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Decision making in public health: using Number Needed to Treat (NNT) to determine intervention effectiveness

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Executive summary

This short report follows discussions with members of the Cumbria and Lancashire public health collaborative about how they and other stakeholders might use Number Needed to Treat (NNT) in their decision making.

Included in the report is:

- background information about the new public health system and preventative interventions
- explanation of NNT (including the advantages and disadvantages) along with details of other methods (such as Absolute and Relative Risk Reduction, Population Impact Analysis and Disease Impact Number)
- a table listing examples of public health interventions (both preventative and non-preventative) across key themes with their NNT and evidence explaining strengths and weaknesses of each
- a small number of case studies showing how NNT has already been used locally to inform public health decision making

Overall the report recommends that while NNT arguably provides useful information about particular interventions, such data must also be considered alongside the wider context and evidence base when making informed decisions in public health.

'NNT is just one part of the information required in making a purchasing decision. There are many other factors, including adverse effects, costs, and individual, social and medical priorities'.

Moore / Bandolier (2009) What is an NNT?¹

'NNT is often used as a tool in medical decision-making under the general rubric of evidence-based practice'.

Garg et al (2013) Use of Number Needed to Treat in Cost-Effectiveness Analyses²

Background

Policy context

Following the release of the Health and Social Care Act 2012 in April 2013, Clinical Commissioning Groups (CCGs), described as the 'cornerstone of the new health system', now commission the majority of NHS health services.³ This includes emergency care, elective hospital care, maternity services, and community and mental health services. Local authorities, supported by Public Health England (PHE)ⁱ, have new responsibilities to improve health and reduce health inequalities and are specifically tasked with commissioning public health interventions, from smoking cessation or alcohol and drug misuse services to programmes tackling obesity, behavioural and lifestyle campaigns and many sexual health services.ⁱⁱ Health and Wellbeing boards, hosted by local authorities, bring together the NHS, public health and other stakeholders (such as CCGs) and are also a key part of the new arrangements.⁴ Similarly, local authorities and their partners need to be mindful of the Public Health Outcomes Framework (PHOF) which sets out the indicators and outcomes against which success in improving population health will be measured.⁵

Types of evidence and interventions

A core function of PHE is to help provide evidence, advice and support to local authorities and their partners in fulfilling their new responsibilities.⁵ In 2013/14, CCGs were responsible for a budget of £65 billion.^{iii,6,5} Local authorities had £2.66 billion to spend on public health,⁴ and while some interventions are mandatory, many are more flexible. Therefore all stakeholders need to make informed decisions about the best ways to spend money.

Relevant evidence can include information (such as NNT, the subject of this report) derived from randomised control trials (RCTs), the so called the 'gold standard' in research terms as these are the least subject to bias.⁷ However, other sources of useful information and evidence can include data from non-randomised control trials and cohort studies, descriptive studies, case reports, opinion or reports from expert committees or factors such as stakeholder knowledge, existing policy commitments and ethical values.⁸

Decision makers also need to be mindful of the rising numbers of people living with long-term health conditions, future limits in funding and a growing recognition of the need for a 'transformation' in healthcare, with the NHS becoming a 'wellness service' with greater commissioning of more preventative healthcare.⁹ For example, current estimates suggest that only around 4% of NHS budget is spent on actual prevention.¹⁰ Enhancing the evidence base for investing in prevention and early intervention is therefore now a

ⁱ A new executive agency of the Department of Health formed in April 2013.

ⁱⁱ From April 2015, public health services for children aged under 5 (including family nurse partnerships and health visiting) will also become the responsibility of local authorities, therefore better allowing for public health services for 0-19 year olds to be joined up.

ⁱⁱⁱ This is said to amount to around 60% of the total NHS budget; the total NHS budget in 2013/14 was £110 billion (the 4% figure for preventative healthcare spending was correct as at 2006/07).

key part of PHE's work programme, in collaboration with colleagues from the National Institute for Health and Care Excellence (NICE).

Existing evidence about public health interventions

NICE has been responsible for assessing public health interventions since 2005, and up to 2012 its calculations were mainly based upon a method known as 'cost-utility analysis'.⁸ This considers an individual's quality of life and the length of life they will gain as a result of an intervention. Since then, NICE has further improved the assessment process uses for public health with greater focus placed upon 'cost-consequences' and 'cost-benefit' analyses. These methods consider all of the health and non-health benefits of an intervention across different sectors, direct costs (such as health, care and transportation) and indirect costs (such as productivity losses and criminal justice expenditure), as well as intangible costs related to improvements to an individual's quality of life. NICE has already analysed 200 public health interventions ranging from smoking cessation, to exercise on prescription, with effectiveness being compared against a control (measures included background quit rates for smoking interventions, standard treatments or in some cases no intervention at all). Key findings from the analyses were that:^{11,8}

- thirty (15.0%) interventions were found to be cost-saving
- 141 (70.5%) were deemed good value for money (i.e. they cost less than £20,000 per Quality Adjusted Life Years [QALY])^{iv}
- 7 fell into the £20,000 to £30,000 per QALY range
- the rest were deemed not to provide value for money or were found to actually cost more than they saved

[Based on their analyses] NICE generally found that interventions aimed at a whole population, such as mass-media campaigns to promote healthy eating or legislation to cut young people's access to cigarettes, were the most cost effective.

