

# *Clinical Pharmacology and Therapeutics*

The case for  
savings in the NHS  
December 2016

Final



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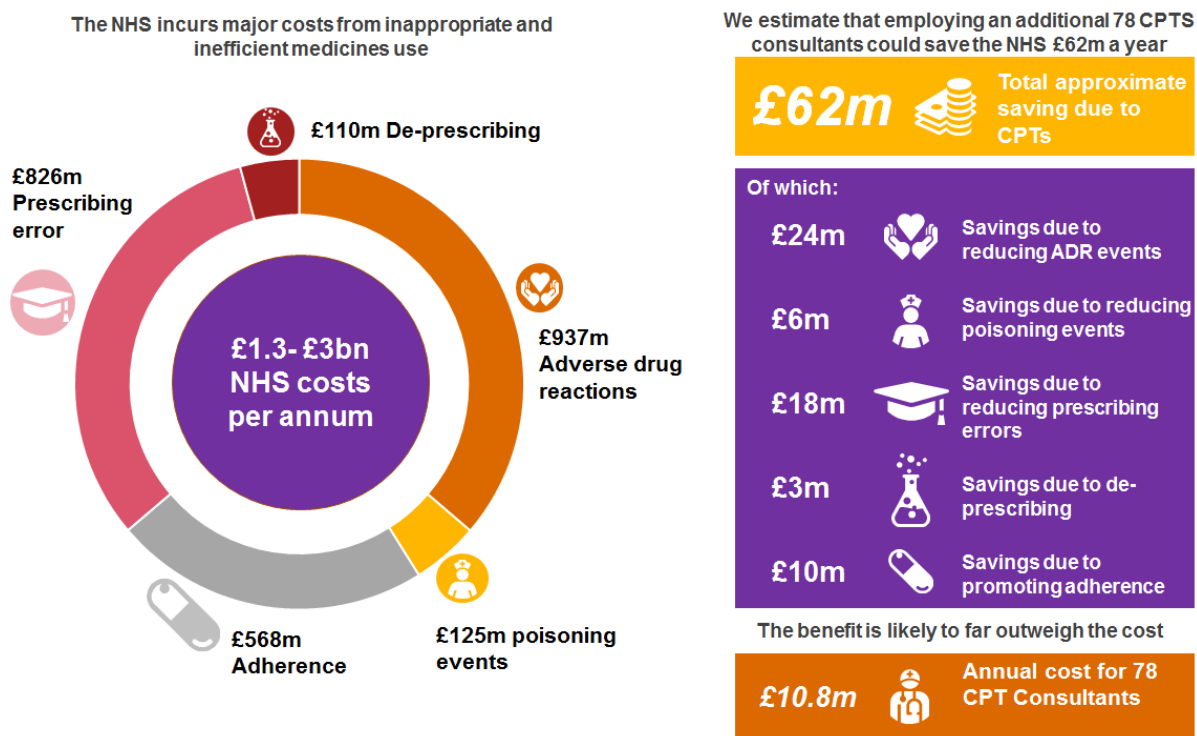
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# Executive Summary

Clinical pharmacologists are trained physicians who focus on the safe and effective use of medicines. They have a multi-faceted role within the NHS that includes treating patients, training other clinicians in prescribing best practice, and the development of innovative new medicines.

At present there are 72 clinical pharmacologists and the British Pharmacological Society (the Society) recommends that by 2025, a further 78 clinical pharmacologists should be recruited<sup>1</sup> to take the total to 150. This would start to address the current shortfall which has been identified by the Society and the Royal College of Physicians<sup>2</sup>. This report explores the costs and benefits of hiring these additional clinical pharmacologists for the UK and quantifies significant social, clinical and financial benefits as a result of this investment. Our key finding is that EACH £1 spent to hire additional clinical pharmacologists has the potential to reduce NHS costs by almost £6.

## Summary of impacts



- Improved patient quality of life
- Fewer sick days and greater economic productivity
- Improved patient access to new treatments
- Better prepared junior and other doctors
- Increased experimental medicine capabilities in UK NHS hospitals
- Reduction in deterioration of disease

Source: PwC analysis

<sup>1</sup> British Pharmacological Society, Clinical Pharmacology: A Dynamic Medical Speciality Essential for UK Healthcare 2015. Available at: <https://www.bps.ac.uk/BPSMemberPortal/media/BPSWebsite/Clinical-Pharmacology-A-dynamic-medical-speciality-essential-for-UK-Healthcare.pdf>.

<sup>2</sup> Royal College of Physicians of London, Consultant physicians working with patients: The duties, responsibilities, and practice of physicians in medicine, 2013. Available at: [http://www.rcplondon.ac.uk/sites/default/files/consultant\\_physicians\\_revised\\_5th\\_ed\\_full\\_text\\_final.pdf](http://www.rcplondon.ac.uk/sites/default/files/consultant_physicians_revised_5th_ed_full_text_final.pdf).

# Introduction

## Introduction

Clinical pharmacologists are trained physicians who focus on the safe and effective use of medicines. They have a multi-faceted role within the NHS. As well as treating patients, they train other clinicians in prescribing best practice and the development of innovative new medicines. Because of these roles, clinical pharmacologists can affect far more patients beyond those they treat directly.

It is estimated that there are only 72 clinical pharmacologists currently working in the NHS<sup>3</sup>. However, the Royal College of Physicians have recommended that 440 clinical pharmacologists would be required across the UK to ensure an appropriate level of patient coverage.<sup>4</sup>

Based on this recommendation, the British Pharmacological Society (the Society), a Learned Society and charitable organisation focusing on the development of pharmacology in the UK, are campaigning to start closing this gap. The Society has proposed that the NHS should employ an additional 78 clinical pharmacologists by 2025 to take the total to 150.

Recognising the many competing spending priorities in the NHS, the Society wishes to better understand the costs and benefits of their proposal and has commissioned PwC to investigate it further. In this report, we (PwC) have set out and tested a series of hypotheses on the impact that clinical pharmacologists have.

## Background

The NHS is facing the biggest financial challenge since its creation, as limited resources contend with an ever-increasing demand for healthcare driven by demographic and technological change. As a result, NHS England has established the Five Year Forward View that aims to improve efficiency and productivity. NHS England has called for a 1.5 per cent net efficiency increase each year from 2014, compared to the 0.8 per cent that has been achieved historically.<sup>5</sup>

The NHS spent £18.1 billion on medicines in 2014/15<sup>6</sup>. Ensuring this spend is both cost-effective and clinically effective can help it meet these efficiency targets. As this report will demonstrate, clinical pharmacologists play an important role in ensuring the cost-effective use of medicines, for example by developing local and national formularies, training current and future clinicians and providing expert advice on prescribing to limit adverse drug reactions (ADRs).

### The role of clinical pharmacologists in the NHS

Clinical pharmacology is a diverse and wide-ranging discipline, but its core role is ensuring the efficient and cost-effective use of medicines. Clinical pharmacologists:

- Provide specialist and generalist patient care in hospitals and other settings, using their expertise in the use of medicines to improve outcomes and prevent avoidable harm;

<sup>3</sup> British Pharmacological Society, Clinical Pharmacology: A Dynamic Medical Speciality Essential for UK Healthcare 2015. Available at: <https://www.bps.ac.uk/BPSMemberPortal/media/BPSWebsite/Clinical-Pharmacology-A-dynamic-medical-speciality-essential-for-UK-Healthcare.pdf>.

