious in relation to expenditure. Initially, spending goes up, compared with the base run, and over a period of between three and four years continues to be higher than it would have been. The investment in additional services takes some time to feed its way into reduced numbers of people in the higher consumption groups, and then it takes time for that change to manifest itself in reduced admissions. However, all the service changes tested did achieve breakeven and then lead to recurring savings.

Figure 5 - Impact of Scenarios on Admissions and Total Costs in Relative Terms (2005 – 2025)

Change in Admissions per Annum	Change in Expenditure (£000 p.a.)
	

It is important to remember that almost all of the service changes tested take place against a background of increasing costs. Figure 6 plots the absolute costs using the baseline against Scenario 5, showing how expenditure first exceeds base, then reduces, but is always increasing.

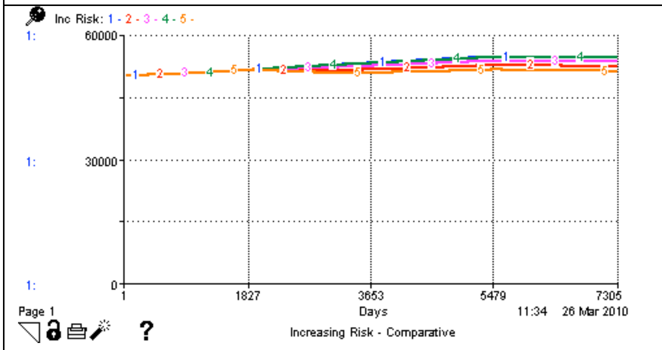
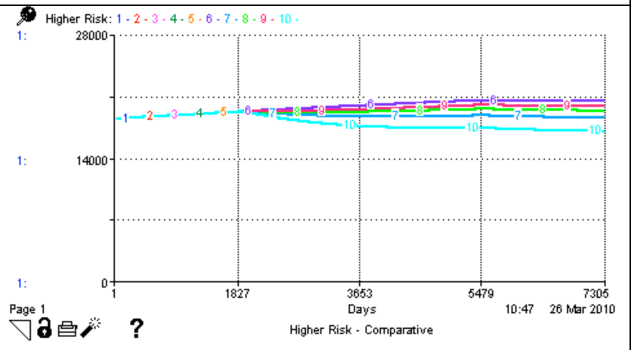
Figure 6 – Absolute Costs of Baseline against Scenario 5



Much of the growth in admissions results from population growth, but also time lag effects where consumption had been increasing, and the ageing population factor. Clearly, the 'do nothing' option – as indicated by Scenario 1, the base run – remains significantly more costly to commissioners.

The model also shows the impact of each intervention on consumption, by plotting the number of adults in each consumption group, as shown in Figure 7.

Figure 7 - Impact of Scenarios on Numbers in the Higher Consumption Groups

<table>
<tr><td>Adults in the Increasing Risk group</td><td>Adults in the Higher Risk group</td></tr>
<tr><td>
</td><td>
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These graphs are very significant, because they show that services have an impact on the population as a whole, and this impact is cumulative because the reduced numbers in consumption groups, especially Higher Risk, result in fewer people needing treatment, including hospital admission.

This kind of effect would be difficult to replicate using a combination of spreadsheet modelling and attributable fractions.

Not surprisingly, the effect is more pronounced on the Higher Risk group, because it experiences a net loss. The Increasing Risk group depletes (because of the impact of services) but it experiences an increased inflow of formerly Higher Risk people reducing their consumption. Even then, the net effect (inflow from Higher Risk minus outflows to Lower Risk and Abstaining) means that all scenarios result in a relative [8]reduction in the Increasing Risk stock.

Of course, given the base rate of change referred to earlier, having reduced consumption, some people will move back up the consumption chain; but the model takes account of this effect. It is also capable of representing greater subtlety. It can break down each consumption group by subsets representing the highest consumption group that an individual has ever people have ever been in. This might be useful because the health profile of people who always have been abstinent, for example, is likely to be different from the profile of those who are now abstinent but once were higher risk. However, for the time being, estimating hospital admission rates by each of these categories is not possible.

