Economic analysis of the prevalence and burden of medication error in England

Supplementary appendix

Informing medication error prevalence

Search strategy

A rapid review carried out by the systematic review team was used as the initial starting point for evidence to support estimation of medication error prevalence and economic impact. Searches were conducted in PubMed (via US NIH), Embase (via Ovid), Cochrane Library (Wiley) including Health Technology Assessment, CINAHL (EBSCO host) from 2007 until September 2017. The search strategy comprised keywords for 'medication errors' following the review by Walsh et al (2017),[1] combined with keywords for 'incidence' and 'prevalence'. To be included, the studies had to be an UK observational study in English of any type of medication errors in any health care setting and reporting the prevalence of medication errors and/or their clinical impact. Studies were excluded if the data were only available in a conference abstract, and if the errors were related to over the counter medication or to patient adherence.

The rapid review only included studies since 2007 because it was a targeted review carried out to support DHSC policy and provide a summary of recent research in this area. However, for the purposes of the estimation of the prevalence and economic impact of medication errors, we have found it necessary to carry out further targeted searches of older work to support population of specific parameters. The use of older studies necessarily introduces uncertainty into our estimates as these data may not reflect current practice.

Evidence on medication error prevalence, by stage and setting, was obtained from the review and additional searches. Where more than one source was available, the studies were chosen based on:

1) Quality assessment as reported in the rapid review
2) Generalisability, where studies involving specific patient populations, types of medication, or providers (e.g. non-medical prescribing) were judged to be less generalisable, so were not included.
3) Format of data reporting, where only studies that reported the prevalence of error per opportunity for error were included (as opposed to per number of patients) to derive the overall number of errors, rather than the number of patients affected by medication errors.

Table S1 shows all studies identified in the review, whether they were used to inform the prevalence of errors, and where appropriate their reasons for exclusion. The justification for including or excluding studies is provided by sector and stage in the medicines use process, after Table S2.

Table S1. Summary of studies selected to inform the prevalence of errors.

Setting	Type of error	Excluded studies, with reasons for exclusion		Included
		Generalisability	Data format	

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Primary care; n=7 (8 citations)	Prescribing	People with dementia[2] Elderly adults[3,4] Middle-aged adults[5] Finite list of prescribing and monitoring errors[6]		Avery et al.[7]
	Dispensing			
	Monitoring	Finite list of prescribing and monitoring errors[6]		Avery et al.[7]
Care homes; n=6 (7 citations)	Prescribing	Intermediate care only[8] Residents with type II diabetes[9]	Barnett et al.[10] Parsons et al.[11]	Alldred et al.[12]
	Dispensing			Alldred et al.[12]
	Administration			Alldred et al.[12] Serrano Santos et al.[13]
	Monitoring			Alldred et al.[12]
Secondary care; n=23 (of which 4 in transition care)	Prescribing	Paediatric cohort[14-16] Elderly adults with chronic kidney disease[17] Antimicrobial-related incidents[18] Opioid prescribing[19] Non-medical prescribing[20] Professional category of prescriber not stated[21,22] Newly qualified doctors[23] Old study superseded by more recent data[24]		Ashcroft et al. - 8.8 %[25] Seden et al. - 10.9 %[26]
	Dispensing			James et al.[27]
	Administration	Mental health[28,29] Antimicrobial-related incidents[18] Patients with dysphagia[30]		
	Monitoring	Antimicrobial-related incidents[18]		
	Transition	Insulin-related errors[31] Mental health[32] Older patients[33] Pharmacist written discharges[33]		

Two studies reporting the prevalence of administration errors in care homes were identified. The study by Alldred et al.[12] was used in the baseline analysis, as it also reported prescribing, dispensing and monitoring errors, as well as severity of each type of error. The second study was used in sensitivity analysis.[13]

Similarly, two studies reported the prevalence of prescribing errors in secondary care. The larger of the two studies was used as the baseline,[25] while the smaller was used in sensitivity analysis.[26]

Extrapolation of published error rates to national estimates

The parameters used to extrapolate the error rates are presented in Table S2.