<sup>4</sup> Royal College of Physicians of London, Consultant physicians working with patients: The duties, responsibilities, and practice of physicians in medicine, 2013. Available at: [http://www.rcplondon.ac.uk/sites/default/files/consultant\\_physicians\\_revised\\_5th\\_ed\\_full\\_text\\_final.pdf](http://www.rcplondon.ac.uk/sites/default/files/consultant_physicians_revised_5th_ed_full_text_final.pdf).

<sup>5</sup> NHS England, Five Year Forward View, October 2014. Available at: <https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf>.

<sup>6</sup> Data obtained from Health and Social Care Information Centre, ISD Scotland, Business services Organisation (Northern Ireland) and the Welsh Government.

- Lead clinical toxicology services and the National Poisons Information Service;
- Advise on all aspects of medicines policy and management including regulation, health economic assessments, prescribing guidance and formulary management in order to optimise the clinical and cost-effective use of medicines;
- Support patients with medicines management to reduce medicine wastage;
- Provide education and training to ensure doctors have the appropriate skills to prescribe safely and effectively;
- Work with industry and support the UK's life sciences sector to enhance the development of innovative new medicines and improve the use of current medicines;
- Bring innovation to the NHS through experimental medicine by designing early phase clinical trials, establishing NHS clinical research facilities and providing overarching clinical support; and
- Deliver medicine optimisation in a system with increasing levels of polypharmacy by supporting patients to ensure the right combination of medicines are prescribed.

Many of these roles are optimally performed by clinical pharmacologists due to their unique training in both clinical medicine and pharmacology, which enhances understanding of how medicines interact with patients at the individual level. Two specific examples of the impact made by clinical pharmacologists are the withdrawal of co-proxamol and the implementation of the UK Prescribing Safety Assessment (PSA).

Co-proxamol is a powerful painkiller, which was often given to patients with muscle and joint pains. It was gradually phased out between 2005 and 2007 after concerns that it was involved in a number of suicides and accidental poisonings. Research from clinical pharmacologists, presented to the Commission on Human Medicine (CHM), was crucial in leading to the phased withdrawal of co-proxamol.

Clinical pharmacologists have also played a defining role in the development and implementation of the PSA. This assessment is designed to improve and test the competence of doctors when prescribing<sup>7</sup>. The aim is for the PSA to become a standard assessment, and from 2016, all new doctors have been required to take the PSA before their first year of practice.

Already, around 36,000 UK medical students have participated in the PSA, with around 8,000 students completing the assessment each year. It is estimated that participants have written approximately 250,000 prescriptions.

Many clinical pharmacologists have also held leadership positions in regulatory and research organisations such as National Institute for Health and Care Excellence (NICE), Medical Healthcare products Regulatory Agency (MHRA), Scottish Medicines Consortium, All Wales Medicines Strategy Group, General Medical Council and the National Institute for Health Research (NIHR). These roles provide guidance nationally for the NHS, researchers and industry to optimise the development and refinement of new and existing medicines.

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<sup>7</sup> "Prescribing safety: ensuring that new graduates are prepared", Simon R J Maxwell, Iain T Cameron, David J Webb, *The Lancet*, Vol 385 February 14, 2015, p579.

## ***Potential benefits of additional clinical pharmacologists***

Given the clinical role that clinical pharmacologists play in the NHS, we have identified six hypotheses for how they may deliver value. These are:

### **1. Reducing incidence and improving treatment of Adverse Drug Reactions (ADRs)**

The role of the clinical pharmacology consultant includes providing training and assurance that medicines are prescribed in accordance with best practice guidance. For example, based on a full clinical assessment (history, examination, investigations), they ensure patients are on the right dose of the right drugs (and combinations), minimising potential interactions and adverse drug reactions. The greatest impact may come through training other medical specialists, pharmacists and nurses. Increasing the number of clinical pharmacologists may reduce the number of hospital admissions due to ADRs, facilitate improved treatment of those in hospital and reduce medical negligence cases.

### **2. Reducing incidence and improving treatment of poisoning**

Clinical pharmacologists have expertise in the detection and management of poisoning. They lead specialist poison centres, which provide advice to clinicians caring for poisoned patients, especially in emergency medicine and intensive care. In acute hospitals without clinical toxicology units, clinical pharmacologists apply their expertise to care directly for patients with poisoning. Our second hypothesis is that increasing the number of clinical pharmacologists may further improve the treatment of those who are poisoned.

### **3. Reducing prescription errors**

It is estimated that 7%-15% of all hospital prescriptions contain an error and junior doctors feel underprepared for and anxious about prescribing<sup>8</sup>. Clinical pharmacologists may reduce prescription errors by supporting and training other physicians in hospitals in prescription best practice.

### **4. De-prescribing**

An estimated 3.6% of hospital medicines prescribed for elderly patients with long-term conditions have no clinical value<sup>9</sup>. Clinical pharmacologists may be able to reduce this cost by reviewing complex medication plans and supporting other clinicians (including those in primary care) in streamlining these plans. This would bring down costs to the NHS through reducing the prescription of unnecessary medicines.

### **5. Boosting clinical R&D**

Clinical pharmacologists in the NHS work in the development of new drugs, often in collaboration with universities and pharmaceutical companies. Their role includes designing early phase clinical trials, establishing NHS clinical research facilities and providing overarching clinical support for trials. Clinical pharmacologists may therefore support the UK's position as a vibrant location for medical research, increase interactions with industry, and thereby contribute to economic development.

### **6. Improving adherence**

Non-adherence is defined as not taking medicines in the appropriate way (e.g. missing doses or taking inaccurate doses). This would lead to extra costs for the NHS if patients who fail to adhere to their medication require additional treatment as a result. One of the reasons for non-adherence is the number of different drugs patients receive and the complexity dosage regimens, particularly in those with multi-morbidities. Indeed, people over 60 are particularly at risk as 58% suffer from long-term health conditions, often requiring multiple medicines<sup>10</sup>. Clinical pharmacologists have an in-depth

<sup>8</sup> Dornan T, Ashcroft D, Heathfield H, et al. An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education: EQUIP study. Final report for the GMC, December 2009. [http://www.gmc-uk.org/FINAL\\_Report\\_prevalence\\_and\\_causes\\_of\\_prescribing\\_errors.pdf\\_28935150.pdf](http://www.gmc-uk.org/FINAL_Report_prevalence_and_causes_of_prescribing_errors.pdf_28935150.pdf) (accessed June 14, 2014).

<sup>9</sup> <http://www.uptodate.com/contents/drug-prescribing-for-older-adults#H7>.

<sup>10</sup> NHS England, Five Year Forward View, October 2014. Available at: <https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf>.

knowledge of drugs and their interactions and may improve adherence by prescribing a simpler mix of medicines and providing guidance and training for other clinicians to enable them to do so.