National Institute for Health and Care Excellence (2013). Judging whether public health interventions offer value for money⁸

Given the growing focus upon preventative interventions and demonstrating the value of this, recent outputs from NICE's programme of work include a report outlining the prioritisation frameworks and associated tools or resources already used by the NHS and local authorities in their decision making about the costs and impacts of different interventions; specifically focussing on the resources already available around the topics of i) tobacco, ii) alcohol and iii) physical activity.¹²

Owen et al (2012) note that a key challenge is to 'provide commissioners with a framework that allows information from economic analyses to be combined with other criteria that supports making better investment decisions at a local level.'¹¹ It is also

^{iv} Quality Adjusted Life Years is a measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to 1 year of life in perfect health. For more details see: www.nice.org.uk/glossary?letter=q

important to bear in mind that the way the same data is presented can influence perception's about a treatment or interventions value, as some measures of effect can look more impressive than others.¹³

Number needed to treat (NNT)

Definition

The Number Needed to Treat (NNT) is described as 'a popular measure of effectiveness of interventions'¹⁴ and is often reported in RCTs and systematic reviews of therapy to describe the difference in a clinical outcome between a treatment and control.^v NNTs can be calculated from any research trial data with so called 'dichotomous' outcomes (i.e. an event or non-event and death or survival, as opposed to an outcome measured on a continuous scale, such as a person's blood pressure for example).ⁱ NNT specifically shows:

'how many people would need to receive a particular treatment or intervention in order that one of them should benefit from the treatment'.¹⁵

An NNT is expressed as a positive whole number, all decimals being rounded up. The best NNT is 1, where all participants benefit from the treatment and nobody does in the control group.¹⁴ In this sense, although it is a statistical measure it is said to be easier to understand than some other techniques because it makes sense; as with any treatment or intervention some recipients could benefit while others could be harmed and some not affected at all.¹⁶ To help better understand NNT it is useful to also consider other related measures of effect such as 'absolute' and 'relative risk reductions' (ARR and RRR), especially as the underlying data upon which the figures are calculated are the same.

Absolute or relative risk reduction and NNT

Everyone has an 'absolute risk' (AR) or chance that they might develop a particular illness or condition in a certain timeframe; for example, a 1 in 10 risk of developing a certain disease in your lifetime, is the same as saying a 10% risk, or a 0.1 risk, the difference is how information is presented (i.e. in percentages or decimals).

'Relative risk' (RR) however compares the risk between two different groups of individuals.¹⁷ Relative Risk Reduction (RRR) is the difference in event rates between two groups (presented as a proportion of the event rate in the untreated group, usually constant across populations with different risks) while the Absolute Risk Reduction (ARR) is the mathematical difference between two event rates, varying with the underlying risk of an event in the individual patient.¹⁸ The NNT is said to be the 'inverse of the ARR'; the difference between the proportion or rate of events in the treatment/intervention group (Pa) and the proportion of events in the control group' (Pc) expressed mathematically as:¹⁸

^v The 'control' group is the participants who do not receive the treatment or intervention.

$$\text{NNT} = 1/(\text{Pa}-\text{Pc})^{\text{vi}}$$

It is noted that ARR becomes smaller when event rates are low, whereas the RRR or ‘efficacy’ of the treatment, often remains constant.¹⁸ Some authors note that in the media the results of research trials are often presented in terms of RRR instead of ARR as these more impressive figures generally make the intervention seem better.¹⁷ Similarly other authors also note that some groups with a vested interest in making a treatment look more effective (such as drug companies or doctors who favour one treatment over another) may also prefer to report RRR rather than ARR.¹⁶ A practical example from Dr Cates, a Cochrane reviewer and editor, who hosts the website www.nntonline.net further illustrates the different measures (his example is based on data about third generation oral contraceptive pills and the risk of Deep Vein Thrombosis [DVT]).

Differences in the RRR, ARR and NNT figures

Third generation pills are thought to carry a risk of DVT of about 25 per 100,000 women per year of use; in comparison for second generation pills it is 15 per 100,000 women a year and for women not taking the pill it is about 5 per 100,000 each year.

Switching users of third generation pills to a second generation equivalent results in an impressive sounding Relative Risk Reduction (RRR) of 40%, but as the risk of DVT is so low overall among women generally the Absolute Risk Reduction (ARR) is only 0.0001 giving an NNT of 10,000 women needing to move drugs to prevent a single DVT in one year.