Table S2. Parameters used to extrapolate error rates in Table 1 to the population of England

Setting	Parameters used to derive the number of errors per year in England	Value	Source	Expected effect of the assumption on the result
Care homes	Total number of items dispensed for patients in care homes	35,942,400	416,000 people live in care homes.[34] Patients take mean 7.2 medicines.[12] Each item is dispensed 12 times (assumption to take into account that items are prescribed multiple times).	Overestimate: The assumption that each time is dispensed 12 times is likely to be an overestimate given that some medication may not be repeated every month (e.g. medication to be used when required).
	Total number of items administered in care homes	1,093,248,000	416,000 people live in care homes.[34] Patients take mean 7.2 medicines.[12] Assume each prescribed medicine is administered once daily.	Underestimate: The assumption that all medication is administered once daily is likely to be an underestimate because some medication are taken twice a day or more.
Primary care	Total number of items dispensed in primary care (excluding care homes)	1,068,157,600	1,104 million items dispensed in primary care in 2016.[35] 35,942,400 of those are dispensed for patients in care homes.	Underestimate: The assumption that the number of items dispensed corresponds to the number of items prescribed is likely to be an underestimate because patients may choose not to have their medication dispensed.
	Number of acute medicines dispensed in primary care (excluding care homes)	245,676,248	23% of prescribed items are for acute medication.[36]	Not an assumption.
	Number of repeat medicines dispensed in primary care (excluding care homes)	822,481,352	Total number of items – number of acute items. (see above)	Calculation.

Secondary care	Number of items dispensed to inpatients every year	44,724,144	9,364,860 hospital admissions in the year 2015 to 2016 (16,251,841 admissions including elective, non-elective and day cases - 6,886,981 day cases.[37] 4.78 items prescribed per inpatient.[25]	Calculation.
	Number of patients discharged from hospital every year	16,251,841	Finished admission episodes reported in 2015-16. [37]	Overestimate: The assumption that the number of patients discharged from hospital every year corresponds to the number of finished admission episodes is likely to be an overestimate because some finished admission episodes correspond to patients who died at hospital.
	Number of items administered in hospitals every year	199,478,714	131,072 hospital beds are available in England.[38] 47,841,280 bed days per year (131,072*365) The average bed occupancy in the NHS was 87.23%.[38] 4.78 items are prescribed per inpatient.[25] Assume each patient takes each medicine once daily	Underestimate: The assumption that all medication is administered once daily is likely to be an underestimate because some medication are taken twice a day or more.

Extrapolation methods used in primary care, secondary care and care homes are described below.

Primary care errors

Primary care prescribing errors

To estimate prescribing errors in primary care, the prescribing error rate reported in a UK study was extrapolated using national dispensing data because there are no national data for prescribing volume.

National dispensing data

According to NHS Digital information, 1.10 billion items were dispensed in primary care in 2016.[35] It is unlikely that 100% of prescribed items are dispensed. Since we have no equivalent national estimates of prescribing rates, we assumed that the prevalence of errors in prescribed and dispensed items are

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similar. The estimate 1.10 billion includes items dispensed for patients who live in care homes. In our analysis, the prevalence of errors in care homes was calculated separately, and so the items dispensed for care homes were excluded from the analysis of errors in primary care. We estimated that 35,942,400 items are dispensed for care homes annually (for details see Section “Deriving a national annual estimate for care home errors”). Therefore, we estimate that 1,068,157,600 items were dispensed for ambulatory patients in primary care in 2016.

Acute versus repeat prescribing
In the UK, most NHS patients receive medicines intended for long-term use as "repeat prescriptions". These are prescription items that are generated without the need for a consultation from a list of authorised repeat medicines. Previous work suggests that only 23% of prescribed items are for acute medication (where only one prescription is issued, such as for a course of antibiotics), as the vast majority of prescriptions issued are repeat prescriptions for long-term chronic health conditions.[36] Extrapolating this to the national dispensing data suggests that 245 million of the items dispensed for ambulatory patients are acute, while 822 million are repeats.

Prevalence of errors
The prevalence of errors was derived from the PRACtICe study,[7] the only study of prescribing errors in primary care identified in Review 1 that included a mixed patient population (in terms of demographics and therapeutic areas). In the study, 2% patient records (1777 patients) from 15 general practices were reviewed to identify prescribing and monitoring errors. In total, 6048 unique items prescribed to 1200 patients were reviewed during the 12-month retrospective review of their records. Unique items refer to items that were prescribed at least once. When a medicine was prescribed for the same patient multiple times, only the most recent prescription for that medicine was considered. Of the 6048 items, 2929 were acute prescriptions, while 3119 items were unique repeat prescriptions.