## ***Summary of impacts considered***

The remainder of this report sets out evidence on these hypotheses. We have considered several different types of impact including:

1. The financial impact on the NHS;
2. The welfare effects on patients; and
3. The wider economic effects.

In practice, as we show in the table below, the bulk of the evidence identified relates to the financial impact on the NHS. We have monetised some of these financial benefits and all of the costs (as highlighted in green in the table).

***There are potentially significant benefits that we have not been able to monetise so we consider our assessment of the benefits to be conservative.***

Our analysis considers the option of increasing the number of clinical pharmacologists by 78 consultants in order to realise these benefits. This is based on the Society's aim to increase the existing pool of clinical pharmacologists to 150 by 2025. We have not considered alternative options that may be available to realise some of the potential benefits described above.

**Summary of clinical pharmacology consultant impacts considered (monetised impacts highlighted in green)**

<b>Topic</b>	<b>Financial impact on NHS</b>	<b>Health impact on patients (patient welfare)</b>	<b>Wider economic impacts</b>
ADRs	Savings to NHS from treating patients	Improved patient welfare effects from improved health	Fewer days away from work, boosting GDP
Poisoning events	Savings to NHS from treating patients	Improved patient welfare effects from improved health	Fewer days away from work, boosting GDP
Prescription errors	Reduced cost of wasted medicines due to inefficient use	Increased funding for other treatments	No adverse impact expected
De-prescribing	Reduced cost of wasted medicines due to inefficient use	Increased funding for other treatments	No adverse impact expected
Research and development	Savings to NHS relating to R&D (e.g. payments from pharmaceutical companies conducting clinical trials)	Improved patient welfare effects from greater access to medicines	Economic benefits from R&D activity in the UK
Adherence	Savings to NHS from treating patients	Improved patient welfare effects from improved health	Fewer days away from work, boosting GDP
Cost of extra clinical pharmacologists	Cost of employing additional clinical pharmacologists	No adverse impact expected	No adverse impact expected

Source: PwC



# Summary of benefits assessed

## Introduction

In this section, we summarise our assessment of the potential benefits of employing 78 additional clinical pharmacology consultants in the NHS.

We conducted a review of existing literature and identified over two dozen reports capturing the costs of inefficient medicine use and the efficacy of clinical pharmacology led interventions. We also undertook analysis of in-patient activity data from NHS Trusts in England to compare how patient outcomes vary with the presence of clinical pharmacologists. Further details of the methodology are contained in the Annex.

## Adverse Drug Reactions (ADRs)



Clinical pharmacologists specialise in understanding how patients react to medicines. Our hypothesis is that their presence in hospitals improves the treatment of ADRs (measured by a lower average duration of inpatient stay) and may reduce the number of admissions through training other clinicians in prescription best practice. The evidence suggests clinical pharmacologists have a significant impact on ADRs. Of the total annual cost of £937m to the NHS, we estimate that £24m of savings could be unlocked by hiring an additional 78 clinical pharmacologists.

There is some uncertainty over the total cost of ADRs to the NHS. Our analysis of Health Episode Statistics (HES) suggests that both ADR and poisoning admissions accounted for 0.8% of total admissions in England, costing £92.3m in 2015/6<sup>11</sup>. Assuming the prevalence rates are the same in Scotland, Wales and Northern Ireland, the cost of in-patient treatments in the UK is £103.7m per annum for both conditions.

However, survey-based evidence suggests a far greater impact. Studies have estimated that admissions due to ADRs alone may be 6.5% of the total<sup>12</sup> and the potential cost of ADRs to the NHS may be £937m<sup>13</sup>. This suggests material underreporting in the HES data, most likely as ADRs are coded as different conditions. This estimate also contains a broader range of costs including medical negligence related costs.

We have developed scenarios to reflect this uncertainty. We take the 6.5% figure to form our high scenario. This is also our “best estimate” because it is derived from a dedicated prospective study of hospitals specifically aimed at identifying ADR cases so we consider it more robust than the HES data, which is used to form the low scenario. The study is also peer-reviewed and widely cited in the BMJ.

<sup>11</sup> In the HES statistics ADRs and poisoning are coded together and it is not possible to separate the statistics.

<sup>12</sup> Pirmohamed, M. et al. ‘Adverse drug reactions as cause of admission to hospital: prospective analysis of 18820 patients’, BMJ, 2004, Jul 3; 329(7456): pp. 15–19.

<sup>13</sup> Frontier economics, Exploring the costs of unsafe care in the NHS, October 2014. Available at: <http://www.frontier-economics.com/documents/2014/10/exploring-the-costs-of-unsafe-care-in-the-nhs-frontier-report-2-2-2-2.pdf>, we have extrapolated their estimate from 2007 to 15/16 by applying the GDP deflator from 2009 to 2016.

## The impact of employing additional clinical pharmacologists in the NHS

In order to identify the impact of 78 additional clinical pharmacologists we compared the prevalence and average duration of hospital stay for ADR's and poisoning in trusts with and without clinical pharmacologists and specialist registrars. We used cross sectional regressions across 160 trusts in England to test whether the presence of clinical pharmacologists led to a statistically significant reduction in admissions and average duration of stay. The results showed lower levels of each in Trusts that employ clinical pharmacology clinicians. This was the case in both univariate regressions and multivariate regressions that controlled for the levels of deprivation and patient profiles in the Trust's catchment area<sup>14</sup>.

We used the regression results to estimate the impact on ADR costs if the number of clinical pharmacologists were increased by 78. This yields estimated cost savings of between £2.7m (2.6% of the estimated £103.7m total cost) and £24.4m (using the estimated £937m annual cost),

As described above, this low estimate includes the cost of both ADRs and poisoning, as it is not possible to separate the two values in the HES dataset.

## Poisoning events



Clinical pharmacologists are specialists in the detection and management of poisoning. They lead specialist poison centres and provide advice to other clinicians. The evidence we identified shows that poisoning costs the NHS up to £226m and that 78 additional clinical pharmacologists could unlock £6m of savings.

We estimate poisoning costs for both inpatient and A&E admissions. HSCIC data shows that there were 164,000 A&E attendances for poisoning in England in 2015<sup>15</sup> costing £23.1m per annum<sup>16</sup>.

As we discussed in the ADR section, the costs of poisoning for inpatient admissions are not differentiated from the cost of ADRs in the HES data. Therefore, our low estimate of the total cost for in-patient admissions for poisoning is already captured in the low estimate for ADR costs referenced above. We do not include it again to avoid double counting and the low estimate consists only of the A&E costs.

This is not an issue in the high and best scenarios where the estimate is specific to ADRs so we need to add the cost of inpatient admissions. In-patient admission costs use data from the National Poisons Information Service, which shows that 170,000 patients were admitted to hospital due to poisoning<sup>17</sup>. The average inpatient tariff related to drug admissions was £1,193<sup>18</sup>. These yield an estimate of £202m annual NHS costs for poisoning in-patient admissions. By combining these with A&E attendance costs, we derive our high estimate of total poisoning costs of £226m. As for ADRs,

<sup>14</sup> See methodological annex for more detail. It should be noted that cross sectional regressions of this type are sufficient to demonstrate correlation, but not causation.