Cates (2014). What is Number Needed to Treat?¹⁵

Some general advantages and disadvantages of using NNT in decision making are therefore presented for consideration in table 1.

Table 1: Key advantages and disadvantages of using NNT as a tool

Advantages	Disadvantages
Relatively easy to calculate ^{18,vii}	Caution must be taken when interpreting an NNT value for less common conditions as it can be skewed (higher) because the incidence rate in the control group is directly accounted for in the calculation. High NNT values might discourage practitioners from choosing one treatment over another but the only reason why the NNT is high is because the disease is very rare. ¹⁹
Provides a quick summary of trial results. ¹⁸	If patients in a study have a greater severity of

^{vi} Or $100/\text{ARR} = \text{NNT}$ if ARR is in a percentage.

^{vii} A number of tools are available online to help with this that were not specifically stated in a research paper (see www.medicine.ox.ac.uk/bandolier/Extraforbando/NNTsheet.pdf and www.phi.man.ac.uk)

	disease compared to the general population, the ARR could be very impressive. But, if the treatment is approved and marketed for use by less severely affected patients, the ARR would be much smaller. ⁷
Helps to inform decision-making about individual patients and treatment options. ¹⁸	Based on the most probable value in a normally distributed population, therefore it does not take into account an individual patient's baseline risk. ¹⁸
While a particular reduction in risk may appear impressive, NNT has the benefit of showing how many patients would have to be treated before seeing a benefit. ^{viii}	Has a subjective clinical meaning. For example, an NNT of between 2-5 would normally indicate an effective therapy, such as a pain killer for acute pain, yet an NNT of 40+ might be useful in other situations, such as using aspirin after a heart attack. ¹⁸
The NNT is an expected value only, as the NNT originates from the risk difference, it is still a <i>comparative</i> measure of effect (an NNT of 8 for example does not mean that one additional person will benefit in each and every group of 8 people).	Limited to clinical decision making and lacks a public health perspective. ²⁰

^{viii} For further details see: www.ebm.med.ualberta.ca/TherapyCalc.html

Other measures of effect - Population Impact Number (PIN) and Disease Impact Number (DIN)

Despite the popularity of NNT as a measure of intervention effectiveness some authors have noted that NNT is ‘limited to clinical decision making and lacks a public health perspective’ as it only concerns the effects upon individuals actually treated or undergoing the particular intervention. It does not show how many people with the disease under study, or how many of the total population in an area, will benefit from applying the intervention.²⁰ Other suggested tools or frameworks to overcome this limitation and offer a ‘population perspective to measures of risk’ include Population Impact Number (PIN) and Disease Impact Number (DIN).^{21,22} For example, ‘the DIN reflects the impact of that intervention on all those with the disease regardless of whether they are eligible for the intervention or not; in the same way, the PIN reflects the impact of that intervention on the entire population, regardless of whether they have disease or not.’²¹

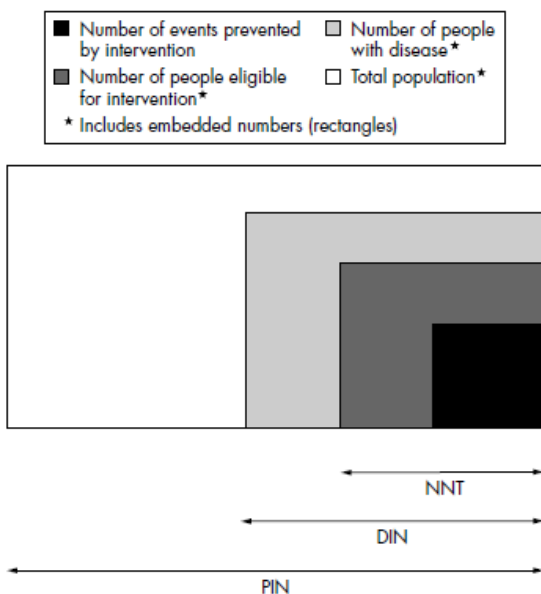


Figure 1: Relation between impact numbers and NNT.