The authors did not report how many prescriptions were issued in total for the 1200 patients. Therefore, we do not know how many times each repeat medicine was prescribed or dispensed. Assuming that the ratio between acute and repeat prescriptions in the practice study were the same as that reported by Petty et al. [36], then the 2929 acute items would comprise 23% of all items, and the total number of items prescribed in the PRACtICe study (when each repeat prescription is counted as a separate item) can be estimated to be 12,734.

In the PRACtICe study, 247 (4.08%) of the 6048 unique items were found to contain at least one prescribing error. The authors did not report the error rates in acute and repeat prescriptions separately, nor whether prescribing errors in repeat items perpetuated through every subsequent repeat.

Number of errors
We applied the 4.08% rate of errors to the number (1.068 billion) of dispensed items to estimate the total number of prescribing errors in primary care, assuming that any prescribing errors that occurred for a chronic treatment perpetuated through every subsequent repeat.

We also explored an alternative assumption, that errors occurred only in unique items, i.e. in acute items and one issue of each repeat, and that all subsequent repeats are free of error. If all such errors were captured in the PRACtICe study and the total number of items prescribed during the study period was 12,734, then the prevalence of errors across all items would be 1.94% (247/12,734). This prevalence was then applied to all dispensed items (1.068 billion) to estimate the total number of prescribing errors under this alternative assumption.

Primary care dispensing errors

To estimate dispensing errors in primary care, the dispensing error rate in primary care reported in a UK-based study was applied to the 1.068 billion items dispensed for ambulatory patients in primary care in 2016, estimated in the previous section.[39]

Review 1 did not identify any studies on the dispensing error rates in primary care. Therefore, the study by Franklin and O'Grady [39] was used on advice from our expert advisory panel (personal communication, Bryony Dean Franklin). Franklin and O'Grady identified dispensing errors by checking 2,859 items that had undergone the dispensing process and were ready to be collected by patients, against corresponding prescriptions. The study conducted in 15 UK pharmacies found that 3.1% of the items were found to contain at least one dispensing error.

Primary care monitoring errors

The prevalence of monitoring errors in primary care was derived from the PRACtICE study.[7] As described in the 'Primary care prescribing errors' section, the study was conducted in 2% of the patient population in 15 general practices in the UK. Medical records of 1777 patients were reviewed retrospectively, and 770 items that required blood monitoring were identified. All 770 items were repeat medication. Fifty-five monitoring errors were identified; this comprised 7.14% of all repeat medication requiring monitoring. However, we had no data regarding the prescribing error rate for the items that require monitoring nationally. We estimated that 7.14% of all repeat medication requiring monitoring would equate to 1.76% of all repeat items and applied this estimate to the 822 million items estimated to be dispensed nationally. By doing this we assumed that each monitoring error perpetuates through each repeat.

Secondary care (hospital) errors

Secondary care prescribing errors

Out of 11 studies on prescribing errors in secondary care, only one study by Ashcroft *et al*. [25] included patients from a range of therapeutic areas and prescribers with different levels of experience. Therefore, it was used to derive the national estimate of the prevalence of errors in secondary care. It was a UK-based study where pharmacists recorded all errors in newly prescribed or written inpatient medication orders. The study was conducted in 20 hospitals, and included 124,260 medication orders prescribed to 26,019 patients over seven prospectively selected days. The authors found that 8.8% of medication orders had at least one prescribing error.

Extrapolating the rate of errors requires an estimate of the annual number of medication orders in secondary care in England. These data are not available. Therefore, we estimate the annual number of medication orders from known annual hospital admission rates and reported numbers of items prescribed per patient admission. In England, there were 9,364,860 hospital admissions (finished admission episodes elective and non-elective, excluding day cases) in the year 2015 to 2016.[40] Using the rate of a mean of 4.78 items prescribed per inpatient,[25] this equates to an estimated 44,724,144 items prescribed annually in secondary care.