[8] i.e. compared with the Base Run

5. Key Findings

The key findings from the project were as follows:

- The model allows the simulation of the impact of service developments on levels of Alcohol Related Harm. In this context the key proxy indicator of harm has been the level of hospital admission. This in turn is driven by the propensity to admit, differentiated between four alcohol consumption groups. The model simulates the impact of movement between these groups resulting from both broader population change and specific Alcohol related changes, including the specific service developments
- In relation to cost, the model compares the direct costs of the given service development with the potential savings achieved from a reduction in both hospital admissions and attendance at A&E departments
- The project started against a background of significant and continuing increased growth in the rate of hospital admissions. More recent analysis by DH has indicated that alcohol consumption appears to have reached a plateau and the model replicates this behaviour in its base run. Admissions to hospital are still projected to increase, because of a combination of increasing population, ageing, and the time lag between treatment and resultant health benefit
- So, whilst the rate of increase overall may not be as high as previously indicated, the 'do nothing' option would still result in an increase in admission for the foreseeable future. In addition, the resource associated with alcohol related hospital admissions will remain significant and yet there are alternative services available that are clinically effective, reduce alcohol related harm and reduce cost
- The model simulated the impact of three such service alternatives, taken from the list of High Impact Changes for Alcohol – IBA in Primary Care; AHWs; and Specialised Services. We do not suggest that these services will remove the need for admission entirely or that one type of service development is 'better' than another. In practice PCTs will need a mix of services to ensure that they are meeting the range of needs within their populations.
- The model shows that in each case, there is a return on investment. Relative[9] costs increase initially before reaching a break-even point after four or five years, and thereafter reduce
- The model can also be used to simulate other service developments and the final version includes five 'blank' routines that PCTs can use

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[9] Costs compared against the cost of doing nothing; due to the underlying increase in admissions baseline costs are always increasing

to reflect local service developments. These could include, for example, the impact of ‘virtual’ AHWs – i.e. the presence of staff in A&E and key inpatient specialties who are not primarily ‘alcohol’ workers but have sufficient training to provide relevant support.

- The findings from this work will also facilitate local partnership discussions about the broader impact of reducing alcohol related harm beyond the reduction in hospital admission and A&E attendance. This could include, for example, discussion with colleagues from the Police and Probation services and the potential for the joint funding of some of the service developments tested in the model
- The issues of dependency and binge drinking are covered in the model. Reductions in the dependent population can be shown, but were not central to the group’s discussions; policies to tackle binge drinking were not covered
- The model yielded some new findings, especially in relation to the underlying rates of movement of people between consumption groups, both increasing and decreasing
- The model has provided a rich learning environment for its stakeholder group, and has been thoroughly tested

6. Next steps

Our overall conclusion is that PCTs will continue to face growth in the number of alcohol related admission but that there are measures they can take to address this and in the process achieve a reduction in the rate of growth in cost

To support the process of using the model at an operational level, we have now developed a roll-out plan in conjunction with DH colleagues. It focuses effort at a Regional level in the first instance and will enable Regional Alcohol Managers (RAMs) and colleagues to operate the model. The work will be in two parts – firstly to design a more user-friendly interface, complete with detailed user manuals and online guides; then to train colleagues in the use of this more straightforward version of the model.

This in turn will allow RAMs and their colleagues to work with individual PCTs or groups of PCTs on a sub-Regional basis, using the model to inform local alcohol commissioning strategies.

Work on the revised version of the model, and training in its use, is scheduled for completion by July. This will enable RAMs to work with PCTs during the Summer/Autumn in preparation for the development of local operational plans for 2011/12.

We remain grateful to the numerous people who have contributed to this work. We would like to thank in particular the members of the Expert Reference Group who have willingly shared their valuable insights, learning and data to ensure the project is successful.

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April 2010

Department of Health - Alcohol Improvement Programme

Alcohol Modelling Project – Interim Report

Expert Reference Group Membership

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Summary of Model Runs in Figures

		Scenario 1: Base	Scenario 2: GP Brief Advice	Scenario 3: AHW	Scenario 4: More Specialist	Scenario 5: Combine All
Admissions Saved (per annum)	*2010*	0	0	0	0	0
	2015	0	149	85	39	270
	2020	0	258	151	64	464
	2025	0	300	174	70	540
Costs Saved (£ per annum)	*2010*	0	0	0	0	0
	2015	0	-37,000	*+54,000*	*+67,000*	*+84000*
	2020	0	-288,000	-58,000	*+9,000*	-329,000
	2025	0	-393,000	-102,000	-9,000	-501,000
Percentage of Pop. in Increasing Risk group	*2010*	18.9	18.9	18.9	18.9	18.9
	2015	19.0	18.4	18.7	18.9	18.1
	2020	19.0	18.3	18.7	19.0	17.9
	2025	19.0	18.2	18.6	18.9	17.8
Percentage of Pop. in Higher Risk group	*2010*	7.0	7.0	7.0	7.0	7.0
	2015	7.1	6.7	6.8	6.9	6.3
	2020	7.1	6.5	6.8	6.9	6.0
	2025	7.1	6.4	6.7	6.9	5.9