Source: Attia et al (2002)

The PIN method, for example, involves combining local data (such as about population size, demographics and level of inequalities) with the estimates of effect size gained from systematic reviews and meta-analyses to determine the health benefits to a local health care organisation from implementing a new intervention or increasing availability of an existing one. To summarise, although there are also a number of caveats with DIN and PIN, such as the need to have in place high quality,

systematic methods locally to collect local morbidity and mortality data such as through disease registers (a potential problem being that relevant local data might not be easily available and may have considerable errors in it) the main benefits are that these can allow comparison of the population impact of different interventions and can help health policy decision makers develop an evidence base for these measures to support public health decisions.²¹

Public health interventions and their relevant NNTs

In scoping this short report a number of key public health themes emerged as being most relevant to stakeholders (including smoking, alcohol, obesity and/or physical activity, falls and mental health) and therefore formed the focus of the NNT summary table below. It was of note that no single report synthesising information on NNT for public health interventions appears to currently be readily available. Similarly, although the initial brief was to focus upon ‘prevention’ interventions, searches of the NNT literature show evidence often relates to clinical or non-prevention public health interventions, such as

treatments for those already ill. Searches of relevant NNTs for an intervention were restricted to credible sources of evidence, such as that available from NICE and the Cochrane Database of Systematic Reviews, along with the Bandolier^{ix} and NNT websites. The latter two sources have already synthesised NNT evidence from across a range of different interventions and were recommended by members of the collaborative.

Table 2 lists examples of public health interventions with their associated NNT, along with the strengths and weaknesses of each one. The NNT website (www.thennt.com/home-nnt) for example already includes a list of 'therapeutic' treatments/interventions with their NNT, a small number of which (10 examples) are specifically categorised as 'public health' (including a mixture of both non/preventative) such as Routine health checks for reducing mortality and morbidity. However, under other headings in the NNT.COM list there are some other interventions, including some preventative ones, also relevant to public health such as within the 'Cardiology' category (aspirin to prevent a first heart attack or stroke or mediterranean diet for heart disease prevention without known heart disease), 'Geriatrics' group (strength and balance programs for elderly falls) or 'Oncology' sections (PSA test to screen for prostate cancer) which could provide further useful information for the collaborative though not necessarily included in this report's summary table.

^{ix} An independent print and internet journal about health care, using evidence-based medicine techniques to provide advice about particular treatments or diseases for healthcare professionals and consumers.

Table 2: Summary of NNT for public health interventions across key themes

Theme	Study/author	NNT	Notes	Strengths	Weaknesses
Obesity					
Antenatal lifestyle advice for women who are overweight or obese	LIMIT randomised trial Dodd et al (2014) ²³	Infants born to women after lifestyle advice were less likely to have birth weight above 4000g (1654/1075 (15%) v 201/1067 (19%); NNT 28 (15 to 263, P=0.04) compared with women allocated to standard care.	Lifestyle advice during pregnancy does not reduce the risk of infants born large for gestational age or improve maternal outcomes of pregnancy and birth but is associated with a significant reduction in the risk of birth weight above 4000g.	Largest RCT to assess the effect of an antenatal lifestyle intervention for overweight or obese women. Robust trial methods (i.e. prospective measurement of height, weight, and Body Mass Index (BMI) in all participants, central randomisation and blinding of outcome assessors).	Applicability of findings elsewhere (i.e. participants mainly white and highly socially disadvantaged).
Exercise for treatment of overweight and obese children and adolescents	Systematic review of previous meta-analyses Kelley et al (2013) ²⁴	For both studies that met eligibility criteria (aggregate data meta analyses including 14 and 17 studies and 481 and 701 boys and girls) statistically significant reductions in percent body fat were observed NNT of 4 and 3 (P = 0.006 and P < 0.00001).	Exercise works to reduce percent body fat in overweight and obese children and adolescents.	RCTs only included so control for confounders. With lack of cost-effectiveness and safety data, the use of exercise appears to be efficacious for improving adiposity, specifically percent body fat, in overweight and obese children and adolescents.	Studies only showed efficacy (treatment works) not effectiveness (whether work in the real world) and only evidence of improvements in percent body fat with insufficient evidence to show whether exercise improves BMI-related measures, body weight, and central obesity (although noted that lack of evidence of effect does not mean evidence of no effect).
Drugs to aid weight loss	A systematic review and meta-analysis of randomized controlled trials published in the Cochrane Collaboration Padwal et al (2003) ²⁵	Orlistat 120 mg three times a day for a year or more produced a consistent reduction in weight above that of placebo by an average of 2.7 kg or 2.9% of initial weight. Compared with placebo 21% of patients (NNT 5) had at least a 5%	Double-blind, randomized controlled studies of approved antiobesity medications (there is a lack of experience with most approved antiobesity agents in RCTs with follow-up periods of 1 year or greater, Sibutramine and	Useful in cases of those already obese (given scale of issues, focus should be on prevention of obesity in the non-obese).	Mostly women (70-80%). Average age of 50 years. Many trials enrolled higher risk populations with diabetes and cardiovascular risk factors. Very high withdrawal rates (approx. 33% for Orlistat and 43% for Sibutramine) which most trials dealt