Secondary care dispensing errors

Review 1 in this report identified one study reporting dispensing errors in secondary care.[41] The authors reported the proportion of all dispensed items, which patients and health professionals reported to contain an error after they left the pharmacy. The authors reported that 0.016% of the dispensed items were reported to contain an error. As this is a retrospective incident reporting study, this is likely to be an underestimate of the total prevalence of errors. Therefore, the number of dispensing errors in secondary care was derived by extrapolating the dispensing error rate in primary care to the number of items dispensed in secondary care (personal communication, Bryony Dean Franklin).

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The rate of errors in primary care is 3.1% of all dispensed items.[39] The number of medication items dispensed annually in secondary care in England is not known. Therefore, it was assumed to be equivalent to the total number of items prescribed in secondary care, estimated to be 44,724,144 earlier in this section.

Secondary care transitional errors

Transitional errors represent errors due to miscommunication between different settings. There is very little evidence around transitional error rates other than inaccurate prescribing of patients' regular medication on admission to hospital, inaccurate prescriptions on discharge from hospital, and failure of GPs to continue hospital-initiated treatment post-discharge. Therefore, we have only considered transitional errors in the secondary care setting. It is likely that this underestimates the true rate of transitional errors.

Accuracy of hospital prescribing on admission was measured in the study by Ashcroft et al. 2015 [25], therefore these errors are captured in the estimate of prescribing errors in secondary care.
Review 1 identified one study that included a patient population representative of the general population so this study was used to estimate the total number of errors [42]. The authors found that 20.8% of 259 discharge prescriptions contained an error.

The total number of errors was calculated by applying this error rate to the total number of patients discharged from hospitals in England. These discharge data are not directly available. In our estimation of errors, we used total number of finished admission estimates to estimate total hospital discharges (16,251,841 FAEs in 2015-16)[40], assuming that all discharged patients had a prescription, of which 20.8% were assumed to contain an error.

The review did not identify any studies that measured errors that occur in primary care due to failure to adopt changes recommended by the hospital. The PRACtICe study reported discrepancies between hospital discharges and subsequent medication prescribed by the GP.[7] They reported that, out of 87 medicines newly prescribed by the hospital, 21 were not continued by the GP; however, it is not clear whether these decisions were errors or intentionally omitted by the prescriber. The findings from the PRACtICe study were thus not included in the analysis.

Secondary care administration errors

On advice from our expert panel, we used a systematic review of medication administration errors in secondary care to estimate the rate of errors.[43] The review reported 87 studies on administration errors published internationally between 1985 and 2015. Five studies in the review were conducted between 2007 and 2015 and set in different inpatient populations (surgical, paediatrics, geriatric, stroke, dementia) in the UK.[15 29 30 44 45] The five studies were pooled and their mean administration errors rate was 18.64% of administered doses.

Extrapolating the rate of errors requires an estimate of the annual number of administered doses in England. These data are not directly available. We estimated annual number of administered doses from known number of overnight beds and reported numbers of items prescribed per patient admission. In England there are 131,072 hospital beds,[38] which can approximate to 47,841,280 bed days per year (131,072*365). We used NHS England data to estimate the average bed occupancy in NHS hospitals in England. Based on the number of available and occupied beds in each quarter we estimated that the average occupancy was 87.23%.[46] From this, we estimated that the number of occupied bed days per year was 41,731,948. Ashcroft et al.[25] reported that 4.78 items are prescribed per inpatient. These data can be used to generate an approximate estimate of 200,313,353 administered doses annually in secondary care. This is likely to be an underestimate of administered doses.

Secondary care monitoring errors
Review 1 did not identify any studies on monitoring errors in secondary care, and so findings from the PRACtICe study (in monitoring in primary care) were used, where 1.76% of medicines for chronic conditions were found to contain a monitoring error.

The rate of 1.76% was extrapolated to 77,614,580 items estimated to be prescribed for inpatients annually. Use of this value to estimate number of secondary care monitoring errors is likely to be associated with high levels of uncertainty. It is difficult to predict whether this value is an under- or over-estimate. The medicines prescribed in secondary care and nature of conditions that require admission mean that the need for monitoring is likely to be higher in secondary care than in primary care, suggesting that this estimate is an underestimate. Conversely, the higher availability of routine monitoring in secondary care suggests that it could be an overestimate.