<sup>15</sup> <http://www.hscic.gov.uk/searchcatalogue?productid=20143&q=A%26E+attendance&sort=Relevance&size=10&page=1#top>

<sup>16</sup> Based on average cost per A&E attendance of £124 (2013-14) and applying the GDP deflator to 2015-16. [http://www.nuffieldtrust.org.uk/sites/files/nuffield/publication/election\\_briefing\\_urgent\\_care\\_in\\_crisis\\_final\\_web.pdf](http://www.nuffieldtrust.org.uk/sites/files/nuffield/publication/election_briefing_urgent_care_in_crisis_final_web.pdf)

<sup>17</sup> National Poisons Information Service – 2014/15 report.

<sup>18</sup> Based on HES data

we also use this as our best estimate as we think it is likely that the HES data is under-reporting both ADRs and poisonings.

### The impact of employing additional clinical pharmacologists in the NHS

We have used the same regression results (which were based on combined poisoning and ADR data) to estimate the potential impact of employing an additional 78 clinical pharmacologists. These suggest the uplift in clinical pharmacology consultant numbers could reduce costs by 2.6% leading to the saving of £0.6m-£5.9m per annum<sup>19</sup>.

## Prescription errors



Prescription errors are estimated to be present in 7%-15% of all hospital prescriptions<sup>20</sup>. Many of these errors result from clinicians with insufficient training in prescribing drugs to patients. Clinical pharmacologists spend approximately 10%<sup>21</sup> of their time teaching other clinicians about medicines management and usage. In England, £7 billion<sup>22</sup> is spent on hospital prescriptions in the NHS each year implying a cost of £526m to £1,126m from prescription errors. Based on the evidence we have identified we estimate that clinical pharmacologists could unlock up to £18.5m in savings from fewer prescription errors.

### The impact of employing additional clinical pharmacologists in the NHS

Our literature review identified several case studies where clinical educational initiatives led to a reduction in prescribing errors.

The first study looked at neonatal medication across a sample of patients. On average, errors were reduced by 18%<sup>23</sup> through a comprehensive training strategy for health professionals that focussed on preventing prescription errors.

A second study measured the impact of ward based teaching and prescriber education tutorials. Across three groups of patients, these initiatives were found to reduce prescription errors by 17% on average<sup>24</sup>.

We used these case study results to estimate the savings that could be delivered by 78 additional clinical pharmacologists. These estimates were then applied to the number of patients likely to be

<sup>19</sup> We consider this assumption reasonable since the regressions use data for both ADR and Poisoning events combined. It also assumes that the impact of clinical pharmacology consultants on inpatient admission prevalence is replicated in A&E.

<sup>20</sup> An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education. EQUIP study.

<sup>21</sup> Aronson JK. 'What do clinical pharmacologists do? A questionnaire survey of senior UK clinical pharmacologists'. Br J Clin Pharmacol 2012; 73(2): 161-169.

<sup>22</sup> Health and Social Care Information Centre, Prescribing Costs in Hospitals and the Community, England 2014-15, November 2015.

Available at:

<http://www.hscic.gov.uk/searchcatalogue?productid=19276&topics=1%2fPrescribing%2fHospital+prescribing&sort=Relevance&size=10&page=1#top>.

<sup>23</sup> Campino A, Lopez-Herrera MC, Lopez-de-Heredia I, Valls-iSoler A. Educational strategy to reduce medication errors in a neonatal intensive care unit. Acta Paediatr 2009;98(5):782-785.

<sup>24</sup> Thomas AN, Boxall EM, Laha SK, Day AJ, Grundy D. An educational and audit tool to reduce prescribing error in intensive care. Qual Saf Health Care 2008;17(5):360-363.

impacted by a clinical pharmacological intervention<sup>25</sup> and results in an estimated financial saving to the NHS of £11.3m to £25.7m per annum.

## De-prescribing



The over-prescription of medicines with no clinical value is another significant cost in the NHS. It is estimated that 3.6%<sup>26</sup> of hospital medicines prescribed to patients over 65 years old with long-term conditions are unnecessary. If these medicines were de-prescribed, we estimate that the NHS could save approximately £109.7m per year in the UK and that an extra 78 clinical pharmacologists would unlock £3.5m of savings.

### The impact of employing additional clinical pharmacologists in the NHS

The case studies we identified suggest that interventions in patient medication plans can lead to a significant fall in the number of medicines prescribed. An audit at a large acute hospital in the West Midlands measured the changes in anti-hypertensive medicines prescribed to inpatients over 80 years old following an inpatient fall. The results showed that 27% of prescriptions were stopped and a further 7% reduced following medication review. We have used these results to estimate the potential impact additional clinical pharmacologists may have through de-prescribing to be £3.5m per annum.<sup>27</sup> There may also be further benefits in this case through reducing the prevalence of falls, but this is not accounted for in the analysis.

A further study of the All-Wales Therapeutics and Toxicology Centre provides further evidence of the savings that can be achieved from de-prescribing.<sup>28</sup> In this case, a £350,000 investment in training and prescription pattern analysis has resulted in a £5.8m of cost savings between 2009/10 and 2011/12.

## Research and development

The UK is a major centre for health related innovation, with an estimated £2,750m<sup>29</sup> spent on R&D in health, dentistry and medicines development in 2014/15.

An important part of the UK's success is in the field of clinical trials, which are used to assess the effectiveness and safety of new medicines in patients. It is estimated that 63,000 patients were involved in UK clinical trials in 2012<sup>30</sup>. Clinical pharmacologists are vital to these trials. They are not only clinicians but also scientists who focus on developing and understanding new drugs. They work in laboratories to study biomarkers, pharmacokinetics and genetics and work in hospital settings in partnership with pharmaceutical companies to manage and initiate these trials. This value is

<sup>25</sup> HES data used in the regression analysis shows that there are 31,000 admissions per clinical pharmacology consultant or specialist registrar in hospitals where they are present. Note that we are not assuming that each individual clinical pharmacology clinician will see 31,000 patients, but that by training other clinicians they will be able to impact a large number of patients.

<sup>26</sup> <http://www.uptodate.com/contents/drug-prescribing-for-older-adults/abstract/61?utdPopup=true>.

<sup>27</sup> Prescription review-post inpatient fall, Audit of a large West Midland Acute Hospital, Omer H1, Hodson J2,1, Pontefract SK1,2, Martin U1. 1. University of Birmingham; 2. University Hospitals Birmingham NHS Foundation Trust.

<sup>28</sup> Investing-to-Save 3, Welsh Government, October 2012. <http://www.senedd.assembly.wales/documents/s10974/Action%20Point%20-%20Invest2save3%20English.pdf>

<sup>29</sup> [https://www.hesa.ac.uk/index.php?option=com\\_content&view=article&id=1900&Itemid=](https://www.hesa.ac.uk/index.php?option=com_content&view=article&id=1900&Itemid=)

<sup>30</sup> House of Commons Science and Technology Committee: Clinical trials, third report of session 2013/14.

recognised by the Medicines and Healthcare Regulatory Agency, who require principal investigators to hold clinical pharmacology qualifications at accredited research facilities undertaking phase one clinical trials.