		weight loss and 12% (NNT 10) achieved a 10% weight loss.	Orlistat are the most extensively studied agents, but interpretation of data hindered by high drop out rates. In long term studies (of a year or more) drugs - Orlistat and Sibutramine achieved weight loss of 3-4% more than doing nothing, or with diets.		with by imputing values. Gastrointestinal effects most likely for Orlistat, including fatty/oily stool, faecal urgency, and oily spotting in 15% to 30% of patients (faecal incontinence in 7% of those on Orlistat compared with 1% on placebo NNT = 17). Negative effects of Sibutramine included raised systolic and diastolic blood pressure of 1-3 mmHg, and pulse rate increases of 4-5 beats per minute. Other negative effects were insomnia, dry mouth, nausea and constipation in 7-20%. Long-term safety of antiobesity medications (such as Sibutramine and increased cardiovascular risk).
LINDA - a solution-focused low-intensity intervention aimed at improving health behaviors of young females	A cluster-randomized controlled trial Valve et al (2013) ²⁶	In the intervention arm, 37% vs. 31% in the control group made an overall improvement in their health behaviours concerning physical activity, meal regularity and/or earlier bedtime (solution-focused brief therapy intervention, with individually tailored content) NNT = 18, 95% CI = 11-50.	Physical activity, diet, sleep and weight status are key determinants of health and well-being. Participants were recruited from the population-based human papilloma virus (HPV) vaccination trial.	Large sample size. A long maintenance period, and individually tailored personally relevant intervention content. The counselling approach's intensity is deemed appropriate to run in a primary health care setting. Changes in physical activity are more easily achieved compared with changes in diet.	Finnish study Females only Self-reported data Differences in the level of physical activity, BMI, and the current educational level between the intervention and control groups.
Examining interventions for addressing obesity in adults, such as managing obesity, using	Evidence based review of for example WHO information, Cochrane database, MEDLINE etc Orzano et al (2004) ²⁷	Evidence that modest weight loss (10%) positively affects prevention/ treatment of hypertension (NNT = 3) or diabetes (NNT = 9).	Obesity is an independent risk factor for increased mortality. Combination of diet and exercise is best way to	Weight loss has beneficial effects on blood pressure, glucose, lipids, and psychological status BMI is a useful tool to establish a diagnosis in obese	Most studies investigating weight loss and mortality have not controlled for unintentional weight loss or for smoking.

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<p>BMI to screen, modest weight loss, effective treatments (such as exercise) or counselling to achieve a goal.</p>		<p>Effective treatments exist for overweight/obese patients and it is a combination of diet and exercise that provides the best results (NNT = 7).</p>	<p>reduce weight in adult. Given scale of the obesity epidemic, primary care staff should promote social policies that encourage healthy nutrition and greater exercise not only treat obesity.</p>	<p>patients and to decide on treatment options.</p>	
<p>Alcohol</p>					
<p>Alcohol brief intervention</p>	<p>Meta-analytic review (studies comparing brief interventions with either control or extended treatment conditions) Moyer et al (2002)²⁸</p>	<p>At follow-up after > 3-6 months, the effect for brief interventions compared to control conditions was significantly larger when individuals with more severe alcohol problems were excluded. On average for every 8 who receive an alcohol brief intervention, 1 will reduce their alcohol consumption to safer levels (NNT = 8).</p>		<p>Alcohol brief intervention NNT suggests that if routinely implemented in primary healthcare the potential to reduce alcohol-related harm in the population is considerable.</p>	<p>Generalizations should be restricted to the populations, treatment characteristics and contexts represented in those studies. NNT underestimates the full effectiveness of brief intervention as the drinker may not reduce drinking straight away but may later.</p>
<p>Screening in brief intervention trials targeting excessive drinkers in general practice</p>	<p>Systematic review and meta-analysis Beich et al (2003)²⁹</p>	<p>All results favoured intervention to some degree (two studies had considerably higher NNTs). Pooled NNT (from 8 studies included) = 10 (7 to 14). NNTs of single studies ranged from 6 to 61.</p>	<p>Results call into question the model of universal screening in general practice as a case finding approach.</p>	<p>Used the basic review and meta-analysis principles recommended by the Cochrane collaboration.</p>	<p>Several sources of bias (such as impossible to blind patient and practitioner and self-reporting) all pointing to overestimation of effect). The 95% confidence intervals of five studies include the possibility of harm.</p>
<p>Universal school-based prevention</p>	<p>Cochrane Database Systematic Review</p>	<p>Faggiano 2007(EU-DAP - European drug abuse prevention trial)</p>	<p>Gender, baseline alcohol use, and ethnicity modified the</p>	<p>Faggiano is a multi-country review (but ethnic composition not reported)</p>	<p>Wide differences across interventions, populations, and outcomes, therefore, results were summarized only</p>