Errors in care homes

In Review 1, six studies were found to measure the prescribing error rates in care homes.[10-13 47 48] One study (CHUMS) included a mixed patient population (as opposed to patients with specific conditions) and provided estimates of prescribing, dispensing, administration and monitoring errors, both in nursing and residential homes.[12] The estimates from this study were used to estimate the number of errors in care homes in England. The study included 1843 medicines taken by 256 patients (mean: 7.2 medicines per patient) in 55 care homes in the UK. The methods for measuring the rates of errors and extrapolating them are described for each type of error individually.

Care home prescribing errors
In the CHUMS study, 1843 medicines were reviewed and 8.3% of the items were found to contain a prescribing error. The error rate was extrapolated to the items prescribed nationally in care homes every year, derived from the total number of people reported to live in care homes and the average number of medicines taken by care home residents.

ENRICH 2017 cite the results of the Laing and Buisson survey, 2016, that 416,000 people lived in care homes in 2016. If each resident takes 7.2 medicines,[12] this amounts to 2,995,200 items taken by care home residents. Some of these 2,995,200 medicines are repeat medication, and they are prescribed multiple times every year. We did not have an estimate of how many times each item is prescribed annually, and so we assumed that each medicine is prescribed 12 times per year (i.e. monthly). This amounts to 35,942,400 items prescribed and dispensed for care homes annually.

Care home dispensing errors
The authors of the CHUMS study visually inspected the dispensed items against the prescription to identify any medication errors [12]. Errors were identified in 9.8% of the items. The total number of dispensing errors in care homes was derived by applying the rate of care home errors (9.8%) to the total number of medicines taken by care home residents (35,942,400) derived in the previous section.

Care home administration errors
In the CHUMS study two medication rounds were observed for each patient in the study and 8.4% of administered doses were found to contain an error [12]. This suggests that, if a patient takes one medicine daily, the expected number of administration errors per year would be 31 (8.4% of 365).
We had no data on the number of doses administered to care home residents annually. Therefore, we assumed that each medicine was administered once daily to provide a conservative estimate. If 2,995,200 medicines are administered once daily, the total number of doses administered annually is 1,093,248,000. The total number of errors was derived by applying the rate of errors to this estimate of annually administered doses.

Care home monitoring errors

The monitoring error rate in the CHUMS study was found to be 1.74% (of all medicines).[12] The rate was extrapolated to the derived number of medicines prescribed to care home patients.

Number of opportunities for error by stage and setting in the NHS in England

Table S3 summarises the estimated number of opportunities for error by stage and setting for the whole of England in one year.

Table S3: Estimated number of opportunities for error in the NHS in England (2015-16)

Stage in the medication use process	**Setting**		
	Primary care	**Care homes**	**Secondary care**
Prescribing	1,068 million	35.9 million	77.6 million
Transition	Not available	Not available	16.251 million
Dispensing	1,068 million	35.9 million	77.6 million
Administration	Not included	151.8 million	199.5 million
Monitoring	822 million	35.9 million	77.6 million

Estimating proportion of medication errors likely to cause minor, moderate or severe harm

Five of the studies we used to estimate error prevalence assessed the proportion of errors with potential to cause minor, moderate or severe harm.[7 25 27 49 41] The studies used different methods to assess the severity of errors:

Avery et al[7] and Frankly and Grady[49] assessed errors according to the judgement of a panel of experts using a visual analogue scale from zero to 10. Errors with scores <3 were classified as minor, 3-7 as moderate and >7 as severe. In Ashcroft et al, a panel of clinicians and pharmacies classified errors as minor, significant, serious and potentially lethal.[25] The former two categories were assumed to be comparable to minor and moderate errors, respectively, while the latter two were assumed to be severe. In Haw et al, three researchers classified errors as doubtful or negligible importance; likely to result in minor adverse effects or worsening condition, likely to result in serious effects or relapse, and likely to result in fatality.[29] The former two categories were assumed to be comparable to minor and moderate errors, respectively, while the latter two were assumed to be severe. In James et al pharmacists who identified errors used a standardised matrix to categorised them as no harm, minor harm (non-permanent harm, or increased length of stay or level of care for up to 7 days), moderate harm (semi-permanent harm, 3-15 people affected, or increased length of stay or level of care between 8 and 15 days), severe harm (major permanent harm, 16-50 people affected, or an increased length of stay or level of care for more than 15 days), and catastrophic (death or more than 50 people affected at one time, e.g. vaccination errors).[27] In this paper no and minor harm, and severe and catastrophic harm were pooled.