Clinical trials benefit patients by allowing them access to medicines that would otherwise be unavailable. They also benefit the NHS through the funding that pharmaceutical firms provide. Consequently, over 99% of NHS Trusts actively seek patients to be involved in clinical trials<sup>31</sup>.

Additional clinical pharmacologists would contribute to academic and research work. The Association of the British Pharmaceutical Industry (ABPI) has highlighted the considerable shortage of high quality clinical pharmacologists to fill this role as a barrier to their investment in UK R&D<sup>32</sup>. George Freeman, the Parliamentary Secretary of State for Life Sciences (November 2015), also re-iterated the need for highly skilled individuals to support research and development. As a result, there is a significant drive to improve their supply with Cogent, the UK's strategic body for life science skills, providing funding for training and apprenticeships in this area.<sup>33</sup>

Along with the ABPI, the RCP and the Office of Life Sciences, we believe the enhanced presence of clinical pharmacologists in the NHS will help to address this skills shortage and make the UK a more attractive location for clinical R&D. However, we have not been able to identify any evidence that allows us monetise the scale of this impact.

## Non-adherence



Non-adherence is a major issue in the NHS that can result in significant costs. It is estimated that 50% of patients do not take their medicines properly.<sup>34</sup> Many of these patients will require additional treatment as a direct result. We estimate that employing an extra 78 clinical pharmacologists in the NHS would deliver £10m per annum in non-adherence savings.

Research in 2010 by the York Health Economics Consortium and School of Pharmacy (University of London) suggests that non-adherence may cost the NHS £500m a year<sup>35</sup>. This is based on evidence from six case studies<sup>36</sup> and captures the additional cost of GP visits, outpatient appointments, treatment and non-elective spells. Inflating this to 2015/16 prices implies a cost today of £568m per annum across the UK<sup>37</sup>.

### The impact of employing additional clinical pharmacologists in the NHS

Case studies identified in our literature review demonstrate how clinical pharmacologists can reduce non-adherence in patients.

<sup>31</sup> <http://www.publications.parliament.uk/pa/cm201314/cmsselect/cmsstech/104/104.pdf>.

<sup>32</sup> [http://www.abpi.org.uk/our-work/library/industry/Documents/Skills\\_Gap\\_Industry.pdf](http://www.abpi.org.uk/our-work/library/industry/Documents/Skills_Gap_Industry.pdf).

<sup>33</sup> <http://www.scienceindustrypartnership.com/home/>.

<sup>34</sup> Brown, M et al, 'Medication Adherence: WHO Cares?', *Mayo Clin Pro*, 2011; 86(4): 304–314. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3068890/>.

<sup>35</sup> York Health Economics and The School of Pharmacy University of London. Evaluation of the Scale, Causes and the Costs of Waste Medicines. November 2010. Available at [http://eprints.pharmacy.ac.uk/2605/1/Evaluation\\_of\\_NHS\\_Medicines\\_Waste\\_web\\_publication\\_version.pdf](http://eprints.pharmacy.ac.uk/2605/1/Evaluation_of_NHS_Medicines_Waste_web_publication_version.pdf). Last accessed: May 2014.

<sup>36</sup> Case studies were related to asthma, type 2 diabetes, high cholesterol/coronary heart disease, statins, hypertension and schizophrenia.

<sup>37</sup> Throughout we use the GDP deflator to inflate values, the implicit price deflator based on the prices of all new, domestically produced, final goods and services.

The first case study is based on a tertiary hospital in Germany and focused on adherence for cardiovascular patients over a 6-week period. The study found that adherence improved by 4% for patients whose doctors received pharmacological support when making prescriptions.<sup>38</sup>

A second case study assessed the impact of drug counselling for people receiving anti-depressant drugs over a 12-week period. This study was based on a sample of 250 patients and the intervention was found to boost adherence by 24%.<sup>39</sup>

To estimate the impact of clinical pharmacologists on non-adherence costs, we used these case study results to provide a high and low impact scenario. Our “best estimate” uses the mid-point of these results<sup>40</sup>. This results in an estimated financial saving to the NHS from reduced non-adherence of £2.9m to £17.4m per annum from 78 additional clinical pharmacologists.

## Other non-quantified benefits

### Patient impact

Some of the impacts described above will also affect patient health, leading to welfare gains. These gains may be significant, as it is estimated that a person will privately value a year of good health at £20,141<sup>41</sup>. This value is also broadly consistent with the benchmark of £20,000-£30,000 per Quality Adjusted Life Year used by the National Institute for Clinical Excellence when assessing the value for money of medicines.

The below table provides an overview of potential health impacts of increasing the number of clinical pharmacologists.

### Summary of potential health effects

Area	Detail
ADR and poisoning	<ul style="list-style-type: none"> <li>Reduction in ADR and poisoning prevalence</li> <li>Reduction in length of hospital stay due to ADRs and poisoning</li> </ul>
Prescribing errors	<ul style="list-style-type: none"> <li>Improved teaching of clinicians results in fewer prescription errors and more efficient care</li> </ul>
De-prescribing	<ul style="list-style-type: none"> <li>Reduction in the risk of ADR admissions</li> <li>Improved health due to simpler medication combinations and better adherence</li> </ul>
Non-adherence	<ul style="list-style-type: none"> <li>Improved health due to medicines being taken as prescribed</li> </ul>
Medical R&D	<ul style="list-style-type: none"> <li>Improved patient access to new treatments</li> </ul>

Source: PwC

### Wider economic impact

A final benefit from the additional clinical pharmacologists working in the NHS may accrue to the wider economy. If the health effects outlined above were realised then there would be an additional benefit of fewer sick days and less time off work because of these health issues. This would have a positive effect on UK GDP and tax revenues.

## Benefit summary

<sup>38</sup> <http://amcp.org/WorkArea/DownloadAsset.aspx?id=16596>.

<sup>39</sup> <http://www.bmj.com/content/319/7210/612.full>.

<sup>40</sup> As with prescription errors, these estimates assume that 31,000 patients will be impacted by a clinical pharmacology consultant or specialist registrar by training other clinicians.

<sup>41</sup> Measuring the Social Impact of Community Investment: A Guide to using the Wellbeing Valuation Approach, HACT. <http://www.hact.org.uk/sites/default/files/uploads/Archives/2014/3/MeasuringSocialImpactHACT2014.pdf?sid=9120>



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The table below provides a summary of our monetised benefit estimates from employing an additional 78 clinical pharmacologists in the NHS. As we set out in the section above, where there is a range of impact estimates available, we have used the values at each end of the range to generate a high and low estimate. In most cases, we have taken a mid-point of the high and low estimates as our best estimate.

The exception to this is for the savings associated with reduced ADRs and poisonings, where we have taken the high estimate as our best estimate since we considered this more robust. We therefore, estimate that additional 78 clinical pharmacologists may result in a saving to the NHS of between £19m and £77m per annum, with a best estimate of £62.4m per annum.