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<p>programs for alcohol misuse in young people aged up to 18^x</p>	<p>One of three reviews, other two examined family-based, and multi-component prevention programs. (53 trials included, mainly cluster-randomised) Foxcroft et al (2011)³⁰</p>	<p>examined intervention made up of 12 sessions of 1 hour a week (covered social skills, personal skills knowledge etc) finding that the the intervention program (compared to standard curriculum) significantly reduced 'any or frequent drunkenness in the past month' at three months and at 18months of follow-up. For example: Any drunkenness in the past month at 3 months post NNT=82 (95% CI: 47, 305). Any drunkenness in past 30 days at 18 months post NNT=26 (no CIs quoted) Other interventions with NNTs are available in the Foxcroft 2011 review (e.g. Konig 2009).^{xi}</p>	<p>effects of interventions. Faggiano - the intervention program was significantly more effective in reducing any drunkenness compared to standard curriculum among males.</p>	<p>Review included studies that found no effects of preventive interventions, but also studies that showed statistically significant effects. Named generic psychosocial and developmental prevention programs that are most effective and should be considered. These include the Life Skills Training Program (no NNT quoted but see Botvin 1995³¹ for details) and the Good Behaviour Game (see Furr-Holden 2004).³² Also the Unplugged program.</p>	<p>qualitatively Lack of detail available about the actual content of interventions often in the outlines of the study/research.</p>
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^x See also Foxcroft DR, Ireland D, Lowe G and Breen R (2007). Primary prevention for alcohol misuse in young people (Cochrane Review)

^{xi} Koning IM, Vollebergh W, Smit F, Verdurmen J, van den Eijnden R, ter Bogt T, et al. Preventing heavy alcohol use in adolescents (PAS): Cluster randomised trial of a parent and student intervention offered separately and simultaneously. *Addiction* 2009;104(10):1669–78.

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Drug treatments	Summary of current research including three systematic reviews and meta-analyses of alcohol cessation studies (including one Cochrane review) Bandolier/Oxford University (2008) ³³	Without any drug intervention, about 1 user in 5 will be abstinent between 3 and 24 months. NNTs are for one participant to be abstinent at six months who would not have been if treated with placebo. No intervention (with at least 200 patients) had an NNT better than 10.	Acamprosate Naltrexone Opioid antagonists Use various methods to assess abstinence, and used placebo, usually with some form of psychosocial intervention.	Used only properly randomised trials.	Evidence concerning interventions deemed to be limited.
Smoking					
Nicotine Replacement Therapy for Smoking Cessation	Cochrane Collaboration review of randomized trials where NRT was compared to placebo or to no treatment, or where different doses of NRT were compared (excluded trials which did not report cessation rates, and those with follow-up of less than six months) Stead et al (2012) ³⁴ NB a summary is already available on NNT.com (see www.thennt.com/nnt/nicotine-replacement-therapy-for-smoking-cessation/)	Overall, NRT increased successful cessation rates from 10 to 17% NNT of 15	This review includes 150 studies enrolling over 50,000 subjects comparing NRT to placebo.	Similar to other studies, NRT is not associated with any significant increase in cardiovascular events and is safe to use during pregnancy. NNT.com conclude that given the quality of research and the absence of serious negative effects, NRT appears safe and effective for current smokers wanting to quit.	The use of NRT slightly increased rates of symptomatic chest pains and palpitations (OR 1.88, NNH 94) and other side effects, thought rare and differing by type of NRT included for example stomach upset, dental problems, and pain in gums, skin irritation, throat/nose irritation, sore throat, headache, dizziness, sleep disturbance. NRT's relative benefit seems consistent but the absolute effect could differ with other factors (such as behavioral support, financial incentives, etc).
Physician	Cochrane review of	In the author's	Main outcome measure	Basic advice has a small effect	Absolute quit rates are influenced by