In summary, we have judged the methods to be broadly comparable.

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Burden of ADEs occurring in primary care: scenario analysis methods

Scenario analysis: Admissions to intensive care

There were no UK studies reporting the impact of ADEs on ICU admissions. A French observational study assessed how many adult ICU admissions were caused by ADEs.[50] Admissions to ICU were assessed for causality and classified as avoidable or unavoidable. Of 743 ICU admissions, 60 (8.1%) were due to avoidable ADEs (excluding those due to non-adherence (n=31) and self-medication (n=11)). The median LOS *within* the ICU associated with an ADE was 4 days with a 14% unit mortality rate. The error rate and LOS were applied to the total number of critical care FAEs recorded in the NHS in 2015/16 to estimate the burden of errors treated in ICU.

Scenario analysis: Accident and emergency visits

No UK studies were found that examined A&E visits (not resulting in a hospitalisation) due to medication errors occurring in primary care. A German prospective observational study investigated adult non-trauma A&E attendances related to ADEs.[51] ADEs were classified in terms of causality, predictability, and avoidability. Of 2262 adult non-trauma attendances, 366 (16.2%) were related to ADEs, 20.5% of which were avoidable.[51] Results were not reported separately for admitted and non-admitted attendances so this was estimated using national data for England. In 2015/16 in England, 79.8% of A&E attendances did not result in a hospitalisation.[52] These values were combined with the German data to estimate the burden of avoidable errors resulting in A&E attendances.

Scenario analysis: Primary health care contact

No UK studies were found that examined primary care resource use (not resulting in an A&E visit or hospitalisation) due to primary care medication errors. Avery et al.[7] estimated that 12% of patients registered at a primary care practice in England experience prescribing or monitoring errors of which, 54% and 3.6% could lead to moderate or serious harm, respectively. In previous work modelling the impact of six clinically important medication errors, the probability of an error requiring a GP visit was estimated to be the midpoint between 2.03% and 15.41% (6.0%).[53] These errors were assumed to be of similar clinical significance in both studies and were combined with the number of people registered with a general practice in England in April 2016[54] (i.e. those at risk of an error) to provide an estimate of primary health care burden due to medication errors occurring in primary care.

Burden of ADEs occurring in secondary care: scenario analysis methods

Scenario analysis: post-discharge resource use associated with ADEs occurring in secondary care

Parkeh et al reported that 37.0% of over 65s who are discharged from a non-elective hospital admission experienced some medication-related harm in the following 8 weeks, 74.0% of which were related to a prescription issued in secondary care.[55] The authors also reported that 4.6% of medication-related harm involved a medication error (3.4% medication error alone; 1.2% ADE plus medication error). Therefore 1.3% (i.e. 4.6% of 74.0% of 37.0%) of non-elective admissions were associated with a medication error. Of these medication errors, 74.4% required some type of healthcare resource use. This included GP consultations (71.7%), outpatient clinic attendances (2.7%), and out-of-hours visits (1.8%). These estimates were applied to the number of non-elective admissions, excluding obstetrics and paediatrics, in 2015/16.

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Sources of unit costs used to generate national estimates of burden

Unit costs, extrapolation parameters and their sources used in estimations are presented in Table S4.