**Summary of total financial impacts, annual savings, 2015/16 prices**

<b>Area</b>	<b>Total cost to NHS per annum</b>	<b>Low saving estimate</b>	<b>High saving estimate</b>	<b>Best saving estimate</b>
ADRs events (inpatient admissions)	£104m - £937m (low estimate includes inpatient poisoning costs) Best estimate: £937m	£2.7m (includes poisoning in-patient costs)	£24.4m	£24.4m
Poisoning events (A&E attendances)	£23m-£226m Best estimate: £125m	£0.6m (A&E attendances only)	£5.9m	£5.9m
Prescription errors	£526m-£1,126m Best estimate: £826m	£11.3m	£25.7m	£18.5m
De-prescribing	£110m	£3.5m	£3.5m	£3.5m
Adherence	£568m	£2.9m	£17.4m	£10.2m
<b>Total saving</b>	<b>£1,330m - £2,967m</b>	<b>£21.0m</b>	<b>£77.0m</b>	<b>£62.4m</b>

Source: PwC analysis, figures may not sum due to rounding.



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# *Summary of costs assessed*

## *Introduction*

In this section, we provide an estimate of the costs of employing 78 additional clinical pharmacology consultants in the NHS based on salary information.

## *Costs of employing additional clinical pharmacology professionals*

During 2015/16, a clinical pharmacology consultant was paid a salary of £111,863 on average and a registrar was paid a salary of £53,060. This salary includes non-basic pay components such as overtime.<sup>42</sup>

We have also included an uplift of 24% to these figures to factor in pension costs and employer taxes. This uplift is based on Eurostat data on the wage and non-wage shares of total labour costs.<sup>43</sup>

As a result, the total cost of employing 78 clinical pharmacologists is estimated at £10.8m per annum in 15/16 prices.

This estimate does not include the cost of training because we would not expect this proposal to result in any net change in the total number of medical students given the relatively low number of staff being proposed (78 over a 10-year period). Instead, we would expect the posts to be filled through an increase in the number of current students electing to specialise in clinical pharmacology.

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<sup>42</sup> Health & Social Care Information Centre: NHS Staff earnings estimates to March 2016, Provisional Statistics.

<sup>43</sup> [http://ec.europa.eu/eurostat/statistics-explained/index.php/Wages\\_and\\_labour\\_costs](http://ec.europa.eu/eurostat/statistics-explained/index.php/Wages_and_labour_costs).

# Cost and benefit summary

## Introduction

In government appraisal, it is common to consider the present value of costs and the benefits of an option over a number of years. This section summarises the results of our analysis by presenting the present value of these impacts and the benefit to cost ratio.

## Approach

In order to estimate the impact of the additional clinical pharmacologists in present value terms we have used the following approach:

- We have assumed that it will take 10 years to train and recruit the additional 78 clinical pharmacologists. Therefore, we assume both costs and benefits will phase in linearly over ten years.
- When calculating the present value, we have assessed the costs and benefits over a 30-year appraisal period from 2015/16 to 2045/2046 and applied a 3.5% real discount rate as set out in the Green Book<sup>44</sup>.
- Future benefits have been derived by assuming all medical costs grow in-line with real GDP (i.e. NHS spending remains constant as share of GDP).
- Real wages are assumed to grow in-line with Office for Budget Responsibility forecasts to 2020. A trend rate of 1.5% is used thereafter<sup>45</sup>.
- We assume each clinical pharmacology consultant will first be employed for five years as a clinical pharmacology registrar. This period represents their training period.
- We have not allowed for any productivity improvements for the savings clinical pharmacologists deliver to the NHS. This is to add further conservatism to the estimates.

## Summary of costs and benefits

Over the next 30 years, the value of hiring an additional 78 clinical pharmacologists is estimated to exceed the cost in all scenarios. There is clear evidence that over a longer duration of time this proposal could make significant savings to the NHS. The below table summarises the savings attributable to the additional 78 clinical pharmacologists. As in the previous table, we include high, low and best estimates, based on the range of estimates developed.

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<sup>44</sup> HM Treasury [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/220541/green\\_book\\_complete.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf)

<sup>45</sup> OBR March 2016.

### Financial impact of additional clinical pharmacologists and associated registrars (net present value of impact over 30 years, 15/16 prices)

Impact category	High	Low	Best
ADRs events	£419m	£46m	£419m
Poisoning events	£101m	£10m	£101m
Prescription errors	£440m	£194m	£317m
De-prescribing	£59m	£59m	£59m
Non-adherence	£299m	£50m	£174m
<b>Total monetised savings</b>	<b>£1,318m</b>	<b>£360m</b>	<b>£1,070m</b>
<b>Total cost</b>	<b>£201m</b>	<b>£201m</b>	<b>£201m</b>
<b>Net present value</b>	<b>£1,118m</b>	<b>£159m</b>	<b>£870m</b>
<b>Benefit to cost ratio</b>	<b>6.6:1.0</b>	<b>1.8:1.0</b>	<b>5.3:1.0</b>

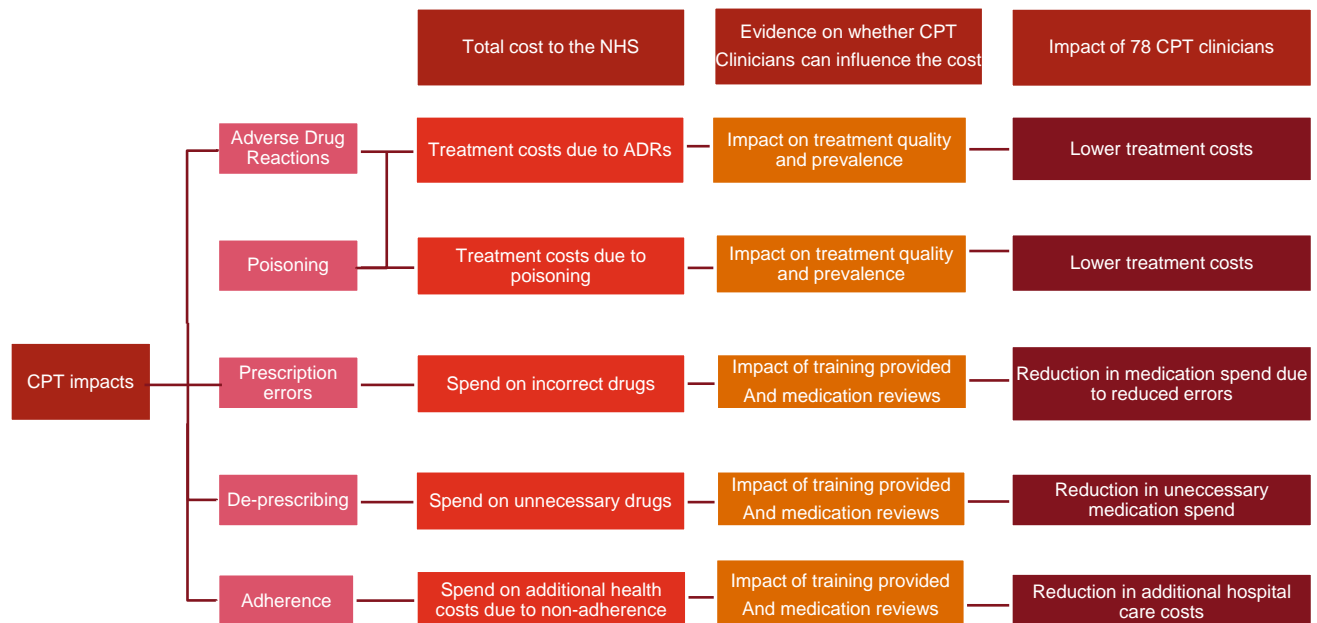
Source: PwC

These findings provide a strong case that clinical pharmacologists can have a significant benefit to the NHS. Recruiting clinical pharmacologists may result in not only patient and societal benefits, but also significant financial savings that more than offset their salary costs. It should also be noted we would expect these impacts to be scalable to some extent. Therefore, by hiring 150 clinical pharmacologists rather than 78, we expect both costs and benefits would be roughly doubled.