<p>advice for smoking cessation</p>	<p>randomised trials in which stopping smoking at least 6 months post advice from a Physician was assessed. Aimed to examine the effectiveness of advice in promoting smoking cessation, compare minimal and more interventions, examine effectiveness of different aids to advice on cessation and to examine the effect of anti-smoking advice on disease-specific and all-cause mortality.</p> <p>Stead et al (2008)^{35,xii}</p>	<p>conclusion, taking an unassisted quit rate of 2% at 12 months in a population of primary care attenders, used CIs to estimate an NNT of 50-120.</p> <p>Whereas if the background quit rate was 3%, then the same effect size estimate would lead to an NNT of 35-80.</p>	<p>was stopping smoking after at least 6 months follow up (also looked at the impact of advice on mortality where such long-term follow-up data were available).</p>	<p>on cessation rates (assuming an unassisted quit rate of 2 to 3%) whereas brief advice intervention can increase quitting by a further 1 to 3%.</p> <p>Additional components appear to have only a small effect, though there is a small additional benefit of more intensive interventions compared to very brief interventions.</p>	<p>motivation of the participants who are recruited or treated, the period of follow up, the way in which abstinence is defined, and whether biochemical confirmation of self-reported abstinence is required.</p> <p>Only a small number of trials used biochemical measures to confirm self-reports of abstinence (tending to result in higher rates of quitting)</p> <p>oted in NICE that smoking cessation services offer very cost effective interventions to help people stop smoking, their range of guidance is intended to compliment and enhance the reach of those services.</p> <p>Interventions can include a range of benefits for such as employers including less staff breaks/time of sick due to smoking related illness and less house fires (savings for fire/rescue and LA)³⁶</p>
<p>Falls</p>					
<p>Interventions in the community for preventing falls in older population</p>	<p>Systematic Cochrane Collaboration review Gillespie et al (2009)³⁷</p> <p>(NB summary available on NNT.COM. See: www.thennt.com/nnt/strength-and-balance-</p>	<p>At-risk elderly were helped (avoid suffering a fall over a one year period). NNT 11.</p>	<p>Based on 62 trials enrolling nearly 22 000 patients.</p>	<p>NNT quoted is for a single intervention as easiest to implement</p> <p>Limited evidence of any disadvantages to intervention (with the exception of a single study here which found negative effects from brisk walking in women with recent osteoporotic</p>	<p>Weaknesses in studies reviewed (e.g. definition of falls and possible recall bias) can impact upon measurement of outcomes</p> <p>NNT.COM note that the best evidence on fall prevention comes not from simple intervention of strength and balance training reported here, instead it is from multidisciplinary,</p>

^{xii} There is also the 2012 version:

Stead LF, Buitrago D, Preciado N, Sanchez G, Hartmann-Boyce J and Lancaster T (2013). Physician advice for smoking cessation. *Cochrane Database of Systematic Reviews* 2013, Issue 5.

Decision making in public health: using Number Needed to Treat (NNT) to determine intervention effectiveness

	programs-for-elderly-falls/).			fractures) apart from costs and the efforts required from participants and caregivers.	multifactorial, health and environmental risk factor screening and interventions programmes, e.g. an established fall prevention outreach program as these show most efficacy in both high risk groups and in terms of a broader outreach program to all community-dwelling elderly.
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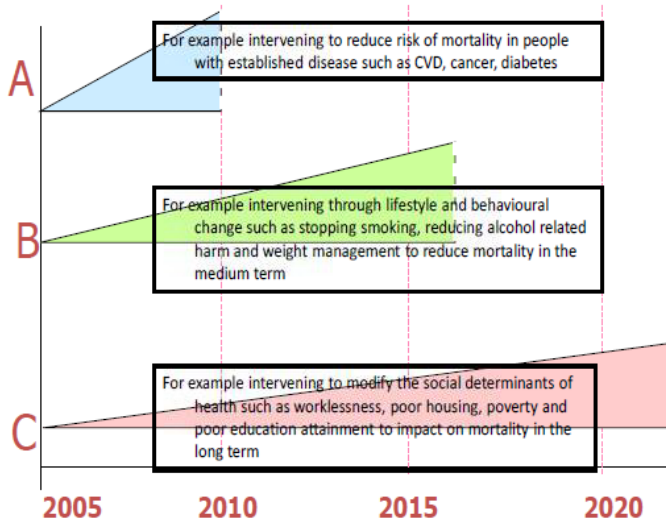
Local case studies showing use of NNT to inform decision making

A number of local areas in the North West have already used NNT to help inform their decision making to tackle some key priorities for their area and to present evidence to stakeholders. The following lists some examples.

Blackpool - identifying interventions to best help meet the life expectancy targets^{38,39}

- life expectancy across Blackpool has improved in recent times, yet these improvements are at a slower rate than for the country as a whole, plus the gap to the national average continues to widen.
- Colleagues worked with the [former] National Support Team (NST)^{xiii} to identify actions that could reduce mortality in the shorter-term as well as those in the medium and long term time.
- by modelling the improvement required (in terms of the number of deaths that would need to be prevented to improve life expectancy) the NST helped show the scale of the challenge.^{xiv}

Figure 2: Different timescales for interventions to take effect



- the NST calculated that a further 673 deaths would need postponing to achieve the current best rate in the North West for life expectancy (in 2014-2016).
- data (from measures such as NNT) was then used to work out which interventions could have most impact upon achieving the 673 target.

^{xiii} for Health Inequalities

^{xiv} These were modelled against the best of a comparable peer group (Warrington); the best [Spearhead local authority] in the North West.

- such evidence-based interventions included secondary prevention treatments following a CVD event (for example statins and aspirin) as well as interventions for improving diabetes management (such as reducing blood sugars).
- analyses showed that over a third of these deaths could potentially be prevented by implementing the suggested interventions.