Table S4: Unit costs, extrapolation parameters and their sources used in estimations

Parameter	Value	Source
Unit costs		
Excess bed day cost • non-elective • elective • Mean Cost per non-admitted A&E attendance Cost per (adult) critical care (ICU) admission Mean non-elective inpatient stay: 5 days Per additional day	 £298 £362 £330 £140 £1307 £3058 £298	NHS reference costs[40]
GP visit	£36	PSSRU [56]
Outpatient clinic visit	£117	NHS reference costs[40]
Out-of-hours visit	£70	Estimated as half cost of A&E visit
Number of episodes in England per annum (2015-16)		
Finished admission episodes (FAEs) Elective and non-elective FAEs excluding obstetrics and paediatrics Elective and non-elective FAEs excluding obstetrics, paediatrics, and day cases Non-elective FAEs excluding obstetrics and paediatrics Critical care FAEs	16,251,841 8,464,215 4,443,564 5,821,746 12,926	NHS Digital[37]
A&E attendances % A&E visits leading to admissions If 79.8% non-admitted	20,457,805 20.2% 16,325,328	NHS Digital[52]
People registered at a GP practice	57,631,776	NHS Digital[54]

A&E: accident and emergency; FAE: finished admission episodes, PSSRU: Personal Social Services Research Unit

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Table S5: Estimated national burden associated with primary and secondary care errors (base case and alternative scenarios)

Base case and higher cost scenarios	**Cost (£)**	**Bed days/year**	**Deaths**
Base case (hospitalisations linked to definitely avoidable primary care ADRs and definitely avoidable ADRs during overnight hospital admissions)			
• Hospitalisations due to primary care ADRs (base case and lowest cost estimate) • 2.3% of ADRs directly result in death • 9% of ADRs definitely avoidable	83,673,627	136,811	627
• ADRs during overnight inpatient admissions (14.7% error rate); 4 days added to length of stay for 26.8% of patients with an inpatient ADR; £330 for each day added to admission; • 0.38% of all admissions result in a death for which an ADR was a **contributing factor** • 0.03% of all admissions result in a death **caused by** an ADR* • 53.36.4% of ADRs definitely avoidable	14,788,955	44,815	1,081 85*
Total (base case)	98,462,582	181,626	1,708[(1)]
Alternative base case scenarios			
Scenario 1a: (base case + probably avoidable ADRs during overnight admissions - 14.7% error rate, 53.3% definitely or probably avoidable)			
• Hospitalisations due to primary care ADRs • ADRs directly resulting in death • 72% of ADRs probably or definitely avoidable	605,298,575	989,697	5,013
• ADRs during overnight inpatient admissions • Deaths for which inpatient ADR was a **contributing factor** • 53.3% of ADRs probably or definitely avoidable	123,164,262	373,225	9,000
Total (Scenario 1a)	728,462,837	1,362,922	14,013
Scenario 1b: (base case + definitely avoidable ADRs during day case admissions)			
• ADRs during all inpatient admissions • Deaths for which inpatient ADR was a **contributing factor** • 6.4% of ADRs definitely avoidable	28,170,381	85,365	2,058
Total (Scenario 1b)	111,844,008	222,176	2,685
Cumulative burden scenarios			
Scenario 2: (base case + cost of primary care contacts for 6.0% of primary care errors)			
Total (Scenario 2)	107,066,960	181,626	1,708
Scenario 3: (base case + A&E attendances for primary care medication errors)			
Total (Scenario 3)	174,365,564	181,626	1,708

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Scenario 4: (base case + ICU admissions related to ADEs)			
• ICU admissions related to preventable ADEs (8.1% of ICU admissions); length of ICU stay 4 days; £5228 per ICU admission • Death during ICU admission (14% of ICU admissions for preventable ADEs)	5,473,747	4,188	147
Total (Scenario 4)	103,936,329	185,814	1,855
Scenario 5: (base case + primary care costs (6.0% of errors) + A&E attendances for primary care errors + ICU admissions related to ADEs)			
Total (Scenario 5)	188,443,689	185,814	1,855
Scenario 6: (base case + post-discharge costs for secondary care errors)			
Total (Scenario 6)	100,164,827	181,626	1,708
Scenario 7: (highest cost scenario)			
• definitely or probably avoidable ADRs (3.74% of admissions), admission length 14.25 days, primary care costs for 15.41% of errors, and A&E attendances for primary care medication errors	1,364,012,168	3,102,700	5,013
• definitely or probably avoidable inpatient ADRs (including day cases)	234,606,454	710,929	17,143
• ICU admissions related to ADEs	5,473,747	4,188	147
• post-discharge costs for secondary care errors	1,702,245	-	-
Total (Scenario 7)	1,605,794,614	3,817,817	22,303

(1)The base case estimate includes deaths in which an ADR was a contributing factor rather than the direct cause.

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