In order to reach the target of 78 additional clinical pharmacologists being recruited by 2025, the clinical pharmacology registrar workforce will need to grow by just under 16 individuals each year for the first five years. From year six onwards they would transition into consultants. This is a substantial increase relative to the current number of clinical pharmacologists in the NHS each year and it is recognised that this supply will not immediately be met. To meet these figures the NHS would need to prioritise attracting individuals to this profession and encourage hospitals to include the recruitment of clinical pharmacologists and registrars in their workforce strategies.

# Annex – Methodological summary

## Overview of approach



## Adverse Drug Reactions (ADRs)

Area	Approach	Value
<b>Hypothesis</b>	Clinical pharmacologists may reduce the number of in-patient spells for drug admissions relating to adverse drug reactions and reduce the average length of hospital stay for drug admissions.	NA
<b>Total cost to the NHS - low</b>	HES data on cost of ADR and poisoning inpatient admission costs, extrapolated from England to UK level.	£104m
<b>Total cost to the NHS – high</b>	Academic evidence that ADRs account for 6.5% of total hospital admissions <sup>46</sup> . As a result, studies have proposed that the potential cost of ADRs to the NHS may be £937m <sup>47</sup> .	£937m
<b>Evidence on clinical pharmacology clinician impact</b>	Econometric cross sectional regression (see detail below)	NA

<sup>46</sup> Pirmohamed, M. et al. ‘Adverse drug reactions as cause of admission to hospital: prospective analysis of 18820 patients’, *BMJ*, 2004, Jul 3; 329(7456): pp. 15–19.

<sup>47</sup> Frontier economics, Exploring the costs of unsafe care in the NHS, October 2014. Available at: <http://www.frontier-economics.com/documents/2014/10/exploring-the-costs-of-unsafe-care-in-the-nhs-frontier-report-2-2-2-2.pdf>, we have extrapolated their estimate from 2009 to 15/16 by applying the GDP deflator from 2009 to 2016.

<b>Impact of 78 clinical pharmacologists</b>	Derived from the regression coefficients – estimated to be a 2.6% improvement in outcomes.	£2.7m-£24.4m
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### Details of the regressions.

Data	Description	Source
Drug admissions	Total in-patient spells at each site due to adverse drug reactions, poisoning and toxicology issues	Hospital Episode Statistics
Drug admissions as a share of total	Total drug spells as a proportion of the total in-patient spells related to all illnesses	Hospital Episode Statistics
Average length of stay per drug admission	Average bed days due to drug related reasons	Hospital Episode Statistics
Number of clinical pharmacologists	This is the number of clinical pharmacology consultants and registrars	HSCIC data, updated following review by BPS
Index of Multiple Deprivation	We constructed a bespoke weighted IMD measure for each hospital trust based on the proportion of patients they received from each CCG, and the IMD level within the CCG of origination.	ONS
Proportion over 65 years old	We constructed a bespoke weighted age measure for each hospital trust based on the proportion of patients they received from each CCG, and the level within the CCG of origination.	ONS

We used two different dependent variables:

- Drug admissions as a share of total; and
- Average length of stay per drug admission.

We tested both univariate and multivariate regressions across 160 trusts. All regressions included clinical pharmacologists per admission as an explanatory variable. This was used rather than simply the number of clinical pharmacologists in order to control for the size of the hospital, as we would expect one clinical pharmacology consultant or specialist registrar in a small hospital would have a greater impact than one consultant or specialist registrar in a large hospital.

The multivariate regressions also used the deprivation and the proportion of people over 65 as control variables. The results identified a positive relationship between the presence of clinical pharmacologists and improved outcomes.

### Regression results

Dependent variable		Multivariate	Univariate
Drug admissions as a share of	T-stat	-1.80	-2.31

total	p-value	0.07	0.02
	Co-efficient	-34.9	-44.6
Average length of stay per drug admission	T-stat	-1.59	-1.44
	p-value	0.11	0.15
	Co-efficient	-4,165	-3,737

We note several limitations in this form of analysis:

- Generally, cross sectional analysis is sufficient to demonstrate correlation rather than causation.
- We would normally undertake panel data analysis on this type of data to test relationships over time. However, the HSCIC data on clinical pharmacology consultant and specialist registrar numbers has only recently been collected and no historic data is available.
- The statistical significance of the results from the average length of stay per drug admission regressions are slightly outside the normal 10% criteria that is applied.
- Many other factors influence the dependent variables tested, beyond those we were able to control for with our set of explanatory variables. As such, we would expect these results to suffer from omitted variable bias.

## Poisonings

Area	Approach	Value
<b>Hypothesis</b>	Clinical pharmacologists may reduce the number of in-patient spells for poisonings and reduce the average length of hospital stay.	NA
<b>Total cost to the NHS - low</b>	No additional value is estimated for inpatient costs to avoid double counting with the ADR and poisoning estimate from the HES statistics. This is combined with A&E costs estimated by combining the number of A&E attendances due to poisoning (164,400 in 2015 <sup>48</sup> ) with the average cost of an A&E attendance was (£124 in 2013-14 <sup>49</sup> ), and uplifting to 15/16 prices using the GDP deflator.	£23m (A&E only)
<b>Total cost to the NHS – high</b>	A&E estimates of £23m as in low estimate above. We combine this with inpatient costs. These are based on data from the National Poisons Information Service (170,000 patients were admitted to hospital due to poisoning <sup>50</sup> ). Combining this with the Average cost of a drug admission was £1,193 <sup>51</sup> , inflating to 2015/16 prices and extrapolating to the UK results in an estimated cost of £202m.	£226m
<b>Evidence on Clinical pharmacology</b>	Econometric cross sectional regression as described in ADR section.	NA

<sup>48</sup> <http://www.hscic.gov.uk/searchcatalogue?productid=20143&q=A%26E+attendance&sort=Relevance&size=10&page=1#top>.

<sup>49</sup> Based on average cost per A&E attendance of £125 (2013-14) and applying the GDP deflator to 2015-16.

[http://www.nuffieldtrust.org.uk/sites/files/nuffield/publication/election\\_briefing\\_urgent\\_care\\_in\\_crisis\\_final\\_web.pdf](http://www.nuffieldtrust.org.uk/sites/files/nuffield/publication/election_briefing_urgent_care_in_crisis_final_web.pdf).

<sup>50</sup> National Poisons Information Service – 2014/15 report.

<sup>51</sup> Health Episode Statistics - 2015/16 data.