Central and Eastern Cheshire - modelling mortality reductions needed to achieve targets⁴⁰

- similar to the approach in Blackpool, Central and Eastern Cheshire Public Health presented their local commissioners with details of the so called 'NST Interventions' identified as most effective in helping to reduce premature deaths in the short to medium term.
- interventions specifically with lower NNTs^{xv} are secondary prevention of cardiovascular disease, anti-coagulant therapy for patients over 65 with atrial fibrillation and cardiovascular disease risk in patients with chronic obstructive pulmonary disease.
- using the NST Modelling Mortality Reductions tool,^{xvi} their annual report included three tables outlining NNT and potential gains for the Eastern Cheshire, South Cheshire and Vale Royal CCGs separately.

Liverpool - modelling the impacts of changes in cancer screening services⁴¹

- NNTs formed part of a predictive model to measure the impact of changes in the uptake and age ranges for breast and bowel cancers screening interventions on overall life expectancy of the population.
- for example, increasing the uptake rate for bowel cancer screening from 55% to 60% of the eligible population (people aged between 60 and 69 years old) would mean an extra 3 cancers could potentially be detected each year representing an overall increase of 9.1% with no predicted change to life expectancy in 2014 but potentially no impact on annual numbers of deaths.

^{xv} Interventions with lower NNTs are generally the most efficient, however, some interventions with higher NNT values can also lead to considerable life expectancy gains for the population as they prevent very early deaths, for example, reducing smoking during pregnancy.

^{xvi} Specifically v6.1, December 2010

- whereas by extending the age groups eligible for bowel screening (to cover 50 to 69 year olds - and assuming a screening take-up rate of 60%) the model showed that an additional 23 cancers could potentially be detected each year (representing an increase of 67%) with life expectancy in 2014 therefore predicted to increase by 0.01 life years and the annual number of deaths estimated to decrease by 2 each year.
- the NNT included in the model showed that to prevent one bowel cancer death occurring within 5 years, 47 people aged between 60 and 69 years rising to 93 for persons between the ages of 50 and 69 years would need to receive intervention.

Appendix

Examples of further smoking-related high impact interventions with their NNT for helping smokers to quit.

Intervention	Target population	Effect size ¹	NNT ² (95% CI ³)
Brief opportunistic advice from a health care professional to stop	Smokers attending GP surgeries or outpatient clinics	1-3%	50 (33-100)
Face-to-face intensive behavioural support from a specialist ⁴	Moderate to heavy smokers seeking help with stopping	3-10%	14 (10-33)
Face-to-face intensive behavioural support from a specialist	Pregnant smokers	5-9%	14 (11-20)
Face-to-face intensive behavioural support from a specialist ⁵	Smokers admitted to hospital	0-8%	25 (13-infinity)
Proactive telephone counselling ⁶	Smokers wanting help with stopping but not receiving face-to-face support	1-4%	50 (25-100)
Written self-help materials	Smokers seeking help and not receiving other support	0-2%	100 (50-infinity)
Nicotine gum	Moderate to heavy smokers given limited behavioural support ⁷	4-6%	20 (17-25)
Nicotine gum	Moderate to heavy smokers given intensive behavioural support	6-10%	13 (10-17)
Nicotine transdermal patch	Moderate to heavy smokers given limited behavioural support	4-7%	20 (14-25)
Nicotine transdermal patch	Moderate to heavy smokers given intensive behavioural support	5-8%	17 (13-20)
Nicotine nasal spray	Moderate to heavy smokers receiving intensive behavioural support	7-17%	8 (6-14)
Nicotine inhalator	Moderate to heavy smokers given intensive behavioural support	4-12%	13 (8-25)
Nicotine sublingual tablet	Moderate to heavy smokers given intensive behavioural support	1-14%	13 (7-100)
Bupropion (300 mg/day sustained-release)	Moderate to heavy smokers given intensive behavioural support	5-14%	11 (7-20)
Intensive behavioural support plus NRT or bupropion ⁸	Moderate to heavy smokers seeking help from a smokers' clinic	13-19%	-

1. Difference in '> 6 months abstinence' rate between intervention and control/placebo in the studies reported; data from Cochrane meta-analyses unless otherwise stated. The range within which one can be 95% confident that the true underlying value lies.
2. NNT, Number needed to treat
3. CI, Confidence interval.
4. Efficacy figures based on subset of studies from general population with biochemical verification.
5. No Cochrane review available; data from USDHHS meta-analysis.
6. No Cochrane review available; data from USDHHS meta-analysis.
7. The term 'limited behavioural support' refers to brief sessions required primarily for collecting data. Following the Cochrane definition, 'intensive' behavioural support was defined as an initial session of more than 30 minutes, or an initial session of less than 30 minutes plus more than two subsequent visits.
8. Expected effect combining effect of medication with effect of behavioural support.

Source: Hodgson P and Furber A (2007). Ten High Impact Changes. Achieving four: making it easier for smokers to quit. NHS Yorkshire and Humber review [Online]. Available at: www.yhpho.org.uk/resource/view.aspx?RID=9629 [Accessed 15.10.2014].

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