**clinician impact**

<b>Impact of 78 clinical pharmacologists</b>	Derived from the regression coefficients as for ADRs – estimated to be a 2.6% improvement in outcomes.	£0.6m-£5.9m
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**Prescription errors**

Area	Approach	Value
<b>Hypothesis</b>	Clinical pharmacologists may be able to reduce the cost of drugs spent in error by educating other clinicians in better prescribing practices. This may result in reducing the inefficient spend on drugs.	NA
<b>Total cost to the NHS - low</b>	Total hospital prescriptions cost £6,688m in England in 2014/15 <sup>52</sup> . We inflated this to 2015/16 prices and extrapolated UK level. We then combined this with the low estimate of the share of prescription errors of 7% <sup>53</sup> .	£526m
<b>Total cost to the NHS – high</b>	As above but using higher estimate that 15% <sup>54</sup> of hospital prescriptions are in error.	£1,126m
<b>Evidence on clinical pharmacology clinician impact</b>	Evidence on the impact of educational initiatives on prescription error (a 17% <sup>55</sup> to 18% <sup>56</sup> reduction).	17%-18%
<b>Impact of 78 clinical pharmacologists</b>	Estimated by calculating the cost of prescription errors per inpatient admission and scaling the impact of educational initiatives for 78 clinicians. This uses the estimate that each clinical pharmacology clinician affects 31,000 patients. This is based on the number of patient spells per clinical pharmacology clinician in hospitals where they are present (estimated from the HES and HSCIC data used in the regression analysis).	£11m-£26m

**De-prescribing**

Area	Approach	Value
<b>Hypothesis</b>	Clinical pharmacologists may be able to reduce the cost of overprescribing unnecessary drugs by educating other clinicians to prescribe only necessary medicines. This tends to affect people over 65 years old with long-term conditions.	NA

<sup>52</sup> Health and Social Care Information Centre, Prescribing Costs in Hospitals and the Community, England 2014-15, November 2015. Available at:

<http://www.hscic.gov.uk/searchcatalogue?productid=19276&topics=1%2fPrescribing%2fHospital+prescribing&sort=Relevance&size=10&page=1#top>.

<sup>53</sup> EQUIP final report. [http://www.gmc-uk.org/FINAL\\_Report\\_prevalence\\_and\\_causes\\_of\\_prescribing\\_errors.pdf\\_28935150.pdf](http://www.gmc-uk.org/FINAL_Report_prevalence_and_causes_of_prescribing_errors.pdf_28935150.pdf) (accessed 3 Jan 2013).

<sup>54</sup> Franklin BD, Reynolds M, Shebl NA, et al. Prescribing errors in hospital inpatients: a three-centre study of their prevalence, types and causes. *Postgrad Med J* 2011;87:739–45.

<sup>55</sup> Campino A, Lopez-Herrera MC, Lopez-de-Heredia I, Valls-iSoler A. Educational strategy to reduce medication errors in a neonatal intensive care unit. *Acta Paediatr* 2009;98(5):782-785.

<sup>56</sup> Thomas AN, Boxall EM, Laha SK, Day AJ, Grundy D. An educational and audit tool to reduce prescribing error in intensive care. *Qual Saf Health Care* 2008;17(5):360-363.

<b>Total cost to the NHS</b>	Total hospital prescriptions cost £6,688m in England in 2014/15 <sup>57</sup> . We inflate this to 2015/16 and extrapolate to UK level. We take the subset of these prescriptions spent on over 65s with long-term conditions (41%) <sup>58</sup> . We then estimated the cost of overprescribing based on evidence that 3.6% of medicines are overprescribed to those over 65 years old and with a long-term condition <sup>60</sup> .	£110m
<b>Evidence on clinical pharmacology clinician impact</b>	Evidence on de-prescribing initiatives suggests that 27% of unnecessary prescriptions for those over 80 years old can be de-prescribed <sup>61</sup> .	27%
<b>Impact of 78 clinical pharmacologists</b>	There are approximately 31,000 in-patient admissions per clinical pharmacology physician. 16% of the in-patients are over 80 years old <sup>62</sup> . Therefore, there are approximately 1,500 in-patient admissions over 80 years old per clinical pharmacology clinician. Scaling the saving per admission by the number of people affected by 78 clinical pharmacology clinician yields the estimate.	£3.5m

## Adherence

Area	Approach	Value
<b>Hypothesis</b>	Clinical pharmacologists train other clinicians to prescribe simpler and more appropriate medication for patients. This is expected to make it easier for patients to take their medication and consequently reduce the cost of additional health requirements.	NA
<b>Total cost to the NHS</b>	Estimated health costs in 2009 due to non-adherence is £500m <sup>63</sup> . Converting to 2015/16 prices and extrapolating to the UK results in an estimated cost of £568m	£568m
<b>Evidence on clinical pharmacology clinician impact</b>	Studies on the impact of drug counselling and wider clinical advice given by clinical pharmacologists suggest that the potential improvement in non-adherence is 4% <sup>64</sup> - 24% <sup>65</sup>	4%-24%
<b>Impact of 78 clinical pharmacologists</b>	Total hospital in-patient admissions are 17.2m <sup>66</sup> . Adherence cost per admission is estimated to be £29. Combining with the number of patients a clinical pharmacology clinician can affect (31,000); based on training doctors and nurses at the hospital we calculate the impact estimate.	£2.9m-£17.4m

<sup>57</sup> Health and Social Care Information Centre, Prescribing Costs in Hospitals and the Community, England 2014-15, November 2015.

Available at:

<http://www.hscic.gov.uk/searchcatalogue?productid=19276&topics=1%2fPrescribing%2fHospital+prescribing&sort=Relevance&size=10&page=1#top>.

<sup>58</sup> The King's Fund, Long-term conditions and multi-morbidity. Accessed August 2015. Available at: <http://www.kingsfund.org.uk/time-to-think-differently/trends/disease-and-disability/long-term-conditions-multi-morbidity>.

<sup>59</sup> NHS England, Five Year Forward View, October 2014. Available at: <https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf>.

<sup>60</sup> <http://annals.org/article.aspx?articleid=737751>.

<sup>61</sup> Prescription review-post inpatient fall, Audit of a large West Midland Acute Hospital, Omer H1, Hodson J2,1, Pontefract SK1,2, Martin.

<sup>62</sup> <http://www.hscic.gov.uk/catalogue/PUB16719>.

<sup>63</sup> York Health Economics and The School of Pharmacy University of London. Evaluation of the Scale, Causes and the Costs of Waste Medicines. November 2010. Available at [http://eprints.pharmacy.ac.uk/2605/1/Evaluation\\_of\\_NHS\\_Medicines\\_Waste\\_web\\_publication\\_version.pdf](http://eprints.pharmacy.ac.uk/2605/1/Evaluation_of_NHS_Medicines_Waste_web_publication_version.pdf). Last accessed: May 2014.

<sup>64</sup> <http://amcp.org/WorkArea/DownloadAsset.aspx?id=16596>.

<sup>65</sup> <http://www.bmj.com/content/319/7210/612.full>.

<sup>66</sup> Health Episode Statistics 2015-16.



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